Agriculture and Allied Science

Restructured and Revised Syllabi of Post-graduate Programmes

Volume 3 - Social Science

- Agricultural Economics
- Agricultural Statistics
- Agricultural Extension Education
- Agri-Business Management

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Compiled By

Dean & Director of Instruction Co-Ordination Committee of SAU's 2022-23

Restructured and Revised Syllabus of

Post-graduate Programme

Masters and Doctoral Degree
in
Agricultural Economics

(As per B.S.M.A. Recommendations - 2022)

CONTENTS

Implementation of New Curriculum

The universities offering PG programmes in Agricultural Economics need to be supported for establishing specialized laboratories equipped with state-of-the art equipments for conducting practical classes especially, Econometrics, Production Economics, Linear Programming & Statistics.

One-time catch-up grant should be awarded to each SAU, offering PG programmes in Agricultural Economics for meeting expenditure for upgrading the course requirements.

Faculty training and retraining should be an integral component. For imparting total quality management, a minimum of two faculties in each department under an SAU should be given on job training in reputed national and international institutes. To execute the new PG and Ph.D. programmes in Agricultural economics discipline in effective manner, special funds from ICAR would be required for outsourcing of faculty from Indian/Foreign Universities for some initial years.

The already existing M.Sc. and Ph.D. Programmes in Agricultural economics with the recommended M.Sc. & Ph.D. programme by Vth Deans Committee for admission and employment.

Expected Outcome

- Revamping of post graduate programme in whole agricultural economics throughout the country.
- Imparting quality education.
- Development of technical manpower to cater the need of governments, corporate sector and research organization in India and abroad.
- Exposure to the faculty in the latest technical knowhow.

Committee on Social Science

ICAR-BSMA Broad Subject	ICAR-BSMA Approved Disciplines	Degree Programmes		Broad Subject Coordinator (Chairman of all Disciplines' Sub-Committees	Discipline Coordinator (Subject Coordinator of respective Discipline)
Social Science	Agri-Business Management	M.Sc. (Agri.)	Ph.D.	Dr. P.A. Sawant Head, Dept. of Extension Education Dr.BSKKV, Dapoli	Dr. B.N. Pawar Asso. Prof., CoA, Pune MPKV, Rahuri
	Agricultural Economics	M.Sc. (Agri.)	Ph.D.		Dr. D.S. Perke Head, Dept. of Agril. Economics, VNMKV, Parbhani
	Agricultural Statistics	M.Sc. (Agri.)	Ph.D.		Dr. Vilas Wani/ Dr. M.R. Patil Head (Stat.), MPKV, Rahuri
	Agricultural Extension Education	M.Sc. (Agri.)	Ph.D.		Dr. Milind Ahire Head, Dept. of Extension Education, MPKV, Rahuri

The following committee appointed as discipline Co-Ordinator to revised PG and Ph.D. Syllabi of Agricultural Economics as per BSMA Report

Committee on Agricultural Economics

Sr. No.	Name of the Scientist	Name of the University	Designation
1	Dr. D.S. Perke Head, Dept. of Agril. Economics	VNMKV, Parbhani	**Chairman**
2	Dr. N.V. Shende Head, Dept. of Agril. Economics & Statistics	Dr. PDKV, Akola	**Member**
3	Dr. R. B. Hile Head, Dept. of Agril. Economics	MPKV, Rahuri	**Member**
4	Dr. S. R. Torne Head, Dept. of Agril. Economics	Dr. BSKKV, Dapoli	**Member**
5	Dr. V. A. Thorat Associate Professor, Dept. of Agril. Economics	Dr. BSKKV, Dapoli	**Member**
6	Dr. R. V. Chavan Associate Professor, Dept. of Agril. Economics	VNMKV, Parbhani	**Member**
7	Dr. P. J. Kshirsagar Associate Professor, Dept. of Agril. Economics	Dr. BSKKV, Dapoli	**Member**
8	Dr. Vanita K. Khobarkar Assistant Professor, Dept. of Agril. Economics & Statistics	Dr. PDKV, Akola	**Member**
9	Dr. G. G. Joshi Assistant Professor, Dept. of Agril. Economics	MPKV, Rahuri	**Member**
10	Prof. S.H. Kamble Associate Professor, Dept. of Agril. Economics	VNMKV, Parbhani	**Member**
11	Dr. R.D. Shelke Associate Professor, Dept. of Agril. Economics	VNMKV, Parbhani	**Member**
12	Dr. S. S. More Associate Professor, Dept. of Agril. Economics	VNMKV, Parbhani	**Member Secretary**

Organization of Course Contents & Credit Requirements

Minimum Residential Requirement:

M.Sc.: 4 Semesters

Ph.D.: 6 Semesters

Name of the Department / Division

- Agricultural Economics

Nomenclature of Degree Programme

(a) M.Sc. Programme

M.Sc. (Agri.) Agricultural Economics

(b) Ph. D. Programme

Ph.D. (Agri.) Agricultural Economics

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600- series to Doctoral level.
- Credit Seminar for Master's level is designated by code no. 591, and the Two Seminars for Doctoral level are coded as 691 and 692, respectively
- Deficiency courses will be of 400 series.
- Master's research: 599 and Doctoral research: 699

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not obviously exclude such a reference material that may be recommended according to the advancement and local requirement.
- A list of international and national reputed journals pertaining to the discipline is provided at the end which may be useful as study material for 600/700 series courses as well as research topics.
- Lecture schedule and practical schedule has also be given at the end of each course to facilitate the teacher to complete the course in an effective manner.

Eligibility for Admission

- **Master's Degree Programme**

(i) **B.Sc. Agri. (4 year programme)/B.Sc. (Hons.) Agriculture**

B.Sc.(Agri.) / B. Sc. (Hons.) Agriculture/ B. Sc. (Hort.)/ B.Sc. (Hons.) Horticulture/ B.Sc.(Forestry) / B. Sc. (Hons.) Forestry / BBM (Agri.) / B.Sc. (ABM) / B.Sc. (Hons.) Agri. Business Management/ B.B.A. (Agri.) or equivalent degree with four years duration of Agriculture related Universities and having the Common Entrance Test in Agriculture conducted by competent authority.

(Note:- In case B.Sc. Agri./B.Sc. (Hons.) Agriculture candidates are not available, B.Sc. (Hort.)/ B.Sc. (Hons.) Horticulture/ B.Sc.(Forestry) / B. Sc. (Hons.) Forestry / BBM (Agri.) / B.Sc. (ABM) / B.Sc. (Hons.) Agri. Business Management/ B.B.A. (Agri.) may be considered subject to completion of deficiency courses)

- **Doctoral Degree Programme**

(i) Master Degree in the concerned Department/Discipline of Agricultural Economics and having appearing the Common Entrance Test of Agricultural Economics subject conducted by competent authority.

Sr. No	**Name of Department**	**Specialization in Ph. D**	**Eligibility criteria**
1.	Agricultural Economics	Ph.D.(Agri.) Agricultural Economics	M.Sc.(Agri.)Agricultural Economics

Credit Requirements

Course Details	**Masters Degree**	**Doctoral Degree**
Major Courses	20	12
Minor Courses	08	06
Supporting / Optional	06	05
Common PGS Courses	05	-
Seminar	01	02
Research	30	75
Total	**70**	**100**

M.Sc. (Agri.) Agricultural Economics
Course Structure

LIST OF CORE COURSES / DEPARTMENT WISE SPECIALIZATION / COMPULSORY / SUPPORTING COURSES

1. M.Sc. (Agri.)Agricultural Economics

Course Code	Semester	Course Title	Credit Hrs.
AEC 501*	I	Micro Economic Theory and Applications	3(3+0)
AEC 502*	II	Agricultural Production Economics	2(1+1)
AEC 503*	II	Agricultural Marketing & Price Analysis	3(2+1)
AEC 504*	I	Macro Economics and Policy	2(2+0)
AEC 505*	II	Econometrics	3(2+1)
AEC 506	II	Agricultural Development and Policy Analysis	2(2+0)
AEC 507*	I	Agricultural Finance and Project Management	3(2+1)
AEC 508*	III	Linear Programming	2(1+1)
AEC 509*	I	Research Methodology for Social Sciences	2(1+1)
AEC 510	III	Indian Economy: History and Contemporary Issues	2(2+0)
AEC 511	III	International Economics	2(1+1)
AEC 591*	III	Master's Seminar	1 (0+1)
Total			19+08=27
AEC 599		Master's Research	0+30

***Compulsory Courses**

a. It is suggested the student may choose at least two out of three courses listed above as part of minor courses as these are related to policy advocacy and aim to build larger understanding of the subject.

b. Further, it is suggested that the student may also opt to choose the remaining Courses from any other discipline including the disciplines of Agricultural Extension Education, Agronomy, Horticulture, Animal Husbandry and Dairy Science, Agri. Business Management and are related to the research problem selected by the student.

c. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/HOD.

Minor Courses:

Course code	Semester	Course Title	Credits
AEC 512	III	Institutional Economics	1(1+0)
AEC 513	I	Natural Resources and Environmental Economics	2(1+1)
AEC 514	II	Commodity Future Trading	2(2+0)
AEC 515	I	Development Economics	2(2+0)
AEC 516	III	Rural Marketing	2(2+0)
AEC 517	II	Evaluation of Economic Thought	1(1+0)
		Total	09+01=10

Minor Disciplines:

1. Agricultural Extension Education
2. Agronomy
3. Horticulture
4. Animal Husbandry and Dairy Science
5. Agri. Business Management

Minor courses may be taken from above list or subjects closely related to a student's major subject.

Supporting / Optional Courses:

Supporting / Optional Courses may be taken from below mentioned discipline list

Supporting Disciplines:

1. Agricultural Statistics
2. Computer science
3. Mathematics

Common Courses: (Non Credit)

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Library Information Services	0+1
PGS 502	II	Technical Writing and Communications Skills	0+1
PGS 503	II	Intellectual Property and its management in Agriculture	1+0
PGS 504	I	Basic Concepts in Laboratory Techniques	0+1
PGS 505	III	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	III	Disaster Management	1+0
		Total	03+03= 06

Compulsory Non Credit Deficiency Courses

(Those who are non-Agriculture Graduates)

Course Code	Semester	Course Title	Credit Hrs.
AEC401	I	Fundamental of Agricultural economics	2 (2+0)
AEC 402	I	Farm management, Production and Resource Economics	2 (1+1)
AEC 403	II	Agricultural Finance and Cooperation	3 (2+1)
AEC 404	II	Agricultural Marketing, Trade and Prices	3 (2+1)
AEC 405	III	Agri-Business Management	3 (2+1)

Students from B.Sc. (Hort.)/ B.Sc. (Hons.) Horticulture/ B.Sc.(Forestry) / B. Sc. (Hons.) Forestry / BBM (Agri.) / B.Sc. (ABM) / B.Sc. (Hons.) Agri. Business Management/ B.B.A. (Agri.) stream will be required to complete Non-credit deficiency courses (6 to 10 credits) from the above courses related to the discipline in which admitted and as decided by the Student Advisory committee.

Ph.D. Agricultural Economics
Course Structure

1. Ph. D. Agricultural Economics

Course Code	Semester	Course Title	Credit Hrs.
AEC-601*	I	Advanced Micro Economic Analysis	2(1+1)
AEC-602*	I	Advanced Macro Economic Analysis	2(2+0)
AEC-603*	III	Advanced Econometrics	3(2+1)
AEC-604*	II	Advanced Production Economics	3(2+1)
Common*	II	Research and Publication Ethics	2(2+0)
AEC-660*	IV	Doctoral Seminar-I	1(1+0)
AEC-661*	V	Doctoral Seminar-II	1(1+0)
		Total	**11+03 =14**
AEC 699*		Doctoral Research	0+75

***Compulsory Courses**

Common* Student may choose course from Agronomy or Agricultural Meteorology

Minor Courses:

Course code	Semester	Course Title	Credits
AEC-606	II	Advanced Agricultural Marketing and Price Analysis	3(2+1)
AEC-607	III	Quantitative Development Policy Analysis	2(1+1)
AEC-608	II	Natural Resource Management	3(2+1)
AEC-609	III	Environmental Economics	3(2+1)
		Total	07+04=11

Minor Disciplines:

1. Agricultural Extension Education
2. Agronomy
3. Horticulture
4. Animal Husbandry and Dairy Science
5. Agri. Business Management

It is suggested the student may choose at least one out of four courses listed above as part of minor courses as these are related to policy advocacy and bring in global perspectives with an aim to build a larger understanding of the subject to the student. Further, it is suggested that the student may choose the remaining Courses from any other discipline including the disciplines of Agril. Extension Education /Agronomy/Horticulture/Animal Husbandry and Dairy Science/ Agr. Business

Management and are related to the research problem selected by the student. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/ HOD.

Supporting / Optional Courses:

Course Code	Semester	Course Title	Credit Hrs.
AEC-605	II	Operations Research	3(2+1)

Supporting Disciplines:

1. Agricultural Economics
2. Agricultural Statistics
3. Computer science
4. Mathematics

Some of these courses are available in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform.

Common Courses: (Non-Credit)

Course code	Semester	Course Title	Credits
PGS 501*	I	Library and Library Information Services	0+1
PGS 502*	II	Technical Writing and Communications Skills	0+1
PGS 503*	II	Intellectual Property and its management in Agriculture	1+0
PGS 504*	I	Basic Concepts in Laboratory Techniques	0+1
PGS 505*	III	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506*	III	Disaster Management	1+0
		Total	03+03= 06

Note: * Ph.D. Students may exempt from these courses if already studied during Masters degree

Course Contents

M.Sc. Agri. (Agricultural Economics)

AEC-501 Micro Economic Theory and Applications 3 + 0

Why this course?

Markets form an integral part of the economy. They are governed by demand and supply mechanism with profit making its ultimate goal. Thus, it is imperative to expose the students towards how the markets function, their types and how the buyers and sellers behave. That will help them make correct decision when it comes to price setting and choice of product.

Aim of the course

The course envisages the concepts and principles embodying micro-economics. The economic problems, functioning of price mechanism, theory of household behaviour and consumer's demand function. Theory of firm, supply determinants, determination of price under different market structures and factor pricing (micro economic components).

Organisation of the course

The course is organised as follows:

No Block	Unit
1. Introduction to micro-economic	1. Basic Concepts: A review
2. Insight of consumer, production and cost involved	1. Consumer Choice 2. Production and Costs
3. Overview of market	1. Market Forms 2. Factor Markets

Theory

Block 1: Introduction to micro-economics

Unit 1: Basic Concepts: A review

Scarcity and Choice; Production possibility frontier, Positive and normative economics; concepts of opportunity cost, Demand and Supply: determinants of individual demand/supply; demand/ supply schedule and demand/ supply curve; market versus individual demand/supply; shifts in the demand/supply curve

Block 2- Insight of consumer, production and cost involved

Unit1: Consumer Choice

Cardinal Utility Approach – Ordinal Utility Approach -Budget sets and Preferences under different situations–Hicks and Slutsky income and substitution effects- Applications of Indifference curve approach – Revealed Preference Hypothesis – Consumer surplus – Derivation of Demand curve – Elasticity of demand – Demand and supply together; how prices allocate resources; controls on prices – price floor and price ceiling–applications in agriculture.

Unit2: Production and Cost

Production functions: single variable - average and marginal product, variable proportions, stages of production. Two variables- isoquants, returns to scale and to a factor; factor prices; Technical progress; cost minimization and output maximization; Elasticity of substitution. Expansion path and the cost function Concept of economic cost; Short run and long run cost curves; increasing and decreasing cost industries; envelope curve; L-shaped cost curves; economies of scale; revenue and expenditure, elasticity and marginal revenue; Firm equilibrium and profit.

Block3: Overview of market

Unit1: Market Forms

Behaviour of profit maximizing firms and the production process- Perfect competition: Equilibrium of the market. Long run industry supply, applications: effects of taxes and subsidies; Monopoly: Equilibrium; supply; multi-plant firm; monopoly power; dead weight loss; price discrimination; Monopolistic Competition: Product differentiation; equilibrium of the firm in the industry-with entry of new firms and with price competition. Comparison with pure competition. Duopoly: Cournot model and reaction curves; Stackelberg‘s model, Bertrand model; Oligopoly.

Unit2: Factor Markets

Labour and land markets - basic concepts (derived demand, productivity of an input, marginal productivity of labour, marginal revenue product); demand for labour; input demand curves; shifts in input demand curves; competitive labour markets; Economic rent and quasi rent.

Teaching Schedule:

Theory- Micro Economic Theory and Applications

Lecture No.	Details of Topic	Weightage
1 & 2	Scarcity and Choice; Production possibility frontier, Positive and normative economics; concepts of opportunity cost	**7**
3 & 4	Demand and Supply: determinants of individual demand/supply; demand/ supply schedule and demand/ supply curve	**7**
5 & 6	Market versus individual demand /supply; shifts in the demand/supply curve	**6**
7, 8&9	Cardinal Utility Approach – Ordinal Utility Approach - Budget sets and Preferences under different situations– Hicks and Slutsky income and substitution effects	**8**
10& 11	Applications of Indifference curve approach – Revealed Preference Hypothesis, Consumer surplus – Derivation of Demand curve	**8**
12&13	Elasticity of demand – Demand and supply together; how prices allocate resources; controls on prices – price floor and price ceiling–applications in agriculture	**6**
14 & 15	Production functions: single variable - average and marginal product, variable proportions, stages of production	**8**
16 & 17	Two variables- isoquants, returns to scale and to a factor; factor prices	**8**
18 & 19	Technical progress; cost minimization and output maximization; Elasticity of substitution	**8**
20 & 21	Expansion path and the cost function Concept of economic cost; Short run and long run cost curves	**8**
22 & 23	Increasing and decreasing cost industries; envelope curve; L-shaped cost curves; economies of scale	**7**
24	Revenue and expenditure, elasticity and marginal revenue; Firm equilibrium and profit	**6**
25	Behaviour of profit maximizing firms and the production process- Perfect competition: Equilibrium of the market	**8**
26 & 27	Long run industry supply, applications: effects of taxes and subsidies	**7**
28 & 29	Monopoly: Equilibrium; supply; multi-plant firm; monopoly power; dead weight loss; price discrimination	**8**
30 & 31	Monopolistic Competition: Product differentiation; equilibrium of the firm in the industry-with entry of new firms and with price competition	**6**

32 & 33	Comparison with pure competition. Duopoly: Cournot model and reaction curves	**8**
34	Stackelberg's model, Bertrand model; Oligopoly	**6**
35 & 36	Labour and land markets - basic concepts (derived demand, productivity of an input, marginal productivity of labour, marginal revenue product)	**8**
37 &38	Demand for labour; input demand curves; shifts in input demand curves	**6**
39 & 40	Competitive labour markets; Economic rent and quasi rent	**6**

Teaching Methods/Activities

- Lectures
- Case studies
- Assignments (Group/individual)
- Group Discussions on practices done by firms.
- Power point presentations by students.
- Exploring the agricultural market and identification of industries and their type.

Learning outcome

After completion of the course the student will be able to:

- Get acquainted with the basic concepts of market functions.
- Build up vision towards how consumers make choices and market reaches the equilibrium.
- Develop decision making skill for firms about product selections and scale of production to ensure maximum profit.
- Understand about different types of markets existing in the real world, their principles and where abouts.

Suggested Reading

- Koutsoyiannis A. *Modern Micro Economics*. Macmillan Press Ltd
- Ferguson and Gould. *Micro economic Theory*. Richard D Erwin In. USA
- RichardA. Bilas, *Micro Economic Theory*.
- Leftwich Richard H. *The Price System and Resources Allocation*
- Allen CL. *A Frame Work of Price Theory*.
- David M Kreps 1990. *A Course in Microeconomic Theory*.
- Dewett KK. 2002. *Modern Economic Theory*.
- Henderson JM and Quandt RE. 2000. *Microeconomic Theory: Mathematical Approach.*
- Silberberg E and Suen W. 2001. *The Structure of Economics- A Mathematical Analysis.*
- Varian Hal R. 1999. *Intermediate Microeconomics.*
- H.L. Ahuja 1970, Advanced Economic Theory –Microeconomic Analysis

AEC-502 Agricultural Production Economics 1 + 1

Why this course?

Production in agriculture is the outcome of the input factors involved. In this competitive and uncertain market, it is important that the farmers take the right decision about the combination of inputs that will result in higher income. Thus, as an economist it is a pre-requisite that the students understand the interaction between output and input. And workout the most effective production plan.

Aim of the course

To expose the students to develop the concept, significance and uses of production economics. To understand the relationships between factors and output. To learn how to decide the combination of inputs to be used as per the resources available. Ensure that the production process works efficiently.

Organization of the course

The course is organized as follows-

No Block	Unit
1. Introduction to production economics	1. Concepts of production economics
2. Factors and costs	1. Factors and theory of production 2. Concepts of costs
3. Assessment	1. Dynamics of assessment

Theory :

UNIT I

Nature, scope and significance of agricultural production economics-Agricultural Production processes, character and dimensions-spatial, temporal - Centrality of production functions, assumptions of production functions, commonly used forms- Properties, limitations, specification, estimation and interpretation of commonly used production functions.

UNIT II

Factors of production, classification, interdependence, and factor substitution- Determination of optimal levels of production and factor application -Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product

combination.

UNIT III

Cost functions and cost curves, components, and cost minimization -Duality theory– costandproductionfunctionsanditsapplications-Derivationoffirm's input demand and output supply functions -Economies and diseconomies of scale.

UNIT IV

Technology in agricultural production, nature and effects and measurement– Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.

Practical

- Different forms of production functions
- Specification, estimation and interpretation of production functions
- Returns to scale, factor shares, elasticity of production
- Physical optima-economic optima
- Least cost combination
- Optimal product choice
- Cost function estimation, interpretation
- Estimation of yield gap
- Incorporation of technology in production functions
- Measuring returns to scale-risk analysis.
- Scale of production
- Trend and growth analysis

Teaching Schedule:

Theory- Agricultural Production Economics

Lecture No.	Topic	Weightage (%)
1	Nature, scope and significance of agricultural production economics. Agricultural Production process. character and dimensions – spatial	5
2	Temporal - Centrality of production functions, assumptions of production functions.	5
3	Commonly used forms of production functions- properties limitations, specification.	9

4	Estimation and interpretation of commonly used production functions.	15
5	Factors of production, classification, interdependence.	5
6	Factor substitution- Determination of optimal levels of production and factor application	6
7	Optimal factor combination and least cost combination of production	6
8	Theory of product choice Selection of optimal product combination	10
9	Cost functions and cost curves Cost components and cost minimization	10
10	Duality Theory Cost and production functions and its applications	10
11	Derivation of firms input demand and output supply functions Economies and diseconomies of scale	10
12	Technology in agricultural production Nature and effects and measurement Measuring efficiency in agricultural production	5
13	Technical, allocative and economic efficiencies	5
14	Yield gap analysis- concepts-types and measurement.	5
15	Nature and sources of risk	10
16	Modeling and coping strategies	

Teaching Schedule:

Practical - Agricultural Production Economics

Exercise No.	Topic
1	Different forms of production functions
2& 3	Specification, estimation and interpretation of production functions
4 & 5	Returns to scale, factor shares, elasticity of production
6	Physical optima-economic optima
7	Least cost combination
8	Optimal product choice
9 &10	Cost function estimation, interpretation
11	Estimation of yield gap
12	Incorporation of technology in production functions
13 & 14	Measuring returns to scale-risk analysis
15	Scale of production
16	Trend and growth analysis

Teaching Methods/Activities

- Lectures
- Assignments (Group/individual)
- Group Discussions on working out
- Power point presentations by students
- Exploring the agricultural market and identification of industries and their type.

Learning outcome

After the successful completion of the course the student will be able to—understand how the factors and output interact with each other. - Work out whether the production system is working efficiently and point out the loop holes.- Apply the knowledge of costs and profits to work out the demand and supply functions. This will result into more efficient decision making.

Suggested Reading

- EO Heady. *Economics of Agricultural Production and resources use.*
- John P Dolland Frank Orazem. *Production Economics: Theory with application*
- Heady EO& Dillon JL.1961.*Agricultural Production functions.* Kalyani Publishers, Ludhiana, India. 667 p.
- Baumol WG.1973.*Economic theory and operations analysis*. Practice Hall of India Private Limited, New Dehli.626 p.
- Gardner BL & Rausser GC.2001. *Hand book of Agricultural Economics* Vol. I Agricultural Production. Elsevier.
- Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.
- Sankayan P. L. 1983. *Introduction to Farm Management*. Tata McGraw Hill.
- K. Palanisami, P. Paramasivam and C.R. Rangnathan 2002, Agricultural Production Economics-Analytical Methods and Applications
- Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*.John Wiley & Sons.

AEC-503 Agricultural Marketing and Price Analysis 2 + 1

Why this course?

The ultimate aim of production process is to sell the produce in the market and generate income. A market serves as platform where this exchange takes place. Agriculture markets are different from other markets due to the nature of the commodity. Thus, it is important to develop a strong foundation of agricultural marketing, its components and issues. The student needs to know about the multi- pronged ways of marketing the produce, agencies involved. In this modern era, it is important to understand how technology is transforming this sector.

Aim of the course

The course is designed to acquaint the students about the basics of dynamics of agricultural marketing. The content includes supply, demand and marketing of farm production, marketing functions and channels, marketing costs, margins and efficiency, agricultural prices, New marketing formats like e-marketing, e-NAM future trading, supply chain management, market intelligence etc.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction to agricultural marketing	1. Introduction to agricultural marketing
2. Agricultural markets	1. Aspects of agricultural marketing 2. Future marketing and government
3. Advances in agricultural marketing	1. Use of information technology 2. Dynamics of price

Theory

Block1: Introduction to Agricultural Marketing

Unit 1: Introduction to Agricultural Marketing

New Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency-

Vertical and Horizontal integration- Structure Conduct and Performance analysis – Integration over space, time and form- Vertical co-ordination.

Block 2: Agricultural Markets

Unit 1: Aspects of agricultural marketing

Different Forms of marketing: Co-operatives Marketing – APMC Regulated Marketing- Direct marketing, Farmer Producer Companies, e-NAM and marketing under e-NAM, e-marketing Contract farming and Retailing, Organized retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies -Market infrastructure needs, performance and Government role- Value Chain Finance.

Unit 2: Future marketing and government

History and introduction to Commodities markets and future trading –Terms used in future trading-Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery – Speculation and Hedging -Basis Fundamental analysis - Technical Analysis –Role of Commodity exchanges in India- (MCX, NCDEX etc.). Role of Government/SEBI in promoting commodity trading and regulatory measures.

Block 3: Advances in Agricultural Marketing

Unit 1: Use of Information Technology

Role of Information Technology and Market Intelligence in marketing of agricultural commodities, electronic auctions (e-bay), e-Chaupals, Agmarknet and Domestic and Export market Intelligence Cell (DEMIC).

Unit 2: Dynamics of price

Price forecasting – time series analysis – time series models – spectral analysis. Price policy and economic development–non-price instruments- Emerging problems in Agricultural Marketing, New policy for Agricultural Marketing.

Practical

- Supply and demand elasticities in relation to problems in agricultural marketing.
- Price spread and marketing efficiency analysis.
- Marketing structure analysis through concentration ratios.
- Performance analysis of Regulated market and marketing societies. Analysis on

contract farming and supply chain management of different agricultural commodities, milk and poultry products.

- Supply Chain Analysis-quantitative estimation of supply chain efficiency.
- Market Intelligence–Characters, Accessibility, and Availability Price forecasting.
- Onlinesearchesformarketinformationsourcesandinterpretationofmarket intelligence reports – commodity outlook.
- Technical Analysis for important agricultural commodities.
- Fundamental Analysis for important agricultural commodities.
- Presentation of the survey results and wrap-up discussion-
- Computation of indices

Teaching Schedule:

Theory: Agricultural Marketing and Price Analysis

Lecture No	Topics	Weightage (%)
1	New Concepts in Agricultural Marketing, Scope & Importance	**5**
2&3	Characteristic of Agricultural Product and Production: Characteristic of developed markets & ideal system of Agril. Marketing, Channel of a good marketing system.	**5**
4	Problems in Agricultural Marketing from Demand and Supply and Institutions sides.	**3**
5	Market intermediaries and their role, Need for regulation in the present context	**3**
6	Marketable and Marketed surplus: Concept, relationship, factor affecting marketable surplus, estimation of Marketed surplus.	**5**
7&8	Market Integration : Vertical and Horizontal integration,	**3**
9	Integration over space, time and form Vertical coordination	**3**
10&11	Different form of Marketing Cooperatives: meaning, functions, history, types etc. APMC Regulated Markets.	4
12	Farmer Producer Companies,	2
13	e-NAM and marketing under e-NAM, e-marketing Contract farming and Retailing, Organized retailing	3
14	Supply Chain Management: Meaning, importance,	3
15	Types State trading, Warehousing and other Government agencies	3
16	Performance and Strategies-Market infrastructure needs: importance, types of marketing infrastructural facilities.	5
17	Performance and Government role, Value Chain Finance: Meaning, advantages.	5
18&19	History and introduction to Commodities markets and future trading –Terms used in future trading	3

20	Basics of commodity futures - Operation Mechanism of Commodity markets	3
21	Price discovery	5
22	Speculation and Hedging -Basis Fundamental analysis - Technical Analysis	5
23&24	Role of Commodity exchanges in India- (MCX, NCDEX etc.). Role of Government/SEBI in promoting commodity trading and regulatory measures.	5
25	R o l e of Information Technology and market Intelligence in marketing of agricultural commodities	5
26 &27	Electronic auctions (e-bay), e-Chaupals, Agmarknet and Domestic and Export market Intelligence Cell (DEMIC).	3
28	Price forecasting.	5
29	Time series analysis – time series models – spectral analysis	3
30	Price policy and economic development–non-price instruments-	5
31	Emerging problems in Agricultural Marketing	3
32	New policy for Agricultural Marketing.	3

Teaching Schedule:

Practical

Sr. No	Name of the Exercise
1	Estimation of supply and demand elasticities in relation to problems in agricultural marketing
2	Estimation of price spread and marketing efficiency analysis
3	To study the marketing structure analysis through concentration ratios.
4	To study the performance analysis of regulated Market
5	To study the performance analysis of marketing societies
6	Analysis on contract farming
7	Supply chain management of different agricultural commodities.
8	Supply chain management of milk
9	Supply chain management of poultry products
10	To study the supply chain analysis-quantitative estimation of supply chain efficiency
11	To study the market intelligence–characters, accessibility, and availability price forecasting.
12	To study the online searches for market information sources and interpretation of market intelligence reports – commodity outlook
13	Study of technical analysis for important agricultural commodities.
14	Study of fundamental analysis for important agricultural commodities.
15	Study of presentation of the survey results and wrap-up discussion
16	Estimation of computation of indices

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Group Discussions on price volatility and control measures prevailing.
- Power point presentations by students on government schemes.
- Visit to e-NAM Mandies, Warehouses, etc.

Learning outcome

After the completion of this course the student will be able to–

- Understand the where about of agricultural marketing.
- The different forms of marketing existing in this sector.
- Gain expertise in market intelligence and price forecasting.

Suggested Reading

- Acharya SS & Agarawal NL. 2004. Agricultural Marketing in India. Oxford and IBH Publishing company Pvt. Ltd. New Delhi.
- Acharya SS & Agarawal NL. 1994. Agricultural Prices-Analysis and Policy. Oxford and IBH Publishing company Pvt. Ltd. New Delhi.
- Richard H Kohls and Joseph N. Uhl: Marketing of Agricultural products by Collier Mac Millan International.
- Purecell WD and Koontz SR. 1999. Agricultural Futures and Options: Principles and Strategies.
- Rhodes VJ. 1978. The Agricultural Marketing System. Grid Publ., Ohio
- Shephered SG and Gene AF. 1982. Marketing Farm Products. Towa State Univ. Press.
- Singhal AK. 1986. Agricultural Marketing in India. Annual Publ., New Delhi.

AEC-504 Macro Economics and Policy 2+0

Theory

BLOCK 1: Conceptualizing Macro Economics

UNITI: Introduction: Measurement and Concepts

Basic concept and Scope of Macro Economics, National Income, Accounting methods of measurement of key macroeconomics aggregates, relationship of national income and other aggregates (with numerical exercises), Real and Nominal income.

BLOCK 2: Theories of Macroeconomics

UNIT I: Classical Macroeconomics

Classical postulates, Say's Law, classical theory of employment, aggregate labour supply and demand of labour, classical theory of determining output, wages and prices.

UNITII: Income and Spending: Keynesian Framework

Simple Keynesian model of income determination; Keynesian multiplier- aggregate spending, taxation, transfer payment, foreign spending, balance budget; budget surplus (with numerical exercises) Concepts of Accelerator and its working

BLOCK 3: Money, Consumption and Inflation

UNIT I: Money, interest and income

Goods market equilibrium-IS curve, Demand for money, the liquidity preference theory-Liquidity trap; Asset market equilibrium- LM curve; simultaneous equilibrium in goods and asset market – effect of fiscal and monetary policy.

UNITII: Theories of Aggregate Consumption and Investment

Consumption function and its technical attributes, Investment, its type, factor influencing investment, fiscal and monitory factors. Absolute income hypothesis, Relative income hypothesis, Fishers Inter -temporal choice model, Life- cycle and Permanent Income hypothesis; profit and accelerator theory.

UNITIII: Inflation and Unemployment.

Inflation: Nature, Effects and control. Type of inflation- Demand pull, Cost push,. Stagflation, core inflation, hyperinflation; Phillips curve. Business cycles, Unemployment- type of unemployment.

Teaching Schedule:
Theory

Lecture No.	**Topic**	**Weightage** (%)
l, & 2	Meaning, Concepts, Introduction scope Methodology and Keynesian-Concepts of National Income	6
3, 4	Definition, factors determining NI, GNP, NNP,GDP, Accounting Relationships of national income	8
	Real and nominal income, GNP deflator and GNP implicit deflator (conversion of nominal to real income numerical exercise)	8
5 &6	Methods of measurement of National Income: output method,IncomeMethod,1`1Expendituremethod,Identitymethod and difficulties of measurement	6
7 , 8 &9	Classical theory of Employment: Says law, Aggregate labour supply and demand of labour, Classical theory of determining output, Wages and prices.	8
10,11,12,13,14 & 15	Keyne's theory of income determination, Concept of Multiplier, Accelerator, Keynesian simple multiplier, Income determination with aggregate spending, income determination with taxation, income determination with transfer payment, income determination with foreign spending, income determination with balance budget, budget surplus (exercises with numerical examples)	18
16,17,	Goods market equilibrium -IS curve, Money market equilibrium LM curve, Simultaneous equilibrium in goods and money market. The relative Effectiveness of Monetary policies and. Fiscal policies Theory of liquidity preferences- Liquidity trap	8
18 &19	Consumption function: Theories of consumption function, Absolute income hypothesis of Keynesian theory, Relative income hypothesis, Fishers Inter -temporal choice model, Life- cycle theory of consumption and Permanent income and consumption hypothesis; profit and accelerator theory.	12
24 &25	Average and Marginal Propensity to consume, Keyne's law of consumption, Assumptions and criticism.	4
26 & 27	Investment: Meaning of investment, types, Importance, factors affecting Investment Fiscal and monitory policies, Marginal efficiency of capital, investment and interest rate	4
28& 29	Inflation: nature, effects and control. Type of inflation Demand pull, Cost push, Stagflation, Core Stagflation, core inflation, hyperinflation; Phillips curve.	8
30	Business cycles,	2

31 &32	Unemployment and full employment: Types of Employment, structural, seasonal frictional unemployment, Keynesian or cyclical unemployment, Measures to remove it. Full Employment: Meaning, measurement, Policy for full employment, Fiscal and Monetary policy for full employment, and International measures for full employment.	8

Suggested Reading

- Stonier &Hegue. A Text Book of Economic Theory
- Samuelson PA. 1948. Foundation of Economic Analysis. Harvard University Press
- MC VaishAllid. 1983. Macro–Economics Theory
- Gardner Ackley. 1961. Macro–Economics Theory: Macmillan, New York.
- TF Dernburg& DM Mcdougali-Macro Economics
- G. Sirkin – Introduction to Macro–Economic Theory
- RL Heibroker-Understanding Macro–Economics
- JK Mehta –Macro Economics
- Michael R Edgemand – Macro-Economics: Theory & Policy
- David' W Pearce –The dictionary of modern Economics
- Dwivedi D. N. Macroeconomics Theory and Policy
- AhujaHL.2007Macroeconomics:TheoryandPolicy.
- EugeneADiulio2006.Macroeconomics.4^Ed.

AEC-505 Econometrics 2+1

Why this course?

Development of analytical skills is imperative to make students proficient in conducting quality research work. The knowledge of variables, their models, and problems encountered when dealing with variables will build up a compatibility with the analytical aspects.

Aim of the course

The course provides knowledge of the econometric methods like time series analysis, linear regression models and their application in economic analysis. The course provides an insight into the econometric problems in analyzing time series and cross section data.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction to econometrics	1. Introduction
2. Classical Regression	1. Classical Linear Regression
	2. Breaking down of Classical assumptions
3. Qualitative Variables	1. Qualitative variables and simultaneous Equation models

Theory

Block 1: Introduction to Econometrics

Unit1: Introduction

Concepts of Econometrics. Relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics- regression analysis.

Block 2: Classical Regression

Unit 1: Classical Linear Regression

Basic two variable regressions-Population regression function, Simple regression function, The method of ordinary least squares, Assumption of classical linear regression model, Estimation, properties of least-squares estimators (The Gauss-Markov theorem), standard error of least squares estimates, measures of goodness of fit (The coefficient of determination r^2) and Interpretation. Functional forms of regression model. Approaches to

estimation-OLS and their properties. Extensions to multi-variable models-multiple regression-estimation and interpretation.

Unit 2: Breaking down of Classical assumptions

Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches– model misspecification and diagnostic testing.

Block 3: Qualitative Variables

Unit 1: Qualitative variables and simultaneous equation models

Nature of qualitative response model, Nature of dummy variable, Caution in the use of dummy variable, Use of dummy variables- Introduction to simultaneous equations-identification problem

Practical

- Single equation two variable model specification and estimation
- Hypothesis testing and OLS application
- Estimation of multiple regression model
- Testing and correcting specification errors
- Testing and managing multi-collinearity
- Testing and managing Autocorrelation
- Testing and managing Heteroscedasticity
- Estimation of regressions with dummy variables

Teaching Schedule:

Theory: Econometrics

Lecture No	Topic to be covered	Weightage
1&2	What is econometrics? Relationship between economic theory, mathematical economics etc. (Why separate discipline) Types of econometrics, objectives of econometrics, Data, types of data, measurement scale of variable.	5
3&4	Methodology of econometrics, Models-Types of Models, Correlation- Definition, Significance, types, methods, properties	10
5&6	Basic two variable Regression, PRF, SRF, interpretation, statistical Vs deterministic relationship, regression Vs correlation, terminology and notation, Assumption of classical linear regression model.	5
7&8	The method of ordinary least square, OLS derivation, properties of least square estimators (The Gauss Markov theorem)	9
9&10	Standard error of least square estimates, measure of goodness of fit i.e. coefficient of determination r^2, interpretation. Functional	5

	form of regression model.	
11&12	Multiple linear regression analysis, PRF, SRF, Assumption of Multiple linear regression model. OLS derivation, properties of least square estimators (The Gauss Markov theorem)	9
13&14	Standard error of least square estimates, measure of goodness of fit i.e. multiple coefficient of determination R^2, Adjusted R^2, Modified R^2, interpretation.	5
15,16 &17	Identification, consequences and remedies for multicollinearity	9
18, 19 &20	Identification, consequences and remedies for Autocorrelation	9
21,22 &23	Identification, consequences and remedies for heteroscedasticity	9
24,25&26	Model specification and diagnostic testing-model selection criteria, types of specification errors, consequences, tests, errors of measurement, nested Vs Non- nested model	9
27&28	Qualitative response regression model- LPM, application of LPM, alternatives to LPM	5
29&30	Dummy variable regression model- Nature, caution and use. ANOVA model with qualitative variables and ANCOVA model	6
31&32	Simultaneous equation models- Nature, example, the identification problem, estimation	5

Teaching Schedule: Practical

Practical No	Topic
1&2	Estimation of correlation coefficient; estimation of two variable regression model
3&4	Test of significance of correlation coefficient and regression coefficient
5&6	Estimation of three variable regression model and its test of significance
7&8	Testing and managing multicollinearity
9&10	Testing and managing Autocorrelation
11&12	Testing and managing heteroscedasticity
13&14	Testing and managing specification errors
15&16	Estimation of regression with dummy variables

Teaching Methods/Activities

- Lectures.
- Assignments(Group/individual).

Learning outcome

After the completion of the course, the student will be able to-Understand the variables and the properties of regression models. Identify the problems in variables and remove them before conducting the analysis and avoid biased results.

Suggested Reading

- Dorfman R. 1996. *Linear Programming and Economic Analysis*. McGrawHill.
- Greene WH. 2002. *Econometric Analysis*. Pearson Education.
- Johnston J and Dinardo J. 2000. *Econometric Methods*. McGrawHill.
- Koutseyianis, A. 1997. *Theory of Econometrics*. Barner&Noble.
- Maddala GS. 2002. *Econometrics*. McGraw-Hill.
- Pinndyck RS and Rubinfeld DL. 1990. *Econometric Models and Econometric Forecasts*. McGraw Hill.
- Maddala GS and KajalLahiri. 2014. Introduction to Econometrics. Wiley.
- Christopher Dougherty. 2015. Introduction to Econometrics. Oxford.
- Gujarati, DN, Porter Dc and Sangeetha, Gunasekar (2015) Basic Econometrics. McGraw-Hill.
- Johnson AG Jr., Johnson MB and Buse RC. 1990. Econometrics - Basic and Applied. Macmillan.
- Kelejan HH and Oates WE. 1994. Introduction to Econometrics Principles and Applications. Harper and Row Publ.
- Acharya-Madnani, 1988, Applied Econometrics for Agricultural Economists-Himanshu Publications, Udaipur

AEC-506 Agricultural Developments and Policy Analysis 2+0

Why this course?

The ultimate aim of the economies is to attain a satisfactory level of development. Development ensures that there is not only increase in income but also the distribution is such that lesser inequalities exist. The students need to know what is development and its related concepts. All the policies framed are with one sole objective of increasing the welfare. Thus, once concept of development is buildup, students can better understand policies and their genesis.

Aim of the course

Concept of economic development and policy, theories of development, performance of Indian agriculture. The process and implementation of policies over a period of time.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Basic concepts	1. Introduction
2. Theoretical Concepts	1. Theories of Agricultural Development
3. Performance and policies	1. Performance of Indian Agriculture 2. Agricultural Policy: Process and Implementation

Theory

Block 1: Introduction

Unit 1: Introduction

Role of agriculture in economic/ rural development – Evolution of thinking on agriculture and development; Agricultural development – meaning, stages and determinants–Population and food supply–need for sound agricultural policies

Block 2: Theoretical Concepts

Unit 1: Theories of Agricultural Development

Resource exploitation model- Conservation model- Location (Urban impact) model- Diffusion model- High pay-off input model-Induced Innovation Model- Agricultural R&D and Linkages.

Block 3: Performance and policies

Unit 1: Performance of Indian Agriculture

Agrarian structure and land relations; trends in performance and productivity; agrarian structure and technology; credit, commerce and technology; capital formation; subsidies; pricing and procurement; Post Green Revolution agriculture; Production and productivity crisis in agriculture; Regional differences; Food Security, PDS system and Malnutrition.

Unit 2: Agricultural Policy: Process and Implementation

Instruments of Agricultural Policy; Process of agricultural policy formulation, implementation, Monitoring and Evaluation in India; Global experiences in participatory approach to Agricultural policy process; critical review of various elements of Indian agricultural policy-resource policies – credit policies – input and product marketing policies – price policies; WTO – Agreement on Agriculture; Planning models. Planning for utilization of resources and Indian Five-Year Plans.

Teaching Schedule:

Theory: Agricultural Developments and Policy Analysis

Lecture No.	Topic	Weightage (%)
1	Role of agriculture in economic/ rural development	03
2	Evolution of thinking on agriculture and development	03
3	Agricultural development–meaning, stages and determinants	03
4	Population and food supply	03
5	Need for sound agricultural policies	03
6	Resource exploitation model	03
7	Conservation model	04
8	Location (Urban impact) model	04
9	Diffusion model	03
10	High pay-off input model	03
11	Induced Innovation Model	04
12	Agricultural R&D and Linkages	05
13&14	Agrarian structure and land relations	06
15&16	Trends in performance and productivity	06
17	Agrarian structure and technology; credit, commerce and technology	03
18	capital formation; subsidies; pricing and procurement	04
19&20	Post Green Revolution agriculture	06

21	Production and productivity crisis in agriculture	04
22	Regional differences; Food Security, PDS system and Malnutrition	03
23	Instruments of Agricultural Policy	03
24	Process of agricultural policy formulation, implementation, Monitoring and Evaluation in India	03
25	Global experiences in participatory approach to Agricultural policy process	03
26&27	Critical review of various elements of Indian agricultural policy-resource policies	04
28	Credit policies – input and product marketing policies – price policies	03
29&30	WTO – Agreement on Agriculture; Planning models.	05
31&32	Planning for utilization of resources and Indian Five-Year Plans.	06

Suggested Reading

- Albert O. Hirschman 1958. *Strategy of Economic Development.* New Man Yale University
- Simon Kuznets 1965. *Economic Growth and Structures.* Oxford New Delhi.
- Das Gupta AK. 1965. *Planning and Economic Growth.* George Allen and Unwin London
- Robert E. Baldwin 1966. *Economic Development and Growth*. John Willey, New York.
- Chakaravathi RM. 1986. *Under Development and Choices in Agriculture*. Heritage Publ., New Delhi.
- Eicher KC & Staatz JM. 1998. *International Agricultural Development*. Johns Hopkins Univ. Press.
- Frank E. 1992. *Agricultural Polices in Developing Countries*. Cambridge Univ. Press.
- Ghatak S &Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate, New Delhi.
- Jhingan ML. 1998. *The Economics of Development and Planning*. Vrinda Publ.
- Jules PN. 1995. *Regenerating Agriculture – Polices and Practice for Sustainability and Self Reliance*. Vikas Publ. House.
- Naqvi SNH. 2002. *Development Economics – Nature and Significance*. Sage Publ.

AEC-507 Agricultural Finance and Project Management 2+1

Why this course?

Money is the fuel of driving all the economic activities. India is a land of small and marginal farmers. The financial conditions of the farmers are not so strong that they can finance themselves. They require credit to meet the requirements of inputs. Thus, the student should know the sources, principles involved and types of credit available. The institutions involved and on what grounds the finance is given to the farmer. What are the risks involved and how to overcome them?

Aim of the course

This course is designed with an objective to deliver knowledge of the principles, procedures, problems and policies relating to financing agricultural firms. In addition to this the students are also given knowledge about the research developments in the subject. The approach is analytic.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction to Agricultural Finance	1. Basic Concepts: A review
2. Credit and financial analysis	1. Credit and its aspects
	2. Financial analysis
3. Project and risk management	1. Project Overview
	2. Risk and its Management

Theory

Block 1: Introduction to Agricultural Finance

Unit 1: Basic concepts: A Review

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing- Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's- NGO's, and SHG's.

Block 2: Credit and Financial Analysis

Unit 1: Credit and its aspects

Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

Unit 2: Financial analysis

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

Block 3- Project and Risk Management

Unit1: Project Overview

Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Network Techniques–PERT and CPM.

Unit 2: Risk and its Management

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes - yield loss and weather-based insurance and their applications.

Practical:

- Development of Rural Institutional Lending;
- Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving;
- An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme;
- Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions;

- Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements;
- Performance of Micro Financing Institutions: NGO's and Self-Help Groups, Identification and formulation of investment projects.
- Project appraisal techniques–Undiscounted Measures and their limitations;
- Project appraisal techniques–Discounted Measures;
- Preparation of project report
- Network techniques–PERT and CPM for project management;
- Case Study Analysis of an Agricultural project;
- Financial Risk and risk management strategies–crop insurance schemes;
- Financial instruments and methods–E-banking, Kisan Cards and core banking.

Teaching Schedule:

Theory: Agricultural Finance and Project Management

Lecture No.	Topic	Weightage (%)
1	Role and importance of Agril. Finance	3
2	Financial Institutions and credit flow to rural /priority sector	3
3	Agricultural lending-Direct and indirect Financing	3
4	Financing through Co-operatives	3
5	Financing through NABARD, Commercial banks and RRBs	3
6	District credit Plan and lending to agriculture/priority sector	3
7	Micro-Financing and role of MFI's, NGO's and SHG's	3
8	Lending to farmer's-Concept of 3 C's,7 P's and 3 R's of credit	4
9	Estimation of technical feasibility	3
10	Economic viability and repaying capacity of borrowers	3
11	Appraisal of credit proposals	3
12	Understanding lenders and developing better working relationship	3
13	Supervisory credit system	3
14	Credit inclusions-Credit widening and credit deepening	3

15	Financial Decisions-Investment, Financing	3
16	Financial Decisions-Liquidity and Solvency	3
17	Preparation of Financial Statements-Balance sheet, Cash Flow Statement	3
18	Preparation of Financial Statements-Profit and Loss Account	3
19	Ratio Analysis	3
20	Assessing the performance of farm/firm	3
21	Project Approach in financing agriculture	3
22	Financial ,Economic and Environmental appraisal of investment project	4
23	Identification, preparation, appraisal of the project	3
24	Financing and implementation of project	3
25	Project Appraisal techniques-Undiscounted measures-Time value of money	3
26	Use of Discounted measures-B:C ratio, NPV, and IRR	4
27	Agreements, Supervision, Monitoring and Evaluation phases in appraising agricultural investment projects	4
28	Net work techniques-PERT and CPM	3
29	Risks in financing agriculture	3
30	Risks management strategies and coping mechanism	3
31	Crop Insurance Programme-Review of different crop insurance schemes	3
32	Yield loss and weather based insurance and their applications	3

Teaching Schedule: Practical

Exercise No.	Title of Exercise
1	Development of Rural Institutional Lending
2	Branch expansion, demand and supply of institutional agricultural credit, overdues and Loan waiving
3	An overview - Rural lending programmes of Commercial banks, Lead

	Bank scheme
4	Preparation of District Credit Plan
5	Rural lending programmes of Co-operative lending Institutions
6	Preparation of Financial Statements using farm/firm level data
7	Farm credit appraisal techniques and farm financial analysis through financial statements
8	Performance of Micro-financing Institutions-NGO's, SHG's
9	Identification and formulation of investment project
10	Project Appraisal techniques-Undiscounted measures and their limitations and
11	Project Appraisal techniques- Discounted measures
12	Preparation of project report
13	Net work techniques-PERT and CPM for project management
14	Case study analysis of an Agricultural project
15	Risk and Risk management strategies- Crop Insurance schemes
16	Financial instruments and methods - E-banking and Kisan Cards and Core banking

Teaching Methods/Activities

- Lectures
- Case studies
- Assignments (Group/individual)
- Group Discussions on inflation

Learning outcome

After the completion of the course the student will be able to-Understand the key issues of finance in Agriculture. Learn the techniques of assessing the worth of a project.

Suggested Reading

- E Die Sollem H and Heady EO. (Ed.). *Capital and Credit Needs in Changing Agriculture*, Bauman.

- Hopkins A Barry, Peter Jo and Baker C B. *Financial Management in Agriculture*.
- Murray WG and Nelson AG. 1960. *Agricultural Finance.* Iowa State University
- Chanona C. 1969. *Agricultural Finance in India: Role of Commercial Banks*. Marketing and Economics Research Bureau, New Delhi.
- Gittinger JP. 1972. *Economic analysis of agricultural projects*, John Hopkins Univ. Press, Baltimore.
- Little IMD and JA Mirrless.1974, *Project appraisal and planning for developing countries*, Oxford and IBH publishing Co. New Delhi.
- Arnold CH. 1972. *Project Evaluation, collected papers*, Macmillan.
- Nelson, A. and W.G. Moore. Agricultural Finance.
- Chandra, Prasanna.1997. Project: Planning and Appraisal. Tata McGraw-Hill Publishing Co., New Delhi-110 002.
- Dhubashi, P.R. 1986. Policy and Performance-Agricultural and Rural Development in Post Independent India. Sage Publ.
- Muniraj, R. 1987. Farm Finance for Development. Oxford & IBH Publ.
- S Subba Reddy and P Raghu Ram, Agricultural finance and Management. Oxford & IBH Publ.

AEC-508 Linear Programming 1+1

Why this course:

Linear programming is one of the widely used technique for decision-making. Understanding of method of linear programming will be helpful to sharpen the skills of students in agricultural planning while dealing with allocation of limited resources such as land, labour, water supply, capital, etc. in a way so as to maximise net revenue.

Objective

The objective of this course is to introduce the students to concepts and applications of linear programming techniques which will be helpful for practical decision-making

Organization of the course

The course is organized as follows-

No Block	Unit
1. Introduction to quantitative techniques in decision making	1.Concepts of decision making
2. Simplex method and its extension	1.Simplex method 2. Extension of linear programming models
3.Game Theory	1.Concepts of game theory

Theory

Block – I - Introduction to quantitative techniques in decision making

UNIT I - Concepts of decision making

Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems. Inventory management.

Block II - Simplex method and its extension

UNIT I - Simplex method

Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non-farm problems as linear programming models and solutions. Theory of duality.

UNIT II - Extension of linear programming models

Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

Block III - Game Theory

UNIT I - Concepts of game theory

Game Theory- Concepts of game theory, two-person constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game as Linear Programming.

Practical

Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex methods. Formulation of the simplex matrices for typical farm situations. Methods of solving transportation problems. Problems related to Game theory.

Teaching Schedule:

Theory: Linear Programming

Lecture No.	Topic	Weightage
1,2,	Decision making : Introduction, Decision making environment, Decision under uncertainty Criterion : Laplace, Maximin or Minimax, Maximax or Minimin, Savage and Hurwicz criterion	15
3,4,	Decisions under risk : Criterion : Expended monetary value, Expected opportunity loss, Expected value of perfect information	10
5,6	Linear programming : Introduction, Components: Decision variables, objective function coefficient, Technological coefficient, Availability of resources. Assumptions: Linearity, Divisibility, Non negativity, Additively. Properties of linear programming Solution: Feasible, Optimal, Alternate optimum, unbounded, Infeasible and degenerate solution.	20

7	Application of LP, Development of LP models / problems.	10
8	Graphical method	5
9,10	Simplex methods, maximization, minimization problems, Big M method, Theory of duality Dual simplex method formulation of dual problem.	10
11	Transportation problem Recursive and dynamic programming.	10
12,13	Inventory Management, Reasons, Types, Decisions, Economic order quantity	10
14,15,16	Game Theory: Concepts, Two person zero sum, maximin, Minimax principle, saddle point, Mixed strategies.	10

Teaching Schedule: Practical

Exercise No.	Topic
1	Graphical method problems
2	LP Model formulation
3	Simplex method: Maximization problem.
4& 5	Simplex method: Minimization problem
6	Big M Method
7	Dual simplex Method
8& 9	Transportation problems Balanced and unbalanced Transportation problem
10	Northwest corner cell Method
11	Least cost cell method
12	Vogel's approximation method
13	Game with pure strategies
14	Game with mixed strategies.
15	Dominance property
16	Formulation of simplex matrices for farm situations

Teaching Methods / Activities

- Lectures
- Case studies
- Assignments (Group / Individual)
- Power point presentations

Learning outcome

After the completion of the course the students will be able to-

- Understand various techniques of optimization

- Be able to apply linear programming techniques to issues in agriculture and other fields, where optimal allocation is required

Suggested Readings

- Vohra ND. 2006. Quantitative Techniques in Management. McGraw Hill
- Dorfman R. 1996. Linear Programming & Economic Analysis. McGraw Hill.
- Loomba NP.2006. Linear Programming. Tata McGraw Hill.
- Shenoy G. 1989. Linear Programming-Principles & Applications. Wiley Eastern Publ.
- Vaserstein. 2006. Introduction to Linear Programming. Pearson Education Publication
- C. R. Kothari, 2021, Quantitative Techniques - 3rd Edition-Vikas Publications

AEC-509 Research Methodology for Social Sciences 1+1

Why this course

Planning of research is very crucial to conduct successful research. There is need to give an insight to the student about how to conduct a research, right from data collection to analysis and finally writing the references.

V. Aim of the course

The course deals with scientific methods of research, the initiation of an inquiry, formulation of research problems and hypotheses, the role of induction and deduction in research, collection and analysis of date and interpretation of results

VI. Organization of the course

The course is organised as follows:

No Block	Unit
1. Concepts of research methodology	1. Concepts of research methodology
2. Building up hypothesis and sample selection	1. Hypothesis: Framing and Testing
	2. Sampling
3.Data collection and analysis	1. Data collection
	2. Data Analysis

VII. Theory

Block 1: Concepts of research methodology

Unit 1: Concepts of research methodology

Importance and scope of research in agricultural economics. Types of research– Fundamentals vs. Applied. Concept of researchable problem–research prioritization– selection of research problem. Approach to research–research process.

Block 2- Building up hypothesis and sample selection

Unit 1: Hypothesis

Framing and Testing Hypothesis–meaning–characteristics–types of hypothesis–review of literature- Setting of Course Objective and hypotheses–testing of hypothesis.

Unit 2: Sampling

Sampling theory and sampling design – sampling error - methods of sampling – probability and non-probability sampling methods - criteria to choose. Project

proposals–contents and scope–different types of projects to meet different needs-trade-off between scope and cost of the study. Research design and techniques- Types of research design.

Block 3- Data Collection and Analysis

Unit 1: Data Collection

Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pretesting.

Unit 2: Data Analysis

Data coding, tabulation, cleaning validation of data. Tools of analysis – data processing. Interpretation of results – Preparing research report / thesis–Multivariate analysis – factor analysis' PCA' cluster analysis. Universal procedures for preparation of bibliography – writing of research articles.

Practical

- Exercises in problem identification.
- Project proposals – contents and scope.
- Formulation of Objective and hypotheses.
- Assessment of data needs–sources of data–methods of collection of data.
- Methods of sampling–criteria to choose–discussion on sampling under different situations.
- Scaling Techniques– measurement of scales.
- Preparation of interview schedule - Field testing.
- Method of conducting survey.
- Exercise on coding, editing, tabulation and validation of data.
- Preparing for data entry into computer.
- Hypothesis testing–Parametric and Non-Parametric Tests.
- Exercises on format for Thesis/ Report writing.
- Presentation of the results.

Teaching Schedule:

Theory: Research Methodology for Social Sciences

Lecture No.	Topic(s)	Weightage (%)
1	Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied.	3
2	Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.	4
3	Framing and Testing Hypothesis – meaning - characteristics - types of hypotheses	3
4	Review of literature – Setting of course objectives and hypotheses - Testing of hypothesis.	3
5	Sampling theory and sampling design – sampling error - methods of sampling – probability and non-probability sampling methods - criteria to choose.	3
6	Project proposals – contents and scope – different types of projects to meet different needs – trade-off between scope and cost of the study.	3
7	Research design and techniques – Types of research design	3
8	Data collection – assessment of data needs – sources of data collection – discussion of different situations.	3
9	Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions.	3
10	Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture.	3
11	Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.	4
12	Data coding, tabulation, cleaning, validation of data.	3
13	Tools of analysis – data processing and Interpretation of results – Preparing research report / thesis	3
14	Multivariate analysis and Factor analysis,	3
15	Principal Component Analysis (PCA) and Cluster analysis.	3
16	Universal procedures for preparation of bibliography – writing of research articles.	3

Teaching Schedule: Practical:

Exercise No.	Title of Exercise
1	Identification of need-based problem in local areas. Project proposals – contents and scope.
2	Formulation of Objective and hypotheses.
3	Assessment of data needs – sources of data – methods of collection of data
4& 5	Methods of sampling – criteria to choose – discussion on sampling under different situations.
6	Scaling Techniques – measurement of scales.
7	Preparation of interview schedule and Field testing.
8	Method of conducting survey.
9	Exercise on coding, editing,
10	Exercise on tabulation and validation of data.
11	Preparing for data entry into computer.
12	Analysis of data
13	Hypothesis testing – Parametric Tests.
14	Hypothesis testing –Non-Parametric Tests.
15	Exercises on format for Thesis / Report writing.
16	Presentation of the results.

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Group Discussions

Learning outcome

After the successful completion of this course, student will be able to-Understand fundamentals of research. How to carefully plan out the research work and conduct it.

Suggested Reading

- Baker CB. *Research Methodology in Agricultural Economics*
- Cohen MR and Nagel R. *An Introduction to Logic and Scientific Method*
- Devey J Logic. *The Theory of Enquiry*
- Dhondhyal SP. *Social Science Research and Thesis Writing*
- Ezekiel M. *Correlation Analysis*
- Heady EO. *Linear Programming Methods*
- Willson ER. *An Introduction to Scientific Research*

- Kumar A.2008. *Research Methodology: A Survey.* Alts, New Delhi.
- P. C. Tripathi *A textbook of Research Methodology in Management and Social Sciences.*
- Black TR. 1993. *Evaluating Social Science Research - An Introduction. SAGE* Publ.
- Creswell JW. 1999. *Research Design - Qualitative and Quantitative Approaches*. SAGE Publ.
- Kothari CR. 2004. *Research Methodology - Methods and Techniques*. WishwaPrakashan, Chennai.
- Rao KV. 1993. *Research Methodology in Commerce and Management.* Sterling Publ., New Delhi.
- Singh AK. 1993. *Tests, Measurements and Research Methods in Behavioral Sciences*. Tata McGraw-Hill.
- Venkatasubramanian V. 1999. *Introduction to Research Methodology in Agricultural and Biological Sciences*. SAGE Publ.

AEC-510 Indian Economy: History and Contemporary Issue 2+0

Why this course?

India is a developing economy. The evolution of the Indian economy will enlighten the student with how an economy develops. Students will understand how the policies and measures taken shape up the economy of the country.

Aim of the course

To introduce the students to the economic history over a period of time. It also highlights the contemporary issues of Indian economy.

Organization of the course

The course is organized as follows:

No Block	Unit
1.History of Indian Economy	1. India from Independence to Liberalization 2. India since 1980's (Liberalization and Beyond): Overview 3.Macro Trends Since1990
2.Contemporary Issues	1.Contemporary Issues

Theory

Block 1-History of Indian Economy

Unit 1: India from Independence to Liberalization

An overview of the economic developments during the period 1947-1980; Objectives and strategies of planned economic development and the role of the State; Sectoral growth performance; savings and investment; Demographic trends and issues; education; health and malnutrition; Trends and policies in poverty; inequality and unemployment.

Unit 2: India Since 1980's (Liberalization and Beyond): Overview

Policy Changes since 1980s. The 1990 Crisis. Causes and Effects of Regional differences: infrastructure, primary, secondary and tertiary sector.

Unit 3: Macro Trends Since 1990

Growth; Savings and Investment, Employment; productivity; diversification; Agro- based industries; competition policy; foreign investment, Regional differences.

Block 2- Contemporary Issues

Unit1: Contemporary Issues

Monetary and Financial trends- areas of government spending in India, Capital expenditure, revenue expenditure, plan expenditure, non-plan expenditure, Deficits (fiscal, primary, revenue), impact of fiscal deficit on economy, Capital receipts, revenue receipts, tax and non tax revenue, direct and indirect taxes, need to rationalize tax structure. Goods and Services Tax (GST). Union Budget, Zero base budgeting, Gender budgeting, Fiscal devolution and centre state financial relations in India, WPI, CPI implicit deflators. Foreign Trade policy.

Teaching Schedule:

Theory: Indian Economy: History and Contemporary Issue

Lecture No.	Topic	Weightage (%)
1	An overview of the economic developments during the period 1947-1980	03
2	Objectives and strategies of planned economic development and the role of the State	03
3	Sectoral growth performance; savings and investment	03
4	Demographic trends and issues; education; health and malnutrition	03
5	Trends and policies in poverty	03
6	Inequality and unemployment	03
7	Policy Changes since 1980s	04
8	The 1990 Crisis	04
9	Causes and Effects of Regional differences:	03
10	Infrastructure, primary, secondary and tertiary sector	03
11	Growth; Savings and Investment	04
12	Employment; productivity; diversification	05
13&14	Agro- based industries, competition policy	06
15&16	Foreign investment, Regional differences	06

17	Monetary and Financial trends- areas of government spending in India	03
18	Capital expenditure, revenue expenditure	04
19&20	Plan expenditure, non-plan expenditure	06
21	Deficits (fiscal, primary, revenue)	04
22	Impact of fiscal deficit on economy	03
23	Capital receipts, revenue receipts, tax and non tax revenue	03
24	Direct and indirect taxes, need to rationalize tax structure	03
25	Goods and Services Tax (GST).	03
26&27	Union Budget, Zero base budgeting, Gender budgeting	04
28	Fiscal devolution and centre state financial relations in India,	03
29&30	WPI, CPI implicit deflators	05
31&32	Foreign Trade policy	06

Teaching Methods /Activities

- Lectures
- Power point presentation by students on monetary and fiscal policy in past and present.
- Assignments(Group/individual).
- Group Discussions on Tax and its reforms.

Learningoutcome

After the completion of the course the student will be able to-Visualize how the Indian economy has evolved. Get acquainted with the basic steps involved in the working of the national economy.

Suggested Reading

- Dutt and Sundaram. *Indian Economy*
- Ramesh Singh 2010, Indian Economy, Tata McGraw Hill

AEC-511 International Economics 1+1

Why this course?

The era of Globalization, liberalization and privatization has unified the whole world. There is trade across national boundaries and one economy has effect on the other. Getting familiar with national economy is not sufficient to understand the mechanism of trade and economic aspects. Thus, this course is designed to teach student about the trade as international level.

Aim of the course

The major objective of this course is to give an insight of the interactions between national economies. What are the theories governing the trade across national boundaries. The methods involved to regulate the international trade and institutions involved.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction	1. Concepts of International Economics
2. Models, Rate and terms of trade	1. Barriers to trade 2. Models of trade 3. Rates and Terms of trade
3. Institutions	1. Trades Institutions

Theory

Block 1- Introduction

Unit 1: Concepts of International Economics

Scope and Significance of International Economics – The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) – Equilibrium in a Simple Open Economy-Possibility of World Trade-Trade gains and Trade Equilibrium.

Block 2- Models, Rate and Terms of Trade

Unit 1: Barriers to trade

Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.

Unit 2: Models of trade

Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model - Trade Creation and Trade Diversion – Offer Curve - Export Supply Elasticity and Import Demand Elasticity–Comparative Advantage and Absolute Advantage.

Unit 3: Rates and Terms of trade

Foreign Exchange Rates. Official Exchange Rate and Shadow Exchange Rate - Walra's Law and Terms of Trade–Trade Blocks.

Block 3- Institutions

Unit 1: Trades Institutions

IMF, World Bank, IDA, IFC, ADB– International Trade agreements– Uruguay Round– GATT–WTO.

Practical

- Producer's Surplus, Consumer's Surplus, National Welfare under Autarky and Free Trade Equilibrium with small and large country assumption.
- Estimation of Trade Gains
- Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC
- Estimation of Offer Curve Elasticity
- Estimation of Effect of Tariff, Export Subsidy, Producer Subsidy, Import Quota and Export Voluntary Restraints on National Welfare
- Estimation of Ricardian Model
- Estimation of Effect of Trade under Specific Factor Model
- Estimation of trade Equilibrium under Heckscher-Ohlin model.

Teaching Schedule:

Theory: International Economics

Lecture No.	Topic	Weightage (%)
1	Scope and Significance of International Economics.	5
2	The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium	5
3	Equilibrium in a Simple Open Economy-Possibility of World Trade-Trade gains and Trade Equilibrium.	5
4,5	Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.	10
6,7	Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model -	20
8	Trade Creation and Trade Diversion	5
9	Offer Curve - Export Supply Elasticity and Import Demand Elasticity	5
10	Comparative Advantage and Absolute Advantage.	5
11	Foreign Exchange Rates. Official Exchange Rate and Shadow Exchange Rate	10
12	Walra's Law and Terms of Trade–Trade Blocks.	5
13	Introduction , role and objectives of IMF, World Bank	5
14	Introduction , role and objectives of IDA, IFC, ADB	5
15,16	International Trade agreements– Uruguay Round–GATT–WTO.	15

Practical Schedule

Exercise No.	Title of Exercise
1	Estimation of Producer's Surplus
2	Estimation of Consumer's Surplus
3	Estimation of National Welfare under Autarky with small and large country assumption
4	Estimation National Welfare under Free Trade Equilibrium with small and large country assumption.
5	Estimation of Trade Gains
6	Estimation of competitive and comparative measures like NPC and EPC
7	Estimation of competitive and comparative measures like ERP and DRC
8	Estimation of Offer Curve Elasticity
9	Study of Impact of tariff on Export

10	Estimation of Effect of Export Subsidy on export
11	Estimation of Effect of Producer Subsidy on export
12	Estimation of Effect of Import Quota on export
13	Estimation of Effect of Export Voluntary Restraints on National Welfare
14	Estimation of Ricardian Model
15	Estimation of Effect of Trade under Specific Factor Model
16	Estimation of trade Equilibrium under Heckscher-Ohlin model

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Power point presentation on International Trade in current scenario.

Learning outcome

After successful completion of the course the student will be able to –Understand how trade take place between nations. Be able to work out strategies to maintain a favorable trade balance. Understand how the institutions play role in regulating the cross country trade and deal with the issues.

Suggested Reading

- Kindelberger and Joshi PK.2016. International Economics AITBS Delhi-110051
- Brouwer F. International Trade and Food Security. LEI- Wageningen UR, The
- Netherlands.
- Apple Yard D R & Field A J Jr. 1995. International Economics - Trade, Theory and
- Policy. Irwin, Chicago.
- Cherunilam F. 1998. International Economics. Tata McGraw Hill.
- Krugman PR &Obstfeld M. 2000. International Economics – Theory and Policy.
- Addison-Wesley.
- M.L. Jhingan, 1990-International Economics. Vrinda Publishers

AEC-512 Institutional Economics 1+0

Why this course?

Institutions are involved in framing of economic development. The human behavior is governed by the institutions working in their environment. Thus, the student need to understand the institutions and their working.

Aim of the course

To develop critical and informed understanding about institutions, their role in the working of economy. Exposure of issues, policies & regulations and its application in agricultural system

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction	1. Basics of Institutional Economics
2. Approaches	1. Institutional changes & Resource allocation
	2. Group and collective Approach
3. Law Protection and Institutions	1. Property rights
	2. Agrarian Institutions

Theory Syllabus

BLOCK 1: Introduction

UNITI: Basics of Institutional Economics

Old and New Institutional Economics - Institutional Economics Vs Neo- classical, Economics. Definition of institutions – Distinction between institutions and organizations - Institutional evolution

BLOCK 2: Approaches

Unit I: Institutional changes & Resource allocation

Institutional change and economic performance - national and international economic institutions. Transaction cost economics – Transaction costs and the allocation of resources. Transaction costs and efficiency. Asymmetric information, - Moral hazard and Principal-Agent problem.

UNITII: Group and collective Approach

Free rider problem – path dependency – Interlinked transactions. Collective action and thee limitation of free-rider problem - The logic of collective action and its role in reducing free rider problem – theory of Groups. Rent seeking – interest groups and policy formulation.

BLOCK 3: Law Protection and Institutions

Unit I: Property right

Economic analysis of property rights- property rights regimes – private property – State Property - Common property Resources (CPRs) – public goods and club goods.

UNITII: Agrarian Institution

Special features of institutional arrangements in agriculture – Transaction costs in agriculture -Case Studies - Theories of agrarian institutions - tenancy institutions.

Teaching schedule:

Theory: Institutional Economics

Lecture No.	Topics	**Weightage** (%)
1	Institutional Economics, meaning, definitions	2
2	Institutional economics Vs Neo classical economics	2
3	Concept of old and new institutional economics	**2**
4	Institutions and organizations, meaning, definitions, Distinction between institutions and organizations	8
5	Institutional change and their economic performance	4
6	National and international economic Institutions and their role in economic development	8
7	Transaction cost and allocation of resources	4
8	Transaction cost and efficiency	4
9	Moral hazards and principle problems in moral hazards	6
10	Path dependency – meaning interlinked transactions	6
11	Free rider problems – meaning collective action and elimination of free rider problems	6
12	The logic collective action and its role in reducing free rider problem	6
13	Theory of groups, Rent seeking, interest groups and policy formulation	8
14	Property rights – meaning, economic analysis of property rights	6
15	Private property, state property resources Public goods and club goods	6
	Special features of institutional arrangements in agriculture	10

16	Transaction costs in agriculture Theories of agrarian institutions tenancy institutions	6

Teaching Methods /Activities

- Lectures.
- Case studies.
- Assignments(Group/individual).
- Group Discussions on Property rights

Learning out come

After successful completion of this course the student will be able to- Understand institutions and their roles in economic development. Know about the policies and their issues in an institution.

Suggested Reading

- Stonier & Hegue. A Text Book of Economic Theory
- Samuelson PA. 1948. Foundation of Economic Analysis. Harvard University Press
- MC Vaish Allid. 1983. Macro–Economics Theory
- Gardner Ackley. 1961. Macro–Economic Theory: Macmillan, New York.
- TF Dernburg& DM Mcdougali-Macro Economics
- G. Sirkin – Introduction to Macro–Economic Theory
- RL Heibroker-Understanding Macro–Economics
- JK Mehta –Macro Economics
- Michael R Edgemand – Macro-Economics: Theory & Policy
- David' W Pearce –The dictionary of modern Economics
- Dwivedi D. N. Macroeconomics Theory and Policy AhujaHL.2007Macroeconomics:TheoryandPolicy.
- EugeneADiulio2006.Macroeconomics.4thEd.

AEC-513 Natural Resource and Environmental Economics 1+1

Why this course?

Sustainable development is the need of the hour. The economic activities affect not only the society but also the environment. Every activity has its social cost. The students, hence will be taught about the economic aspect of environment.

Aim of the course

To understand about economics of environment and social costs incurred due to economic development. Work out methods to maintain environment quality and reduce social costs

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction to natural resource and environmental economics	1. Basic Foundation
2. Insight of the subject	1. Theories and economics of natural resources
	2. Functioning of market
3. Dealing with Issues and sustainability	1. Environmental Issues
	2. Regulations
	3. Sustainability aspects

Theory

Block 1- Introduction to natural resource and environmental economics

Unit 1: Basic Foundation

Concepts, Classification and Problems of Natural Resource Economics – Economy Environment interaction – The Material Balance principle, Entropy Law-Resources Scarcity-Limits to Growth-Measuring and mitigating natural resource scarcity– Malthusian and Recardian scarcity – scarcity indices - Resource Scarcity and Technical Change.

Block 2- Insights of the subject

Unit 1: Theories and economics of natural resources

Theory of optimal extraction renewable resources– economic models of oil extraction-efficiency - time path of prices and extraction - Hotelling's rule, Solow-Harwick's Rule.

Theory of optimal extraction exhaustible resources – economic models of forestry and fishery.

Unit 2: Functioning of Market

Efficiency and markets– market failures- externalities– types- property rights– transaction costs – Coase's theorem and its critique - public goods - common property and open access resource management- Collective action.

Block 3- Dealing with the issues and sustainability

Unit1: Environmental Issues

Environmental perspectives - biocentrism, sustainability, anthropocentrism – Environmental problems and quality of environment- Sources and types of pollution-air, water, solid waste, land degradation– environmental and economic impacts-Economics of pollution control- efficient reduction in environmental pollution.

Unit 2: Regulations

Environmental regulation – economic instruments - pollution charges – Pigovian tax-tradable permits – indirect instruments – environmental legislations in India.

Unit 3: Sustainability aspects

Concept of sustainable development – Economic Perspective – Indicators of sustainability Relation between development and environment stress-Environmental Kuznet's curve Environmental Accounting– resource accounting methods–International Environmental Issues – climate change – likely impacts – mitigation efforts and international treaties.

Teaching schedule:

Theory: Natural Resource and Environmental Economics

Lecture No.	Topic(s)	Weightage (%)
1	Concepts, Classification and Problems of Natural Resource Economics, Economy Environment interaction	3
2	The Material Balance principle, Entropy Law-Resources Scarcity-Limits to Growth	3
3	Measuring and mitigating natural resource scarcity– Malthusian and Recardian scarcity – scarcity indices - Resource Scarcity and Technical Change.	4
4	Theory of optimal extraction renewable resources– economic models of oil extraction- efficiency - time path of prices and extraction	3
5	Hotelling's rule, Solow-Harwick's Rule, Theory of optimal extraction exhaustible resources – economic models of forestry and fishery.	3
6	Efficiency and markets– market failures- externalities	3
7	types- property rights– transaction costs – Coase's theorem and its critique	3
8	Public goods - common property and open access resource management- Collective action.	3
9	Environmental perspectives - biocentrism, sustainability, anthropocentrism	3
10	Environmental problems and quality of environment-Sources and types of pollution-air, water, solid waste, land degradation	3
11	Environmental and economic impacts-Economics of pollution control- efficient reduction in environmental pollution.	3
12	Environmental regulation – economic instruments - pollution charges – Pigovian tax- tradable permits – indirect instruments – environmental legislations in India.	4
13	Concept of sustainable development – Economic Perspective, Indicators of sustainability	3
14	Relation between development and environment stress-Environmental Kuznet's curve	3
15	Environmental Accounting– resource accounting methods–	3
16	International Environmental Issues – climate change – likely impacts – mitigation efforts and international treaties.	3

Teaching schedule: Practical

Exercise No.	Title of Exercise
1&2	Exhaustible resource management–optimum rate of oil extraction.
3& 4	Renewable resource management– optimum harvest of Forestry/fishery.
5	Exercise on pollution abatement-I.
6	Exercise on pollution abatement-II.
7	Concepts in valuing the environment.
8	Taxonomy of valuation techniques.
9& 10	Productivity change method – substitute cost method
11	Hedonic price method
12	Travel cost method Contingent valuation methods.
13 & 14	Discount rate in natural resource management.
15	Environment impact assessment
16	Visit to Pollution Control Board.

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).

Learning outcome

After successful completion of this course, the student will be able to-Work out the plan for extraction / use of natural resource in most economical way. Understand the environment and its pollution. Learn how markets are affected if environment is not taken into consideration. Gain proficiency in rules and regulation governing economic aspect of environment.

Suggested Reading

- Pearce D W and Turner RK. *Economics of Natural Resource and Environment*
- Kwak J .*Economism: Bad Economics and the Rise of Inequality*
- Tietenberg T and Lewis L. *Environmental and Natural Resource Economics*
- Schwarz PM. *Energy Economics*
- Ahmad Y, El Serafy S & Lutz E. (Eds.). 1989.Environmental Accounting for Sustainable Development. World Bank.
- Freeman AM. 1993. *The Measurement of Environmental and Resource Values*. Resources for the Future Press, Baltimore.

- Hackett SC. 2001. *Environmental and Natural Resource Economics: Theory, Policy, and the Sustainable Society*. M. E. Sharpe, Armonk, NY.
- Hartwick JM &Olewiler ND. 1998. *The Economics of Natural Resource Use*. 2nd Ed. Addison-Wesley Educational Publ.
- Kerr JM, Marothia DK, Katar Singh, Ramasamy C & Bentley WR. 1997. *Natural Resource Economics: Theory and Applications in India.* Oxford & IBH.
- Kolstad CD. 2000. Environmental Economics. Oxford Univ. Press. Pearce DW & Turner K. 1990. *Economics of Natural Resources and the Environment*. John Hopkins Univ. Press.
- Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.
- Sankar U. 2001. Environmental Economics. Oxford Univ. Press.
- Sengupta R. 2000. *Ecology and Economy, an Indian Perspective*. Oxford Univ. Press.

AEC-514 Commodity Futures Trading 2+0

Why this course?

Risk is involved in marketing. Price fluctuation is a very common phenomenon in agriculture marketing. In such situation selling of commodity in future market serves as a resort to insulate from this uncertainty. Thus, knowledge of futures market is helpful in...

Aim of the course

To disseminate the knowledge about risk mitigating measures especially future trading. The future trading in agricultural commodities is increasing day by day therefore the role of SEBI, functioning of commodity exchanges are discussed.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction to commodity market	1. Concepts of commodity future trading
2. Techniques and risks in commodity Market	1. Technical aspects 2. Risk and its Management
3. Commodity exchange and market analysis	1. Commodity Exchange–A review 2. Analysis of commodity market

Theory Syllabus :

Unit I

History and Evolution of commodity markets–Terms and concepts: spot, forward and futures Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures.

Unit II

Transaction and settlement – delivery mechanism - role of different agents –trading strategies- potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.

Unit III

Risk in commodity trading, importance and need for risk management measures-managing market price risk: hedging, speculation, arbitrage, swaps-pricing and their features.

Unit IV

Important global and Indian commodity exchanges - contracts traded – special features -

Regulation of Indian commodity exchanges - FMC and its role.

Unit V

Fundamental Vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introductiontotechnicalanalysissoftware–analyzingtradingpatternof different commodity groups.

Teaching Schedule:

Theory-Commodity Futures Trading

Lecture No.	Topic	Weightage (%)
1 & 2	History and evaluation of commodity markets	05
3&4	Terms and concepts used - commodity market, spot market. forward and futures market. Differentiate between forward and futures market	10
5	Factors influencing spot and futures market	10
6&7	Speculator mechanism in commodity futures	05
8&9	Transactions and settlement delivery mechanism. Role of different agents	08
10&11	Trading strategies - potential impact of interest rate	03
12&13	Foreign exchange FDI in commodity markets	05
14&15	Risk in commodity trading, importance and need for risk management measures	05
16,17,&18	Managing market price risk hedging, speculation, Arbitrage, swaps - pricing and their features.	10
19&20	Important global and Indian commodity exchanges	05
21&22	Contracts traded Special features Regulation of Indian commodity exchange	05
23&24	FMC & its role	10
25,26&27	Fundamental Vs Technical analysis - Consumption and interpretation of charts & chart patterns for analyzing the market trend.	10
28&29	Market indicators - Back testing	05
30,31&32	Introduction to technical analysis software Analysing trading pattern of different commodity groups	04

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Group Discussions.
- Power point presentations by students.

Learning outcome

After successful completion of this course, the student will be able to-The basic concepts of commodity markets. The national and international commodity markets.

Suggested Reading

- Kaufman PJ.1986. *The Concise Handbook of Futures Markets*: Jhon Wiley & Sons
- Purcell WD. 1991.*Agricultural Futures and Options: Principles and Strategies*: MacMillan Publications
- Wasendorf RR &McCaffery 1993. *All About Commodities from the Inside Out.* McGraw Hill
- Leuthold RM, Junkus JC &Cordier JE. 1989. The Theory and Practice of Futures Markets. Lexington Books.
- Lofton T. 1993. Getting Started in Futures. 3rd Ed. John Wiley & Sons, 1993.

AEC-515 Development Economics 2+0

Why this course?

Development is more important than growth. The development of a nation ensures that condition of welfare prevails. The student has to understand different measures of development. How to measure them and relevant theories.

Aim of the course

To develop concept of growth and development. Methods and theories of measuring development. Study of different developed economies will give exposure towards measures to create economic upliftment.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Introduction to development economics	1. Conceptions of Development
2. Theories and comparison	1. Theories of Economic growth and Development 2. Comparative Economic Development

Theory

Block 1- Introduction to Development Economics

Unit 1: Conceptions of Development

Development Economics – Scope and Importance - Economic development and economic growth- divergence in concept and approach- Indicators and Measurement of Economic Development –GNP as a measure of economic growth – New Measures of Welfare – NEW and MEW – PQLI – HDI – Green GNP - Criteria for under development – Obstacles to economic development –Economic and Non-Economic factors of economic growth- Development issues, poverty, inequality, Connection between inequality and development, poverty measurement, unemployment and environmental degradation.

Block 2- Theories and comparison

Unit 1: Theories of Economic growth and development

Classical theories- Adam smith- Ricardo- Malthus, Marx's theory of economic development; Schumpeter's theory, Approaches to development- low income equilibrium trap - critical minimum effort- The Strategy of economic development- Balanced vs. Unbalanced growth, choice of technique, investment criteria, big push theory, Rostow's stages of Economic Growth, unlimited supply of labour; social and technological dualisms; roles of capital accumulation, human capital and technological change in economic development, Models of economic growth Harrod- Domar, Kaldor, Mahalanobis, Lewis, Fei-Ranis, Input-Output, multi-sectoral models.

Unit 2: Comparative Economic Development

Countries selected for case studies -USA, Japan, China and India; Overview of economic development is selected countries; agrarian surplus and the role of the peasantry in economic development; industrial revolution; division of labour, organization of work and industrial production, the role of the State in developmental transition

Teaching Schedule:

Theory-Commodity Futures Trading

Lecture No.	Topic	Weightage (%)
1 & 2	Development Economics – Scope and Importance - Economic development and economic growth	05
3&4	Divergence in concept and approach- Indicators and Measurement of Economic Development GNP as a measure of economic growth	10
5& 6	New Measures of Welfare – NEW and MEW – PQLI – HDI – Green GNP	10
7&8	Criteria for under development – Obstacles to economic development	05
9 & 10	Economic and Non-Economic factors of economic growth- Development issues, poverty, inequality	08
11 &12	Connection between inequality and development, poverty measurement, unemployment and environmental degradation.	03
13 &14	Theories of Economic growth and development Classical theories- Adam smith- Ricardo- Malthus, Marx's theory of	05

	economic development	
15 &16	Schumpeter's theory, Approaches to development- low income equilibrium trap - critical minimum effort-	05
17 &18	The Strategy of economic development- Balanced vs. Unbalanced growth, choice of technique, investment criteria, big push theory,	10
19&20	Rostow's stages of Economic Growth, unlimited supply of labour; social and technological dualisms;	05
21&22	Roles of capital accumulation, human capital and technological change in economic development,	05
23, 24& 25	Models of economic growth Harrod- Domar, Kaldor, Mahalanobis, Lewis, Fei-Ranis, Input-Output, multi-sectoral models	10
26&27	Countries selected for case studies -USA, Japan, China and India; Overview of economic development is selected countries	10
28&29	Agrarian surplus and the role of the peasantry in economic development	05
30,31&32	Industrial revolution; division of labour, organization of work and industrial production, the role of the State in developmental transition	04

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Group Discussions on inflation

Learning outcome

After successful completion of this course, the student will be able to-Measure the development using different methods. Understand the theories of development and relate it to real world.

Suggested Reading

- Blaug M. 1986. *Economic History and the History of Economic Thought*
- Chenery HB and TN Srinivasan. *Handbook of Development Economics*
- Baldwin RE. *Economic Development and Growth*. John Willey, New York
- M. L. Jhingan 2016. The Economics of Development and Planning – Vrinda Publications.
- R.K. Lekhi and Jogindar Singh 2020. The Economics of Development and Planning 21st Edition– Kalyani Publishers.

AEC-516 Rural Marketing 2+0

Why this course?

Rural Marketing is more important than growth. The student has to understand different measures of development. How to measure them and relevant theories.

Aim of the course

To explore the possibilities and potential of the rural market. It aims at critically analysing the market opportunities, consumer trends and patterns and development of better marketing strategies for the rural areas.

Organization of the course

The course is organized as follows:

Theory

UNIT I

Concept and scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India

UNIT II

Environmental factors - socio-cultural, economic and other environmental factors affecting rural marketing.

UNIT III

Rural consumer's behaviour - behavior of rural consumers and farmers; buyer characteristics and buying behaviour; Rural v/s urban markets.

UNIT IV

Rural marketing strategy - Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; product mix, pricing Course Objective, pricing policy and pricing strategy.

UNIT V

Product promotion - Media planning, planning of distribution channels, and organizing personal selling in rural market in India

Teaching Schedule: Theory- Commodity Futures Trading

Lecture No.	Topic	Weightage (%)
1, 2& 3	Concept and scope of rural marketing, nature and characteristics of rural markets	05

4, 5 & 6	Potential of rural markets in India	10
7, 8 & 9	Environmental factors - socio-cultural, economic and other environmental factors affecting rural marketing	10
10, 11 &12	Rural consumer's behaviour - behavior of rural consumers and farmers	10
13 & 14	Buyer characteristics and buying behaviour	08
15 & 16	Rural v/s urban markets	07
17, 18,19 & 20	Rural marketing strategy - Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning	10
21 & 22	Product mix	05
23 &24	Pricing Course Objective	10
25 & 26	Pricing policy and pricing strategy.	10
27 & 28	Product promotion - Media planning	05
29,30, 31 & 32	Planning of distribution channels, and organizing personal selling in rural market in India	10

Suggested Reading

- Krishnamacharyulu and Ramakrishnan. 2010. Rural Marketing: Text and Cases: Pearson Education. 2nd edition
- Singh S. 2004. Rural Marketing: Focus on Agricultural Inputs, Vikas Publishing
- Kashyap P. 2011. Rural Marketing. Pearson Education
- Kumar D and Gupta P. 2017. Rural Marketing: Challenges and Opportunities. Sage Publications.
- Ramaswamy VS &Nanakumari S. 2006. Marketing Management. 3rd Ed. MacMillan.
- Singh AK & Pandey S. 2005. Rural Marketing. New Age.

AEC-517 Evaluation of Economic Thought 1+0

Why this course?

Evaluation of Economic Thought is more important. The student has to understand different measures of development. How to measure them and relevant theories.

Aim of the course

Evaluation of Economic thought to study the thoughts of scientists.

Organization of the course

The course is organized as follows:

Theory

Unit I

Approaches for the study of History of economic thought Absolutist vs. Relativist approaches. Economic Thoughts of the various economist like Adam Smith, Paul Samuelson and Keynes. Economic History: Evolution of economics from Great Depression, Economic theory, econometrics. Development of the Ancient economic thoughts medieval economic thought, Mercantilism(evolution of trade, tariff with new voyages in 1942), physiocracy (circular flow of income), Forerunners of Classical Political Economy.

Unit II

Development of Classical Thoughts (Adam Smith & Robert Malthus), Development of Classical Thoughts (David Ricardo), Critics of Classical Thoughts, Socialist critics – Socialist, Marxian Economic Ideas - Austrian School of Thought, Origins of Formal Microeconomic Analysis - William Stanley Jevons, Cournot and Dupuit.

Unit III

The birth of neoclassical economic thought- Marshal & Walrus, General Equilibrium Theory, Welfare Theory and Keynesian economics.

Unit IV

The Era of globalization - Experiences of developing world - Rigidity of the past "vs " emerging realism, The changing path of international Institutions to economic growth and development approaches.

Unit-V

Economic Thought in India - Naoroji and Gokhale - Gandhian Economics, Economic thought of independent India - Nehru's economic philosophy, Experiences of the Structural adjustment programmes of the post.

Theory Lesson Plan:

Lectures	Topics	Weightage
	Unit-I	
1	Approaches for the study of History of economic thought Absolutist vs. Relativist approaches	3
2	Economic Thoughts of the various economist like Adam Smith, Paul Samuelson and Keynes. Economic History: Evolution of economics from Great Depression, Economic theory, econometrics	3
3	Development of the Ancient economic thoughts medieval economic thought.	3
4	Mercantilism(evolution of trade, tariff with new voyages in 1942), physiocracy (circular flow of income), Forerunners of Classical Political Economy	4
	Unit-II	
5	Development of Classical Thoughts (Adam Smith & Robert Malthus).	3
6	Development of Classical Thoughts (David Ricardo).	3
7	Critics of Classical Thoughts, Socialist critics - Socialist	3
8	Marxian Economic Ideas - Austrian School of Thought	3
9	Origins of Formal Microeconomic Analysis - William Stanley Jevons, Cournot and Dupuit.	3
	Unit-III	
10	The birth of neoclassical economic thought- Marshal & Walrus	3
11	General Equilibrium Theory, Welfare Theory and Keynesian economics	4
	Unit-IV	
12	The Era of globalization - Experiences of developing world - Rigidity of the past "vs " emerging realism	3
13	The changing path of international Institutions to economic growth and development approaches	3
	Unit-V	
14	Economic Thought in India - Naoroji and Gokhale - Gandhian Economics.	3
15	Economic thought of independent India - Nehru's economic	3

	philosophy	
16	Experiences of the Structural adjustment programmes of the post	3

Suggested Readings

- Blaug M. 1964. Economic Theory in Retrospect Heineman.
- Blaug M. 1986. Economic History and the History of Economic Thought Wheatsheaf Books, Brighton.
- Ekelund RB & Hebert RF, 1975. A History of Economic Theory and Methods. McGraw-Hi11.
- John Mills A.2002. Critical History of Economics. Missed opportunities. Palgrave Macmillan.
- Screpanti E & Zamagni S. 1995. An Outline of the History of Economic Thought. Clarendon Press, Oxford'
- V. Lokanathan 1973- A History of Economic Thought- S. Chand Publishing

Course Contents
Ph. D. (Agricultural Economics)

AEC-601 Advanced Micro Economic Analysis 1+1

Why this course?

This course is required to up scale the knowledge of students about microeconomics. So that they can get a deeper and better understanding of the subject

Aim of the course

To gain fundamental understanding of consumer behavior, producer's strategy, market structure through which transactions take place and human and firms interact. Develop foundation of scarce resource allocation for optimum results.

Organization of the course

The course is organized as follows–

No Block	Unit
1. Consumer Theory	1. Consumer Theory
2. Market and General equilibrium	1. Market 2. General Equilibrium
3. Market failure and welfare	1. Market Failure 2.Welfare Economics

Theory

Block 1- Consumer Theory

Unit 1: Consumer Theory

Theory of consumer behavior – Duality in consumer theory - expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions– Integrability of demand functions. Demand Models–Linear Expenditure System, Almost Ideal Demand System. Applications of consumer theory– Household model and time allocation–Labour supply decisions by households.

Block 2- Market and General Equilibrium

Unit 1: Market

Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models–collusive and non-collusive models of oligopoly- Cournot model, Chamberlin model, Stackleberg solution.

Unit 2: General Equilibrium

General equilibrium theory–Conceptual overview- General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.

Block 3- Market Failure and Welfare

Unit 1: Market failure

Market failure - Incomplete markets - Asymmetric information – Principal-Agent problem, adverse selection and moral hazard. Externalities– Network externalities, Public goods– Optimal provision of public goods.

Unit 2: Welfare Economics

Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare – Criteria for social welfare – Social Welfare functions, Social versus Private costs and benefits.

Practical

- Problems in consumer utility maximization
- Estimation of income and substitution effects;
- Estimation and comparison of Consumer's surplus, equivalent variation and compensating variation.
- Estimation of demand models– Derivation and estimation of labour supply equations from household models comparative static analysis in consumption.
- Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition.
- Game theory models.
- Problems solving in General Equilibrium Theory and Welfare Economics.
- Problems in public goods provision.

Theory Lecture Schedules:

Lecture No.	Details of Topic	Weightage
1	Theory of consumer behavior- Duality in consumer theory - expenditure function and indirect utility function	**4**
2 & 3	Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating.	**4**
4	Variation and Equivalent Variation - Dynamic versions of demand functions– Integrability of demand functions.	**4**
5	Demand Models–Linear Expenditure System, Almost Ideal Demand System.	**3**
6	Applications of consumer theory– Household model and time allocation–Labour supply decisions by households.	**4**
7	Perfect competition – Monopoly, monopolistic competition and oligopoly.	**3**
8	Oligopoly models–collusive and non-collusive models of oligopoly- Cournot model, Chamberlin model, Stackleberg solution.	**4**
9	General equilibrium theory–Conceptual overview- General equilibrium conditions with Production and Consumption.	**4**
10	Existence, Uniqueness and Stability of general competitive equilibrium.	**3**
11	Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.	**3**
12	Market failure - Incomplete markets - Asymmetric information – Principal-Agent problem, adverse selection and moral hazard.	**4**
13	Externalities– Network externalities, Public goods– Optimal provision of public goods.	**3**
14	Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics,	**3**
15 & 16	Pareto conditions of maximum welfare – Criteria for social welfare – Social Welfare functions, Social versus Private costs and benefits.	**4**

Practical:

Exercise No.	Title of Exercise
1	Problems in consumer utility maximization
2	Estimation of income and substitution effects;
3& 4	Estimation and comparison of Consumer's surplus, equivalent variation and compensating variation.
5, 6 & 7	Estimation of demand models– Derivation and estimation of labour supply

	equations from household models comparative static analysis in consumption.
8, 9 & 10	Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition.
11 & 12	Game theory models.
13 & 14	Problems solving in General Equilibrium Theory and Welfare Economics.
15 & 16	Problems in public goods provision.

Teaching Methods/Activities

- Lectures
- Case studies
- Assignments (Group/individual) Group Discussions

Learning outcome

After successful completion of the course, the student will be able to-Understand the different market competition. Work out strategies for attaining equilibrium in the market.

Suggested Reading

- Henderson JM and Quandt RE. *Microeconomic Theory: A Mathematical Approach* Tata McGraw Hill Publishing Co Ltd
- Koutsoyiannis A. *Modern Micro Economics.* Macmillan Press Ltd
- Ferguson and Gould. *Micro Economic Theory.* Richard D Erwin Inc. USA
- Varian HR 1992. *Microeconomic Analysis.*
- Alpha C. Chiang Kevin Wainwright- 1967, Fundamental methods of Mathematical Economics, 4th Edition

AEC-602 Advanced Macro Economic Analysis 2+0

Why this course?

A deeper understanding of the conceptual and structural framework is imperative to develop vision of a student about how the knowledge of various macroeconomic models is applied in real economy.

Aim of the course

To understand the functioning of national economy, its history and models. The policies governing the modern economic system and concerned institutions.

Organization of the course

The course is organized as follows–

No Block	Unit
1. Introduction	1. Overview
2. Economic Models	1. Open Economy Models 2. Dynamic Macroeconomic Models
3. Business cycle and policies	1. Business Cycles 2. Macroeconomic Policies

Theory

Block 1- Introduction

Unit 1: Overview

Conceptual framework - Classical, Keynesian, Neo-Classical, and Neo-Keynesian macroeconomics; Review of Keynes-Classical Synthesis; Aggregate Demand and Supply in the closed economy with fixed and variable price level- determination of wage, prices, output and employment

Block 2- Economic Models

Unit 1: Open Economy Models

Exchange rate determination; purchasing power parity; asset market approach; Short-run open economy models; Mundell-Fleming model- exchange rate regime: perfect capital mobility under fixed and flexible exchange rate; effectiveness of fiscal policy

and monetary policy; Dornbusch's overshooting model; monetary approach to balance of payments; international financial markets

Unit 2: Dynamic Macroeconomic Models

Introduction to dynamic macroeconomic Models; Dynamic aggregate demand and supply–short and long term equilibrium-rational expectations approach

Block 3: Business Cycle and Policies

Unit 1: Business Cycles

Business cycle and its alternative equilibrium model, Stability analysis Economics of Great Events-Depression, Hyperinflation and Deficits; Advances in Business Cycle Theory; Real Business Cycles & Neo-Keynesian Economics

Unit 2: Macroeconomic Polices

Monetary policy - Design of Monetary Policy; Inflation Targeting, Fiscal Policy - Government Budget Constraint: The Arithmetic of Deficits and Debt, Current versus Future Taxes, the Evolution of Debt-to-GDP Ratio; Public Borrowing-Internal and external aid, Deficit financing, Development Financing; BOP & Adjustment Policies-Foreign Exchange Policy -International macro-economic policies, IMF, IBRD, UNCTAD.

Theory Schedule:

Lecture No.	Topic	Weightage (%)
1	Conceptual framework - Classical, Keynesian, Neo-Classical, and Neo-Keynesian macroeconomics	03
2	Review of Keynes-Classical Synthesis	03
3	Aggregate Demand and Supply in the closed economy with fixed and variable price level- determination of wage, prices, output and employment	03
4	Exchange rate determination	03
5	Purchasing power parity; asset market approach	03
6	Short-run open economy models	03
7	Mundell-Fleming model- exchange rate regime	04
8	Perfect capital mobility under fixed and flexible exchange rate	04
9	Effectiveness of fiscal policy and monetary policy	03
10	Dornbusch's overshooting model	03

11	Monetary approach to balance of payments	04
12	International financial markets	05
13&14	Introduction to dynamic macroeconomic Models	06
15&16	Dynamic aggregate demand and supply–short and long term equilibrium-rational expectations approach	06
17	Business cycle and its alternative equilibrium model	03
18	Stability analysis Economics of Great Events-Depression	04
19&20	Hyperinflation and Deficits; Advances in Business Cycle Theory;	06
21	Real Business Cycles & Neo-Keynesian Economics	04
22	Monetary policy - Design of Monetary Policy;	03
23	Inflation Targeting, Fiscal Policy - Government Budget Constraint:	03
24	The Arithmetic of Deficits and Debt, Current versus Future Taxes, the Evolution of Debt-to-GDP Ratio	03
25	Public Borrowing-Internal and external aid, Deficit financing, Development Financing;	03
26&27	BOP & Adjustment Policies	04
28	Foreign Exchange Policy	03
29&30	International macro-economic policies,	05
31&32	IMF, IBRD, UNCTAD	06

Suggested Reading

- HeibrokerRL .Understanding Macro Economics.
- Mehta JK. Macro Economics.
- Edgemand MR. Macro-Economics: Theory &Policy.
- Davi'W Pearce. The dictionary of modern Economics.
- Allen RGD. 1968. Macro–Economic Theory: A Mathematical Treatment. London: Macmillan.
- Stanlake GF. Macro–Economics: An Introduction. Longman, London.
- Mithai DM. 1981. Macro–Economics: Analysis and Policy. Oxford and IBH, New Delhi.
- Hicks JR Critical Essays in Monetary Theory.
- Nawiyn WT. Theory of Money.
- Frogen RT.1999 .*Macro Economic: Theory and Policies*. 6th Ed.
- Ahuja H.L. *Macro Economics: Theory and Policy*.
- D. N. Dwivedi, 2005. Macro-Economics: Theory and Policy.

AEC-603 Advanced Econometrics 2+1

Why this course?

The heart of any research is carrying out the analysis with the most appropriate model. The results obtained are crucial for the researchers. Thus, this course acts as the centre point of building up analytical framework of research. The students need to learn building up of models that will be used to test the hypothesis framed. Use different analysis depending upon the requirement and type of data.

Aim of the course

The course aims at providing the knowledge and command over analysis of data collected to get the desired result. Train the student in use of econometric models.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Concepts	1. Review
2. Least squares and dummy variables	1. Concept of Least Squares 2. Dummy Variable
3. Econometric models	1. Models and their extensions 2.Simultaneous equation models

Theory

Block 1: Concepts

Unit 1: Review

Review of classical regression model–review of hypothesis testing–restrictions on parameters – single equation techniques.

Block 2: Least Squares and Dummy Variables

Unit 1: Concept of least squares

Ordinary least squares – weighted least squares - generalized least squares – method of principal components – instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests – non spherical error terms.

Unit 2: Dummy Variable

Dummy variables - Qualitative and truncated dependent variables - limited dependent variables - Models for qualitative dependent variable–LPM, probit and logit models and their multinomial extensions.

Block 3: Econometric Models

Unit1: Models and their extensions

Autoregressive distributed lag models–panel data fixed and random effects models and their extensions. Analysis of time series – stationarity and unit root test, ARIMA, ARCH group of models and co-integration.

Unit 2: Simultaneous equation models

Simultaneous equation systems: Basic rationale, identification problems, Single equation methods of estimation-indirect least squares, two stage least squares. Limited information maximum likelihood, three-stage least squares, and full information maximum likelihood; Relative merits of these methods and their small and large sample properties. SURE estimates.

Practical

Estimation of multiple regression model - GLS estimation methods - testing misspecification errors estimating and Managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, Logit and Probit models - comparing two regressions - Chow test - estimation of distributed lag models – panel data random and fixed effects models - Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models-unit root tests for stationarity, fitting of ARIMA and ARCH group of models –co integration.

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Group Discussions

Learning outcome

After successful completion of the course, the student will be able to–

- Analyse the data collected for testing the framed hypothesis.
- Get expertise in analytical framework.

Teaching Schedule

	Lecture No.	Topic	Weightage (%)
Theory	1&2	Review of Classical regression Model-OLS I. Multicollinearity II. Heteroscedasticity III. Autocorrelation	10
	3	Review of hypothesis testing	5
	4	Restrictions on parameters	5
	5&6	Single equation techniques: a. Errors of Measurement b. Linear Equality Restrictions: Restricted Least Squares c. Nonlinear (in-the-Parameters)Regressions	5
	7,8,9&10	I. Ordinary least Squares II. Weighted least squares III. Generalized least squares A. The Generalized Least- Squares Estimator B. Prediction C. Heteroscedasticity Disturbances D. Pure and Mixed Estimation E. Grouping of Observations F. Grouping of Equations	10
	11&12	I. Method of principal components	5
	13&14	I. Instrumental variables method II. Maximum Likelihood method a. Methods of Solving the Likelihood Equations b. The Cramer- Rao Lower Bound c. Large Sample Tests Basedon ML d. GIVE and GMM	5
	15&16	Errors in variables, Non-linearity and specification tests a. Classical Solution for a Single Equation Model with One Explanatory Variable b. Single Equation Model with Two Explanatory Variables Two Explanatory Variables: One Measured with Error c. Illustrative Example d. Two Explanatory Variables: Both Measured with	10

	Error e. Reverse Regression f. Instrumental Variable Methods g. Proxy Variables h. Some Other Problems i. Errors of Measurement j. Linear Equality Restrictions: Restricted Least Squares k. Nonlinear Regression l. Specification Bias	
17	Nonspherical error terms	5
18,19&20	I. Dummy variables a. Nature of Dummy variables b. Regression on One Quantitative Variable and One Qualitative Variable with Two Classes or Categories c. Regression on One Quantitative Variable and One Qualitative Variable with More than two Classes d. Regression on One Quantitative Variable and Two Qualitative Variables e. Comparing Two Regressions f. Testing the Equivalency of Two Regressions The Use of Dummy Variables in Seasonal Analysis h. Piece wise Linear Regression i. Summary and Conclusions j. Qualitative and truncated dependent variables	10
21	Limited dependent variables	5
22&23	LPM, Probit and logit models, their multinomial extensions a. Illustrative Example b. The Problem of Dis-proportionate Sampling c. Prediction of Effects of Changes in the Explanatory Variables d. Measuring Goodness of Fit	5
24&25	Auto regressive distributed lag models: a. Role of “Time” or Lag” in Economics b. Reasons for Lags c. Estimation of Distributed Lag Models d. Koyck Approach to Distributed Lag Models e. Rationalization of the Koyck Model: The Adaptive Expectation Model f. Another Rationalization of the Koyck Model: The Stock Adjustment, or Partial Adjustment Models g. Method of Instrumental Variables h. Detecting Autocorrelation in Autoregressive Models: Durbin Test i. An Illustrative Example j. The Almon Approach to Distributed Lag Models: The Almon Polynomial Lag k. Summary and Conclusion	5

26&27	Panel data fixed and random effects models and ther extensions: a. Introduction b. LSD Vor Fixed Effects Model c. Random Effects Model d. Fixed Effects Versus Random Effects e. The SURE Model f. Dynamic Panel Data Models g. Random Coefficient Model h. Analysis of time series a. Stationarity and unit root test b. ARIMA, ARCH group of Models and Co-integration	5
28,29,30, 31&32	**I. Simultaneous equation systems:** a. Basic rationale and Approaches to Estimation b. Recursive Models and Ordinary Least Squares c. EstimationofaJustIdentifiesEquation:TheMethodofIn directLeastSquares d. Estimation of an Over identified Equation: The Method of Two Stage Least Squares e. Summary and Conclusions **II. Identification:** a. Simultaneous equation Systems b. The Identification Problem c. Restrictions on Structural Parameters d. Restrictions on Variances and Covariance c. III.Estimationbyindirectleastsquares2SLS,PIM L,SURE,3SLS.	10

Teaching Schedule

Practical

Exercise No.	Title of Exercise
1	Estimation of Multiple regression model
2	Estimation of GLS Methods
3	Testing misspecification errors
4	Testing and Managing Multi collinearity
5	Testing and Managing Heteroscedasticity and Autocorrelation
6	Estimation of LPM, Logit and Probit Models
7	Comparing the Two Regressions
8	Estimation of Chow Test
9	Estimation of distributed lag models
10	Panel data random and fixed effects models
11	EstimationofIndirectLeastSquares2SLS

12	Estimation of Indirect Least Squares SURE
13	Estimation of Indirect Least Squares PIML
14	Estimation of Indirect Least Squares 3SLS
15	Estimation of Simultaneous equation Models
16	Estimation of Unit root tests for stationarity, fitting of ARIMA and ARCH group of models, Co-integration

Suggested Reading

- GreeneWH.2002. *Analysis*. Pearson Education.
- Johnston J and DinardoJ.2000.*Econometric Methods*. McGraw-Hill.
- Koutseyianis A. 1997.*Theory of Econometrics*. Barner&Noble.
- Maddala, G.S. 2002. *Econometrics.* McGraw Hill.
- Gujarati, D.N. 2003. *Basic Econometrics*. McGraw Hill.
- Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman 1998, Forecasting-Methods and Applications

AEC-604 Advanced Production Economics 2+1

Why this course?

There is requirement of getting acquainted with decision making process in case of factors and products. The researcher needs to understand about working on production process and workout suitable suggestions to improve it.

Aim of the course

The course deals with the concept of advanced production economics. The exposition would be mathematically oriented. The course would also cover the analysis of production functions, its interpretation, decision making with multiple input use, factor sharing and decision making under risk and uncertainty.

Organization of the course

The course is organized as follows:

No Block	Unit
1.Consumer Theory	1. Production Process
2.Market and General equilibrium	1.Production Functions and characteristics
3.Market failure and welfare	1. Decision Making in Production
	2. Technology, Efficiency and Risk Management
	3. Programming

Theory Syllabus:

Block 1: Production Process

UNIT I: Production Process:

Agricultural Production process — Relationship between farm planning and production economics-scope agricultural production and planning- methods/procedures in agro-economic research and planning.

Block 2: Production Function:

UNITI: Production Function and characteristics:

Production functions, components, assumptions, properties and their economic interpretation,

Conceptsofhomogeneity,homotheticity,APP,MPP,elasticitiesofsubstitutionandtheir economicrelevance—Productionrelations—optimality-Commonlyusedfunctionalforms, nature,properties,limitations,estimationandinterpretation-linear,Spillman-

CobbDouglas,quadratic, multiplicative (power) functional forms - Translog, and transcendental functional forms -CES, production functional forms-Conceptual and empirical issues in specification, estimationandapplicationofproductionfunctions-Analyticalapproachestoeconomic optimum -Economic optimum —determination of economic optimum with constant and varying input and output prices- Economic optimum with production function analysis - input use behaviour.

Block 3: Dynamics of Production process

UNITI: Decision making in Production

Decision making with multiple inputs and outputs—MRT and product relationship-cost of production and adjustment in output prices-single input and multiple product decisions. Multi input, and multi product production decisions -Decision making with no risk -Cost of wrong decisions - Cost curves— Principles and importance of duality theory - Correspondence of production, cost, and profit functions - Principles and derivation of demand and supply functions.

UNIT2: Technology and Risk

Technology, input use and factor shares -effect of technology on input use-decomposition analysis-factor shares-estimation methods- Economic efficiency in agricultural production — technical, allocative and economic efficiency — measurement -Yield gaps analysis — concepts and measurement- Risk and uncertainty in agriculture—incorporation of risk and uncertainty indecision making — risk and uncertainty and input use level-risk programming.

UNIT3: Programming

Simulation and programming techniques in agricultural production,-Multiple Objective Programming (MOP),Goal programming Weighted sum and Compromise programming –applications.

Practical Syllabus:

Estimation of different forms of production functions- Optimal input and product choice from estimated functions-Derivation of demand and supply functions and estimation-Estimation of cost function and interpretations-Optimal product and input choice under multi input and output system-Estimation of factor shares from empirical functions estimated-Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology- Estimation of efficiency

measures — Stochastic, probabilistic and deterministic frontier production functions- Risk programming MOTAD-Quadratic programming-Simulation models for agricultural production decisions- Goal programming— Weighted,1exicographic and fuzzy goal programming- Compromise programming.

Teaching Schedule:

Theory

Lecture No.	Topic	weightage (%)
1	Agricultural Production process—Relationship between farm Planning and production economics—scope of agricultural production	2
2	Planning methods/procedures in agro-economic research and planning.	3
3	Production functions, components, assumptions, properties and their economic interpretation.	4
4	Concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance	3
5	Production relations-optimality	3
6	Functional forms, nature, properties, limitations, estimation and Interpretation of linear, Spillman production functions	3
7	Functional forms, nature, properties, limitations, estimation and interpretation— Cobb Douglas and Quadratic production functions	3
8	Multiplicative(power)functional forms-Trans log	2
9	Transcendental functional forms—CEO, production function	3
10	Conceptual and empirical issues in specification, estimation and Application of production functions	3
11	Analytical approaches to economic optimum	2
12	Determination of economic optimum with constant &varying input & output prices	3
13	Economic optimum with production function analysis-input use behaviour.	3
14	Decision making with multiple inputs and outputs	5
15	MRT and product relationship	2
16	Cost of production and adjustment in output prices	2
17	Single input and multiple product decisions	3
18	Multi input and multi product production decisions	3
19	Decision making with no risk—Cost of wrong decisions	2
20	Cost curves	4
21	Principles and derivation of demand and supply functions.	4
22	Correspondence of production, cost and profit functions	3
23	Principles and importance of duality theory	2

24	Technology, input use and factor shares-effect of technology on input use	3
25	Decomposition analysis	3
26	Factor shares-estimation methods	4
27	Technical, allocative and economic efficiencies in agricultural production	3
28	Yield gaps analysis-concepts and measurement	4
29	Risk and uncertainty in agriculture- incorporation of risk and Uncertainty in decision making	4
30	Risk and uncertainty and input use level-risk programming.	4
31	Simulation and programming techniques in agricultural production-Multiple Course Objective Programming	4
32	Applications of Goal programming and Compromise programming	2

Teaching Schedule:

Practical

Exercise No.	Title of Exercise
1	Estimation of different forms of production functions-Linear, Quadratic and Cobb Douglas
2	Estimation of different forms of production functions—Spillman and CES
3	Optimal input and product choice from estimated functions
4	Derivation of demand and supply functions and estimation
	Estimation of cost function and interpretations
6	Optimal product and input choice under multi input and out put system
7	Estimation of factor shares from empirical functions estimated
8	Estimating production functions in corporating technology changes
9	Decomposition analysis and incorporation of technology
10	Estimation of efficiency measures—Stochastic, probabilistic
11	Estimation of efficiency measures-deterministic frontier production functions
12	Risk programming—MOTAD
13	Quadratic programming
14	Simulation models for agricultural production decisions
15	Goa1programming-weighted, lexicographic and fuzzy goal programming
16	Compromise programming

Suggested Readings:

- ChambersRG.1988.*AppliedProductionAnalysis.*CambridgeUniv.Press.
- GardnerBL&RausserGC.2001.*HandbookofAgriculturalEconomics.*Vol.IA*Agriculturalproduction.*Elsevier.

- PalanisamiKP,Paramasivam&RanganathanCR.2002.*AgriculturalProduction Economics: Analytical Methods and Applications.* Associated Publishing Co.
- Baumol W. G. 1973. Economics theory and operations analysis. Practice Hall of India Private Ltd. New Dehli.626 p.
- Heady E O. 1952. Economics of Agricultural Production and resource use. Vol.I Agricultural Production. Elsevier
- Heady EO. And Dillon JL. 1961. Agricultural Production Functions. Kalyani Publishers, Ludhiana, India.

AEC-605 Operations Research 2+1

Why this course?

In sphere of management it is important, to take correct decision of assigning tasks and roles to individuals. The business is full of uncertainty and in this situation the manager has to take decision. It becomes imperative to gain knowledge of models used for finding this solution of performing well.

Aim of the course

To gain elementary knowledge of solving problems and decision making for managing farming and organization in resource constraint in order to achieve the objective.

Organization of the course

The course is organized as follows–

No Block	Unit
1. Concepts	1. Concepts
2. Inventory and models	1. Inventory- A Review 2. Models
3. Decision making	1. Decision making 2. Game theory

Theory

Block 1: Concepts

Unit 1: Concepts

Elementary concepts and objectives of Operations Research, Review of Linear programming - Assumptions & Methods, Non-linear programming problem – Quadratic programming, Multi Objective Programming(MOP)

Block 2: Inventory and Models

Unit 1: Inventory- A Review

Inventory control models, costs involved in Inventory management, types of inventory, Economic order quantity model, Waiting line models: Waiting line problem, Characteristics of a waiting line system, Single channel model,

Unit 2: Models

Markov Chains, Sequencing, Replacement models, Transportation and Assignment problems.

Block 3: Decision Making

Unit 1: Decision Making

Decision making under risk and uncertainties, decision problem, maximax criterion, maximin criterion, minimax regret criterion, Laplace criterion, Pay off tables, Decision trees, Expected value of perfect information.

Unit 2: Game Theory

Game Theory – Two-person Zero sum game, Simulation, Network Analysis-PERT&CPM.

Practical

- Linear and Non-linear programming problem,
- Quadraticprogramming,Multi-ObjectiveProgramming-GoalProgramming,
- Lexicographic, Weighted Sum, Determining economic order quantity, reorder levels of EOQ model.
- Waiting line problem, Problems on Markov Chains, Sequencing and Replacement models.
- Formulating and solving transportation type problems, Assignment problems as a special type of transportation problem.
- Solving deterministic and probabilistic queuing models Structuring and solving decision trees for optimal decisions Game theory, Simulation, Developing network (PERT/CPM) diagrams and determining the critical path.

Theory: Teaching Schedule

Lecture No.	Topic	Weightage (%)
1&2	Elementary concepts Objectives of Operations Research	06
3	Review of Linear programming	03

4	Assumptions & Methods	03
5	Non-linear programming problem	03
6	Quadratic programming,	03
7	Multi Objective Programming(MOP)	04
8	Inventory control models,	04
9	Costs involved in Inventory management	03
10	Types of inventory	03
11	Economic order quantity model,	04
12	Waiting line models: Waiting line problem	05
13&14	Characteristics of a waiting line system	06
15&16	Single channel model	06
17	Markov Chains	03
18	Sequencing	04
19&20	Replacement models	06
21	Transportation and Assignment problems.	04
22	Decision making under risk and uncertainties	03
23	Decision problem,	03
24	Maximax criterion, maximin criterion, minimax regret criterion	03
25	Laplace criterion	03
26&27	Pay off tables, Decision trees,	04
28	Expected value of perfect information.	03
29&30	Game Theory – Two-person Zero sum game,	05
31&32	Simulation, Network Analysis- PERT&CPM.	06

Practical

Exercise No.	Title of Exercise
1	Linear and Non-linear programing problem
2	Quadratic programming
3	Multi- Objective Programming- Goal Programming
4	Lexicographic, Weighted Sum, Determining
5	Economic order quantity, reorder levels of EOQ model
6	Formulating and solving transportation type problems
7& 8	Assignment problems as a special type of transportation problem
9	Solving deterministic and probabilistic queuing models
10 & 11	Structuring and solving decision trees for optimal decisions Game theory
12 & 13	Simulation, Developing network (PERT/CPM) diagrams and determining the critical path
14	Waiting line problem
15	Problems on Markov Chains
16	Sequencing and Replacement models

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments(Group/individual).
- Group Discussions

Learning outcome

After successful completion of this course, the student will be able to-

Gain expertise in formulating problems of management into mathematical form and workout the optimum solutions.

Apply the knowledge of different models in better decision making and controlling of the firm.

Suggested Reading

- Taha HA. Operations Research: An Introduction.
- Veerabhadrappa H. An Introduction to Operations Research.
- Gupta PK and Hira DS. Operations Research.
- Sharma R. Operations Research.

- Sharma JK. Operation Research.
- Greene WH. 2002. Econometric Analysis. Pearson Education.
- Johnston J and Dinardo J.2000. Econometric Methods. McGraw-Hill.
- Koutseyianis A. 1997. Theory of Econometrics. Barner &Noble.
- D. S. Hira and Prem Kumar Gupta 1992 Operations Research. S. Chand Publishing.
- Kanti Swarup; P K Gupta; Man Mohan 2004 Operations Research, Sultan Chand and Sons

AEC-606 Advanced Agricultural Marketing and Price Analysis 2+1

Why this course?

Efficient markets, connectivity in markets, facilities of transport and storage ensure that there is growth in marketing of the produce as well as the industries based on those produce. The decision of selling the produce at the right time, and at a higher price is crucial to ensure remunerative returns to the farmer. Thus, this course is required to enhance the knowledge to students in agricultural markets and price analysis.

Aim of the course

To impact adequate knowledge and analytical skills in the field of agricultural marketing and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities. Learning outcome: After successful completion of this course, the student will be able to-Gain the knowledge of marketing and agricultural prices. Work out the interaction between different markets and analyse their working. Gain expertise in forecasting of price and buildup market intelligence.

Organization of the course

The course is organized as follows-

No Block	Unit
1. Concepts	1. Agricultural Marketing-Insights
2. Marketing Institutions and Dynamics	1. Institutions and their functions 2. Market Dynamics
3. Techniques	1. Commodity marketing 2. Models for Analysis

Theory Syllabus :

Unit I

Importance of market analysis in the agricultural system –types of marketing-advantages and disadvantages - quantitative estimation - the distinguishing characteristics and role of agricultural prices -data sources for agricultural products and prices- software's used in market analysis.

Unit II

Role of various formal institutions in agricultural marketing- and functions– measuring their efficiency – public- private partnership-institutional arrangements.

Successful case studies.

Unit III

Multimarket estimation, supply response models. Market integration and price transmission - supply / value chain management. GAP analysis. Current trends in information in the changing agrifood system.

Unit IV

Agricultural commodity marketing- spot and futures– marketing of derivatives- speculation, hedging, swap, arbitrage etc, commodity exchanges –price discovery and risk management in commodity markets- Regulatory mechanism of futures trading.

Unit V

Lag operators and difference equations; stationary and stochastic processes; roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models - forecast evaluation; methods of forecasting. Price indices and econometric estimation and simulation.

Practical

- Different forms of production functions
- Specification, estimation and interpretation of production functions
- Returns to scale, factor shares, elasticity of production
- Physical optima- economic optima
- Least cost combination
- Optimal product choice
- Cost function estimation, interpretation
- Estimation of yield gap
- Incorporation of technology in production functions
- Measuring returns to scale-risk analysis.

Teaching Schedule:

Theory: Advanced Agricultural Marketing and Price Analysis

Lecture No.	Topic	Weightage (%)
1	Importance of market analysis in the agricultural system	03
2	Types of marketing and their advantages and disadvantages	03

3	Quantitative estimation of agricultural products	03
4	The distinguishing characteristics and role of agricultural prices	03
5	Various data sources of agricultural products and their prices	03
6	Different types of software used in market analysis	03
7	Different formal institutions in agriculture and their role in agricultural marketing	04
8	Functions of formal institutions and to measure their efficiency	04
9	Public and private partnership and their institutional arrangements	03
10	Successful case studies of formal institutions in agril. Marketing	03
11	Multimarket meaning and scope and estimation of agricultural products in multi markets	04
12	Application of supply response models in agril. Produce	05
13&14	Market integration - meaning. types degree of integration and measurement of integration	06
15&16	Price integration and transmission supply/value chain management in agricultural produce and GAP analysis	06
17	Current trends in information in the changing agri food system	03
18	Agricultural commodity marketing meaning of spot and future markets	04
19&20	Marketing derivatives, speculation, heading, swap and arbitrage - meaning and advantages	06
21	Commodity exchanges and their roles in future market	04
22	Price discovery and risk management in commodity markets	03
23	Regulatory mechanism of future trading	03
24	Log operators and difference equations	03
25	Stationary and Stochastic processes	03
26&27	Unit roots and cointegration conditional heteroscedasticity	04
28	ARCH and GRACH models	03
29&30	Forecast evaluation - meaning, methods of forecasting	05
31&32	Price indices and econometric estimation and simulation	06

Teaching Schedule:

Practical

Exercise No.	Title of Exercise
1& 2	Different forms of production functions
3 &4	Specification, estimation and interpretation of production functions
5&6	Returns to scale, factor shares, elasticity of production
7 & 8	Physical optima-economic optima
9	Least cost combination
10	Optimal product choice
11 & 12	Cost function estimation, interpretation
13 & 14	Estimation of yield gap
15	Incorporation of technology in production functions
16	Measuring returns to scale-risk analysis

Teaching Methods/Activities

- Lectures
- Assignments(Group/individual)
- Group Discussions on working out
- Power point presentations by students
- Exploringtheagriculturalmarketandidentificationofindustriesandtheirtypes.

Learning outcome

Afterthesuccessfulcompletionofthecoursethestudentwillbeableto—understand how the factors and output interact with each other. - Work out whether the production system is working efficiently and point out the loop holes. Apply the knowledge of costs and profits to work out the demand and supply functions. This will result into more efficient decision making.

Suggested Readings

- FerrisJN.1998.*AgriculturalPricesandCommodityMarketAnalysis*.McGraw-Hill. GoodwinJW.1994.*AgriculturalPriceAnalysisandForecasting*.Wiley.
- HallamD.1990.*EconometricModelingofAgriculturalCommodityMarkets*.New

Routledge.

- Martimort D.(Ed.). 1996. *Agricultural Markets: Mechanisms, Failures, and Regulations.* Elsevier.
- SchrimperRA.2001.*EconomicsofAgriculturalMarkets*.Pearson.
  TimmerCP.1986.*GettingPricesRight.*CornellUniversityPress.
- Tomek WG& Robinson KL. 2003. *Agricultural Produc tPrices*. 4th Ed. Cornell University Press.

AEC-607 Quantitative Development Policy Analysis 1+1

Why this course?

Policy reforms are inevitable. They are continuously required to deal with the loop holes of previous policy and control the present situation in a better manner. Reforms take place in both microeconomic and macroeconomic policies. The analysis of these policies help us to develop a framework for designing and implementing the policies.

Aim of the course

To develop expertise in understanding the rationale behind development of policies. Conceptualization of equilibrium and working out the economic implications of development policy. Learning outcome: After the completion of the course, the student will be able to-Conceptualize policy framework. Get acquainted with analysing the policy and workout corrective solutions.

Organization of the course

The course is organized as follows

No Block	Unit
1. Concepts	1. Policy Framework
2. Demand-supply and household	1. Demand-Supply Analysis behaviour 2. Household Behaviour and models
3. Approaches to review policy and welfare	1. Multi-Pronged approach to policy review 2.General equilibrium and programming

Theory

Block 1: Concepts

Unit 1: Policy Framework

Policy framework – goals, value, beliefs and welfare maximization. Market – Policy and State – State vs. Market – Failure of Policy – Failure of Markets – Rationale for Government Intervention. Role of Quantitative Policy Analysis.

Block 2: Demand-supply and household behaviour

Unit 1: Demand-Supply Analysis

Demand analysis for policymaking – Alternative approaches to demand analysis – Policy implications. Supply response – Alternative approaches to measurement of supply response – Nerlovian models of supply response–Policy implications.

Unit 2: Household Behaviour and models

Household behaviour and policy analysis – Household models.

Block 3: Approaches to review policy and welfare

Unit 1: Multi-Pronged approach to policy review

Partial equilibrium analysis – Concept of reference prices – Price distortions – indicators and impact. Transaction costs– Implications for efficiency and productivity–Institutional solutions- Multimarket approach to policy analysis.

Unit 2: General equilibrium and programming

Social Accounting Matrices and multipliers -– Computable General Equilibrium models to assess economy wide impact of policy changes. Fuzzy goal programming- Compromise programming.

Practical

- Review of criteria for policy evaluation
- Estimation of price elasticities
- Review of estimation of complete demand systems
- Estimation of Nerlovian supply Response model
- Review of Household models
- Specification and estimation of household models
- Partial equilibrium analysis
- Input– output table
- Social Accounting Matrix
- Construction of a SAM
- Computation of Multipliers
- Multi Market Analysis
- Review of Computable General Equilibrium Models.

Teaching Schedule

Lecture No.	Topic	Weightage (%)
1	Policy framework, goals, value, beliefs and welfare maximization.	5
2	Market Policy and State , State vs. Market	5
3	Failure of Market Policy and Failure of Markets	5
4	Rationale for Government Intervention. Role of Quantitative Policy Analysis.	5
5	Demand analysis for policymaking	5
6	Alternative approaches to demand analysis, Policy implications.	5
7	Supply response, Alternative approaches to measurement of supply response	5
8	Nerlovian models of supply response, Policy implications.	10
9	Household behavior and policy analysis, Household models.	10
10	Partial equilibrium analysis	5
11	Concept of reference prices, Price distortions, indicators and impact.	5
12	Transaction costs, Implications for efficiency and productivity, Institutional solutions	5
13	Multimarket approach to policy analysis.	5
14	Social Accounting Matrices	10
15	Multipliers Computable General Equilibrium models to assess economy wide impact of policy changes.	10
16	Fuzzy goal programming- Compromise programming.	5

PracticalSchedule

Exercise No.	Title of Exercise
1	Review of criteria for policy evaluation
2	Estimation of price elasticity's
3	Review of estimation of complete demand systems
4	Estimation of supply Response model
5	Estimation of Nerlovian supply Response model
6	Review of Household models
7	Specification of household models
8	Estimation of household models
9	Partial equilibrium analysis
10	Input– output table
11	Social Accounting Matrix

12	Construction of a SAM
13	Computation of Multipliers
14	Multi Market Analysis
15	Review of Computable General Equilibrium Models.
16	Estimation of General Equilibrium Models.

Suggested Reading

- Elisabeth Sadoulet and Alain de Janvry. 1995. Quantitative Development Policy Analysis. The Johns Hopkins University Press, London.
- Fischer G, Miller J & Sidney MS. (Eds.). 2007. *Handbook of Public Policy Analysis:* Theory, Politics and Methods. CRC Press.
- Shoven Neck R, Christian R &Mooslechner P. (Eds.). 2008. *Quantitative Economic Policy* Essays in Honour of Andrew Hughes Hallett.
- Ghatak S &Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate, New Delhi.
- Jhingan M. L. 1998. *The Economics of Development and Planning*. Vrinda Publ.

AEC-608 Natural Resource Management 2+1

Why this course?

The environment envisages the whole living creatures' within it. There are resources we obtain from the nature and at the same time spoil the environment by exploiting the resources. Thus, it is necessary for the student to develop environment friendly plans to utilize the scarce resources.

Aim of the course

Concept building on natural resources. Gaining expertise in economic aspect of Natural resources and maintain a balance between economic gains and environment conservation. Learning outcome-After the completion of the course, the student will be able to- Understand the natural resources and methodologies to develop plans for their optimal use. Work out the economics of forest, fisheries and ground water. Be able to deal with the legal matters of the natural resources.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Concepts	1. Concepts
2. Models and Management	1. Models for economic view of natural resources 2. Management of water resources
3. Regulations and planning	1. Property Rights 2. Dynamics of resource economics

Theory Syllabus

Block 1: Concept

UNIT I: Concept:

Natural resources - definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources.

Fundamental equation of renewable resources.

Block 2: Models and Management:

UNITI: Models for economic view of natural resources:

Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.

UNITII: Management of water resources:

Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery.

Block 3: Regulations and planning

UNITI: Property Rights:

Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources – Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.

UNITII: Dynamics of resource economics

Resource scarcity – Natural resource degradation – Poverty and resource degradation – Natural resource accounting - Pricing and valuation of natural resources – Natural resources policy.

Practical Syllabus:

Derivation of the fundamental equation of renewable resources-Estimation of growth curves and stock dynamics for fishery and forestry resources. Simple two period problem of optimal resource use – Numerical solution for simple two- period model of dynamic efficiency in natural resource extraction. Multi-period dynamic efficiency – Using Excel Solver in solving dynamic natural resource harvesting problems. Using analytical solution procedures for solving natural resource management problems – Optimal control.

Teaching Schedule:

Theory

Lecture No.	Topic	Weightage (%)
1	Natural resources - definition - characteristics and classification.	2
2	Stock dynamics of renewable and non-renewable resources.	3
3	Equation of motion for renewable and non-renewable resources.	2
4	Fundamental equation of renewable resources	2
5	Growth curves of fishery and forest resources.	**2**
6	The role of time preference in natural resource use.	**2**
7 &8	Simple two-period model of optimal use of renewable and non renewable resources.	6
9 &10	Simple two-period model of optimal use of nonrenewable resources.	6
11 &12	Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use	5
13 &14	Applications of dynamic programming and optimal control	5
15&16	Economics of groundwater use - optimal extraction of groundwater.	6
17&18	Analytical and numerical solutions for optimal inter-temporal allocation of natural resources.	6
19 &20	Optimal harvesting of single rotation and multiple rotation forests.	6
21	Optimal management of fishery.	6
22 &23	Property rights in natural resources and their implication for conservation and management of natural resources.	6
23 &24	Management of common property natural resources – Institutional arrangements for conservation.	6
25 &26	Management of common pool fishery, groundwater and forestry resource	6
27 &28	Resource scarcity – Natural resource degradation-Poverty and resource degradation –	6
29 &30	Natural resource accounting Pricing and valuation of natural resources	6
31 &32	Natural resources policy.	6

Teaching Schedule:
Practical

Exercise No.	Title of Exercise
1& 2	Derivation of the fundamental equation of renewable resources-
3&4	Estimation of growth curves and stock dynamics for fishery and forestry resources.

5&6	Simple two period problem of optimal resource use –
7&8	Numerical solution for simple two-period model of dynamic efficiency in natural resource extraction.
9, 10 &11	Multi-period dynamic efficiency – Using Excel Solver in solving dynamic natural resource harvesting problems
12&13	Using analytical solution procedures for solving natural resource management
14, 15 &16	Problems – Optimal control.

Suggested Readings:

- Baland J-M &Platteau JP. 1996. *Halting Degradation of Natural Resources: IsThere a Role for Rural Communities?* Clarendon Press and FAO.
- Carlson GA, Miranowski J &Zilberman D. 1998. *Agricultural and Environmental Resource Economics*.Oxford Univ. Press.
- Chiang AC. 1992. *Elements of Dynamic Optimization*. Waveland Press.
- Clark CW. 1976. *Mathematical Bioeconomics: The Optimal Management ofRenewable Resources*. John Wiley and Sons.
- Conrad JM & Clark CW. 1997. *Natural Resource Economics: Notes andProblems*. Cambridge Univ. Press
- Conrad JM. 1999. *Resource Economics*. Cambridge University Press.
- Fisher AC. 1981.*Resource and Environmental Economics*.CambridgeUniv.Press.
- Prato T. 1998.*Natural Resource and Environmental Economics*.Iowa State Univ.Press.
- Sterner T. 2003. Policy Instruments for Environmental and Natural

AEC-609 Environmental Economics 2+1

Why this course?

Economics not only deals with transaction taking place between human beings within and across national boundaries. Each economic activity has a price to pay to the environment. The activity causes loss to the environment in various ways. Thus, as a student of economics it is necessary to workout the costs and returns in terms of losses to environment while carrying out these development/production activities.

Aim of the course

To understand the economic outcomes of environmental degradation. Make students proficient in decision making regarding environment protection, resource use, and conservation policy.

Organization of the course

The course is organized as follows:

No Block	Unit
1. Overview	1. Overview of Environmental Economics
2. Assessment and Development Dynamics	1. Economic assessment
	2. Developmental Aspects
3. Regulations and Issues	1. Accounting, Policies and Regulations
	2. Environmental Issues

Theory

Block 1: Overview

Unit 1: Overview of Environmental Economics

Environmental pollution as a consequence of market failure- Causes and consequences of market failure- Externalities- Public goods and externalities-Economics of pollution– Private vs. Social cost of environmental pollution– Property rights, environment and development– Theory of environmental policy.

Block2: Assessment and Development Dynamics

Unit 1: Economic assessment

Environmental cost benefit analysis- Environmental impact assessment techniques Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.

Unit 2: Developmental aspects

Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts - Population and environmental quality - poverty and environmental degradation – Sustainable development – Indicators of sustainable development–Issues in sustainable development. Sustainable Development Goals.

Block 3: Regulations and Issues

Unit 1: Accounting, Policies and Regulation

Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution- Coastal externalities- Urbanization and environment- Basic approaches to environmental policy (Tax, subsidy, pollution permits, *etc*.) Green taxes- Political economy of environmental regulation and management.

Unit 2: Environmental Issues

Transboundary environmental problems - Economics of global warming, climate change and emission trading- Environment, international trade and development.

Practical

- Contemporary global environmental global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms
- Criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques
- Recreation demand models of environmental valuation
- Contingent evaluation techniques
- Environmental Resource Accounting Techniques
- Discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts - forest environment and wild life conservation
- Green GDP and Green house insurance
- Practical considerations and compares on of instruments of environmental policy

- Non-point source pollution control methodologies
- Environment in macroeconomic modeling
- Meta-analysis, economic evaluation and environmental economics
- Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment
- Input output analysis, technology and the environment
- Computable general equilibrium models for environmental economics and policy analysis.

Theory

Lecture No.	Details of Topic	Weightage (%)
1& 2	Environmental pollution as a consequence of market failure- Causes and consequences of market failure.	**8**
3& 4	Externalities- Public goods and externalities-Economics of pollution–Private vs. Social cost of environmental pollution.	**8**
5&6	Property rights, environment and development– Theory of environmental policy.	**6**
7&8	Environmental cost benefits analysis- Environmental impact assessment techniques.	**5**
9&10	Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.	**8**
11&12	Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts.	**8**
13&14	Population and environmental quality - poverty and environmental degradation.	**6**
15&16	Sustainable development – Indicators of sustainable development–Issues in sustainable development. Sustainable Development Goals.	**8**
17&18	Environment, ecology and environmental accounting.	**6**
19&20	Environmental pollution with respect to water and air - Land and forest resources related environmental pollution.	**6**
21&22	Coastal externalities- Urbanization and environment- Basic approaches to environmental policy (Tax, subsidy, pollution permits, *etc*.).	**6**
23&24	Green taxes- Political economy of environmental regulation and management.	**5**
25&26	Transboundary environmental problems.	**5**
27&28	Economics of global warming.	**5**

29&30	Climate change and emission trading.	**5**
31&32	Environment, international trade and development.	**5**

Practical:

Exercise No.	Title of Exercise
1	Contemporary global environmental global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms
2	Criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques
3	Recreation demand models of environmental valuation
4	Contingent evaluation techniques
5	Environmental Resource Accounting Techniques
6	Discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts - forest environment and wild life conservation
7	Green GDP and Green house insurance
8	Practical considerations and compares on of instruments of environmental policy
9	Non-point source pollution control methodologies
10	Environment in macroeconomic modeling
11	Meta-analysis, economic evaluation and environmental economics
12&13	Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment
14	Input output analysis, technology and the environment
15 & 16	Computable general equilibrium models for environmental economics and policy analysis.

Teaching Methods/Activities

- Lectures.
- Case studies.
- Assignments (Group/individual).
- Group Discussions

Learning outcome

After the successful completion of the course, the student will be able to-Understand the concept of pollution and externalities caused by economic activity. Workout the economics of productions activities in terms of losses to environment. Learn about accounting of environmental costs and other issues related.

Suggested Reading

- Hackett SC.2001.Environmental and Natural Resource Economics: Theory, Policy and the Sustainable Society. ME. Sharpe, Armonk, NY.
- Hartwick JM and Olewiler ND. 1998. The Economics of Natural Resource Use. 2ndEd. Addison-Wesley Educational Publ.
- Kerr JM, Marothia DK, Katar Singh, Ramasamy C and Bentley WR. 1997. Natural Resource Economics: Theory and Applications in India. Oxford & IBH.
- Pearce DW and Turner K.1990. Economics of Natural Resources and the Environment. John Hopkins Univ. Press.
- Prato T.1998. Natural Resource and Environmental Economics. Iowa State University Press.
- Sengupta R.2000. Ecology and Economy, an Indian Perspective. Oxford University Press.
- Tietenberg T .2003. Environment and Natural Resource Economics. 6thEd. Addison Wesley.
- Subhashini Muthukrishnan 2011.Economics of Environment, 2nd edition
- M. L. Jhinganand Chandar K Sharma2008.Environmental Economics(Theory, Management and Policy)Vrinda Publications

LIST OF JOURNALS & E-RESOURCES

Sr. No.	Journal ID	ISSN No.	Journal Name	NAAS Score
1	A086	0742-4477	Agribusiness	8.06
2	A089	0169-5150	Agricultural Economics	8.59
3	A090	0971-3441	Agricultural Economics Research Review	5.84
4	A131	0002-9092	American Journal of Agricultural Economics	10.08
5	A243	2040-5790	Applied Economic Perspectives and Policy (Review of Agricultural Economics)	10.08
6	A300	2278-1811	Arthshastra: Indian Journal of Economics & Research	#
7	A308	2320-7027	Asian Journal of Agricultural Extension, Economics & Sociology	4.86
8	A334	1364-985X	Australian Journal of Agricultural and Resource Economics	8.86
9	C004	0008-3976	Canadian Journal of Agricultural Economics	7.4
10	E012	0921-8009	Ecological Economics	11.39
11	E030	1864-6042	Economics-The Open Access Open-Assessment E-Journal	7.13
12	E072	1355-770X	Environment and Development Economics	7.94
13	E145	0165-1587	European Review of Agricultural Economics	9.84
14	F068	1389-9341	Forest Policy and Economics	9.67
15	G043	2211-9124	Global Food Security-Agriculture Policy Economics and Environment	13.77
16	I029	0019-5014	Indian Journal of Agricultural Economics	5.3
17	I030	0971-8664	Indian Journal of Agricultural Marketing	4.04
18	I031	0367-8245	Indian Journal of Agricultural Research	5.2
19	I032	0019-5022	Indian Journal of Agricultural Sciences	6.37
20	I033	2454-7964	Indian Journal of Agriculture Business	#*
21	I057	2277-5412	Indian Journal of Economics and Development (Indian Journal of Industrial Economics and Development)	5.15
22	I065	0973-8711	Indian Journal of Finance	#
23	I217	2348-4969	International Journal of Economics, Commerce and Business Management	#
24	I218	2250-0006	International Journal of Economics, Commerce and Research	#
25	I363	2229-7278	International Research Journal of Agricultural Economics and Statistics	#*
26	J018	0021-857X	Journal of Agricultural Economics	9.58
27	J029	0973-5100	Journal of Agricultural and Food Economics	#
28	J029a	1068-5502	Journal of Agricultural and Resource Economics	7.38

29	J181	0976-5239	Journal of Economics	#
30	J182	2456-9216	Journal of Economics, Management and Trade (British Journal of Economics, Management and Trade)	#
31	J234	2249-1074	Journal of Fisheries Economics and Development	#
32	J275	2454-2504	Journal of Global Economics, Management and Business Research	#*
33	M004	2348-0793	Maharashtra Journal of Agricultural Economics	2.97
34	S045	2319-961X	Shanlax International Journal of Economics	#*
35	E026	0424-2513	Economic Affairs	5.08
36	E028	0939-3625	Economic Systems	9.21
37	E029	0012-9976	Economic and Political Weekly	#*
38	I077	0973-8703	Indian Journal of Marketing	#

SUPPORTING COURSES (COMPULSORY)

M.Sc. Programmes

M.Sc. (Agri.) Agricultural Economics

Supporting / Optional Courses:

Supporting / Optional Courses may be taken from below mention discipline list

Supporting Disciplines:

1. Agricultural Statistics
2. Computer science
3. Mathematics

Ph. D. Programmes

Ph.D. (Agri.) Agricultural Economics

Supporting / Optional Courses:

Course Code	Semester	Course Title	Credit Hrs.
AEC-605	II	Operations Research	3(2+1)
STAT 604	I	Advanced Statistical Methods	3(2+1)

Supporting Disciplines:

1. Agricultural Economics
2. Agricultural Statistics
3. Computer science
4. Mathematics

Some of these courses are available in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform.

Restructured and Revised Syllabus of Post-Graduate Programme

M. Sc. and Ph. D.
In
Agricultural Statistics

Broad Subject Coordinator,
Social Science and Head (Extn. Edu.)
Dr.BSKKV, Dapoli

CONTENT

Preamble:

The origin of the discipline of Agricultural Statistics can be traced back to 1930 when the then Imperial Council of Agricultural Research decided setting up a Statistical Section to assist the State Departments of Agriculture and Animal Husbandry in planning their experiments and analysis of data. The activities of this section increased rapidly and acquired International recognition as a centre for research and training in the field of Agricultural Statistics. Training programmes were started in this discipline in 1945. This activity resulted in the conversion of this section to a full-fledged Institute named as Institute of Agricultural Research Statistics (IARS) where subsequently the M.Sc. and Ph.D. degree courses in Agricultural Statistics were started in 1964 in collaboration with Indian Agricultural Research Institute (IARI).

With the strengthening of NARS through more SAUs and ICAR Institutes, the demand for trained and qualified manpower in Agricultural Statistics increased rapidly which resulted in starting of M.Sc. and Ph. D. degree courses in Agricultural Statistics in many other State Agricultural Universities (SAUs) and Deemed to-be Universities (DUs). Throughout the growth of this discipline, the main emphasis was to develop trained manpower in the country in the field of Agricultural Statistics and later on in the field of Computer Application so as to meet the challenges of agricultural research in the newer emerging areas. These disciplines have now become an integrated component of agricultural research and help in making agricultural research globally acceptable. Use of computers in agricultural research began more than three decades ago. Initially the electronic data processing requirements of agricultural research workers and students in the NARS were catered by ICAR-Indian Agricultural Statistics Research Institute (ICARIASRI).

Late sixties and seventies saw statisticians - programmers at IASRI shouldering the onerous responsibility of training agricultural research workers in the use of computers. Around the same time a course on Computer Programming was introduced and offered in the curriculum of M.Sc. and Ph.D. students of PG School of IARI and subsequently at many other SAUs. Seventies witnessed an increase in the computing facilities in NARS; there was a great demand for qualified and trained manpower to manage these facilities. In the present day world, the role of Information Technology has become very important. Together with the discipline of Statistics, it does wonders in agricultural research. The newer areas of research like genomics, geo-informatics, market intelligence, quality management depend very heavily on Statistics and Information Technology.

Yet, in the four State Agricultural Universities this discipline is not started. In view of the importance of Statistical Sciences, it is important that the course curricula framed to initiate the students to conduct research in these areas and to expose them to their applications to agricultural sciences.

In view of the importance of Statistical Sciences, it is important that the course curricula framed to initiate the students to conduct research in these areas and to expose them to their applications to agricultural sciences. Courses Syllabi content should have modified as practical oriented and job oriented. All modifications in syllabus are must be focused to Govt. sector and Corporate sector/ Industrial Benefits. Accordingly, a national level core group was constituted to revise the syllabi of agricultural

sciences so as to cater to the requirements of the present day world. A Broad Subject Matter Area (BSMA) Committee for statistical sciences was constituted to look into the revision of the course curricula of the disciplines of Agricultural Statistics and Computer Application.

1. Committee of Broad Subject Coordinators and Discipline Coordinators for finalizing the PG Degrees Syllabi in the Maharashtra SAUs as per the ICAR-NCG-BSMA recommendations.

BSMA Broad Subject	ICAR-BSMA Approved Disciplines	Degree Programmes		Broad Subject Coordinator (Chairman of all Disciplines' Sub-Committees)	Discipline Coordinator (Secretary of respective Discipline Sub-Committee)
Social Sciences	Agricultural Statistics	M.Sc. (Agricultural Statistics)	Ph. D. (Agricultural Statistics)	Dr. P.A. Sawant Head (Extn. Edu.) Dr.BSKKV, Dapoli E-mail: pas14262@rediffmail.com Mobile:9420718141i	Dr. Vilas Wani Head (Stat.) E-mail: vswani9@gmail.com Mobile: 9423468335 & Dr M.R. Patil , Professor (Stat) MPKV, Rahuri E- mail: mrpatil2003@gmail.com Mobile: 9420807600

2. Committee for finalization of new syllabi 2022 for PG in Vegetable Science at Discipline Coordinator level

Sr. No.	Name of Faculty	Designation	Contact Number	Remarks
1.	Dr. V. S. Wani, ,	Professor and Head, Department of Agril. Statistics, PGI, MPKV, Rahuri	9423468335	Coordinator
2.	Dr. M. R. Patil,	Professor of Statistics, Department of Agril. Statistics, PGI, MPKV, Rahuri	9420807600	Coordinator
3.	Dr. D. B. Yadav,	Head ,Department of Agril. Economics, PGI, MPKV, Rahuri. (Now Dr. Hille sir)	9403186264	Invitee
4.	Dr. N.V. Shende	Head Department of Agril. Economics PDKV, Akola	9823274574	Invitee
5.	Dr. S. S. Wadkar	Head, Dept. of Agril. Economics, KKV, Dapoli	9421228639	Invitee
6.	Dr. Digambar Perke	Head, Dept. of Agril. Economics, VNMKV, Parbhani	9421354438	Invitee
7.	Dr. C.A. Nimbalkar	Ex..Professor of Statistics, MPKV, Rahuri.	9421884012	Invitee
8.	Dr. D. P. Kaledhonkar,	Asso. Prof. of Statistics, COA, Dhule, MPKV, Rahuri	9325090516	Member
9.	Dr. J. S. Dhekale	Ex. Prof. of Statistics, Dr. B.S.KKV, Dapoli	9423048607	Invitee

10.	Prof. Simanpini M. Kulkarni,	Associate Prof. of Statistics , Department of Economics, BSKKV, Dapoli	9423296329	Member
11.	Prof. M. R. Shewale	Asso. Prof. of Statistics, Pune, MPKV, Rahuri	7709940267	Member
12.	DR. A. J. Shivgaje	Asso. Prof. of Statistics, COA, Dhule, MPKV, Rahuri	9420748400	Member
13.	Dr. R. D. Walke	Asso. Prof. of Statistics, P. D. K. V. Akola	9403072036	Member
14.	Dr. A. A. Bhagat	Assistant Professor of Statistics, Ganeshkhind, NARP, Pune	9421804090	Member
15.	Prof. V. R. Bavdekar,	Assistant Professor of Statistics, R.S. Agril. College of Kolhapur	9970547789	Member
16.	Dr. P. B. Bansode,	Assistant Professor of Statistics, College of Agri. Engg., BSKKV, Dapoli	9049344243	Member
17.	Dr. S. D. Shinde	Assistant Professor of Statistics, Dept of Statistics, PGI, MPKV, Rahuri	7588078466	Member Secretary

Implementation of New Curriculum

The State Agricultural universities does not offering PG programme in Agricultural Statistics. There is need to be establish the Department with specialized Computer laboratories.

One time catch up grant should be awarded to each SAU, offering PG programmes in Agricultural Statistics for meeting expenditure for upgrading the course requirements.

Faculty training and retraining should be an integral component. For imparting total quality management, a minimum of two faculties in each department under an SAU should be given on job training in reputed national and international institutes. To execute the new PG and Ph.D. programmes in the discipline of Agricultural Statistics in effective manner, special funds from ICAR would be required for outsourcing of faculty from Indian/Foreign Universities for some initial years.

Expected Outcome

- Starting the post graduate programme in whole of Agricultural Statistics throughout the SAU, Universities.
- Imparting quality education.
- Development of technical manpower to cater the need of governments, corporate sector and research organization in India and abroad.
- Exposure to the faculty in the latest technical knowhow.

Organization of Course Contents & Credit Requirements

Minimum Residential Requirement:

M. Sc. : 4 Semesters

Ph. D. : 6 Semesters

Name of the Departments / Divisions

M. Sc. (Agricultural Statistics) / Ph. D. (Agricultural Statistics)

Nomenclature of Degree Programme

1. **M. Sc. Programme**

   M. Sc. (Agricultural Statistics)

2. **Ph. D. Programme**

   Ph. D. (Agricultural Statistics)

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level and 600- series to Doctoral level. Supporting courses are divided into two series: 500-series
- Credit Seminar for Master's level is designated by Code No. 591, and two Seminars for Doctoral level are coded as 691 and 692, respectively
- Master's Research: 599 and Doctoral Research: 699

Following Statistics courses are in Supporting Courses are mentioned in BSMA syllabus.

Supporting Courses			
Course No.	**Course Title**	**Credits**	**Semester**
STAT 501	Mathematics for Applied Sciences	2+0	I
STAT 502	Statistical Methods for Applied Sciences	3+1	I
STAT 511	Experimental Designs	2+1	II
STAT 512	Basic Sampling Techniques	2+1	II
STAT 521	Applied Regression Analysis	2+1	III
STAT 522	Data Analysis Using Statistical Packages	2+1	III

M. Sc. Agricultural Statistics

Course Structure at a Glance

Course Title with Credit Load M.Sc. in Agricultural Statistics			
Course Code	**Course Title**	**Credit Hours**	**Semester**
*STAT 552	Probability Theory	2+0	I
*STAT 553	Statistical Methods	2+1	I
*STAT 562	Statistical Inference	2+1	II
*STAT 563	Design of Experiments	2+1	II
*STAT 564	Sampling Techniques	2+1	II
*STAT 565	Statistical Genetics	2+1	II
*STAT 571	Multivariate Analysis	2+1	III
*STAT 572	Regression Analysis	1+1	III
*STAT 573	Statistical Computing	1+1	III
STAT 591	**Seminar**	**0+1**	**III**
Total Credits		16+8 = 24	
Minor Courses		08	
Supporting Courses Credits		06	
Common Courses Credits		05	
STAT 599	Research	0+30	II-IV
Total Credits		**20+8+6+5+1+30 = 70**	
Other major Courses suggested by BSMA			
STAT 551	Mathematics-I	3+0	I
STAT 554	Actuarial Statistics	2+0	I
STAT 555	Bioinformatics	2+0	I

STAT 556	Econometrics	2+0	I
STAT 561	Mathematics-II	2+0	II
STAT 566	Statistical Quality Control	2+0	II
STAT 567	Optimization Techniques	1+1	II
STAT 574	Time Series Analysis	1+1	III
STAT 575	Demography	2+0	III
STAT 576	Statistical Methods for Life Sciences	2+0	III
STAT 577	Statistical Ecology	2+0	III

***Compulsory among major courses**

Common Courses:

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Information Services	0+1
PGS 502	II	Technical Writing and Communications Skills	0+1
PGS 503	II	Intellectual Property and its management in Agriculture	1+0
PGS 504	I	Basic Concepts in Laboratory Techniques	0+1
PGS 505	III	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	III	Disaster Management	1+0

Minor Disciplines: Suggestive list of discipline for minor courses

1. Genetics and Plant Breeding
2. Seed Science and Technology
3. Plant Physiology
4. Horticulture
5. Agronomy
6. Soil Science
7. Plant Protection
8. Animal Husbandry and Dairy Science
9. Agricultural Engineering

Minor Courses- To be selected as per the research requirement and students advisory committee suggestions.

Supporting Courses- Suggestive list of Supporting Courses

Code	Course title	Credit hours
STAT 501	Mathematics for Applied Sciences	2+0
STAT 522	Data Analysis Using Statistical Packages	2+1
MCA 511	Introduction to Communication Technologies, Computer Networking and Internet	1+1
	Total Credits required	**06**

Compulsory Non Credit Deficiency Courses:

Note: Students from B. Sc. (Agri.)/ B. Sc. (Hons.) Agriculture/ B. Sc. (Hort.)/ B. Sc. (Hons.) Horticulture and B. Sc. (Forestry)/ B. Sc. (Hons.) Forestry or equivalent degree with four years duration of agriculture-related Universities have completed the basic Statistics course, still if Student Advisory committees suggested, that courses may be kept as Non Credit Deficiency Courses.

Ph. D. (Agricultural Statistics)

Course Structure- at a Glance

Course Code	Course Title	Credit Hours
Major Courses		**12 Credits**
*STAT 601	Advanced Data Analysis	1+2
*STAT 602	Simulation Techniques	1+1
*STAT 603	Linear Models	2+0
*STAT 604	Advanced Statistical Methods	2+1
*STAT 611	Baysian Inference	2+0
Total Credits		**8+4=12**
STAT 691	Doctoral Seminar I	0+1
STAT 692	Doctoral Seminar II	0+1
Total Credits		**8+6=14**
Minor courses		6
Supporting courses		5
	Total Credits	**25**
STAT 699	Research	0+75
	Total Credits	**25+75=100**
Other major Courses suggested by BSMA		
STAT-605	Modeling Techniques for Forecasting	2+1
STAT 606	Stochastic Process	2+0
STAT 607	Survival Analysis	2+0
STAT 608	Spatial Statistics	1+1
STAT 612	Advanced Design of Experiments	2+1
STAT 613	Advanced Sampling Techniques	2+1
STAT 614	Advanced Statistical Genetics	2+1
STAT 615	Advanced Time Series Analysis	2+0
STAT 616	Advanced Bioinformatics	2+0
STAT 617	Advanced Econometrics	2+0

STAT 618	Recent Advances in the Field of Specialization	1+0

***Compulsory among major courses**

Minor Disciplines: Suggestive list of minor discipline

1. Genetics and Plant Breeding
2. Seed Science and Technology
3. Plant Physiology
4. Horticulture
5. Agronomy
6. Soil Science
7. Plant Protection
8. Animal Husbandry and Dairy Science
9. Agricultural Engineering

Minor Courses- To be selected as per the research requirement.

Supporting Courses- Suggestive list of Supporting Courses

Code	Course title	Credit hours
MCA 501	**Computers Fundamentals and Programming**	**2+1**
MCA 502	**Computer Organization and Architecture**	**2+0**
MCA 511	**Introduction to Communication Technologies, Computer Networking and Internet**	**1+1**
	Total Credit	**5**

COURSE CONTENT OF SUPPORTING COURSES

Course Title : Mathematics for Applied Sciences
Course Code: STAT 501
Credit Hours : 2+0

IV. Aim of the course

This course is meant for students who do not have sufficient background of Mathematics. The students would be exposed to elementary mathematics that would prepare them to study their main courses that involve knowledge of Mathematics. The students would get an exposure to Linear Algebra, differentiation, integration and differential equations etc.

Theory

Unit I

Set theory-set operations, finite and infinite sets, operations of set, function.

Unit II

Vectors and vector spaces, Matrices notations and operations, laws of matrix algebra; transpose and inverse of matrix,. Determinants - evaluation and properties of determinants, Solutions of Linear Equations.

Unit III

Variables and functions, limits and continuity of specific functions. Differentiation: theorems of differentiation, differentiation of logarithmic, introductory trigonometric function, exponential and inverse functions, Differentiation of function of a function, derivatives of higher order, partial derivatives. Application of derivatives, Application of partial derivative, derivatives determination of points of inflexion, maxima

Unit IV

Integration, methods of integration, reduction formulae, definite and indefinite integral, Applications of integration in Agriculture, Differential Equations

Teaching Schedule

Lecturer No.	Topics	Weightage
1, 2	Set theory- types of sets, vonn diagram, etc.set operations, finite and infinite sets, operations of set,	5
3, 4, 5	Function, and types of function, Variables and functions,	5
6, 7	limits and continuity of specific functions.	5
8, 9	Matrices notations and operations, laws of matrix algebra; properties, Solution of simultaneous equation by matrix method (Cramer rule)	5
10, 11, 12	Transpose and inverse of matrix, Ad-joint method	5
13, 14	Determinants - evaluation and properties of determinants,	5

15	Solutions of Linear Equations.	5
16	Differentiation, Introduction to differential calculus and derivative of function by first principle : theorems of differentiation	5
17,,18,	differentiation of logarithmic, trigonometric, exponential and inverse functions,	5
19, 20, 21	Differentiation of function of a function, derivatives of higher order, Application of derivatives. Elasticity of function by derivative method.	10
21, 22	partial derivatives, examples of partial derivatives	5
23	Applications of partial derivative, concave and convexity	5
24, 25	determination of points of inflexion, maxima and minima	10
26, 27	Integration, methods of integration, reduction formulae,	5
28, 29	definite and indefinite integral	5
30, 31	Applications of integration in Agriculture,	10
32, 33	Differential Equations.	5

Suggested Reading

Hohn FE. 2013. Elementary Matrix Algebra, 3rd Ed., Kindle Edition

Harville D.A. 1997. Matrix Algebra from a Statistician's Perspective. Springer.

Hohn F.E. 1973. Elementary Matrix Algebra. Macmillan.

Searle S.R. 1982. Matrix Algebra Useful for Statistics. John Wiley. Stewart J. 2007. Calculus. Thompson.

Thomas G.B. Jr. and Finney R.L. 1996. Calculus. 9th Ed. Pearson Edu

Course Title Statistical Methods for Applied Sciences

Course Code : STAT 502

Credit Hours : 3+1

Aim of the course

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

Theory

Unit I

Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

Unit II

Discrete and continuous probability distributions, Binomial, Poisson, Normal distribution, and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Unit III

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

Unit IV

Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test.

Unit V

Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

Practical

1. Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Normal.
2. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.
3. Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model.
4. Non-parametric tests. ANOVA: One way, Two Way, SRS.

Teaching Schedule

Lecturer No.	Topics	Weightage
1, 2,3	Some basic concepts , Box-plot, Descriptive statistics, Measures of central tendency and Dispersions. definition, types , properties etc. Exploratory data analysis,	5
4, 5, 6	Theory of probability,: Random experiment, Trial, event, equally likely cases, Exhaustive Definition of classical, empirical and Axiomatic probability : additive and multiplicative law of probability. Random variable	5
7,8,9,10	Random variable and mathematical expectation, Discrete and continuous probability distributions, Binomial, Poisson, normal Probability law. Parameter, mean, variance, properties, uses and applications.	5
11,12	Normal distribution : Normal probability law , area of Probability / ordinate probability, standard normal distribution	5
13, 14, 15, 16	Concept of sampling distribution: Sampling distribution : concept of parameter. Estimate of parameter , statistics, sample, population , S.E. sampling error, level of significance, Type I and II error, one and two tailed test. Critical region, hypothesis. chi-square, t and F distributions	6
17,18,19	Tests of significance based on Normal, Z – test : One and two sample for proportion , t – test : One sample, Paired and independent test., testing of significance of r. and F – test : Two variances, properties and application.	6
20, 21	Chi – square test: Properties, application and limitation 2 Chi – quare test: Properties, application and limitation 2x2 , m x n : testing f goodness of fit.	5
22, 23	Introduction to theory of estimation and confidence-intervals,	5
24, 25, 26	Simple and multiple correlation coefficient, partial correlation, rank correlation, test of significance of these correlations.	6
27, 28, 29, 30	regression coefficients, Coefficient of determination, models. Multiple linear regression). Test of Significance of simple, multiple regression model	8
31, 32	Non linear regression, exponential and power function, Fitting of quadratic models.	5

33, 34	Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test. With examples.	5
35, 36, 37	Introduction to ANOVA: One way ANOVA, Two way ANOVA, Concept of Analysis of Variance , mathematical model, assumption, random component, Practical consideration of one way and two way , classification for field experiments.	5
38, 39	Introduction to Sampling Techniques, Concept of sampling, definition of technical terms, complete enumeration.	5
40, 41	Sampling vs complete enumeration. Sample survey, Planning of sampling	5
42,43	Method of sampling, sampling with and without replacement. Simple random sampling with practical consideraron.	5
44, 45	Introduction to other sampling methods, e.g. sampling of proportion, Stratified sampling. cluster sampling. PPS sampling, Systematic sampling.	5
47,48	Introduction to Multivariate Analysis, Introduction to multivariate concept, definition of different Terms, Arrangement of data into matrix form, Mean vector, Variance covariance matrix.	4
49, 50	Transformation of Data, reason for Transformation of Data. log transformation of Data., square root transformation, Arc-sign transformation .	5

Practical Schedule

Practical No.	**Topics**
1	Some basic concepts , Exploratory data analysis, Descriptive statistics, count, mean, standard deviation, minimum and maximum values and the quantiles of the data etc. Box plot graph
2	fitting of Binomial distributions
3	fitting of Poisson distributions
4	fitting of Normal distributions
5	Large sample tests based on Normal, Z – test : One and two sample for mean and proportion ,
6	Tests of significance : t – test : One sample, Paired and independent test., testing of significance of r.
7	Testing of significance F – test : Two variances,

8	Chi – square test: applications Chi – square Test 2x2 , m x n : testing of goodness of fit.
9	Confidence-intervals estimation
10	Simple correlation, testing of simple correlation, Spearman's rank correlation
11	Multiple and Partial correlation with testing .
12	Linear regression (a, b, r, Tests of significance).
13	Multiple Linear regression of Y on X1,X2,R^2 and Tests of significance.
14	Non linear regression, exponential and power function, Fitting of quadratic models.
15,16,17	Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test. With examples.
18	ANOVA- one way and Two way
19	Simple random sampling with and without replacement practical consideration.

Suggested Reading

Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.

Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.

Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.

Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.

Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.

Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.

Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.

Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley d . John Wiley

http://freestatistics.altervista.org/en/learning.php.

http://www.statsoft.com/textbook/stathome.html.

Course Title : Experimental Designs

Course Code : STAT 511

Credit Hours : 2+1

Aim of the course

This course is meant for students of agricultural and animal sciences other than Agricultural Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

Unit I

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

Unit II

Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.

Unit III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of
degrees of freedom. Concept of confounding.

Unit IV

Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical

1. Uniformity trial data analysis2.
2. formation of plots and blocks,
3. Fairfield Smith Law,
4. Analysis of data obtained from CRD, RBD, LSD,
5. Analysis of factorial experiments,
6. Analysis with missing data
7. Split plot and strip plot designs.

Teaching Schedule

Lecturer No.	Topics	Weightage
1	Need for designing of experiments: definition, experiment, type of experiment, field experiment., characteristics of a good design.	3

2	Basic principles of designs- randomization, replication and local control.	5
3,4	Practical considerations : Deciding no. of replication, randomization of treatment, use of random number table, Local control, need of local control, size, shape of plots uses.	3
5	Uniformity trials, size and shape of plots and blocks,	3
6	Concept of Analysis of Variance , mathematical model, assumption, random component,	5
7	C.R.D. : Definition, Model , Method of randomization for treatment and analysis, It's Merits, demerits and Application	5
8	R. B.D. : Definition, Model , Method of randomization for treatment and analysis, It's Merits, demerits and Application.	5
9, 10	L.S.D. : Definition, Model , Method of randomization for treatment and analysis, It's Merits, demerits and Application	5
11	Factorial experiment: One factor, two factor and more than two factor experiment , level of factor , definition of simple , main and interaction effect	8
12,13	Symmetrical , Asymmetrical factorial experiment 2^2 , 2^3 --- 2^nexpt. general method of analysis.	5
14	Yates method of analysis in 2^n .	3
15	3^n Factorial experiments, method of analysis.	5
16,17	Concept of confounding : 2^n factorial experiment.	3
18,19	Split plot design : Layout, analysis and application.	7
19,20	Strip plot : Layout, analysis and application	7
20,21	Missing plot technique in RBD (one observation)	3
22,23	Missing plot technique in LSD (one observation)	3
24	Data transformation : Arcsign, Square root, Log.	3
25	Analysis of covariance in RBD	3
26,27, 28	BIBD. : Definition, Model , Method of randomization for treatment and analysis, It's Merits, demerits and Application	8
29, 30	Concept of Response surface analysis	3
31, 32	Combined Analysis	5

Practical Schedule

Lecturer No.	Topics	
1,2,3	Uniformity trial data analysis	
3,4,	formation of plots and blocks,	
5	Fairfield Smith Law,	
6,7,8	Analysis of data obtained from CRD, RBD, LSD,	
9,10,11	Analysis of factorial experiments,	
12,13	Analysis with missing data	
14, 15,16	Split plot and strip plot designs.	

Suggested Reading

Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.

Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.

www.drs.icar.gov.in.

Course Title : Basic Sampling Techniques

Course Code : STAT 512

Credit Hours : 2+1

Aim of the course

This course is meant for students of agricultural and animal sciences other the Statistics. The students would be exposed to elementary sampling techniques. It would help them in understanding the concepts involved in planning and designing their surveys, presentation of survey data analysis of survey data and presentation of results. This course would be especially important to the students of social sciences.

Theory

Unit I

Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.

Unit II

Simple random sampling with and without replacement, sampling for proportion, determination of sample size, inverse sampling, Stratified sampling.

Unit III

Cluster sampling, Multi-stage sampling, systematic sampling; Introduction to PPS sampling,

Unit IV

Use of auxiliary information at estimation, Ratio product and regression estimators. Double Sampling, sampling and non-sampling errors.

Practical

1. Random sampling ~ use of random number tables,
2. concepts of unbiasedness, variance, etc.;
3. Simple random sampling, determination of sample size, inverse sampling, stratified sampling, cluster sampling and systematic sampling;
4. Estimation using ratio and regression estimators;
5. Estimation using multistage design, double sampling.

Teaching Schedule

Lecturer No.	Topics	Weightage
1,2	Concept of sampling, definition of technical terms	5
3,4	Sample survey vs complete enumeration.	3
5,6	Planning of sample survey, sampling from a finite population	5
7,8,9	Methods of sampling, Simple random sampling with and without replacement	10
10,11	sampling for proportion, determination of sample size	5
12,13	Inverse sampling	5

14,15, 16	Stratified sampling.	10
17,18	Cluster sampling.	7
19,20	Multistage sampling.	8
21,22	Systematic sampling.	10
23,24	Introduction to PPS sampling	5
25,26	Use of auxiliary information at estimation	5
27,28	Ratio product and regression estimators	10
29,30	Double sampling	7
31,32	Sampling and non-sampling error	5
		100

Practical Schedule

Lecturer No.	**Topics**	
1,	Random sampling ~ use of random number tables,	
2	concepts of unbiasedness, variance, etc.;	
3,4	Simple random sampling, determination of sample size,	
5	inverse sampling,	
6,7	stratified sampling,	
8,9	cluster sampling	
10,11	systematic sampling;	
12,13	Estimation using ratio and regression estimators;	
14, 15,16	Estimation using multistage design, double sampling.	

Suggested Reading

Cochran WG. 1977. Sampling Techniques. John Wiley.

Murthy MN. 1977. Sampling Theory and Methods. 2nd Ed. Statistical Publ. Soc., Calcutta.

Singh D, Singh P and Kumar P. 1982. Handbook on Sampling Methods. IASRI Publ.

Sukhatme PV, Sukhatme BV, Sukhatme S and Asok C. 1984. Sampling Theory of Surveys with Applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

Cochran WG. 2007. Sampling Techniques, 3rd Edition. John Wiley & Sons Publication

Course Title : Applied Regression Analysis

Course Code : STAT 521

Credit Hours : 2+1

Aim of the course

This course is meant for students of all disciplines including agricultural and animal sciences. The students would be exposed to the concepts of correlation and regression. Emphasis will be laid on diagnostic measures such as autocorrelation, multi collinearity and heteroscedasticity. This course would prepare students to handle their data for analysis and interpretation.

Theory

Unit I

Introduction to correlation analysis and its measures, Correlation from grouped data, correlation, Rank correlation, Testing of population correlation coefficients; Multiple and partial correlation coefficients and their testing.

Unit II

Problem of correlated errors; Auto correlation; Heteroscedastic models, Durbin Watson Statistics; Removal of auto correlation by transformation; Analysis of collinear data; Detection and correction of multi collinearity, Regression analysis; Method of least squares for curve fitting; Testing of regression coefficients; Multiple and partial regressions .

Unit III

Diagnostic of multiple regression equation; Concept of weighted least squares; regression equation on grouped data; Various methods of selecting the best regression equation.

Unit IV

Concept of nonlinear regression and fitting of quadratic, exponential and power curves; Economic and optimal dose, Orthogonal polynomial.

Practical

1.Correlation coefficient, various types of correlation coefficients,

2. Partial and multiple, testing of hypotheses;

3. Multiple linear regression analysis, partial regression coefficients, testing of hypotheses,

residuals and their applications in outlier detection;

5. Handling of correlated errors, multi collinearity;

6. Fitting of quadratic, exponential and power curves, fitting of orthogonal polynomials.

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1	Introduction to correlation analysis and its measures,	6

2,3	Correlation from grouped data, correlation, Rank correlation, Testing of population correlation coefficients;	7
4,5	Multiple and partial correlation coefficients and their testing.	7
6,7	Problem of correlated errors; Auto correlation;	6
8,9	Heteroscedastic models,	7
710,11,12	Durbin Watson Statistics; Removal of auto correlation by transformation;	7
13,14	Analysis of collinear data; Detection and correction of multi collinearity,	8
15,16	Regression analysis; Method of least squares for curve fitting;	6
17,,18	Testing of regression coefficients; Multiple and partial regressions	8
19,20	Diagnostic of multiple regression equation	8
21,22	Concept of weighted least squares; regression equation on grouped data;	7
23,24,	Various methods of selecting the best regression equation.	6
25,26	Concept of nonlinear regression and fitting of quadratic, exponential and power curves;	8
27	Economic and optimal dose,	6
28,29	Orthogonal polynomial.	6
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Correlation coefficient, various types of correlation coefficients
2	Partial and multiple, testing of hypotheses;\
3	Multiple linear regression analysis,
4	partial regression coefficients, testing of hypotheses,
5	residuals and their applications in outlier detection;
6	Handling of correlated errors
7	Multi collinearity;
8	Fitting of quadratic regression

9	Fitting of exponential regression
10	Fitting of power curves,
11	Fitting of quadratic regression

Suggested Reading

Kleinbaum DG, Kupper LL, Nizam A. 2007. Applied Regression Analysis and Other Multivariable Methods (Duxbury Applied) 4th Ed.

Draper NR and Smith H. 1998. Applied Regression Analysis. 3rd Ed. John Wiley.

Ezekiel M. 1963. Methods of Correlation and Regression Analysis. John Wiley.

Koutsoyiannis A. 1978. Theory of Econometrics. MacMillan.

Kutner MH, Nachtsheim CJ and Neter J. 2004. Applied Linear Regression Models. 4th Ed. With Student CD. McGraw Hill.

Course Title : Data Analysis Using Statistical Packages
Course Code : STAT 522
Credit Hours : 2+1

Aim of the course

This course is meant for exposing the students in the usage of various statistical packages for analysis of data. It would provide the students a hands on experience in the analysis of their research data. This course is useful to all disciplines.

Theory

Unit I

Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

Unit II

Test for normality; Testing of hypothesis using chi-square, t and F statistics and Z-test.

Unit III

Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

Unit IV

Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.

Unit V

Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.

Practical

1. Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data;
2. Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, one-way analysis of variance;
3. Designs for Factorial Experiments, fixed effect models, random effect models, mixed effect
   models, estimation of variance components;
4. Linear regression, Multiple regression, Regression plots;
5. Discriminant analysis - fitting of discriminant functions, identification of important variables;
6. Factor analysis. Principal component analysis - obtaining principal component

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1,2,	Introduction to various statistical packages: Excel, Data Preparation;	3

	Descriptive statistics; Graphical representation of data, Exploratory data analysis	
3,4,5	Introduction to various statistical packages:, R, Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis	5
5,6,7	Introduction to various statistical packages: SAS, (if available) Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis	5
8	Test for normality	4
9,10	Testing of hypothesis using chi-square test	5
11	Z-test.	3
12	t test	6
13	F statistics test	5
14	Data preparation for ANOVA and ANCOVA,	3
15,16	Factorial Experiments,.	5
17,18	contrast analysis, multiple comparisons,	6
19,20,	Analyzing crossed designs	5
21,22	Analyzing nested classified designs	5
23	Analysis of mixed models;	5
24,25	Estimation of variance components;.	5
26,27,28	Correlation and regression analysis,	6
29,30,31	Discriminant function; Factor analysis;	6
32,33	Principal component analysis;	6
34,35	Analysis of time series data,	6
36	Fitting of non-linear models;	6
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1,2	Use of software packages-Excel, R and SAS for summarization and tabulation of data,
3,4,5	Use of software packages Excel, R and SAS for obtaining descriptive statistics, graphical representation of data;

6,7,8	Use of software packages Excel, R and SAS for Designs for Factorial Experiments
9,10,11,12	Use of software packages Excel, R and SAS for Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, one-way analysis of variance;
12,13,14	Use of software packages Excel, R and SAS for fixed effect models, random effect models, mixed effect models,
15,16	Use of software packages Excel, R and SAS for estimation of variance components;
8	Use of software packages Excel, R and SAS for estimation of variance components
9	Linear regression, Multiple regression, Regression plots;
10	Discriminant analysis - fitting of discriminant functions, identification of important variables;
11	Factor analysis. Principal component analysis - obtaining principal component.

Suggested Reading

Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley.

Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press.

Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmount, California.

Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.

Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.

Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.

Erickson B.H. and Nosanchuk T.A. 1992. Understanding Data. 2nd Ed. Open University Press, Milton Keynes.

Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall.

Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.

Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.

Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.

Weisberg S. 1985. Applied Linear Regression. John Wiley.

Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.

COURSE CONTENT OF MASTERS DEGREE

Course Title : : Mathematics-I

Course Code : STAT 551

Credit Hours : 3+0

Aim of the course

This course lays the foundation of all other courses of Agricultural Statistics discipline by preparing them to understand the importance of mathematical methods in research. The students would be exposed to the basic mathematical tools of real analysis, calculus, differential equations and numerical analysis. This would prepare them to study their main courses that involve knowledge of Mathematics.

Theory

Unit I

Calculus: Limit and continuity, differentiation of functions, successive differentiation, partial differentiation, mean value theorems, Taylor and Maclaurin's series. Application of derivatives, L'hospital's rule.

Unit II

Real Analysis: Convergence and divergence of infinite series, use of comparison tests - D'Alembert's Ratio - test, Cauchy's nth root test, Raabe's test, Kummer's test, Gauss test. Absolute and conditional convergence. Riemann integration, concept of Lebesgue integration, power series, Fourier, Laplace and Laplace -Steiltjes' transformation, multiple integrals. Integration of rational, irrational and trigonometric functions. Application of integration.

Unit III

Differential equation: Differential equations of first order, linear differential equations of higher order with constant coefficient.

Unit IV

Numerical Analysis: Simple interpolation, Divided differences, Numerical differentiation and integration.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1,2	Introduction of calculus, Definition of calculus, types of calculus : differential and integral	3
3,4	Applications of calculus, problems and its solutions	4
5	Introduction of Limit	3
6	Important theorems of limits	6
7	Properties of limits	4
8,9	Simple numerical examples based on limits with their solutions	4
10,11	Basic concept of differentiation of functions, degree of differential equation, meaning of finite and infinite differentiation	3
12,13	Successive differentiation: $1^{st,}$ 2^{nd} and 3^{rd} order by using numerical examples	5
14,15	Concept of Partial differentiation and its applications in agriculture	4
16,17	Mean value theorems , graphical representation of mean value theorem	4
18,19	Introduction of Taylor and Maclaurin's series, definitions	3
20	Findings of Taylor and Maclaurin's polynomials	3
21	Application of derivatives in agriculture	5
22	L'hospital's rule : general form, necessity of conditions	1
23	Introduction of Real Analysis	1
24	Concept of Convergence and divergence of infinite series	1
25,26,27	Use of comparison tests -D'Alembert's Ratio - test, Cauchy's n^{th} root test	2
28,29	Raabe's test, Kummer's test and Gauss test	1
30	Basic concept of absolute and conditional convergence	2
31,32	Riemann integration, concept of Lebesgue integration	2
33,34	Power series, Fourier, Laplace and Laplace -Steiltjes' transformation	2
35	Introduction of Multiple integrals	2
36,37	Integration of rational and irrational functions with numerical examples	3
38,39	Introduction of trigonometric functions: sine, cosine, tangent,	5

	cotangent, secant and cosecant their formulas and reciprocals etc.	
40	Application of integration in agriculture	5
41	Differential equation: Differential equations of first order	5
42	Concept of linear differential equations of higher order with constant coefficient	1
43	Introduction of interpolation, definition	1
44,45	Numerical Analysis: Simple interpolation	3
26	Introduction of divided differences its basic properties	2
47	Numerical examples of differentiation	5
48	Numerical examples of integration	5
	Total	**100**

Suggested Reading

BartleRG.1976.ElementsofRealAnalysis.JohnWiley.ChatterjeeSK.1970.Mathematical Analysis. Oxford &IBH.

Gibson GA. 1954. Advanced Calculus. Macmillan.

Henrice P. 1964. Elements of Numerical Analysis. John Wiley.

Hildebrand FB. 1956. Introduction to Numerical Analysis. Tata McGraw Hill.

Priestley HA. 1985. Complex Analysis. Clarenton Press.

RudinW.1985.PrinciplesofMathematicalAnalysis.McGrawHill.SauerT.2006. Numerical Analysis With CD-Rom. Addison Wesley. Scarborough JB. 1976. Numerical Mathematical Analysis. Oxford & IBH. Stewart J. 2007. Calculus. Thompson.

Thomas GB Jr. and Finney RL. 1996. Calculus. 9th Ed. Pearson Edu.

Course Title : : Probability Theory

Course Code : STAT 552

Credit Hours : 2+0

Aim of the course

This is a fundamental course in Statistics. This course lays the foundation of probability theory, random variable, probability distribution, mathematical expectation, etc. which forms the basis of basic statistics. The students are also exposed to law of large numbers and central limit theorem. The students also get introduced to stochastic processes.

Theory

Unit I

Basic concepts of probability. Elements of measure theory: class of sets, field, sigma field, minimal sigma field, Borel sigma field in R, measure- probability measure. Axiomatic approach to probability. Properties of probability based on axiomatic definition. Addition and multiplication theorems. Conditional probability and independence of events. Bayes theorem.

Unit II

Random variables: definition of random variable, discrete and continuous, functions of random variables. Probability mass function and Probability density function, Distribution function and its properties. Notion of bivariate random variables, bivariate distribution function and its properties. Joint, marginal and conditional distributions. Independence of random variables. Transformation of random variables (two dimensional caseonly). Mathematical expectation: Mathematical expectation of functions of a random variable. Raw and central moments and their relation, covariance, skewness and kurtosis. Addition and multiplication theorems of expectation. Definition of moment generating function, cumulating generating function, probability generating function and statements of their properties.

Unit III

Conditional expectation and conditional variance. Characteristic function and its properties. Inversion and uniqueness theorems. Chebyshev, Markov, CauchySchwartz,

Sequence of random variables and modes of convergence (convergence in distribution in probability, almost surely, and quadratic mean) and their interrelations.

Unit IV

Laws of large numbers: WLLN, Bernoulli and Kintchin's WLLN. Kolmogorov inequality, Kolmogorov's SLLNs. Central Limit theorems: Demoviere- Laplace CLT, Lindberg – Levy CLT and simple applications.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Basic concepts of probability and its applications in Agriculture	4
2,3	Elements of measure theory: class of sets, field, sigma field, minimal sigma field, Borel sigma field in R	5
4,5	Measure- probability measure. Axiomatic approach to probability, Properties of probability based on axiomatic definition	6
6,7	State and prove addition and multiplication theorems of probability	6
8,9	Conditional probability and independence of events and Bayes theorem	7
10	Random variables: definition of random variable, discrete and continuous, functions of random variables	5
11,12	Probability mass function and Probability density function, Distribution function and its properties	6
13	Notion of bivariate random variables, bivariate distribution function and its properties	7
14,15	Joint, marginal and conditional distributions. Independence of random variables. Transformation of random variables (two dimensional case only)	5
16,	Mathematical expectation: Mathematical expectation of functions of a random variable by using numerical examples	5
17	Raw and central moments and their relation, covariance, skewness and kurtosis	7
18,19	Addition and multiplication theorems of expectation explain with numerical examples	7
20,21	Definition of moment generating function, cumulating generating function, probability generating function and statements of their properties	5
22,23	Conditional expectation and conditional variance. Characteristic function and its properties	4

24,25	Inversion and uniqueness theorems. Chebyshev, Markov, Cauchy-Schwartz	3
26,27,28	Sequence of random variables and modes of convergence (convergence in distribution in probability, almost surely, and quadratic mean) and their interrelations	3
29	Laws of large numbers: WLLN, Bernoulli and Kintchin's WLLN.	4
30	Kolmogorov inequality, Kolmogorov's SLLNs	5
31,32	Central Limit theorems: Demoviere- Laplace CLT, Lindberg – Levy CLT and simple applications	6
	Total	**100**

Suggested Reading

Ash RB. 2000. Probability and Measure Theory. 2nd Ed. Academic Press. Billingsley P. 1986. Probability and Measure. 2nd Ed. John Wiley.

Capinski M and Zastawniah. 2001. Probability Through Problems. Springer.

Dudewicz EJ & Mishra SN. 1988. Modern Mathematical Statistics. John Wiley.

Feller W. 1972. An Introduction to Probability Theory and its Applications. Vols. I., II. John Wiley.

Loeve M. 1978. Probability Theory. 4th Ed. Springer

Marek C, Tomasz JZ. 2003. Probability Through Problems (Problem Books in Mathematics) Corrected Ed.

Marek F. 1963. Probability Theory and Mathematical Statistics. John Wiley.

Rohatgi VK & Saleh AK Md. E. 2005. An Introduction to Probability and Statistics. 2nd Ed. John Wiley

Course Title : Statistical Methods

Course Code : STAT 553

Credit Hours : 2+1

Aim of the course

This course lays the foundation of probability distributions and sampling distributions and their application which forms the basis of Statistical Inference. Together with probability theory, this course is fundamental to the discipline of Statistics. The students are also exposed to correlation and regression, and order statistics and their distributions. Categorical data analysis is also covered in this course.

Theory

Unit I

Descriptive statistics: probability distributions: Discrete probability distributions ~ Bernoulli, Binomial, Poisson, Negative-binomial, Geometric and Hyper Geometric, uniform, multinomial ~ Properties of these distributions and real life examples. Continuous probability distributions ~ rectangular, exponential, Cauchy, normal, gamma, beta of two kinds, Weibull, lognormal, logistic, Pareto. Properties of these distributions. Probability distributions of functions of random variables.

Unit II

Concepts of compound, truncated and mixture distributions (definitions and examples). Sampling distributions of sample mean and sample variance from Normal population, central and non–central chi-Square, t and F distributions, their properties and inter relationships.

Unit III

Concepts of random vectors, moments and their distributions. Bivariate Normal distribution - marginal and conditional distributions. Distribution of quadratic forms. Cochran theorem. Correlation, rank correlation, correlation ratio and intra-class correlation. Regression analysis, partial and multiple correlation and regression.

Unit IV

Sampling distribution of correlation coefficient, regression coefficient. Categorical data analysis, Association between attributes. Variance Stabilizing Transformations.

Unit V

Order statistics, distribution of r-th order statistics, joint distribution of several order statistics and their functions, marginal distributions of order statistics.

Practical

1. Fitting of discrete distributions and test for goodness of fit;
2. Fitting of continuous distributions and test for goodness of fit; Fitting of truncated distribution.
3. Computation of simple, multiple and partial correlation coefficient, correlation ratio and intra-class correlation
4. Regression coefficients and regression equations
5. Fitting of Pearsonian curves
6. Analysis of association between attributes, categorical data and log-linear models.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1,2	Descriptive statistics: definition of Arithmetic mean, median, mode, harmonic mean, geometric mean with their formulas and its relationship between them,	3
3,4	Descriptive statistics: Range, mean deviation, quartile deviation along with their formulas and its relationship between them, standard deviation, coefficient of variation, skewness and kurtosis	5
5,6	Probability distributions: Discrete probability distributions ~ Bernoulli, Binomial, Poisson with its properties and real life examples	5
7,8,9	Negative-binomial, Geometric and Hyper Geometric, uniform, multinomial distributions with their properties and real life examples	5
10,11	Continuous probability distributions : rectangular, exponential, Cauchy distribution along with properties of these distributions	5
12,13	Normal and gamma distribution and its properties along with numerical examples	6
14,15	Beta of two kinds, Weibull, lognormal distribution with its properties	5
16,17	Logistic and Pareto distributions and explain its properties. Probability distributions of functions of random variables	5

18	Concepts of compound, truncated and mixture distributions (definitions and examples)	3
19	Sampling distributions of sample mean and sample variance from Normal population	4
20	Central and non-central chi-Square their properties and inter relationships	2
21	t and F distributions its properties and explain relationships between them	5
22	Concepts of random vectors, moments and their distributions	4
23	Bivariate Normal distribution - marginal and conditional distributions.	4
24	Distribution of quadratic forms. Cochran theorem.	3
25	Definition of Correlation, rank correlation, correlation ratio and intra-class correlation	7
26	Introduction of Regression analysis with its important properties	6
27	Basic concept of partial and multiple correlation and regression by using numerical examples in agriculture	6
28	Sampling distribution of correlation coefficient, regression coefficient. Categorical data analysis	3
29	Concept of association between attributes. Variance Stabilizing Transformations	6
30	Introduction of order statistics, Distribution of r-th order statistics and their functions	3
31	Joint distribution of several order statistics and their functions	2
32	Concept of marginal distributions of order statistics, distribution of range, median, etc.	3
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1,2	Fitting of discrete distributions and test for goodness offit
3,4	Fitting of continuous distributions and test of good ness of fit
5,6	Fitting of truncated distribution
7	Computation of simple correlation coefficient
8	Computation of multiple correlation coefficient

9	Computation of partial correlation coefficient
10	Correlation ratio and intra-class correlation
11,12	Regression coefficients and regression equations
13	Fitting of Pearsonian curves
14	Analysis of association between attributes, categorical data
15,16	Practical based on Log-linear models

Suggested Reading

Agresti, A. 2012. Categorical Data Analysis 3rd Ed. John Wiley.

Arnold BC, Balakrishnan N and Nagaraja HN. 1992. A First Course in Order Statistics. JohnWiley.

David HA and Nagaraja HN. 2003. Order Statistics. 3rd Ed. John Wiley.

Dudewicz EJ and Mishra SN. 1988. Modern Mathematical Statistics. John Wiley.

Huber PJ. 1981. Robust Statistics. John Wiley.

Johnson NL, Kotz S and Balakrishnan N. 2000. Continuous Univariate Distributions. JohnWiley.

Johnson NL, Kotz S and Balakrishnan N. 2000. Discrete Univariate Distributions. JohnWiley.

Marek F.1963. Probability Theory and Mathematical Statistics. John Wiley.

Rao CR. 1965. Linear Statistical Inference and its Applications. John Wiley.

Rohatgi VK and Saleh AK Md. E. 2005. An Introduction to Probability and Statistics. 2nd Ed. John Wiley.

Gupta. S.P 2008. Statistical Methods. Sultan Chand & sons Educational Publisher

Course Title : Actuarial Statistics

Course Code : STAT 554

Credit Hours : 2+0

Aim of the course

This course is meant to expose to the students to the statistical techniques such as probability models, life tables, insurance and annuities. The students would also be exposed top practical applications of these techniques in computation of premiums that include expenses, general expenses, types of expenses and per policy expenses.

Theory

Unit I

Insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality.

Unit II

Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

Unit III

Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

Unit IV

Distribution of aggregate claims, compound Poisson distribution and its applications.

Unit V

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

Unit VI

Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions.

Unit VII

Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due.

Unit VIII

Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.

Unit IX

Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses. Claim amount distributions, approximating the individual model, stop-loss insurance.

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1	Introduction of Insurance and utility theory	03
2,3	What are the different models for individual claims and their sums, survival function, curtate future lifetime, force of mortality	05
4,5,6	What is meant by Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables	06
7,8	Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws	05
9,10	Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations	05
11,12	Distribution of aggregate claims, Compound Poisson distribution and	09

	its applications	
13,14,15	Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding	04
16,17,18	Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions	09
19,20,21	Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions,completeannuities-immediateandapportionableannuities-due	09
22,23	Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits.	09
24	Payment premiums, apportionable premiums, commutation functions, accumulation type benefits	05
25	Net premium reserves: Continuous and discrete net premium reserve	08
26	Reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis	05
27,28	Reservesatfractionaldurations,allocationsoflosstopolicyyears,recursivef ormulas and differential equations fore serves, commutation functions	08
29,30	Some practical considerations: Premiums that include expenses-general expenses types of expenses per policy expenses	05
31,32	Some practical considerations: Claim amount distributions, approximating the individual model, stop-loss insurance	05
	Total	**100**

Suggested Reading

Atkinson ME and Dickson DCM. 2000. An Introduction to Actuarial Studies. Elgar Publ.

Bedford T and Cooke R. 2001. Probabilistic Risk Analysis. Cambridge. • Booth PM, Chadburn RG, Cooper DR, Haberman, S and James DE.1999. Modern Actuarial Theory and Practice. Chapman & Hall.

Borowiak Dale S. 2003. Financial and Actuarial Statistics: An Introduction. Marcel Dekker.

Bowers NL, Gerber HU, Hickman JC, Jones DA and Nesbitt CJ.1997. Actuarial Mathematics. 2nd Ed. Society of Actuaries, Ithaca, Illinois.

Dale SB, Arnold FS. 2013. Financial and Actuarial Statistics: An Introduction, 2nd Ed. (Statistics: A Series of Textbooks and Monogrphs)

Daykin CD, Pentikainen T and Pesonen M. 1994. Practical Risk Theory for Actuaries. Chapman & Hall.

Klugman SA, Panjer HH, Willmotand GE and Venter GG. 1998. Loss Models: From data to Decisions. John Wiley.

Course Title : Bioinformatics

Course Code : STAT 555

Credit Hours : 2+0

Aim of the course

Bioinformatics is a new emerging area. It is an integration of Statistics, Computer applications and Biology. The trained manpower in the area of Bioinformatics is required for meeting the new challenges in teaching and research in the discipline of Agricultural Sciences. This course is meant to train the students on concepts of basic biology, statistical techniques and computational techniques for understanding bioinformatics principals.

Theory

Unit I

Basic Biology: Cell, genes, gene structures, gene expression and regulation, Molecular tools, nucleotides, nucleic acids, markers, proteins and enzymes, bioenergetics, single nucleotide polymorphism, expressed sequence tag. Structural and functional genomics: Organization and structure of genomes, genome mapping, assembling of physical maps, strategies and techniques for genome sequencing and analysis.

Unit II

Computing techniques: OS and Programming Languages – Linux, perl, bioperl, python, bio python, cgi, MySQL, php My Admin; Coding for browsing biological databases on web, parsing & annotation of genomic sequences; Database designing; Computer networks – Internet, World wide web, Web browsers– EMB net, NCBI; Databases on public domain pertaining to Nucleic acid sequences, protein sequences, SNPs, etc.; Searching sequence databases, Structural databases.

Unit III

Statistical Techniques: MANOVA, Cluster analysis, Discriminant analysis, Principal component analysis, Principal coordinate analysis, Multidimensional scaling; Multiple regression analysis; Likelihood approach in estimation and testing; Resampling techniques – Bootstrapping and Jack-knifing; Hidden Markov Models; Bayesian estimation and Gibbs sampling;

Unit IV

Tools for Bioinformatics: DNA Sequence Analysis – Features of DNA sequence analysis, Approaches to EST analysis; Pairwise alignment techniques: Comparing two sequences, PAM and BLOSUM, Global alignment (The Needleman and Wunsch algorithm), Local Alignment (The Smith-Waterman algorithm), Dynamic programming, Pairwise database searching; Sequence analysis– BLAST and other related tools, Multiple alignment and database search using motif models, Clustal W, Phylogeny; Databases on SNPs; EM algorithm and other methods to discover common motifs in bio sequences; Gene prediction based on Neural Networks, Genetic algorithms, Computational analysis of protein sequence, structure and function; Design and Analysis of microarray/ RNAs experiments.

Teaching Sc*h*edule

Lecture No.	Topic	Weightage
1,2	Basic Biology: Cell, genes, gene structures, gene expression and regulation, Molecular tools, nucleotides	5
3,4	Introduction to nucleic acids, markers, proteins and enzymes, bioenergetics, single nucleotide polymorphism, expressed sequence tag	5
5,6	Structural and functional genomics: Organization and structure of genomes	4
7,8	Genome mapping, assembling of physical maps, strategies and techniques for genome sequencing and analysis	5
9,10	Computing techniques: OS and Programming Languages– Introduction to Linux, perl, Inbioperl	5
11,12	Introduction to python, biopyth on, cgi, MySQL, php My Admin	6
13,14	Coding for browsing biological databases on web, parsing & annotation of genomic sequences	6
15,16	Database designing; Computer networks–Internet ,World wide web, Web browsers–EMB net, NCBI; Databases on public domain pertaining to Nucleic acid sequences, protein sequences, SNPs, etc.	5
17,18	Searching sequence databases, Structural databases	5
19,20	Statistical Techniques: Introduction to MANOVA, Cluster analysis	6
21,22	Introduction to Discriminant analysis, Principal component analysis, Principal coordinate analysis	6

23,24	Introduction to Multidimensional scaling; Multiple regression analysis; Likelihood approach in estimation and testing	5
24,25	Re sampling techniques – Bootstrapping and Jack-knifing	6
26,27	Hidden Markov Models; Bayesian estimation and Gibbs sampling	6
28,29	Tools for Bioinformatics: DNA Sequence Analysis–Features of DNA sequence analysis	6
30,31	Approaches to EST analysis; Pairwise alignment techniques: Comparing two sequences, PAM and BLOSUM	6
32,33	Global alignment (The Needleman and Wunschal gorithm),Local Alignment(The Smith-Waterman algorithm), Dynamic programming, Pairwise database searching; Sequence analysis–BLAST and other related tools	6
34,35	Multiple alignment and database search using motif models, Clustalw, Phylogeny; Databases on SNPs; EM algorithm and other methods to discover common motifs in biosequences; Gene prediction based on Neural Networks, Geneticalg orithms, Computational analysis of protein sequence, structure and function; Design and Analysis of microarray/RNA seq eXperiments	7

Suggested Reading

Baldi P. and Brunak S. 2001. Bioinformatics: The Machine Learning Approach. 2nd Ed. (Adaptive Computation and Machine Learning). MIT Press. •

Baxevanis A.D. and Francis B.F. (Eds.). 2004. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley.

Bergeron B.P. 2002. Bioinformatics Computing. Prentice Hall. • Duda R.O, Hart P.E and Stork D.G. 1999. Pattern Classification. John Wiley.

Ewens W.J and Grant G.R. 2001. Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health). Springer.

Graham B. Zweig, J. Buffett, WE. 2006.The Intelligent Investor: The Definitive Book on Value Investing. A Book of Practical Counsel, Revised Edition

Hunt S and Livesy F. (Eds.). 2000. Functional Genomics: A Practical Approach (The Practical Approach Series, 235). Oxford Univ. Press.

Jones N.C. and Pevzner P.A. 2004. An Introduction to Bioinformatics Algorithims. MIT Press.

Koski T and Koskinen T. 2001. Hidden Markov Models for Bioinformatics. Kluwer. • Krane D.E. and Raymer M.L. 2002. Fundamental Concepts of Bio-informatics. Benjamin / Cummings.

Krawetz S.A and Womble D.D. 2003. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana Press.

Lesk A.M. 2002. Introduction to Bio-informatics. Oxford Univ. Press. • Percus J.K. 2001. Mathematics of Genome Analysis. Cambridge Univ. Press.

Sorensen D and Gianola D. 2002. Likelihood, Bayesian and MCMC Methods in Genetics. Springer.

Tisdall J.D. 2001. Mastering Perl for Bioinformatics. O'Reilly & Associates.

Wang J.T.L., Zaki M.J., Toivonen H.T.T. and Shasha D. 2004. Data Mining in Bioinformatics. Springer.

Wu C.H. and McLarty J.W. 2000. Neural Networks and Genome Informatics. Elsevier.

Wunschiers R. 2004. Computational Biology Unix/Linux, Data Processing and Programming. Springer.

Course Title : Econometrics

Course Code : STAT 556

Credit Hours : 2+0

Aim of the course

This course is meant for training the students in econometric methods and their applications in agriculture. This course would enable the students in understanding the economic phenomena through statistical tools and economics principles.

Theory

Unit I

Representation of Economic phenomenon, relationship among economic variables, linear and non-linear economic models, single equation general linear regression model, basic assumptions, Ordinary least squares method of estimation for simple and multiple regression models; summary statistics correlation matrix, co-efficient of multiple determination, standard errors of estimated parameters, tests of significance and confidence interval estimation. BLUE properties of Least Squares estimates. Chow test, test of improvement of fit through additional regressors. Maximum likelihood estimation.

Unit II

Heteroscedasticity, Auto-correlation, Durbin Watson test, Multi-collinearity. Stochastic regressors, Errors in variables, Use of instrumental variables in regression analysis. Dummy Variables. Distributed Lag models: Koyck's Geometric Lag scheme, Adaptive Expectation and Partial Adjustment Mode, Rational Expectation Models and test for rationality.

Unit III

Simultaneous equation model: Basic rationale, Consequences of simultaneous relations, Identification problem, Conditions of Identification, Indirect Least Squares, Two-stage least squares, K-class estimators, Limited Information and Full Information Maximum Likelihood Methods, three stage least squares, Generalized least squares, Recursive models, SURE Models. Mixed Estimation Methods, use of instrumental variables, pooling of cross-section and time series data, Principal Component Methods.

Unit IV

Problem and Construction of index numbers and their tests; fixed and chain based index numbers; Construction of cost of living index number.

Unit V

Demand analysis – Demand and Supply Curves; Determination of demand curves from

market data. Engel's Law and the Engel's Curves, Income distribution and method of its estimation, Pareto's Curve, Income inequality measures.

Teaching Schedule

Lecture No.	Topic	Weightage
1	Representation of Economic phenomenon, relationship among economic variables, linear and non-linear economic models	4
2,3	Single equation general linear regression model, basic assumptions and estimation	5
4,5	Ordinary least squares method of estimation of multiple regression models	7
6	Summary statistics correlation matrix, co-efficient of multiple determination, standard errors of estimated parameters, tests of significance and confidence interval estimation	7
7,8	BLUE properties of Least Squares estimates. Chow test, test of improvement of fit through additional regressors. Maximum likelihood estimation	6
9,10	Heteroscedasticity, Auto-correlation, Durbin Watson test, Multi-collinearity. Stochastic regressors, Errors in variables	6
11,12	Use of instrumental variables in regression analysis. Dummy Variables. Distributed Lag models	7
13,14	Koyck's Geometric Lag scheme, Adaptive Expectation and Partial Adjustment Mode	5
15,16	Rational Expectation Models and test for rationality.	5
17,18	Simultaneous equation model: Basic rationale, Consequences of simultaneous relations, Identification problem, Conditions of Identification	6
19,20	Indirect Least Squares, Two-stage least squares, K-class estimators, Limited Information and Full Information Maximum Likelihood Methods	6

21,22	Three stage least squares, Generalized least squares, Recursive models, SURE Models. Mixed Estimation	7
23,24	Methods, use of instrumental variables, pooling of cross-section and time series data, Principal Component Methods.	7
25,26	Problem and Construction of index numbers and their tests; fixed and chain based index numbers;	6
27,28	Construction of cost of living index number.	5
29,30	Demand analysis – Demand and Supply Curves; Determination of demand curves from market data.	5
31,32	Engel's Law and the Engel's Curves, Income distribution and method of its estimation, Pareto's Curve, Income inequality measures.	6

Suggested Reading

Croxton F.E. and Cowden D.J. 1979. Applied General Statistics. Prentice Hall of India.

James H.S. and Mark W.W. 2017. Introduction to Econometrics, 3rd Ed. John Wiley

Johnston J. 1984. Econometric Methods. McGraw Hill.

Judge G.C., Hill R.C., Griffiths W.E., Lutkepohl H and Lee T.C. 1988. Introduction to the Theory and Practice of Econometrics. 2nd Ed. John Wiley.

Kmenta J. 1986. Elements of Econometrics. 2nd Ed. University of Michigan Press. • Koop G. 2007. Introduction to Econometrics. John Wiley.

Maddala G.S. 2001. Introduction to Econometrics. 3rd Ed. John Wiley.

Pindyck R.S. and Rubinfeld D.L. 1998. Econometric Models and Economic Forecasts. 4th Ed. McGraw Hill.

Verbeek M. 2008. A Guide to Modern Econometrics. 3rd Ed. John Wiley.

Course Title : Mathematics-II

Course Code : STAT 561

Credit Hours : 2+0

Aim of the course

This is another course that supports all other courses in Agricultural Statistics. The students would be exposed to the advances in Linear Algebra and Matrix theory. This would prepare them to study their main courses that involve knowledge of Linear Algebra and Matrix Algebra.

Theory

Unit I

Linear Algebra: Group, ring, field and vector spaces, Sub-spaces, basis, Gram Schmidt's orthogonalization, Galois field - Fermat's theorem and primitive elements. Linear transformations. Graph theory: Concepts and applications.

Unit II

Matrix Algebra: Basic terminology, linear independence and dependence of vectors Row and column spaces, Echelon form. Determinants, Trace of matrices rank and inverse of matrices. Special matrices – idempotent, symmetric, orthogonal. Eigen values and eigen vectors, Spectral decomposition of matrices.

Unit III

Unitary, Similar, Hadamard, Circulant, Helmert's matrices. Kronecker and Hadamard product of matrices, Kronecker sum of matrices. Sub-matrices and partitioned matrices, Permutation matrices, full rank factorization, Grammian root of a symmetric matrix. Solutions of linear equations, Equations having many solutions.

Unit IV

Unit IV Generalized inverses, Moore-Penrose inverse, Applications of g-inverse. Inverse and Generalized inverse of partitioned matrices, Differentiation and integration of vectors and matrices, Quadratic forms.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-6	Linear Algebra: Group, ring, field and vector spaces, Sub-spaces, basis, Gram Schmidt's orthogonalization, Galois field - Fermat's theorem and primitive elements. Linear transformations. Graph theory: Concepts and applications	20
7-15	Matrix Algebra: Basic terminology, linear independence and dependence of vectors Row and column spaces, Echelon form. Determinants, Trace of matrices rank and inverse of matrices. Special matrices – idempotent, symmetric, orthogonal. Eigen values and eigen vectors, Spectral decomposition of matrices.	30
16-25	Unitary, Similar, Hadamard, Circulant, Helmert's matrices. Kronecker and Hadamard product of matrices, Kronecker sum of matrices. Sub-matrices and partitioned matrices, Permutation matrices, full rank factorization, Grammian root of a symmetric matrix. Solutions of linear equations, Equations having many solutions.	30
26-32	Generalized inverses, Moore-Penrose inverse, Applications of g-inverse. Inverse and Generalized inverse of partitioned matrices, Differentiation and integration of vectors and matrices, Quadratic forms.	20

Suggested Reading

Aschbacher M. 2000. Finite Group Theory. Cambridge University Press.

Deo N. 1984. Graph Theory with Application to Engineering and Computer Science. Prentice Hall of India.

Gentle JE. 2007. Matrix Algebra: Theory, Computations and Applications in Statistics. Springer.

Graybill FE.1961. Introduction to Matrices with Applications in Statistics. Wadsworth Publ. • Hadley G. 1969. Linear Algebra. Addison Wesley.

Harville DA. 1997. Matrix Algebra from a Statistician's Perspective. Springer.

Rao CR. 1965. Linear Statistical Inference and its Applications. 2nd Ed. John Wiley.

Robinson DJS. 1991. A Course in Linear Algebra with Applications. World Scientific.

Searle SR. 2006. Matrix Algebra Useful for Statistics John Wiley, 2nd Ed.

Seber GAF. 2008. A Matrix Handbook for Statisticians. John Wiley

Course Title : Statistical Inference

Course Code : STAT 562

Credit Hours : 2+1

Aim of the course

This course lays the foundation of Statistical Inference. The students would be taught the problems related to point and confidence interval estimation and testing of hypothesis. They would also be given the concepts of nonparametric and sequential test procedures and elements of decision theory.

Theory

Unit I

Concepts of point estimation: unbiasedness, consistency, efficiency and sufficiency. Statement of Neyman's Factorization theorem with applications. MVUE, RaoBlackwell theorem, completeness, Lehmann- Scheffe theorem. Fisher information, Cramer-Rao lower bound and its applications.

Unit II

Moments, minimum chi-square, least square and maximum likelihood methods of estimation and their properties. Interval estimation-Confidence level, shortest length CI. CI for the parameters of Normal, Exponential, Binomial and Poisson distributions.

Unit III

Unitary, Similar, Hadamard, Circulant, Helmert's matrices. Kronecker and Hadamard product of matrices, Kronecker sum of matrices. Sub-matrices and partitioned matrices, Permutation matrices, full rank factorization, Grammian root of a symmetric matrix. Solutions of linear equations, Equations having many solutions.

Unit IV

Fundamentals of hypothesis testing-statistical hypothesis, statistical test, critical region, types of errors, test function, randomized and non- randomized tests, level of significance, power function, most powerful tests: Neyman-Pearson fundamental lemma, MLR families and UMP tests for one parameter exponential families. Concepts of consistency, unbiasedness and invariance of tests. Likelihood Ratio tests, asymptotic properties of LR tests with applications (including homogeneity of means and variances).Relation between confidence interval estimation and testing of hypothesis.

Unit V

Sequential Probability ratio test, Properties of SPRT.Termination property of SPRT, SPRT for Binomial, Poisson, Normal and Exponential distributions. Concepts of loss, risk and decision functions, admissible and optimal decision functions, estimation and testing viewed as decision problems, conjugate families, Bayes and Minimax decision functions with applications to estimation with quadratic loss.

Unit VI

Non-parametric tests: Sign test, Wilcoxon signed rank test, Runs test for randomness, Kolmogorov – Smirnov test for goodness of fit, Median test and Wilcoxon-Mann-Whitney U-test. Chi-square test for goodness of fit and test for independence of attributes. Spearman's rank correlation and Kendall's Tau tests for independence.

Practical

1. Methods of estimation - Maximum Likelihood, Minimum c2 and Moments;

2. Confidence Interval Estimation;

3. MP and UMP tests;

4. Large Sample tests;

5. Non-parametric tests, Sequential Probability Ratio Test;

6. Decision functions.

Teaching Schedule

Lecture No.	Topic	Weightage
1,2	Concepts of point estimation: unbiasedness, consistency, efficiency and sufficiency.	5
3	Statement of Neyman's Factorization theorem with applications..	4
4,5	MVUE, Rao- Blackwell theorem, completeness, Lehmann- Scheffe theorem.	5
6,7	Fisher information, Cramer-Rao lower bound and its applications	5
8,9	Moments, minimum chi-square, least square and maximum likelihood methods of estimation and their properties.	6
10,11	Interval estimation-Confidence level, shortest length CI. CI for the parameters of Normal, distributions.	6
12,13	CI for the parameters of Exponential, Binomial and Poisson	6

14,15	Fundamentals of hypothesis testing-statistical hypothesis, statistical test, critical region, types of errors, test function, randomized and non- randomized tests, level of significance, power function, most powerful tests	6
16,17	Neyman-Pearson fundamental lemma, MLR families and UMP tests for one parameter exponential families. Concepts of consistency, un biasedness and invariance of tests.	7
18,19	Likelihood Ratio tests, asymptotic properties of LR tests with applications (including homogeneity of means and variances). Relation between confidence interval estimation and testing of hypothesis.	5
20,21	Sequential Probability ratio test, Properties of SPRT. Termination property of SPRT	5
22,23	SPRT for Binomial, Poisson, Normal and Exponential distributions.	6
24,25	Concepts of loss, risk and decision functions, admissible and optimal decision functions, estimation and testing viewed as decision problems, conjugate families,	6
26,27	Bayes and Minimax decision functions with applications to estimation with quadratic loss.	6
29	Sign test, Wilcoxon signed rank test, Runs test for randomness, Kolmogorov – Smirnov test for goodness of fit	7
30,31	Median test and Wilco Xon-Mann-Whitney U-test. Chi-square test for goodness of fit and test for independence of attributes.	8
32,33	Spearman's rank correlation and Kendall's Tau tests for independence.	6

Practical Schedule

Practical No.	Topic
1,2	Methods of estimation- Maximum Likelihood
3,4	Methods of estimation
5,6,7	Minimum c^2 and Moments
8,9	Confidence Interval Estimation for the parameters of Normal, distributions
10,11,12	Confidence Interval for the parameters of Exponential, Binomial and Poisson
13,14,15	MP, UMP tests for one parameter exponential families
16	Large Sample tests

10	Non-parametric tests: Sign test, Wilco Xon signed rank test, Runs test for randomness, Kolmogorov – Smirnov test for goodness of fit
11	Median test and Wilco Xon-Mann-Whitney U-test.
12,13	Chi-square test for goodness of fit and test for independence of attributes.
14,15	SPRT for Binomial, Poisson, Normal and Exponential distributions.
16	Spearman's rank correlation and Kendall's Tau tests for independence.
17	Decision functions.

Suggested Reading

Box G.E.P. and Tiao G.C. 1992. Bayesian Inference in Statistical Analysis. John Wiley.

Casela G and Berger R.L. 2001. Statistical Inference. Duxbury Thompson Learning.

Christensen R. 1990. Log Linear Models. Springer.

Conover W.J. 1980. Practical Nonparametric Statistics. John Wiley.

Dudewicz EJ and Mishra SN. 1988. Modern Mathematical Statistics. John Wiley.

Gibbons J.D. 1985. Non Parametric Statistical Inference. 2nd Ed. Marcel Dekker. +

Kiefer J.C. 1987. Introduction to Statistical Inference. Springer.

Lehmann EL. 1986. Testing Statistical Hypotheses. John Wiley.

Lehmann EL. 1986. Theory of Point Estimation. John Wiley.

Randles R.H and Wolfe D.S. 1979. Introduction to the Theory of Nonparametric Statistics. John Wiley.

Rao C.R. 2009. Linear Statistical Inference and Its Applications, 3rdEd. John Wiley.

Rohatgi V.K. and Saleh A.K. Md. E. 2005. An Introduction to Probability and Statistics. 2nd Ed. John Wiley.

Rohtagi V.K. 1984. Statistical Inference. John Wiley

Sidney S and Castellan N.J. Jr. 1988. Non Parametric Statistical Methods for Behavioral Sciences. McGraw Hill.

Wald A. 2004. Sequential Analysis. Dover Publ.

Michael J.Panik. 2012. Statistical Inference. A John Wiley & Sons, INC, publication

Course Title : Design of Experiments

Course Code : STAT 563

Credit Hours : 2+1

Aim of the course

Design of Experiments provides the statistical tools to get maximum information from least amount of resources. This course is meant to expose the students to the basic principles of design of experiments. The students would also be provided with mathematical background of various basic designs involving one-way and two-way elimination of heterogeneity and their characterization properties. This course would also prepare the students in deriving the expressions for analysis of experimental data.

Theory

Unit I

Elements of linear estimation, Gauss Markoff Theorem, relationship between BLUEs and linear zero-functions. Aitken's transformation, test of hypothesis, Analysis of Variance, Partitioning of degrees of freedom.

Unit II

Orthogonality, contrasts, mutually orthogonal contrasts, analysis of covariance; Basic principles of design of experiments, uniformity trials, size and shape of plots and blocks, Randomization procedure.

Unit III

Basic designs - completely randomized design, randomized complete block design and Latin square design; Construction of orthogonal Latin squares, mutually orthogonal Latin squares (MOLS), Youden square designs, Graeco Latin squares.

Unit IV

Balanced Incomplete Block (BIB) designs – general properties and analysis without and with recovery of intra block information, construction of BIB designs. Partially balanced incomplete block designs with two associate classes - properties, analysis and construction, Lattice designs, alpha designs, cyclic designs, augmented designs.

Unit V

Factorial experiments, confounding in symmetrical factorial experiments (2nand 3nseries), partial and total confounding, asymmetrical factorials.

Unit VI

Cross-over designs. Missing plot technique; Split plot and Strip plot design; Groups of experiments. Sampling in field experiments.

Practical

1. Determination of size and shape of plots and blocks from uniformity trials data;

2. Analysis of data generated from completely randomized design, randomized complete block design;

3. Latin square design, Youden square design; Analysis of data generated from a BIB design, lattice design, PBIB designs;

4. 2n, 3n factorial experiments without and with confounding;

5. Split and strip plot designs, repeated measurement design;

6. Missing plot techniques,

7. Analysis of covariance;

8. Analysis of Groups of experiments,

9. Analysis of clinical trial experiments.

Teaching Schedule

Lecture No.	Topic	Weightage
1	Elements of linear estimation, Gauss Markoff Theorem, relationship between BLUEs and linear zero-functions.	3
2	Aitken's transformation, test of hypothesis, Analysis of Variance, Partitioning of degrees of freedom.	3
3,4	Orthogonality, contrasts, mutually orthogonal contrasts, analysis of covariance;	6
5	Basic principles of design of experiments, uniformity trials, size and shape of plots and blocks, Randomization procedure.	5
6	Basic designs - completely randomized design,	6
7	Randomized complete block design	6
8	Latin square design;	6
9,10	Construction of orthogonal Latin squares, mutually orthogonal Latin squares (MOLS),	6
11,12	Construction of Youden square designs, Graeco Latin squares.	5

13,14	Balanced Incomplete Block (BIB) designs – general properties and analysis without and with recovery of intra block information, construction of BIB designs.	7
15,16	Partially balanced incomplete block designs with two associate classes - properties,	5
17,18	Analysis and construction of Lattice designs, alpha designs	5
19,20	Analysis and construction of cyclic designs, augmented designs.	5
21,22	Factorial experiments, confounding in symmetrical factorial experiments (2nand 3nseries),.	7
23,24	Partial and total confounding, asymmetrical factorials	6
25,26	Cross-over designs	5
27,28	Missing plot technique;.	4
29,30	Split plot and Strip plot design;	7
31,32	Groups of experiments. Sampling in field experiments	3

Practical Schedule

Practical No.	Topic
1	Determinationofsizeandshapeofplotsandblocksfromuniformitytrialsdata
2	Analysis of data generated from completely randomized design
3	Analysis of data generated from randomized block design
4	Analysis of data generated from Latin Square Design
5	Analysis of data generated from Youden square Design
6	Analysis of data generated from a BIB design
7	Analysis of data generated from a lattice design
8	Analysis of data generated from Partially BIB designs
9	2^2 , 2^3 factorial experiments without and with confounding
10	3^2 factorial experiments without and with confounding
11	Analysis of data generated from Split plot designs
12	Analysis of data generated from Strip plot designs
13	Missing plot techniques in RBD
14	Analysis of covariance
15	Analysis of Groups of experiments
16	Analysis of clinical trial experiments

Suggested Reading

Chakrabarti M.C. 1962. Mathematics of Design and Analysis of Experiments. Asia Publ.House.

Cochran W.G. and Cox D.R. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean A.M. and Voss D. 1999. Design and Analysis of Experiments. Springer.

Dey A and Mukerjee R. 1999. Fractional Factorial Plans. John Wiley.
Dey A 1986. Theory of Block Designs. Wiley Eastern. Hall M Jr. 1986. Combinatorial Theory. John Wiley.
John J.A. and Quenouille M.H. 1977. Experiments: Design and Analysis. Charles & Griffin.
Kempthorne, O. 1976. Design and Analysis of Experiments. John Wiley. Khuri AI & Cornell JA. 1996. Response Surface Designs and Analysis. 2nd Ed. Marcel Dekker.
Kshirsagar A.M. 1983. A Course in Linear Models. Marcel Dekker.
Montgomery D.C. 2013. Design and Analysis of Experiments. John Wiley & Sons
Raghavarao D. 1971. Construction and Combinatorial Problems in Design of Experiments. John Wiley.
Searle S.R. 2006. Linear Models. John Wiley.
Street A.P. and Street D.J. 1987. Combinatorics of Experimental Designs. Oxford Science Publ.
Design Resources Server. Indian Agricultural Statistics Research Institute (ICAR), New

Course Title : Sampling Techniques

Course Code : STAT 564

Credit Hours : 2+1

Aim of the course

This course is meant to expose the students to the techniques of drawing representative samples from various populations and then preparing them on the mathematical formulations of estimating the population parameters based on the sample data. The students would also be exposed to the real life applications of sampling techniques and estimation of parameters.

Theory

Unit I

Sample survey vs complete enumeration, probability sampling, sample space, sampling design, sampling strategy; Determination of sample size; Confidence interval; Simple random sampling, Estimation of population proportion, Stratified random sampling, Proportional allocation and optimal allocation, Inverse sampling.

Unit II

Ratio, Product and regression methods of estimation, Cluster sampling, Systematic sampling, Multistage sampling with equal probability, Separate and combined ratio estimator, Double sampling, Successive sampling –two occasions. Unbiased ratio type estimators

Unit III

Non-sampling errors – sources and classification, Non-response in surveys, Randomized response techniques, Response errors/ Measurement error – interpenetrating sub-sampling.

Unit IV

PPS Sampling with and without replacement, Cumulative method and Lahiri's method of selection, Horvitz-Thompson estimator, Ordered and unordered estimators, Sampling strategies due to Midzuno-Sen and Rao-Hartley-Cochran. Inclusion probability proportional to size sampling.

Practical

1. Determination of sample size and selection of sample;
2. Simple random sampling, Inverse sampling, Stratified random sampling, Cluster sampling, systematic sampling;

3. Ratio and regression methods of estimation;
4. Double sampling, multi-stage sampling, Imputation methods;
5. Randomized response techniques;
6. Sampling with varying probabilities.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-2	Sample survey vs complete enumeration, probability sampling, sample space,	5
3-4	sampling design, sampling strategy; Determination of sample size;	3
5-6	Confidence interval; Simple random sampling,	5
7	Estimation of population proportion,	3
8-9	Stratified random sampling	7
10-11	Proportional allocation and optimal allocation, Inverse sampling.	8
12-13	Ratio, Product and regression methods of estimation	8
14-15	Cluster sampling, Systematic sampling,	7
16	Multistage sampling with equal probability,	5
17,18	Separate and combined ratio estimator, Double sampling,	7
19	Successive sampling –two occasions. Unbiased ratio type estimators	5
20	Non-sampling errors – sources and classification, Non-response in surveys,	5
21-22	Randomized response techniques, Response errors/ Measurement error – interpenetrating sub-sampling.	8
23-24	PPS Sampling with and without replacement,	7
25-26	Cumulative method and Lahiri's method of selection	7
27-29	Horvitz-Thompson estimator, Ordered and unordered estimators,	5
30-32	Sampling strategies due to Midzuno-Sen and Rao-Hartley-Cochran. Inclusion probability proportional to size sampling.	5
		100

Practical Schedule

Practical No.	Topic
1	Determination of sample size and selection of sample;
2	Simple random sampling,
3	Inverse sampling,
4,5,	Stratified random sampling,

6,7	Cluster sampling,
8	systematic sampling;
9,10	Ratio and regression methods of estimation
11	Double sampling,
12,13	multi-stage sampling, Imputation methods;
14,15	Randomized response techniques;
16	Sampling with varying probabilities.

Suggested Reading

Cassel C.M., Sarndal C.E. and Wretman J.H. 1977. Foundations of Inference in Survey Sampling. John Wiley.

Chaudhari A and Stenger H. 2005. Survey Sampling Theory and Methods. 2nd Ed. Chapman & Hall.

Chaudhari A and Voss J.W.E. 1988. Unified Theory and Strategies of Survey Sampling. North Holland.

Cochran W.G. 1977. Sampling Techniques. John Wiley.

Hedayat A.S. and Sinha B.K. 1991. Design and Inference in Finite Population Sampling. John Wiley.

Kish L. 1965. Survey Sampling. John Wiley.

Mukhopadhyay, P. 2008.

Theory and Methods of Survey Sampling, John Wiley & Sons

Murthy M.N. 1977. Sampling Theory and Methods. 2nd Ed. Statistical Publ. Society, Calcutta.

Sukhatme P.V., Sukhatme B.V., Sukhatme S and Asok C. 1984. Sampling Theory of Surveys with Applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

Thompson SK. 2000. Sampling. John Wiley.

Kochran WG. 2007. Sampling Techniques. A John Wiley & Sons Publication

Course Title : Statistical Genetics

Course Code : STAT 565

Credit Hours : 2+1

Aim of the course

This course is meant to prepare the students in applications of statistics in quantitative genetics and breeding. The students would be exposed to the physical basis of inheritance, detection and estimation of linkage, estimation of genetic parameters and development of selection indices.

Theory

Unit I

Physical basis of inheritance. Analysis of segregation, detection and estimation of linkage for qualitative characters. Amount of information about linkage, combined estimation, disturbed segregation.

Unit II

Gene and genotypic frequencies, Random mating and Hardy -Weinberg law, Application and extension of the equilibrium law, Fisher's fundamental theorem of natural selection. Disequilibrium du

Unit III

Concepts of inbreeding, Regular system of inbreeding. Forces affecting gene frequency - selection, mutation and migration, equilibrium between forces in large populations, Random genetic drift, Effect of finite population size.

Unit IV

Polygenic system for quantitative characters, concepts of breeding value and dominance deviation. Genetic variance and its partitioning, Effect of inbreeding on quantitative characters, Multiple allelism in continuous variation, Sex-linked genes, Maternal effects - estimation of their contribution.

Unit V

Correlations between relatives, Heritability, Repeatability and Genetic correlation. Response due to selection, Selection index and its applications in plants and animals' improvement programmes, Correlated response to selection.

Unit VI

Restricted selection index. Variance component approach and linear regression approach for the analysis of GE interactions. Measurement of stability and adaptability for genotypes. Concepts of general and specific combining ability. Diallel and partial diallel crosses - construction and analysis..

Practical

1. Test for the single factor segregation ratios, homogeneity of the Families with regard to single factor segregation;
2. Detection and estimation of linkage parameter by different procedures;
3. Estimation of genotypic and gene frequency from a given data.
4. Hardy-Weinberg law;
5. Estimation of changes in gene frequency due to systematic forces, inbreeding coefficient, genetic components of variation, heritability and repeatability coefficient, genetic correlation coefficient;
6. Examination of effect of linkage, epistasis and inbreeding on mean and variance of metric traits;
7. Mating designs;
8. Construction of selection index including phenotypic index, restricted selection index. Correlated response to selection.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-4	Physical basis of inheritance. Analysis of segregation, detection and estimation of linkage for qualitative characters. Amount of information about linkage, combined estimation, disturbed segregation.	10
5-9	Gene and genotypic frequencies, Random mating and Hardy - Weinberg law, Application and extension of the equilibrium law, Fisher's fundamental theorem of natural selection. Disequilibrium du	12
10-15	Concepts of inbreeding, Regular system of inbreeding. Forces affecting gene frequency - selection, mutation and migration, equilibrium between forces in large populations, Random genetic drift, Effect of finite population size.	18

16-21	Polygenic system for quantitative characters, concepts of breeding value and dominance deviation. Genetic variance and its partitioning, Effect of inbreeding on quantitative characters, Multiple allelism in continuous variation, Sex-linked genes, Maternal effects - estimation of their contribution.	20
22-26	Correlations between relatives, Heritability, Repeatability and Genetic correlation. Response due to selection, Selection index and its applications in plants and animals' improvement programmes, Correlated response to selection.	20
27-32	Restricted selection index. Variance component approach and linear regression approach for the analysis of GE interactions. Measurement of stability and adaptability for genotypes. Concepts of general and specific combining ability. Diallel and partial diallel crosses - construction and analysis.	20

Practical Schedule

Practical No.	Topic
1	Test for the single factor segregation ratios,
2,3	Homogeneity of the Families with regard to single factor segregation;
4,5	Detection and estimation of linkage parameter by different procedures;
6	Estimation of genotypic and gene frequency from a given data.
7	Hardy-Weinberg law;
8	Estimation of changes in gene frequency due to systematic forces,
9,10	Inbreeding coefficient, genetic components of variation
11,12	Heritability and repeatability coefficient
13	Genetic correlation coefficient;
14,15	Examination of effect of linkage,
16,17	Eepistasis and inbreeding on mean and variance of metric traits;

Suggested Reading

Agarwal BL and Agarwal SP. 2007. Statistical Analysis of Quantitative Genetics. New Age International Publisher.

Bailey NTJ. 1961. The Mathematical Theory of Genetic Linkage. Clarendon Press.

Balding DJ, Bishop M and Cannings C. 2001. Hand Book of Statistical Genetics. John Wiley.

Crow JF and Kimura M. 1970. An Introduction of Population Genetics Theory. Harper and Row.

Dahlberg G. 1948. Mathematical Methods for Population Genetics. Inter Science Publ.

East EM and Jones DF. 1919. Inbreeding and Outbreeding.

Lippincott JB & Co. Ewens WJ. 1979. Mathematics of Population Genetics. Springer.

Falconer DS. 1985. Introduction to Quantitative Genetics. ELBL.

Fisher RA. 1949. The Theory of Inbreeding. Oliver & Boyd.

Fisher RA. 1950. Statistical Methods for Research Workers. Oliver& Boyd.

Fisher RA. 1958. The Genetical Theory of Natural Selection. Dover Publ.

Kempthorne O. 1957. An Introduction to Genetic Statistics. The Iowa State Univ. Press.

Lerner IM. 1950. Population Genetics and Animal Improvement. Cambridge Univ. Press.

Lerner IM. 1954. Genetic Homeostasis. Oliver & Boyd.

Lerner IM. 1958. The Genetic Theory of Selection. John Wiley.

Li CC. 1982. Population Genetics. The University of Chicago Press.

K & Jinks JL. 1977. Introduction to Biometrical Genetics.Chapman & Hall.

Mather K and Jinks JL. 1982. Biometrical Genetics. Chapman & Hall.

Mather K. 1949. Biometrical Genetics. Methuen.

Mather K. 1951. The Measurement of Linkage in Heredity.

Methuen. N. P. 1990. Statistical Genetics. Wiley Eastern.

Course Title : Statistical Quality Control

Course Code : STAT 566

Credit Hours : 2+0

Aim of the course

This course is meant for exposing the students to the concepts of Statistical Quality Control and their applications in agribusiness and agro- processing industries. This course would enable the students to have an idea about the statistical techniques used in quality control. Students who do not have sufficient background of Statistical Methods.

Theory

Unit I

Introduction to Statistical Quality Control; Control Charts for Variables – Mean, Standard deviation and Range charts; Statistical basis; Rational subgroups.

Unit II

Control charts for attributes- 'np', 'p' and 'c' charts.

Unit III

Fundamental concepts of acceptance, sampling plans, single, double and sequential sampling plans for attributes inspection.

Unit IV

Sampling inspection tables for selection of single and double sampling plans.

Teaching Schedule

Lecturer No.	Topics	Weightage
1, 2	Introduction to Statistical Quality Control	8
3,-6	Control Charts for Variables – Mean, Standard deviation and Range charts;.	12
7-8	Statistical basis; Rational subgroups	8
9-12	Control charts for attributes- 'np', 'p' and 'c' charts.	12
13-16	Fundamental concepts of acceptance,	10
17-26	sampling plans, single, double and sequential sampling plans for attributes inspection.	30

27-29	Sampling inspection tables for selection of single sampling plans.	10
30-32	Sampling inspection tables for selection of double sampling plans.	10

Suggested Reading

Cowden D.J. 1957. Statistical Methods in Quality Control. Prentice Hall of India.

Dodge H.F. and Romig H.G. 1959. Sampling Inspection Tables. John Wiley.

Duncan A.J. 1986. Quality Control and Industrial Statistics. 5th Ed. Irwin Book Co.

Grant E.L. and Leavenworth R.S. 1996. Statistical Quality Control. 7th Ed. McGraw Hill.

Montgomery D.C. 2008. Introduction to Statistical Quality Control. 6th Ed. John Wiley.

Wetherhil G.B. 1977. Sampling Inspection and Quality Control. Halsted Press.

Course Title : Optimization Techniques

Course Code : STAT 567

Credit Hours : 1+1

Aim of the course

This course is meant for exposing the students to the mathematical details of the techniques optimization techniques. They will be taught numerical methods of optimization, linear programming techniques, nonlinear programming and multiple objective programming. Students will also be exposed to practical applications of these techniques.

Theory

Unit I

Classification of optimization problems, Classical optimization techniques: single variable optimization, multivariable optimization techniques with no constraints, multivariable optimization techniques with equality constraints, multivariable optimization techniques with inequality constraints.

Unit II

Linear programming: simplex method, duality, sensitivity analysis, Karmarkar's method, transportation problem.

Unit III

Nonlinear programming Unconstrained optimization techniques: direct search methods such as random search, grid search, Hooke and Jeeves' method, Powel's method. Descent methods such as gradient method, steepest descent method, conjugate gradient method, Newton's method, Marquardt method.

Unit IV

Quadratic programming, integer linear programming, integer nonlinear programming, geometric programming, dynamic programming, stochastic programming, multi objective optimization, optimal control theory, genetic algorithms, simulated annealing, neural network based optimization,

Practical

1. Problems based on classical optimization techniques, optimization techniques with constraints,

minimization problems using numerical methods.

2. Linear programming (LP) problems through graphical method, simplex method, simplex two-phase method, primal and dual method.
3. Sensitivity analysis for LP problem, LP problem using Karmarkar's method.
4. Problems based on Quadratic programming, integer programming, dynamic programming, stochastic programming.
5. Problems based on Pontryagin's maximum principle.
6. Problems based on multiobjective optimization.

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1	Basic concept and classification of optimization problems	05
2,3	What is mean by Classical optimization techniques, single variable optimization and multivariable optimization techniques with no constraints	06
4	Classification of optimization problems, Multivariable optimization techniques with equality constraints	05
5	Multivariable optimization techniques with inequality constraints	06
6	Introduction of Linear Programming problem and simplex method in detail	08
7	Concept Duality and Sensitivity analysis, Karmarkar's method	04
8	Transportation problem and its application	06
9	Introduction of Nonlinear programming Unconstrained optimization techniques	03
10	Different methods of non- linear programming : direct search methods such as random search	08
11	Introduction of Grid search, Hooke and Jeeves' method, Powel's method of non linear programming	05
12	Basic concept of Descent methods such as gradient method, steepest descent method	03

13	Conjugate gradient method, Newton's method, Marquardt method	04
14,15	Basic concept of quadratic programming, integer linear programming, integer nonlinear programming and its application in agriculture	08
16	Introduction and application of Geometric programming and dynamic programming	08
17	Stochastic programming, Multi objective optimization, optimal control theory and its applications.	06
18	Introduction of Genetic algorithms, simulated annealing	06
19	Neural network based optimization and it's application in agriculture	09
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Problems based on classical optimization techniques
2	Optimization techniques with constraints, minimization problems by using numerical methods
3	Linear programming (LP) problems through graphical method
4	Simplex method
5	Simplex two-phase method
6	Primal and dual method
7	Sensitivity analysis for LP problem
8	LP problem using Karmarkar's method
9	Problems based on Quadratic programming
10	Integer programming
11	Dynamic programming
12	Stochastic programming
13	Problems based on Pontryagin's maximum principle

14	Problems based on Multiobjective optimization

Suggested Reading

Antunes C.H., Alves, M.J., Climaco J. 2016. Multi objective Linear and Integer Programming (EURO Advanced Tutorials on Operational Research)

Nocedal, J. and Wright, S.J. 1999. Numerical Optimization. Springer.

Rao, S.S. 2007. Engineering Optimization: Theory and Practice. New Age International Publishers.

Rustagi, J.S. 1994. Optimization Techniques in Statistics. Academic Press.

Taha, H.A. 2007. Operations Research: Introduction with CD. Pearson Education.

Xu, H, Teo, K.L. Zhang Y. 2016. Optimization and Control Techniques and Applications (Springer Proceedings in Mathematics & Statistics)

Zeleny, M. 1974. Linear Multi objective Programming. Springer.

Course Title : Multivariate Analysis

Course Code : STAT 571

Credit Hours : 2+1

Aim of the course

This course lays the foundation of Multivariate data analysis. Most of the data sets in agricultural sciences are multivariate in nature. The exposure provided to multivariate data structure, multinomial and multivariate normal distribution, estimation and testing of parameters, various data reduction methods would help the students in having a better understanding of agricultural research data, its presentation and analysis.

Theory

Unit I

Concept of random vector, its expectation and Variance-Covariance matrix. Marginal and joint distributions. Conditional distributions and Independence of random vectors. Multinomial distribution. Multivariate Normal distribution, marginal and conditional distributions. Sample mean vector and its distribution. Maximum likelihood estimates of mean vector and dispersion matrix. Tests of hypothesis about mean vector.

Unit II

Wishart distribution and its simple properties. Hotelling's T2 and Mahalanobis D2 statistics. Null distribution of Hotelling's T2. Rao's U statistics and its distribution. Wilks' O criterion and its properties. Concepts of discriminant analysis, computation of linear discriminant function, classification between k (t2) multivariate normal populations based on LDF and Mahalanobis D2.

Unit III

Principal Component Analysis, factor analysis. Canonical variables and canonical correlations. Cluster analysis: similarities and dissimilarities of qualitative and quantitative characteristics, Hierarchical clustering. Single, Complete and Average linkage methods. K-means cluster analysis.

Unit IV

Path analysis and computation of path coefficients, introduction to multidimensional scaling,

some theoretical results, similarities, metric and non-metric scaling methods.

Practical

1. Maximum likelihood estimates of mean-vector and dispersion matrix;
2. Testing of hypothesis on mean vectors of multivariate normal populations;
3. Cluster analysis, Discriminant function, Canonical correlation, Principal component analysis, Factor analysis;
4. Multivariate analysis of variance and covariance, multidimensional scaling.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Concept of random vector and its expectation	03
2,3	Variance-Covariance matrix	02
4	Introduction of Marginal and joint distributions	02
5	Concept of Conditional distributions and Independence of random vectors	02
6	Multinomial distribution and its properties	03
7	Multivariate Normal distribution and its properties	03
8	Basic concept of Marginal and conditional distributions	02
9	Sample mean vector and its distribution	02
10,11	Maximum likelihood estimates of mean vector and dispersion matrix and Tests of hypothesis about mean vector	02
12	Wishart distribution and its simple properties	04
13,14	Hotelling's T^2	04
15	Mahalanobis D^2 statistics	04
16	Null distribution of Hotelling's T^2	04
17	Rao's U statistics and its distribution	03
18	Wilks' O criterion and its properties	02
19,20	Concept of Discriminant analysis and computation of linear discriminant function	06
21	Classification between k (t^2) multivariate normal populations based on LDF and Mahalanobis D^2	04

22,23	Principal Component Analysis and its applications	08
24,25	Factor analysis and their applications in detail	08
26	Canonical variables and canonical correlations	02
27,28	Cluster analysis: similarities and dissimilarities of qualitative and quantitative characteristics	07
29,30	Different methods of clustering: Hierarchical clustering, Single, Complete	06
31,32	Average linkage methods and K-means cluster analysis	03
33,34	Path analysis and computation of path coefficients and its application	08
35	Introduction to multidimensional scaling with some theoretical results	03
36	Concept of Similarities, metric and non-metric scaling methods	03
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Maximum likelihood estimates of mean-vector
2	Dispersion matrix
3	Testing of hypothesis on mean vectors of multivariate normal populations
4,5	Problem based on Cluster analysis
6	Discriminant function
7	Canonical correlation
8	Principal component analysis
9	Factor analysis
10	Multivariate analysis of variance
11	Multivariate analysis of Covariance
12	Multidimensional scaling

Suggested Reading

Abdelmonem A, Virginia AC and Susanne M. 2004. Computer Aided Multivariate Analysis. Chapman & Hall/CRC.

Anderson TW. 1984. An Introduction to Multivariate Statistical Analysis. 2nd Ed. John Wiley.

Arnold SF. 1981. The Theory of Linear Models and Multivariate Analysis. John Wiley.

Giri NC. 1977. Multivariate Statistical Inference. Academic Press.

Johnson RA and Wichern DW. 1988. Applied Multivariate Statistical Analysis. Prentice Hall.

Kshirsagar AM. 1972. Multivariate Analysis. Marcel Dekker.

Muirhead RJ. 1982. Aspects of Multivariate Statistical Theory. John Wiley. Muirhead, RJ. (2005) Aspects of Multivariate Statistical Theory. 2nd Ed. John Wiley.

Rao CR. 1973. Linear Statistical Inference and its Applications. 2nd Ed. John Wiley.

Rencher AC. 2012. Methods of Multivariate Analysis. 3rd Ed. John Wiley.

Srivastava MS and Khatri CG. 1979. An Introduction to Multivariate Statistics. North Holland. I. Course Ti

Course Title : : Regression Analysis

Course Code : STAT 572

Credit Hours : 2+1

Aim of the course

This course is meant to prepare the students in linear and non-linear regression methods useful for statistical data analysis. They would also be provided a mathematical foundation behind these techniques and their applications in agricultural data.

Theory

Unit I

Simple and Multiple linear regressions: Least squares fit, Properties and examples. Polynomial regression: Use of orthogonal polynomials.

Unit II

Assumptions of regression; diagnostics and transformations; residual analysis ~ Studentized residuals, applications of residuals in detecting outliers, identification of influential observations. Lack of fit, Pure error. Test of normality, test of linearity, Testing homoscedasticity and normality of errors, Durbin-Watson test. Test of goodness of fit for the model evaluation and validation. Concept of multi- collinearity

Unit III

Weighted least squares method: Properties, and examples. Box-Cox family of transformations. Use of dummy variables, Over fitting and under fitting of model, Selection of variables: Forward selection, Backward elimination. Stepwise and Stagewise regressions**.**

Unit IV

Introduction to non-linear models, nonlinear estimation: Least squares for nonlinear models.

Practical

1. Multiple regression fitting with three and four independent variables;
2. Estimation of residuals, their applications in outlier detection, distribution of residuals;
3. Test of homoscedasticity, and normality, Box-Cox transformation;
4. Restricted estimation of parameters in the model, hypothesis testing, Step wise regression analysis;

5.Least median of squares norm, Orthogonal polynomial fitting.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Introduction to Simple and Multiple linear regressions and their properties	10
2	Least squares method and examples	07
3	Polynomial regression and use of orthogonal polynomials in agriculture	04
4	Assumptions of regression: diagnostics and transformations	04
5	Residual analysis: Studentized residuals	05
6	Applications of residuals in detecting outliers, Identification of influential observations	05
7,8	Lack of fit, Pure error, Test of normality and test of linearity	08
9	Testing homoscedasticity and normality of errors	06
10	Durbin-Watson test, Test of goodness of fit forth emodel evaluation	08
11	Concept of validation of multi-collinearity	06
12	Weighted least squares method: Properties, and examples	05
13	Box-Cox family of transformations	03
14	Use of dummy variables in agriculture	05
15	Identification of over fitting and under fitting of model	06
16,17	Selection of variables: Forward selection, Backward elimination. Stepwise and Stage wise regressions	08
18	Introduction to non-linear models and their application	05
19	Non-linear estimation: Least squares for nonlinear models	05
	Total	**100**

Practical Schedule

Practical No.	Topics
1	Problem based on Multiple regression fitting with three independent variables
2	Problem based on Multiple regression fitting with four independent variables
3,4	Estimation of residuals, their applications in outlier detection and distribution of residuals
5	Test of homoscedasticity and normality
6	Box-Cox transformation
7	Restricted estimation of parameters in the model
8	Hypothesis testing
9	Numerical example on Step wise regression analysis

10	Least median of squares norm
11,12	Fitting of Orthogonal polynomial

Suggested Reading

Barnett V and Lewis T. 1984. Outliers in Statistical Data. John Wiley.

Belsley DA, Kuh E and Welsch RE. 2004. Regression Diagnostics-Identifying Influential Data and Sources of Collinearity. John Wiley.

Chatterjee S and Hadi AS. 2013. Regression Analysis by Example. A John Wiley & sons Publication.

Draper NR and Smith H. 1998. Applied Regression Analysis. 3rd Ed. John Wiley.

McCullagh P and Nelder JA. 1999. Generalized Linear Models. 2nd Ed.Chapman & Hall.

Montgomery DC, Peck EA and Vining GG. 2003. Introduction to Linear Regression Analysis. 3rd Ed. John Wiley.

Rao CR. 1973. Linear Statistical Inference and its Applications. 2ndEd. John Wiley.

Course Title : : Statistical Computing

Course Code : STAT 573

Credit Hours : 1+1

Aim of the course

This course is meant for exposing the students in the concepts of computational techniques. Various statistical packages would be used for teaching the concepts of computational techniques.

Theory

Unit I

Introduction to statistical packages and computing: data types and structures, Use of Software packages like, SAS, SPSS or "R: The R Project for Statistical Computing". Data analysis principles and practice, Summarization and tabulation of data, Exploratory data analysis; Graphical representation of data. Statistical Distributions: Fitting and testing the goodness of fit of discrete and continuous probability distributions;

Unit II

ANOVA, regression and categorical data methods; model formulation, fitting, diagnostics and validation; Matrix computations in linear models. Analysis of discrete data. Multiple comparisons, Contrast analysis.

Unit III

Numerical linear algebra, numerical optimization, graphical techniques, numerical approximations, Time Series Analysis.

Unit IV

Analysis of mixed models; Estimation of variance components, Analysis of Covariance, Fitting of non-linear model, Discriminant function; Principal component analysis. techniques in the analysis of survival data and longitudinal studies, Approaches to handling missing data, and meta-analysis

Practical

1. Data management, Graphical representation of data, Descriptive statistics;
2. General linear models ~ fitting and analysis of residuals, outlier detection;
3. Fitting and testing the goodness of fit of probability distributions;

4. Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, One way analysis of variance, contrast and its testing, pairwise comparisons;
5. Mixed effect models, estimation of variance components;
6. Categorical data analysis, dissimilarity measures, similarity measures;
7. Analysis of discrete data, analysis of binary data;
8. Numerical algorithms;
9. Spatial modeling, cohort studies;
10. Clinical trials, analysis of survival data;
11. Handling missing data.Analysis of time series data - fitting of ARIMA models.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Introduction to statistical packages: SAS, SPSS or R	04
2	Different types of data, structures of data and computing methods, File creation in different statistical packages, importing , exporting and saving of outputs	05
3	Introduction to "R Project for Statistical Computing", data analysis, principles and practice, Summarization and tabulation of data	04
4	Exploratory data analysis, graphical representation of data by using statistical softwares	05
5	Fitting of discrete and continuous probability distributions and testing the goodness of fit	08
6	Basic principles of design of experiments and layout of ANOVA	04
7	Fitting of Linear regression, Model formulation along with diagnostics and validation process	07
8	Concept of matrix computations in linear models	05
9	Analysis of discrete data and Multiple comparisons	05

10	Introduction of Contrast analysis	07
11	Basic concept of numerical linear algebra, numerical optimization, graphical techniques, numerical approximations	05
12	Time Series Analysis, Analysis of mixed models	08
13	Estimation of variance components, Analysis of Covariance	05
14	Fitting of non-linear model, Discriminant function	10
15,16	Principal component analysis	10
17,18	Techniques in the analysis of survival data and longitudinal studies, Approaches to handling missing data, and meta-analysis	08
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Data management, Graphical representation of data, Descriptive statistics
2	General linear models , fitting and analysis of residuals, outlier detection
3	Fitting and testing the goodness of fit of probability distributions
4	Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test,
5	One way analysis of variance
6	Contrast and its testing, pairwise comparisons
7	Mixed effect models, estimation of variance components
8	Categorical data analysis, dissimilarity measures, similarity measures
9	Analysis of discrete data, analysis of binary data
10	Numerical algorithms
11	Spatial modeling, cohort studies
12	Clinical trials, analysis of survival data
13	Handling missing data
14	Analysis of time series data - fitting of ARIMA models

Suggested Reading

Agresti A. 2013. Categorical Data Analysis. 3rd Ed. John Wiley.

Everitt BS and Dunn G. 1991. Advanced Multivariate Data Analysis. 2nd Ed. Arnold.

Geisser S. 1993. Predictive Inference: An Introduction. Chapman & Hall.

Gelman A & Hill J. 2006. Data Analysis Using Regression and Multilevel/Hierarchical Models. Cambridge Univ. Press.

Gentle JE, Härdle W and Mori Y. 2012. Handbook of Computational Statistics - Concepts and Methods. 2nd Ed. Springer.

Han J and Kamber M. 2000. Data Mining: Concepts and Techniques. Morgan.

Hastie T, Tibshirani R and Friedman R. 2001. The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer.

Kennedy WJ & Gentle JE. 1980. Statistical Computing. Marcel Dekker.

Miller RG Jr. 1986. Beyond ANOVA, Basics of Applied Statistics. John Wiley.

Rajaraman V. 1993. Computer Oriented Numerical Methods. Prentice-Hall.

Ross S. 2000. Introduction to Probability Models. Academic Press.

Ryan BF and Joiner BL. 1994. MINITAB Handbook. 3rd Ed. Duxbury Press. 2 Simonoff JS. 1996. Smoothing Methods in Statistics. Springer. . Singh, AK. 2016. Practical R-Book by Examples for Agricultural Statistics. Deptt. Of Ag. Statistics, IGKV. Raipur

Snell EJ. 1987. Applied Statistics: A Handbook of BMDP Analyses. Chapman & Hall.

Thisted RA. 1988. Elements of Statistical Computing. Chapman & Hall.

Venables WN and Ripley BD. 1999. Modern Applied Statistics With S-Plus. 3rd Ed. Springer.

http: //www.r-project.org/

http: //www.stat.sc.edu/~grego/courses/stat706/.

Design Resources Server: www.drs.icar.gov.in.

Course Title : Time Series Analysis

Course Code : STAT 574

Credit Hours : 1+1

Aim of the course.

This course is meant to teach the students the concepts involved in time series data. They would also be exposed to components of time series, stationary models and forecasting/ projecting the future scenarios based on time series data. It would also help them in understanding the concepts involved in time series data presentation, analysis and interpretation.

Theory

Unit I

Components of a time-series. Autocorrelation and Partial autocorrelation functions, Correlogram and periodogram analysis.

Unit II

Linear stationary models: Autoregressive, moving average and Mixed processes. Linear non-stationary models: Autoregressive integrated moving average processes.

Unit III

Forecasting: Minimum mean square forecasts and their properties, Calculating and updating forecasts.

Unit IV

Model identification: Objectives, Techniques, and Initial estimates. Model estimation: Likelihood function, Sum of squares function, Least squares estimates. Seasonal models. Intervention analysis models and Outlier detection.

Teaching Schedule

Lecturer No.	**Topics**	**Weightage**
1, 2	Component of Time series, Trends, types of trends, Secular trend, long term movement, periodic changes, seasonal and cyclic variations random or irregular movements.	10
3,4,5	Autocorrelation and Partial autocorrelation functions, Correlogram and periodogram analysis. Auto correlation and correlogram.	10

	Correlogram of moving averages . Correlogram of Harmonic series. Etc.	
6,,7	Correlogram of moving averages . Correlogram of Harmonic series. Etc.	10
8,,9	Linear stationary models: Autoregressive,	10
10,,11	first and second order Auto- regression series.	10
12,13	moving average and Mixed processes.	10
14,15	Linear non-stationary models: Autoregressive integrated moving average processes.	10
16,17	Forecasting: Minimum mean square forecasts and their properties, Calculating and updating forecasts.	10
18,19, 20	Model identification: Objectives, Techniques, and Initial estimates. Model estimation: Likelihood function,	10
21, 22	Sum of squares function, Least squares estimates. Seasonal models. Intervention analysis models and Outlier detection.	10

Practical Schedule

Practical No.	**Topics**
1	Time series analysis,
2	Autocorrelations
3	Correlogram and
4	Periodogram;
5	Linear stationary model;;
6	Linear non-stationary model
7	Model identification and model estimation;
8	Intervention analysis
9	Outlier detection.

Practical

1. Time series analysis, autocorrelations, correlogram and periodogram;
2. Linear stationary model;
3. Linear non-stationary model;
4. Model identification and model estimation;
5. Intervention analysis and outlier detection.

Suggested Reading

Box GEP, Jenkins GM and Reinsel GC. 2007.

Brockwell PJ and Davis RA. 2002. Introduction to Time Series and Forecasting. 2nd Ed. Springer.

Chatterjee S, Hadi A and Price B.1999. Regression Analysis by Examples.John Wiley.

Draper NR and Smith H. 1998. Applied Regression Analysis. 3rd Ed. John Wiley.

Jenkins, GM, Reinsel, GC, Greta M. L,George E.P.B. 2015. Time Series Analysis: Forecasting

and Control, Wiley Series in Probability and Statistics

Johnston J. 1984. Econometric Methods. McGraw Hill.

Judge GG, Hill RC, Griffiths WE, Lutkepohl H and Lee TC. 1988. Introduction to the Theory and Practice of Econometrics. 2nd Ed. John Wiley.

Montgomery DC and Johnson LA. 1976. Forecasting and Time Series Analysis. McGraw Hill.

Montgomery DC, Jennings CA and Kulahci M. 2015. Introduction to Time Series Analysis and Forecasting, Wiley Series in Probability and Statistics

Shumway RH and Stoffer DS. 2006. Time Series Analysis and its Applications: With R Examples. 2nd Ed. Springer.

Course Title : Demography

Course Code : STAT 575

Credit Hours : 2+0

Aim of the course

This course is meant for training the students in measures of demographic indices, estimation procedures of demographic parameters. Students would also be exposed to population projection techniques and principle involved in bioassays

Theory

Unit I

Introduction to vital statistics, crude and standard mortality and morbidity rates, Estimation of mortality, Measures of fertility and mortality, period and cohort measures.

Unit II

Life tables and their applications, methods of construction of abridged life tables, Increment-Decrement Life Tables.

Unit III

Stationary and stable populations, Migration and immigration. Application of stable population theory to estimate vital rates, migration and its estimation. Demographic relations in Nonstable populations. Measurement of population growth, Lotka's model (deterministic) and intrinsic rate of growth, Measures of mortality and morbidityPeriod.

Unit IV

Principle of biological assays, parallel line and slope ratio assays, choice of doses and efficiency in assays quantal responses, probit and logit transformations, epidemiological models

Teaching Schedule

Lecturer No.	Topics	Weightage
1-6	Introduction to vital statistics, crude and standard mortality and morbidity rates, Estimation of mortality, Measures of fertility and mortality, period and cohort measures.	30
7-12	Life tables and their applications, methods of construction of abridged life tables, Increment-Decrement Life Tables.	20
13-23	Stationary and stable populations, Migration and immigration.	30

	Application of stable population theory to estimate vital rates, migration and its estimation. Demographic relations in Nonstable populations. Measurement of population growth, Lotka's model (deterministic) and intrinsic rate of growth, Measures of mortality and morbidity Period.	
24-32	Principle of biological assays, parallel line and slope ratio assays, choice of doses and efficiency in assays quantal responses, probit and logit transformations, epidemiological models.	20

Suggested Reading

Cox DR. 1957. Demography. Cambridge Univ. Press.

Charles Griffin. Fleiss JL. 1981. Statistical Methods for Rates and Proportions. John Wiley.

Finney DJ. 1981. Statistical Methods in Biological Assays.

Grow A, Bavel JV. 2016. Agent-Based Modelling in Population Studies: Concepts, Methods, and Applications (The Springer Series on Demographic Methods and Population Analysis)

Lawless JF. 1982. Statistical Models and Methods for Lifetime Data. John Wiley.

Mac Mahon B and Pugh TF. 1970. Epidemiology- Principles and Methods. Little Brown, Boston.

Mann NR, Schafer RE and Singpurwalla ND. 1974. Methods for Statistical Analysis of Reliability and Life Data. John Wiley.

Newell C. 1988. Methods and Models in Demography. Guilford Publ.

Preston S, Heuveline P and Guillot M. 2001. Demography: Measuring and Modeling Population Processes. Blackwell Publ.

Rowland DT. 2004. Demographic Methods and Concepts. Oxford Press.

Siegel JS and Swanson DA. 2004. The Methods and Material ofDemography. 2nd Ed. Elsevier.

Woolson FR. 1987. Statistical Methods for the Analysis of Biomedical Data. JohnWiley.

Yakovlev AY, Klebanov L and Gaile D. 2013. Statistical Methods for Microarray Data Analysis: Methods and Protocols (Methods in Molecular Biology)

Course Title : Statistical Methods for Life Sciences

Course Code : STAT 576

Credit Hours : 2+0

Aim of the course

This course focuses on statistical methods for discrete data collected in public health, clinical and biological studies including survival analysis. This would enable the students to understand the principles of different statistical techniques useful in public health and clinical studies conducted.

Theory

Unit I

Proportions and counts, contingency tables, logistic regression models, Poisson regression and log-linear models, models for polytomous data and generalized linear models.

Unit II

Computing techniques, numerical methods, simulation and general implementation of biostatistical analysis techniques with emphasis on data applications. Analysis of survival time data using parametric and non- parametric models, hypothesis testing, and methods for analyzing censored (partially observed) data with covariates. Topics include marginal estimation of a survival function, estimation of a generalized multivariate linear regression model (allowing missing covariates and/or outcomes).

Unit III

Proportional Hazard model: Methods of estimation, estimation of survival functions, time-dependent covariates, estimation of a multiplicative intensity model (such as Cox proportional hazards model) and estimation of causal parameters assuming marginal structural models.

Unit IV

General theory for developing locally efficient estimators of the parameters of interest in censored data models. Rank tests with censored data. Computing techniques, numerical methods, simulation and general implementation of biostatistical analysis techniques with emphasis on data applications.

Unit V

Newton, scoring, and EM algorithms for maximization; smoothing methods; bootstrapping; trees and neural networks; clustering; isotonic regression; Markov chain Monte Carlo methods.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-5	Proportions and counts, contingency tables, logistic regression models, Poisson regression and log-linear models, models for polytomous data and generalized linear models.	15
6-14	Computing techniques, numerical methods, simulation and general implementation of bio statistical analysis techniques with emphasis on data applications. Analysis of survival time data using parametric and non- parametric models, hypothesis testing, and methods for analyzing censored (partially observed) data with covariates. Topics include marginal estimation of a survival function, estimation of a generalized multivariate linear regression model (allowing missing covariates and/or outcomes).	30
15-22	Proportional Hazard model: Methods of estimation, estimation of survival functions, time-dependent covariates, estimation of a multiplicative intensity model (such as Cox proportional hazards model) and estimation of causal parameters assuming marginal structural models.	20
23-27	General theory for developing locally efficient estimators of the parameters of interest in censored data models. Rank tests with censored data. Computing techniques, numerical methods, simulation and general implementation of bio statistical analysis techniques with emphasis on data applications.	20
28-32	Newton, scoring, and EM algorithms for maximization; smoothing methods; bootstrapping; trees and neural networks; clustering; isotonic regression; Markov chain Monte Carlo methods.	15

Suggested Reading

Biswas S. 2007. Applied Stochastic Processes. A Biostatistical and Population Oriented Approach. Wiley Eastern Ltd.

Collett D. 2003. Modeling Survival Data in Medical Research. Chapman & Hall.

Cox D.R. and Oakes D. 1984. Analysis of Survival Data. Chapman & Hall.

Hosmer DW Jr. and Lemeshow S. 1999. Applied Survival Analysis: Regression Modeling or Time to Event. John Wiley.

Klein J.P. and Moeschberger M.L. 2003. Survival Analysis: Techniques for Censored and Truncated Data. Springer.

Kleinbaum D.G. and Klein M 2005. Survival Analysis. A Self Learning Text. Springer.

Kleinbaum D.G. and Klein M. 2005. Logistic Regression. 2nd Ed. Springer.

Lee ET. 1992. Statistical Methods for Survival Data Analysis.

John Wiley and Miller RG. 1981. Survival Analysis. John Wiley.

Therneau T.M. and Grambsch P.M. 2000. Modeling Survival Data: Extending the Cox Model.Springer

Course Title : Statistical Ecology

Course Code : STAT 577

Credit Hours : 2+0

Aim of the course

This course is meant for exposing the students to the importance and use of Statistical Sciences: Agricultural Statistics 737 statistical methods in collections of ecological data, species-abundance relations, community classification and community interpretation.

Theory

Unit I

Ecological data, Ecological sampling; Spatial pattern analysis: Distribution methods, Quadrant-variance methods, Distance methods.

Unit II

Species-abundance relations: Distribution models, Diversity indices; Species affinity: Niche-overlap indices, inter specific association, inter specific covariation.

Unit III

Community classification: Resemblance functions, Association analysis, Cluster analysis; Community Ordination: Polar Ordination, Principal Component Analysis, Correspondence analysis, Nonlinear ordination.

Unit IV

Community interpretation: Classification Interpretation and Ordination Interpretation.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-7	Ecological data, Ecological sampling; Spatial pattern analysis: Distribution methods, Quadrant-variance methods, Distance methods	20
7-14	Species-abundance relations: Distribution models, Diversity indices; Species affinity: Niche-overlap indices, inter specific association, inter specific covariation	30
15-25	Community classification: Resemblance functions, Association analysis, Cluster analysis; Community Ordination: Polar Ordination, Principal Component Analysis, Correspondence analysis, Nonlinear ordination.	35

26-32	Community interpretation: Classification Interpretation and Ordination Interpretation.	15

Suggested Reading

Gotelli N.J. and Ellison A.M. 2004. A Primer of Ecological Statistics

Pielou E.C. 1970. An introduction to Mathematical Ecology. John Wiley.

Reynolds J.F. and Ludwig J.A. 1988. Statistical Ecology: A Primer on Methods and Computing. JohnWiley.

Young L.J., Young J.H. and Young J. 1998. Statistical Ecology: A Population Perspective. Kluwer.

COURSE CONTENT OF DOCTORAL DEGREE

Course Title : Advanced Data Analytics
Course Code : STAT 601
Credit Hours : 1+2

Aim of the course

This is an advanced course in Statistical Computing that aims at describing Some advanced level topics in this area of research with a very strong potential of applications. This course also prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to agricultural sciences and use of statistical packages.

Theory

Unit I

Measures of association. Structural models for discrete data in two or more dimensions. Estimation in complete tables. Goodness of fit, choice of a model. Generalized Linear Model for discrete data, Poisson and Logistic regression models. Log linear models.

Unit II

Elements of inference for cross-classification tables. Models for nominal and ordinal response.

Unit III

Computational problems and techniques for robust linear regression, nonlinear and generalized linear regression problem, tree-structured regression and classification, cluster analysis, smoothing and function estimation, robust multivariate analysis.

Unit IV

Analysis of incomplete data: EM algorithm, single and multiple imputations. Markov Chain, Monte Carlo and annealing techniques, Neural Networks, Association Rules and learning algorithms.

Unit V

Linear mixed effects models, generalized linear models for correlated data (including generalized estimating equations), computational issues and methods for fitting models, and dropout or other missing data. Unit VI Multivariate tests of linear hypotheses, multiple comparisons, confidence regions, prediction intervals, statistical power, transformations and diagnostics, growth curve models, dose-response models.

Practical

1. Analysis of qualitative data;
2. Generalized linear for correlated data;
3. Generalized linear models for discrete data;
4. Robust methods of estimation and testing of non-normal data;
5. Robust multivariate analysis;
6. Cluster analysis;

7. Analysis of Incomplete data;
8. Classification and prediction using artificial neural networks;
9. Markov Chain;
10. Analysis of data having random effects using Linear mixed effects models;
11. Analysis of data with missing observations;
12. Applications of multiple comparison procedures;
13. Building Simultaneous confidence intervals;
14. Fitting of growth curve models to growth data;
15. Fitting of dose-response curves and estimation of parameters.

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1	Introduction of measures of association	02
2	Structural models for discrete data in two or more dimensions	05
3,4	Estimation in complete tables. Goodness of fit, choice of a model. Generalized Linear Model for discrete data	05
5	Basic concept of Poisson and Logistic regression models, Log- linear models and its uses in agriculture by using examples	10
6	Elements of inference for cross-classification tables, Models for nominal and ordinal response	05
7	Computational problems and techniques for robust linear regression in agriculture	08
8	Nonlinear and generalized linear regression problem and tree-structured regression and classification	04
9	Cluster analysis and its applications in agriculture	10
10	Concept of Smoothing and function estimation , Robust multivariate analysis	05
11	Analysisofincompletedata:EMalgorithm,singleandmultipleimputations	05
12	Markov Chain, Monte Carlo and annealing techniques and its uses	10
13	Neural Networks, Association Rules and learning algorithms	09
14	Linear mixed effects models, generalized linear models for correlated data (including generalized estimating equations), computational	05

	issues and methods for fitting models, and dropout or other missing data	
15	Multivariate tests of linear hypotheses, multiple comparisons, confidence regions, prediction intervals	04
16	Statistical power, transformations and diagnostics	05
17,18	Different types of growth curve and dose-response models	08
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1,2	Analysis of qualitative data
3,4	Practical based on Generalized linear for correlated data
5,6	Practical based on Generalized linear models for discrete data
7,8	Robust methods of estimation
9,10	Practical based on testing of non-normal data
11	Robust multivariate analysis
12,13,14	Numerical examples based on Cluster analysis
15,16	Analysis of Incomplete data
17,18	Classification and prediction using artificial neural networks
19,20	Markov Chain Analysis
21,22	Analysis of data having random effects using Linear mixed effects models
23,24	Analysis of data with missing observations
25,26	Applications of multiple comparison procedures
27,28	Building Simultaneous confidence ntervals
29,30	Fitting of growth curve models to growth data
31,32	Fitting of dose-response curves and estimation of parameters

Suggested Reading

Everitt B.S. and Dunn G. 1991. Advanced Multivariate Data Analysis. 2nd Ed. Arnold.

Geisser S. 1993. Predictive Inference: An Introduction. Chapman & Hall. • Gentle J.E., Härdle W and Mori Y. 2004. Handbook of Computational Statistics-Concepts and Methods. Springer.
Han J and Kamber M. 2000. Data Mining: Concepts and Techniques. Morgan.
Hastie T, Tibshirani R and Friedman R. 2017. The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer. 2nd Ed.
Kennedy W.J. and Gentle J.E. 1980. Statistical Computing. Marcel Dekker. • Miller R.G. Jr. 1986. Beyond ANOVA, Basics of Applied Statistics. John Wiley.
Rajaraman V. 1993. Computer Oriented Numerical Methods. Prentice-Hall.
Robert C.P. and Casella G. 2004. Monte Carlo Statistical Methods. 2nd Ed. Springer.
Ross S. 2000. Introduction to Probability Models. Academic Press.
Simonoff J.S. 1996. Smoothing Methods in Statistics. Springer.
Thisted R.A. 1988. Elements of Statistical Computing. Chapman & Hall.
Venables W.N. and Ripley B.D. 1999. Modern Applied Statistics With S-Plus. 3rd Ed. Springer.
Free Statistical Softwares: http: //freestatistics.altervista.org/en/stat.php.
Design Resources Server: www.drs.icar.gov.in

Course Title : Simulation Techniques
Course Code : STAT 602
Credit Hours : 1+1
Aim of the course

This course is meant for students who have a good knowledge in Statistical Inference and Statistical Computing. This course would prepare students for undertaking research in the area of simulation techniques and their applications to agricultural sciences.

Theory

Unit I

Uses and purposes of simulation; Classification of models. Generation and testing of random numbers, Review of simulation methods; Implementation of simulation methods - for Discrete and continuous probability distribution, sampling and resampling methods: theory and application of the jackknife and the boot strap.

Unit II

Randomization tests, analysis using computer software packages. Simulating multivariate distributions, MCMC methods and Gibbs sampler.

Unit III

Simulation of generalized linear models and time series models, Simulated data sets to be analyzed using popular computer software packages.

Unit IV

Stochastic simulation: Markov Chain, Monte Carlo, Hastings-Metropolis algorithms, critical slowing-down and remedies, auxiliary variables, simulated tempering, reversible- jump MCMC and multi-grid methods.

Practical

1. Simulation from various probability models;
2. Resampling methods, jackknife and the bootstrap;
3. Randomization tests;
4. Simulating multivariate distributions, MCMC methods and Gibbs sampler;
5. Simulated data sets to be analyzed using popular computer software packages;
6. Markov Chain, Monte Carlo, Gibbs' sampling;
7. Reversible- jump MCMC and multi-grid methods

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Introduction, Uses and purposes of simulation in agriculture	02
2	Classification of models. Generation and testing of random numbers	05

3,4	Review of simulation methods; Implementation of simulation methods - for Discrete probability distribution	05
5	Implementation of simulation methods - for continuous probability distribution	10
6	Concept of sampling and resampling methods	05
7	Introductory theory and application of the jackknife and the bootstrap	05
8	Randomization tests, analysis using computer software packages.	07
9	Simulating multivariate distributions	10
10	Introduction of MCMC methods and Gibbs sampler	05
11	What is mean by simulation of generalized linear models and time series models	05
12	Simulated data sets to be analyzed using popular computer software packages (commands viz. file creation, how to import and export of data for analysis?, how to save data file in a software?, how to get output of simulated data in statistical softwares?)	10
13	Stochastic simulation: Markov Chain analysis	09
14	Stochastic simulation: Monte Carlo	05
15	Basic concept of Hastings-Metropolis algorithms	04
16	What is mean by critical slowing-down and remedies, auxiliary variables, simulated tempering,	05
17,18	Reversible-jump MCMC and multi-grid methods	08
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1,2	Practical based on simulation from various probability models
3,4	Resampling methods
5	Concept of Jackknife and the bootstrap with examples
6	Practical based on randomization tests
7	Simulating multivariate distributions

8,9	MCMC methods and Gibbs sampler with numerical examples
10,11	Simulated data sets to be analyzed using popular computer software packages
12,13	Practical based on Markov Chain Analysis
14,15	Monte Carlo, Gibbs' sampling
16	Reversible- jump MCMC and multi-grid methods

Suggested Reading

Averill M.L. 2017. Simulation, Modeling and Analysis. Tata McGraw Hill.

Balakrishnan N, Melas V.B. and Ermakov S. (Ed.). 2000. Advances in Stochastic Simulation Methods. Basel-Birkhauser.

Banks J. (Ed.). 1998. Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice. John Wiley.

Brately P, Fox B.L. and Scharge L.E. 1987. A Guide to Simulation. Springer. Davison A.C. and Hinkley D.V. 2003. Bootstrap Methods and their Application. Cambridge Univ. Press.

Gamerman D, Lopes H.F. and Lopes H.F. 2006. Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference. CRC Press.

Gardner F.M. and Baker J.D. 1997. Simulation Techniques Set. John Wiley. Gentle J.E. 2005. Random Number Generation and Monte Carlo Methods. Springer.

Janacek G and Louise S. 1993. Time Series: Forecasting, Simulation, Applications. Ellis Horwood Series in Mathematics and its Applications.

Kleijnen J and Groenendaal W.V. 1992. Simulation: A Statistical Perspective. John Wiley.

Kleijnen J. 1974 (Part I), 1975 (Part II). Statistical Techniques in Simulation. Marcel Dekker.

Law A and Kelton D. 2000. Simulation Modeling and Analysis. McGraw Hill.

Press W.H., Flannery B.P., Tenkolsky S.A. and Vetterling W.T. 1986. Numerical Recipes. Cambridge Univ.Press.

Ripley B.D. 1987. Stochastic Simulation. John Wiley. Ross SM. 1997. Simulation. John Wiley.

Course Title : Linear Models

Course Code : STAT 603

Credit Hours : 2+0

Aim of the course

The students would be exposed to the theory of linear models, estimation of variance components for unbalanced data and advanced techniques for analysis of data in agriculture.

Theory

Unit I

General Gauss Markoff set up, Gauss-Markoff's theorem, Aitken's transformation. Theory of linear estimation, test of hypothesis in linear models. Analysis of variance, partitioning of degrees of freedom. Restricted least squares. Special cases of one and two way classifications (including disproportionate cell frequencies and interaction, cross and nested classifications).

Unit II

Analysis of covariance. Variance components models, estimation of variance components from unbalanced data. Unified theory of least-squares, MINQUE, MIVQUE. Mixed models. LAR, LASSO.

Teaching Schedule

Lecture No.	***Topic***	**Weightage**
1,2	*General Gauss Markoff set up and Gauss-Markoff's theorem*	5
3,4	Theory of lineare stimation	5
5,6	Test of hypothesis in linear models	5
7,8	Analysis of variance	5
9,10	Partitioning of degrees of freedom	5
11,12	Restricted least squares	5
13,14	Special cases of one and two way classifications (including disproportionate cell frequencies and interaction, cross and nested classifications).	8
15,16,17	Analysis of covariance for CRD and RBD	10
18,19	Variance components models	5

20,21	Estimation of variance components from unbalanced data	5
22,23	Unified theory of least-squares	5
24,25	The theory of minimum norm quadratic unbiased estimation (*MINQUE*)	7
26,27	Minimum variance quadratic unbiased estimators (*MIVQUE's*) Mixed models	10
28,29	Least Angle Regression LAR	10
30,31,32	Least absolute shrinkage and selection operator; also Lasso or LASSO) -Regression analysis method that performs both variable selection and regularization in order to enhance the prediction accuracy and interpretability of the resulting statistical model. LASSO.	10

Suggested Reading

Bapat, R.B. 2012. Linear Algebra and Linear Models. Springer-Verlag.

Graybill, F. A. 1976. Theory and Application of the Linear Model. Duxbury, North Scituate.

Joshi, D.D. 1987. Linear Estimation and Design of Experiments. Wiley Eastern.

Rao, C. R. 2001. Linear Inference and its Application. Wiley Eastern.

Searle, S. R. 1998. Variance Components. John Wiley.

Searle, S.R. 1971. Linear Models. John Wiley.

Seber, G.A. F. 1996. The Linear Hypothesis: A General Theory. Griffin, Charles and Co. Ltd.

Sheffe, H. 1999. Analysis of Variance. John Wiley

Course Title : Advanced Statistical Methods

Course Code : STAT 604

Credit Hours : 2+1

Aim of the course

This is an advanced course in Statistical Methods that aims at describing some advanced level topics in this area of research with a very strong potential of applications. This course also prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to agricultural sciences.

Theory

Unit I

Truncated and compound distributions. Fitting of orthogonal polynomials. Pearsonian curves. Categorical data analysis - loglinear models, Association between attributes. Variance stabilizing transformations.

Unit II

Sampling distribution of correlation coefficient, regression coefficient, correlation ratio, intra class correlation coefficient

Unit III Non-central t, Chi-square distribution and F distributions. Distribution of quadratic forms. Cochran's theorem. Tests for normality. Large sample tests. Tests of significance based on t, F2 and F distributions. Order statistics, distribution of rth order statistics, joint distribution of several order statistics and

their functions, marginal distributions of order statistics, distribution of range, median, etc.

Unit IV

Fitting of a generalized linear model, mixed model and variance components estimation, MINQUE, MIVQUE, REML

Practical

1. Fitting of truncated distribution,
2. Fitting of Pearsonian curves,
3. Analysis of association between attributes, categorical data.
4. Fitting of non-central t, F2 and F distributions.
5. Computation of Tests of significance based on t, F2 and F distributions.

Order statistics.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1,2	Truncated and compound distributions	4
3,4	Fitting of orthogonal polynomials	5

5	Estimation of Pearsonian curves	4
6,7	Categorical data analysis - loglinear model	5
8	Identification of association between attributes	6
9	Variance stabilizing transformations	4
10	Sampling distribution of correlation coefficient	4
11,12	Regression coefficient, correlation ratio, intra class correlation coefficient	7
13,14	Non-central t distribution	5
15,16	F^2 and F distributions	6
17	Distribution of quadratic forms	3
18	Cochran's theorem	5
19,20	Tests for normality	5
21	Large sample tests	4
22,23,24	Tests of significance based on t, F^2 and F distributions.	3
25	Basic concept of order statistics	5
26	Distribution of r^{th} order statistics	8
27,28	Joint distribution of several order statistics and their functions	5
29,30	Marginal distributions of order statistics, distribution of range, median, etc	5
31,32,33	Fitting of a generalized linear model	4
33,35,36	Fitting of mixed model and variance components estimation MINQUE, MIVQUE, REML	3
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Fitting of truncated distribution
2	Fitting of Pearsonian curves
3	Analysis of association between attributes, categorical data
4	Fitting of non-central t distribution

5	Fitting of F distribution
6	Fitting of F^2 distributions
7	Computation of Tests of significance based on t distribution
8	Computation of Tests of significance based on F^2 distribution
9,10	Computation of Tests of significance based on F distributions
11,12	Practical based on order statistics

Suggested Reading

Chatterjee S, Hadi A and Price B. 2013. Regression Analysis by Examples. 5th Ed. John Wiley.

Draper N.R. and Smith H. 1998. Applied Regression Analysis. 3rd Ed. John Wiley.

Rao C.R. 2009. Linear Statistical Inference and its Applications. 2nd Ed. John Wiley.

Searle S.R, Casella G and McCulloch C.E. 1992. Variance Components. John Wiley.

Searle S.R. 1971. Linear Models. John Wile

Course Title : Modeling Techniques for Forecasting

Course Code : STAT 605

Credit Hours : 2+1

Aim of the course

This is an advanced course in Statistical Methods that aims at describing some advanced level topics in this area of research with a very strong potential of applications. This course also prepares students for undertaking research in the area of empirical and mechanistic models and nonlinear estimation and the replications in different disciplines of agricultural sciences.

Theory

Unit I

Empirical and mechanistic models. Nonlinear growth models: monomolecular, logistic, Gompertz, Richards. Applications in agriculture and fisheries.

Unit II

Nonlinear estimation: Least squares for nonlinear models, Methods for estimation of parameters like Linearization, Steepest, and Leven berg- Marquardt's Parameterization.

Unit III

Two-species systems. Lotka-Volterra, Leslie-Gower and Holling-Tanner non-linear prey-predator models. Volterra's principle and its applications. Gauss competition model.

Unit IV

Compartmental modelling - First and second order input-output systems, Dynamics of a multivariable system

Unit V

Forecasting techniques with special reference to agriculture. Forecast based on time series data: exponential smoothing, Box – Jenkins approach and non-linear models. Forecast models using weather parameters, crop-weather relationships and their use in yield forecast. Forecast using plant characters.

Unit VI Forecast surveys, between-year models (regression model, Markov chain probability model and group method of data handling) and within-year models. Agrometeorological models: climatic water balance model and crop yield assessment. Forewarning of crop pests and diseases. Application of remote sensing techniques in forecasting. Use of ANN in forecasting.

Practical

1. Fitting of mechanistic non-linear models;
2. Application of Schaefer and Fox non-linear models;
3. Fitting of compartmental models. Fitting of forecast models using weather parameters.
4. Time series analysis: plots, decomposition, stationarity tests, exponential smoothing.
5. Univariate Box – Jenkins ARIMA models and seasonal ARIMA models.
6. Forecast models using plant characters,

7. Agrometeorological models for crop forecasting, Markov chain models and ANN models.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Introduction of empirical and mechanistic models	2
2,3	Nonlinear growth models: monomolecular and logistic	2
4,5	Nonlinear growth models: Gompertz and Richards	5
6	Applications of non linear models in agriculture and fisheries	4
7	Nonlinear estimation: Least squares for nonlinear models	5
8	Methods for estimation of parameters like Linearization, Steepest	3
9	Methods for estimation of parameters like Levenberg- Marquardt's Parameterization	2
10,11	Two-species systems, Lotka-Volterra, Leslie-Gower	4
12	Holling-Tanner non-linear prey-predator models	3
13,14	Volterra's principle and its applications	5
15	Gauss competition model	4
16	Compartmental modeling - First and second order input-output systems	2
17	Dynamics of a multivariable system	3
18	Introduction of forecasting techniques with special reference to agriculture	4
19,20	Forecast based on time series data: exponential smoothing, Box - Jenkins approach	10
21	Non-linear models, Forecast models using weather parameters	5
22,23	Crop-weather relationships and their use in yield forecast	7
24,25	Forecast using plant characters	5
26, 27,28	Forecast surveys, between-year models (regression model, Markov	4

	chain probability model and group method of data handling) and within-year models	
29,30	Agro- meteorological models: climatic water balance model and crop yield assessment	6
31,32	Forewarning of crop pests and diseases	3
33,34	Application of remote sensing techniques in forecasting	6
35,36	Use of ANN in forecasting	6
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Fitting of mechanistic non-linear models
2	Application of Schaefer and Fox non-linear models
3	Fitting of compartmental models
4	Fitting of forecast models using weather parameters
5	Practical based on time series analysis: plots, decomposition, stationarity tests
6	Exponential smoothing: Univariate Box-Jenkins ARIMA models
7	Practical based on seasonal ARIMA models
8	Numerical example on forecast models using plant characters
9	Agro meteorological models for crop forecasting
10	Practical based on Markov chain models
11,12	Practical based on ANN models

Suggested Reading

Draper, N.R. and Smith, H. 1998. Applied Regression Analysis. 3rd Ed. John Wiley.

Efromovich S. 1999. Nonparametric Curve Estimation. Springer.

Fan, J. and Yao, Q. 2003. Nonlinear Time Series-Nonparametric and Parametric Methods. Springer.

France, J. and Thornley, J.H.M. 1984. Mathematical Models in Agriculture. Butterworths.

Harvey, A.C. 1996. Forecasting, Structural Time Series Models and the Kalman Filter. Cambridge Univ. Press.
Makridakis, S., Wheelwright, S.C. and Hyndman, R.J. 1998. Forecasting: Methods and Applications. John Wiley.
Pankratz, A. 1983. Forecasting with Univariate Box Jenkins Models: Concepts and Cases. John Wiley.
Thornley, J. and France J. 2006. Mathematical Models in Agriculture: Quantitative Methods for the Plant, Animal and Ecological Sciences (Cabi) 2nd Ed

Course Title : Stochastic Processes

Course Code : STAT 606

Credit Hours : 2+0

Aim of the course

This is a course on Stochastic Processes that aims at describing some advanced level topics in this area of research with a very strong potential of applications. This course also prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to agricultural sciences.

Theory

Unit I

Introduction to stochastic process - classification according to state space and time domain. Finite and countable state Markov chains; time- homogeneity; Chapman Kolmogorov equations, marginal distribution and finite dimensional distributions. Classification of Markov chain. Canonical form of transition probability matrix of a Markov chain. Fundamental matrix; probabilities of absorption from transient states into recurrent classes in a finite Markov chain, mean time for absorption. Ergodic state and Ergodic chain. Stationary distribution of a Markov chain, existence and evaluation of stationary distribution. Random walk and gamblers ruin problem.

Unit II

Discrete state continuous time Markov process: Kolmogorov difference – differential equations. Birth and death process, pure birth process (Yule- Fury process). Immigration-Emigration process. Linear growth process, pure death processUnit III Renewal process: renewal process when time is discrete and continuous. Renewal function and renewal density. Statements of Elementary renewal theorem and Key renewal theorem.

Unit IV

Stochastic process in biological sciences: Markov models in population genetics, compartmental analysis. Simple deterministic and stochastic epidemic model. General epidemic models-Karmack and McKendrick's threshold theorem. Recurrent epidemics.

Unit V

Elements of queueing process; the queuing model M/M/1: steady state behaviors. Birth and death process in queuing theory- Multi channel models. Network of Markovian queuing system.

Unit VI

Branching process: Galton-Watson branching process. Mean and variance of size of nth generation, probability of ultimate extinction of a branching process. Fundamental theorem of branching process and applications.

Unit VII

Wiener process- Wiener process as a limit of random walk. First passage time for Wiener process.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Introduction to stochastic process	03
2	Classification according to state space and time domain of stochastic process	02
3	Finite and countable state Markov chains, time-homogeneity	04
4	Chapman- Kolmogorov equations	03
5	Marginal distribution and finite dimensional distributions	02
6	Classification of Markov chain. Canonical form of transition probability matrix of a Markov chain	05
7,8,9	Fundamental matrix; probabilities of absorption from transient states into recurrent classes in a finite Markov chain, mean time for absorption. Ergodic state and Ergodic chain	09
10,11	Stationary distribution of a Markov chain, existence and evaluation of stationary distribution. Random walk and gamblers ruin problem	08
12	Discrete state continuous time Markov process	05
13	Kolmogorov difference - differential equations	04
14	Birth and death process, pure birth process (Yule- Fury process)	04
15	Immigration-Emigration process. Linear growth process, pure death process	04
16	Renewal process: renewal process when time is discrete and continuous	03
17	Renewal function and renewal density	02
18	Statements of Elementary renewal theorem and Key renewal theorem	03

19	Application of Stochastic process in biological sciences	07
20	Markov models in population genetics	05
21	Compartmental analysis. Simple deterministic and stochastic epidemic model	04
22,23	General epidemic models-Karmack and McKendrick's threshold theorem, Recurrent epidemics	04
24	Introduction of queueing process, elements of queueing process	05
25	Queuing model M/M/1: steady state behaviors	05
26	Birth and death process in queuing theory- Multi channel models	03
27	Network of Markovian queuing system	03
28	Branching process: Galton-Watson branching process	03
29,30,31	Mean and variance of size of n^{th} generation, probability of ultimate extinction of a branching process. Fundamental theorem of branching process and applications	03
32,33	Wiener process- Wiener process as a limit of random walk. First passage time for Wiener process	03
34,35,36	Kolmogorov backward and forward diffusion equations and their applications	03
	Total	**100**

Suggested Reading

Adke SR and Manjunath SM. 1984. Finite Markov Processes. John Wiley. • Bailey NTJ. 1964. Elements of Stochastic Processes with Applications to the Natural Sciences. Wiley Eastern.

Bartlett MS. 1955. Introduction to Stochastic Processes. Cambridge Univ. Press.

Basawa IV and Prakasa Rao BLS. 1980. Statistical Inference for Stochastic Processes. Academic Press.

Bharucha-Reid AT. 2012. Elements of the Theory of Markov Processes and their Applications. McGraw Hill.
Bhat BR. 2000. Stochastic Models; Analysis and Applications. New Age. Restructured and Revised Syllabi of Post-graduate Programmes Vol. 2 746 • Draper NR and Smith H. 1981. Applied Regression Analysis. Wiley Eastern. France J &Thornley JHM. 1984. Mathematical Models in Agriculture. Butterworths.
Lawler GF. 2006. Introduction to Stochastic Processes. Chapman & Hall. 2nd Ed.
Medhi J. 2001. Stochastic Processes. 2nd Ed. Wiley Eastern.
Prakasa Rao BLS and Bhat BR.1996. Stochastic Processes and Statistical Inference. New Age.
Ratkowsky DA. 1983. Nonlinear Regression Modelling: a Unified Practical Approach. Marcel Dekker.
Ratkowsky DA. 1990. Handbook of Nonlinear Regression Models. Marcel Dekker.
Seber GAF and Wild CJ. 1989. Non-linear Regression. John Wiley

Course Title : Survival Analysis

Course Code : STAT 607

Credit Hours : 2+0

Aim of the course

The course deals with the study of demographic profiles and survival times. Indepth statistical properties and analysis is an important component of this course.

Theory

Unit I

Measures of Mortality and Morbidity: Ratios and proportions, rates of continuous process, rates of repetitive events crude birth rate, Mortality measures used in vital statistics relationships between crude and age specific rates, standardized mortality ratios evaluation of person-year of exposed to risk in long term studies, prevalence and incidence of a disease, relative risk and odds ratio. Survival Distribution: Survival functions, hazard rate, hazard function, review of survival distributions: exponential, Weibull, Gamma, Rayleigh, Pareto, Lognormal~ IFR and TFRA, Gompertz and Makeham. Gompertz and logistic distributions. Parametric (m.l.e) estimation. Types of Censoring: Type I, Type II, random and other types of censoring, right and left truncated distributions. Expectation and variance of future life time, series and parallel system of failures. Life Tables: Fundamental and construction.

Unit II

Complete Mortality data, Estimation of Survival Function: Empirical survival function, estimation of survival function from grouped mortality data, joint distribution of the number of deaths, distribution of the estimation Pi covariance of estimate, estimation of curves of deaths and central death rate and force of mortality rate. Incomplete Mortality data (non-parametric models): Actuarial method, m.1.e method, moment and reduced sample method of estimation and their comparison. Product limit (Kaplan-Meier) method and cumulative hazard function (CHF) of estimation of survival function.

Unit III

Fitting Parametric Survival Distribution: Special form of survival function cumulative hazard function (CHF) plots, Nelson's method of ungrouped data, construction of the likelihood function for survival data, least squares fitting, fitting a Gompertz distribution to grouped data. Some tests of Goodness of fit: Graphical, Kolmogorov-Smirnov statistics for complete, censored and truncated data, ChiSquare test and Anderson-Darling A2-statistics. Comparison of Mortality Experiences: Comparison of two life tables, some distribution- free methods (two samples) for ungrouped data, Two samples Kolmogorov-Smirnov test, Wilcoxon test for complete data and modified Wilcoxon test for incomplete data. Gilbert and Gehan's test, mean and variance of Wilcoxon statistics, generalization of Gehan's test. Testing for Consistent Differences in Mortality: Mantel-Haenszel and log rank test. Generalized Mantel-Haenszel test (k-sample).

Unit IV

Concomitant Variables: General parametric model for hazard function with observed concomitant variables. Additive and multiplicative models of hazard rate functions. Estimating multiplicative models, selection of concomitant variables. Logistic linear model, Concomitant Variable regarded as random variable. Age of onset distributions: Models of onset distributions and their estimation. Gompertz distribution, parallel system and Weibull distribution, Fatal short models of failure. Two component series system.

Unit V

Interval Censoring Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations. Concept of COX regression Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition and concept (without derivation). Duration of an epidemic.

Unit IV

Concomitant Variables: General parametric model for hazard function with observed concomitant variables. Additive and multiplicative models of hazard rate functions. Estimating multiplicative models, selection of concomitant variables. Logistic linear model, Concomitant Variable regarded as random variable. Age of onset distributions: Models of onset distributions and their estimation. Gompertz distribution, parallel system and Weibull distribution, Fatal short models of failure. Two component series system.

Unit V

Interval Censoring Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations. Concept of COX regression Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition and concept (without derivation). Duration of an epidemic.

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Measures of Mortality and Morbidity: Ratios and proportions, rates of continuous process, rates of repetitive events crude birth rate, Mortality measures used in vital statistics	3
2	Relationships between crude and age specific rates, standardized mortality ratios evaluation of person-year of exposed to risk in long term studies, prevalence and incidence of a disease, relative risk and odds ratio	8
3	Survival Distribution: Survival functions, hazard rate, hazard	5

	function	
4	Review of survival distributions: exponential, Weibull, Gamma, Rayleigh, Pareto, Lognormal~ IFR and TFRA, Gompertz and Makeham, Gompertz and logistic distributions. Parametric (m.l.e) estimation	4
5	Types of Censoring: Type I, Type II, random and other types of censoring, right and left truncated distributions, Expectation and variance of future life time, series and parallel system of failures	3
6	Life Tables: Fundamental and construction, Complete Mortality data, Estimation of Survival Function: Empirical survival function	3
7	Estimation of survival function from grouped mortality data, joint distribution of the number of deaths, distribution of the estimation Pi covariance of estimate	5
8	Estimation of curves of deaths and central death rate and force of mortality rate. Incomplete Mortality data (non-parametric models)	4
9	Actuarial method, m.1.e method, moment and reduced sample method of estimation and their comparison.	6
10	Product limit (Kaplan-Meier) method and cumulative hazard function (CHF) of estimation of survival function	4
11	Fitting Parametric Survival Distribution: Special form of survival function cumulative hazard function (CHF) plots,	5
12	Nelson's method of ungrouped data, construction of the likelihood function for survival data, least squares fitting,	6
13	Fitting of Gompertz distribution to grouped data	7
14	Some tests of Goodness of fit: Graphical, Kolmogorov-Smirnov statistics for complete, censored and truncated data	6
15	Chi- Square test and Anderson- Darling A2-statistics. Comparison of Mortality	5
16,17	Experiences: Comparison of two life tables, some distribution-free methods (two samples) for ungrouped data, Two samples	2

	Kolmogorov-Smirnov test	
18,19,20	Wilcoxon test for complete data and modified Wilcoxon test for incomplete data. Gilbert and Gehan's test, mean and variance of Wilcoxon statistics, generalization of Gehan's test.	5
21,22,23	Testing for Consistent Differences in Mortality: Mantel-Haenszel and log rank test. Generalized Mantel-Haenszel test (k-sample)	5
24,25	Concomitant Variables: General parametric model for hazard function with observed concomitant variables. Additive and multiplicative models of hazard rate functions.	3
26,27	Estimating multiplicative models, selection of concomitant variables. Logistic linear model, Concomitant Variable regarded as random variable.	3
28,29,30	Age of onset distributions: Models of onset distributions and their estimation. Gompertz distribution, parallel system and Weibull distribution, Fatal short models of failure. Two component series system	3

Suggested Reading

Anderson B. 1990. Methodological Errors in Medical Research. Blackwell.

Armitage P and Berry G. 1987. Statistical Methods in Medical Research. Blackwell.

Biswas, S. 2007. Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, 2nd Ed., New Central Book Agency. • Collett D. 2014. Modeling Survival Data in Medical Research. Chapman & Hall. 3rd Ed.

Cox D.R. and Oakes D. 1984. Analysis of Survival Data. Chapman & Hall

Elandt-Johnson R.C. and Johnson N.L. 1980. Survival Models and Data Analysis. John Wiley.

Everitt B.S. and Dunn G. 1998. Statistical Analysis of Medical Data. Arnold. Hosmer D.W. Jr. and Lemeshow S. 1999. Applied Survival Analysis: Regression Modeling or Time to Event. John Wiley.

Indrayan, A. 2008. Medical Biostatistics, 2nd Ed. Chapman and Hall/CRC. • Lee E.T. 1980. Statistical Methods for Survival Data Analysis. Lifetime Learning Publ.

Kalbfleisch J.D. and Prentice. R.L. 2002. The Statistical Analysis of Failure Time Data. John Wiley.

Klein J.P. and Moeschberger M.L. 2003. Survival Analysis: Techniques for Censored and Truncated Data. Springer.

Kleinbaum D.G. and Klein M. 2002. Logistic Regression.Springer.
Kleinbaum D.G. and Klein M. 2005. Survival Analysis. Springer.

Course Title : Spatial Statistics

Course Code : STAT 608

Credit Hours : 1+1

Aim of the course

This is a course on Spatial statistics aims at exposing the students to some advanced level spatial methods and their applications to agricultural situations. Restructured and Revised Syllabi of Post-graduate Programmes Vol. 2 748 V.

Theory

Unit I Spatial Analysis and types of spatial data; Visualizing Spatial Data – Exploratory data Analysis.

Unit II Spatial Relationship- Random forest, spatially autocorrelated data, weight matrix, measures of spatial Auto-correlation – Moran's I & Geary's C; Measuring of autocorrelation of spatially continuous data.

Unit III Spatial Sampling – Methods and procedures, Statistical Analysis of Spatial Point Process – homogenous Poisson Process, Spatial interpolation – non- statistical methods; Variogram modelling; Spatial Prediction – Simple Kriging, Co-kriging;

Unit IV

Modelling Areal data – Autoregressive and spatial regression models and model diagnostics. Examples of Spatial Data analysis in Agriculture– Disease Mapping; Incorporating spatial effects in Agricultural Field experiments

Practical

1. Spatial Data – Import, export;
2. Spatial Classes in R;
3. Visualizing Spatial Data;
4. Spatial Auto-correlation;

5 . Spatial Sampling, Spatial Interpolation, Spatial Autoregressive Models, Spatial Regression Model

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1	Introduction of Spatial Analysis	3
2	Types of spatial data, Visualizing Spatial Data - Exploratory data Analysis	7
3	Spatial Relationship-Random forest	9
4	Spatially auto correlated data, weight matrix	6
5,6	Measures of spatial Auto-correlation - Moran's I & Geary's C	10

7	Measuring of autocorrelation of spatially continuous data	10
8,9	Basic concept of Spatial Sampling - Methods and procedures	5
10	Statistical Analysis of Spatial Point Process - homogenous Poisson Process	6
11	Spatial interpolation : non-statistical methods	4
12	Variogram modeling	5
13,14	Spatial Prediction - Simple Kriging, Co-kriging	4
15	Modeling Areal data - Autoregressive and spatial regression models and model diagnostics	9
16	Examples of Spatial Data analysis in Agriculture	10
17	Disease Mapping	7
18	Incorporating spatial effects in Agricultural Field experiments	5
	Total	**100**

Practical Schedule

Practical No.	**Topics**
1	Spatial Data - Import, export
2,3	Spatial Classes in R
4	Visualizing Spatial Data
5	Spatial Auto-correlation
6,7	Spatial Sampling
8	Spatial Interpolation
9,10	Spatial Autoregressive Models
11,12	Spatial Regression Model

Suggested Reading

Cressie, N.A.C. 1993.Statistics for Spatial Data. Revised Edition. John Wiley

Richard E.P. 2018. Spatial Data Analysis in Ecology and Agriculture Using R, 2nd Ed.

Roger S. Bivand, E Pebesma J. and Rubio B.G. 2008. Applied Spatial Data Analysis using R. Springer-Verlog.

Course Title : Baysian Inference

Course Code : STAT 611

Credit Hours : 2+0

Aim of the course

This course aims at describing the advanced level topics in statistical methods and statistical inference. This course would prepare students to have a strong base in basic statistics that would help them in undertake basic and applied research in Statistics.

Theory

Unit I

Introduction and history and criticism of Bayesian Approach; Subjective interpretation of Probability, Review of Bayes Theorem, Sufficiency, Likelihood Principle. Statistical Sciences: Agricultural Statistics 749

Unit

Subjective Prior distribution of a parameter; Posterior Distribution of parameters using Bayes Theorem

Unit III

Informative and non-informative priors for Location and scale; Conjugate families – Discrete and Continuous and interpretation of Hyper-parameters of conjugates.

Unit IV

Non-informative, improper and invariant priors for location and scale and in general settings.

Unit V

Bayesian Point Estimation – squared error loss, absolute error loss etc. Bayesian Interval Estimation – Credible Interval, interpretation and comparison with frequentist confidence Intervals

Unit VI

Bayesian Hypothesis Testing - Specification of the appropriate form of the prior distribution for a Bayesian testing of hypothesis problem. Prior odds, Posterior odds, Bayes factor for various types of testing hypothesis problems Unit VII Bayesian Prediction; Numerical and Monte-Carlo Integrations

Unit VIII

Applications of Bayesian Inference - Bayesian Data Analysis

Teaching Schedule

Lecture No.	**Topics**	**Weightage (%)**
1,2	Introduction and history and criticism of Bayesian Approach ; Subjective interpretation of Probability	10

3,4	Review of Bayes Theorem, Sufficiency, Likelihood Principle	05
5,6	Subjective Prior distribution of a parameter	06
7,8	Posterior Distribution of parameters by using Bayes Theorem	05
9,10	Informative and non-informative priors for Location and scale; Conjugate families	05
11,12,13	Discrete and Continuous and interpretation of Hyper-parameters of conjugates	09
14,15,16	Non-informative, improper and invariant priors for location and scale and in general settings	04
17,18,19	Bayesian Point Estimation - squared error loss, absolute error loss etc.	09
20,21,22	Bayesian Interval Estimation – Credible Interval, interpretation and comparison with frequentist confidence Intervals	09
23,24,25	Bayesian Hypothesis Testing - Specification of the appropriate form of the prior distribution for a Bayesian testing of hypothesis problem	10
26,27,28	Prior odds, Posterior odds, Bayes factor for various types of testing hypothesis problems	05
29,30	Bayesian Prediction; Numerical examples	10
31,32	Basic concept of Monte-Carlo Integrations	05
33,34,35	Applications of Bayesian Inference - Bayesian Data Analysis in agriculture	08
	Total	**100**

Suggested Reading

Berger, J.O. 1985. Statistical Decision Theory and Bayesian Analysis, Springer Verlag.

Box, G.P. and Tiao, G.C. 1992. Bayesian Inference in Statistical Analysis, Addison – Wesley

Pilon C.D. 2015. Bayesian Methods for Hackers: Probabilistic Programming and Bayesian Inference (Addison-Wesley Data and Analytics)

Course Title : Advanced Design of Experiments

Course Code : STAT 612

Credit Hours : 2+1

Aim of the course

This is an advanced course in Design of Experiments that aims at describing some advanced level topics for students who wish to pursue research in Design of Experiments. This course prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to agricultural sciences.

Theory

Unit I

General properties and analysis of block designs. Balancing criteria. m- associate PBIB designs, and their association schemes including lattice designs - properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs, Mating designs. Structurally Incomplete block designs

Unit II

General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs., Designs for two sets of treatments.

Unit III

Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Resolution plans, Regular and irregular fractions.

Unit IV

Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking, Canonical analysis and ridge analysis, CCD, Box-Jenkins, Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors.

Unit V

Optimality criteria and optimality of designs, robustness of designs against loss of data, outliers, etc. Diagnostics in design of experiments

Practical

Analysis of block designs, Analysis of Latin square type designs, group divisible designs, triangular designs, lattice designs. Analysis of fractional replications of factorial experiments, analysis of asymmetrical factorials and block designs with factorial structure. Analysis of second order response surface designs.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-6	General properties and analysis of block designs. Balancing criteria. m- associate PBIB designs, and their association schemes including lattice designs - properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs, Mating designs. Structurally Incomplete block designs.	17
7-12	General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs., Designs for two sets of treatments.	15
13-19	Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Resolution plans, Regular and irregular fractions.	25
20-26	Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking, Canonical analysis and ridge analysis, CCD, Box-Jenkins, Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors.	25
27-32	Optimality criteria and optimality of designs, robustness of designs against loss of data, outliers, etc. Diagnostics in design of experiments.	18

Practical Schedule

Practical No.	Topics	
1	Analysis of block designs.	
2-3	Analysis of Latin square type designs,	
4-5	group divisible designs, triangular designs,	
6-8	lattice designs.	
9-11	Analysis of fractional replications of factorial experiments,	

12-14	analysis of asymmetrical factorials and block designs with factorial structure	
15-16	Analysis of second order response surface	

Suggested Reading

Chakraborti M.C. 1962. Mathematics of Design and Analysis of Experiments. Asia Publ.House.

Dean A.M. and Voss D. 1999. Design and Analysis of Experiments.

pringer. Dey A and Mukerjee R. 1999. Fractional Factorial Plans. John Wiley.

Dey A 1986. Theory of Block Designs. Wiley Eastern.

Hall M Jr. 1986. Combinatorial Theory. John Wiley.

Hedayat A.S., Sloane N.J.A. and Stufken J. 1999. Orthogonal Arrays: Theory and Applications. Springer.

John J.A. and Quenouille M.H. 1977. Experiments: Design and Analysis. Charles and Griffin.

Khuri A.I. and Cornell J.A. 1996. Response Surface Designs and Analysis. 2nd Ed. Marcel Dekker.

Montgomery D.C. 2005. Design and Analysis of Experiments. John Wiley.

Ogawa J. 1974. Statistical Theory of the Analysis of Experimental Designs. Marcel Dekker.

Parsad R, Gupta V.K., Batra P.K., Satpati S.K. and Biswas P. 2007. Monograph on a-designs. IASRI, New Delhi.

Raghavarao D. 1971. Construction and Combinatorial Problems in Design of Experiments. John Wiley.

Shah K.R. and Sinha B.K. 1989. Theory of Optimal Designs. Lecture notes in Statistics. Vol. 54. Springer.

Sharma M.K. 2012. Design and Analysis of Experiments. Kindle Ed. 1st Ed.

Resources Server: www.drs.icar.gov.in.

Course Title : Advanced Sampling Techniques

Course Code : STAT 613

Credit Hours : 2+1

Aim of the course

This is an advanced course in Sampling Techniques that aims at describing some advanced level topics for students who wish to pursue research in Sampling Techniques. This course prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to Statistical System in the country.

Theory

Unit I

Optimum Stratification, two-way stratification, collapsed strata, Controlled selection, Use of combinatorics in controlled selection, Systematic sampling in two dimensions. Sampling with varying probabilities without replacement, Horvitz – Thompson estimator

Unit II

Variance estimation in complex surveys. Taylor's series linearization, balanced repeated replication, Jackknife and bootstrap methods. Ordered and unordered estimators, Sampling strategies, Midzuno-Sen, Rao-Hartley-Cochran, ðPS Sampling: procedures such as Brewer, Durbin and Sampford,

Unit III

Unified theory of sampling from finite populations. UMV - Non-existence theorem and existence theorem under restricted conditions. Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper- admissibility.

Unit IV

Post-stratified estimator, imperfect frames, multiple frames, randomized response techniques. Inference under super population models - concept of designs and model unbiasedness, prediction approach. Regression analysis and categorical data analysis with data from complex surveys. Domain estimation. Small area estimation. Longitudinal survey.

Practical

1. Sampling with varying probability,
2. Ordered and un-ordered estimators,
3. Sampling strategies due to Horvitz-Thompson, Midzuno-Sen, Rao-Hartley-Cochran and PPS sampling: procedures such as Brewer, Durbin and Sampford, etc.
4. Imperfect frames, Randomized response technique.
5. Small area estimation**.**

Teaching Schedule

Lecture No.	Topics	Weightage (%)
1	Introduction of Optimum Stratification	05
2	Basic concept of Two-ways tratification	04
3,4	Collapsed strata, Controlled selection, Use of combinatoric sin controlled selection	03
5,6	Systematic sampling in two dimensions	04
7	Sampling with varying probabilities without replacement	08
8	Horvitz – Thompson estimator	08
9	Variance estimation in complex surveys	04
10,11	Taylor's series linearization, balanced repeated replication	03
12,13	Jackknife and bootstrap methods	08
14	Ordered and unordered estimators	03
15,16	Sampling strategies, Midzuno-Sen, Rao-Hartley-Cochran	05
17,18,19	PPS Sampling: procedures such as Brewer, Durbin and Sampford	08
20,21	Unified theory of sampling from finite populations	04
22,23	UMV - Non-existence theorem and existence theorem under restricted conditions	04
24,25	Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper- admissibility	04
25,26,27	Post-stratified estimator, imperfect frames, multiple frames, Randomized response techniques	06
28,29,30	Inference under super population models - concept of designs and model unbiasedness, prediction approach.	05
31,32,33	Regression analysis and categorical data analysis with data from complex surveys	10
34,35,36	Domain estimation. Small area estimation. Longitudinal survey	04
	Total	**100**

Practical Schedule

Practical No.	Topics
1	Practical based on Sampling with varying probability
2	Ordered and un-order ed estimators
3	Practical based on Sampling strategies due to Horvitz-Thompson
4	Sampling strategies due to Midzuno-Sen
5	Sampling strategies due to Rao-Hartley-Cochran
6	PPS sampling: procedures such as Brewer
7	PPS sampling: procedures such as Durbin
8	PPS sampling: procedures such as Sampford
9	Imperfect frames
10	Randomized response technique
11,12	Small area estimation

Suggested Reading

Berger J.O. 1993. Statistical Decision Theory and Bayesian Analysis. Sringer.

Bolfarine H and Zacks S. 1992. Prediction Theory for Finite Population Sampling. Springer.

Cassel C.M., Sarndal C.E and Wretman J.H. 1977. Foundations of Inference in Survey Sampling. John Wiley.

Des Raj and Chandhok P. 1998. Sample Survey Theory. Narosa Publ.

House. Ghosh M and Meeden G. 1997. Bayesian Method for Finite Population

Sampling. Monograph on Statistics and Applied Probability. Chapman and Hall. Mukhopadhyay P. 1998. Theory and Methods of Survey Sampling. Prentice Hall of India.

Rao J.N.K. 2003. Small Area Estimation. John Wiley.

Sarndal C.E., Swensson B and Wretman J.H. 1992. Model Assisted Survey Sampling. Springer.

Course Title : Advanced Statistical Genetics

Course Code : STAT 614

Credit Hours : 2+1

Aim of the course

This is an advanced course in Statistical Genetics that aims at describing some advanced level topics for students who wish to pursue research in Statistical Genetics. This course prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject in plant and animal breeding.

Theory

Unit I

Hardy-Weinberg law with multiple allelic systems, auto-tetraploids and self-sterility alleles. Complex cases of selection with two or more loci.

Unit II

Different approaches to study inbreeding process, methods of path co- efficient, probability and generation matrix. Fisher's approach to inbreeding. Stochastic process of gene frequency change, transition matrix approach using finite Markov chains, diffusion approximation, Steady decay and distribution of gene frequency, Probability of fixation of a gene, Conditional process - Markov chains and diffusion approaches, Distribution of time until fixation, random fluctuations in selection intensity, stationary distribution of gene frequency. Effective population size.

Unit III

Prediction and estimation of genetic merit. Best linear unbiased prediction, Use of mixed model methodology in analysis of animal and plant breeding experiments. Newer reproductive technology and its effect in genetic evaluation of individual merit. Estimation of genetic parameters - problems relating to computational aspects of genetic variance components, parameter estimation in variance component models for binary response data.

Unit IV

Identification of genes with large effects, Use of molecular markers (RFLP, PCRAFLP, RAPD and SSR), Gene mapping and Quantitative trait loci. Molecular manipulation for genetic variability.

Unit V

Variance component approach and linear regression approach for the analysis of GE interactions. Measurement of stability and adaptability for genotypes. Concepts of general and specific combining ability, diallel and partial diallel crosses: construction and analysis.

Practical

1. Hardy-Weinberg law,
2.Estimation of genetic load and random genetic drift.
3.Effect of finite population size.

4.Estimation of path coefficients.
5.Detection and estimation of multiple allelism in continuous variation, sexlinked genes, maternal effects.
6. Analysis of G × E interaction, measurement of stability and adaptability.
7. Analysis of data of diallel and partial diallel crosses.

Teaching Schedule

Lecturer No.	Topics	Weightage
1-5	Hardy-Weinberg law with multiple allelic systems, auto-tetraploids and self-sterility alleles. Complex cases of selection with two or more loci.	15
6-14	Different approaches to study inbreeding process, methods of path co- efficient, probability and generation matrix. Fisher's approach to inbreeding. Stochastic process of gene frequency change, transition matrix approach using finite Markov chains, diffusion approximation, Steady decay and distribution of gene frequency, Probability of fixation of a gene, Conditional process - Markov chains and diffusion approaches, Distribution of time until fixation, random fluctuations in selection intensity, stationary distribution of gene frequency. Effective population size.	25
15-22	Prediction and estimation of genetic merit. Best linear unbiased prediction, Use of mixed model methodology in analysis of animal and plant breeding experiments. Newer reproductive technology and its effect in genetic evaluation of individual merit. Estimation of genetic parameters - problems relating to computational aspects of genetic variance components, parameter estimation in variance component models for binary response data.	25
23-27	Identification of genes with large effects, Use of molecular markers (RFLP, PCRAFLP, RAPD and SSR), Gene mapping and Quantitative trait loci. Molecular manipulation for genetic variability.	17
28-32	Variance component approach and linear regression approach for the analysis of GE interactions. Measurement of stability and adaptability for genotypes. Concepts of general and specific combining ability, diallel and partial diallel crosses: construction and analysis.	18

Practical Schedule

Practical No.	Topics	
1-2	Hardy-Weinberg law,	
3-4	Estimation of genetic load and random genetic drift.	
5	Effect of finite population size.	
6	Estimation of path coefficients.	
7-10	Detection and estimation of multiple allelism in continuous variation, sex linked genes, maternal effects.	
11-13	Analysis of G × E interaction, measurement of stability and adaptability.	
14-16	Analysis of data of diallel and partial diallel crosses.	

Suggested Reading

Crow J.F. and Kimura M. 1970. An Introduction of Population Genetics Theory. Harper & Row.

Ewens W.J. 1979. Mathematical Population Genetics. Springer.

Falconer D.S. 1985. Introduction to Quantitative Genetics. ELBL.

Fisher R.A. 1949. The Theory of Inbreeding. Oliver & Boyd.

Fisher R.A. 1958. The Genetical Theory of Natural Selection. Dover Publ.

Haldane J.B.S. 1932. The Causes of Evolution. Harper & Bros.

Kempthorne O. 1957. An Introduction to Genetic Statistics. The Iowa State Univ. Press.

Lerner I.M. 1950. Population Genetics and Animal Improvement. Cambridge Univ. Press. • Lerner I.M. 1958. The Genetic Theory of Selection. John Wiley.

Li C.C. 1982. Population Genetics. The University of Chicago Press.

Mather K and Jinks J.L. 1982. Biometrical Genetics. Chapman & Hall.

Mather K. 1951. The Measurement of Linkage in Heredity.

Methuen. Nagilaki T. 1992. Introduction to Theoretical PopulationGenetics.Springer.

Narain P. 1990. Statistical Genetics. Wiley Eastern.

Nielsen R, Montgomery S. 2013. An Introduction to Population Genetics: Theory and Applications 1st Ed.

Course Title : Advanced Time Series Analysis
Course Code : STAT 615
Credit Hours : 2+0
Aim of the course

This is an advanced course in Time Series Analysis that aims at describing some advanced level topics in this area of research with a very strong potential of applications. This course also prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to agricultural sciences.

Theory

Unit I

Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting, VAR models with elements of nonlinearity, Non-stationary multivariate time series: spurious regression, co-integration, Vector Error Correction Model (VECM).

Unit II

Volatility: The class of ARCH and GARCH models; Extensions of GARCH models: TGARCH, IGARCH, PGARCH, EGARCH, GJR-GARCH, ARCH and GARCH model with-t distributed error; ARCD (Auto-RegressiveConditional Density), Multivariate GARCH model: estimation, analysis and forecasting, stochastic volatility.

Unit III

Structural time-series modelling: State space models, Kalman filter, Local level model, Local linear trend model, Seasonal models, Cyclical models. Threshold and Functional coefficient autoregressive models, Structural Break in time series.

Unit IV

Fuzzy time series models, Artificial Neural Network (ANN) methodology, Support vector machines, Wavelets for time series analysis, combinations of time series models

Teaching Schedule

Lecture No.	*Topic*	*Weightage*
1,2	A Multivariate time series, more than one time-dependent variable modeling the mean	5
3,4	Stationary VAR models: properties, estimation, analysis and forecasting,	6
5,6	VAR models with elements of nonlinearity	5
7,8	Non-stationary multivariate time series: spurious regression, co-integration.	6
9,10	Vector Error Correction Model (VECM).	6

11,12	Volatility: The class of ARCH and GARCH models; Extensions of GARCH models:	6
13,14	TGARCH, IGARCH, PGARCH, EGARCH, Models with-t distributed error;	8
15,16	GJR-GARCH, ARCH and GARCH model with- t distributed error;	8
17,18	ARCD (Auto-Regressive Conditional Density),	5
19,20	Multivariate GARCH model: estimation, analysis and forecasting, stochastic volatility.	8
21,22	Structural time-series modelling: State space models,	8
23,24	Kalman filter, Local level model, Local linear trend model, Seasonal models, Cyclical models.	5
25,26	Threshold and Functional coefficient autoregressive models, Structural Break in time series.	5
27,28	Fuzzy time series models,	5
29,30	Artificial Neural Network (ANN) methodology	6
31,32	Support vector machines, Wavelets for time series analysis, combinations of time series models.	8

Suggested Reading

Box G.E.P., Jenkins G.M. and Reinsel G.C. 2015. Time Series Analysis: Forecasting and Control. 5th Ed. John Wiley.

Brockwell P.J. and Davis R.A. 1991. Time Series: Theory and Methods. 2nd Ed. Springer.

Chatfield C. 2004. The Analysis of Time Series: An Introduction. 6th Ed. Chapman& Hall/ CRC.

Johnston J. 1984. Econometric Methods. McGraw Hill.

Singh, P. 2016. Applications of Soft Computing in Time Series Forecasting: Simulation and Modeling Techniques. Springer International Publishing AG

Tong H. 1995. Nonlinear Time Series: A Dynamical System Approach.Oxford Univ. Press.

Vapnik, V. N. (2000). The Nature of Statistical Learning Theory. Springer- Verlag, New York.

Percival, D.B. and Walden, A.T. 2000. Wavelet Methods for Time-Series Analysis. Cambridge University Press, U.K.

Course Title : Advanced Bioinformatics

Course Code : STAT 616

Credit Hours : 2+1

Aim of the course

This is a course on Bioinformatics that aims at exposing the students to some advanced statistical and computational techniques related to bioinformatics. This course would prepare the students in understanding bioinformatics principles and their applications.

Theory

Unit I

EM algorithm and other statistical methods to discover common motifs in biosequences. Concepts in phylogeny. Gene prediction based on codons, Decision trees, Clustering Techniques, Classificatory analysis, Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models.

Unit II

Computational analysis of protein sequence, structure and function. Expression profiling by microarray/ gene chip/ RNA seq, proteomics etc., Multiple alignment of protein sequences, Modelling and prediction of structure of proteins, Designer proteins, Drug designing.

Unit III

Analysis of one DNA sequence (Modeling signals in DNA; Analysis of patterns; Overlaps and Generalizations), Analysis of multiple DNA or protein sequences (Alignment algorithms – Gapped global comparisons and Dynamic programming; Statistical Sciences: Agricultural Statistics 755 use of linear gap models; protein sequences and substitution matrices – BLOSUM, PAM; Multiple sequences), BLAST (Comparison of two aligned sequences – Parameter calculation; Choice of a score; Bounds for P-value; Normalized and Bit scores, Karlin – Altschul sum statistic; comparison of two unaligned sequences; Minimum significance Lengths).

Unit IV

Markov Chains (MC with no absorbing states, higher order Markov dependence, patterns insequences, Markov Chain Monte Carlo – Hastings-Metropolis algorithm, simulated annealing, MC with absorbing States). Bayesian techniques and use of Gibbs Sampling. Advanced topics in design and analysis of DNA microarray experiments.

Unit V

Modeling protein families; Multiple sequence alignments; Pfam; Gene finding), Computationally intensive methods (Classical estimation methods; Bootstrap estimation and Confidence Intervals; Hypothesis testing; Multiple Hypothesis testing), Evolutionary models (Models of Nucleotide substitution; Discrete time models – The Jukes-Cantor Model, The Kimura Model, The Felsenste in Model; Continuous-time models)

Unit VI

Phylogenetic tree estimation (Distances; Tree reconstruction – Ultrametric and Neighbor-Joining cases; Surrogate distances; Tree reconstruction; Parsimony and Maximum Likelihood; Modeling, Estimation and Hypothesis Testing;) Neural Networks (Universal Approximation Properties; Priors and Likelihoods, Learning Algorithms – Backpropagation; Sequence encoding and output interpretation; Prediction of Protein Secondary Structure; Prediction of Signal Peptides and their cleavage sites; Application for DNA and RNA Nucleotide Sequences), Analysis of SNPs and Haplotypes**.**

Practical

1. Genomic databases and analysis of high-throughput data sets, BLAST and related sequence comparison methods.
2. Statistical methods to discover common motifs in biosequences.
3. Multiple alignment and database search using motif models, clustalw, classificatory analysis, neural networks, genetic algorithms, pattern recognition,
4. Hidden Markov models.
5. Computational analysis of protein sequence.
6. Expression profiling by microarray/ gene chip, proteomics.
7. Modelling and prediction of structure of proteins.
8. Bayesian techniques and use of Gibbs Sampling.
9. Analysis of DNA microarray experiments.
10. Analysis of one DNA sequence, multiple DNA or protein sequences.
11. Computationally intensive methods, multiple hypothesis testing,
12. Phylogenetic tree estimation,
13. Analysis of SNPs and haplotype

Teaching Schedule

Lecture No.	Topic	Weightage
1,2	EM algorithm and other statistical methods to discover common motifs in biosequences, Concepts in phylogeny	6
3,4	Gene prediction based on codons, Decision trees, Clustering Techniques, Classificatory analysis,	6
5,6	Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models. Computational analysis of protein sequence, structure and function.	6
7,8	Expression profiling by microarray/ gene chip/ RNA seq, proteomics etc., Multiple alignment of protein sequences, Modelling and prediction of structure of proteins, Designer proteins, Drug designing.	6

9,10	Analysis of one DNA sequence (Modeling signals in DNA; Analysis of patterns; Overlaps and Generalizations), Analysis of multiple DNA or protein sequences (Alignment algorithms – Gapped global comparisons and Dynamic programming	7
11,12	Use of linear gap models; protein sequences and substitution matrices – BLOSUM, PAM; Multiple sequences), BLAST (Comparison of two aligned sequences – Parameter calculation)	6
13,14	Choice of a score; Bounds for P-value; Normalized and Bit scores, Karlin – Altschul sum statistic; comparison of two unaligned sequences; Minimum significance Lengths).	6
15,16	Markov Chains (MC with no absorbing states, higher order Markov dependence, patterns insequences, Markov Chain Monte Carlo – Hastings-Metropolis algorithm, simulated annealing, MC with absorbing States).	8
17,18	Bayesian techniques and use of Gibbs Sampling. Advanced topic sin design and analysis of DNA microarray experiments.	6
19,20	Modeling protein families; Multiple sequence alignments; P fam; Gene finding), Computationally intensive methods (Classical estimation methods; Bootstrap estimation and Confidence Intervals	7
21,22	Hypothesis testing; Multiple Hypothesis testing), Evolutionary models (Models of Nucleotide substitution	6
23,24	Discrete time models – The Jukes-Cantor Model, The Kimura Model, The Felsenstein Model; Continuous-time models)	6
25,26	Phylogenetic tree estimation (Distances; Tree reconstruction – Ultrametric and Neighbor-Joining cases; Surrogate distances	6
27,28	Tree reconstruction; Parsimony and Maximum Likelihood; Modeling, Estimation and Hypothesis Testing;) Neural Networks (Universal Approximation Properties; Priors and Likelihoods	6
29,30	Learning Algorithms – Back propagation; Sequence encoding and output interpretation; Prediction of Protein Secondary Structure	6
31,32	Prediction of Signal Peptides and their cleavage sites; Application for DNA and RNA Nucleotide Sequences), Analysis of SNPs and Haplotypes.	6

Practical Schedule

Practical No.	Topic
1	Genomic databases and analysis of high-throughput data sets,
2	BLAST and related sequence comparison methods

3	Statistical methods to discover common motifs in biosequences.
4	Multiple alignment and database search using motif models, clustalw
5	Classificatory analysis, neural networks
6	Genetic algorithms, pattern recognition
7	Hidden Markov models.
8	Computational analysis of protein sequence
9	Expression profiling by microarray/ gene chip, proteomics
10	Modelling and prediction of structure of proteins
11	Bayesian techniques and use of Gibbs Sampling
12	Analysis of DNA microarray experiments
13,14	Analysis of one DNA sequence, multiple DNA or protein sequences
15	Computationally intensive methods, multiple hypothesis testing
16	Phylogenetic tree estimation, Analysis of SNPs and haplotypes**.**

Suggested Reading

Baldi P and Brunak S. 2001. Bioinformatics: The Machine Learning Approach. MIT Press.

Baxevanis AD and Francis BF. (Eds.). 2004. Bioinformatics: A Practical Guide to the Analysis Restructured and Revised Syllabi of Post-graduate Programmes Vol. 2 756 of Genes and Proteins. John Wiley.

Duda RO, Hart PE and Stork DG. 1999. Pattern Classification. John Wiley.

Ewens WJ and Grant GR. 2001. Statistical Methods in Bioinformatics.Springer.

Jones NC and Pevzner PA. 2004. Introduction to Bioinformatics Algorithms. The MIT Press.

Koskinen T. 2001. Hidden Markov Models for Bioinformatics. Kluwer.

Krane DE and Raymer ML. 2002. Fundamental Concepts of Bio-informatics.
Benjamin/ Cummings.

Krawetz SA &Womble DD. 2003. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana Press.

Lesk AM. 2002. Introduction to Bio-informatics. Oxford Univ. Press.

Linder E and Seefeld K. 2005. R for Bioinformatics. O'Reilly and Associates.

Percus JK. 2001. Mathematics of Genome Analysis. Cambridge Univ. Press.

Sorensen D and Gianola D. 2002. Likelihood, Bayesian and MCMC Methods in Genetics. Springer.

Tisdall J.D. 2001. Mastering Perl for Bioinformatics. O'Reilly & Associates.

Wang J.T.L., Zaki M.J., Toivonen H.T.T. and Shasha D. 2004. Data Mining in Bioinformatics. Springer.

Wu C.H. and McLarty J.W. 2000. Neural Networks and Genome Informatics. Elsevier.

Wunschiers R. 2004. Computational Biology Unix/Linux, Data Processing and Programming. Springer.

Yang M.C.C. 2000. Introduction to Statistical Methods in Modern Genetics. Taylor & Francis

Course Title : Advanced Econometrics

Course Code : STAT 617

Credit Hours : 1+1

Aim of the course

This is a course on Econometrics aims at exposing the students to some advanced level econometric methods and their applications to agricultural situations.

Theory

Unit I

Quantile regression, binary quantile regression, extreme values, copula, loss functions, Point and interval forecasting, unconditional and conditional forecasting, forecasting with serially correlated errors, bootstrap: asymptotic expansion, bootstrap consistency, asymptotic refinement, recent developments for dependent timeseries. Co integration analysis.

Unit II

Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting, VAR models with elements of nonlinearity, Non-stationary multivariate time series: spurious regression, co-integration, common trends; Volatility: Modelling the variance, The class of ARCH models: properties, estimation, analysis and forecasting, stochastic volatility, realized volatility

Unit III

Basic Concepts of Bayesian Inference, Probability and Inference, Posterior Distributions and Inference, Prior Distributions. The Bayesian linear model and autoregressive (AR) processes; Model selection with marginal likelihoods and fractional priors, Comparison of Bayesian Methods with Classical approaches, Bayes risk and their applications, and Sample Selection Monte Carlo integration, importance sampling and Gibbs sampling, The Regression Model with General Statistical Sciences: Agricultural Statistics 757 Error Covariance Matrix, Qualitative Choice Models, Bayesian information criterion (BIC), Markov Chain Monte Carlo (MCMC) Model Composition and stochastic search variable selection, BUGS [Bayesian Inference Using Gibbs Sampling], BUCC [Bayesian Analysis, Computation and Communication].

Practical

1. Fitting of equation with serially correlated errors, ordinary least-squares and generalized least squares methods of estimation.
2. Non-stationary multivariate time series analysis.
3. Fitting of The Regression Model with General Error Covariance Matrix, Qualitative Choice Models, Bayesian information criterion (BIC), Markov Chain Monte Carlo (MCMC) Model Composition and stochastic search variable selection, BUGS Fitting of ARCH model.

Teaching Schedule

Lecture No.	Topic	Weightage
1,2	Quantile regression, binary quantile regression, extreme values, copula, loss ,functions, Point and interval forecasting, unconditional and conditional forecasting, forecasting with serially correlated errors	*10*
3,4	Bootstrap: asymptotic expansion, bootstrap consistency, asymptotic refinement, recent developments for dependent timeseries. Co integration analysis.	*10*
		10
5,6	Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting,	*5,6*
7,8	VAR models with elements of nonlinearity, Non-stationary multivariate time series: spurious regression, co-integration, common trends; Volatility:	*10*
9,10	Modelling the variance, The class of ARCH models: properties, estimation, analysis and forecasting, stochastic volatility, realized volatility.	*10*
11,12	Basic Concepts of Bayesian Inference, Probability and Inference, Posterior Distributions and Inference, Prior Distributions. The Bayesian linear model and autoregressive (AR) processes;	*15*
13,14	Model selection with marginal likelihoods and fractional priors, Comparison of Bayesian Methods with Classical approaches, Bayes risk and their applications, and Sample Selection Monte Carlo integration, importance sampling and Gibbs sampling	*10*
15,16	The Regression Model with General Error Covariance Matrix, Qualitative Choice Models, Bayesian information criterion (BIC)	*10*
17,18	Markov Chain Monte Carlo (MCMC) Model Composition and stochastic search variable selection, BUGS [Bayesian Inference Using Gibbs Sampling], BUCC [Bayesian Analysis, Computation and Communication	*15*

Practical Schedule

Practical No.	Topic
1,2	Fitting of equation with serially correlated errors, ordinary least-squares and generalized least squares methods of estimation.
3,4	Non-stationary multivariate time series analysis
5,6	Fitting of The Regression Model with General Error Covariance Matrix

7,8	Qualitative Choice Models
9,10	Bayesian information criterion (BIC),
11,12	Markov Chain Monte Carlo (MCMC) Model
13,14	Composition and stochastic search variable selection
15,16	BUGS Fitting of ARCH model.

Suggested Reading

Banerjee A, Dolado J, Galbraith J and Hendry D.F. 1993. Co-integration, Error Correction, and the Econometric Analysis of Non stationary Data. Oxford Univ. Press.

Bauwens L, Lubrano M. and Richard J.F. 1999. Bayesian Inference in Dynamics of Econometric Models. Oxford Univ. Press.

Carlin B.P. and Louis T.A. 2008. Bayes and Empirical Bayes Methods for Data Analysis. Chapman & Hall.

Gilks W.R., Richardson S and Spiegel halter D. 1996. MCMC in Practice. Chapman & Hall.

Greenberg E. 2012. Introduction to Bayesian Econometrics. Cambridge Univ. Press.

Hamilton J.D. 1994. Time Series Analysis. Princeton Univ. Press.

Judge G.G., Griffith W.E., Hill R.C., Lee C.H. and Lutkepohl H. 1985. The Theory and Practice of Econometrics. 2nd Ed. John Wiley.

Koop G, Poirier D and Tobias J. 2007. Bayesian Econometric Methods. Cambridge Univ. Press.

Koop G. 2003. Bayesian Econometrics. John Wiley.

Lancaster A. 2004. An Introduction to Modern Bayesian Econometrics. Blackwell.

Pindyck R.S. and Rubinfeld D.L. 1981. Econometric Models and Economic Forecasts. McGraw Hill.

Course Title : Recent Advances in the Field of Specialization
Course Code : STAT 618
Credit Hours : 1+0

Aim of the course

To familiarize the students with the recent advances in the areas of their specialization to prepare them for undertaking research.

Theory

Recent advances in the field of specialization - sample surveys / design of experiments /statistical genetics / statistical modeling / econometrics / statistical inference, etc. will be covered by various speakers from the University / Institute as well as from outside the University / Institute in the form of seminar talks.

Suggested Reading

Recent journals related to the research works.

Restructured and Revised Syllabus of Post-Graduate Programme

M. Sc. and Ph. D.

in

Agricultural Extension Education

Broad Subject Coordinator,
Social Science and Head (Extn. Edu.)
Dr.BSKKV, Dapoli

CONTENTS

Committee on Agricultural Extension Education

Sr. No.	Name	
A.	**DBSKKV, Dapoli**	
1	Dr. P.A. Sawant, Head	Coordinator
2	Dr. J. R. Kadam, Associate Professor	Member
3	Dr. H.V. Borate, Assistant Professor	Member
4	Dr. A.S. Shigwan, Assistant Professor	Member
5	Dr. P.M. Mandavkar, SMS, KVK	Member
6	Dr. S.S. Patil, SMS, KVK	Member
B.	**VNMKV, Parbhani**	
1.	Dr. R.P. Kadam, Head	Coordinator
2.	Dr. V.B. Kambale, Professor	Member
3.	Dr. P.R. Deshmukh, Associate Professor	Member
4.	Dr. S.R. Jakkawad, Associate Professor	Member
5.	Dr. P.S. Kapse, Associate Professor	Member
6.	Dr. A.S. Lad, Assistant Professor	Member
C.	**PDKV, Akola**	
1.	Dr. P.S. Wakale, Head	Coordinator
2.	Dr. N.M. Kale, Associate Professor	Member
3.	Dr. M.K. Rathod, Associate Professor	Member
4.	Dr. R.T. Katole, Assistant Professor	Member
5.	Dr. U.R. Chinchmalpure, Assistant Professor	Member
D.	**MPKV, Rahuri**	
1.	Dr, M.C. Ahire, Head & Associate Dean, PAHCoA, Halgaon	Coordinator
2.	Dr. G.K. Sasane, Professor	Member
3.	Dr. V.J. Tarde, Associate Professor	Member
4.	Dr.S.B. Bhange, Associate Professor	Member
5.	Dr. A.M. Chavai, Assistant Professor	Member
6.	Dr. M.B. Dhadwad, Assistant Professor	Member

Implementation of New Curriculum

The universities offering PG programmes in Agricultural Extension Education need to be supported for establishing specialized laboratories, especially social labs in field, communication media labs, Social research lab, equipped with state-of-the art equipments for conducting practical classes especially.

One-time catch-up grant should be awarded to each SAU, offering PG programmes in Agricultural Extension Education for meeting expenditure for upgrading the course requirements.

Faculty training and retraining should be an integral component. For imparting total quality management, a minimum of two faculty in each department under an SAU should be given on job training in reputed national and international institutes. To execute the new PG and Ph.D. programmes in different discipline of Agricultural Extension Education in effective manner, special funds from ICAR would be required for outsourcing of faculty from Indian/Foreign Universities for some initial years.

Expected Outcome

- Revamping of post graduate programme in whole of Agricultural Extension Education throughout the country.
- Imparting quality education.
- Development of technical manpower to cater the need of governments, corporate sector and research organization in India and abroad.
- Exposure to the faculty in the latest technical knowhow.

Organization of Course Contents & Credit Requirements

Minimum Residential Requirement:

M.Sc.: 4 Semesters
Ph.D.: 6 Semesters

Name of the Departments / Divisions

- Agricultural Extension Education

Nomenclature of Degree Programme

(a) M.Sc. Programmes

i) M.Sc. (Agri.) in Agricultural Extension Education

(b) P.hD. Programmes

i) Ph.D. (Agri.) in Agricultural Extension Education

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600- series to Doctoral level.
- Credit Seminar for Master's level is designated by code no. 591, and the Two Seminars for Doctoral level are coded as 691 and 692, respectively
- Deficiency courses will be of 400 series.
- Master's research: 599 and Doctoral research: 699

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not obviously exclude such a reference material that may be recommended according to the advancement and local requirement.
- A list of international and national reputed journals pertaining to the discipline is provided at the end which may be useful as study material for 500/600 series courses as well as research topics.
- Lecture schedule and practical schedule has also be given at the end of each course to facilitate the teacher to complete the course in an effective manner.

Eligibility for Admission

- **Master's Degree Programme**
  - **i) B.Sc. Agri. (4 years programme)/ B.Sc. (Hons.) Agriculture**
    B.Sc. (Agri.) / B. Sc. (Hons.) Agriculture/ B. Sc. (Hort.)/ B.Sc. (Hons.) Horticulture/ B. Sc. (Forestry)/ B.Sc. (Hons.) Forestry/ BBM (Agri.)/ B.Sc. (ABM)/ B.Sc. (Hons.) Agri.

Business Management/ B.B.A. (Agri.) or equivalent degree with four years duration of agriculture related Universities and having the Common Entrance Test in Agriculture conducted by competent authority.
(Note: - Candidates from B. Tech (Biotech. /Food Tech./Agril. Engg.) background may be considered subject to completion of deficiency package)

- **Doctoral Degree Programme**

(i) Master Degree in the concerned Department/Discipline of Agricultural Extension Education and having appearing the Common Entrance Test of Agricultural Extension Education subject conducted by competent authority.

Sr. No	Name of Department	Specialization in Ph. D	Eligibility criteria
1.	Agricultural Extension Education	Agricultural Extension Education	M.Sc. Agri. in Agricultural Extension Education

Credit Requirements

Course Details	Masters Degree	Doctoral Degree
Major Courses	20	12
Minor Courses	08	06
Supporting / Optional	06	05
Common PGS Courses	05	-
Seminar	01	02
Research	30	75
Total	**70**	**100**

M.Sc. Agri (Agricultural Extension Education)
Course Structure

LIST OF CORE COURSES/ DEPARTMENT WISE SPECIALIZATION/ COMPULSORY/SUPPORTING COURSES

1. M.Sc. Agri (Agricultural Extension Education)

Course Code	Semester	Course Title	Credit Hrs.
EXT 501*	I	Extension Landscape	2 + 0
EXT 502*	I	Applied Behaviour Change	2 + 1
EXT 503*	II	Organisational Behaviour and Development	2 + 1
EXT 504*	I	Research Methodology in Extension	2 + 1
EXT 505*	II	Capacity Development	2 + 1
EXT 506*	III	ICTs for Agricultural Extension and Advisory Services	2 + 1
EXT 507*	III	Evaluation and Impact Assessment	2 + 1
EXT 508	I	Managing Extension Organizations	2 + 1
EXT 509	II	Enabling Innovation	2 + 1
EXT 510*	III	Gender Mainstreaming	2 + 1
EXT 591*	II	Master's Seminar	0+1
STAT-502	I	Statistical Methods for Applied Sciences	3+1
STAT/COMP	II	Computer Applications for Agricultural Extension Research	2 + 1
		Total	**25+12=37**
EXT 599		Master's Research	0+30

***Compulsory Courses**

Common Courses: (Non Credit)

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Information Services	1+0
PGS 502	I	Technical Writing and Communications Skills	1+0
PGS 503	II	Intellectual Property and its management in Agriculture	1+0
PGS 504	II	Basic Concepts in Laboratory Techniques	1+0
PGS 505	III	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	III	Disaster Management	1+0

Supporting / Optional Courses:

Supporting / Optional Courses may be taken from below mentioned discipline list

Supporting Disciplines:

1. Agricultural Statistics
2. Agricultural Economics
3. Computer Science and Information Technology

Some of the suggestive courses are given below

Course Code	Semester	Course Title	Credit Hrs.
AEC 507	I	Agricultural Finance and Project Management	2+1
AEC- 505	II	Econometrics	2+1
STAT 512	II	Basic Sampling Techniques	2+1

Minor Disciplines:

1. Agricultural Economics
2. Agricultural Statistics
3. Agronomy
4. Horticulture
5. Animal Husbandry and Dairy Science
6. Irrigation Water and Disaster Management
7. Soil Science
8. Organic Farming
9. Computer Science and Information Technology

Compulsory Non Credit Deficiency Courses

(Candidates from B. Tech (Biotech. /Food Tech./Agril. Engg. background)

Course Code	Semester	Course Title	Credit Hrs.
EXT 411	I	Fundamentals of Agricultural Extension Education	2+1
EXT 412	II	Rural Sociology & Educational Psychology	2+1
EXT 413	III	Communication and Diffusion of Agricultural Innovations	2+1
EXT 413	III	Agricultural Journalism	2+1

Students from B. Tech (Biotech. /Food Tech./Agril. Engg. background) stream will be required to completed Non credit deficiency courses (6 to 10 credits) from the above courses related to the discipline in which admitted and as decided by the Student Advisory committee.

Ph.D. Agri (Agricultural Extension Education)
Course Structure

LIST OF CORE COURSES/ DEPARTMENT WISE SPECIALIZATION/ COMPULSORY/SUPPORTING COURSES

Ph. D. Agri (Agricultural Extension Education)

Course Code	Semester	Course Title	Credit Hrs.
EXT 601*	I	Policy Engagement and Extension	2+1
EXT 602*	II	Methodologies for Social and Behavioural Sciences	2+1
EXT 603*	III	Technology Commercialization and Incubation	2+1
EXT 604*	IV	Educational Technology and Instructional Design	2+1
EXT 605	I	Risk Management and Climate Change Adaptation	2+1
EXT 606	II	Livelihood Development	1+1
EXT 607	III	Facilitation for People centric Development	2+1
STAT	I	Multivariate Statistical Methods for Extension Research	2+1
COMP	II	Multimedia and Applications	1+1
EXT 691*	III	Doctoral Seminar I	0+1
EXT 692*	IV	Doctoral Seminar II	0+1
		Total	**16+11 =27**
EXT 699		Doctoral Research	0+75

***Compulsory Courses**

Supporting / Optional Courses:

Supporting / Optional Courses may be taken from below mentioned discipline list

Supporting Disciplines:

1. Agricultural Statistics
2. Agricultural Economics
3. Computer Science and Information Technology

Some of the suggestive courses are given below

Course Code	Semester	Course Title	Credit Hrs.
AEC 507		Quantitative Development Policy Analysis	1+1
AEC 507		Quantitative Development Policy Analysis	1+1
AEC 608		Natural Resource Management	2+1
AEC 609		Environmental Economics	2+1
AEC 506	II	Agricultural Development and Policy Analysis	2+0

Minor Disciplines :

1. Agricultural Economics
2. Agronomy
3. Horticulture
4. Animal Husbandry and Dairy Science
5. IWDM
6. Soil Science
7. Organic Farming

Course Contents

1. M.Sc. Agri. (Agricultural Extension Education)

EXT 501 Extension Landscape (2+0)

Theory

Lecture	Topic	Weightage
BLOCK 1	**GLOBALLY,WHAT IS NEW IN EXTENSION**	
Unit I	**Challenges before Extension and Advisory Services (EAS)**	**23**
1	**Extension and Advisory Services (EAS)**- Meaning (embracing pluralism and new functions) New Challenges before farmers and extension professionals: **Natural Resource Management**-Supporting farmers to manage the declining/deteriorating water and soil for farming	5
2	**Gender Mainstreaming**- How extension can enhance access to new knowledge among women farmers; **Nutrition- Role** of extension in supporting communities with growing nutritious crop and eating healthy food	4
3	**Linking farmers to markets**- Value chain extension including organizing farmers, strengthen value chain and supporting farmers to respond to new standards and regulations in agri-food systems; **Adaptation to climate- changes**-How extension can contribute to up-scaling Climate Smart Agriculture; **Supporting family farms**- strengthening the capacities of family farms	5
4	**Migration**-Advising farmers to better respond to opportunities that emerge from increasing mobility and also supporting migrants in enhancing their knowledge and skills; **Attracting and Retaining**-Youth in Agriculture including promotion of agri preneurship and agri-tourism	5
5	**Urban and peri-urban farming**- How to support and address issues associated with urban and peri-urban agriculture; **Farmer distress**, **suicides**- Supporting farmers in tackling farm distress	4
Unit 2	**New Functions and New Capacities**	**13**
6&7	**Beyond transfer of technology**: Performing new functions to deal with new challenges; **Organising producers into groups**-dealing with problems that need collective decision making such as **Natural Resource Management (NRM) and access to markets**	4
8	**Mediating conflicts and building consensus** to strengthen collective decision making; **Facilitating access to credit, inputs and services**-including development of service providers	2
9	**Influencing policies** to promote new knowledge at a scale ,**Networking and partnership** development including convening multi-stakeholder platforms/innovation platforms	2
10	**New Capacities needed by extension and advisory services at different levels** –at the individual (lower, middle management and senior management levels), organizational and enabling environment levels	3
11	**Core competencies** at the individual level; Varied mechanisms for capacity development (beyond training)	2
Unit 3	**Pluralism in EAS**	**10**
12	**Pluralism in Extension Delivery**: Role of **private sector**(input firms, agri-business companies, consultant firms and individual consultants)- Trends in the	2

	development of private extension and advisory services in India and other countries	
13	Challenges faced by private extension providers	2
14	Role of **Non-Governmental Organizations**(National/international)/ Civil Society Organizations (CSOs) in providing extension-Experiences from India and other countries	2
15	**Producer Organizations**- Role in strengthening demand and supply of extension services; their strength and weaknesses-experiences from different sectors	2
16	Role of **Media and ICT advisory** service providers; global experiences with use of media and ICTs in advisory services provision	2
BLOCK 2	**INSIGHTS FROM INNOVATIONSTUDIES AND NEW EXTENSION APPROACHES**	
Unit 1	**From the Linear Paradigm to Systems Paradigm**	**12**
17	**Diffusion of Innovations paradigm**- strengths and limitations**; multiple sources of innovation**-farmer innovation, institutional innovation; **farmer participation in technology generation and promotion**; strength and limitations	4
18	**Agricultural Knowledge and Information Systems (AKIS)**; strength and limitations;	2
19	**Agricultural Innovation Systems (AIS); Redefining Innovation**- Role of Extension and Advisory Services in AIS-From information delivery to intermediation across multiple nodes; Role of brokering; Innovation Platforms, Innovation Management; Strength and weaknesses of AIS.	4
20	**Rethinking Communication in the Innovation Process**– Network building, support social learning, dealing with dynamics of power and conflict;	2
Unit 2	**Evolving Extension Approaches**	**09**
21	**Evolution and features of extension approaches**: Transfer of technology approach; educational approach, farmer participatory extension approach, demand-driven extension,	3
22	Market led extension (value chain extension), extension for climate smart agriculture, gender sensitive extension, extension for entrepreneurship	2
23	**Extension systems in different regions**: Asia-Pacific, Europe, Latin America, Australia, North America	2
24	**Networking for Strengthening EAS**: GFRAS (Global Forum for Rural Advisory Services) and its regional networks	2
BLOCK 3	**EXTENSION REFORMS AND POLICY CHALLENGES**	**13**
Unit 1	**Changes in Governance, Funding and Delivery**	
25	**Reduction in public funding**: public withdrawal from extension provision (partial/full);Examples/Cases	2
26	**Privatization: Public funding and private delivery**; cost sharing and cost recovery; Examples/Cases	2
27	**Decentralization of extension services**; Examples/Cases; Lessons from extension reforms in different countries; Extension and Sustainable Development Goals (SDGs)	2
Unit 2	**Challenges in Managing Pluralistic Extension Systems**	
28 &29	**Pluralism**: Managing pluralism and Co-ordination of pluralistic extension provision; Public private partnerships in extension (including the role of local governments / panchayats and producer organisations); Examples, challenges in co-ordination; Achieving convergence in extension planning and delivery	3
30	**Financing Extension**: Mobilizing resources for extension: public investments, donor support (grants/loans)	2
31& 32	**Monitoring and Evaluation of Extension**: Generating appropriate data for Assessment and Evaluation of pluralistic extension;	2

	Strengthening extension policy interface; generating evidence on impact of extension and policy relevant communication	

RESOURCES

Adolph B. 2011. Rural Advisory Services World wide: A Synthesis of Actors and Issues. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/knowledge/gfraspublications.html?download=6:rural-advisory-services-worldwide&start=40

Ashok G, Sharma P, Anisha S and Prerna T. 2018. Agriculture Extension System in India Review of Current Status, Trends and the Way Forward. Indian Council for Research on International Economic Relations (ICRIER). http://icrier.org/pdf/Agriculture-Extension-System-in-India-2018.pdf

Barber J, Mangnus E and Bitzer V. 2016. Harnessing ICT for agricultural extension. KIT Working Paper 2016:4. https://213ou636sh0ptphd141fqei1-wpengine.netdna-ssl.com/sed/wpcontent/ uploads/sites/2/2016/11/KIT_WP2016- 4_Harnessing-ICT-for-agricultural extension.Pdf

Bentley J, Chowdhury A and David S. 2015. Videos for Agricultural Extension. Note 6.GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/6-video-for-agriculturalextension.html#SNote1

Bingen RJ and Simpson BM. 2015. Farmer Organizations and Modernizing Extension and Advisory Services. MEAS Discussion Paper. http://meas.illinois.edu/wpcontent/uploads/2015/04/Bingen-Simpson-2014-FarmerOrganizations-MEAS-Discussion-Paper.pdf

Bitzer V, Wennink B and de Steenhuijsen PB. 2016. The governance of agricultural extension systems. KIT Working Paper16016:1.http://213ou636sh0ptphd141fqei1.wpengine.netdnacdn. com/sed/wpcontent/uploads/sites/2/2016/03/WPS_1-2016-web.pdf

Bitzer V, Wongtschowski M, Hani M and Blum M. 2016. New directions for inclusive Pluralistic Service Systems. In New Directions for Inclusive Pluralistic Service Systems Rome (Italy). FAO. http://www.fao.org/3/a-i6104e.pdf

Burton ES & Kristin D. 2014. Status of Agricultural Extension and Rural Advisory Services Worldwide. GFRAS: Lindau, Switzerland. http://www.gfras.org/en/knowledge/gfras-publications.html?download=391:status-of-agriculturalextension-and-rural-advisory-services-worldwide

Christoplos I. 2010. Mobilizing the potential of rural and agricultural extension. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/012/i1444e/i1444e.pdf

Colverson KE. 2015. Integrating Gender into Rural Advisory Services. Note 4. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/integrating-gender-into-rural-advisoryservices. html#SNote1

David S. 2018. Migration and rural advisory services. GFRAS Issues Paper 2. Global Forum for Rural Advisory Services. https://www.g-fras.org/en/knowledge/gfraspublications/ category/97-gfras-issues-papers.html?download=856:migration-and-ruraladvisory-services

Davis K and Heemskerk W. 2012. Coordination and Collective Action for Agricultural Innovation Overview Module 1 Investment in Extension and Advisory Services as Part of Agricultural Innovation Systems. In Agricultural Innovation Systems: An Investment Sourcebook. Agricultural and Rural Development. World Bank. © World Bank.

http://siteresources.worldbank.org/INTARD/Resources/335807 - 1330620492317/
9780821386842ch3.pdf

FAO. 2016. New directions for inclusive Pluralistic Service Systems. Report of FAO Expert Consultation. Food and Agriculture Organization of the United Nations and Royal Tropical Institute, Rome. http://www.fao.org/3/ai6103e.pdf

FAO.2017. Climate-Smart Agriculture Sourcebook. Available at: http://www.fao.org/3/ai3325e.
Pdf

Faure G, Pautrizel L, de Romémont A, Toillier A, Odru M and Havard M. 2015. Management Advice for Family Farms to Strengthen Entrepreneurial Skills. Note 8.
GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/management-advice-for-familyfarms- to-strengthen-entrepreneurial-skills.html#SNote8

Francis J, Mytelka L, Van Huis A and Röling N (eds.). 2016. Innovation Systems: Towards Effective Strategies in support of Smallholder Farmers. Technical Centre for Agricultural and Rural Cooperation (CTA) and Wageningen University and Research (WUR)/Convergence of Sciences Strengthening Innovation Systems (CoS-SIS),
Wageningen. https://publications.cta.int/media/publications/downloads/1829_PDF.pdf 17

GFRAS. 2012. Building Knowledge Systems in Agriculture Five Key Areas for Mobilising the Potential of Extension and Advisory Services. Global Forum for Rural Advisory Services.
http://www.fao.org/uploads/media/1_gfras_positionpaper_final2_websmallpdf%20com%20(
1).pdf

GFRAS. 2015. Producer organisations in rural advisory services: Evidence and experiences. Position Paper. Lindau: Global Forum for Rural Advisory Services. http://www.g-fras.org/en/593-producer-organisations-in-rural-advisory-servicesevidence-andexperiences. Html

GFRAS. 2016. Five Key Areas for Mobilising the Potential of Rural Advisory Services.
GFRAS Brief 1. Global Forum for Rural Advisory Services. https://www.gfras. org/en/knowledge/gfras-publications.html?download=4:five-key-areas-for-mobilisingthe-potential-of-rural-advisory-services

GFRAS.2016. The New Extensionist Learning Kit. http://g-fras.org/en/knowledge/newextensionist-learningkit-nelk.html#module-1-introduction-to-the-new-extensionist
GRFAS. 2014. Policy Compendium. http://www.g-fras.org/en/policy-compendium.html

Gwyn EJ and Garforth C. nd. The history, development, and future of agricultural extension. FAO. Rome. http://www.fao.org/docrep/W5830E/w5830e03.htm

Jennings JR, Packham RG and Woodside D. 2011. Shaping change: natural resource management, agriculture and the role of extension. Australasia Pacific Extension Network. http://www.apen.org.au/shaping-change

Leeuwis C with A W van den Ban. 2004. Communication for rural innovation: Rethinking agricultural extension. John Wiley & Sons.

Magdalena Blum and SanneChipeta. 2016. Innovative Financing Mechanisms for Demand-driven Agricultural Advisory Services. Gfras good practice note for extension and advisory services 21. Global

Forum for Rural Advisory Services. https://www.gfras. org/en/good-practice-notes/20-innovative-financing-mechanisms.html#SNote8

Manfre C, Rubin D and Nordehn C. 2017. Assessing How Agricultural Technologies can Change Gender Dynamics and Food Security Outcomes. A three part toolkit. Integrating Gender and Nutrition within Agricultural Extension Services (INGENAES). http://www.culturalpractice.com/wp-content/uploads/Introduction-to-the-Toolkit-Final- 10_17.pdf

Mittal N, Sulaiman RV and Prasad RM. 2016. Assessing capacity needs of Extension and Advisory Services: A Guide for Facilitators. Agricultural Extension in South Asia (AESA). http://crispindia.org/wpcontent/uploads/2015/09/Facilitators-Guide-Final-LR.pdf

Posthumus H and Wongtschowski M. 2014. Innovation Platforms. Note 1. GFRAS good practice note for extension and advisory services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/innovation-platforms.html#SNote1

Rajalahti R, Janssen W and Pehu E. 2008. Agricultural innovation systems: From diagnostics toward operational practices. Agriculture & Rural Development Department, 18

World Bank. https://agrilinks.org/sites/default/files/resource/files/ARDDiscussionPaper38.pdf

Rao S. 2015. Using Radio in Agricultural Extension. Note 18. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.gfras. org/en/good-practice-notes/using-radio-in-agricultural-extension.html#SNote8

Rivera W and Zijp W. 2002. Contracting for Agricultural Extension-International Case Studies and Emerging Practices. CABI Publishing.

Saravanan R and Suchiradipta B. 2015. mExtension – Mobile Phones for Agricultural Advisory Services. Note 17. Gfras good practice note for extension and advisory services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practicenotes/ mextension.html#SNote17

Saravanan R, Suchiradipta B, Meera SN, Kathiresan C and Anandaraja N. 2015. Web Portals for Agricultural Extension and Advisory Services. Note 16. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/16-web-portals-for-agricultural-extension-andadvisory- services.html#SNote8

Saravanan R, Sulaiman RV, Davis K and Suchiradipta B. 2015. Navigating ICTs for extension and Advisory Services. Note 11. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://agrilinks.org/sites/default/files/resource/files/gfras-ggpnote11_ navigating_icts_for_ras_1.pdf

Sulaiman RV 2015. Agricultural Innovation Systems. Note 13. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.gfras. org/en/good-practice-notes/agricultural-innovation-systems.html#SNote8

Sulaiman RV and Davis K. 2012. The New Extensionist: Roles, strategies, and capacities to strengthen extension and advisory services. In Lindau, Switzerland: Global Forum for Rural Advisory Services. http://www.g-fras.org/en/157-thenew-extensionist

Suvedi M and Kaplowitz MD. 2016. What Every Extension Worker Should Know: Core Competency Handbook. Michigan State University. Department of Community Sustainability. https://agrilinks.org/library/what-every-extensionworker-should-know-corecompetency- Handbook

Swanson BE and Rajalahti R. 2010. Strengthening Agricultural Extension and Advisory Systems: Procedures for Assessing. Transforming, and Evaluating Extension Systems. Agriculture and Rural Development Discussion Paper; No. 45. World Bank, Washington, DC. © World Bank.http://siteresources.worldbank.org/INTARD/Resources/Stren_combined_web.pdf

Swanson BE. 2008. Global Review of Good Agricultural Extension and Advisory Service Practices. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/pdf/011/i0261e/i0261e00.pdf
19

Terblanche S and H Ngwenya. 2017. Professionalisation of Rural Advisory Services. Note 27. GFRAS Global Good Practice Notes for Extension and Advisory Services. GFRAS: Lausanne, Switzerland. https://www.g-fras.org/en/good-practice-notes/27- professionalisation.html#SNote27

World Bank. 2006. Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/7184

WEBSITES

AESA-Agricultural Extension in South Asia http://www.aesanetwork.org/
FAO -Food and Agricultural Organisation (Research and Extension)
http://www.fao.org/research-and-extension/en/
GFRAS- Global Forum for Rural Advisory Services http://www.g-fras.org/en/
INGENEAS -Integrating Gender and Nutrition within Agricultural Extension Services
https://ingenaes.illinois.edu/
IFPRI- International Food Policy Research Institute (Extension)
http://www.ifpri.org/topic/agricultural-extension
KIT- Royal Tropical Institute (KIT)-Sustainable Economic Development
https://www.kit.nl/sed/
WUR-Wageningen University and Research Research (Knowledge, Technology and Innovation Group (KTI)) https://www.wur.nl/en/Research-Results/Chair-groups/Social-Sciences/KnowledgeTechnology-and-Innovation-Group.htm

EXT-502 Applied Behaviour Change 3(2+1)

Theory

Block 1: Foundations Of Behaviour Change

Unit 1: Foundations of Human Behaviour

Human behaviour – Meaning, importance and factors influencing human behaviour; Biological bases of human behaviour – Nervous system, brain, endocrine system and genes; Individual variations – intelligence, ability and creativity– foundations and theories,
personality and temperament - foundations, approaches, theories of personality, measuring personality (traits, locus of control, self-efficacy; Personal, social and moral development – meaning, concepts – self-concept, self-esteem and self-worth and theories. Motivation – foundations, approaches, theories, managing human needs and motivations; perceiving others – impression, attitude, opinions; Emotions - foundations, types and functions, measuring emotional intelligence

Block 2: Cognitive Processes And Learning

Unit 1: Cognitive Processes affecting Human Behaviour

Sensory organs and their role cognition; Cognitive processes – Attention, perception, remembering and forgetting, knowledge and expertise – foundations and theories; Principles and processes of perception; Consciousness – meaning, types, sleep and dreams; Learning and Memory – Memory - meaning, types and mechanisms of storage and retrieval of memories in the Human brain; Complex cognitive processes - Concept formation, Thinking, Problem solving and transfer – foundations, theories and approaches

Unit 2: Information Processing

Information processing – meaning, principles; Models of information processing – Waugh and Norman model of primary and secondary memory; Atkinson and Shiffrin's stage model of memory; other models including blooms taxonomy and Sternberg's Information Processing Approach; Attention and perception – meaning, types, theories and models; Consciousness

Unit 3: Learning

Learning – foundations, approaches and theories; Cognitive approaches of learning – meaning, principles theories and models; Memory – foundations, types ; Behavioural approaches of learning – foundations and theories - classical conditioning, operant conditioning, applied behaviour analysis; Social cognitive and constructivist approaches to learning – foundations and theories – social cognitive theory, Self-regulated learning; learning styles – meaning, types and applications in learning

Unit 4: Judgement, Choice and Decision-making

Human judgement – meaning, nature, randomness of situations, theories and models; Choice – meaning, criteria for evaluating options; theories and models of human choice; Choice architecture; Decision-making – Meaning, problem analysis; steps and techniques of decision-making under different contexts

Block 3: Human Behaviour In The Society

Unit 1: Attitudes and Influence

Attitudes - meaning, assumptions, types, theories and models of attitude formation; methods of changing attitudes, Relating to others - liking, attraction, helping behaviour, prejudice, discrimination and aggression; Liking / affect – meaning, types and theories; Attraction –

meaning, types and theories; Persuasion – meaning, theories and techniques; Social influence and groups – conformity, compliance and obedience

Unit 2: Social Judgement, Social Identity and Inter-Group Relations
Social judgement – meaning, frame of reference, stereotyping; The judgement of attitude models; Attribution – meaning, theories; Rational decision making; Social identify – meaning, types; assessment; Groups – meaning, types, group processes; sustainability of groups; Inter group processes and theories social learning

Practicals
1. Understanding perception – Attentional Blink and Repetition Blindness exercise
2. Understanding attention - Testing selective attention capacity and skills and processing speed ability through Stroop test
3. Hands-on experience in the techniques for assessing creative thinking – divergent and convergent thinking
4. Lab exercise in applying Maslow's need hierarchy to assess motivation
5. Learning - Classical conditioning and operant conditioning
6. Assessing learning styles through Barsch and Kolb inventories
7. Practical experience in building self-esteem
8. Assessment of emotional intelligence
9. Exercises in problem solving
10. Exercises in visual perception
11. Measuring self-concept using psychometric tools
12. Experiment on factors influencing information processing
13. Assessment of attitudes
14. Hands on experience in methods of persuasion
15. Field experience in assessing social judgement
16. Simulation exercise to understand decision-making under different situations
17. Exercise in rational decision-making.

Teaching Methods/Activities
- Lecture cum discussion
- Class exercises
- Group Presentation

Suggested Readings
Eiser J, Richard. 2011. Social Psychology: Attitudes, Cognition and Social Behaviour. Cambridge: Cambridge University Press.(First Edition, 1986))
Eysenck MW and Keane M T. 2010.Cognitive psychology: A student's handbook. Sixth Edition, Hove: Psychology Press.
Feldman RS. 2008. Essentials of understanding psychology (7th ed.). Boston: McGraw-Hill.
Gilovich T, Keltner D, and Nisbett RE. 2011. Social psychology. New York: W.W. Norton & Co.
Moreno R. 2010.Educational Psychology. Hoboken, NJ: John Wiley & Sons Inc.
Nevid JS. 2012. Essentials of psychology: Concepts and applications Belmont, CA: Wadsworth, Cengage Learning.
Rachlin H. 1989. Judgment, decision, and choice: A cognitive/behavioral synthesis. New York: W.H. Freeman.

Teaching Schedule

Objectives

By the end of the course students will be able to

- Understand the biological and cognitive processes determining human behavior
- Understand the process of learning under different context
- Develop competencies in influencing the human decision process in various contexts
- Design effective strategies to influence attitude and behaviour
- Build capacities to understand the fundamental psychological processes which guide human behaviour at individual, group and community levels in specific contexts, to develop sound extension strategies.

.

Theory

Unit No.	Lecture No.	Topic	Weightage
		Block 1: Foundations of Behaviour Change	
Unit1: Foundations of Human Behaviour	1	Human behaviour – Meaning, importance and factors influencing human behaviour.	2
	2	Biological bases of human behaviour – Nervous system, brain, endocrine system and genes.	3
	3	Individual variations – Intelligence, ability and creativity– foundations and theories	3
	4	Personality and temperament - Foundations, approaches, theories of personality, measuring personality (traits, locus of control, self-efficacy)	3
	5	Personal, social and moral development – Meaning, concepts – self-concept, self-esteem and self-worth and theories.	2
	6	Motivation –Foundations, approaches, theories, managing human needs and motivations., perceiving others – impression, attitude, opinions.	3
	7	Emotions - Foundations, types and functions, measuring emotional intelligence	3
		Block 2: Cognitive Processes and Learning	
Unit 1: Cognitive Processes affecting Human Behaviour	8	Sensory organs and their role cognition; Cognitive processes – Attention, perception, remembering and forgetting	3
	9	knowledge and expertise – Foundations and theories; Principles and processes of perception	3
	10	Consciousness – Meaning, types, sleep and dreams;	2
	11	Learning and Memory – Memory - Meaning, types and mechanisms of storage and retrieval of memories in the Human brain;	3
	12	Complex Cognitive Processes - Concept formation, Thinking, Problem solving and transfer – foundations, theories and approaches	3

Unit 2: Information Processing	13-14	Information Processing – Meaning, principles; Models of information processing – Waugh and Norman model of primary and secondary memory; Atkinson and Shiffrin's stage model of memory; other models including blooms taxonomy and Sternberg's Information Processing Approach	5
	15	Attention and Perception – meaning, types, theories and models; Consciousness;	3
Unit3: Learning	16	Learning – Foundations, approaches and theories	2
	17	Cognitive Approaches of Learning –Meaning, principles, theories and models;	3
	18	Memory – Foundations, types	2
	19	Behavioural Approaches of Learning – foundations and theories - classical conditioning, operant conditioning, applied behaviour analysis	3
	20	Social Cognitive and Constructivist Approaches to Learning – Foundations and theories – social cognitive theory, Self-regulated learning; learning styles – meaning, types and applications in learning	4
Unit:4 Judgement, Choice and Decision-making	21	Human Judgement – Meaning, nature, randomness of situations, theories and models	3
	22	Choice – Meaning, criteria for evaluating options; theories and models of human choice; Choice architecture	3
	23	Decision-making – Meaning, problem analysis; steps and techniques of decision-making under different contexts	2
		Block 3: Human Behaviour in the Society	
Unit 1: Attitudes and Influence	24	Attitudes - Meaning, assumptions, types, theories and models of attitude formation;	3
	25	Methods of changing attitudes relating to others - liking, attraction, helping behaviour, prejudice, discrimination and aggression; Liking / affect – meaning, types and theories	3
	26	Attraction – Meaning, types and theories; Persuasion – meaning, theories and techniques	3
	27	Social influence and groups – conformity, compliance and obedience	2
Unit 2: Social Judgement, Social Identity and Inter-Group Relations	28	Social Judgement – Meaning, frame of reference, stereotyping; The judgement of attitude, models;	2
	29	Attribution – Meaning, theories; Rational decision making; Social identify – Meaning, types; assessment	2
	30	Groups – Meaning, types, group processes; sustainability of groups; Inter group processes and theories, social learning	2

EXT-503 ORGANISATIONAL BEHAVIOR AND DEVELOPMENT 2+1

WHY THIS COURSE?

In changing and competitive world, the survival of any organization is dependent on its ability to adjust to the new challenges, adapt its structure and develop the competencies needed among its staff. This course is designed to understand the theory and practice relating to the processes of organizational behavior, development and change. It attempts to bring about change in the different levels of the organization (the individual, group and organization) using a wide variety of interventions.

AIM OF THIS COURSE

- To understand the theory and practice relating to the processes of organizational behavior, development and change.
- To develop insight and competence in diagnostic and intervention processes and skills for initiating and facilitating change in organizations.
- To gain necessary self-insight, skills in facilitation, organizational development (OD) skills, group process and techniques, to become an effective change agents and OD consultants.
- To understand the behavior of individuals and small groups in organization with special focus on beliefs, attitudes and values, human inference - attribution, self concept, motivation, active listening, interpersonal communication, conflicts management.

Theory

BLOCK No.	Lecture No	Topic	Weightage	
1. ORGANIZATIONAL BEHAVIOR	**Unit 1: Basics of Organization**			
	1	Introduction to organizations-concept and characteristics of organizations; Typology of organizations;	2	6
	2,3	Theories of organizations: nature of organizational theory, Classical theories, Modern management theories, System Theory; Criticisms and lessons learnt/analysis	4	
	Unit 2: Basics of Organizational Behaviour			
	4	Concepts of Organisational Behaviour, Scope, Importance,	2	4
	5	Models of Organisational Behaviour	2	

	Unit 3: Individual Behaviour in Organizations			
	6	Introduction, Self-awareness, Perception and Attribution, Learning	3	11
	7	Systems approach to studying organization needs and motives – attitude, values and ethical behavior, Personality	4	
	8	Motivation-Concept & Theories, Managing motivation in organizations	4	
	Unit 4: Group Behaviour in Organization			
	9	Foundations of group, group behaviour and group dynamics; Group Development and Cohesiveness, Group Performance and Decision Making, Intergroup Relations;	3	13
	10	Teams in Organizations-Team building experiential exercises	2	
	11	Interpersonal Communication and Group;	2	
	12,13	Leadership: Meaning, types, Theories and Perspectives on Effective Leadership, Power and Influence, managing Conflict and Negotiation skills	4	
	14	Job/stress management, decision-making, problem-solving techniques	2	
	Unit 5: Productive Behaviour and Occupational Stress			
	15	Productive behaviour - Meaning, dimension;	2	12
	16	Job analysis and Job performance – meaning, dimensions, determinants and measurement;	2	
	17	Job satisfaction and organizational commitment - meaning, dimensions and measures roles and role clarity;	3	
	18	Occupational stress – meaning, sources, theories and models, effects, coping mechanism, effects and management;	3	
	19	Occupational stress in farming, farmer groups/ organizations, research and extension organizations	2	
	Unit 6: Organizational System			
	20	Organizations Structure- Need and Types, Line & staff, functional, committee, project structure organizations, centralization & decentralization, Different stages of growth and designing the organizational structure;	4	9

	21	Organizational Design-Parameters of Organizational Design, Organization and Environment, Organizational Strategy, Organization and Technology, Power and Conflicts in Organizations; Organizational Decision-Making;	3	
	22	Organizational Culture vs Climate; Organizational Change; Organizational Learning and Transformation	2	
2. ORGANISATIONAL DEVELOPMENT	**Unit 1: Overview of Organizational Development**			6
	23	Concept of Organizational Development, Importance and Characteristics, Objectives of OD,	3	
	24	History and Evolution of OD, Implications of OD Values	3	
	Unit 2: Managing the Organizational Development Process			
	25	Basic Component of OD Program-Diagnosis-contracting and diagnosing the problem, Diagnostic models, open systems, individual level group level and organizational level diagnosis;	3	8
	26	Action-collection and analysis for diagnostic information, feeding back the diagnosed information and interventions;	2	
	27	Program Management- entering OD relationship, contracting, diagnosis, feedback, planned change, intervention, evaluation	3	
	Unit 3: Organizational Development Interventions			
	28	Meaning, Importance, Characteristics of Organization development Interventions,	2	5
	29	Classification of OD Interventions-Interpersonal interventions, Team Interventions, Structural Interventions, Comprehensive Interventions	3	
	Unit 4: Organizational Development Practitioner or Consultant			
	30	Who is OD consultant? Types of OD consultants and their advantages, qualifications,	2	6
	31	Comparison of traditional consultants Vs. OD consultants,	2	
	32	Organizational Development process by the practitioners skills and activities.	2	
			80	**80**

RESOURCES

Bhattacharyya DK. 2011. Organizational Change and Development, Oxford University Press.

Hellriegel D, Sloccum JW and Woodman. 2001. Organizational Behaviour. Cincinnati, Ohio : South-Western College Pub.
Luthans F. 2002. Organizational Behaviour. Tata McGraw-Hill, New York
Newstrom JW and Davis K. 2002. Organizational Behaviour: Human behaviour at Work. Tata-McGraw Hill, New Delhi.
Peter MS. 1998. The Fifth Discipline: The Art and Practice of Learning Organization. Random House, London.
Pradip NK. 1992. Organizational Designs for Excellence.Tata McGraw Hill, New Delhi.
Shukla, Madhukar. 1996. Understanding Organizations. Prentice Hall of India, New Delhi.
Stephens PR and Timothy AJ. 2006. Organizational Behaviour, 12th Edition. Prentice Hall Pub.
Thomas GC and Christopher GW. 2013. Organizational development and change, 10th edition, South-Western college publishing.
Wendell LF and Cecil HB. 1999. Organizational Development: Behavioural science interventions for organization improvement, Pearson. 368 pp.

Course Title : Research Methodology in Extension
Course Code : EXT 504
Credit Hours : 2+1

Why this course?

Growth of any discipline is directly proportional to the creation of knowledge in that discipline. Extension research is the backbone of extension discipline. Extension research is a unique social science inquiry where research ideas are gathered from the field problems and put through a systematic cycle of objective investigations that result in significant solutions. Apart from developing theories and models that advance scientific knowledge, extension research should also provide new insights for improving extension policy and practice. As extension is a field oriented discipline seeking to improve the welfare of its stakeholders, the extension professionals require critical competencies in conducting empirical research for developing sound extension models, methods and tools.

V. Aim of the course

This course aimed to create a workforce which has sound fundamental knowledge Social Sciences: Agricultural Extension Education and critical competencies in planning, conducting and applying behavioural research for developing quality extension models, methods and tools.
The course is organized as follows:

No.	Blocks	Units
1.	Introduction to behavioural research	1. Nature of Behavioural Research
		2. The Behavioural Research Process
2.	Steps in behavioural research process	1. Formulating a Research Problem
		2. Reviewing the Literature
		3. Identifying Variables and Hypotheses
		4.Formulating Research Designs, Methods and Tools
		5. Selecting Sample
		6. Collecting Data

		7. Analysing and Interpreting the Data
		8. Reporting and Evaluating Research

Theory Teaching Schedule:

Block No.	Lecture No.	Topic	Weightage	
1:	**Unit 1: Nature of Behavioural Research**			
Introduction To Behavioural Research	1	Methods of knowing; Science and scientific method; Behavioural research – Concept, Definition, aim, goals and objectives; Characteristics and Paradigms of research; Types of behavioural research based on applications, objectives and inquiry	5	8
	2	Types of knowledge generated through research – historical, axiological, theoretical and conceptual knowledge, prior research studies, reviews and academic debate; Role of behavioural research in extension; Careers in behavioural research	3	
	Unit 2: The Behavioural Research Process			
	3	Basic steps in behavioural research – Formulating a Research Problem; Reviewing the Literature; Identifying the variables and hypotheses; Formulating research designs, methods and tools	4	7
	4	Selecting sample; Collecting data; Analyzing and Interpreting the Data; Reporting and Evaluating Research; Skills needed to design and conduct research; Writing research proposals	3	
2:	**Unit 1: Formulating a Research Problem**			
Steps in Behavioural	5	The research problem and research topic - definitions; Importance of formulating a research problem;	3	11

Research Process		Sources of research problems; Characteristics of a good research problem;		
	6	Research problems in quantitative and qualitative research; Steps in formulating a research problem; Strategies for writing research problem statement; Research purpose statement	4	
	7	Research questions – Types, Criteria for selecting research questions, techniques for narrowing a problem into a research question; Objectives - Meaning, types and criteria for judging the objectives.	4	
	Unit 2: Reviewing the Literature			
	8	Review-meaning and importance; Types of literature review – Context, Historical, Integrative, methodological, self-study and theoretical; Literature review for quantitative and qualitative studies	4	7
	9	Steps in conducting literature review – Identify key terms, locate literature, critical evaluation and selection; organising literature and writing literature review	3	
	Unit 3: Identifying Variables and Hypotheses			
	10	Developing theoretical, conceptual, empirical frameworks; Approaches for identifying concepts, constructs and variables; Role of theory in behavioural research; Steps in identifying variables – Domain, Concepts, Constructs, Dimensions; Indicators; Variables, Definitions,	5	10

		premises, propositions and hypotheses		
	11	Techniques of identifying concepts, constructs and variables - Types of concepts; Types of variables–causal relationship, the study design; and the unit of measurement	2	
	12	Types of definitions-Types of propositions and hypotheses. Characteristics of good hypotheses; Measurement – Meaning, levels of measurement – nominal, ordinal, interval and ratio; Criteria for choosing measurement levels for variables.	3	
	Unit 4: Formulating Research Designs, Methods and Tools			
	13,14	Research designs – Definition, purpose and functions; Research Design as Variance Control - MAXMINCON Principle; Criteria for selecting a suitable Research Design; Classification of research designs: Quantitative designs - experimental, descriptive, comparative, correlational, survey, ex-post facto and secondary data analysis; Qualitative designs - ethnographic, grounded theory, phenomenological and Narrative research	5	12
	15	Mixed method designs – Action research design; Translational research; Elements of research design - Research strategies, Extent of researcher interference, Study setting, Unit of analysis and Time horizon. Sources of errors while	5	

		specifying research designs. Internal and external validity; Choosing right research design; Triangulation - Importance in behavioural research, Types of triangulation		
	16	Research methods: Designing research Instruments – questionnaires, interview schedules; tests – knowledge tests, behaviour performance tests; scales – scales and indexes, checklists, focus groups; Steps in developing and using research methods and tools; participatory rural appraisal	2	
	Unit 5: Selecting Sample			
	17	Sampling - population, element, sample, sampling unit, and subject; Sampling strategies for quantitative and qualitative research; Principles of sampling	3	12
	18	Factors affecting the inferences drawn from a sample; Types of sampling, Methods of drawing a random sample, Sampling with or without replacement	3	
	19	Types of sampling- Probability Sampling - Simple random sampling, Cluster sampling, Systematic sampling, Stratified random sampling and Unequal probability Sampling; Nonprobability Sampling - Reliance of available subjects, Purposive or judgmental sampling, accidental sampling, expert sampling, Snowball sampling, and Quota sampling	4	

	20	Sample size requirements for quantitative and qualitative studies. Methods for estimating sample size; Generalisation – Importance, Types of generalisations.	2	
	Unit 6: Collecting Data			
	21	The process of collecting data – Selection, training, supervision, and evaluation of field investigators; Online data collection; Errors and biases during data collection.	3	10
	22	Testing goodness of measures through item analysis - Reliability and validity; Types of validity – Content validity: Face and content validity, Criterion-related validity: concurrent and predictive validity, Construct validity: convergent, and discriminant validity, factorial validity, and nomological validity	3	
	23	Types of reliability– Test-Retest, Parallel forms, Inter-item consistency reliability, Split-half reliability. Factors affecting the validity and reliability of research instruments, Strategies for enhancing validity and reliability of measures. Validity and reliability in qualitative research	4	
	Unit 7: Analyzing and Interpreting the Data			
	24	Data coding, exploration and editing; Methods of data processing in quantitative and qualitative studies	3	20
	25	Quantitative data analysis - parametric and non-parametric	5	

		statistical analyses; Parametric analysis – Descriptive and inferential statistics		
	26	Hypothesis testing - Type I and Type II errors	3	
	27	Concepts in hypothesis testing - Effect Size, á, â, and Power, P Value	2	
	28	Multivariate data analysis – regression, factor analysis, cluster analysis, logistic regression and structural equation modelling.	2	
	29	Guidelines for choosing appropriate statistical analysis; Statistical packages for data analysis	3	
	30	Methods of interpreting data and drawing inferences - The Ladder of Inference Methods of communicating and displaying analysed data.	2	
	Unit 8: Reporting and Evaluating Research			
	31	Writing reports and research publications	2	3
	32	Evaluation Methodology	1	

Practicals

• Selecting a research problem and writing problem statement
• Narrowing down research problem to purpose, research questions and objectives
• Choosing, evaluating and reviewing research literature
• Selection of variables through construct conceptualization and defining variables
• Choosing research design based on research problem
• Choosing right sampling method and estimating sample size
• Developing research methods and tools – questionnaires, interview schedule, checklists and focus group guides
• Writing a research proposal
• Field data collection using research methods and tools
• Testing reliability and validity of research instruments

• Hands on experience in using SPSS for coding, data exploration, editing, analysis and interpretation Formulation of secondary tables based on objectives of research
• Writing report, writing of thesis and research articles
• Presentation of reports

Teaching methods/activities
– Lecture cum discussion
– Class exercises
– Assignment (Reading/Writing)
– Student's Book/Publication Review
– Student presentation
– Group Work
– Research Report

Learning outcome
– Understand the concepts, paradigms, approaches and strategies of behavioural research
– Enable to choose research design, methods and tools suitable for the research problem
– Design research instruments skilfully and conduct research in an objective and unbiased way
– Analyse the data through appropriate analytical methods and tools and derive meaningful interpretations

Suggested Reading
Babbie E. 2008. The basics of social research. 4th ed. Belmont, CA, USA; Thompson Wordsworth.
Creswell JW. 2009. Research design: Qualitative, quantitative, and mixed methods approaches. Third edition. Thousand Oaks: Sage Publications.
Creswell JW. 2012. Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Fourth edition. Boston, MA: Pearson.
Kerlinger FN and Lee HB. 2000. Foundations of Behavioral Research. Orlando, FL: Harcourt College Publishers.
Kothari CR.2009. Research Methodology, Methods and Techniques. New Age International Publishers.
Kumar R. 2014. Research Methodology: A Step- by- Step Guide for Beginners. Fourth. Edition.Thousand Oaks, California: Sage Publications.
Malhotra NK. 2010. Marketing research: An applied orientation. Sixth Edition. Upper Saddle River, NJ: Prentice Hall.
NeumanWL. 2006. *Social Research Methods: Qualitative and Quantitative Approaches.* Toronto : Pearson.
Sekaran U and Bougie R. 2013. *Research Methods for Business A Skill-Building Approach*. 6th Edition, Wiley, New York.
Sendhil R, Kumar A, Singh S, Verma A, Venkatesh K and Gupta V. 2017. *Data Analysis Tools and Approaches (DATA) in Agricultural Sciences*. e-Compendium of Training-cum-Workshop organised at the ICAR-IIWBR during March 22-24, 2017. pp 1-126.
Sinha SC and Dhiman AK. 2002. *Research Methodology.* ESS ESS Publications.
Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. *Good Practices in Agricultural extension Research*. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia. Centre for Research on Innovation and Science and Policy (CRISP), Hyderabad. India.
Sivakumar PS and Sulaiman RV. 2015. *Extension Research in India-Current Status and Future*

Strategies. AESA Working Paper 2. Agricultural Extension in South Asia.http:// www.aesanetwork.org/aesa-working-paper-2-on-extension-research-in-india-currentstatus-and-future-strategies-p-sethurman-sivakumar-and-rasheed-sulaiman-v-december-2015/
Wilkinson TS and Bhandarkar PC.1993. *Methodology and Techniques of Social Research.* Himalaya Publ. Home.

EXT 505 Capacity Development 2+1

Aim of the course

- To understand the concepts of training, capacity building, capacity development and human resource development in the context of roles and responsibilities of extension professionals
- To discuss capacity development- approaches, strategies, needs assessment and methods / tolls
- To help you devise, organize, implement and evaluate capacity development programmes

Theory

Block 1: Introduction to Capacity Development

Unit 1: Capacity Development–An Overview

Training, capacity building, capacity development and HRD-Meaning and differences; Need and principles of capacity development; Types and levels of capacities - Institutional capacities (include the rules, regulations and practices that set the overarching contextual environment), Organizational capacities (how various actors come together to perform given tasks), Individual capacities (technical, functional and leadership skills). Types of capacity building - Based on structure (structured, semi-structured &unstructured), Based on context (orientation, induction and refresher), and other categories (online, Webinar, distance etc.). Components of capacity development; Capacity development cycle.

Unit 2: Capacity Development- Approaches and Strategies

Capacity Development Dilemma- Theory versus Practice, Trainee versus Task, Structured versus Unstructured, Generic and Specific; Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance based approach; Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy

Unit 3: Planning and Organization of Capacity Development Programmes

Steps in Designing and Planning of Capacity Development- Step 1. Select the participants, Step 2. Determine the participants' needs, Step 3. Formulate goal and objectives, Step 4. Outline the content, Step 5. Develop instructional activities, Step 6. Prepare the design, Step 7. Prepare evaluation form, Step 8. Determine follow-up activities; Organising capacity development programme; Operational arrangements at different stages- Before the programme, During the programme, Middle of the programme, At the end of the programme, After the programme, Follow up; Stakeholders' responsibilities.

Block 2: Capacity Development Needs Assessment

Unit 1: Planning and Organization of Capacity Development Programmes

Concept of Need Assessment; Approaches in Need Analysis- Performance Analysis, Task Analysis, Competency Study; Needs Survey.

Unit 2: Capacity Development Needs Assessment Methods

Data Collection Methods in Identifying Needs - Rational Methods (Observation, Informal talks, Complaints, Comparison, Analysis of report, Opinion poll, Buzz session, Analysis of the new programme), Empirical Methods (Job analysis, Performance evaluation, Checklist or Questionnaire Method, Tests, Critical Incident Technique, Card Sort Method, Focus Group Discussion, Interview, SWOT Analysis); Information and Skills required in Need Analysis; Identification of Needs through Task Analysis - Task identification, Task Analysis, Gap Analysis.

Block 3: Capacity Development Institutions and Management

Unit 1: Capacity Development Institutions

Capacity Developer (Trainer): Meaning and concept; Types of Capacity Developers (regular, ad-hoc, part time, guest and consultants); Roles of Capacity Developer (explainer, clarifier, supporter, confronter, role model, linker, motivator, translator/ interpreter, change agent); Good Capacity Developer – Qualities, skills and roles Qualities, Skills (Intrapersonal & Inter personal), Roles (Manager, Strategist, Task Analyst, Media Specialist, Instructional Writer, Marketer, Facilitator, Instructor, Counsellor, Transfer Agent, Evaluator); Capacity Development Centres and Locations; Organisation's Role in Capacity Development.

Unit 2: Capacity Development Project Formulation

Project Proposal: Concept and Meaning; Steps in Project Formulation- Review of past proposals, Consulting experts, consultants, and previous organizers, Review past project evaluation reports, Interact with the prospective beneficiaries; Format for Writing Project Proposal (LFA).

Block 4: Capacity Development Process and HRD

Unit 1: Capacity Development Methods and Tools

Capacity Development Methods –Lecture, Discussion, Syndicate, Seminars, Conference, Symposium, Role Play, Case study, Programmed Instruction, T - group/ Laboratory methods; Factors Determining Selection of Methods - Capacity development objectives, subject matter, categories of participants, and the available resources like time, location, budget; Capacity Development Aids.

Unit 2: Evaluation

Capacity Development Programme Evaluation - Meaning & Importance; Purpose of Evaluation; Principles of Evaluation; Types of Evaluation – Formative, Summative, Kirkpatrick's four levels of evaluation; Process of Evaluation- Evaluation at the beginning, Evaluation during the programme, Evaluation at the end; Use of evaluation findings; Statistical Tools for evaluation.

Unit 3: Impact Assessment

Impact Assessment- Meaning, Need, Features, Benefits, Concepts; Indicators for Impact Assessment - Direct indicators, Indirect or proxy indicators, Quantitative indicators,

Qualitative indicators, Result chain / hierarchy of indicators; Methods of Impact Evaluation-Learning retention of participants (KOSA), Impact on the job performance, Impact on organizational effectiveness, Impact on stakeholder's competency.

Unit 4: Human Resource Development

HRD: Meaning, Importance and Benefits; Types of HRD Systems & Sub-systems Career system (Manpower planning, Recruitment, Career planning, Succession planning, Retention), Work system (Role analysis, Role efficacy, Performance plan, Performance feedback and guidance, Performance appraisal, Promotion, Job rotation, Reward), Development system (Induction, Training, Job enrichment, Self-learning mechanisms, Potential appraisal, Succession development, Counselling, Mentor system), Self-renewal system (Survey, Action research, Organisational development interventions), Culture system (Vision, mission and goals, Values, Communication, Get together and celebrations, Task force, Small groups); Components of HRD System - Performance Appraisal, Potential Appraisal, Task System, Development System, Socialisation System, Governance; Functions of HRD-Organisational Development, Career Development, Capacity Development.

Practicals

- Capacity development needs assessment exercise
- Capacity development project formulation exercise
- Planning organizing and conducting an extension capacity development programme
- Designing a programme
- Writing learning objectives
- Developing objectives into curriculum
- Training plan
- Organizing capacity development workshop
- Evaluation with pre- and post-training tests
- Training methods – Practicing each method mentioned in contents as group exercise

Teaching Schedule

Sr. No.	Topic	No. of Lecture (s)
	Block 1: Introduction to Capacity Development	
	Unit 1: Capacity Development–An Overview	
1.	Training, capacity building, capacity development and HRD-Meaning and differences	1
2.	Need and principles of capacity development	
3.	Types and levels of capacities - Institutional capacities (include the rules, regulations and practices that set the overarching contextual environment), Organizational capacities (how various actors come together to perform given tasks), Individual capacities (technical, functional and leadership skills).	1
3	Types of capacity building - Based on structure (structured, semi-structured &unstructured), Based on context (orientation, induction and refresher), and other categories (online, Webinar, distance etc.).	1

4	Components of capacity development; Capacity development cycle	
	Unit 2: Capacity Development- Approaches and Strategies	
5	Capacity Development Dilemma- Theory versus Practice, Trainee versus Task, Structured versus Unstructured, Generic and Specific	1
6	Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance based approach	1
7	Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy	1
	Unit 3: Planning and Organization of Capacity Development Programmes	
8	Steps in Designing and Planning of Capacity Development- Step 1. Select the participants, Step 2. Determine the participants' needs, Step 3. Formulate goal and objectives, Step 4. Outline the content, Step 5. Develop instructional activities, Step 6. Prepare the design, Step 7. Prepare evaluation form, Step 8. Determine follow-up activities	1
9	Organising capacity development programme	1
10	Operational arrangements at different stages- Before the programme, During the programme, Middle of the programme, At the end of the programme, After the programme, Follow up; Stakeholders' responsibilities	
	Block 2: Capacity Development Needs Assessment	
	Unit 1: Planning and Organization of Capacity Development Programmes	
11	Concept of Need Assessment	1
12	Approaches in Need Analysis- Performance Analysis, Task Analysis, Competency Study	1
13	Needs Survey	1
	Unit 2: Capacity Development Needs Assessment Methods	
14	Data Collection Methods in Identifying Needs - Rational Methods (Observation, Informal talks, Complaints, Comparison, Analysis of report, Opinion poll, Buzz session, Analysis of the new programme), Empirical Methods (Job analysis, Performance evaluation, Checklist or Questionnaire Method, Tests, Critical Incident Technique, Card Sort Method, Focus Group Discussion, Interview, SWOT Analysis);	1
15	Information and Skills required in Need Analysis	1
16	Identification of Needs through Task Analysis - Task identification, Task Analysis, Gap Analysis	1
	Block 3: Capacity Development Institutions and Management	
	Unit 1: Capacity Development Institutions	
17	Capacity Developer (Trainer): Meaning and concept	1
18	Types of Capacity Developers (regular, ad-hoc, part time, guest and consultants)	1
19	Roles of Capacity Developer (explainer, clarifier, supporter, confronter, role model, linker, motivator, translator/ interpreter, change agent); Good Capacity Developer – Qualities, skills and roles	2

	Qualities, Skills (Intrapersonal & Inter personal), Roles (Manager, Strategist, Task Analyst, Media Specialist, Instructional Writer, Marketer, Facilitator, Instructor, Counsellor, Transfer Agent, Evaluator)	
20	Capacity Development Centres and Locations; Organisation's Role in Capacity Development	1
	Unit 2: Capacity Development Project Formulation	
21	Project Proposal: Concept and Meaning; Steps in Project Formulation- Review of past proposals, Consulting experts, consultants, and previous organizers, Review past project evaluation reports, Interact with the prospective beneficiaries; Format for Writing Project Proposal (LFA).	1
	Block 4: Capacity Development Process and HRD	
	Unit 1: Capacity Development Methods and Tools	
22	Capacity Development Methods –Lecture, Discussion, Syndicate, Seminars, Conference, Symposium, Role Play, Case study, Programmed Instruction, T - group/ Laboratory methods; Factors Determining Selection of Methods - Capacity development objectives, subject matter, categories of participants, and the available resources like time, location, budget; Capacity Development Aids	2
	Unit 2: Evaluation	
23	Capacity Development Programme Evaluation - Meaning & Importance	1
24	Purpose of Evaluation; Principles of Evaluation	1
25	Types of Evaluation – Formative, Summative, Kirkpatrick's four levels of evaluation	1
26	Process of Evaluation- Evaluation at the beginning, Evaluation during the programme, Evaluation at the end	1
27	Use of evaluation findings	1
28	Statistical Tools for evaluation	1
	Unit 3: Impact Assessment	
29	Impact Assessment- Meaning, Need, Features, Benefits, Concepts; Indicators for Impact Assessment - Direct indicators, Indirect or proxy indicators, Quantitative indicators, Qualitative indicators, Result chain / hierarchy of indicators	1
30	Methods of Impact Evaluation- Learning retention of participants (KOSA), Impact on the job performance, Impact on organizational effectiveness, Impact on stakeholder's competency	1
	Unit 4: Human Resource Development	
31	HRD: Meaning, Importance and Benefits	1
32	Types of HRD Systems & Sub-systems Career system (Manpower planning, Recruitment, Career planning, Succession planning, Retention), Work system (Role analysis, Role efficacy, Performance plan, Performance feedback and guidance, Performance appraisal, Promotion, Job rotation, Reward), Development system (Induction, Training, Job enrichment, Self-learning mechanisms, Potential appraisal, Succession development, Counselling, Mentor system),	2

	Self-renewal system (Survey, Action research, Organisational development interventions), Culture system (Vision, mission and goals, Values, Communication, Get together and celebrations, Task force, Small groups)	
33	Components of HRD System - Performance Appraisal, Potential Appraisal, Task System, Development System, Socialisation System, Governance; Functions of HRD-Organisational Development, Career Development, Capacity Development	1
	TOTAL	**32**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Capacity development needs assessment exercise	**1**
2	Capacity development project formulation exercise	**1**
3	Planning, organizing and conducting an extension capacity development programme	**2**
4	Designing a programme	**2**
5	Writing learning objectives	**1**
6	Developing objectives into curriculum	**2**
7	Training plan	**1**
8	Organizing capacity development workshop	**2**
9	Evaluation with pre- and post-training tests	**2**
10	Training methods – Practicing each method mentioned in contents as group exercise	**2**
	TOTAL	**16**

Suggested Reading

ADB. 2009. Training Needs Assessment and Strategic Training Plan.

Bentaya GM, and Hoffmann V (Eds). 2011. Rural Extension Volume 3 -Training Concepts and Tools. Margraf Publishers GmbH, Scientific books, KanalstraBe 21; D-97990, Weikersheim, 191 pp.

DFID .2003. Promoting Institutional and Organisational Development. A Source Book of Tools and Techniques, Department for International Development, United Kingdom

DoPT.2014. Civil Services Competency Dictionary: Strengthening Human Resource Management of Civil Service. Department of Personnel and Training, Government of India

FAO .2010. FAO Capacity Assessment Approach and Supporting Tools - Discussion Draft, Food and Agriculture Organisation of the United Nations

FAO .2012. Capacity Development: Learning Module 2. FAO Approaches to Capacity Development in Programming. Processes and Tools, Food and Agriculture Organisation of the United Nations

FAO .2012. Corporate Strategy on Capacity Development.

FAO .2013. Capacity Development: Learning Module 4. Organization Analysis and Development Food and Agriculture Organisation of the United Nations

GFRAS. 2012. The New Extensionist: Roles, Strategies, and Capacities to Strengthen Extension and Advisory Services, Global Forum for Advisory Services

GFRAS. 2015. The New Extensionist: Core Competencies for Individuals, GFRAS Brief 3.

Horton D. 2002. Planning, Implementing, and Evaluating Capacity Development. ISNAR Briefing Paper 50.

ICAR 2015. Training Policy 2015, Indian Council of Agricultural Research.

IISD 2015. Appreciative Inquiry and Community Development. International Institute for Sustainable Development.

LENCD 2011. How to assess existing capacity and define capacity needs, Learning Network on Capacity Development.

Maguire. 2012. Module 2: Agricultural Education and Training to Support Agricultural Innovation Systems. Overview. Agricultural Innovation Systems: An Investment Source book. The World Bank.

Mbabu AN and Hall A. 2012. Capacity Building for Agricultural Research For DevelopmentLessons from Practice in Papua New Guinea. United Nations University-Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT). https://www.merit.unu.edu/archive/docs/hl/201302_Capacity%20Building%20for%20 Agricultural%20Research%20Development_Final.pdf

Mittal N, Sulaiman RV and Prasad R M. 2016. Assessing Capacity Needs of Extension and Advisory Services a Guide for Facilitators. Agricultural Extension in South Asia. http://www.aesanetwork.org/assessing-capacity-needs-of-extension-and-advisory-services-aguide-for-facilitators/

Mishra DC. 1990. New Directions in Extension Training. Directorate of Extension, Ministry of Agriculture, Govt. of India, New Delhi.

OECD/DAC. 2006. The Challenge of Capacity Development: Working Towards Good Practice, Organisation for Economic Cooperation and Development.

Pretty JN, Gujit I, Thompson J, and Scoones I. 1995. A Trainer's Guide for Participatory Learning and Action. IEED Participatory Methodology Series. Social Sciences: Agricultural Extension Education 259

Rolf PL and Udai P. 1992. Facilitating Development: Readings for Trainers, Consultants and Policy-makers, New Delhi: Sage Publications, pp. 359

Rolf PL and Udai P. 1990. Training for Development, (3rd edn) by (West Hartford, Kumarian Press, 1990, pp. 333.

SIDA.2000. Capacity Development. SIDA Working Paper No. 4. Analysis of Needs for Capacity Development.

SIDA. 2000. Working Paper No. 4. Analysis of Needs for Capacity Development

Sulaiman RV and Mittal N. 2016. Capacity Needs of Extension and Advisory Services (EAS) in South Asia. Policy Brief No 1. Agricultural Extension in South Asia. http:// www.aesanetwork.org/policy-brief-no-1-capacity-needs-of-extension-and-advisory-serviceseas-in-south-asia/

Swanson BE and Rajalahti R. 2010. Strengthening Agricultural Extension and Advisory Services. A Guide for Facilitators.

TAP. 2013. Capacity Development for Agricultural Innovation Systems - Key Concepts and Definitions. Tropical Agricultural Platform

TAP. 2016. Common Framework on Capacity Development for Agricultural Innovation Systems. Guidance Note on Operationalization, Tropical Agricultural Platform

UNDP. 1998. Capacity Assessment and Development in a Systems and Strategic Management Context. Technical Advisory Paper No. 3. Management Development and Governance Division Bureau for Development Policy, January 1998, United Nations Development Programme

UNDP. 1998. Capacity Assessment and Development in a Systems and Strategic Management Context. Technical Advisory UNU-MERIT, Netherlands.

UNDP. 2008. Capacity Assessment Methodology. User's Guide. Capacity Development Group. Bureau for Development Policy.

UNDP. 2009. Capacity Development: A UNDP Primer, United Nations Development Programme

WAC. 2013. Assessing Capacity Needs and Strategy Development for Grassroots Rural Institutions: A Guide for Facilitators. World Agroforestry Centre (WAC)

Websites

- TAP–Tropical Agriculture Platform for Capacity Development– https://www.tapipedia.org/
- FAO–FAO Capacity Development– http://www.fao.org/capacity-development/en/
- GFRAS–Global Forum for Rural Advisory Services– http://www.g-fras.org/en/
- AESA–Agricultural Extension in South Asia– http://www.aesanetwork.org/

EXT 506 ICTs for Agricultural Extension and Advisory Services 2+1

Why this course?

Information and Communication Technologies (ICTs) are continuously evolving. More ICT applications having better relevance to extension and advisory services (EAS) are currently available considering the human and other resource constrains faced by EAS, ICTs can supplement and complement EAS extension efforts in a cost-effective way. Extension professionals should have sound knowledge of ICTs and comprehensive understanding on its various applications for effectively deploying these in EAS provision. This course will provide knowledge and hands-on-experience on ICT applications relevant for EAS.

Aim of the course

- To discuss different ICT initiatives, knowledge management process and application aspects
- To orient students on advances in smart/ disruptive technologies and data analytics
- Hands on experience in navigating ICTs

The course is organized as follows:

No.	Blocks	Units
1	Introduction to Information and Communication Technologies (ICTS) and e-Extension	1. ICTs- Concepts and Status 2. ICTs in Knowledge Management 3. e-Extension initiatives in Agriculture and allied sectors
2	Application of ICTs in Extension and advisory services	1. ICT Applications 2. ICT Expert Systems 3. ICT Networks
3	Knowledge management and Standards	1. Policies in Knowledge Management 2. Web Standards 3. Social Media Applications to engage audience
4	Smart and disruptive Technologies and advanced analytics for agricultural extension	1. Smart Technologies 2. Human Computer Interactions

Teaching Schedule

Block	Unit	Lecture	Content	Weightage
1. Introduction to Information & Communication	1. ICTs- Concepts & Status	1, 2	ICTs- meaning, concepts, basics of ICTs, global & national status, types & functions of ICTs, innovations.	**6**

Technologies (ICTs) & E-extension		3, 4	Meaning of e-Governance, e-learning, m Learning, advantages and limitations of ICTs.	**6**
	2. ICTs in Knowledge Management	5, 6	Knowledge management-meaning, approaches & tools. Role of ICTs in Agricultural Knowledge Management.	**6**
	3. e-Extension initiatives in Agriculture & allied sectors	7, 8	e-Extension, overview on Global & national e-extension initiatives, Inventory of e-Extension initiatives in Agriculture & allied sectors from Central and State governments, ICAR, SAUs, private sector & NGO initiatives in India.	**6**
Block 2: Application of ICTs in Extension and Advisory Services	1: ICT Applications	9, 10	Knowledge centres (tele centres), digital kiosks, websites & web portals, community radio, farmers call centres, mobile phone based advisory services and mobile applications (m Extension, m Learning),	**6**
		11, 12	Self-learning CDs on Package of practices, social media, digital videos, Market Intelligence and Information Systems- ICT enabled Supply-Chains and Value-Chains/ e-Marketing (e-NAM, Agmarknet, *etc*.).	**6**
	2. ICT Expert Systems	13, 14	Expert System / Decision Support System/ Management Information Systems, Farm Health Management & Intelligence System for Plant Health, Animal Health, Soil Health, Fishery, Water, Weather, etc. Social Sciences: Agricultural Extension Education	**6**
	3 ICT Networks	15, 16	Global & regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Course CCRA, Edu Ex, *etc*), e-Governance Systems;	**6**

		17	Digital networks among extension personnel, Farmer Producers Organisations (FPOs)/ SHGs/ Farmers Groups.	**3**
Block 3: Knowledge Management and Standards	1. Policies in Knowledge Management	18, 19	Global policy / Standards on e-Governance, National policy on e-governance, Open Data / Open Gov Standards & Open Source etc.	**6**
		20	Language Technology Applications; National e-Agriculture policy/ Strategies/ guidelines.	**3**
	2. Web Standards	21, 22	Web standards, creating & writing for webportals, Development of mobile applications	**6**
		23, 24	Developing digital videos storyboard, video recording- video editing, types of blogs & writing guidelines	**6**
	3. Social Media Applications to engage audience	25	Video conference, live streaming & webinars,	**4**
		26	Types & functions of social media applications, guidelines for preparing social media content, engaging audience and data-analytics.	**6**
Block 4: Smart and Disruptive Technologies and Advanced Analytics for Agricultural Extension	1. Smart Technologies	27, 28	Open technology computing facilities, System for data analytics/ mining/ modelling/ Development of Agricultural simulations; Remote Sensing, GIS, GPS, Information Utility (AIU); disruptive technologies- Analysis; Internet of Things (IoTs), Drones, Artificial intelligence (AI), block chain technology, social media & Big Data analytics for extension.	**6**
	2. Human Computer Interactions	29, 30	Human Centered Learning/Ergonomics/ Human Computer Interactions- Meaning; Theories of multimedia learning - Sweller's cognitive load	**6**

			theory, Mayer's cognitive theory of multimedia learning, Schnotz's integrative model of text and picture comprehension, van Merriënboer's four-component instructional design model for multimedia learning; Basic Principles of Multimedia Learning - Split-attention, Modality, Redundancy, Coherence, Signaling, segmenting, pre-training, personalisation, voice embodiment;	
		31, 32	Advanced principles - Guided discovery, worked examples, Self-explanation, drawing, feedback, multiple representation, Learner control, animation, collaboration, prior knowledge, and working memory. Designing ICT gadgets based on human interaction principles - Interactive design-Meaning, importance; Approaches of interactive design - user-centered design, activity centered design, systems design, and genius design; Methods of interactive design - Usability testing methods.	**6**
			Total Weightage	**100**

Practicals

• Content and client engagement analysis
• Designing extension content for ICTs
• Creating and designing web portals, blogs, social media pages
• Developing digital videos
• Live streaming extension programmes and organising webinars
• Working with Farmers call centres
• Engaging with professional digital networks
• Writing for digital media

Teaching methods/activities

– Lecture
– Guest Lectures
– Assignment (Reading/Writing/ developing m Apps/ media management/Social media initiatives)

– Student's Book/Publication Review
– Student presentation
– Group Work
– Student's interview of ICT practitioners/ champions
– Documenting good practices and case studies
– Review of ICT policy documents and guidelines/ standards
– Short internship with ICT projects

Learning outcome

After successful completion of this course, the students are expected to be able to:
– Appreciate the importance of the ICTs in EAS
– Understand the ICT application aspects
– Critically evaluate ICT initiatives and smart/disruptive technologies
– To execute extension functions by applying ICTs and
– Engage stakeholders in knowledge management process

Suggested Reading

Andres D and Woodard J. 2013. *Social media handbook for agricultural development practitioners.* Publication by FHI360 of USAID. http://ictforag.org/toolkits/ social/ SocialMedia4 AgHandbook.pdf

Barber J, Mangnus E and Bitzer V. 2016. *Harnessing ICT for agricultural extension.* KIT Working Paper 2016: 4. https://213ou636sh0ptphd141fqei1-wpengine.netdna-ssl.com/sed/wp-content/uploads/ sites/ 2/2016/11/KIT_WP2016-4_Harnessing-ICT-for-agricultural-extension.pdf

Bheenick K and Bionyi I. 2017. *Effective Tools for Knowledge Management and Learning in Agriculture and Rural Development.* CTA Working paper. https://publications.cta.int/media/publications/downloads/1986_PDF.pdf

Fafchamps M and Minten B. 2012. *Impact of SMS based Agricultural Information on Indian Farmers.* The World Bank Economic Review, Published by the Oxford University Press on behalf of the International Bank for Reconstruction and Development.

FAO 2011. *E-learning methodologies a guide for designing and developing e-learning courses.*

Food and Agriculture Organization of the United Nations. http://www.fao.org/ docrep/015/i2516e/i2516e.pdf

George T, Bagazonzya H, BallantyneP, Belden C, Birner R, Del CR and Treinen S. 2017. *ICT in agriculture: connecting smallholders to knowledge, networks, and institutions.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/12613 16

Heike Baumüller. 2018. The little we know: An exploratory literature review on the utility of mobile phone enabled services for smallholder farmers. *Journal of International Development.* 30, 134–154.

Laurens K. 2016. *NELK Module 6: Basic Knowledge Management and Extension*, New Extensionist Learning Kit (NELK), Global Forum for Rural Advisory Services (GFRAS). http://www.g-fras.org/en/knowledge/new-extensionist-learning-kit-nelk.html# module-6-Social Sciences: Agricultural Extension Education basic-knowledge-management-and-extension

Mayer RE. 2005. *The Cambridge handbook of multimedia learning.* New York: University of Cambridge.

MEAS & Access Agriculture 2013. *A Guide to Producing Farmer-to-Farmer Training Videos.*https://www.agrilinks.org/sites/default/files/resource/files/MEAS%20Guide%20to%20Producing%20Farmer-to-Farmer%20Training%20 Videos%202013_04.pdf

Meera SN.2013. *Extension, ICTs and Knowledge Management: The 10 difficult questions.* Blog 15. Agricultural Extension in South Asia. http://www.aesanetwork.org/extension-icts-and-knowledge-management-the-10-difficultquestions/

Meera SN. 2017. *Disruptive Technologies – Big Data and Internet of Things in Strengthening Extension & Advisory Services.* Blog 68. Agricultural Extension in South Asia. http://www.aesanetwork.org/disruptive-technologies-big-data-and-internet-of-things-instrengthening- extension-advisory-services/

Meera SN. 2018. *A Treatise on Navigating Extension and Advisory Services through Digital Disruption.* Blog 90. Agricultural Extension in South Asia. http://www.aesanetwork.org/atreatise- on-navigating-extension-and-advisory-services-through-digital-disruption/

Mittal N, Surabhi, Gandhi, Sanjay and Gaurav T. 2010. *Socio-Economic Impact of Mobile Phones on Indian Agriculture.* ICRIER Working Paper No. 246, Indian Council for Research on International Economic Relations (ICRIER), New Delhi.

Preece J, Rogers Y, & Preece, J. 2007. *Interaction design: Beyond human-computer interaction.*Chichester: Wiley.

Saravanan R, Sulaiman RV, Davis K and Suchiradipta B. 2015. *Navigating ICTs for Extension and Advisory Services. Note 11. GFRAS Good Practice Notes for Extension and Advisory Services.* GFRAS: Lindau, Switzerland. https://agrilinks.org/sites /default/ files/resource /files/gfras-ggp-note11_navigating_icts_for_ras_1.pdf

Saravanan R and Suchiradipta B. 2015. *M Extension – Mobile Phones for Agricultural Advisory Services.* Note 17. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. www.g-fras.org/en/download.html?download=349: ggp-note-17-mextension-mobile-phonesfor- agricultural-advisory-services

Saravanan R and Suchiradipta B. 2016. *Social media policy guidelines for agricultural extension and advisory services,* GFRAS interest group on ICT4RAS, GFRAS: Lindau, Switzerland. www.g-fras.org/en/knowledge/gfras-publications.html?download =415: social-media-policy guidelines- for-agricultural-extension-and-advisory-services

Saravanan R. 2010. (Ed.) *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*, New India Publishing Agency (NIPA), New Delhi.
http://www.saravananraj.net/wp-content/uploads/2014/12/32_India_ICTs-for-Agricultural-Extension_Saravanan.pdf

Saravanan R, Suchiradipta B, Chowdhury A, Hambly OH and Hall K. 2015. *Social Media for Rural Advisory Services.* Note 15. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland.
www.g-fras.org/en/download.html?download=355: ggp-note-15-social-media-for-rural advisory - services

Saravanan R, Suchiradipta B, Meera SN, Kathiresan C and Anandaraja N. 2015. *Web Portals for Agricultural Extension and Advisory Services.* Note 16. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland.
www.g-fras.org/en/download.html?download=356: gfras-ggp-note-16-web-portals-foragricultural- extension-and-advisory-services

Saravanan R.2014. (Ed.). *Mobile Phones for Agricultural Extension: Worldwide mAgri Innovations and Promise for Future*, New India Publishing Agency, New Delhi. http://www.saravananraj.net/wp-content/uploads/2014/12/27_Mobile-phones-for-Agricultural-Extension-in-India_Saravanan-Raj-Draft.pdf Restructured and Revised Syllabi of Post-graduate Programmes Vol. 2

Saravanan R, Kathiresan C, and Indra DT. 2011. (Eds.) *Information and Communication Technology for Agriculture and Rural Development,* New India Publishing Agency (NIPA), New Delhi.

Sophie T and Alice VDE.2018. *Gender and ICTs - Mainstreaming gender in the use of information and communication technologies (ICTs) for agriculture and rural development*, FAO. http://www.fao.org/publications/card/en/c/I8670EN

Suchiradipta B and Saravanan R. 2016. *Social media: Shaping the future of agricultural extension and advisory services,* GFRAS interest group on ICT4RAS discussion paper, GFRAS: Lindau, Switzerland.
www.g-fras.org/en/knowledge/gfras-publications.html? download=414: social-mediashaping-the-future-of-agricultural-extension-and-advisory-services

Vignare K. 2013. *Options and strategies for information and communication technologies within agricultural extension and advisory services.* MEAS Discussion paper. http://meas.illinois.edu/wpcontent/uploads/2015/04/Vignare-K-2013-ICT-and-Extension-MEAS-Discussion-Paper.pdf

World Bank. 2017. *ICT in Agriculture (Updated Edition): Connecting Smallholders to Knowledge, Networks, and Institutions.* Washington, DC: World Bank.
https://openknowledge.worldbank.org/handle/10986/27526

Websites

FAO–Food and Agricultural Organisation (Research and Extension)
http://www.fao.org/research-and-extension/en/

CTA–The Technical Centre for Agricultural and Rural Cooperation: Digitalization–
https://www.cta.int/en/channel/digitalisation-sid05951b8c7-e611-4f34-9ae6-8c0fc0c822bc

GFRAS–Global Forum for Rural Advisory Services–
http://www.g-fras.org/en/

AESA–Agricultural Extension in South Asia–
http://www.aesanetwork.org/

EXT 507 Evaluation and Impact Assessment 2+1

Aim of the course

- To orient students on the importance of evaluation and impact assessment
- To develop capacities for evaluation and impact assessment
- Discuss ways of conducting evaluations and impact assessment

Theory

Block 1: Programme Evaluation

Unit 1: Introduction to Evaluation

Concept of Evaluation: Meaning and concept in different contexts; Why Evaluation is Done and When? Programme planning, analyse programme effectiveness, decision making, accountability, impact assessment, policy advocacy; Objectives, types, criteria and approaches of programme evaluation, evaluation principles; the context of program evaluation in agricultural extension; Role and Credibility of Evaluator: Role as educator, facilitator, consultant, interpreter, mediator and change agent. Competency and credibility of evaluator.

Unit 2: Evaluation Theories

Evaluation theory vs. practice – synergistic role between practice and theory in evaluation; Evaluation theories - Three broad categories of theories that evaluators use in their works - programme theory, social science theory, and evaluation theory (other theories/ approaches - Utilization-Focused Evaluation & Utilization-Focused Evaluation (U-FE) Checklist, Values Engaged Evaluation, Empowerment Evaluation, Theory-Driven Evaluation). Integration between theory and practice of evaluation: –evaluation forums, workshops, conferences and apprenticeship/ internship.

Block 2: Evaluation Process

Unit 1: How to Conduct Evaluation

Ten Steps in programme evaluation: (1) Identify and describe programme you want to evaluate (2) Identify the phase of the programme(design, start-up, ongoing, wrap-up, follow-up) and type of evaluation study needed (needs assessment, baseline, formative, summative, follow-up) (3) Assess the feasibility of implementing an evaluation (4) Identify and consult key stakeholders (5) Identify approaches to data collection (quantitative, qualitative, mixed) (6) Select data collection techniques (survey interviews and questionnaires with different types) (7) Identify population and select sample (sampling for evaluation, sample size, errors, sampling techniques (8) Collect, analyse and interpret data (qualitative and quantitative evaluation data analysis) (9) Communicate findings (reporting plan, evaluation report types, reporting results, reporting tips, reporting negative findings (10) Apply and use findings (programme continuation/ discontinuation, improve on-going programme, plan future programmes and inform programme stakeholders).

Unit 2: Evaluating the Evaluation

Evaluating the Evaluation - 10 Steps as above with focus on conceptual clarity, representation of programme components and stakeholders, sensitivity, representativeness of needs, sample and data, technical adequacy, methods used for data collection and analysis, costs, recommendations and reports.

Block 3: Programme Management Techniques

Unit 1: SWOT Analysis and Bar Charts

SWOT Analysis – Concept, origin and evolution; SWOT As a Programme Management Tool; Conducting SWOT Analysis - Common Questions in SWOT Analysis; Advantages and

Disadvantages of SWOT; Bar Charts (Gantt Charts and Milestone Charts) - Characteristics, advantages and limitations.

Unit 2: Networks

Networks – Introduction, origin and widely used networks (Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM), differences between PERT and CPM, advantages and disadvantages. Networks Terminology – Activity, Dummy activity, Event (predecessor event, successor event, burst event, merge event, critical event), Earliest Start Time (EST), Latest Start Time (LST), Critical Path, Critical Activity, Optimistic time (To), Pessimistic time (Po), Most likely time (TM), Expected time (TE), Float or Slack, Event Slack, Lead time, Lag time, Fast tracking, Crashing critical path, Acclivity Table, Danglers, Normal Time. Rules for Preparation of Networks and Steps in Network Preparation with example.

Block 4: Programme Evaluation Tools

Unit 1: Bennett's Hierarchy of Evaluation

Introduction to Bennett's hierarchy – Background and description; Relation between programme objectives & outcomes at 7 levels of Bennett's hierarchy – Inputs, activities, participation, reactions, KASA changes, practice and behaviour changes, end results. Advantages and Disadvantages of Bennett's hierarchy

Unit 2: Logic Framework Approach (LFA)

Introduction to LFA – Background and description; Variations of LFA - Goal Oriented Project Planning (GOPP) or Objectives Oriented Project Planning (OOPP); LFA Four-by-Four Grid – Rows from bottom to top (Activities, Outputs, Purpose and Goal & Columns representing types of information about the events (Narrative description, Objectively Verifiable Indicators (OVIs) of these events taking place, Means of Verification (MoV) where information will be available on the OVIs, and Assumptions). Advantages and Disadvantages of LFA.

Block 5: Impact Assessment

Unit 1: Introduction to Impact Assessment

Concept of Impact Assessment: Meaning, concept and purpose in different contexts; Impact Assessment Framework: Meaning of inputs, outputs, outcomes, impacts and their relation with monitoring, evaluation and impact assessment.

Unit 2: Impact Assessment Indicators

Indicators for impact assessment – meaning and concept; Selecting impact indicators; Types of impact indicators for technology and extension advisory services - social and behavioral indicators, socio-cultural indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators.

Unit 3: Approaches for Impact Assessment

Impact assessment approaches – Quantitative, qualitative, participatory and mixed methods with their advantages and disadvantages; Quantitative Impact Assessment Types – Based on Time of Assessment (Ex-ante and ex-post), Based on Research Design (Experimental, quasi experimental, Non-experimental). Econometric Impact Assessment: - (Partial Budgeting Technique, Net Present Value, Benefit Cost Ratio, Internal Rate of Return, Adoption Quotient, etc). Qualitative and Participatory Impact Assessment Methods.

Unit 4: Environment Impact Assessment (EIA)

Concept of EIA – Introduction, What it is? Who does it? Why it is conducted? How it is done?; Benefits and important aspects of EIA-risk assessment, environmental management and post product monitoring. Environmental Components of EIA – air, noise, water, biological, land; Composition of the expert committees and Steps in EIA process - screening, scoping, collection of baseline data, impact prediction, mitigation measures and EIA report, public hearing, decision making, monitoring and implementation of environmental management plan,

assessment of alternatives, delineation of mitigation measures and EIA report; Salient Features of 2006 Amendment to EIA Notification - Environmental Clearance/Rejection, participants of EIA; Shortcomings of EIA and How to improve EIA process?

Practicals

- Search the literature using web / printed resources and identify evaluation indicators for the following:
  - Utilization-Focused Evaluation
  - Values Engaged Evaluation
  - Empowerment Evaluation
  - Theory-Driven Evaluation
- Visit Directorate of Extension in your university and enquire about extension programmes being implemented / coordinated by Directorate. Develop an evaluation proposal of any one programme using 'Ten Steps in Programme Evaluation' discussed in the theory class.
- Review any comprehensive programme evaluation report from published sources. Evaluate the report and write your observations following the 'Evaluating the Evaluation' approach.
- Identify at least four agriculture development programmes and their objectives being implemented in your state. Write two attributes each on Strengths, Weaknesses, Opportunities and Threats related to the identified programme objectives in the SWOT grid.
- Identify an on-going development programme and make-out 6 activities from the programme.
- Draw a Gantt chart for 12 months programme activities.
- Write a report on evaluation hierarchy levels and indicators as per Bennett's hierarchy of evaluation for any development programme or project.
- Develop LFA four-by-four grid for any development programme or project with activities, outputs, purpose and goal and objectively verifiable indicators, means of verification & assumptions.
- Visit a nearby KVKs / ATIC. Select any agriculture technology with package of practices and extension advisory services promoted by KVK / ATIC. Identify impact assessment indicators for social and behavioral indicators, socio-cultural indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators.
- Refer any Environment Impact Assessment report and analyse steps in EIA. Write your observations.

Teaching Schedule

Sr. No.	Topic	No. of Lecture (s)
	Block 1: Programme Evaluation	
	Unit 1: Introduction to Evaluation	
1	Concept of Evaluation: Meaning and concept in different contexts	**1**
2	Why Evaluation is Done and When? Programme planning, analyse programme effectiveness, decision making, accountability, impact assessment, policy advocacy; Objectives, types, criteria and approaches of programme evaluation, evaluation principles	

3	The context of program evaluation in agricultural extension	**1**
4	Role and Credibility of Evaluator: Role as educator, facilitator, consultant, interpreter, mediator and change agent. Competency and credibility of evaluator	
	Unit 2: Evaluation Theories	
5	Evaluation theory vs. practice – synergistic role between practice and theory in evaluation	**2**
6	Evaluation theories - Three broad categories of theories that evaluators use in their works - programme theory, social science theory, and evaluation theory (other theories/ approaches - Utilization-Focused Evaluation & Utilization-Focused Evaluation (U-FE) Checklist, Values Engaged Evaluation, Empowerment Evaluation, Theory-Driven Evaluation)	
7	Integration between theory and practice of evaluation: –evaluation forums, workshops, conferences and apprenticeship/ internship	**1**
	Block 2: Evaluation Process	
	Unit 1: How to Conduct Evaluation	
8	Ten Steps in programme evaluation: (1) Identify and describe programme you want to evaluate (2) Identify the phase of the programme(design, start-up, ongoing, wrap-up, follow-up) and type of evaluation study needed (needs assessment, baseline, formative, summative, follow-up) (3) Assess the feasibility of implementing an evaluation (4) Identify and consult key stakeholders (5) Identify approaches to data collection (quantitative, qualitative, mixed) (6) Select data collection techniques (survey interviews and questionnaires with different types) (7) Identify population and select sample (sampling for evaluation, sample size, errors, sampling techniques (8) Collect, analyse and interpret data (qualitative and quantitative evaluation data analysis) (9) Communicate findings (reporting plan, evaluation report types, reporting results, reporting tips, reporting negative findings (10) Apply and use findings (programme continuation/ discontinuation, improve on-going programme, plan future programmes and inform programme stakeholders).	**3**
	Unit 2: Evaluating the Evaluation	
9	Evaluating the Evaluation - 10 Steps as above with focus on conceptual clarity, representation of programme components and stakeholders, sensitivity, representativeness of needs, sample and data, technical adequacy, methods used for data collection and analysis, costs, recommendations and reports	**2**
	Block 3: Programme Management Techniques	
	Unit 1: SWOT Analysis and Bar Charts	
10	SWOT Analysis – Concept, origin and evolution; SWOT As a Programme Management Tool	**1**
11	Conducting SWOT Analysis - Common Questions in SWOT Analysis; Advantages and Disadvantages of SWOT	
12	Bar Charts (Gantt Charts and Milestone Charts) - Characteristics, advantages and limitations	**1**

	Unit 2: Networks	
13	Networks – Introduction, origin and widely used networks (Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM), differences between PERT and CPM, advantages and disadvantages	**1**
14	Networks Terminology – Activity, Dummy activity, Event (predecessor event, successor event, burst event, merge event, critical event), Earliest Start Time (EST), Latest Start Time (LST), Critical Path, Critical Activity, Optimistic time (To), Pessimistic time (Po), Most likely time (TM), Expected time (TE), Float or Slack, Event Slack, Lead time, Lag time, Fast tracking, Crashing critical path, Acclivity Table, Danglers, Normal Time	**2**
15	Rules for Preparation of Networks and Steps in Network Preparation with example	
	Block 4: Programme Evaluation Tools	
	Unit 1: Bennett's Hierarchy of Evaluation	
16	Introduction to Bennett's hierarchy – Background and description	**1**
17	Relation between programme objectives & outcomes at 7 levels of Bennett's hierarchy – Inputs, activities, participation, reactions, KASA changes, practice and behaviour changes, end results	**2**
18	Advantages and Disadvantages of Bennett's hierarchy	
	Unit 2: Logic Framework Approach (LFA)	
19	Introduction to LFA – Background and description	**1**
20	Variations of LFA - Goal Oriented Project Planning (GOPP) or Objectives Oriented Project Planning (OOPP)	
21	LFA Four-by-Four Grid – Rows from bottom to top (Activities, Outputs, Purpose and Goal & Columns representing types of information about the events (Narrative description, Objectively Verifiable Indicators (OVIs) of these events taking place, Means of Verification (MoV) where information will be available on the OVIs, and Assumptions)	**1**
22	Advantages and Disadvantages of LFA	
	Block 5: Impact Assessment	
	Unit 1: Introduction to Impact Assessment	
23	Concept of Impact Assessment: Meaning, concept and purpose in different contexts	**1**
24	Impact Assessment Framework: Meaning of inputs, outputs, outcomes, impacts and their relation with monitoring, evaluation and impact assessment	**1**
	Unit 2: Impact Assessment Indicators	
25	Indicators for impact assessment – meaning and concept	**1**
26	Selecting impact indicators	
27	Types of impact indicators for technology and extension advisory services - social and behavioral indicators, socio-cultural indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators	**2**

Sr. No.	Topic	No. of Lecture (s)
	Unit 3: Approaches for Impact Assessment	
28	Impact assessment approaches – Quantitative, qualitative, participatory and mixed methods with their advantages and disadvantages	**1**
29	Quantitative Impact Assessment Types – Based on Time of Assessment (Ex-ante and ex-post), Based on Research Design (Experimental, quasi experimental, Non-experimental). Econometric Impact Assessment: - (Partial Budgeting Technique, Net Present Value, Benefit Cost Ratio, Internal Rate of Return, Adoption Quotient, etc). Qualitative and Participatory Impact Assessment Methods	**2**
	Unit 4: Environment Impact Assessment (EIA)	
30	Concept of EIA – Introduction, What it is? Who does it? Why it is conducted? How it is done?; Benefits and important aspects of EIA-risk assessment, environmental management and post product monitoring	**2**
31	Environmental Components of EIA – air, noise, water, biological, land	
32	Composition of the expert committees and Steps in EIA process - screening, scoping, collection of baseline data, impact prediction, mitigation measures and EIA report, public hearing, decision making, monitoring and implementation of environmental management plan, assessment of alternatives, delineation of mitigation measures and EIA report	**2**
33	Salient Features of 2006 Amendment to EIA Notification - Environmental Clearance/Rejection, participants of EIA	**1**
34	Shortcomings of EIA and How to improve EIA process?	**1**
	TOTAL	**32**

Practicals

Sr. No.	Topic	No. of Practicals (s)
1	Search the literature using web / printed resources and identify evaluation indicators for the following: • Utilization-Focused Evaluation • Values Engaged Evaluation • Empowerment Evaluation • Theory-Driven Evaluation	**1**
2	Visit Directorate of Extension in your university and enquire about extension programmes being implemented / coordinated by Directorate. Develop an evaluation proposal of any one programme using 'Ten Steps in Programme Evaluation' discussed in the theory class	**2**
3	Review any comprehensive programme evaluation report from published sources. Evaluate the report and write your observations following the 'Evaluating the Evaluation' approach	**2**
4	Identify at least four agriculture development programmes and their objectives being implemented in your state. Write two attributes each on Strengths, Weaknesses, Opportunities and Threats related to the identified programme objectives in the SWOT grid	**2**
5	Identify an on-going development programme and make-out 6 activities from the programme	**2**
6	Draw a Gantt chart for 12 months programme activities	**1**
7	Write a report on evaluation hierarchy levels and indicators as per Bennett's hierarchy of evaluation for any development programme or project	**1**
8	Develop LFA four-by-four grid for any development programme or project with activities, outputs, purpose and goal and objectively verifiable indicators, means of verification & assumptions	**2**
9	Visit a nearby KVKs / ATIC. Select any agriculture technology with package of practices and extension advisory services promoted by KVK / ATIC. Identify impact assessment indicators for social and behavioral indicators, socio-cultural indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators	**2**
10	Refer any Environment Impact Assessment report and analyse steps in EIA. Write your observations	**1**
	TOTAL	**16**

Suggested Reading

Adrienne M, Gundel S, Apenteng E and Pound B. 2011. Review of Literature on Evaluation Methods Relevant to Extension. Lindau, Switzerland: Global Forum for Rural Advisory Services, Lindau, Switzerland

Bagnol B. 2014. Conducting participatory monitoring and evaluation. Pages 81-85 in FAO, Decision tools for family poultry development. FAO Animal Production and Health Guidelines, No. 1 6. Rome, Italy: FAO.

Bennett CF. 1979. Analyzing impacts of extension programs. Washington, D.C., USA: U.S. Department of Agriculture.

Boyle R and Le Maire D. 1999. Building effective evaluation capacity: lessons from practice. New Brunswick, NJ: Transaction Publishers.

Bradford RW, Duncan, P.J. and Tarcy, B. 1999. Simplified Strategic Planning: A No-nonsense Guide for Busy People Who Want Results Fast. New York: Chandler House.

Braverman MT and Engle M. 2009. Theory and rigor in Extension program evaluation planning. Journal of Extension 47(3). www.joe.org/joe/2009june/a1.php

Chen H. 2012. Theory-driven evaluation: Conceptual framework, application and advancement. In: Strobl R., Lobermeier O., Heitmeyer W. (eds) Evaluation von Programmen und Projekten für eine demokratische Kultur. Springer VS, Wiesbaden

Chen, H.T. 2011. Practical program evaluation: Theory-Driven Evaluation and the Integrated Evaluation Perspective. Thousand Oaks, CA: Sage.

Dale R. 2004. Evaluating Development Programmes and Projects, New Delhi, India: Sage Publications.

Duncan Haughey 2017. SWOT Analysis. https://www.projectsmart.co.uk/swot-analysis.php.

Fetterman, D.M. 2012. Empowerment Evaluation: Learning to think like an evaluator. In M.C. Alkin (Ed.), Evaluation Roots (2nd edition) (pp. 304-322).

GFRAS. 2012. Guide to evaluating rural extension. Lindau, Switzerland: Global Forum for Rural Advisory Services (GFRAS).

Greene, J.C., Boyce, A., and Ahn, J. (2011). A values-engaged educative approach for evaluating education programs: A guidebook for practice. Champaign, IL: University of Illinois at Urbana-Champaign. http://comm.eval.org/communities/community-home/librarydocuments/ viewdocument? DocumentKey=f3c734c0-8166-4ba4-9808-a07e05294583

Greene J. 1988. Stakeholder participant and utilization in program evaluation. Evaluation Review, 12: 91–116.

Hall A, Sulaiman VR, Clark N and Yoganand B. 2003. From measuring impact to learning institutional lessons: An innovation systems perspective on improving the management of international agricultural research. Agricultural Systems, 78(2): 213–241.

Karthikeyan, C., Vijayaraghavan, K. and Lavanya, P. 2007. Formative evaluation of Kisan Call Centres. Tamil Nadu. Indian Journal of Extension Education, 43(1 &2): 20-25 (For LFA Example).

Murray P. 2000. Evaluating participatory extension programs: challenges and problems. Australian Journal of Experimental Agriculture, Vol. 40 No. 4 pp. 519–526.

Narayan D.1993. Participatory Evaluation: Tools for Managing Change in Water and Sanitation (Technical Paper 207). Washington, D.C.: The World Bank.

Neuchatel Group. 2000. Guide for Monitoring, Evaluation and Joint Analyses of Pluralistic Extension Support. Lindau, Switzerland: Neuchâtel Group.

www.g-fras.org/fileadmin/UserFiles/Documents/Frames-and-guidelines/M_E/Guide-forMonitoring-Evaluation-and-Joint-Analysis.pdf

Njuki J, Mapila M, Kaaria S and Magombo T. 2008. Using community indicators for evaluating research and development programmes: Experiences from Malawi. Development in Practice 18(4): 633–642.

OECD. 1998. Review of the DAC Principles for Evaluation of Development Assistance. Paris: DAC Working Party on Aid Evaluation.

www.oecd.org/dataoecd/63/50/2065863.pdf (accessed 6 June 2011)

Patton, M.Q. 2013. Utilization-Focused Evaluation (U-FE) Checklist. Western Michigan University Checklists.

Rosanne Lim .2012. Why You Should Do a SWOT Analysis for Project Management.

Rossi PH and Freeman HE. 1985. Evaluation: a systematic approach (third edition). Beverly Hills, CA Sage Publications, Inc.

Sanders J. 1994. The program evaluation standards, 2nd edition. Joint committee on standards for educational evaluation. Thousand Oak, CA: Sage Publications, Inc.

Sasidhar, P.V.K. and Suvedi, M. 2015. Integrated contract broiler farming: An evaluation case study in India. Urbana, IL: USAID-MEAS. www.meas.illinois.edu (For Bennett's Hierarchy Example).

Shadish, W. R. Jr., Cook, T. D., and Leviton, L. C. 1991. Chapter 2: Good theory for social program evaluation. Foundations of Program Evaluation: Theories of Practice (pp. 36-67). Newbury Park, CA: Sage.

Srinath, L.S. 1975. PERT and CPM Principles and Applications, East-West Press, New Delhi.

Suvedi M, Heinze K and Ruonavaara D. 1999. How to Conduct Evaluation of Extension Programs. ANRECS Center for Evaluative Studies, Dept of ANR Education and Communication Systems, Michigan State University Extension, East Lansing, MI, USA

https://msu.edu/~suvedi/Resources/Documents/4_1_Evaulation%20manual%202000.pdf

Suvedi M. 2011. Evaluation of agricultural extension and advisory services — A MEAS training module. Urbana Champaign, IL: Modernizing Extension and Advisory Services Project.

http://www.meas-extension.org/meas-offers/training/evaluatingextensionprograms

Suvedi, M. and Kaplowitz, M.D. 2016. Process skills and competency tools – what every extension worker should know – Core Competency Handbook. Urbana, IL: USAID-MEAS.

Suvedi, M and Morford S. 2003. Conducting Program and Project Evaluations: A Primer for Natural Resource Program Managers in British Columbia. Forrex-Forest Research Extension Partnership, Kamloops, B.C. Forrex Series 6.

USAID .2011. Evaluation policy. Washington, D.C., USA: Bureau for Policy and Planning.

Venkateswarlu, K and Raman, K.V. 1993. Project Management Techniques for R&D in Agriculture. Sterling Publishers Pvt.Ltd., New Delhi.

Wholey JS, Harty HP and Newcomer KE. 1994. Handbook of practical program evaluation. San Francisco, USA: Jossey-Bass Publishers.

Websites

- Better Evaluation– www.betterevaluation.org

- TAP– Tropical Agriculture Platform: Monitoring and Evaluation - www.tapipedia.org
- GFRAS– Global Forum for Rural Advisory Services http://www.g-fras.org/en/
- AESA– Agricultural Extension in South Asia http://www.aesanetwork.org/
- USAID– United States Agency for International Development: Evaluation https://www.usaid.gov/evaluation
- https://education.illinois.edu/faculty/jennifer-greene

EXT 508 Managing Extension Organizations (2+1)

Objective

By the end of the course students will be able to

- Understand management related terminologies and concepts and demonstrate their knowledge and skills on various management functions, as applicable to extension organizations.
- Analyse organizational structures, functions and interlinkages in public and private sector extension management.
- Critically analyse and apply decision making approaches, leadership approaches and motivation approaches to manage extension organizations.
- Make sound decisions, lead, motivate, coordinate and control extension management activities.

Theory

Block	**Unit No.**	**Lecture No.**	Topic	*Weightage*
Block 1: Basics of Management	Unit 1: Management- An Over view	1-2	Management and Extension management – Meaning, concept, nature and importance; and theories of management.	6
		3-4	Management, administration and supervision -meaning, definition and scope; Approaches to management,	6
		5-6	Principles, functions and levels of management;	6

		7-8	Qualities and skills of a manager; Interpersonal relations in the organization; Reporting and budgeting	6
Block 2: Management in different types of Extension Organizations	Unit 1: Extension Management in public, private sector and other sectors	9-11	Extension management (POSDCORB) in public sector, Department of Agriculture, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), SAUs, ICAR Institutes, Private sector, Cooperatives, NGOs, FPOs etc. Organisational Structure, Relations between different units- Challenges in management	9
	Unit 2: Concepts in Management	12-13	Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions;	6
		14-15	Human Resource Management: Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development; Dealing with fund and staff shortages in different extension organizations (KVK, ATMA etc.);	6
		16-17	Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles;	6
		18	Authority and responsibility, Delegation and decentralization, line and staff relations;	3

		19	Challenges of co-ordination in extension organizations; Managing interdepartmental coordination and convergence between KVK, ATMA and line departments; Coordinating pluralism in extension services; Challenges in managing public-private partnerships (PPPs) at different levels in agricultural development in general and extension in particular;	4
		20	Performance appraisal – Meaning, Concept, Methods.	4
Block 3: Motivation and Organizational Communication	Unit 1: Motivation and Communication	21-22	Managing work motivation – Concept, Motivation and Performance, Approaches to motivation,	6
		23-24	Team building; Mentoring, Team work and team-building strategies;	6
		25-26	Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication;	6
		27	Time management, Modernization of information handling	4
	Unit 2: Supervision and Control	28	Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision;	4
		29-30	Managerial Control – Nature, Process, Types, Techniques of Control, Observation, PERT and CPM,	6

		31-32	Management Information Systems (MIS): Concept, tools and techniques, MIS in extension organizations.	6

Practical

- Simulated exercises on techniques of decision making
- Study the structure and function of agro-enterprises, Designing organizational structure/ organograms.
- Group activity on leadership development skills
- Simulated exercise to understand management processes
- Field visit to extension organizations (ATARI, KVKs, NGOs), FPOs, dairy cooperatives to understand the functions of management
- Practical exercises on PERT & CPM
- Group exercise on development of short term and long-term plans for agro-enterprises
- Developing model agriculture-based projects including feasibility study, financial planning and cost-benefit analysis

EXT 509: Enabling Innovation (1+1)

Objective

By the end of the course students will be able to

- Understand concepts and elements in agricultural innovation systems.
- Analyse innovation enabling environments, innovation platforms and existing methodologies for AIS Diagnosis.
- Assess Extension and Advisory Services within AIS and role of capacity development in AIS to innovate.
- Understand concept, tools, approaches and pathways to scaling up
- Plan and implement scaling up pathways and apply scalability assessment tools to evaluate them.
- Appreciate role of policies and innovation management for scaling up knowledge and their implications for Extension and Advisory Services.

Theory

Block	Unit No.	Lecture No.	Topic	*Weightage*
Block 1: Agricultural Innovation Systems	Unit 1: Agricultural Innovation Systems: Concepts and Elements	1-2	Origins of the innovation systems concept-Innovation vs Invention; Agricultural Innovation System (AIS) - ToT, FSR, AKIS and AIS compared, Key insights from AIS: How Innovation takes place;	10
		3	Role of different actors in AIS; Importance of interaction and knowledge flows among different actors,	6
		4	Role of Communication in Innovation Process; Role of Extension in AIS,	6
		5	Different views to analyze AIS: structural view, functional view, process view and capacity view.	6
	Unit 2: Enabling Innovation	6	Role of enabling environment: Policies and institutions in enabling innovation; Role of Government-Innovation Policy: Achieving coordination and policy coherence;	6
		7	Innovation Platforms; Role of Innovation Brokers,	6
		8-9	Methodologies for AIS Diagnosis: Typologies of existing methodologies-strengths and limitations;	10
		10	Assessing Extension and Advisory Services within AIS;	6
		11	Capacity Development in AIS: Strengthening capacities to innovate.	6
Block 2: Scaling Up Knowledge	Unit 1: Scaling Up: Tools,	12	Scaling Up: Definitions; Changing views on scaling up: Approaches to Scaling Up: Push, pull, plant, probe	6

for Innovation	Approaches and Pathways	13-14	Scaling up pathways: Drivers and spaces for scaling up; Framework and Tools for Scaling up	10
		15-16	Planning and implementing a scaling up pathways; Scalability assessment tools;	10
		17	Role of policies in scaling up: Influencing policies for scaling up;	6
		18	Innovation Management for scaling up knowledge and implications for Extension and Advisory Services.	6

Practical

- Identify one crop/commodity sector and use AIS framework to diagnose actors and their roles, patterns of interaction, institutions determining interaction and the enabling policy environment and develop a AIS Diagnosis Report (Review and Key informant interviews)
- Undertake a case study on a successful case of scaling up knowledge and identify factors that contributed to its success
- Identify one specific knowledge (a technology, an approach) that has been recently introduced and develop an Up-scaling Strategy

EXT 510 Gender Mainstreaming (2+1)

Objective

By the end of the course students will be able to

- Understand gender related terminologies and concepts and appreciate the importance of gender in agriculture.
- Analyse gender issues, conduct gender analysis, identify gender needs and apply strategies to address gender and women empowerment.
- Appreciate gender in agricultural research and extension and integrate it in the process of agro-technology development and dissemination.
- Understand importance of gender mainstreaming in agriculture and apply appropriate extension strategies to address gender issues such as gender in agricultural value chains, gender and climate change adaptation etc.
- Evaluate women empowerment approaches, global best practices, policies and frameworks for women empowerment and gender mainstreaming.
- Understand entrepreneurship development for women in agriculture and agro processing sector.

Theory

Block	Unit No.	Lecture No.	Topic	Weightage
1 Why Gender Matters	UNIT I Historical Perspective of Gender	1	Historical perspective of gender: Feminism and emergence of gender as a concept,	3
		2	Scope of gender studies in agriculture and rural development	3
	UNIT II Agrarian Importance of Gender	3	Agrarian Importance of Gender: Understanding the importance of gender in national and global agriculture	3
		4	Key gender issues and challenges in agriculture	6
		5	Gender and value chain	3
		6	Global actions to address gender-needs and strategies to address gender and women empowerment.	3
2 Gender Related Concepts, Analysis, Gender and Technology	UNIT I Gender Related Concepts and Divides	7-8	Understanding of the concepts of gender, gender equality and equity, gender balance, gender blindness, gender relations, gender neutrality, gender bias and discrimination, gender rights, gender roles and responsibilities.	6
		9	Gender budgeting,	3
		10-11	Gender divides and their implications such as gender digital divide, gender access to resources and inputs divide, gender mobility divide, gender wage divide,	4
		12	Gender needs: practical and strategic.	4
	UNIT II Gender Analysis	13	Gender analysis: Importance, usage, prerequisites, techniques of gender analysis	4
		14-15	Tools for gender analysis.	6
	UNIT III Gender and Technology	16-17	How gender and technology impact each other, Gender neutral technology, Gender sensitive technology,	6
		18-19	Gender supportive assistance in technology adoption- Gender in agricultural research and extension.	5
3 Gender Mainstreaming and Women Empowerment	UNIT I Gender Mainstreaming	20-21	Importance of gender mainstreaming in agriculture, Extension strategies to address gender issues such as gender and health, nutrition, gender in agricultural value chains, gender and climate change adaptation, gender and globalization& liberalization	5
		22-23	Strategies/Tools for mainstreaming gender concerns into the national programmes and policies	5
	UNIT II Women Empowerment	24	Importance of women empowerment, Current national women empowerment and gender indices.	4
		25	Women empowerment approaches (technological, organizational, political, financial, social, legal and psychological),	5
		26	Case studies based on experiences and learning from various development and rural development programmes	2

	UNIT III Global Best Practices, Policies and Frameworks	27-28	Global best practices, women empowerment and gender mainstreaming models and frameworks for addressing gender concerns in agriculture, approaches of various organizations.	6
		29	Gender mainstreaming and special women focused programmes in agriculture and rural development.	4
	UNIT IV Entrepreneurship Development for Women	30-31	Women entrepreneurship development in agriculture and agro processing: current status, women led enterprises, supporting organizations and schemes,	6
		32	Govt. policies, entrepreneurship development programme and process for women in agriculture.	4

Practical

- Visit to a village for understanding rural gender roles and responsibilities as groups, followed by class presentation by groups
- Exercise for capturing shifts in gender roles and responsibilities
- Conducting gender analysis in a village using gender analysis techniques
- Visit to agencies supporting women empowerment followed by report presentation. (Each student to visit a different organization such as State Rural Livelihood Mission, Women Development Corporation, Department of Agriculture, Important NGOs working for women empowerment)
- Exercise for identification and prioritization of issues affecting/needs for women empowerment
- Interaction with a successful women entrepreneur/ SHG

Suggested Readings

AGRIPROFOCUS 2014. Gender in value chains Practical toolkit to integrate a gender perspective in agricultural value chain development https://agriprofocus.com/upload/ToolkitENGender_in_Value_ChainsJan2014compressed1415203230.pdf

Christine J, Nafisa F and Taylor DS. 2014. Gender and Inclusion Toolbox: Participatory Research in Climate Change and Agriculture. Global Forum for Rural Advisory Services, Switzerland. http://www.gfras.org/en/component/phocadownload/category/17-gender.html?download=456:gender-and-inclusion-toolbox-participatory-research-in-climate-change-and-agriculture

Colverson KE. 2015. Gender into Rural Advisory Services. Global Forum for Rural Advisory Services, Switzerland. http://www.g-fras.org/en/good-practice-notes/integrating-gender-into-rural-advisory-services.html#SNote1

Cristina M, Deborah R, Andrea A, Gale S, Kathleen C and Mercy A.2013. Reducing the Gender Gap in Agricultural Extension and Advisory Services: How to find the best fit for men and women farmers MEAS Discussion Paper 2, Modernizing Extension and Advisory Services. https://meas.illinois.edu/wp-content/uploads/2015/04/Manfre-et-al-2013-Gender-and-Extension-MEAS-Discussion-Paper.pdf

Fanzo, J., Marshall, Q., Wong, J., Merchan, R., Haber, M., Souza, A. &Verjee, N. 2015. The Integration of Nutrition into Extension and Advisory Services: A Synthesis of Experiences, Lessons, and Recommendations. Food and Nutrition Bulletin 36(2): 120-137. https://journals.sagepub.com/doi/10.1177/0379572115586783

FAO. 2011. Gender and agricultural value chains A review of current knowledge and practice

and their policy implications. ESA Working Paper No. 11-05 (March 2011) http://www.fao.org/docrep/013/am310e/am310e00.pdf
GFRAS. 2013. Gender equality in Rural Advisory Services, Towards a Common Understanding. Global Forum for Rural Advisory Services, Switzerland. http://www.g-fras.org/en/component/phocadownload/category/17-gender.html?download=169:gender-equality-in-rural-advisory-services-towards-a-common-understanding
GFRAS. 2013. Gender equality in Rural Advisory Services. Global Forum for Rural Advisory Services, Switzerland. http://www.g-fras.org/en/component/phocadownload/category/17-gender.html?download=180:gender-equality-in-rural-advisory-services
GFRAS. Gender in Extension and Advisory Services, Module 12, GFRAS New Extensionist Learning Kit (NELK). Global Forum for Rural Advisory Services. https://ingenaes.illinois.edu/wp-content/uploads/GFRAS_NELK_Module12_Gender-Manual-2.pdf
GFRAS. 2018. Nutrition-Sensitive Extension. Module 16, GFRAS New Extensionist Learning Kit (NELK). Global Forum for Rural Advisory Services. http://www.g-fras.org/en/component/phocadownload/category/70-new-extensionist-learningkit-nelk.html?download=713:module-16-nutrition-sensitive-extension
GIZ. 2013. Gender and Agricultural Extension. https://www.giz.de/fachexpertise/downloads/giz2012-en-gender-and-agricultural-extension.pdf
Grover I and Grover D. 2002. Empowerment of Women. Agrotech Publishing Academy.
JAEE (Editorial article). 2013. Gender Inequality and Agricultural Extension. The Journal of Agricultural Educatiion and Extension Vol 19 (5) 433-436.
Jaiswal S. 2013. Research Methodology in Gender Studies. Maxford Dynamic Series: 1-296.
Jessica F. 2015. Integrating Nutrition into Rural Advisory Services and Extension. Global Forum
for Rural Advisory Services, Switzerland.
https://www.g-fras.org/en/download.html?download=344: ggp-note-9-integrating-nutrition-into-rural-advisory-services-and-extension
Liz P. 2018. Implementing Gender Transformative Approaches (GTAs) in Agricultural Initiatives.
IGENAES and USAID.
https://ingenaes.illinois.edu/wp-content/uploads/ING-DP-2018_06-Gender-Transformative-Approaches-in-Agricultural-Initiatives-Poulsen.pdf
Michele MT and Kathleen C. 2014. Increasing access to agricultural extension and advisory services: How effective are new approaches in reaching women farmers in rural areas? International Livestock Research Institute.
http://www.gfras.org/en/component/phocadownload/category/17-gender.html?download=183:increasing-access-to-agricultural-extension-and-advisory-services-how-effective-are-new-approaches-in-reaching-women-farmers-in-rural-areas
Pena I and Garrett J. 2018. Nutrition-sensitive value chains-A guide for project design. International Fund for Agricultural Development (IFAD).
https://www.ifad.org/documents/38714170/40804965/NSVC+A+guide+for+project+design+-
+Vol.+I.+Web+filepdf.pdf/5177a3c0-a148-4b1f-8fff-967a42f51ce8
Ponnusamy K and Sharma P. 2015. Gender Sensitization for Development. NDRI Publ.No.130/
2015.

Porter F, Smyth I and Sweetman C. 1999. Gender works: Oxfarm Experience in Policy and Practice. Oxfarm Publ.
Raj MK. 1998. Gender Population and Development. Oxford Univ. Press.
Rhoda MM and Kabisa M.2016. Analysis of Indicators and Management Tools Used in Zambia
to assess impact of Agricultural Extension Programmes on Gender Equity and Nutrition Outcomes.
https://ingenaes.illinois.edu/wp-content/uploads/ING-DP-2016_12-Measuring-Impact-of-Tools-in-Zambia-on-G-and-N_IAPRI-Mofya-Mukuka-Kabisa.pdf
Sahoo RK and Tripathy SN. 2006. SHG and Women Empowerment. Anmol Publ.
Sinha K. 2000. Empowerment of Women in South Asia. Association of Management Development
Institute in South Asia, Hyderabad.

Websites

AESA- Agricultural Extension in South Asia– http://www.aesanetwork.org/
GFRAS- Global Forum for Rural Advisory Services– http://www.g-fras.org/en/
INGENAES- Integrating Gender and Nutrition within Agricultural Extension Services– https://www.agrilinks.org/activities/ingenaes-integrating-gender-and-nutrition-within-agricultural-extension-services
RRW- Reaching Rural Women– http://www.reachingruralwomen.org/
UN WOMEN– http://www.unwomen.org/en

Ph.D. (Agri.) Agricultural Extension Education
Course Contents

EXT 601 Policy Engagement and Extension2+1

Aim of the course

- To orient students on the importance of policies in shaping extension's performance
- To discuss ways of generating policy relevant evidence to influence policies
- To develop capacities to engage with policy actors and the policy development process

Theory

Block 1: Why Policies Matter?

Unit 1: Understanding Policy

Why policies are important for extension? Role in providing structure, ensure funding and framework for providing functions-examples; Policy: definitions and types: Is policy a product or a process or both? Policies and institutions-How these influence defining organisational roles and performance in extension organizations Role of policies in upscaling knowledge-Role of extension in influencing policies to enable innovation.

Unit 2: Policy Advocacy and Tools

Definition of advocacy, Approaches to policy advocacy-Advising, Media campaigning, Lobbying, Activism, Information Education Communication (IEC) and Behavior Change Communication (BCC); Advocacy for Rural Advisory Services (RAS); Policy advocacy strategy

Unit 3: Policy Analysis

Explain the meaning and use of policy analysis in decision- making; Describe different types of policy analysis- empirical, evaluative or normative policy analysis, retrospective/ prospective policy analysis, predictive/prescriptive/descriptive policy analysis; How to do policy analysis? - understand the process of policy analysis, highlight the different methods and techniques used in policy analysis, doing ethical policy analysis; Tools for policy impact-research tools, context assessment tools, communication tools, policy influence tools

Unit 4: Policy Development Process

Policy development process: Who drives policy change?: National Governments, Donors, Civil Society-varied experiences: Understanding the environment and key actors in policy space-problem identification-policy adoption, implementation and evaluation; stakeholder mapping, identifying opportunities and barriers, mobilising financial resources; Dealing with policy incoherence: identifying contradictions and challenges in policy implementation

Block 2: Using Evidence to Influence Policy Change

Unit 1: Influencing Policy Change

Generating evidence: Role of policy research; analyzing the usefulness and appropriateness of the evidence; Using evidence in policy advocacy; Understanding your audience: analyzing channels of influence; creating alliances; identifying policy champions; Defining goals and objectives; Developing advocacy messages: Policy papers, Policy briefs, good practice notes, etc.: Good practices in influencing policies Organising policy dialogues: Policy engagement strategy-Engaging with policy makers: GO and NGO experiences; Policy working groups; advisory panels; use of committees: Use of media including ICTs and social media for influencing policies.

Unit 2: Global Experience with Extension Policy

Extension policy in different countries: Explicit extension policy Vs extension as part of Agriculture Policy, Challenges in policy implementation: lack of capacities, financial resources, ownership, lack of stakeholder consultations: Strengthening capacities in extension

to influence policies: Global Forum for Rural Advisory Services (GFRAS)'s efforts in strengthening extension policy advocacy: policy compendium, training modules, training for strengthening capacities to influence policies.

Practicals

- Analysis of country/state level agricultural/extension policy to understand the policy intentions from strengthening EAS
- Analysis of extension policy of other countries: policy intentions, processes adopted in development of the policy and mechanisms of policy implementation
- Interview key policy actors in EAS arena at the state/national level (eg: Director of Agriculture, Director of Extension in SAU, Chairman/Managing Director of Commodity Board. Member Agriculture, State Planning Board) to explore policy level challenges in EAS
- Identify what evidence policy makers look for from extension research? Is the evidence available? If so what form? (Reports, Briefs etc), If not, develop a plan
- Explore how different stakeholders influence policies (eg: policy advocacy of prominent NGOs, private sector and public sector) -What mechanisms and tools they use
- Identify policy level bottlenecks that constrain effective EAS delivery at the district level-Eg: Issues around linkages between KVK and ATMA; inter-departmental collaboration; public private partnerships; joint action etc.

Teaching Schedule

Sr. No.	Topic	No. of Lecture (s)
	Block 1: Why Policies Matter?	
	Unit 1: Understanding Policy	
1	Why policies are important for extension? Role in providing structure, ensure funding and framework for providing functions-examples	**1**
2	Policy: definitions and types: Is policy a product or a process or both? Policies and institutions-How these influence defining organisational roles and performance in extension organizations	**2**
3	Role of policies in upscaling knowledge-Role of extension in influencing policies to enable innovation	**2**
	Unit 2: Policy Advocacy and Tools	
4	Definition of advocacy	**2**
5	Approaches to policy advocacy-Advising, Media campaigning, Lobbying, Activism, Information Education Communication (IEC) and Behavior Change Communication (BCC)	
6	Advocacy for Rural Advisory Services (RAS)	**1**
7	Policy advocacy strategy	**1**
	Unit 3: Policy Analysis	
8	Explain the meaning and use of policy analysis in decision- making	**1**
9	Describe different types of policy analysis- empirical, evaluative or normative policy analysis, retrospective/ prospective policy analysis, predictive/prescriptive/descriptive policy analysis	**2**

10	How to do policy analysis? - understand the process of policy analysis, highlight the different methods and techniques used in policy analysis, doing ethical policy analysis	**2**
11	Tools for policy impact- research tools, context assessment tools, communication tools, policy influence tools	**2**
	Unit 4: Policy Development Process	
12	Policy development process	**1**
13	Who drives policy change?: National Governments, Donors, Civil Society-varied experiences	**1**
14	Understanding the environment and key actors in policy space-problem identification-policy adoption, implementation and evaluation; stakeholder mapping, identifying opportunities and barriers, mobilising financial resources	**2**
15	Dealing with policy incoherence: identifying contradictions and challenges in policy implementation	**2**
	Block 2: Using Evidence to Influence Policy Change	
	Unit 1: Influencing Policy Change	
16	Generating evidence: Role of policy research; analyzing the usefulness and appropriateness of the evidence; Using evidence in policy advocacy;	**1**
17	Understanding your audience: analyzing channels of influence; creating alliances; identifying policy champions; Defining goals and objectives	**1**
18	Developing advocacy messages: Policy papers, Policy briefs, good practice notes, etc.: Good practices in influencing policies	**1**
19	Organising policy dialogues: Policy engagement strategy-Engaging with policy makers: GO and NGO experiences; Policy working groups; advisory panels; use of committees	**1**
20	Use of media including ICTs and social media for influencing policies	**1**
	Unit 2: Global Experience with Extension Policy	
21	Extension policy in different countries	**1**
22	Explicit extension policy Vs extension as part of Agriculture Policy	**1**
23	Challenges in policy implementation: lack of capacities, financial resources, ownership, lack of stakeholder consultations	**1**
24	Strengthening capacities in extension to influence policies	**1**
25	Global Forum for Rural Advisory Services (GFRAS)'s efforts in strengthening extension policy advocacy: policy compendium, training modules, training for strengthening capacities to influence policies	**1**
	TOTAL	**32**

Practicals

Sr. No.	Topic	No. of Practical (s)
1	Analysis of country/state level agricultural/extension policy to understand the policy intentions from strengthening EAS	**2**

2	Analysis of extension policy of other countries: policy intentions, processes adopted in development of the policy and mechanisms of policy implementation	**2**
3	Interview key policy actors in EAS arena at the state/national level (eg: Director of Agriculture, Director of Extension in SAU, Chairman/Managing Director of Commodity Board. Member Agriculture, State Planning Board) to explore policy level challenges in EAS	**4**
4	Identify what evidence policy makers look for from extension research? Is the evidence available? If so what form? (Reports, Briefs etc), If not, develop a plan	**2**
5	Explore how different stakeholders influence policies (eg: policy advocacy of prominent NGOs, private sector and public sector) - What mechanisms and tools they use	**3**
6	Identify policy level bottlenecks that constrain effective EAS delivery at the district level- Eg: Issues around linkages between KVK and ATMA; inter-departmental collaboration; public private partnerships; joint action etc	**3**
	TOTAL	16

Suggested Reading

AEPF. 2015. Report on the Policy Forum by Ghana Directorate of Agricultural Extension Services, Ministry of Food and Agriculture; Modernizing Extension and Advisory Services and Agriculture Policy Support Project, Ghana.

http://www.g-fras.org/en/knowledge/documents/category/18-policy.html?download=490: report-on-the-ghana-agricultural-extension-policy-forum-2015

Amosa, MDU. 2018. Policy Analysis and Engagement Toolkit. A guide for Pacific Non-government Organizations in the Fisheries Sector.WWF. http://d2ouvy59p0dg6k.cloudfront.net/downloads/policy_analysis_toolkit_quality.pdf

Anonymous.N.d. Policy analysis. http://www.egyankosh.ac.in/bitstream/123456789/25760/1/Unit-19.pdf

Anonymous. N.D. Policy analysis. https://web.csulb.edu/~msaintg/ppa670/670steps.htm

Bardach E. A Practical Guide for Policy Analysis The Eightfold Path to More Effective Problem Solving Fourth Edition. Sage Publications. CQ Press. http://dlib.scu.ac.ir/bitstream/Ebook/32773/2/9781608718429.pdf

Cairney P. 2015. Chapter 2: Policymaking in the UK: What is Policy and How is it Made?. Policy and Policymaking in the UK. https://paulcairney.files.wordpress.com/2013/08/chapter-2-20-8-13-cairney-policypolicymaking-uk.pdf

CRISP, MANAGE and ICAR-ATARI.2016. Training cum workshop on Strengthening Extension Policy Interface at MANAGE on 9-11th Nov, 2016 in collaboration with the CRISP & ICARATARI, Bangalore. http://crispindia.org/index.php/events/

DAC. 2000. POLICY FRAME WORK FOR AGRICULTURAL EXTENSION. Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India https://sameti.org/Policy%20Framework%20for%20Agricultural%20Extension.pdf

DAFF.n.d. National Policy on Extension and Advisory Services for Agriculture, Forestry and Fisheries. Department of Agriculture, Forestry and Fisheries, Republic of South Africa. https://www.daff.gov.za/doaDev/topMenu/National%20Policy.pdf

Douglas JA.1984. Why policy analysis and ethics are incompatible. Journal of Policy Analysis and Management. https://doi.org/10.1002/pam.4050030407

Dube L, Nii A Addy, Blouin C and Drager N. 2014. From policy coherence to 21st century convergence: A whole-of-society paradigm of human and economic development. Annals of the New York Academy of Sciences. 1331: 201–215. https://nyaspubs.onlinelibrary. wiley.com/doi/epdf/10.1111/nyas.12511

FAO. 2013. FAO Policy on Gender Equality. Attaining Food Security Goals in Agriculture and Rural Development. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/017/i3205e/i3205e.pdf

FAO. 2018. Policy Guidance Series. Strengthening Sector Policies for Better Food Security and Nutrition Results. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/publications/policy-guidance-series/en/

FOS. 2006. Tracking the Impact of Policy Strategies in Conservation Work. Foundations of Success. Prepared for The Nature Conservancy's Global Conservation Approach Team. https://www.cbd.int/doc/pa/tools/Tracking%20the%20Impact%20of%20Policy%20 Strategies% 20in%20Conservation%20Work%20.pdf

GFRAS. 2018. RAS Policy Compendium. Global Forum for Rural Advisory Services, Switzerland. http://compendium.g-fras.org/

GoI. 2011. Report of the Working Group on Agricultural Extension for Agriculture and Allied Sectors for the Twelfth Five Year Plan (2012-17), Section V-Recommendations IV,73-74. http://planningcommission.gov.in/aboutus/committee/wrkgrp12/agri/wg_ agriextn.pdf

GoK. 2012. National Agricultural Sector Extension Policy (NASEP), Government of Kenya https://www.kenyamarkets.org/wp-content/uploads/2016/06/National-Agricultural-SectorExtension-2012.pdf

Howlett, M. 2005. What is a policy instrument? Tools, mixes, and implementation styles. Designing Government: From Instruments to Governance. 31-50. https://www.researchgate.net/publication/285756495_What_is_a_policy_instrument_ Tools_ mixes_and_implementation_styles

IFAD. 2017. Country-level policy engagement in IFAD Guide book. International Fund for Agricultural Development. https://www.ifad.org/documents/38714170/39144386/CLPE_book_170412_W.pdf/a203813d8918-43ac-a94c-ad700bcca036

IFAD. 2017. How to incorporate policy engagement into a Country Strategic Opportunities Programme (COSOP)-Country-level policy engagement toolkit. International Fund for Agricultural Development. https://www.ifad.org/documents/38714170/39144386/CLPE_HTDN_COSOP_web.pdf/ 1037e846-dcd3-4c7d-9764-edc08eb4950b

John Y, Shaxson L, Jones H, Hearn S, Datta and Cassidy C. 2014. Rapid Outcome Mapping Approach. A guide to policy engagement and influence. Overseas Development Institute. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9011.pdf

Klaus von Grebmer. 2014. Converting Policy Research into Policy Decisions: The Role of Communication and the Media. IFPRI.

https://www.ifpri.org/cdmref/p15738coll2/id/64522/filename/64523.pdf

March SP, Pannell DJ. 2000. Agricultural Extension Policy in Australia: the good, the bad and the misguided. The Australian Journal of Agricultural and Resource Economics. 44: 4, 605-627. http://ageconsearch.umn.edu/bitstream/117854/2/1467-8489.00126.pdf

Michael Mintrom. n.d. Public Policy: Why ethics matters. Doing ethical policy analysis. http://press-files.anu.edu.au/downloads/press/p80991/html/ch03.xhtml?referer=375&page=6

MoA&FW.2017. Report of the Committee on Doubling Farmers' Income: Empowering the Farmers through Extension and Knowledge Dissemination, Volume XI, Ministry of Agriculture & Farmers Welfare, New Delhi. http://agricoop.gov.in/sites/default/files/DFI%20Volume%2011.pdf

MoAFF. 2015. Agricultural Extension Policy in Cambodia. Ministry of Agriculture, Forestry, and Fisheries. http://extwprlegs1.fao.org/docs/pdf/cam152453.pdf

MoAF. 2008. Policy Framework for Agricultural Extension in Timor Leste, Agricultural Rehabilitation Project III, Ministry of Agriculture and Fisheries, Dili, Timor Leste. https://g-fras.org/en/2015-05-28-15-50-27/australia-20.html?download=329: policyframework-for-agricultural-extension-in-timor-leste

MoAA&HF. 2016. National Agricultural Extension Policy of Uganda, Ministry of Agriculture, Animal Industry and Fisheries, The Republic of Uganda. https://nutrition.opm.go.ug/wp-content/uploads/2017/06/National-Agriculture-ExtensionPolicy.pdf

Mwamakamba S. 2016. Policy Advocacy for Rural Advisory Services. Module 15. New Extensionist Learning Kit. Global Forum for Rural Advisory Services. http://www.g-fras.org/en/component/phocadownload/category/70-new-extensionist-learningkit-nelk.html?download=664: module-15-policy-advocacy-for-rural-advisory-servicesmanual5

NAEP. 2012. National Agricultural Extension Policy. Government of the People's Republic of Bangladesh. Ministry of Agriculture. https://dae.portal.gov.bd/sites/default/files/files/dae.portal.gov.bd/page/dd7d2be1_aeef_ 452f_9774_8c23462ab73a/National%20Agricultural%20Extension%20Policy_%28NAEP %29.pdf

Nicholas J Sitko, Babu S, and Hoffman B. 2017. Practitioner's Guidebook and Toolkit for Agricultural Policy Reform: The P.M.C.A. Approach to Strategic Policy Engagement. Research Paper 49. Feed the Future Innovation Lab for Food Security Policy. https://www.ifpri.org/cdmref/p15738coll2/id/131127/filename/131338.pdf

ODI. 2004. Bridging Research and Policy in International Development- An analytical and practical framework. Briefing Paper. Overseas Development Institute. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/198.pdf

Paul A S. 1987. Knowledge, Policy-Oriented Learning, and Policy Change: An Advocacy Coalition Framework. Science Communication8: 649. DOI: 10.1177/0164025987008004005 https://dokumen.tips/download/?url=540f2870a41d106fd6b4f488025fcae1a3d2b6e30f47 a1fd4b24faa014d1faffa8761297009947bbedc0238800f8002c059c70b2b1822c9073b4228fc10d1c70EclGpe0XdPZz3Xvyo6vyP75kIJsIt/ulHaimMrK38Q9TGEL0at8BX9Dj

dER/8RDlh/DJpiqGHeJfRq+6GbXfimIiyR27rnjntLue4IInS63ip3IBqRfUlemI+oBl1SIJ

Picciotto. R. 2004. Policy Coherence and Development Evaluation Concepts, Issues and Possible Approaches. OECD. http://www.oecd.org/pcd/31659358.pdf

Richard KC.2014. Policy Analysis for Social Workers. Sage Publication. http://dx.doi.org/10.4135/9781544303550

Sharma R.2002. Reforms in Agricultural Extension: New Policy Framework. Economic and Political Weekly. Vol. 37, No. 30 pp. 3124-3131. https://www.epw.in/journal/2002/30/review-agriculture-review-issues-specials/reforms- agricultural-extension.html

Sprechmann. S and Pelton. E 2001. Advocacy Tools and Guidelines Promoting Policy Change. Cooperative for Assistance and Relief Everywhere, USA. https://onthinktanks.org/wp-content/uploads/2016/01/CARE_Advocacy_Guidelines.pdf

Start D and IngieHovland. 2004. Tools for Policy Impact: A Handbook for Researchers. Overseas Development Institute. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/194.pdf

Sulaiman RV and Hall A. 2005. Extension Policy at the National Level in Asia. Plant Production Science Vol 8, 308-319. https://www.tandfonline.com/doi/pdf/10.1626/pps.8.308

Sulaiman RV. 2014. How to Develop and Implement Extension Policies? Lessons from Four Australasian Countries. Global Forum for Rural Advisory Services, Switzerland http://compendium.g-fras.org/component/phocadownload/category/27-checklists-stepwiseapproaches.html?download=263: how-to-develop-and-implement-extension-policies-lessonsfrom-four-australasian-countries

The Policy Project. 1999. Networking for Policy Change An Advocacy Training Manual. The Futures Group International, Research Triangle Institute (RTI) and The Centre for Development and Population Activities (CEDPA). http://www.policyproject.com/pubs/AdvocacyManual.pdf

EXT 602 Methodologies for Social and Behavioural Sciences 2+1

Why this course?

In general, social and behavioural science research plays a crucial role in the professional development in a subject domain, through advancing knowledge and developing working modalities and standards. Precisely, the empirical research helps to develop robust and outcome focused working strategies, processes and models to enable the professionals to maximise their efficiency. This course on advanced social science research caters to the need to equipping the scholars with essential skills in conducting high quality research which helps them to design working strategies, processes and models for professional development. V. Aim of the course This course aims to equip the doctoral students to conduct outcome-oriented social and behavioural science research and to develop sound field focused extension strategies and models with adequate replicability, while advancing knowledge on processes governing

success of those strategies. The focus of the course is on equipping the scholars with advanced capacities in conducting systematic, objective and outcome oriented research by applying state-of-art methods and tools at every stage of research from planning to publishing. The course is organized as follows:

Block Number	Lecture Number	Topic	Weightage	Total
Block 1: Advanced Methods for Improving Quality of Research Data	**Unit 1: Measurement Properties of Research Instruments**			
	1-2	Measurement properties – Dimensionality, reliability and validity; Dimensionality – Unidimensionality and multidimensionality, Methods of assessing dimensionality, Formative and reflective constructs; Validity - Importance, Internal validity - face validity; content validity, Substantive Validity, Structural Validity; External validity - Convergent and Discriminant Validity, known-group validity, Criterion-Related Validity, Consequential Validity,	10	10
	3-4	Nomological validity; Methods of assessing various forms of validities – Judges rating, Lawshe's Content Validity Ratio, Item-objective congruence index; latent variable method; Reliability - Internal consistency reliability – Split-Half, Cronbach alpha; Temporal Stability reliability - test-retest method; Interrater Consistency and Consensus – inter rater reliability and interrater agreement; Alternative Forms or parallel forms reliability – Reliability of difference - Factors Affecting the Validity and Reliability of Test Scores; Generalizability Theory	10	10
	Unit 2: Threats to Data Quality			
	4	Errors and biases; Errors – Meaning and sources; Types - Sampling error, Nonsampling or measurement error and Processing error – Meaning, causes; Effects of errors and biases on data quality;	05	05
	5	Bias in behavioural research – Meaning, causes, Types – Respondent and researcher biases; Methods of reducing errors and biases in surveys, questionnaires, personal interviews, focus groups and online methods	05	05

Block 2: Scales, Indexes and Tests	**Unit 1: Scales, Indexes and Tests-1**			
	6	Approaches to measurement and scale development - Classical test theory. Formative or index models, The C–OAR–SE approach and Item Response Theory; Item analysis in Classical test theory – item difficulty and item discrimination;	05	05
	7	Scoring performance in scales and tests – meaning, types and methods; Scale development strategies – deductive and empirical; Stimulus-centred scales – method of equally appearing intervals, paired comparison, Person scaling – Q methodology; Subjectcentre scales – The Likert scale and Semantic Differential	05	05
	Unit 2: Scales, Indexes and Tests-2			
	8	Steps in constructing a multi-dimensional scale using confirmatory factor analysis,; Response scales - Guttman's scalogram analysis and The Rasch method; Indexes – Meaning, types, importance; Similarities and differences with scales, Methods of constructing indexes; Common indexes used in extension.	05	05
	9	Measurement invariance –Meaning, types, methods of assessing measurement invariance. Tests – meaning, types, importance; steps in conducting various tests – knowledge test	05	05
Block 3: Emerging Research Approaches and Designs	**Unit 1: Qualitative Research Methods**			
	10	Qualitative methods – Meaning; Types – Ethnography, Grounded theory, Phenomenology, Ecological psychology, Discourse Analysis; Observational research; Case study research Sampling and sample size; Data collection methods - Indepth interviews, Focus groups, Direct observation, Record review; Content analysis; Unobtrusive Measures; Projective and semi-projective techniques;	10	10
	11	Selecting right qualitative method – Strengths and limitations of qualitative research; Analysis and interpretation of qualitative research data; Research synthesis – meaning, importance, methods; Systematic reviews and meta analysis – meaning, steps, and applications; Policy research	10	10

	Unit 2: Emerging Approaches			
	12	Mixed methods research – meaning, purpose, types and applications; Participatory research – Meaning, importance, types, methods and tools and applications; Action research – Meaning, importance, Principles, Types, Steps in conducting action research, application in behavioural sciences	05	05
	13	Social Network Analysis – Meaning, importance, types, steps in social network analysis, applications; Advanced methods of measuring perception and beliefs. Multi criteria decision making, analytical hierarchy approach	10	10
Block 4: Utilising Research Outputs	**Unit 1: Publishing Research**			
	14	Scholarly communication process; Research reports – Meaning, types, contents; Presentations – Meaning, types, principles of good presentation - Tell 'Em" and KISS 'Em" principles	05	05
	15	Research publications – meaning, importance, types; Guidelines for preparing research papers - Peer review process, citation styles; Open access publishing; Publishing in social media. Software in academic writing	05	05
	Unit 2: Ethics in Extension Research			
	16	Ethics in conducting behavioural research; Human subject research – Meaning, history, and ethical guidelines; Ethical aspects of collecting and using Indigenous knowledge and farmers technologies; Ethical practices in publishing; Plagiarism – meaning, sources, Identifying and correcting plagiarism in a research paper using anti-plagiarism software	05	05

Practicals

- Practice in developing research instruments
- Methods of assessing measurement properties of research instruments - dimensionality, reliability and validity
- Hands-on exercise in minimising errors and biases
- Hands-on experience in constructing tests, scale and indexes
- Practice in summated scale development using confirmatory factor analysis
- Hands on experience in assessing measurement invariance

• Practicing and collecting data using participatory tools and techniques, analyzing and interpreting qualitative data
• Hands-on experience in writing systematic review using meta-analysis
• Field practice in conducting action research
• Practical experience in writing research paper
• Hands on exercises using software for qualitative data analysis
• Practice in detecting and correcting plagiarism using software

Teaching methods/activities

– Lecture – Assignment (Reading/Writing)
– Student presentation
– Group Work
– Guest Lectures
– Research Report (Writing)

Learning outcome

– The scholars should develop critical skills in conducting systematic and objective research by using robust methods while minimising biases and errors
– The students should intelligently choose and apply advanced methods and tools at every stage of research and execute them in a objective way by managing the actors and processes effectively
– The students should develop expertise in designing tests, scales and indexes along with other tools to measure the socio-psychological processes at individual, group and community levels

Suggested Reading

Berg B. 2009. Qualitative Research. Methods for the Social Sciences. Boston: Allyn& Bacon.
Creswell JW .2007. Qualitative inquiry and research design: Choosing among five approaches (2nd ed.). Thousand Oaks, CA: SAGE Pub.
Edwards AL. 1957. Techniques of attitude scale construction. East Norwalk, CT, US: Appleton Century-Crofts.
Furr, RM. 2011. Scale construction and psychometrics for social and personality psychology. Los Angeles: SAGE Pub.
Malhotra, NK. 2010. Marketing research: An applied orientation. Sixth Edition. Upper Saddle River, NJ: Prentice Hall Pub.
Netemeyer R G, Bearden WO and Sharma S. 2003. Scaling procedures: issues and applications. Thousand Oaks: SAGE Publications.
Nunnally, JC, and Bernstein IH. 1994. Psychometric theory (3rd ed.). New York, NY: McGraw Hill Rao, C.R. and Sinharay S. 2007. Handbook of Statistics, Vol. 26: Psychometrics, The Netherlands; Elsevier Science B.V.
Raykov T and Marcoulides GA. 2010. Introduction to Psychometric Theory. New York, NY: Taylor & Francis

Scott J and Carrington PJ. 2011. The SAGE handbook of social network analysis. London: SAGE.
Sekaran U and Bougie R. 2013. Research Methods for Business A Skill-Building Approach. 6th Edition, Wiley, New York.
Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. Good Practices in Agricultural extension Research. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia. Centre for research on innovation and science and policy (CRISP), Hyderabad. India. http://www.aesanetwork.org/ wp-content/uploads/2018/07/6.pdf

EXT 603 Technology Commercialization and Incubation 2+1

Aim of the course

This course is aimed to develop a critical understanding among extension students about how the technology commercialization process is linked to IPR management and entrepreneurship development

Theory

Block 1: Technology Commercialization and the Modern Context

Unit 1: Basics of technology commercialization

Technology - Definition, functions, process of technological advancement – invention, discovery, innovation and technology; types of innovation - Basic research, Breakthrough innovation, Disruptive Innovation and Sustaining Innovation; Technology transfer and commercialisation

Unit 2: Nature of Agricultural Technology

Agricultural technology – meaning, types; technology generation system; technology life cycle

Unit 3: Basics of Technology transfer and commercialisation

Technology transfer Vs Commercialisation; Technology commercialisation process – elements, models, systems and processes; Technology transfer model – research, disclosure, development and commercialisation

Block 2: Intellectual Property Resources (IPR) Management

Unit 1: Overview of Intellectual Property Resources

Introduction to IPR; Overview & Importance; Genesis; IPR in India and IPR abroad; Patents, copyrights, trademarks & trade secrets, geographical indication, industrial design; Emergence of IPR Regimes and Governance Frameworks - Trade-Related Aspects of Intellectual Property Rights (TRIPS), Convention on Biological Diversity (CBD), Cartagena Protocol, International Union for Protection of New Plant Varieties (UPOV), and BIMSTEC.

Unit 2: Systems for Protecting IP

IPR protection laws and systems – National IPR Policy; and IPR laws; procedures for filing IP protection; Systems of IP protection and management in agricultural universities and research institutions and also by stakeholders

Unit 3: Management of IPR

Mechanisms of IPR Management – Institutional arrangement, IP Management processes – invention disclosure; IP portfolio management; Infringement management

Unit 4: Protection and Management of Biological Resources

Introduction; National Biodiversity Act (2002); Protection of Plant Varieties and Farmers Rights Act (2001); Guidelines for registration and transfer of biological resources; Farmers rights; Mechanisms of documenting/ collecting, protecting and commercialising farmers varieties and other biological resources; National Biodiversity Authority, PPVFRA and other agencies involved in management of biological resources in India. Access to Genetic Resources and Sharing of Benefits

Unit 5: Protection, Management and Commercialisation of Grassroot and Farmers Innovations, Traditional and Indigenous Knowledge

Traditional and Indigenous Knowledge, Grassroot and Farmers Innovations – Meaning, forms and importance; Systems of documentation, registration, protection and commercialisation. Documentation of traditional indigenous knowledge - Traditional Knowledge Digital Library (TKDL), Community Biodiversity Registers (CBRs), People's Biodiversity Registers (PBRs), Plant Biodiversity Register, and Honeybee Network.

Unit 6: Geographical Indications (GI) and Appellation of Origin

Geographical indications and appellation of origin – meaning, origin; Geographical Indications of Goods (Registration and Protection) Act (1999); Documentation, registration and commercialisation of GI protected materials and processes.

Unit 7: Genetically Modified Organisms (GMO), Agriculture and Biosafety

The Global Concerns on Use of Genetically Modified Organisms in Food and Agriculture; The Cartagena Protocol on Bio-safety; Regulation of GMO in India - Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Bio-safety Coordination Committee (SBCC) and District Level Committee (DLC). Laws and Acts for regulation of GMO - Guidelines for Research in Transgenic Plants, 1998; Seed Policy, 2002; Plant Quarantine Order, 2003; Regulation for Import of GM Products Under Foreign Trade Policy, 2006; National Environment Policy, 2006

Block 3: Technology Commercialisation

Unit 1: Technology Assessment and Refinement

Meaning; Importance; Approaches and methods of assessment and refinement of various technologies – stakeholder oriented approaches including participatory technology assessment and refinement; assessment and refinement of traditional and indigenous knowledge and grassroot innovations

Unit 2: Technology Valuation

Returns to investment; IP Valuation-Oxford context, IP Valuation methods - Cost approach; Income approach - Discounted Cash Flow, Risk-Adjusted Net Present Value, Net Present Value with Monte Carlo Simulation and Real Options Theory; Market approach - Industry Standards Method, Rating/Ranking Method, Rules of Thumb Approach and Auction Method; Hybrid approaches; Royalty rate method

Unit 3: Technology Commercialisation Strategies

Meaning- approaches for technology commercialisation – technology scaling up, technology licensing, handholding, agripreneur development, technology business incubation

Unit 4: Scaling up of Technologies

Meaning, types and stages of technology scaling up; mechanisms

Unit 5: Technology Licensing

Meaning and types - Procedures of licensing, preparing licensing documents; Management of technology licensing process

Unit 6: Technology Takers and Entrepreneurship

Meaning; types of technology takers; Technology Taking as a Strategy; Types of entrepreneurship – agripreneurs, startups, small businesses, Producer Organizations, Self Help Groups, Clusters and other forms of entrepreneurship

Unit 7: Policy support for Technology Commercialisation and Entrepreneurship Development

Policy support for entrepreneurship development in India - National Policy on Skill Development and Entrepreneurship and other polices; Government of India Support for Innovation and Entrepreneurship – Startup India, Make in India, Digital India, Atal Innovation Mission and others; Entrepreneurship policy and schemes at different states of India; Organisations promoting entrepreneurship in India

Block 4: Technology Incubation

Unit 1: Basics of Technology Incubation

Meaning, functions and types; stakeholder oriented incubation process – Livelihood incubation, village incubators

Unit 2: Technology Incubation in India

System of technology incubation- incubation process; its effectiveness; Managing profit oriented and non-profit incubators; Schemes for promoting incubators in India

Block 5: Technology Promotion And Essential Skills For Technology Commercialisation

Unit 1: Technology Promotion

Technology promotion – meaning, types, business meetings, scientist-industry/ entrepreneur meets, technology conclave, business plan competition, farmers fairs, technology shows

Unit 2: Dealing with Entrepreneurs, Agripreneurs and Other Stakeholders

Business communication; Business Etiquette; business networking

Block 6: Emerging Approaches in Technology Commercialisation and Incubation

Unit 1: Technology Scouting

Technology Scouting and Innovations in technology incubation

Practicals

- Understanding the technology commercialization process – Visit to Technology Commercialization Unit of ICAR Institute/ Agricultural University
- Understanding the IPR protection practices – Visit to Patent Attorney office
- Hands-on experience in drafting IPR application – Patent/Copyright/ Trademark
- Understanding protection of biological resources including plant varieties – Visit to PPVFRA Branch office/ ICAR Institute or Agricultural University involved in plant variety protection
- Documenting Traditional and indigenous knowledge – Field experience in using various protocols of using traditional and indigenous knowledge
- Protecting unique local goods through Geographical Indications – Hands on experiences in documenting and registering Geographical indications
- Technology assessment/ validation of traditional and indigenous knowledge – QuIK and other methods
- Hands on experience in technology valuation
- Hands on experience in technology licensing process including drafting agreements

- Understanding the Technology Business Incubation – Visit to Agri Business Incubator or Technology Business incubator
- Hands on experience in planning and organising technology promotion events
- Hands on experience in various techniques in business communication and Business etiquette

Teaching Schedule

Sr. No.	Topic	No. of Lecture (s)
	Block 1: Technology Commercialization and the Modern Context	
	Unit 1: Basics of technology commercialization	
1	Technology - Definition, functions, process of technological advancement – invention, discovery, innovation and technology	**1**
2	Types of innovation - Basic research, Breakthrough innovation, Disruptive Innovation and Sustaining Innovation	**1**
3	Technology transfer and commercialization	
	Unit 2: Nature of Agricultural Technology	
4	Agricultural technology – meaning, types	**1**
5	Technology generation system; technology life cycle	
	Unit 3: Basics of Technology transfer and commercialization	
6	Technology transfer Vs commercialization	**1**
7	Technology commercialization process – elements, models, systems and processes	
8	Technology transfer model – research, disclosure, development and commercialization	**1**
	Block 2: Intellectual Property Resources (IPR) Management	
	Unit 1: Overview of Intellectual Property Resources	
9	Introduction to IPR; Overview & Importance; Genesis	**1**
10	IPR in India and IPR abroad	
11	Patents, copyrights, trademarks & trade secrets, geographical indication, industrial design	
12	Emergence of IPR Regimes and Governance Frameworks - Trade-Related Aspects of Intellectual Property Rights (TRIPS), Convention on Biological Diversity (CBD), Cartagena Protocol, International Union for Protection of New Plant Varieties (UPOV), and BIMSTEC	
	Unit 2: Systems for Protecting IP	
13	IPR protection laws and systems – National IPR Policy and IPR laws; procedures for filing IP protection	**1**
14	Systems of IP protection and management in agricultural universities and research institutions and also by stakeholders	
	Unit 3: Management of IPR	
15	Mechanisms of IPR Management – Institutional arrangement, IP Management processes – invention disclosure	**1**
16	IP portfolio management, Infringement management	
	Unit 4: Protection and Management of Biological Resources	
17	Introduction; National Biodiversity Act (2002)	**1**
18	Protection of Plant Varieties and Farmers Rights Act (2001)	

19	Guidelines for registration and transfer of biological resources, Farmers rights	
20	Mechanisms of documenting/ collecting, protecting and commercialising farmers varieties and other biological resources	
21	National Biodiversity Authority, PPVFRA and other agencies involved in management of biological resources in India	
22	Access to Genetic Resources and Sharing of Benefits	
	Unit 5: Protection, Management and commercialization of Grassroot and Farmers Innovations, Traditional and Indigenous Knowledge	
23	Traditional and Indigenous Knowledge	**1**
24	Grassroot and Farmers Innovations – Meaning, forms and importance; Systems of documentation, registration, protection and commercialization	
25	Documentation of traditional indigenous knowledge - Traditional Knowledge Digital Library (TKDL), Community Biodiversity Registers (CBRs), People's Biodiversity Registers (PBRs), Plant Biodiversity Register, and Honeybee Network	
	Unit 6: Geographical Indications (GI) and Appellation of Origin	
26	Geographical indications and appellation of origin – meaning, origin	**1**
	Geographical Indications of Goods (Registration and Protection) Act (1999)	
27	Documentation, registration and commercialization of GI protected materials and processes	
	Unit 7: Genetically Modified Organisms (GMO), Agriculture and Biosafety	
28	The Global Concerns on Use of Genetically Modified Organisms in Food and Agriculture; The Cartagena Protocol on Bio-safety	**1**
29	Regulation of GMO in India - Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Bio-safety Coordination Committee (SBCC) and District Level Committee (DLC)	
30	Laws and Acts for regulation of GMO - Guidelines for Research in Transgenic Plants, 1998	
31	Seed Policy, 2002; Plant Quarantine Order, 2003; Regulation for Import of GM Products Under Foreign Trade Policy, 2006; National Environment Policy, 2006	
	Block 3: Technology commercialization	
	Unit 1: Technology Assessment and Refinement	
32	Meaning; Importance	**1**
33	Approaches and methods of assessment and refinement of various technologies – stakeholder oriented approaches including participatory technology assessment and refinement	
34	Assessment and refinement of traditional and indigenous knowledge and grassroot innovations	
	Unit 2: Technology Valuation	

35	Returns to investment, IP Valuation-Oxford context	**1**
36	IP Valuation methods - Cost approach; Income approach - Discounted Cash Flow, Risk-Adjusted Net Present Value, Net Present Value with Monte Carlo Simulation and Real Options Theory, Market approach - Industry Standards Method, Rating/Ranking Method, Rules of Thumb Approach and Auction Method; Hybrid approaches; Royalty rate method	
	Unit 3: Technology Commercialization Strategies	
37	Meaning- approaches for technology commercialization – technology scaling up, technology licensing, handholding, agripreneur development, technology business incubation	**1**
	Unit 4: Scaling up of Technologies	
38	Meaning, types and stages of technology scaling up; mechanisms	**1**
	Unit 5: Technology Licensing	
39	Meaning and types - Procedures of licensing, preparing licensing documents; Management of technology licensing process	**1**
	Unit 6: Technology Takers and Entrepreneurship	
40	Meaning; types of technology takers	**1**
41	Technology Taking as a Strategy	
42	Types of entrepreneurship – agripreneurs, startups, small businesses, Producer Organizations, Self Help Groups, Clusters and other forms of entrepreneurship	
	Unit 7: Policy support for Technology Commercialization and Entrepreneurship Development	
43	Policy support for entrepreneurship development in India - National Policy on Skill Development and Entrepreneurship and other polices	**1**
44	Government of India Support for Innovation and Entrepreneurship – Startup India, Make in India, Digital India, Atal Innovation Mission and others	
45	Entrepreneurship policy and schemes at different states of India; Organisations promoting entrepreneurship in India	
	Block 4: Technology Incubation	
	Unit 1: Basics of Technology Incubation	
46	Meaning, functions and types	**1**
47	Stakeholder oriented incubation process – Livelihood incubation, village incubators	
	Unit 2: Technology Incubation in India	
48	System of technology incubation- incubation process; Its effectiveness	**1**
49	Managing profit oriented and non-profit incubators	
50	Schemes for promoting incubators in India	
	Block 5: Technology Promotion And Essential Skills For Technology Commercialization	
	Unit 1: Technology Promotion	
51	Technology promotion – meaning, types, business meetings, scientist-industry/ entrepreneur meets, technology conclave, business plan competition, farmers fairs, technology shows	**1**

	Unit 2: Dealing with Entrepreneurs, Agripreneurs and Other Stakeholders	
52	Business communication; Business Etiquette; business networking	**1**
	Block 6: Emerging Approaches in Technology Commercialization and Incubation	
	Unit 1: Technology Scouting	
53	Technology Scouting and Innovations in technology incubation	**1**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Understanding the technology commercialization process – Visit to Technology Commercialization Unit of ICAR Institute/ Agricultural University	**1**
2	Understanding the IPR protection practices – Visit to Patent Attorney office	**1**
3	Hands-on experience in drafting IPR application – Patent/Copyright/ Trademark	**1**
4	Understanding protection of biological resources including plant varieties – Visit to PPVFRA Branch office/ ICAR Institute or Agricultural University involved in plant variety protection	**2**
5	Documenting Traditional and indigenous knowledge – Field experience in using various protocols of using traditional and indigenous knowledge	**2**
6	Protecting unique local goods through Geographical Indications – Hands on experiences in documenting and registering Geographical indications	**1**
7	Technology assessment/ validation of traditional and indigenous knowledge – QuIK and other methods	**2**
8	Hands on experience in technology valuation	**1**
9	Hands on experience in technology licensing process including drafting agreements	**1**
10	Understanding the Technology Business Incubation – Visit to Agri Business Incubator or Technology Business incubator	**2**
11	Hands on experience in planning and organising technology promotion events	**1**
12	Hands on experience in various techniques in business communication and Business etiquette	**1**
	TOTAL	**16**

Suggested Reading

Bandopadhyay D. 2018. Securing Our Natural Wealth: A Policy Agenda for Sustainable Development in India and for Its Neighbouring Countries. Singapore; Springer.

Ghosh, S. and Joshi, A. 2017. Handbook for Non-Profit Incubator Managers. New Delhi: Deutsche Gesellschaftfür Internationale.

Gupta AK. 2016. Grassroots Innovation: Minds on the margin are not marginal minds. Gurgaon: Penguin Books.

ICAR.2018. ICAR Guidelines for Intellectual Property Management and Technology Transfer/ Commercialization (Revised in 2018). Indian Council of Agricultural Research, New Delhi.

Pandey N and Dharni K. 2014. Intellectual Property Rights. Delhi. PHI Learning Pvt. Ltd.

Sharma G and Kumar H. 2018. Intellectual property rights and informal sector innovations: Exploring grassroots innovations in India. The Journal of World Intellectual Property. 1- 17. DOI: https://doi.org/10.1111/jwip.12097.

Stevens AJ. 2016. Intellectual property valuation manual for academic institutions (Report No. CDIP/17/INF/4). Geneva: Committee on Development and Intellectual Property (CDIP).

WIPO and ITC. 2010. Exchanging Value – Negotiating Technology Licenses, A Training Manual. World Intellectual Property Organization (WIPO).

EXT 604 Educational Technology and Instructional Design 2+1

Why this course?

Technology, digital media and mobile access have drastically changed how people learn. And the field of education is rapidly becoming a dynamic opportunity for interactive instruction. Today's curriculum developers and instruction designers, especially in the extension and RAS ecosystem, need to equip themselves with the continuous developments in both theory and practice of instructional design so as to create satisfying learning experiences. Similarly, knowledge and skilful use of social media and disruptive technologies like internet of things (IOT), augmented reality, artificial intelligence, etc. makes this course essential for extension professionals who are expected to act as harbingers of change.

Aim of the course

The aim is to develop knowledgeable, responsive and effective teachers committed to educating diverse group of learners in a dynamic extension landscape. This course will help the learners to appreciate the role of technology in learning and how it can be integrated into instructional design to create engaging learning experience in both classroom and online learning environment. The course also aims to prepare the students as competent professionals employable in the extension and RAS providers both as specialised researchers as well as designers.

Block Number	Lecture Number	Topic	Weightage	Total
Block 1: Educational Technology	**Unit 1: The Landscape of Educational Technology and Instructional Design**			
	1-2	Understanding various terms - educational technology, instructional design, instructional systems design, curriculum design,	10	10

		pedagogy, andragogy; Brief overview of the origin and evolution of ET and ID as theory and practice		
	3-4	what is the relevance of ET and ID relevant in extension and rural advisory services? Extensional professionals as instructional designers and architects of the learning experience	10	10
	Unit 2: Theories of Learning			
	4-5	What is learning? Critical overview of Behaviorism, Cognitivism, Constructivism and Complex learning theories; instructional designers and learning theories; Types of learning or learning domains-	05	05
	6-7	Bloom's taxonomy of the cognitive domain, Krathwohl and Bloom's affective domain and Simpson's psychomotor domain	05	05
	Unit 3: Technology Enabled Learning			
	8-9	What is the role of technology in education? Digital media, new tools and technology; Open and distance Learning (ODL); Online Education - Synchronous and Asynchronous learning models; eLearning	05	05
	10-11	Massive Open Online Courses - SWAYAM, Open Education Resources (OERs), Course CERA, EduEx, CoL, RLOs; digital education and its applications in higher agricultural education; Smart classrooms and Campuses, Web-based remote laboratory (WBRL)	10	10
		Integrating media and digital tools into ID; types and implications of disruptive technologies for higher education and extension; Augmented learning; Adaptive learning; meaning, features and good practices in using open source Learning Management Systems (Moodle); Quality assurance and certification in e-learning.		

Block 2: Instructional Design	**Unit 1: Theories and Models of Instruction**			
	12-13	Howard Gardner's Theory of Multiple Intelligences, David Kolb's Experiential Learning Cycle, Albert Bandura's Social Learning Theory, Rand Spiro's Cognitive Flexibility Theory and Its Application In eLearning	05	05
	14-15	Wlodkowski's Motivational Framework for Culturally Responsive Adult Learning; ADDIE Model, Dick and Carey Model, SAM Model, Bloom's Taxonomy; integrating the theories of instruction into the practice of ID in extension and RAS ecosystem.	05	05
	Unit 2: Creating Instruction			
	16-17	Overview of planning, designing and implementing the curricula and learning experiences; Needs Analysis - meaning, approaches and steps; Task and content analysis - meaning, approaches, steps and techniques (topic analysis, procedural analysis, and the critical incident method);	10	10
	18-19	Learner analysis – meaning, importance and approaches, relevance of Maslow's Hierarchy of Needs and learning styles, Captive Audience vs. Willing Volunteers, Universal vs. user-centered design, Learner Analysis Procedures; Writing learning objectives:	05	05
	20-21	Meaning of Learning Goal and Learning Objectives; ABCDs of well-stated objectives; Setting goals, translating goals into objectives; Contextualising ADDIE process within the Extension learning environment		
	Unit 3: Instructional Strategies			
	22-23	events of instruction, Edgar Dale's Cone of Experience	05	05
	24-25	Methods of Delivery- classroom teaching, programmed instruction, synchronous and asynchronous modes of distance education;	05	05

		Changing role of a teacher in classroom and teaching competencies		
	Unit 4: Evaluating Instruction			
	26-27	Meaning of Assessment, Measurement and Evaluation; Developing learner evaluations and their reliability & validity; assessment techniques for measuring change in knowledge,	05	05
	28-29	skill and attitude of learners - Objective Test Items, Constructed-Response Tests, Direct Testing, Performance Ratings, Observations and Anecdotal Records, Rubrics, Portfolios, Surveys and Questionnaires	05	05
	30-31	SelfReporting Inventories, Interviews; Conducting learner evaluation pre-, during and post-instruction; Formative and Summative Evaluation- meaning, approaches and steps; Evaluating Learner Achievement and the Instructional Design Process; Evaluating the success of instruction; Performance appraisal of teachers	10	10
	Unit 5: Trends in Instructional Design			
	32	Alternatives to ADDIE model - Rapid prototyping and constructivist ID, reflections on instructional design as science and as an art; Relating ID models and process in extension learning environment political economy of higher education in developed and developing countries; University assessment and rating methods, returns from agricultural higher education; research in education and instructional design.	05	05

Practicals

• Exercises on preparation of the Analysis Report that includes the task/content analysis and learner analysis and the Design Plan includes learning objectives and corresponding instructional strategies and assessment items

• Prepare course outline and lesson plan with an appreciation for diverse learning styles based on temperament, gender, and cultural/ethnic differences and deliver a lecture for UG/PG students
• Assessing learning styles through Barsch and Kolb inventories
• Development and testing of survey instruments for evaluating learning outcomes/ competencies of students
• Development and testing of survey instruments for performance appraisal / competency assessment of teachers.
• Design an online e-learning module on a topic of interest as a capstone project - integrate and apply the knowledge and skills gained from the course for creating an effective learning experience for a target audience
• Designing and developing a theme based knowledge portals
• Exercises on designing an online course using open source LMS like moodle or EdX
• Select and evaluate or design for social al media
• Prepare a short research paper on recent theories and models of instructional design
• Interview an instructional designer of your choice and prepare a synthesis report about what job roles he/she perform, What ID processes does he or she use, challenges faced
• Develop a prototype for one of the lessons in your design plan using PowerPoint or a website builder such as Weebly to create the screens integrating multimedia content and various functionalities
• Field visit to a virtual learning / augmented learning labs, e-learning labs, distance learning centres, etc.
• Hands-on practice with video-editing software, web conferencing and video conferencing solutions

Teaching methods/activities

– Lectures & Videos
– Individual and group assignments
– Group discussion and debating
– Enactive learning exercises
– Case studies / Case analysis
– Storyboarding
– Guest Lectures
– Field Visits
– Capstone Project
– Prototype development

Learning outcome

After successful completion of this course, the students are expected to be able to: – Develop a critical understanding of concepts of learning and education within the context of agricultural development – Relate and apply learning theories and models to the development, design and evaluation of courses utilizing educational technology and instructional design – Hone their skills to take up research work in analysing and evaluating different learning systems, teaching-learning environments, competencies and learning outcomes – Find placement opportunities in the industry for job profiles such as e-learning specialist, training officer, curriculum developer, instructional designer, education consultant, etc.

Suggested Reading

Agarwal JC. 2007. Essentials of Educational Technology Innovations in Teaching – Learning. 2nd Ed. Vikas Publ. House.

Allen M. 2013. Leaving ADDIE for SAM: An Agile Model for Developing the Best Learning Experiences https://www.alleninteractions.com/about Anglin GJ (Ed.), 1995. Instructional technology: Past, present, and future. Englewood, CO: Libraries Unlimited.

Anonymous. 2000. Contents Pages of the Journal Educational Technology from January, 2OO0 to December, 2O15 Volume 40-Volume 55 http://publicationshare.com/pdfs/ET-Contents-Pages-2000-2015.PDF

Bandura A. 1977. Social learning theory. Englewood's Cliffs, NJ: Prentice-Hall Bandura A. 2001. Social cognitive theory: An agentic perspective. Annual Review of Psychology, 52, 1–26

Britain S. 2004. A Review of Learning Design: Concept, Specifications and Tools. A report for the JISC E-learning Pedagogy Programme, May 2004.

Brown AH and Timothy DG. 2016. The essentials of instructional design: connecting fundamental principles with process and practice, Third edition, Routledge https://ikhsanaira.files.wordpress.com/2016/05/the-essential-of-instructional-design.pdf

Challa J and Reddy NM. 2008. Education Technology for Agricultural Sciences, NAARM, Rajendra Nagar, Hyderabad, Telangana, India.

David HJ. 2003. Learning to Solve Problems: An Instructional Design Guide.

Duffy TM and Cunningham DJ. 1996. Constructivism: Implications for the design and delivery of instruction. In Jonassen D (Ed.), Handbook of Research for Educational Communications and Technology (pp. 170-198). New York:

Simon & Schuster Macmillan Edward T. 2013. Power Point Is Evil. https://www.wired.com/2003/09/ppt2/

Ellen R. 2004. Instructional Design and Curriculum Development: Deconstructing the Difference, Educational Technology, Vol. 44, No. 2 (March-April 2004), pp. 3-12. https://www.jstor.org/stable/44428883

Gardner H. 2008. Multiple intelligences: New horizons in theory and practice. New York, NY: Basic Books.

Gayle VDS, Karen LR, Patrick RL. 2018. Web-Based Learning: Design, Implementation and Evaluation, 2nd Edition

Hsu YC, Hung JL, and Ching YH. 2013. Trends of educational technology research: More than a decade of international research in six SSCI-indexed refereed journals. Educational Technology Research and Development, 61(4), 685-705. https://www. academia.edu/1141731/Aesthetic_principles_for_instructional_design? auto=download James ML. 2006. Small Teaching: Everyday Lessons from the Science of Learning

Kolb D. 2014. Experiential learning: Experience as the source of learning and development (2nd ed.). Upper Saddle River, NJ: Prentice Hall

Koper R. 2006. Current Research in Learning Design, Educational Technology & Society, 9 (1), 13–22.

Kozma RB. 1994. Will media influence learning? Reframing the debate. Educational Technology Research & Development, 42(2), 7-19.

Merrill MD, Drake L, Lacy M J and Pratt J. 1996. Reclaiming instructional design (PDF). Educational Technology. 36 (5): 5–7. Archived (PDF) from the original on 2012-04-26.

Parrish PE. 2007. Aesthetic principles for instructional design, Education Technology Research and Development, DOI 10.1007/s11423-007-9060-7

Parrish PE. 2005. Embracing the aesthetics of instructional design. Educational Technology, 45(2), 16–25.

Reiser RA, Mackal M, and Sachs SG . 2005. Textbooks used in graduate programs in instructional design and technology: Changes over the past twelve years. Educational Technology, 45(5), 53-61.
Reiser RA. 2001. A History of Instructional Design and Technology: Part I: A History of Instructional Media. Educational Technology Research and Development, 49 (1), 53-64.
Reiser RA. 2001. A History of Instructional Design and Technology: Part II: A History of Instructional Design. Educational Technology Research and Development, 49 (2), 57-67.
Spector JM, Merrill MD, Elen J and Bishop MJ. (Eds.), 2014. Handbook of research on educational communications and technology (4th ed.). New York: Springer. Spector JM. 2015. Foundations of educational technology: Integrative approaches and interdisciplinary perspectives.
Routledge. Spiro R. 2018. Cognitive Flexibility Theory & the Post-Gutenberg Mind: Rand Spiro's Home Page, https://postgutenberg.typepad. com/newgutenbergrevolution /?utm_ campaign=elearning industry.com&utm_source=%2Fcognitive-flexibility-theory&utm_ medium=link
Tennyson R, Dijkstra S, Schott F and Norbert S. 1997. Instructional Design: International Perspectives. Theory, Research, And Models. Vol. 1.
Mahwah, NJ: Lawrence Erlbaum Associates, Inc. p. 42. ISBN 0805814000. The Encyclopedia of Educational Technology. What is Educational Technology? http://www.etc.edu.cn/eet/eet/articles/edtech/index.htm
Wlodkowski, Raymond J. 2008. Enhancing adult motivation to learn: a comprehensive guide for teaching all adults, 3rd ed., The Jossey-Bass higher and adult education series http://ekladata.com/iJLoOLufKEurVuG5mA2Ke1rJ5dQ/-Raymond_J._Wlodkowski-_Enhancing_adult_ motivation-Bokos-Z1-.pdf

Websites

e-Learning Industry– https://elearningindustry.com/
Instructional Design Central– https://www.instructionaldesigncentral.com/
Instructional Design– http://www.instructionaldesign.org/theories/ International Society for Educational Technology– https://www.isfet.org/courses/
Educational Technology– https://educationaltechnology.net/
AESA-Agricultural Extension in South Asia– http://www.aesanetwork.org/
GFRAS-Global Forum for Rural Advisory Services– http://www.g-fras.org/en

EXT 605 Risk Management and Climate Change Adaptation (2+1)

Objective

By the end of the course students will be able to

- Understand basic concepts of risks management and climate change adaptations in the context of Indian Agriculture.
- Analyse ways to reducing/managing risk and distress in Indian agriculture.

- Understand social-psychological and behavioural dimensions of farmers under risk/distress and acquire skills required to help farmers manage farm level risks.
- Conduct vulnerability assessment of farmers to climate change and identify and select appropriate adaptation options.
- Prepare evidence-based intervention plans for vulnerability reduction at micro and macro-levels.
- Identify, evaluate and evolve ways to address (mitigate and manage) risks and climate change.

Theory

Block	Unit No.	Lecture No.	Topic	Weightage
Block 1: Risk Management in Agriculture	Unit 1: Understanding Risk and Distress	1	Introduction to risk, risk management, uncertainty, sensitivity and distress,	3
		2	General risk theory, Risk analysis methods, Risk perception and decision making,	3
		3	Indicators of risk and distress in agriculture – identification, selection and assessment	3
		4	Understanding the agrarian distress in Indian agriculture, Sources of distress in Indian farming -changing farm size, land use, cropping patterns, pricing policy, markets and terms of trade,	4
		5	Typology of crisis in agriculture; Droughts, floods and Indian agriculture,	3
		6	Distress and farmer suicides - causes and socio-economic consequences	3
	Unit 2: Managing Risk and Distress	7-9	Ways to reducing/managing risk and distress in Indian agriculture; crop and life insurance; Developing support systems; Planning, implementation and evaluation of risk/distress management programs; Institutional frameworks for risk and disaster management - NDMA & SDMAs; Developing District Agriculture Contingency Plans; Risk management by diversification; Good practices and lessons from other countries;	10
		10	Responses of government, non-government and extension system to agrarian crisis; National Farmers Policy.	3

	Unit 3: Extension Professionals and Risk management	11	Understanding social-psychological and behavioural dimensions of farmers under risk/distress; Risk perception and communication;	4
		12	Helping farmers manage farm level risks - mobilising resources, linking with markets, strengthening capacities; Working with village level risk management committees; Operational skills for preparing contingency and disaster management plans;	3
		13	Institutional and extension innovations in managing risk and distress; Policy and technological preferences for dealing with drought and flood.	3
Block 2: Adapting to Climate Change	Unit 1: Introduction to Climate Change Science	14	Basic concepts of and terms in climate change science;	3
		15	impacts of climate change; anthropogenic drivers of climate change,	3
		16	Climate change and Indian agriculture;	3
		17	climate adaptation vs. disaster risk reduction; anticipated costs of adaptation; climate change and poor;	3
		18	Overview of UNFCCC framework and institutions, Kyoto Protocol and beyond;	3
		19	India's National Action Plan on Climate Change and National Mission on Strategic Knowledge on Climate Change; National Coastal Mission,	3
		20	Institutional arrangements for managing climate change agenda.	3
	Unit 2: Introduction to Climate Change Adaptation and Mitigation	21-22	Introduction to Climate Change Adaptation, conducting a vulnerability assessment (CVI and SEVI frameworks), Identifying and selecting adaptation options;	6
		23	Global, national and state level initiatives and plans to support climate change adaptation, private sector and civil society initiatives and activities;	3
		24	Mainstreaming climate change adaptation into development planning, Financing climate adaptation and budgetary allocations for programmes,	3
		25	Gender and climate change adaptation,	3

		26	Agricultural development programmes and strategies towards climate change adaptation and mitigation, Community based and Ecosystem based adaptation strategies,	3
		27	Preparing evidence-based intervention plans for vulnerability reduction at micro and macro-levels.	3
	Unit 3: Climate Smart Agriculture (CSA) and Extension & Advisory Services	28	Climate smart agriculture; Developing climate smart and climate resilient villages;	3
		29	Stakeholders and determinants involved in climate smart agriculture;	3
		30	Climate smart agriculture and EAS; Innovative extension approaches used in CSA; Climate information services,	4
		31	Farmers perceptions about climate change; Farm and household level manifestations and adaptation strategies; Barriers and limits to adaptation; Farmers feedback on performance of extension methods;	3
		32	Skills, competencies and tools required for extension professionals at different levels and development departments in up scaling CSA	3

Practical

- Hands-on practice in using risk assessment/analysis tools
- Case studies on risk / distress assessment in agriculture -Indian and global
- Lessons / Experiences from NICRA Project in agriculture and allied sectors
- Developing criteria, indicators and indices for assessment of risk, vulnerability and resilience
- Hands on practice on use of vulnerability and risk assessment tools and techniques
- Case studies on success stories of climate change adaptation and community-based initiatives
- Developing district and village level intervention plans for climate change adaptation
- Field Visits to State Disaster Management Authority
- Case studies on climate smart agriculture / villages from India and world
- Case studies on impact assessment of crop insurance programs, disaster management programs
- Capstone project on documenting ITKs and local practices related to reducing risk/ climate resilience agriculture

EXT 606 Livelihood Development (1+1)

Objective

By the end of the course students will be able to

- Understand the concept of livelihood and its various forms
- Analyse the various alternative approaches that has been adopted to support livelihoods
- Apply the methods, tools and techniques to design livelihood interventions
- Evaluate the context, especially the economic models and policy environment that guides the livelihood choices
- Work in multidisciplinary teams and engage at multiple levels on livelihood issues

Theory

Block	**Unit**	**Lecture No.**	Topic	*Weightage*
Block 1: Understanding of Livelihood	Unit 1: Concept of Livelihoods	1	Basic concepts of livelihood and Development, Types of development-Immanent/inherent and interventionist/ intentional; Why promote livelihood;	6
		2	Livelihood intervention: definition, types-Spatial, segmental, sector –sub-sector; Systemic view of Livelihoods	6
		3	Understanding Rural Livelihoods-Farm, Non-Farm, and off farm; Linkages with Farm and Off-farm Livelihoods; Economic Models	6
	Unit 2: Livelihood Challenges	4	Livelihood Challenge- Political economy of Livelihoods, Issues of access to farm and non-farm livelihoods;	6
		5	Livelihoods from a Gender Perspective-Feminization of agriculture/ poverty, women in the unorganized sector, the issue of unpaid and informal work;	6
		6	Livelihood Coping Mechanisms	6
		7	Climate Change and Livelihoods; Livelihoods and Disasters	6
Block 2: Livelihood Analysis	Unit 1: Livelihood Frameworks	8	Sustainable Livelihoods Approaches (SLAs)-Definition and origins of SLA; Assets or capitals and capabilities in SLA and its linkage to the other capitals: Physical, Social, Economic, Human, Natural;	6
		9	Vulnerability Assessment- Shocks, trends, seasonality; Policies, institutional context and processes;	6
		10-11	Conceptual Frameworks- DFID, CARE, UNDP, OXFAM, BASIX livelihood triad, Nine square Mandala or Rural Livelihood System's Framework, etc.;	10
		12	Past, Present and possibilities for the future of the SLA, critiques of the approach	6
	Unit 2: Designing Livelihood Interventio	13	Designing a suitable livelihood intervention-Observing and Understanding the Local Economy; Selecting livelihood activities suitable for the poor in the area; Deciding on the interventions.	5

	n and Promotion	14-15	Livelihood promotion approaches-Poverty and livelihood: Approaches and programs in India; Livelihood and a Rights Based Approach-MGNREGA and its critique; Livelihood and a Social Capital based approach: NRLM	10
Block 3: Livelihood Augmentation (LA)	Unit 1: Pathways for LA	16	Basic concepts; Pathways: a) Entrepreneurial strategies for LA;	5
		17	b) NRM based intervention; c) Market based interventions including Value-chain analysis; d) ICT based interventions;	5
		18	e) Livelihood and allied agriculture (dairy, poultry, Goatery, etc.) based livelihood; f) Forest based Livelihoods vis a vis Livelihood Protection and Promotion: Contribution of NTFP in supporting rural livelihoods	5
			Total	**100**

Note: Block 'A' and 'B' is theoretical; Block 'C' should be covered in the form practical's supported by few classroom discussion through cases

Practical

- Village stays to understand the livelihood pattern of villagers and how the other socio-economic factors affect the livelihood of people
- Visit to institutes/ universities adopted and/or nearby villages to experience the life and natural resources in rural communities-understanding of village culture, evolution, social structure, livelihood pattern, trends, governance arrangements, and the natural context (landscape layout, land use, vegetation types etc)
- Application of participatory rural appraisal skills for understanding village context; Engagement of working with rural communities and their grass-root institutions, understanding dynamics of working in a group
- Visit to different agri-business models as mentioned in the Block 'C'. Group assignments may be given to document the field experience in the form of case study of an enterprise/ entrepreneur/ members and other related stakeholders

EXT-607 Facilitation For People Centric Development 2+1

WHY THIS COURSE?

The prime aim of the agricultural extension professionals is to influence development change among the stakeholders with whom they work. In the Agricultural Innovation Systems (AIS) context, this change will happen when good relationships, networks and partnerships are formed. A new extension approach that aims at participatory and group learning as well as networking, where the extensionist acts as a facilitator is needed. It is important to inculcate the good facilitation skills by the extension professional to increase the effectiveness and impact among the agricultural extension and advisory services stakeholders.

AIM OF THIS COURSE

- To orient students on the importance facilitation
- To inspires students to understand facilitation tools to influence change at the individual, group and organisational levels
- To develop capacities in multi-stakeholder engagement, facilitation and networking The course is organized as follows:

LEARNING OUTCOMES

After successful completion of this course, the students are expected to be able to:

- Appreciate the importance of facilitation skills and tools
- Understand facilitation and networking techniques
- Critically evaluate strategic partnerships and linkages
- How to manage group dynamics and engage multi-stakeholders and virtual platforms

Block No.	Lecture No	Topic	Weightage	
Block 1: Introduction To Facilitation For Development	**Unit 1: Facilitation for development in the AIS**			06
	1	Facilitation for development in the AIS; Understanding facilitation for development.	2	
	2	Importance of facilitation as a core function of extension within the Agricultural Innovation Systems (AIS)	4	
	Unit 2: Principles, Attributes and Skills for Facilitation for Development			14
	3	Basic principles of facilitation for development	3	
	4	Desired attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes	4	
	5	Technical skills of a facilitator for development- Design processes.	2	
	6	Facilitation techniques and tools	3	

	7.	The art of questioning and probing, Process observation and documentation, Visualisation	2	
Block 2: Facilitating Change In Individuals, Groups And Organisations	**Unit 1: Realise Potential- Self-Discovery**			06
	8	Self-discovery to realise our potentials, Tools for self-discovery	2	
	9-10	Formulating a personal vision, Taking responsibility for your own development	4	
	Unit 2: Group Dynamics and Working Together			10
	11	Understanding the dynamics of human interaction.	2	
	12	Group dynamics and power relations	3	
	13	Managing relationships, Shared vision and collective action	3	
	14	Tools for team building	2	
	Unit 3: Organizational Change Process			10
	15	Organizational change process, Organizational learning to adapt to changing environments.	4	
	16	Enhancing performance of organizations	2	
	17	Leadership development	2	
	18	Tools for organizational change	2	
Block 3: Facilitating Operational Level Multi-Stakeholder Engagements	**Unit 1: Multi-Stakeholder Interactions**			07
	19	Defining stakeholders, Development of collective and shared goals.	3	
	20	Building trust and accountability	2	
	21	Tools for stakeholder identification and visioning	2	
	Unit 2: Innovation and Policy engagement Platforms			07
	22	Visualising innovation platforms (IPs), Why are IPs important.	2	
	23	Different models of IPs for multi-stakeholder engagement, policy engagement platforms	3	
	24	Generating issues and evidence for policy action, Advocacy for responsive policy processes	2	
Block 4: Brokering Strategic Partnerships, Networking And Facilitation	**Unit 1: Linkages, Partnerships, Alliances and Networking**			12
	25	Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering.	3	
	26	Creating linkages with markets.	2	
	27	Learning alliances and networking.	2	
	28	Coordination of pluralistic service provision within the AIS.	2	
	29	The concept of action learning and reflective practitioners, Networking.	3	

	Unit 2: Facilitating Capacity Development			08
	30	Facilitating Capacity Development- Facilitate participation and learning in development programs and projects.	4	
	31-32	Virtual platforms-skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders.	4	
			Total	**80**

PRACTICALS

1. Practicing facilitation techniques,
2. Self discovery exercises,
3. Working together and interaction (task based),
4. Arrangement for multi-stakeholder interactions,
5. Understanding organisational change process tools and techniques,
6. Case analysis on organisational change process,
7. Participating with innovation platforms,
8. Policy engagement platforms,
9. Stakeholder analysis mapping,
10. Exercise on networking skills,
11. Facilitating capacity building programmes
12. Facilitating virtual platforms
13. Filed visit to multi-stakeholder partnership projects

RESOURCES

AccountAbility.2005. AA 1000, Stakeholder Engagement Standard Exposure draft. http://www.empresa.org/doc/AA1000_STHEngagement.pdf

Anonymous. . Seeds for Change. Facilitation Tools for Meetings and Workshops. Available https://seedsforchange.org.uk/tools.pdf

Clarke S, Blackman R and Carter I. 2004. Facilitation skills workbook -Training material for people facilitating small group discussions and activities using PILLARS Guides. Tearfund, England. https://www.tearfund.org/~/media/files/tilz/fac_skills_english/facilitation__e.pdf

Davis S. 2014. Using the Socratic Method as a Learning Facilitator https://facilitatoru.com/training/using-the-socratic-method-as-a-learningfacilitator/

Hanson L. and Hanson C. 2001. Transforming participatory facilitation: Reflections from practice. http://pubs.iied.org/pdfs/G01950.pdf

Jost C, Alvarez S and Schuetz T. 2014.CCAFS Theory of Change Facilitation Guide. CGIAR Research Program on Climate Change, Agriculture and Food Security. https://cgspace.cgiar.org/bitstream/handle/10568/41674/CCAFS%20TOC%20facilitation%202014%20FINAL.pdf

Kennon N., Howden P. and Hartley M. 2002 .Who really matters? A stakeholder analysis tool. Extension Farming Systems Journal : 5 (2). https://www.csu.edu.au/__data/assets/pdf_file/0018/109602/EFS_Journal_vol_5_no_2_02_Kennon_et_al.pdf

Koutsouris A. 2012. Exploring the emerging facilitation and brokerage roles for agricultural extension education. AUA Working Paper Series No. 2012-4.Agricultural University of Athens. Department of Agricultural Economics & Rural

Development.http://aoatools.aua.gr/RePEc/aua/wpaper/files/2012-4_koutsouris.pdf

Krick T, Forstater M, Monaghan P, Sillanpaa M. 2005. The Stakeholder Engagement Manual: Volume 2, the Practitioner's Handbook on Stakeholder Engagement. Accountability, United Nations Environment Programme, Stakeholder Research Associates Canada Inc.

Restructured and Revised Syllabus

M.Sc. & Ph. D.
(Masters in Business Administration)

In

Agri - Bussiness Management

Submitted by

Broad Subject Coordinator
Associate Dean and Principal,
Post Graduate Institute of Agri-Bussiness Management, Chakur
VNMKV., Parbhani

CONTENTS

Preamble

Rapid advancement in agriculture has resulted in increased demand for qualified managers to manage this sector. Indian agriculture is facing numerous challenges with a rapidly changing business environment, pace of technological change, globalization, competitive environment and changing role of government. These challenges will place unparalleled demands on the capabilities of tomorrow's managers. Agribusiness Management has enormous potential to address key national and global challenges of inclusive growth, and food and nutritional security. With increasing incomes, the demand for value added agricultural products will also increase, driving the demand for Agribusiness Managers. Increasing integration of World food markets and the expansion of organized retail also imply that the scope of agribusiness is becoming increasingly global. The Agribusiness Management Education System in India is uniquely placed to meet the demand for professional agribusiness managers across the globe.

Agri business management is a specialized two-year MBA programme which focuses on business aspect of agriculture production and its international trade. The postgraduate course aims to craft professional business leaders and entrepreneurs in food, agriculture and allied sectors. The course is offered in premier business schools in and State Agricultural Universities in India and across the globe and focuses on managerial skill development in the agricultural sector. Students learn how to make sustainable business decisions and minimize risk while working in the agricultural sector. The course curriculum is designed to build and enhance a global perspective among students. The course also needs to create awareness among students about the environmental forces that impact managerial decisions.

In light of the above-mentioned issues and concerns, courses and programmes in the field of agri-business management must also be reformed to increase the employability and entrepreneurship opportunities for the Post Graduates and Doctoral participants at the same time prepare them for handling global competitiveness without compromising farmers' and farming community needs and demands.

The sub-committee on Agri Business Management constituted by ICAR (under the ICAR Broad Subject Matter Area (BSMA) for Social Sciences) has kept above development in view while revising the PG and PhD Curricula in Agri Business Management. We also addressed the issue of repetitions of content, updating them with the recent trends in the industry, under-graduate curricula in agriculture. To do these, we identified first the core competencies that are required at the different levels and worked backwards based on the areas and organising them into courses.

We are also recommending summer internship-2 at the Master's level (each for 4-6 weeks with agri. based organisations) and we propose a credit load of 10 and 4 for each of these internships/ attachments at PG level. We believe this will help the students to have more relevant practical experience and this will boost their job prospects.

We have organized the curriculum under different block and units and each course has an introduction explicitly stating the purpose of this course (why this course), aim of the course (what it tries to provide) and learning outcomes. Several new reading references are also provided at the end of each course. The committee recognized the need for organizing training of teachers to impart some of the new courses and this could be further elaborated in consultation with ICAR and other organizations that can support or even lead this exercise.

The committee organized a stakeholders meeting with agri based industry executives, academicians from reputed institutions, alumni from different ABM programmes of the SAUs, teachers involved in ABM teaching in selected SAUs at Bikaner on September 17, 2018 for development of curricula.

Committee on MBA in Agri-Business Management

ICAR-BSMA Broad Subject	ICAR-BSMA Approved Disciplines	Degree Programmes	Broad Subject Coordinator	Members
Agri-Business Management	Agri-Business Management	MBA (Agri-Business Management)	Dr. H. B. Patil ADP, PGIABM, Chakur VNMKV., Parbhani	1. Dr. S. Warade, College of Agril., Nagpur 2. Dr. Bhosale College of Agril., Pune
		Ph.D. (Agri-Business Management)		

Organization of Course Contents &

Credit Requirements

Minimum Residential Requirement:

MBA.: 4 Semesters
Ph.D.: 6 Semesters

Nomenclature of Degree Programme

(a) MBA Programmes
MBA in Agri-Business Management

(b) Ph. D. Programmes
MBA in Agri-Business Management

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600- series to Doctoral level.
- Credit Seminar for Master's level is designated by code no. 591, and the Two Seminars for Doctoral level are coded as 691 and 692, respectively
- Deficiency courses will be of 400 series.
- Master's research: 599 and Doctoral research: 699

Course Contents

The contents of each course have been organized into:

- Objective – To elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not obviously exclude such a reference material that may be recommended according to the advancement and local requirement.
- A list of international and national reputed journals pertaining to the discipline is provided at the end which may be useful as study material for 500/600 series courses as well as research topics.
- Lecture schedule and practical schedule has also been given at the end of each course to facilitate the teacher to complete the course in an effective manner.

Eligibility for Admission

Master's Degree Programme

B.Sc.(Agri.)/B.Sc.(Hons.)Agriculture/B.Sc.(Hort.)/B.Sc.(Hons.)Horticulture/ B.Sc.(Forestry)/B.Sc.(Hons.)Forestry/B.Sc.(Agricultural Biotechnology)/ B.Tech. (Biotechnology)/ B.Tech. (Agricultural Biotechnology)/ B.Tech. (Food Science)/ B.Tech.(Food Tech./Food Technology)/ B.F.Sc./ B.Sc.(Hons.) Home Sci.)/ B.Sc. (Hons.) Community Science/B.F.Sc/ B.Sc.(Social Science), BBM (Agri.)/ B.Sc.(ABM)/ B.Sc. (Hons.) Agril. Business Management/ B.B.A. (Agriculture)/ B.Tech.(Agril. Engg.) or equivalent degree with four years duration of Agriculture-related Universities and having the Common Entrance Test in Agricultural Business Management faculty conducted by the MAUEB, Pune or competent authority as applicable.

Doctoral Degree Programme

Masters degree in concerned discipline with two years duration and minimum 6.5/10 or equivalent OGPA/ equivalent percentage of marks of Agriculture-related Universities and having the Common Entrance Test in Agriculture faculty conducted by MAUEB, Pune or competent authority as applicable

Course and Credit Requirements:

Course Details	**Masters Degree**	**Doctoral Degree**
Major Courses	20	12
Minor Courses	08	06
Supporting / Optional	06	05
Common PGS Courses	05	-
Seminar	01	02
Research(Summer Internship+ Research Project)	30(10+20)	75
Total	**70**	**100**

Compulsory Non Credit PGS Courses (5 Credits):

S. No.	Course Title	Course Code	Credits
1	Library and Information Services	PGS 501	0+1
2	Technical Writing and Communications Skills	PGS 502	0+1
3	Intellectual Property and its management in Agriculture	PGS 503	1+0
4	Basic Concepts in Laboratory Techniques	PGS 504	0+1
5	Agricultural Research, Research Ethics and Rural Development Programs	PGS 505	1+0

Some of these courses are already in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HOD/BOS.

Compulsory Non Credit Deficiency Courses

MKT-121	Introduction to Agricultural marketing	1+1=2
MKT-232	Marketing Institutions and Organizations	1+1=2
MKT-233	Principles of Marketing Management	1+1=2
MKT-234	Market and Trade Acts	2+0=2
MKT-245	Rural Marketing and Market Infrastructure	2+1=3
MKT-246	Input Marketing Management	1+1=2
MKT-357	Product Promotion Methods	1+1=2
ABM-111	Principles of Management and Agribusiness	1+1=2
ABM-122	Agro-based Industrialization	1+1=2
ABM-233	Agri. Informatics	1+1=2
ABM-234	Human Resource Management and development	2+1=3
ABM-245	Office Procedures for Agribusiness	0+1=1
ABM-246	Organizational Behaviour for Business Management	2+0=2
ABM-357	Strategic Business Management	1+1=2
ABM-358	Production Management, Planning and Control	1+1=2
ABM-359	Inventory Management	1+1=2
ABM-3510	Agro-processing Management	1+1=2

ABM-3611	Managerial Accounting	1+1=2
ABM-3612	Market Survey and Price Analysis	0+2=2
ABM-3613	Supply Chain Management	1+1=2
ECON- 111	Agricultural and Natural Resource Economics	2+1=3
ECON-122	Money, Banking and International Trade	2+1=3
ECON-233	Principles of Economic Theory	2+1=3
ECON-244	Agril. Co-operation, Institutions and Management	2+1=3
ECON-355	Structure and Dynamics of Indian Agriculture	2+1=3
ECON- 356	Farm Management and Production Economics	2+1=3
ECON-367	Financial Management in Agribusiness	2+1=3

Students from other than Agri Bussiness Management stream will be required to completed Non credit deficiency courses (6 to 10 credits) from the above courses related to the discipline in which admitted and as decided by the Student Advisory committee.

Course Layout and Structure of Masters Degree

Major Courses 20 Credits

Course Code	Semester	Course Title	Credit hours
ABM 501	I	Principles of Management and Organizational Behavior	3+0
ABM 502	I	Managerial Accounting and Control	3+0
ABM 503	I	Applied Agribusiness Economics	2+0
ABM 504	II	Human Resource Management for Agricultural Organizations	2+0
ABM 505	II	Production and Operations Management	2+0
ABM 506	I	Agricultural and Food Marketing Management- I	2+0
ABM 507	II	Agricultural and Food Marketing Management- II	2+0
ABM 508	II	Agri Supply Chain Management	2+0
ABM 509	II	International Trade for Agricultural Products	2+0
ABM 591*	III	Master's Seminar	0+1
Total			**20+01=21**
ABM 599	III & IV	Master's Research (Summer Internship/Industrial Attachment)	**30(10+20)**

Minor and Supporting Courses

Minor Courses (8 Credits):

Minor Disciplines / Subjects

- Agricultural Business Management
- Finance Management
- Human Resource Management
- Marketing Management
- Production Management

It is suggested the student may choose at least four courses out of the courses listed below as part of minor courses as these are related to specific areas of Agri business and aim to build larger understanding of the subject. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/ HOD.

Suggestive Minor Courses

Course Code	Semester	Course Title	Credit Hours
Production and Processing Management			
ABM 510	I	Food Technology and Processing Management	3+0
ABM 512	I	Fertilizer Technology and Management	3+0
ABM 513	II	Management of Agro-Chemical Industry	3+0
ABM 514	II	Seed Production Technology Management	3+0
ABM 515	I	Technology Management for Livestock Products	3+0
ABM 516	II	Fruit Production & Post Harvest Management	3+0
ABM 517	II	Farm Power & Machinery Management	2+0
Marketing Management			
ABM 511	I	Rural Marketing	3+0
ABM 519	II	Management of Agricultural Input Marketing	2+0
ABM 531	II	Advertising And Brand Management	
Agri-Business Management			
ABM 518	I	Food Retail Management	2
ABM 520	II	Feed Business Management	2
ABM 521	II	Management of Veterinary Hospitals	2
ABM 522	II	Poultry And Hatchery Management	2
ABM 523	II	Management Of Floriculture & Landscaping	2
ABM 525	II	Management Of Agri-Business Co-Operatives	2
ABM 526	II	Business Analytics for Agriculture	2
ABM 527	II	Dairy Business Management	1
ABM 528	II	Agri Extension Management	1
ABM 529	II	Renewable Energy Sources Management	1
ABM 530	II	Quality Management for Agri Business	1
ABM 532	II	Agri Infrastructure and Warehousing Management	1
ABM 533	II	Contract Farming	1
Human Resource Management			
ABM 534	I	Human Resource Competence & Capacity Building Systems	1
Financial Management			
ABM 524	I	Risk Management in Agri Business	2
ABM 535	II	Agri Commodity Markets & Futures Trading	1

Suggestive Supporting Courses (6 Credits)

Course Code	Semester	Course Title	Credit Hours
ABM 536	I	Strategic Management for Agri Business Enterprises	2
ABM 537	II	Operations Research	2
ABM 538	II	Financial Management in Agri Business	2

Courses Mandatory for Summer Internship and Research Project:

Course Code	Semester	Course Title	Credit Hours
ABM 599	III & IV	**Research Project (Summer Internship + Research Project)**	**30 (10+20)**
	IV	Summer Internship/ Industrial Attachment	4+0
Basic Courses mandatory for Summer Internship			6+0
ABM 539	III	Communication for Management and Agri Business	3+0
ABM 540	III	Research Methodology for Agri Business Management	3+0

BASIC Courses Mandatory for project (10 Credits)			
ABM 541	III	Computer Applications for Agri Business	3+0
ABM 542	III	Project Management and Agri Business Entrepreneurship	3+0
ABM 543	III	Agribusiness Environment and Policy	2+0
ABM 544	III	Agri Business Laws and Ethics	2+0
		Project work	**0+10**

Course Syllabus and Contents of Masters Degree

ABM 501 Principles of Management and Organizational Behaviour 3+0

Aim of the course

Provide students with opportunities to understand a wide variety of topics related to business management, focusing on fundamental management principles and concepts that apply to agribusiness, traditional management skills, and new competencies needed to succeed in a fast-paced environment that demands ongoing innovations.

The course is organized as follows:

No	Blocks	Units
1.	Basic Concepts of Management	1. Introduction to Management 2. Planning, Organizing, Directing and Controlling
2.	Insights about Organizational behaviour	1. Foundations of Individual behavior 2. Group Dynamics
3.	Organizational Dynamics	1. Understanding and managing Organizational Culture 2. Concept of Organizational Development

Theory

Block 1: Basic Concepts of Management

Unit-I: Introduction to Management: Nature, Scope and Significance of Management, Evolution of Management Thought, Approaches to Management, functions and skills of a manager

Unit-II: Management functions: Planning – Types, Steps, Objective, Process, Strategies, Policies, MBO, Organizing– Structure & Process, Line, Staff, Authority & Responsibility, Staffing – Recruitment and Selection, Directing – Training, Communication & Motivation, Controlling- Significance, Process, Techniques, Standards & Benchmarks, Management Audit

Block 2: Insights About Organizational Behavior

Unit III: Nature, Scope and Significance of Organizational Behavior; Foundations of individual Behaviour – Emotions, Personality, Values, Attitudes, Perception, Learning and individual decision making, Motivation- Types of motivation, theories of motivation, motivational practices at workplace, managing stress and work life balance

Unit IV: Group dynamics-types of groups, group formation, Group decision making, team building and developing collaboration, leadership styles and influence process; leadership theories, leadership styles and effective leader

Block 3: Organizational Dynamics

Unit V: Understanding and managing organizational culture, power and political behaviorin organizations, conflict Management, negotiation, managing organizational change, concept of organizational development

Teaching methods/activities

- Interactive Lectures
- Assignment(Reading/Writing)
- Student presentations
- Case study related to basics of management and organizational behaviour

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic concepts of management and organizational behaviour
- Developaoverallviewaboutthevariousmanagementfunctions,managerialskills and approaches
- Get insights about the fundamentals of individual and group behavior in the organizational setting
- Analyze the organizational level challenges in managing the resources optimally

Suggested Reading

- Robbins SP, Coulter M and Vohra N. 2010. *Management.* Pearson Edu.
- Weihrich H, Cannice MV and Koontz H. 2015, *Management, A Global, Innovative and Entrepreneurial Perspective,* 14th Edition, McGraw Hill Education Pvt Ltd.
- Beierlein JG, Schneeberger KC, Osburn DD. 2014. *Principles of Agribusiness Management.*
- Fifth edition. Waveland Press
- Neck CP, Houghton JD and Murray EL. 2017, *Organizational behavior*, Sage Publication India PrivateLimited.
- Greenberg J. 2013, *Behavior in Organizations*, PHI Learning Private Limited, New Delhi.
- John A, Wagner III JA and Hollenbeck JR. 2015. *Organizational Behaviour*, Routledge Taylor & Francis Group, New York.
- Koontz Hand WeighhrichK.2010.*Essentials of Management*. Tata McGraw Hill

ABM 502 Managerial Accounting and Control 3+0

Aim of the course

The objective of this course is to expose the learner to the concept and methods of financial and management accounting. Focus will be on understanding techniques, uses and applications of financial and management accounting.

No	Blocks	Units
1.	Financial Accounting	1. Introduction to financial accounting 2. Accounting standards 3. Double Entry system 4. Use of accounting softwares
2.	Managerial Accounting	1. Meaning of Managerial accounting 2. Analysis of financial statements 3. Cash flow and fund flow analysis
3.	Cost Accounting	1. Introduction to accounting 2. Standard costing 3. Variance Analysis 4. Budget and budgetary control

Theory

Block 1: Financial Accounting

Unit I: Financial Accounting- Meaning, Need, Accounting principles: Accounting Concepts and Conventions; Branches of Accounting, Users of Accounting information, Advantages and Limitations of Financial Accounting, Accounting Standards

Unit II: The Double Entry System- Its Meaning and Scope, The Journal, Cash Book, Ledger, Trial Balance, Trading Account Profit and Loss Account, Balance Sheet, entries and adjustments of different heads in different Books and Accounts, Introduction of Company Accounts, Use of Accounting Software

Block 2: Managerial Accounting

Unit III: Management Accounting-Meaning, Functions, Scope, Utility, Limitations and Tools of Management Accounting, Analysis of Financial Statements- Ratio, time series, common size and Dupont Analysis, Comparative and Common Size Statements, Cash Flow and Fund Flow Analysis

Block 3: Cost Accounting

Unit IV: Cost Accounting–Nature, Course, Significance of Cost Accounting; ClassificationofCost,CostingforMaterial;Labourandoverheads;MarginalCosting and cost volume profit Analysis- Its Significance, Uses and Limitations; Standard Costing – Its Meaning, Uses and Limitations, Determination of Standard Cost, Variance Analysis-Material, Labour and Overhead.

Unit V: Budget and Budgetary Control- Meaning, Uses and Limitations, Budgeting and Profit planning, Different Types of Budgets and their Preparations: Sales Budget, Purchase Budget, Production Budget, Cash Budget, Flexible Budget, Master Budget, Zero Based Budgeting. Mergers and Acquisition, Tax System-GST

Teaching methods/activities

- Lecture
- Case studies for making the participants get a clear idea about the real life budgeting and accounting practices
- Liveprojectinthefirmsfinancedepartmentsforgettingthefirsthandexperience

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Develop a clear understanding about the concepts of financial and managerial accounting
- Understand the basics of cost accounting through various tools and techniques available
- Get a insight about the budget and budgetary control methods

Suggested Reading

- JainSPandNarangKL.2014.*FinancialAccounting*.12thEdition.Kalyani publisher
- Sharma and Gupta.2018.*Management Accounting* 13th Edition, Kalyani Publisher
- Maheshwari SN and Maheshwari SK.2018. *Financial Accounting*. 6th Ed. Vikas Publ. House.

ABM-503 Applied Agribusiness Economics 2+0

Aim of the course

This course applies basic economic tools and models to problems involving supply, demand, individual consumer and firm behavior, and market structure. Basic market structure models covered include perfect competition, monopolistic competition, oligopoly, and monopoly. Economic tools and models are related to business strategies throughout the course.

The course is organized as follows:

No	Blocks	Units
1.	Overview of Managerial Economics	1. Basic managerial economics principles 2. Mathematical concepts used in managerial economics 3. Introduction to behavioral economics
2.	Production, cost and supply analysis	1. Production Function 2. Cost Concepts 3. Determinants of price
3.	Macroeconomics	1. The national income 2. Flow of money in the market and economy 3. Business decisions under certain and uncertain situations

Theory

Block 1: Overview of Managerial Economics

Unit I: Scope of managerial economics, objective of the firm and basic economic principles; mathematical concepts used in managerial economics. Introduction to behavioral economics

Unit II: Indifference curves and budget sets - Demand analysis - meaning, types and determinants of demand; demand function; demand elasticity; demand forecasting-need and techniques.

Block 2: Production, Cost and Supply Analysis

Unit III: Production, cost and supply analysis- production function, Multi period production and cost least-cost input combination, factor productivities and returns to scale, cost concepts, cost-output relationship, short and long-run supply functions.
Unit IV: Pricing-determinants of price - pricing under different market structures, pricing of joint products, pricing methods in practice, government policies and pricing. Price discrimination (First, Second and Third level)

Block 3: Macroeconomics

Unit V: The national income; circular flow of income: consumption, investment and saving: money-functions, factors influencing demand for money & supply of money; inflation; economic growth; business cycles and business policies; business decisions under certain and uncertain situations

Teaching methods/activities

- Interactive Lectures
- Assignment (Reading and Writing)
- Cases on recent developments in economic environment
- Live projects to understand the principles of economics for an organisation
- Group analysis of newspapers covering national level economic trends

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the concepts of managerial economics and its implications on the agri business environment
- Develop a clearer overview on the macroeconomic environment that exists for a agri business enterprise to understand and adapt for optimizing the output

Suggested Reading

- Dwivedi DN. 2015. *Managerial Economics*. 8th Edition, Vikash Publishing
- Gupta GS. 2015. *Managerial Economics*. Tata McGraw Hill
- Savatore D. Srivastav R. 2012. *Managerial Economics*. 7th Edition, Oxford University Press
- Suma Damodaran. 2010. *Managerial Economics*. Oxford

ABM 504 Human Resource Management for Agricultural Organizations 2+0

Aim of the course

The objective of this course is to expose the learner to the field of human resource management. The focus will be on human resource practices and their utility for managers in agri based organizations.

The course is organized as follows:

No	Blocks	Units
1	Overview of Human Resource Management	1. Meaning and scope of Human Resource Management 2. Human Resource Planning 3. Recruitment, Selection and Training 4. Performance Appraisal 5. Compensation Management
2	Industrial Relations	1. Trade Union 2. Grievance Management 3. Health and Safety of HR
3	Ethical and Global issues in HRM	1. Global HRM 2. HR Metrics, HRIS and workplace analystics

Theory

Block 1: Introduction to Human Resource Management

Unit I: Strategic Human Resource Management, Human Resource Planning-Nature and Significance, Job Analysis and talent management process, Job Description, job Specification, Job enlargement, Job enrichment, Job rotation

Unit II: Recruitment and Selection Process, Induction, Training and Human Resource Development-Nature, Significance, Process and Techniques, e- recruitment, use of Big Data for recruitment, use of Artificial Intelligence and machine learning tools in recruitment practices Career planning and Development Internal mobility including Transfers, Promotions, employee separation.

Unit III: Performance Appraisal–Significance and methods, Compensation management, Strategic pay plans, Job Evaluation, Wage and Salary Administration; Wage Fixation; Fringe Benefits, Incentive Payment, bonus, and Profit Sharing

Block 2: Industrial Relations

Unit IV: Role and Status of Trade Unions; Collective Bargaining; Worker's Participation in Management, employee retention. Quality of work life, employee welfare measure, work life balance, Disputes and Grievance Handling Procedures; Arbitration and Adjudication; Health and Safety of Human Resources;

Block 3: Ethical And Global Issues In Hrm

Unit V: Ethical issues in HRM**,** Managing Global Human Resources, Managing Human Resources in Small and Entrepreneurial firms, Human Resources

accounting, Human Resources outsourcing. HR Information System, Human Resource Metrics and Workforce Analytics, Future trends in workforce technologies.

Teaching methods/activities

- Lectures
- Videos showing trends and practices of innovative human resource management
- Live project for understanding the application of concepts in the real life situation
- Interaction with the HR managers of the agri based organizations to understand the intricacies involved in the managing the human resource
- Group tasks to study the policy framework and regulatory environment that exists in India and globally to manage human resource

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic concept of HRM and SHRM
- Develop an insight into important human resource management functions like job analysis, job planning, recruitment, selection, performance appraisal, training, development, compensation management etc with major reference to the agri based organisations
- Get a clearer view about the status of employee – employer relationship in Indian agri enterprises and global agri based organizations
- Understand the ethical and recent trends in managing human resource effectively

Suggested Reading

- Gary Dessler & Biju Varkkey 2016, *Human Resource Management*, XIV Edition, Pearson India
- VSP Rao. 2010, *Human Resource Management, Text and Cases*, 3rd Edition, Excel Books
- Ashwathapa K. 2016. *Human Resource Management, Text and Caes*. Tata McGraw Hill
- Michael J. Kavanagh, Mohan Thite & Richard D. Johnson. 2016, *Human Resource Information Systems*, Sage Publications
- Subba Rao P. 2004. *Essentials of Human Resource Management and Industrial Relations*. Himalaya Publ. House.

ABM 505 Production and Operations Management 2+0

Aim of the course

The objective of this course is to expose the learner to the field of production and operations management. The focus will be on imparting knowledge of the basic concepts, tools, and functions of production management.

The course is organized as follows:

No	Blocks	Units
1	Introduction to Production and Operations Management	1. Concept and scope of production and operations management 2. Operations strategy 3. Productivity variables and measurement
2	Inventory management	1. Determination of material requirement 2. Industrial safety 3. Cloud operations management
3	Overview of Quality Management	1. Statistical process control 2. Reengineering and Value engineering

Theory

Block 1: Introduction to Production and Operations Management

Unit I: Nature Concept and Scope of Production and Operations Management; Factors Affecting System; Facility location, Types of Manufacturing Systems and Layouts, Process Selection and Facility Layout, Layout Planning and Analysis, Forecasting

Unit II: Operations Strategy: Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon, Linkage Between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy, Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy.

Unit III: Productivity Variables and Productivity Measurement, Production Planning and Control, Mass Production, Batch Production, Job Order Manufacturing, Product Selection, Product Design and Development, Process Selection, Capacity planning.

Block 2: Inventory Management

Unit IV: An Overview of Inventory Management Fundamentals, Determination of Material Requirement, Safety Management Scheduling, Maintenance Management Concepts, Work Study, Method Study, Work Measurement, Work Sampling, Work

Environment, Production Planning and Control (PPC) Industrial Safety, human-machine interface, types of interface designs. Cloud operations management

Block 3: Quality Management

Unit V: Quality Assurance, Accepting Sampling, Statistical Process Control, Total Quality Management, ISO standards and their Importance, Introduction to re-engineering, value engineering, check sheets, Pareto charts, Ishikawa charts, JIT Pre-requisites for implementation Six Sigma, Lean Management, Reliability Engineering, Safety Engineering, Fault Tree Analysis

Teaching methods/activities

- Interactive sessions
- Live projects
- Assignments (reading and writing)
- Presentations of quality management practices by leading agri and food organizations

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic concepts of production and operations management including manufacturing systems, layout planning and analysis
- Develop a understanding about the operations strategy, productivity variables, and their measurement along with product design and development
- Get an insight about fundamentals of inventory management, safety management, quality assurance practices and techniques with major emphasis on agri and food based industries

Suggested Reading

- William J. Stevenson. 2014. *Operations Management*, 12th Edition, McGraw-Hill
- Panneerselvam K. 2012. *Production and Operations Management* 3rd Edition, Prentice Hall India Learning Private Limited.
- S. N Chary, 2017. *Production and Operations Management*, McGraw Hill Education; 5 edition

ABM 506 Agricultural and Food Marketing Management-I 2+0

Aim of the course

To develop the understanding the concept of marketing system with specific inputs of product, pricing, availability and promotional details

The course is organized as follows:

No	Blocks	Units
1.	Marketing concept	1. Overview of Marketing Management 2. Developing the product mix 3. Branding decisions 4. Packaging technology
2	Pricing decisions	1. Pricing Objectives 2. Types of pricing
3	Channel Management and Physical Distribution	1. Distribution channels 2. Warehouse management, Inventory management 3. Transport management
4	Marketing	1. Marketing communications mix Communications 2. Digital Marketing, Mobile Marketing, Social Marketing and Social Media Marketing 3. Marketing efficiency and effectivenes

Theory

Block 1: Overview Of Marketing Management

Unit 1: Introduction and Concept/ philosophies of Marketing Management; Product Management: The product, The product mix, Product line extensions, Product line deletions, Branding products, The advantages and disadvantages of branding, Branding decisions Brand loyalty models, Homogenous first-order markov models, Higher-order markov models Packaging, The functions of packaging, Packaging technology, Recent developments in packaging

Block 2: Pricing Decisions

Unit 2: Pricing objectives, The laws of supply and demand, Elasticity of demand Cross-price elasticity of demand, Practical problems of price theory, Cost - revenue - supply relationships, The meaning of price to consumers, Price as an indicator of quality, Pricing strategies, Cost-plus methods of price determination, Breakeven analysis, Market-oriented pricing, Psychological pricing, Geographical pricing, Administered pricing

Block 3: Channel Management and Physical Distribution

Unit 3: Channel decisions in relation to marketing strategy, The value of middlemen, Key decisions in channel management, Types of distribution system, Marketing to middlemen, Power and conflict in distribution channels, Physical distribution, Customer service levels, Developing a customer service policy, The total distribution concept, Warehouse management, Inventory management, Calculating the economic order quantity, Transport management, Technological advances in physical

distribution, Vehicle scheduling and routing, Fixed and variable routing systems, Vehicle scheduling tools, Vehicle scheduling models, Computer-based vehicle scheduling

Block 4: Marketing Communications

Unit 4: The nature of marketing communications, Setting marketing communication objectives, Factors influencing the communications mix, The marketing communications mix, Advertising, Sales promotion, Public relations, Personal selling, Digital Marketing, Mobile Marketing, Social Marketing and Social Media Marketing, Training the sales force, Change agents, Selecting the media, Establishing the promotional budget, Monitoring the effectiveness of marketing communications

Unit 5: Marketing Costs And Margins: Assessing the performance of a marketing system, Marketing efficiency and effectiveness, Operational efficiency, Pricing efficiency, Identifying marketing costs and margins, The reference products concept, Handling costs, Packaging costs, Transport costs, Storage costs, Processing costs, Capital costs

Teaching methods/activities

- Lectures
- Cases studies from recent marketing trends from the agri and food organisations
- Assignments (Group/ Individual)
- Live project based upon marketing practices adopted by various organizations
- Group discussions on contemporary marketing practices

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basics of marketing with specific emphasis on managing the product details
- Get detailed insight on the pricing techniques and managing the demand and supply relationship profitably
- Develop the understanding about the marketing channels and intermediaries involved
- Understand the promotional strategies and communication development tools and methods

Suggested Reading

- Kotler P, Keller K, Koshy A and Jha M. 2013. *Marketing Management– Analysis, Planning, Implementation and Control*. Pearson Education.
- Ramaswamy VS. 2017. *Marketing Management: A Strategic Decision Making Approach* McGraw Hill Education
- Saxena R. 2009. *Marketing Management*. Mc Graw Hill.4th Edition

- William Perreault Jr., Mccarthy E. Jerome., 2006, *Basic Marketing: A Global Marketing Approach*, Tata McGraw Hill
- Gay R, Cjarlesworth A, Esen R. 2014, *Online Marketing*, Oxford University Press
- Mohammed, Fisher, Jaworski and Cahill: *Internet Marketing – Building Advantage in a networked economy* Tata McGraw-Hill
- Strauss J and Frost R. 2013. *E-Marketing*, Prentice-Hall
- Roberts M. 2018. *Internet Marketing*, Cengage Learning
- Vassos: *Strategic Internet Marketing – Practical e-commerce and branding Tactics*, Que Books
- Chaffey, Meyer, Johnston and Ellis – Chadwick. 2009. *Internet Marketing*, Prentice-Hall/ Financial Times

ABM 507 Agricultural and Food Marketing Management-II 2+0

Aim of the course

To develop learning about the basic concept of marketing with major emphasis on agri and food marketing by equipping the students with the understanding of ecosystem in which the agri organization functions to meet the requirements of the customer profitably

The course is organized as follows:

No	Blocks	Units
1.	Agricultural and Food Marketing	1. Marketing concept and marketing systems 2. Market Liberalisation
2.	Marketing Strategy, Planning and Control	1. Marketing planning 2. New Product Development:
3.	Commodity Marketing	1. Grain marketing, 2. Livestock and meat marketing, 3. Poultry and eggs marketing, marketing of fresh milk

Theory

Block 1: Agricultural and Food Marketing

Unit 1: The importance of agricultural and food marketing to developing countries, the marketing concept and marketing systems, Marketing sub-systems Marketing functions, Links between agriculture and the food industry, Agricultural and food marketing enterprises, Marketing boards in developing countries, Co- operatives in the agriculture and food sectors, Control and management of secondary co-operatives, The weaknesses of co-operatives, Selling arrangements between co-operatives and their members

Unit 2: Market Liberalization: Economic structural adjustment programmes, Macro-economic stabilization, The role of the state in liberalized markets, Strategies for reforming agricultural marketing, Obstacles to be overcome in commercialization and Privatization of agricultural marketing, Dealing with accumulated deficits, Encouraging private sector involvement in agricultural marketing, Impediments to private sector participation in agricultural markets, impact of the macro-economic environment on private traders, Government action to improve private sector performance

Block 2: Marketing Strategy, Planning and Control

Unit 3: Marketing Strategy, Planning and Control: Strategy, policy and planning, Strategic business units, The need for marketing planning, The process of marketing planning, Contents of the marketing plan, Monitoring, evaluating and controlling the marketing planning, Marketing controls, Marketing plan control, Efficiency control

Unit 4: New Product Development: The impetus to innovation, New product development process
The adoption process, The effect of products characteristics on the rate of adoption, Buyer behavior: The influences on buyer behaviour, Exogenous influences on buyer behaviour Endogenous influences on buyer behaviour, The consumer buying decision process, Buyer behaviour and market segmentation, Lifestyle segmentation, Organisational markets Industrial markets, Industrial buyer characteristics

Block 3: Commodity Marketing

Unit 5: Stages in a commodity marketing system, Grain marketing, Challenges for grain marketing systems, fruits and vegetables, Livestock and meat marketing, Poultry and eggs marketing, marketing of fresh milk

Teaching methods/activities

- Lectures
- Cases studies from recent marketing trends from the agri and food organisations
- Assignments (Group/ Individual)
- Live project based upon marketing practices adopted by various organizations
- Group discussions on contemporary marketing practices

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the agricultural and food marketing concepts and systems
- Get an insight about the marketing planning and strategies for developing products for meeting the specific needs of the final customers
- Develop a clear view about the commodity marketing practices in India and in International markets

Suggested Reading

- Acharya SS and Agarwal NL. 2011. *Agricultural Marketing in India*. 4th Ed. Oxford and IBH.
- Kohls RL and Uhj JN. 2005. *Marketing of Agricultural Products*. 9th Ed. Prentice Hall
- Mohan J. *Agri-Marketing Strategies in India*, NIPA
- Sharma Premjit. 2010. *Agri-Marketing Management*, Daya Publishing House

ABM 508 Agri Supply Chain Management 2+0

Aim of the course

To introduce the students to the concepts, processes and framework of agricultural supply chain management.

The course is organized as follows:

No	Blocks	Units
1	Overview of Supply Chain Chain Management	1. Introduction to Agri Supply Management 2.Demand Management in Supply Chain 3.Manufacturing Management
2	Procurement Management	1. Purchasing Cycle 2. Material Requirement Planning
3	Logistics Management	1. Distribution Strategies and Management 2.Warehouse Management 3.IT application in ASCM

Theory

Block 1: Overview Of Supply Chain Management

Unit I: Supply Chain: Changing Business Environment; SCM: Present Need; Conceptual Model of Supply Chain Management; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM. Innovations in Global Agri-SCM **Unit II:** Demand Management in Supply Chain: Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain, Basic Principles of Manufacturing Management. SCM Metrics/ Drivers and Obstacles.

Block 2: Procurement Management in Agri. Supply Chain

Unit III: Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification ofPurchases Goods or Services, Traditional Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory (VMI).

Block 3: Logistics Management

Unit IV: History and Evolution of Logistics; Elements of Logistics; Management; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management; Fleet Management; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL); GPS Technology.

Unit V: Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; SCM in Electronic Business; Role of Knowledge in SCM; Performance Measurement and Controls in Agri. Supply Chain Management-Benchmarking: introduction, concept and forms of Benchmarking. Case Studies on the following: (a) Green Supply Chains (b) Global Supply Chains (c) Coordination

in a SC. Value of and distortion of information: Bullwhip effect (d) Sourcing and contracts in SC (e) Product availability with uncertain demand (f) Inventory planning with known/ unknown demand (g) Cases from FAO/IFPRI, etc.

Teaching methods/activities

- Lectures
- Case study on the real life situations regarding the supply chain management practices
- Assignments (Group and individual)
- Live projects
- Newspaper analysis
- Presentations of best practices in the industry
- Videos and guest lectures by the eminent and successful organizations

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the various elements involved in managing agri supply chain from farm to fork
- Relate well with the issues and challenges involved in managing and forecasting the demand of the products
- Develop insights on the techniques of procurement management and handling inventory
- Assess the importance of managing logistics along with adequate handling and packaging intricacies
- Get a overall clarity about the use of information technology to make the agri supply chain more efficient and rewarding

Suggested Reading

- Acharya SS and Agarwal NL. 2011. *Agricultural marketing in India*. Oxford and IBH.
- Altekar RV. 2006, *Supply Chain Management: Concepts and Cases*. PHI
- Chopra S, Meindl P and Kalra DV. 2016. *Supply chain management: Strategy, Planning, and Operation*, Pearson Education India
- Mohanty RP. 2010. *Indian Case studies in Supply Chain Management & other Learning Resources.* Oxford.
- Chandrasekaran N. 2010. *Supply Chain Management: Process, system & Practice*. Oxford.
- Singh S. 2004. *Organic Produce Supply Chains in India-Organisation and governance*. Allied Publ.

ABM 509 International Trade in Agricultural Products 2+0

Aim of the course

To impart knowledge to the students about international trade in agriculture and various provisions under WTO in the new trade regime.

The course is organized as follows:

No	Blocks	Units
1.	Introduction to International Trade	1. Basic concepts of International Trade 2. WTO and its implications for Indian agri business sector 3. International trade restrictions and support systems
2.	Regulations and policy measures International trade	1. India's foreign trade policy framework for 2. Market entry methods 3. Export procedures & documentations

Theory

Block 1: Introduction To International Trade

Unit I: International trade–basic concepts, WTO and its implications for Indian economy in general and agriculture sector in particular.

Unit II: TRIPS, TRIMS quotas, anti dumping duties, quantitative and qualitative restrictions, tariff and non-tariff measures, trade liberalization, subsidies, green and red boxes, issues for negotiations in future in WTO; CDMs and carbon trade. **Unit III:** Importance of foreign trade for developing economy; absolute and comparative advantage, foreign trade of India. Cases on agri business commodity trade practices

Block 2: Regulations and Policy Measures for International TRADE

Unit IV: India's balance of payments; inter regional Vs international trade; tariffs andtradecontrol; exchange rate; the foreign trade multiplier.

Unit V: Foreign demand, supply side analysis, opportunity cost, trade and factor prices, implications for developing countries, market entry methods, export procedures & documentations.

Teaching methods/activities

- Lectures
- Cases on contemporary issues
- Group assignments
- Live projects
- Policy discussions
- Guest lectures
- Industrial visits to firms exporting agri commodities

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic concepts of International trade with reference to WTO and International agreements on Agriculture
- Assess the practices of trade of agri business commodities
- Develop a clear understanding about the significant regulations and policy measures for International Trade

Suggested Reading

- Study materials by the Center for WTO Studies, ITPO, New Delhi, *The Future of Indian Agriculture*
- *Brouwer F and Joshi PK. 2016. International Trade and Food Security, LEI - Wageningen UR, The Netherlands.*

ABM 510 Food Technology and Processing Management 3+0

Why this course?

As a discipline, Food Technology is the combination of engineering, food science, hotel management, and home science. It is an advanced study of the technology and processing methods used to develop, research, manufacture, produce, preserve and process food with related substances.

Aim of the course

Food Technology is the application of food science to the selection, preservation, processing, packaging, distribution and use of safe, wholesome and nutritious food. The food processing industry covers a range of food products.

The Course is organized as follows:

No	Blocks	Units
1.	Food Technology	1. Food Industry in India
2.	Processing Management	1. Basics of Food Processing 2.Food Safety and Costs Analysis 3.Case studies on project formulation in various types of food industries

Theory

Block 1: Food Technology

Unit 1: Food Industry in India: Present status of food industry in India; Organization in food industry; Introduction to operations of food industry; Deteriorative factors and hazards during processing, storage, handling and distribution.

Block 2: Processing Management

Unit 2: Basics of Food Processing: Basic principles of food processing and food preservation through technology interventions; Application of energy, radiations, chemicals and other agents for food preservation; aseptic modes of processing-freezing, quick, cryogenic, high pressure, membrane technology; Packaging of foods, labeling techniques, advanced technologies for packaging.

Unit 3: Food Safety and Costs Analysis: Analysis of costs; risk management; Laws and regulations w.r.t to food industry including production, processing and marketing; Food Safety and Quality Standards-AGMARK, BIS/ISO, FPO, FSSAI, TQM, HACCP etc.

Unit 4: Case studies on project formulation in various types of food industries: Discussion sessions and analysis of Case studies related to dairy, cereal milling, sugarcane production; baking/confectionary, vegetable storage, handling, egg processing, fish and meat products; Cases related HACCP.

Learning outcome

After completion of this course, the students are expected to be able to acquaint the students with different food processing techniques and their management.

VIII. Suggested Reading

- Acharya SS and Aggarwal NL. 2004. *Agricultural Marketing in India*. Oxford & IBH.
- Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Springer
- Jelen P. 1985. *Introduction to Food Processing*. Reston Publishing.
- Potly VH and Mulky MJ. 1993. *Food Processing*. Oxford & IBH
- Fellows PJ. 2016. *Food Processing Technology Principles and Practice*, Woodhead Publishing, 4th Edition
- Potter NN. 2018. *Food science*. McGraw-Hill Education, 6th Edition
- Singh RP, Heldman DR. 2013. *Introduction to Food Engineering.* Elsevier Inc., 5th Edition
- Smith JS, Hui YH. 2013. *Food Processing: Principles and Applications*, Wiley

ABM 511 Rural Marketing 3+0

Aim of the course

To explore the possibilities and potential of the rural market. It aims at critically analyzing the market opportunities, consumer trends and patterns and development of better marketing strategies for the rural areas.

The Course is organized as follows:

No	Blocks	Units
1	Rural Marketing Environment	1. Rural Market Concept & Scope 2.Environmental factors 3.Rural finance 4.Rural consumer's behavior
2	Rural Marketing Strategy	1. Rural Product strategy 2.Pricing for rural markets 3.Promotion and communication strategy

Theory

Block 1: Rural Marketing Environment

Unit 1: Rural Market Concept & Scope: Concept, Definition and Scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India, rural V/S urban market.

Unit 2: Environmental factors: Socio-cultural, economic, demographic, and technological and other environmental factors affecting rural marketing.

Unit 3: Rural finance: Concept, demand, banking model; Finance Schemes of NABARD, Other Schemes of State Govt, Central Govt.

Unit 4: Rural consumer's behavior: Behavior of rural consumers and farmers; buyer characteristics and buying behavior; customer relationship management, rural market research.

Block 2: Rural Marketing Strategy

Unit 1: Rural Product strategy: Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; marketing mix, product mix.

Unit 2: Pricing for rural markets: Pricing policy and pricing strategy, distribution strategy, Rural retailing and modern store formats in rural areas.

Unit 3: Promotion and communication strategy: Media Planning, Distribution channels, personal selling strategies in rural markets, innovations in rural marketing

Teaching methods/activities

- Lectures
- Discussion

- Case Studies
- Student-led presentations

Learning outcome

After completion of this course, the students are expected to be able to develop understanding regarding issues in rural markets like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

Suggested Reading

- Krishnamacharyulu and Ramakrishnan. 2010. *Rural Marketing: Text and Cases*: Pearson Education. 2nd edition
- Singh S. 2004. *Rural Marketing: Focus on Agricultural Inputs*, Vikas Publishing
- Kashyap P. 2011. *Rural Marketing*. Pearson Education
- Kumar D and Gupta P. 2017. *Rural Marketing: Challenges and Opportunities*. Sage Publications.

ABM 512 Fertilizer Technology and Management 3+0

Why this course?

Provide exposure to most recent Nitrogenous and Complex fertilizer production technologies. Improve participants' technical knowledge over a varied range of fertilizer production techniques

Aim of the course

Enhance the participants' analytical and trouble-shooting skills by generating awareness to identify and resolve operational inefficiencies, if any, of their facilities. The Course is organized as follows:

No	Blocks	Units
1	Fertilizer Production	1. Fertilizer development 2.Raw material 3.Production efficiency
2	Testing and Field Trials	1. Testing 2. Field trials

Theory

Block 1: Fertilizer Production

Unit 1: Fertilizer development: Concept, scope, need, resource availability; import and export avenues for fertilizer; types of fertilizers, grading and chemical constituents, role of fertilizers in agricultural production, production and consumption of fertilizer in India.

Unit 2: Raw material Supply; Principles of manufacturing-potassic fertilizers, secondary and micro-nutrient formulations.

Unit 3: Production efficiency: Production efficiency and capacity utilization; quality control and legal aspects fertilizer control order

Block 2: Testing and Field Trials

Unit 1: Testing facilities; constraints in fertilizer use; assessment of demand and supply of different fertilizers, fertilizer distribution, fertilizer storage.

Unit 2: Field trialsand demonstrations; environmental pollution due to fertilizers

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

Provide a platform to exchange ideas on a varied range of production topics, opportunity for active interaction with leading technology experts and to acquaint the students in latest advances in fertilizer technology management.

Suggested Reading

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- *Fertilizer Control Order* (different years). Fertilizer Association of India, New Delhi.
- *Fertilizer Statistics* (different years). Fertilizer Association of India, New Delhi
- *Indian Journal of Fertilizers* (different years). Fertilizer Association of India, New Delhi.
- San Chilli V. 1960. *Chemistry and Technology of Fertilizers*. American Chemical Soc. Monograph Series. Reinhold Publ. Corp.
- Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 2002. *Soil Fertility and Fertilizers*. 5th Ed. Prentice Hall

ABM 513 Management of Agro Chemical Industry 3+0

Why this course?

The agrochemicals (pesticides, hydrogels, plant growth regulators etc.) have played a pivotal role in the past in increasing agricultural productivity and production, and in protecting and preserving the human and animal food, feed, health and the belongings.

Aim of the course

Plant protection chemicals have and will continue to play a crucial role in meeting the food, feed and fiber needs of the mankind.

The Course is organized as follows:

No	Blocks	Units
1.	Agro Chemicals	1. Agro Chemicals 2. Insecticides 3. Fungicides
2.	Insecticide Act and Plant Protection	1. Insecticide Act. 2. Plant Protection

Theory

Block 1: Agro Chemicals

Unit 1: Introduction: Agro-chemicals: Definition and classification; Basic knowledge of agro- chemicals; role and status of agro-chemical industry in India; Pesticides – Classification and Introduction, knowledge of different pesticides.

Unit 2: Insecticides: Insecticides – Definition and classification based on (a)Mode of Entry (b) Mode of Action and(c) Chemical Structure with example; Insecticidal formulation; preliminary knowledge of mode of action of insecticides; knowledge of plant protection equipments.

Unit 3: Fungicides: Fungicides – Classification and preliminary knowledge of commonly used fungicides; Biomagnifications of pesticides and pesticidal pollution.

Block 2: Insecticide Act and Plant Protection

Unit 1: Insecticide Act: Introductory knowledge about development of agro-chemicals; Insecticidal poisoning, symptoms and treatment; Main features of Insecticide Act.

Unit 2: Plant Protection: Directorate of Plant Protection, Quarantine and Storage– A brief account of its organizational set up and functions; IPM Concept – Bio-pesticides – Plant products.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To familiarize the students with the agrochemicals, their structure, classification and development and management of agro-chemical industry.

Suggested Reading

- Dhaliwal GS, Singh R and Chhillar BS. 2014. *Essentials of Agricultural Entomology*. Kalyani Publishers.
- Hayes WT and Laws ET. 1991. *Hand Book of Pesticides*. Academic Press.
- Matsumura F. 1985. *Toxicology of Insecticides*. 2nd Ed. Plenum Publ.
- Rajeev K and Mukherjee RC. 1996. *Role of Plant Quarantine in IPM*. Aditya Books.

ABM 514 Seed Production Technology Management 3+0

Aim of the course

The course covers a wide range of seed science and technology issues related to production of high quality seeds, processing, testing, certification, quality control, seed policies and regulations, variety release and registration, seed quality management in *seed* multiplication systems, seed storage, marketing.

The Course is organized as follows:

No	Blocks	Units
1.	Seed Technology	1. Seed Technology
2.	Seed Management Programmes	1. Development and Management of Seed 2. Maintenance of genetic purity 3. Management of seed processing plant 4. Seed Marketing

Theory

Block 1: Seed Technology

Unit 1: Seed Technology: Role of Seed Technology, its Course Objective and goal, Seed Industry in India, National Seed Corporation – Tarai Seed Development, Corporation, State Seed Corporations, National Seed Project and State Farms and their role.

Block 2: Seed Management

Unit 1: Development and Management of Seed Programmes: Seed Village Concept, Basic Strategy of Seed Production and Planning and Organization of Seed Programme; Types of Seed Programme–Nucleus seed, Breeders seed, Foundation seed and Certified seed etc.

Unit 2: Maintenance of genetic purity: Minimum seed certification standard and Management of breeders & Nucleus seed; Management of seed testing laboratory and research and development.

Unit 3: Management of seed processing plant seed storage management; seed packaging and handling.

Unit 4: Seed Marketing: GM Crop seed, IPR, PBR, Patents and related issues and their impact on developing countries; Statutory intervention in the seed industry; Seed legislation and seed law enforcement, Seed act; Orientation and visit to seed production farms, seed processing Units, NSC, RSSC, RSSCA and seed testing laboratories.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To apprise students regarding principles and efficient management of seed production technology.

Suggested Reading

- Agrawal RL. 2017. *Seed Technology*. Oxford & IBH.
- Desai BB, Katecha PM and Salunkhe DK. 2009. *Seed Handbook: Biology, Production, Processing and Storage*. Marcel Dekker.
- Kelly A. 1988. *Seed Production of Agricultural Crops*. Longman.
- McDonald MB Jr. and Copeland LO. 2012. *Seed Production: Principles and Practices*. Chapman & Hall.

ABM 515 Technology Management for Livestock Products 3+0

Why this course?

Students may study two major topics include meat technology and dairy technology.

They may also do research activities on product development, development of functional meat, an extension of shelf life, and development of milk products.

Aim of the course

The main aim of this course is to disseminating knowledge about hygienic milk production, hygienic slaughter, utilization of slaughterhouse by-products, preparation of value-added meat products, preparing of value-added indigenous as well as milk products, and dressing of food animals.

The Course is organized as follows:

No	Blocks	Units
1.	Livestock product & Technology	1. Status of livestock product and technology 2.Manufacturing technologies
2.	TQM and Marketing of Livestock Products	1. TQM in processing 2. Marketing livestock products

Theory

Block 1: Livestock Product and Technology

Unit 1: Present status of livestock products industry in India: Dairy, meat, skin and hides, wool, etc; SWOT analysis of livestock product industry, importance of value addition of livestock products, Concept of organic milk and meat. New techniques of biotechnology for improving food value.

Unit 2: Manufacturing technologies: Dairy-Manufacturing technologies of various dairy products and byproduct utilization. Meat- Manufacturing technologies of meat and its products, industrial processing and utilization of wool and animal by-products, value-added egg product development.

Unit 3: Milk and meat processing plant: Layout and designing of milk and meat processing plant, abattoir design, sanitation and basic slaughterhouse practices, Plant Management- Production, planning and control, packaging, preservation and storage system for livestock products; transportation system for domestic markets and international markets.

Block 2: TQM and Marketing of Livestock Products

Unit1: Total quality management in processing Total quality management in processing of milk and its byproduct, meat and byproduct, value added egg duct and wool, Quality control measures during storage transit; extent of losses during storage and transport, management measures to minimize the loss.

Unit 2: Marketing livestock products

Milk, meat, wool, fish etc and its byproduct, Marketing and distribution system of animal products; National and international specifications and quality standards for various products; environmental and legal issues involved.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To impart knowledge about management of livestock products, product development, quality control, preservation and marketing strategies for livestock products.

Suggested Reading

- Mandal PK and Biswas AK. 2014. *Animal Products Technology*, Studium Press India Pvt. Ltd.; 1st Edition
- Bishwas AK and Mandal PK. 2014. *Textbook of Poultry, Egg and Fish Processing Technology*, Studium Press (India) Pvt. Ltd.

ABM 516 Fruit Production and Post-Harvest Management 3+0

Why this course?

Postharvest management of fruits and vegetable: A potential for reducing a minimum postharvest losses as well as can potentially reduce production cost.

Aim of the course

A dual purpose of preventing losses that occur due to harvest losses of fruits and vegetables vary from 25% to 40%, depending on the kind of produce and the pre and post-harvest practices they are put through. The Course is organized as follows:

No	Blocks	Units
1.	Fruit Production	1. Introduction 2.Management of horticultural crops
2.	Post-Harvest Management	1. Post harvest management in horticulture-Procurement 2.Post harvest management in horticulture process 3.Marketing of fruits

Theory

Block 1: Fruit Production

Unit 1: Introduction: Global and National Status of Horticultural production in India and emerging scenario

Unit 2: Management of horticultural crops: Establishing an orchard, basic cultural practices, regulation of flowering, fruiting and thinning, protection against insect-pest, weeds: Maturity indices, Harvesting and its relationship with quality, sorting and grading, pre-harvest crop management practices and their influence on quality during storage and marketing.

Block 2: **Post-Harvest Management**

Unit 1: Post-harvest management in horticulture-procurement: Procurement management, important factors for marketing, standardization and quality control, packaging. Physiology of ripening and senescence. Storage system: on-farm storage- evaporatively cooled stores, ventilated storage, pit storage etc. Refrigerated storage refrigeration cycle, controlled/modified atmosphere, hypobaric storage.

Unit 2: Post harvest management in horticulture process: Application of growth regulators for quality assurance, post-harvest treatments: pre cooling, heat treatments (hot water, hot air and vapor heat), fungicides & biologically safe chemicals, irradiation, curing, pulsing *etc*. Packing line operations, packaging of horticultural produce. Transportation rail, road, sea, air. Codex norms for export of perishables. Development of fruit-based carbonated drinks, development of dehydrated products from Some important fruits, storage of pulp in pouches, essential oils from fruit waste, dehydrated fruits. Market structure and export potential of fruits.

Unit 3: Marketing of fruits: Problems in marketing of fruits, and government policy; quality standards for domestic and international trade.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To impart knowledge about management of horticultural crops and post-harvest technologies

Suggested Reading

- Rathore NS, Mathur GK and Chasta SS. 2013. *Post-Harvest Management and Processing of Fruits and Vegetables*, ICAR.
- Chadha KL and Pareek OP. 1993. *Advances in Horticulture*. Vols. I-IV. Malhotra Publ. House.
- Kader AA. 1992. *Post-harvest Technology of Horticultural Crops*. Univ. of California. Div. of Agri. & Natural Resources.
- Jacob JP. 2012. Handbook on Post Harvest Management of Fruits and Vegetables, ASTRAL Publishing.
- NIIR Board of Consultants & Engineers. 2016. *The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits & Vegetables*, NIIR PROJECT CONSULTANCY SERVICES; 3rd Revised Edition
- Thompson K. 2003. *Fruit and Vegetables: Harvesting, Handling and Storage*, Wiley- Blackwell; 2nd Edition.

ABM 517 Farm Power and Machinery Management 2+0

Why this course?

The role of mechanization and its relationship to productivity, employment, social and technological change; performance and *power* analysis(Various sources of *farm power*, their availability and utilization) cost analysis of mechanized agriculture.

Aim of the course

Agricultural machinery management is the section of farm management that deals with the optimization of the equipment phases of agricultural production. It is concerned with the efficient selection, operation, repair and maintenance, and replacement of machinery.

The Course is organized as follows:

No	Blocks	Units
1.	Farm Power and Machinery	1. Farm power and tractors 2. Tillage and Tillage machinery 3. Sowing, Planting and Intercultural Equipment
2.	Agricultural equipments industry analysis of operations	1. Agricultural equipments industry and Cost 2. Cost analysis of operations

Theory

Block 1: Farm Power And Machinery

Unit 1: Farm power and tractors: Farm power in India - sources, IC engines – working principles, two stoke and four stoke engines, IC engine terminology, different systems of IC engine. Tractors – types and utilities.

Unit 2: Tillage and Tillage machinery: Tillage – ploughing methods – primary tillage implements – mould board, disc plough and chisel plough – secondary tillage implements –cultivators, harrows and rotovators – wetland equipment – puddlers, tramplers and cage wheels.

Unit 3: Sowing, Planting and Intercultural Equipment: Sowing methods – seed drills, seed cum fertilizer drills – Paddy transplanters – nursery requirements – implements for intercultural operations – wet land, dry land and garden land intercultural tools. **P**lant Protection Gadgets, Harvesting Machinery and Horticulture tools: Plant protection equipment, tools for horticultural crops.

Block 2: Agricultural Equipments Industry and Cost Analysis Of Operations

Unit 1: Agricultural equipments industry: Agricultural equipments production, marketing and constraints; establishment of agricultural engineering enterprises (agro service centers, etc.). Equipment for land development and farm machinery selection: Equipment for land development and soil conservation.

Unit 2: Cost analysis of operations: Cost analysis ofoperations using different

implements, economic performance of machines, optimization of tractor implements system and transport of farm produce. Cost of operation of farm machinery – Tractor and implement selection

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To equip the students with sufficient theoretical knowledge and practical skills about farm power and tractor power, implement resources used in agriculture, their cost of operation and selection.

Suggested Reading

- Senthilkumar T, Kavitha R and Duraisamy VM. 2015. *A text book of farm machinery*, Thannambikkai Publications, Coimbatore.
- Jagadishwar S. 2010. *Elements of agricultural engineering.* Standard Publishers Distributors, New Delhi.

ABM 518 Food Retail Management 2+0

Why this course?

Study a short *course* in *Retail Management* to learn how to run a retail store or department efficiently and to introduce you to key issues and concepts associated with the *retail* environment. Topics covered in the *course* typically include business administration, visual merchandising, and marketing.

V. Aim of the course

Identify the most dramatic change in food retailing today; Assess the variety and Define a target market; Explain why a retailer would want to meet the needs of a Customer. Describe the steps to recruiting top talent; Identify selection and training.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Introduction to Food market 2.Value Chain in Food Retailing
2.	Retail Marketing Strategy	1. Marketing Mix in Food Retail Management 2.Managing Retail Operations 3.Retail Sales Management

Theory

Block 1: Introduction

Unit 1: Introduction to Food market: Introduction to International Food market, India's Competitive Position in World Food Trade, Foreign Investment in Global Food Industry, Retail management and Food Retailing, The Nature of Change in Retailing, Organized Retailing in India, E-tailing and Understanding food preference of Indian Consumer, Food consumption and Expenditure pattern, Demographic and Psychographic factors affecting Food Pattern of Indian Consumer.

Unit 2: Value Chain in Food Retailing: **V**alue chain and value additions across the chain in food retail, Principal trends in food wholesaling and retailing, Competition and pricing in food retailing, various retailing formats, the changing nature of food stores, market implications of new retail developments, food service marketing.

Block 2: Retail Marketing Strategy

Unit 1: Marketing Mix in Food Retail Management: Merchandise Management, Pricing Strategies used in conventional and non-conventional food retailing, Public distribution system, Promotion mix for food retailing, Management of sales promotion and Publicity, Advertisement Strategies for food retailers & Brand Management in Retailing.

Unit 2: Managing Retail Operations: Managing Retailers' Finances, Merchandise buying and handling, Logistics, procurement of Food products and Handling Transportation of Food Products.

Unit 3: Retail Sales Management: Types of Retail Selling, Salesperson selection, Salesperson training, Evaluation and Monitoring, Customer Relationship Management, Managing Human Resources in retailing, Legal and Ethical issues in Retailing.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

It will equip the students with desired knowledge and skills for managing food retail operations.

Suggested Reading

- Singh S. 2011. *Fresh food retails in India: Organisation and impacts*, Allied publishers Pvt. Ltd., New Delhi
- Mahapatra. S, *Food Retail Management*, Kalyani Publishers
- Zentes, Joachim, Morschett, Dirk, Schramm-Klein, Hanna 2017. *Strategic Retail Management: Text and International Cases*, Springer Gabler.
- Agrawal N and Smith SA. 2015. *Retail Supply chain Management: Quantitative Models and Empirical Studies*, Springer; 2nd revised edition.

ABM 519 Management of Agricultural Input Marketing 2+0

Why this course?

It will help in gaining a deeper understanding of the four P's of marketing as applied to agricultural input marketing and an exposure to social and ethical issues is oriented in the course.

Aim of the course

The present course aims at familiarizing the participants with various aspects of agricultural input marketing in India.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Market for agricultural inputs
2.	Marketing of Agricultural	1.Marketing of seeds 2. Marketing of fertilizers Inputs 3. Marketing of pesticides 4. Marketing of tractors

Theory

Block 1: Introduction

Unit 1: Market for agricultural inputs: Nature of demand, promotional media, nature of competition, a framework for understanding the markets for inputs, agronomic potential, agro economic potential, effective demand, actual consumption.

Block 2: Marketing of Agricultural Inputs

Unit 1: Marketing of seeds: Government policy, product, trade practices in seed production, seed pricing, input costs, distribution system, management of seed distribution. proper storage of seeds, promotion, problems faced by seed industry, strategy for a seed enterprise, source of seeds, terms of transaction for seed procurements.

Unit 2: Marketing of fertilizers: Nature of Indian fertilizer market, product, fertilizer distribution, marketing cost and margins, credit, dealer selection and management, fertilizer promotion and extension, promotional program, advertising in fertilizers, emerging marketing mix in fertilizer, extension strategy for the future, marketing of biofertilizers, strategies for fertilizer marketing.

Unit 3: Marketing of pesticides: Market profile, structure of industry, farmer behaviour, problems of farmers in pesticide purchase and usage, marketing mix, bio pesticides market development and promotion activities, problems in marketing of bio pesticides. Integrated pest management.

Unit 4: Marketing of tractors: Segments in tractor market, market share, nature of demand, buyer behaviour, role of distribution, promotion, MNC's. Marketing of

credit-Nature of market, market segment, market players, marketing mix, marketing options. Strategies for input marketing-Client and location specific promotion, joint promotion, interdependence of input markets, management of demands, developmental marketing, usp, extension services, ethics in business, sustainability.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To enhance the understanding and analytical capabilities with respect to products, market environment, and operational issues in marketing of agricultural inputs.

Suggested Reading

- Mahapatra. S. *Management of Agricultural Inputs*, NIPA Publishers
- Seetharaman SP.: *Agricultural Input Marketing,* Oxford & IBH Pub. Co.
- Krishnamacharyulu CSG. : *Rural Marketing: Text and Cases*, Pearson Education India Venugopal P. 2014. *Agri-input Marketing in India,* SAGE Publication; 1st Edition.

ABM 520 Feed Business Management 2+0

Why this course?

It will help in gaining a deeper understanding of the production, processing and marketing of cattle feed, poultry feed and fish feed.

Aim of the course

The present course aims at familiarizing the participants with various aspects feed for livestock and poultry.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Feed resources 2. Nutrients requirements of livestock and poultry
2.	Feed Preparation and Distribution	1. Feed preparation 2. Importance of mineral mixture 3. Feed Distribution

Theory

Block 1: Introduction

Unit 1: Feed resources: Gap between demand and availability of nutrients; status of feed industry in India and world, constraints in the development of Indian feed industry.

Unit 2: Nutrients requirements of livestock and poultry: Knowledge about the quality of feed ingredients used in feed manufacturing. Procurement procedure of feed ingredients, scientific storage of feeds and feed ingredients. BIS, CLAFMA and all other commercial standards of all class of livestock and poultry feeds.

Block 2: Feed Preparation and Distribution

Unit 1: Feed preparation: Layout and design of feed plants, feed plant management; Basic principles of processing of feeds, Feed preparation for cattle and poultry and as specialty feeds for aqua and pet animals.

Unit 2: Importance of mineral mixture: Feed additives, supplements and pass feed, to know the new technology regarding improving the feeding value of poor quality roughages. To acquaint the concept of silage technology, complete feed block technology, hydroponics technology and UMMB technology.

Unit 3: Feed Distribution: Distribution channels, regulations relating to manufacture and sale of feed stuffs.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To acquaint the students with the role and importance of feed industry and the production of feed for livestock and poultry.

Suggested Reading

- Morrison FB. 1961. *Feeds and Feeding*, Abridged, Morrison Publishing; 9th edition John.
- Moran. 2005. Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics, Csiro Publishing.
- Moran J and McDonald S. 2010. *Feedpads for Grazing Dairy Cows*, Csiro Publishing.
- Kellems RO and Church DC. 2009. *Livestock Feeds and Feeding*, Pearson; 6th Edition

ABM 521 Managmement of Veterinary Hospitals 2+0

Aim of the course

It will help in gaining a deeper understanding of the Veterinary Science is the science of *treating* and curing the diverse types of Animals.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Feed resources 2.Nutrients requirements of livestock and poultry
2.	Feed Preparation and Distribution	1. Feed preparation 2.Importance of mineral mixture 3.Feed Distribution

Theory

Block 1: Veterinary Hospital Administration

Unit 1: Needs, aims and objectives: Objectives of Veterinary hospitals; the existing and simulated situations under which veterinary hospitals work or are to work.

Unit 2: Designing and planning an ideal hospital: Optimizing the use of resources - human, space, equipment, drugs, time, capital, etc.; Materials management and problems Normal purchase procedure. Receipt; storage and distribution of materials Cost reduction & scientific inventory control. Information system and materials management performance. Equipment maintenance, condemnation & disposal.

Unit 3: Authority, responsibility: Accountability of management for optimizing the use of skill, developing and upgrading skills and technology; efficient system of record keeping and accounting; Concept of quality & Total quality management (TQM) Introduction to Veterinary audit, Statistical quality control (SQC), Quality control Circle (QCC).

Block 2: Information System & Quality Control

Unit 1: Hospital information system: Hospital information system as an aid to efficient controlling and monitoring; need for financial resources - investment and working capital; Records: Types & Methodology, Reports and Reporting system. Contemporary and need-based methods of accounting; General consideration. Need based information system. Applicability in surveillance & monitoring; planning & policy making; cost control.

Unit 2: Quality control system: Economic functions and quality control system; Animal health Economics: An introduction Need for financial resources (type and need). Investment planning and working capital; Budgeting and cost cutting (cost control). legal aspects in the functioning of the hospital.

Learning outcome

The objective of this course is to acquaint the students about the designing, planning, organizing, and controlling the veterinary hospitals for optimizing the use of space, capital, skill and other resources.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Suggested Readings

- John McCarthy. 2015, Basic Guide to Veterinary Hospital Management 2nd Edition. Amer Animal Hospital Assn.
- Subrahmanyam B.V.2018. Hospital Management And Administration Principles And Practice Including Law. Aatithi Books, Delhi.
- Mark Opperman, CVPM, Sheila Grosdidier, BS, RVT, PHR, Portia Stewart Alison Fulton. 2014. The Art of Veterinary Practice Management. Advanstar Communications.
- Maggie Shilcock and Georgina Stutchfield. 2008. Veterinary Practice Management - A Practical Guide. Elsevier Ltd

ABM 522 Poultry and Hatchery Management 2+0

Why this course?

This course introduces about updated production standards achievable under field conditions and financial viability of poultry operations. This specialized course is designed to train persons in Incubation and Hatchery Management and is meant for those engaged in or scheduled to take up Hatchery operations.

Aim of the course

To give the opportunity for trainees to learn about raising chickens for their meat and eggs in order to manage a small-scale, commercial poultry enterprise that will be profitable

The Course is organized as follows:

No	Blocks	Units
1	Introduction	1. Poultry and hatchery Business 2. Poultry and hatchery unit
2	Hatcheries and Risk Management	1. Incubation and hatching 2.Franchise hatcheries management 3.Personal management and insurance

Theory

Block 1: Introduction to Poultry and Hatchery Industry

Unit 1: Poultry and hatchery Business: Poultry and hatchery industry; Present scenario of Poultry industry, Integration in poultry farming, Scope and future perspective, role of management in poultry industry.

Unit 2: Poultry and hatchery unit: Planning and establishing a poultry and hatchery unit- location, size and construction; farm and hatchery equipments and physical facilities; organizing and managing a poultry farm and hatchery.

Block 2: Hatcheries and Risk Management

Unit 1: Incubation and hatching Production of quality chicks and eggs; factors affecting hatchability; bio-security and hatchery sanitation; handling of hatching eggs; maintaining chick quality-chick grading, sexing, packing, dispatch, transportation and chick delivery.

Unit 2: Franchise hatcheries management: Custom hatching; brooding; growing and laying management; crisis management; industrial breeding, feeding, housing and disease management; waste management; Record management; cost accounting and budgetary control.

Unit 3: Personal management and insurance: Labour relations including wages and salaries, job evaluation and employee appraisal; marketing management direct sale and sale through franchisees/ agents, advertisement, sale and after sale services, other innovative sales strategies.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

The course provides an insight into the importance of management in poultry industry, managing a poultry and hatchery enterprise, planning production of poultry products, financial, personnel and marketing management.

Suggested Reading

- Handbook of Poultry Science.
- Rathinam GK. 2015. *Manual of Hatchery Management: For Poultry Professionals* Hardcover.

ABM 523 Management of Floriculture and Landscaping 2+0

Why this course?

It deals with the cultivation of flowers and ornamental crops from the time of planting to the time of harvesting. It also includes production of planting materials through seeds, cuttings, budding, grafting, etc, up to the marketing of the flower and flower produce.

Aim of the course

The objective of this course is to expose the students with floriculture and landscaping technologies and their Agri-business implications including international trade.

The Course is organized as follows:

No	Blocks	Units
1.	Management of Floriculture	1. Introduction 2. Indoor and ornamental plants
2.	Landscaping and Trading	1. Introduction 2. Landscape gardening 3. Value-addition in floriculture

Theory

Block 1: Management Of floriculture

Unit 1: Introduction: Introduction, importance and scope of floriculture industry and landscaping; Recent advances in floriculture industry.

Unit 2: Indoor and ornamental plants: Raising of foliage plants in pots, production technology of ornamental plants, commercial cultivation of flower crops (rose, jasmine gladiolus, tuberose, marigold, aster, carnation, gerbera, cilium chrysanthemum; special techniques for forcing of flowers for export.

Block 2: Landscaping and Trading

Unit 1: Introduction: Drying and dehydration of flowers; bonsai; scope of landscaping, response of flowering plants to environmental stresses;

Unit 2: Landscape gardening: Styles of gardening; modern and traditional garden planning; Socio-aesthetic planning; use of computers in designing gardens; planning towns

Unit 3: Value Addition in floriculture: Extraction, purification and storage of essential oils and perfumes; post-harvest storage changes; packing techniques of produce harvesting of flowers for export and home use, Export-Import trade in flowers and their specifications along major trading countries.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

Students are suitable for it working independently and apply the latest trends to their work. They should be able to understand about floriculture and landscaping.

Suggested Reading

- Banker N. 2011. *Landscape gardening*, IBDC publishers, Lucknow
- Misra RL and Misra S. 2012. *Landscape gardening*, Westville Publishing House, New Delhi
- Chadha KL and Choudhary B. 2006, *Ornamental Horticulture in India*. ICAR. New Delhi
- Grindal EW. *Every Day Gardening in India*. DB Tarporevala Sons.
- Randhawa GS and Mukhopadhyay A. 1998, *Floriculture in India*. Allied Publ., New Delhi

ABM 524 Risk Management in Agri Business 2+0

Why this course?

Risk and uncertainities is involved in food and Agribusiness industries. Government to formulate policy that will encourage investors adopt the highlighted risk keeping in view priority of food security for rising population. The focus is to foster profitability in agri-allied sector.

Aim of the course

Identification, mitigation and management of risk is unique to agriculture-production, markets, finance, Institutions and HR. Policy implications at local, regional, national as well as international level. Data analysis and research findings to help in decision making at firm and industry levels using history to guide future events/projection, Degree of risk varies in agri-business compared to other sectors. The Course is organized as follows:

No	Blocks	Units
1.	Risk Management process	1. Financial intermediation 2. Strategic Issues in Bank Marketing 3. Credit policy in banks
2.	Introduction to banking Operations and Risk Management	1. Banking operations 2. Definition of Risk and risk management techniques

Theory

Block 1: Risk Management Process

Unit 1. Financial Intermediation, Indian Financial system, Origin and Growth of Banking. RBI and its functions. Principles of Banking, Banking Law and Practice. Nationalization of Banks in India, Deposit Products, Lending Activities, Retail Banking, Wealth Management, Financing SMEs, Corporate Banking, Forex Management, Fee-Based & Subsidiary Services, Plastic Money, Role of Central Banks, Emerging Trends in Banking, Fundamentals of International Banking.

Unit 2: Strategic Issues in Bank Marketing, Positioning Bank Services in the Market, New Product Development, Pricing and Launching, New Distribution Channels for Bank Marketing, Communicating and Promoting Bank Services, Improving Quality and Productivity, Customer Relationship Management in Banks, Globalizing Bank Services, Opportunities and Challenges in Bank Marketing.

Unit 3: Credit Policy in Banks, Principles of Credit Management, Objectives of Credit Management, Credit Disbursal and Monitoring, Credit Deployment and Types of Borrowers, Follow up and Recovery Management, Treasury Operations, Introduction to Risk Management in Banks, Rural Banking in India, Security Considerations, Control System in Banks, Corporate Governance in Banks, Annual Reports and Statutory Audit.

Block 2: Introduction to Banking Operations and Risk Management Unit 1: Introduction to Banking Operations, Front Office and Back Office Operations, Operational Controls, Demand Forecasting and Resource Allocation, Policy Framing – Deposits, Advances and Investments, Services Design and Delivery Strategies in Banks, Service Quality Metrics, Work Measurement and Quality Assurance, Payment and Settlement Systems, RTGS and Clearing House, Cash Management Services, Facilities Planning, ERP in Banks, BPR in Banks, IT Enabled Supply Chain Management, Disaster and Recovery Management.

Unit 2. Introduction to Risk, Risk Management Essentials, Measurement of Risk, Loss Exposure, Risk Management – Non-insurance Techniques, Introduction to Insurance, Principles of Insurance, Insurance Industry, Insurance Market, Insurance as Risk Management Techniques, Selection and Implementation of Risk Management Techniques.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

Developing an understanding of the different types of risk in general to agriculture sector and with special reference to agriculture business.

Suggested Reading

- Sethi J and Bhatia N. 2012. *Elements of Banking and Insurance*. PHI Learning
- Jian W and Rehman A. 2016. *Risk Management in Agriculture: Theories and Methods*. Science Publishing group
- Hardaker JB, Huirne RBM, Anderson JR and Lien G. 2004. *Coping With Risk in Agriculture*, CABI Publishing, 2nd Edition
- Rose PS and Hudgins SC. 2006. *Bank Management & Financial Services.* Mcgraw-Hill College; 7th edition

ABM 525 Management of Agribusiness Cooperatives 2+0

Why this course?

Proper management enables **c**ooperatives to offer high quality, efficient and effective services to their members. Moreover, well managed agricultural cooperatives can also contribute to wider development issues such as food security, sustainable use of natural resources and inclusive employment creation.

Aim of the course

These cooperatives were usually initiated by small scale farmers, as a response to their weak position in the market. By joining forces they could improve this position and obtain better prices and services for the purchase of inputs and the marketing of produce.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Cooperative administration 2. Cooperative management
2.	Cooperative Movement and	1. Cooperative Movement Management 2. Human resource management 3.Overview of agribusiness cooperative

Theory

Block 1: Introduction

Unit 1: Cooperative administration: Global perspective, ecology of cooperative administration, cooperative sector and economic development.

Unit 2: Cooperative management: Nature, functions and purpose of cooperatives procurement, storage, processing, marketing, process of cooperative formation, role of leadership in cooperative management.

Block 2: Cooperative Movement and Management

Unit 1: Cooperative Movement: The state and cooperative movement, effects of cooperative law in management, long range planning for cooperative expansion, policy making.

Unit 2: Human resource management: Placement and role of board of directors in cooperative management.

Unit 3: Overview of agribusiness cooperative: Credit cooperatives, cooperative marketing, dairy cooperative; financing agribusiness cooperative.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To provide the students an understanding about the agribusiness cooperative organizations and their management.

Suggested Reading

- Kamat GS. 2011. *New Dimensions of Cooperative Management*. Himalaya Publ. House.
- Ansari AA. 1990. *Cooperative Management Patterns*. Anmol Publ.
- Ravichandran and Nakkiran. 2009. *Cooperation* (*Theory & Practice*) Neha Publishers & Distributors;
- Sah AK. 1984. *Professional Management for the Cooperatives*. Vikas Publ. House.
- Anwar SA. *HRM Practise in Cooperative Sector*. Idea Publishing.

ABM 526 **Business Analytics for Agriculture** 1+1

Why this course?

Analytics can enble farmers to make data-based decisions like which crops to plant for their next harvest. Reality as actionable insights to make decisions on data and information to improve agronomic opportunities, such as timing of applications, product decisions, amounts of products, and profitability of decision making.

Aim of the course

To make the students understand the concepts of data science tools and techniques and develop the skills for using it strategically and for the developing of the agri business sector.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Introduction 2. Fundamentals of Research
1.	Machine and Deep Learning	1. Supervised machine learning-1 2. Supervised machine learning-2 3. Deep learning

Theory

Block 1: Introduction

Unit 1: Introduction to data science, evolution of data science, work profile of a data scientist, career in data science, nature of data science, typical working day of a data scientist, importance of data science in agribusiness; defining algorithm, big data, business analytics, statistical learning, defining machine learning, defining artificial intelligence, data mining; difference between analysis and analytics, business intelligence and business analytics, typical process of business analytics cycle.

Unit 2: Fundamental of Research

Fundamentals of R and RStudio, fundamentals of packages of RStudio, data manipulations, data transformations, normalization, standardization, missing values imputation, dummy variables, data visualization (2D and 3D), basic architecture of machine learning analytical cycle, descriptive analytics-case study covering data manipulation, measures of central tendency, measures of dispersion, measures of distribution, measures of associations, t-test, f-test, ANOVA, Chi-square test, basic statistical modeling framework.

Block 2: Machine and Deep Learning

Unit 1: Supervised machine learning: Basic framework, regression models and classification models. Linear regression, nonlinear regression, multiple regression, polynomial regression, lasso regression, ridge regression, stepwise regression,

quantile regression, logistic regression.

Unit 2: Supervised machine learning: Linear discriminant analysis, principal component analysis, factor analysis, support vector machines, naïve Bayes, nearest neighbors, decision trees, random forest, ensemble methods, *k*-fold cross validation, X gradient boosting. Unsupervised machine learning—basic framework, concept of clustering, k-means, c-means, hierarchical clustering, hidden markov models, forecasting models (AR, MA, ARMA and ARIMA).

Unit 3: Deep learning: Basic framework of neural nets, types of neural nets, computer vision, object detection and localization, gradient descent optimization for loss function, regularization L1 and L2, feed forward neural nets, back propagation, recurrent neural nets, convolutional neural nets, reinforcement neural net, concurrent net, introduction to IoT. All the illustrations used in the syllabus of Data Science in Agribusiness will be primarily from agribusiness domains and RStudio will be used for practical purposes.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To equip students of agribusiness with knowledge, skills and attitude for using data science tools and techniques so that agribusiness get competent professionals who can strategically and successfully implement data science applications.

Suggested Reading

- *Deep Learning with R*. MEAP Edition, Manning Early Access Program. Version 1, © 2017, Manning Publication.
- James RG, Witten D, Hastie T and Tibshirani R. 2017. *An Introduction to Statistical Learning with Application.* Springer Publication
- Millstein F. 2018. *Machine Learning With Tensorflow: A Deeper Look At Machine Learning*
  With Tensor Flow Frank Millstein
- Stanton J. 2012. *Introduction to Data Science.* Version 3, SAGE Publications, Inc.

ABM 527 Dairy Business Management 1+0

Why this course?

The main objective of dairy management course is to provide basic input to students about production, planning and management of dairy farms, entrepreneurship development in milk preservation, entrepreneurship development in dairy processing and management of dairy farm, co-operative and industry.

Aim of the course

To emphasize on the application of Principles of Management in dairy business with special emphasis on co-operative dairy units. The emphasis shall be on main functional areas like Finance, Marketing, Human Resources, Production and Information Technology.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Introduction to commodity derivatives 2. Dairy Plant Management System
2.	Dairy Business Strategy:	1. Marketing Management, Supply Chain and International Trade in Dairy sector 2. Strategic, HR Management and Entrepreneurship in Dairy Sector 3. Financial Management and Financial Analysis in dairy sector

Theory

Block 1: Introduction

Unit 1: Dairy Development in India: Dairy organizations: functioning, Challenges and Opportunities, Anand pattern dairy Cooperatives: features and impact; Public sector dairy schemes, Dairy Development schemes, Dairy problems and policies, National Dairy Plan-I, Rise of Producer Companies. Policy Frameworks in context to dairying.

Unit 2: Dairy Plant Management System: Production Planning and control in dairy plants, milk procurement from the rural milk producer, milk processing and products manufacturing. Pricing and marketing of milk and milk products. Survey on milk production potential and marketed surplus of milk for setting up of milk plants, energy utilization, Conventional and nonconventional sources of energy used in dairy sector. Concept of Quality; TQM concept and Kaizen in Dairy Industry, new concepts in quality assurance (HACCP; ISO certification); patent laws, pollution control laws in relation to dairy plants. Guidelines for obtaining ISO/HACCP certification for dairy plants. SQC in dairy operations.

Block 2: Dairy Business Strategy:

Unit 1: Marketing Management, Supply Chain and International Trade in Dairy sector: Marketing- mix in relation to dairy sector, marketing environment,. Marketing Opportunities Analysis in Milk and Milk Products: Demand status of Milk and milk products in the country, growth rates, Marketing research and marketing information systems; Market measurement present and future demand; Market forecasting. Market segmentation, Product-mix; Promotion mix decisions. Advertising; Sales Promotion. Food and Dairy Products Marketing, Consumer Buying Behaviour; New product development process Price determination and pricing policy International Marketing. Marketing Composition & direction of Indian exports Exports- Direct exports, indirect exports; WTO and its Implications; SPS/ TBT; Supply chain Management in Dairy sector Logistics Management: Primary and Secondary Markets; Distribution channels; chilling points

Unit 2: Strategic, HR Management and Entrepreneurship in Dairy Sector: PESTLE analysis, BCG matrix, Strategic Management in dairy industry, Governance Structure in Dairy Sector, Management control System. Organisational Performance parameters – Quantitative and Financial, Use of Balanced Score card and other strategy control tools. HR management practices in dairy sector, Promotions, transfers employee remuneration and other HR benefits and problems. Motivation, turnover, employee capacity building, Training and orientation etc. social and business economics; industrial relations and human values; labour laws; trade unionism Business Plan Preparation; TIDP plant setting; Compliances Systems in Dairy Industry

Unit 3: Financial Management and Financial Analysis in dairy sector: Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis. Sources of long term capital in dairy Industry: Grants from NDDB, Grants from NABARD, Government and Other Schemes, cost of debt, debentures, preference share capital, equity share capital & retained earnings, overall cost of capital. Capital budgeting in dairy Industry. Various techniques: NPV, IRR, etc. Financial Planning and control in dairy Industry: Budgeting process, Problems and practices in Budgeting and evaluation. Cost Volume– Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis. Costing in Dairy sector: Costing Techniques and Costing of various dairy products – Milk costing based on Fat and SNF, Ice cream, milk, Paneer, etc. Essentials of sound costing system. Different methods of costing, elements of cost: Labour- recording of time, idle time, methods of remunerating labour, Premium & Bonus Plans, Materials, Overheads.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

- To understand the overall scenario of dairy and develop insights in managing dairy as a entrepreneurial venture.
- To enhance the Decision making, Critical thinking and the problem solving capabilities of the students.
- To bring out the hidden potential and entrepreneurship aptitude of the students and also to encourage team building activities.

Suggested Reading

- Acharya R M and Kumar P. *Dairy Production & Business Management* EIRI, Dairy Darming
- Rao Venkateswara, *Dairy Farm Busines Management* Singh Umashankar, *Dairy Farming*

ABM 528 Agri Extension Management 1+0

Why this course?

To enhance the techno-managerial competence of extension functionaries and to acquaint the extension functionaries on the latest developments in the field of agricultural extension

Aim of the course

To equip the extension functionaries in latest tools and techniques for participatory decision making and to develop an insight into various extension models to enrich the agri - value chain

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Approaches of Agricultural Extension 2.Cyber Extension
2.	Implications and contemporary	1. Implications of WTO issues 2. Extension and contemporary issues

Theory

Block 1: Introduction

Unit 1: Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

Unit 2: Cyber Extension: Concept of cyber extension, national and international cases of extension projects using ICT and their impact of agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research -Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market – Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership. Stakeholder's analysis in Extension. Main streaming gender in Extension - Issues and Prospects

Block 2: Implications and Contemporary Issues

Unit 1: Implications of WTO: OA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI- NGO collaboration to improve efficiency of extension.

Unit 2: Extension and contemporary issues: Extension and issues related to rural poverty. Privatization of Extension. Intellectual Property Rights (IPRs). Extension Reforms in India –Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through

Commodity Interest Groups. Organization innovations in Extension - ATIC, IVLP, Kisan Call Centres.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

By the end of the course student will be able to critically analyze different Agricultural Extension approaches, understand Agricultural Knowledge Information System (AKISs) ITK, Understand Advances in Extension - Cyber extension, ICT enabled extension services; Market Led Extension, Public Private Partnership, Mainstreaming gender in extension organizational Innovations.

Suggested Reading

- Bagchi J. 2007. *Agriculture and WTO Opportunity for India*.
- Sanskruti Chambers R, Pacy A and Thrupp LA. 1989. *Farmers First*. Intermediate Technology Publ.
- Crouch BR and Chamala S. 1981. *Extension Education and Rural Development*. Macmillan.
- John KC, Sharma DK, Rajan CS and Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems*. MANAGE, Concept Publ. Co.
- Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.
- Narasaiah ML. 2005. *Agricultural Development and World Trade Organization*. Discovery Publ.
- Talwar S. 2007. *WTO Intellectual Property Rights*. Serials Publ.
- Van den Ban BW and Hawkins BS. 1998. *Agricultural Extension*. S.K. Jain Publ.
- Venkaiah S. 2001. *New Dimensions of Extension Education*. Anmol Publ.

ABM 529 Renewable Energy Sources Management 1+0

Why this course?

Renewable Energy Management will contribute to the promotion of renewable energy sources in countries, especially developing nations.

Aim of the course

The course aims to provide fundamental clarity regarding various renewable & alternative energy sources/ technologies options available today, its usage potential & related aspects like cost, impact on environment, etc.

The Course is organized as follows:

No	Blocks	Units
1	Introduction	1. Introduction 2. Commercial application
2	Implications and contemporary issues	1. Institutional Framework 2. Devices for renewable energy development

Theory

Block 1: Introduction

Unit 1: Introduction: Concept on alternate and non-conventional energy sources. Biofuels, Geothermal, Ocean, Hydropower, Biogas, Solar and Wind energy.

Unit 2: Commercial application: Commercial application of renewable energy sources and its benefits. Government Policy towards promoting renewable energy.

Block 2: Institutional Framework and Types

Unit 1: Institutional Framework: MNRE, CREDA-Renewable Energy Development Authority, State level Renewable Energy Development Agency, Society of Renewable Energy.

Unit 2: Devices for renewable energy development: Biogas plant, Wind Mills, Solar Cells – Solar Pumps, Solar Dryers, Solar water heating system, etc.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To provide an insight to the meaning and concepts of Renewable energy resources development and Institutional support as well as Government policy framework.

Suggested Reading

- Sorensen B. 2010. *Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning*, Elsevier Publishing; 4th Edition
- Armaroli N, Balzani V and Serpone N. 2013. *Powering Planet Earth– Energy Solutions for the Future*, Wiley
- Boyle G. 2012. *Renewable Energy: Power for a Sustainable Future*, Oxford; 3rd Edition
- Twidell J, Weir T. 2013. *Renewable Energy Resources*, CRC Press; 3rd Edition
- Ahmed AI. *Renewable Energy Sources* by Jain Brothers

ABM 530 Quality Management for Agribusiness 1+0

Why this course?

The focus of the process is to improve the quality of organizations outputs, including goods and services, through continual improvement of internal practices

Aim of the course

The course will help the students to have an understanding of the quality standards in agribusiness.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Basic concepts of quality management 2.TQM
2.	Quality grades, standards and standards Control	1. Quality grades and 2. Statistical to quality control 3.Food quality standards

Theory

Block 1: Introduction

Unit 1: Basic concepts of quality management: importance of quality and the role of quality assurance in agribusiness.

Unit 2: Total Quality Manangement: TQM and business strategy. Quality control process and its relevance.

Block 2: Quality Grades, Standards And Control

Unit 1: Quality grades and standards: Overview and relevance, benefits to consumers, producers and food processors, food grades and standards for various food commodities; cereals, fruits and vegetables, meats, poultry products.

Unit 2: Statistical to quality control: Statistics relevant to quality control, quality control charts used in the food industry, process control to assure food quality, food processing.

Unit 3: Food quality standards: Food quality standards and world food trade. HACCP, ISO9000, auditing and certification.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

The course will help the students to have an understanding of the quality standards in agribusiness.

Suggested Reading

- Luning PA, Marcelis WJ. 2009. *Food Quality Management: Technological and Managerial Principles and Practices.* Wageningen Academic Publishers
- Dale BG. 2004. *Managing Quality*. Blackwell Resources

ABM 531 Advertising and Brand Management 1+0

Why this course?

To impart basic understanding among the candidates about the advertising along with detailed aspects of brand management practices and techniques.

Aim of the course

It aims to ensure consistency of message and the complementary use of media. ... measurable, persuasive brand communication programs with consumers. The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Introduction to Advertising Management 2.Message Strategy 3.Consumer Promotions and Trade Promotions
2.	Branding Decision	1. Major Brand Concepts and branding Decision 2. Managing Brand Equity and Loyalty

Theory

Block 1: Introduction

Unit 1: Introduction to Advertising Management: Integrated Marketing Communications, Setting Goals and Objectives, How advertising works: Segmentation and Positioning Assess the strengths, weaknesses, opportunities and threats (SWOT) of different kinds of promotional campaigns

Unit 2: Message Strategy: Attention and comprehension, Advertising appeals, Associating Feelings with the Brand, Brand Equity, Image and Personality and Group Influence and word of month advertising, Media Planning and Media Strategy, Media Strategy and Tactics, Legal, Ethical and Social concerns of Advertising.

Unit 3: Consumer Promotions and Trade Promotions: Their purpose and types How to plan and evaluate a successful promotion, The relationship between advertising and promotions, Introduction to Global Marketing, Advertising and sales promotion.

Block 2: Branding Decision

Unit 1: Major Brand Concepts and branding Decision: Identifying and selecting brand name Building brand personality, image and identity; Brand positioning and re-launch; Brand extension; Brand portfolio; communication for branding Enhancing brand image through sponsorship and even management.

Unit 2: Managing Brand Equity and Loyalty: Brand Building in Different Sectors - Customers, industrial, retail and service brands. Building brands through Internet, social Media. Building Indian brands for global markets.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

This course investigates various promotional tools used in the communication mix, such as advertising, sales promotion, and publicity, to sell products and services. Concepts include: advertising planning processes, determining advertising and promotional goals and objectives, control and evaluation of advertising and promotional programs, and regulatory issues. Students will develop a comprehensive advertising campaign for a real or imaginary product.

Suggested Reading

- Keller KL. *Strategic Brand Management;* Pearson education, New Delhi Verma, Harsha*: Brand Management;* Excel Books; New Delhi
- Kapferer JN. *Strategic Brand Management;* Kogan Page; NewDelhi
- Kumar S. Ramesh; *Marketing and Branding–The Indian Scenario;* Pearson Education; New Delhi Kapoor, Jagdeep; *24 Brand Mantras*, Sage Publications; New Delhi
- Sengupta S. *Brand Positioning: Strategies for competitive advantage*; Tata McGrawHill; New Delhi.
- Clifton R and Simmons J. *Brands and Branding*; The Economist; Delhi

ABM 532 Agri Infrastructure and Warehousing Management 1+0

Why this course?

To create a pool of Agricultural storage infrastructure, logistics and warehouse professionals with capacity to manage agri-warehouse operations efficiently includes the overall inventory turnover and working capital management.

Aim of the course

The course provides an introduction to the key principles and activities related to the warehousing function in a modern organization designed for receiving, shipping, picking, packing etc. It also includes cold chain project, logistics awareness & training programs.

The Course is organized as follows:

No	Blocks	Units
1.	Introduction	1. Agricultural Infrastructure in India 2. Warehouse Functions: 3. Warehouse Types, Characteristics
2.	Warehouse Management	1. IT for Warehouse Management (WM): 2. Agri-warehousing Management in India

Theory

Block 1: Introduction

Unit 1: Agricultural Infrastructure in India: Incentive schemes, Agri-infra fund, Agri-market Infrastructure, Agri-technological infrastructure fund, Central Government policy on Infrastructure promotion for the development of primary sector such as Irrigation, Watershed development, Rural electrification, Connectivity, Communication and Markets in coordination with the Institutional framework.

Unit 2: Warehouse Functions: Meaning of Warehousing - Importance –Functions: Receiving: Logistics support for Inward Transportation, Unloading, Inspection, Acceptance and Recording; Storing: Space allocation, Facilitation to stocking, Guarding &Recording; Risk bearing- Processing- Grading and branding – Disinfecting services -Issuing: Order preparation, Picking, Dispatching/ Delivery & Recording- Handling, Transportation & Storage of ISO Containers– Utility and Advantages of warehouses- Problems and issues in receiving processes.

Unit 3: Warehouse Types, Characteristics: Warehouse Types, Characteristics of ideal warehouses- Warehouse Layout-Principles and Facilities- Types, Internal Operations: Measures and metrics of warehouse operations, Logistics in the warehouse- Localization of materials in a warehouse, Identification and classification of Materials and products in the warehouse, Managing the material/products turns in warehouse (FIFO/LIFO) - Problems and issues in shipment processes. Warehousing Equipment, Inventory management.

Block 2: Warehouse Management

Unit 1: IT for Warehouse Management (WM): Warehouse documentation- Information flows in the warehouse- ERP-WMS - Bar code – RFID- Organization Data- Warehouse Structure- Warehouse Master Data - WM Material master view- Organization Data- Define Warehouse structure, Warehouse number - Storage type- Storage section - Storage Bin - Picking Area -Storage unit – Quantity- Creating Transfer requirement automatically/ manually – Creating Transfer requirement for storage.

Unit 2: Agri-warehousing Management in India: Agri-warehousing in India, capacity development and utilisation, Role and significance of Central Warehousing Corporation, State warehousing Corporation, Private sector in Agri-warehousing. Status of Warehousing Industry:

Agri-warehousing organisations in India, e-NAM to promote agri-warehouse.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To study the status of development of Agricultural infrastructure as well as the role of Warehouses to boost Agricultural sector.

Suggested Reading

- Study materials of NABARD as well as by the Ministry of Rural development
- Edward F. 2001. *World-Class Warehousing and Material Handling*, McGrraw Hill
- Jeroen P. Van Den Berg. 2009. *Integral Warehouse Management*,Management Outlook Max Muller. 2009. *Essentials of Inventory Management*. AMACOM
- Steven M. Bragg. 2011. *Inventory Best Practices*. Wiley

ABM 533	Contract Farming	1+0

Why this course?

To assess the need of Contract farming arrangement. It relates to agricultural production carried out according to an agreement between a buyer and farmers,

Aim of the course

The course provides an agreement between a farmer and a buyer. At the same time, the buyer also needs to provide the farmer with the necessary inputs required for the farm like land preparation, technical aspects etc. It is an effective means to develop markets and bring about crop rotation.

The Course is organized as follows:

No	Blocks	Units
1	Introduction	1. Need for contract farming 2. Project formulation and management
2	Policies, prospects and global issues	1. Policies for promoting contract farming 2. Prospects of contract farming in India 3. Global issues

Theory

Block 1: Introduction

Unit 1: Need for contract farming: objectives and its definition; contract farming framework, contract farming arrangement-centralized model, nucleus estate model, multipartite model, informal model, intermediary model.

Unit 2: Project formulation and management: Coordination, crop husbandry, human resource. Advantages of contract farming for farmers and sponsors and the problems faced by them.

Block 2: Policies, Prospects And Global Issues

Unit 1: Policies for promoting contract farming: Agreement for contract farming-parties, duration, produce and quality specification, delivery arrangements pricing, insurance, support services, etc.

Unit 2: Prospects of contract farming in India: Prospects of contract farming in India in view of interest for commercialization of agriculture. Active organizations in contract farming and their success stories.

Unit 3: Global issues: lobal issues in contract farming, Contract farming and WTO agreement

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

To provide the students an understanding of concepts, policies, strategies and decisions relating to marketing that can be associated with agribusiness organizations. It involves agricultural production being carried out on the basis of an agreement between the buyer and farm producers. The farmer undertakes to supply agreed quantities of a crop or livestock product, based on the quality standards and delivery requirements of the purchaser.

Suggested Reading

- Sharma P. 2007, C*ontract Farming*, Genetech Books.
- Kuzilwa JA, Fold A, Henningsen A and Larsen MN. *Contract farming and the development of smallholder* agricultural business. Routledge
- Kumaravel KS 2006. *Contract farming in India* - An Introduction.

ABM 534 Human Resource Competence and Capacity Building Systems 1+0

Why this course?

Capacity development is the process by which individuals and organizations obtain, improve, and retain the skills, knowledge, tools, equipment and other resources needed for Human resource development.

Aim of the course

This course is designed to provide an in-depth understanding and enable the participants to manage capacity building processes and performance system for developing human resource.

The Course is organized as follows:

No	Blocks	Units
1	Introduction	1. Human Resource competence 2. Competency modelling and assessment
2	Capacity building	1. Competency based training and development 2. Performance Management System 3. Capacity building systems in agriculture and agri business

Theory

Block 1: **Introduction**

Unit 1: Human Resource competence: Concept and rationale; processes, Organization and Management of competence and competency mapping.

Unit 2: Competency modelling and assessment: Approaches, tools and techniques, competency based human resource management applications.

Block 2: Capacity Building

Unit 1: Competency based training and development: Training methods compared with objectives, learning process and facilities, Developing Group and the Climate: the social process – indicators of group development, the training climate, Trainers And Training Style: Post training support for improved performance at work.

Unit 2: Performance Management System: Establishing and operational sing performance management system; measuring performance- results and behaviour; conducting performance review discussions; harnessing performance management system for performance improvement.

Unit 3: Capacity building systems in agriculture and agri business: Capacity building of farmers and agri stakeholders through e-learning, knowledge management for agri business.

Teaching methods/activities

- Lecture and Discussion
- Case Study
- PPT presentation

Learning outcome

Proactive human resources management is essential to achieve the excellence through Capability Development and Planning. A Competence Profile for Staff Supporting the formal and informal training, job-rotation, traditional class-room courses, internal vs external training.

Suggested Reading

- Kandula SR. 2013. *Competency Based Human Resource Management*. PHI
- Noe RA and Kodwani AD. 2012. *Employee Training and Development*. McGraw Hill Education. Fifth Edition
- Saks AM and Haccoun RR. 2013. *Managing Performance through Training and Development*. Cengage Learning. Sixth Edition

ABM 535 Agri-Commodity Markets and Futures Trading 1+0

Aim of the course

To make the students understand the marketing procedure for commodity futures through commodity exchanges

The course is organized as follows:

No	Blocks	Units
1.	Overview of Commodity Market agricultural in India	1. Price risk management in markets 2. Global Specifications of futures contracts
2.	Mechanics of futures trading	1. Option and forward transaction 2. Clearinghouse and margin system
3.	Market surveillance and risk Control	1. Trading in warehouse receipts 2. Regulation of futures and trading practices in leading national and regional exchanges in India

Theory

Block 1: Overview Of Commodity Market In India

Unit I: Introduction to commodity derivatives and price risk management in agricultural markets; organizational setup of exchanges and specifications of futures contracts in world's leading commodity exchanges

Block 2: Mechanics of Futures Trading

Unit II: Futures trading; hedging price risk using futures contracts; option transaction and forward transaction – concept and mechanism, price discovery mechanism and market efficiency

Unit III: Clearinghouse and margin system; clearing, settlement and delivery of contracts

Block 3: Market Surveillance and Risk Control

Unit IV: Market surveillance and risk control; trading in warehouse receipts (WRs):WRs and collateralized commodity financing

Unit V: Regulation of futures and trading practices in leading national and regional exchanges in India.

Teaching methods/activities

- Lectures
- Live projects
- Assignments (Individual and Group)
- Presentations about the ethical practices of the firms in India
- News paper analysis about the contemporary issues

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Get an overview about the commodity markets in India
- Understand the mechanics of futures trading practices
- Know about the risk and surveillance mechanism available for agri commodity trading in India

Suggested Reading

- Hull, John C. 2017. *Fundamentals of futures and options markets*, Boston, Pearson publication.
- Ram PV and Bala SD. 2016. *Strategic Financial Management*. Snow White Publ. 80.

ABM 536 Strategic Management for Agri Business Enterprises 2+0

Aim of the course

The objective of this course is to provide students a strategic orientation in conduct of the business and to develop a holistic perspective of an organization and to enable the students to analyse the strategic situation strategies in general and functional management areas.

The course is organized as follows:

No	Blocks	Units
1.	Overview of Strategic	1. Strategic management process Management 2. Environment scanning and industry analysis 3. Value Chain Analysis
2.	Strategy Formulation and Choice	1. Strategy formulation 2. Types of strategies 3. Strategic analysis tools and techniques
3.	Strategy implementation and control	1. Strategy implementation and control 2. Entrepreneurial ventures and small businesses

Theory

Block 1: **Overview Of Strategic Management**

Unit I: Introduction - Concepts in Strategic Management, Strategic Management Process; Corporate Governance, Social Responsibility and Ethics in strategic management, Environment Scanning and Industry analysis

Block 2: **Strategy Formulation And Choice**

Unit II: Organization appraisal and strategy formulation: organizational dynamics and structuring organizational appraisal, business models and Value chain analysis, Strategy formulation- corporate level strategies and business strategies, Generic Strategies- Types of Strategies, tools and techniques for strategic analysis.

Unit III: Turnaround and Diversification Strategies: Turnaround strategy - Management of Strategic Change, Strategies for Mergers, Acquisitions, Takeovers and Joint Ventures - Diversification Strategy

Block 3: **Strategy Implementation And Control**

Unit IV: Strategy implementation and control: aspects, structures, design and change: behavioral implementation-leadership, culture, value and ethics, strategic evaluation and control-an overview and techniques of strategic evaluation and control.

Unit V: Strategic issues in managing technology & innovation, entrepreneurial ventures and small businesses, Cases in strategic management

Teaching methods/activities

- Lectures
- Live projects
- Assignments (Individual and Group)
- Presentations about the ethical practices of the firms in India
- News paper analysis about the contemporary issues

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Define the strategic management process and scanning of internal and external environment
- Get a clear picture about value chain analysis
- Understand the different types of strategic choices available and the method of analysis to choose the best among them
- Learn the method of strategic implementation and evaluation for agr entrepreneurial ventures

Suggested Reading

- Wheelen TL and Hunger JD. 2012. *Strategic Management & Business Policy, towards Global Sustainability*, Pearson India Edn. Thirteenth Edition
- David FR and David FR. 2016. Strategic Management, Concept and Cases, Pearson India Edn, Fifteenth Edition
- Thompson Jr. AA, Peteraf M and Gamble JE. 2015. *Crafting and Executing Strategy*. McGraw Hill, Irwin.
- Stead JG and Stead EW. 2014, *Sustainable Strategic Management*. Routledge Taylor & Francis Group.
- Kazmi Azhar. 2015. Strategic Management. Mcgraw Higher Ed. 4th Edition
- Srinivasan R. 2014. Strategic Management. PHI Learning 5th Edition

ABM 537 Operations Management 2+0

Aim of the course

To acquaint the students with the applications of important operations research techniques for better understanding to solve business problems.
The course is organized as follows:

No	Blocks	Units
1.	Introduction to Linear Programming	1. Formulation of Linear Programming problem 2. Methods of solving linear programming problem 3. Transportation and Assignment problems
2.	Inventory control and waiting models	1. Types of inventory and inventory costs line
3.	Decision making under risk and uncertainty	1. Decision problem 2. Decision t ees

Theory

Block 1: Introduction to Linear Programming

Unit I: Linear Programming: Objective, Assumptions, Formulation of Linear Programming Problem, Data Envelopment Analysis, Graphic Method, Simplex method, Introduction to Dynamic Programming, Transportation and Assignment Problems.

Block 2: Inventory Control And Waiting Line Models

Unit II: Inventory control Models: Costs Involved in Inventory Management, Types of Inventory, Economic Order Quantity (EOQ) Model, Continuous Review (Q) System, Periodic Review (P) System, and Hybrid System.

Unit III: Waiting Line Models: Waiting Line Problem, Characteristics of a Waiting- Line System, Single- Channel Model, Multiple-Channel Model, Constant-Service Time Model, Finite Population Model, Sequencing and Replacement models.

Block 3: Decision making Under Risk and Uncertainty

Unit IV: Decision making under Risk and uncertainties, Decision problem, Maximax Criterion, Maximin Criterion, Minimax Regret Criterion, Laplace Criterion, Pay off Tables, Decision Trees, Expected Value of perfect Information, stochastic models, neural networks, Markov process.

Unit V: Game Theory - Two -Person Zero-Sum Game, Simulation, Network analysis– PERT& CPM. Financial Engineering

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Knowledge and understanding about the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type.
- Develop cognitive skills (thinking and analysis) to build and solve Transportation Models and Assignment Models

Suggested Reading

- Taha HA. 2007. *Operations Research - An Introduction*. Prentice Hall.
- Vohra ND. 2017. *Quantitative Techniques in Management*. 5th Edition McGraw Hill.
- Wagner HM. 2005. *Principles of Operation Research*. Prentice Hall.

ABM 538 Financial Management in Agribusiness 2+0

Aim of the course

To impart trainings to the students regarding various aspects of sources of financing agribusiness.

The course is organized as follows:

No	Blocks	Units
1.	Financial management in India	1. Agribusiness Financing in India 2. Risk and return concept and analysis 3. Money and Capital Markets 4. International financial management
2.	Capital budgeting	1. Techniques of capital budgeting decision 2. Cost of Capital 3. Sources of Long and Short term finance
3.	Current assets management	1. Management of Working Capital 2. Perspectives and operational aspects of Micro finance

Theory

Block 1: Financial Management In India

Unit I: Meaning, importance, nature and scope of financing in India, agribusiness financing in India; classification and credit need in changing agriculture scenario; finance functions, investment financing, Risk and return concept & analysis **Unit –II:** Business Financing System in India, Money and Capital Markets, Regional and All -India Financial Institutions; venture capital financing and its stages, International financial management.

Block 2: Capital Budgeting

Unit III: Features, types and Techniques of capital budgeting decision. Cost of Capital, Leverage analysis, Capital structure. Theory and Policy, Sources of Long and Short term finance, Dividend Theory, Dividend Policy.

Block 3: Current Assets Management

Unit IV: Management of Working Capital, Management of Receivables, Management of cash; Cash budget, Management of collections and disbursement, Investment of Surplus cash.

Unit V: Perspectives and operational aspects of Micro finance**:** Definition, Scope and importance of Micro Finance, Evolution of Micro Finance in India, Micro Finance credit lending models: - Association model, Community Banking model, Credit union model, Co-operative model, SHG model, Village Banking model.

Teaching methods/activities

- Lectures
- Live projects
- Assignments (Individual and Group)
- Presentations about the ethical practices of the firms in India
- News paper analysis about the contemporary issues

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the financial management practices in India
- Know about the concepts capital budgeting and cost of capital
- Understand the major sources of financing in India and their implications for a agri-based organization

Suggested Reading

- Nelson AG & Murrey WG. 1988. *Agricultural Finance*. Kalyani Publ.
- Gordon and Natarajan. 2016. *Financial Markets and Services*. Himalaya Publishing House; Tenth Edition
- Machiraju HR. 2010. *Indian Financial System*. Vikas Publishing House
- Pandey IM. 2015. *Essentials of Financial Management*, Vikas Publishing House
- Khan and Jain. 2014. *Financial Management.* McGraw Higher Education
- Srivastav and Misra. 2010. *Financial Management*, Oxford University Press; Second edition
- Reddy GS. 2010. Financial Management, Himalaya Publishing House

ABM 539 Communication for Management and Business 3+0

Aim of the course

The course aims to make students proficient in written as well as in oral communication with focus on business related communication.

The course is organized as follows:

No	Blocks	Units
1.	Introduction to Business and Communication	1. Communication process, barriers methods 2. Types of business communication 3. Developing listening skills 4. Non verbal communication
2.	Reading and writing skills	1. Reading Comprehension and techniques 2. Business writing skills 3. Messages for electronic media
3.	Oral and visual communication skills Technical writing skills skills	1. Oral presentation 2. Public speaking
4.	Team and Interpersonal communication	1. Effective Interpersonal Communication 2. Business etiquettes 3. Problem solving skills 4. Case method of learning

Theory

Block 1: Introduction to Business Communication

Unit I: Communication process, barriers to communication, methods of communication, effective communication, assertive communication, types of organisational communication. Listening skills, active listening, barriers to effective listening, Non Verbal Communication.

Unit II: Reading comprehension and techniques, rules of good writing, business letter writing, e-mail writing, crafting messages for electronic media, social media, business blogs, podcasts, employment messages

Block 3: Oral, Visual Communication and Technical Writing

Unit III: Visual presentation, oral presentation skills, conducting business meetings, brainstorming sessions and presentations, public speaking skills, Communicating across cultures, Various forms of scientific writings, theses, technical papers, reviews, manuals, research work, various parts of thesis and research communication Title page, authorship, contents, preface, introduction, review of literature, material and methods, experimental results and discussion, Technical Writing Style and Editing, Writing Introductions & Conclusions, Editing and Proof reading, Writing a review article and book summary.

Block 4: Team And Interpersonal Communication

Unit IV: Developing interpersonal skills (transactional analysis), Business Etiquettes, essentials of business conversations. Business meeting agenda and minutes, circulars and sales letters, notices, overview of business proposals **Unit V:** Developing self awareness (Johari Window), solving problems analytically and creatively, introduction to case method of learning, case reading, approaches and analysis

Teaching methods/activities

- Interactive sessions to make the participants practice communication skills
- Group and individual presentations followed by feedback
- Live projects to study the challenges faced in the organsiational communication setup
- Make the participants practice communicating on social media platforms to write blogs, make and upload videos
- Self awareness assessment based questionnaires
- Case studies to develop interest and understanding of solving real life situation analytically and creatively

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the concepts of business communication
- Practice listening, reading writing and presentation skills
- Develop clarity about the method of handling team and interpersonal communication effectively

Suggested Reading

- Cardon PW. 2015. *Business Communication, Developing leaders for a networked world* Mc Graw Hill Education
- Chaturvedi PD and Chaturvedi M. 2017. *Business Communication, Skills, Concepts, Cases and Applications*, Pearson India Education
- Bovee CL, Thill JV and Chaterjee A. 2013. *Business Communication Today*, Pearson Education, Tenth Edition.

ABM 540 Research Methodology for Agri Business Management 3+0

Aim of the course

To develop an understanding of research methodology related to efficient agri business management

The course is organized as follows:

No	Blocks	Units
1.	Overview of research	1. Research methodology in management 2. Scales of measurement 3. Questionnaire designing
2.	Use of softwares for statistical analysis analysis	1. Multivariate statistical 2. Evaluation metrices 3. Forecasting Techniques
3.	Data science in agriculture	1. Introduction to data science in agriculture 2. Overview of deep learning and machine learning 3. Concept of cloud machine learning

Theory

Block 1: Overview of Research

Unit I: Meaning, Course Objective, types, and process of research; research methodology in management- exploratory, descriptive, experimental, diagnostic, Problem formulation, setting of Course Objective, formulation of hypotheses, models, types of models, process of modeling.

Unit II: Scales of measurement - nominal, ordinal, interval, ratio, Likert scale and other scales; Primary and secondary data, sources of data, Questionnaire Designing, instruments of data collection, data editing, classification, coding, validation, tabulation, presentation, analysis, development process of scale, identification of variables, variable measurement, variable standardization and dummy variables.

Block 2: Use of Softwares for Statistical Analysis

Unit III: introduction to multivariate statistical analysis techniques, Multivariate linear regression models, principal component analysis, linear discriminant analysis, factor analysis, evaluation matrices and model diagnostics for regression models.

Unit IV: Logistic regression, decision trees, cluster analysis, random forest, GARCH, CART models, support vector machines, Forecasting techniques (AR, MA, ARMA and ARIMA models)

Block 3: Introduction to Data Science

Unit V: Definition, scope and importance, machine learning, types of machine learning, linear and nonlinear models in machine learning, introduction to deep learning, basic differences in machine learning and deep learning, concept of cloud machine learning, Big data analysis.

Teaching methods/activities

- Interactive lectures
- Group assignments
- Presentations
- Live projects for marketing research problems
- Case study on application of marketing research tools

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand research methodology concepts along with its application in marketing research
- Develop insights about the statistical analysis tools and techniques for better research outcomes
- Understand the concept of and usage of data science, big data analysis for agriculture

Suggested Reading

- Cooper DR and Schindler PS. 2006. *Marketing Research Concepts and Cases*. TMH
- Kumar R. 2014. *Research Methodology*, Sage publications, 4th Edition
- Glenn JC. 2010. *Hand book of Research Methods.* OXFORD.
- Kothari CR. 2018. *Research Methodology- Methods and Techniques*. New Age International Publishers; Fourth edition

ABM 541 Computer Applications for Agri Business 3+0

Aim of the course

The course aims to instill the significance of computer applications in the organizations and handling recent trends in information technology and system for improved decision making

The course is organized as follows:

No	Blocks	Units
1.	Basics of computers	1. Concept of computers 2.System and application softwares 3.Data base management system
2.	Business value of internet	1. Cloud computing 2.Cyber security and ethical challenges
3.	Management Information System	1. Concept of MIS 2. Introduction to Artificial Intelligence 3. E-commerce agri business trends

Theory

Block 1: Basics Of Computers

Unit I: Concept of Computers- Brief History of Computers, Generation and Its Evolution, Characteristics of Computers, Main Areas of Computers and their Applications; Classification of Computers, Input-Output Devices, Memory Types (Cache, RAM, ROM), Memory Units,

Unit-II: System Software and Application Software, Open source software, introduction to computer languages, Introduction to Operating Systems – Functions, Features and Types., MS Windows and LINUX. Data Base Management System, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software Like SPSS, SAS etc.

Block 2: Business Value Of Internet

Unit III: The business value of internet, Intranet, extranet and Internet, Introduction to Web page design using HTML, Cloud Computing, Security and ethical challenges: Computer crime – Hacking, cyber theft, unauthorized use at work. Piracy – software and intellectual property. Health and Social Issues, Ergonomics and cyber terrorism.

Block 3: Management Information System

Unit IV: The concept of MIS–Definition, importance, Course Objective, pre-requisites, advantages and challenges; Information Needs of organization, MIS and Decision – Making. Types/Classification of Information System for organizations; Introduction to Artificial Intellignce (AI), Neural Networks, Fuzzy logical control systems.

Unit V: e-business/ e-commerce: e-business models, e-commerce processes,

electronic payment systems, e-commerce trends with special reference to agri business. Applications of MIS in the areas of Human Resource Management, Financial Management, Production/Operations Management, Materials Management, Marketing Management.

Teaching methods/activities

- Lectures
- Practicals
- Live project
- Assignments
- Presentations

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the fundamentals of computers
- Get a clearer idea about the application of Information technology in agri business management
- Use of e commerce, artificial intelligence and MIS for improved decision making in management

Suggested Reading

- Laudon KC and Laudon JP. 2016. *Management Information Systems-Managingthe digital Firm*, 14h Edition, Pearson India
- Turban, Volonino, Woods. Wali OP. 2015. *Information Technology for Management, Advancing Sustainable, Profitable Business Growth*, Wiley
- Jaiswal M and Mittal M. 2005. Management Information System, Oxford.

ABM 542 Project Management and Agribusiness Entrepreneurship 2+1

Why this course?

This course aims at providing student an insight into the nature of small scale industry. They will be exposed to various aspects of establishment and management of a small business unit.

The course is organized as follows:

No	Blocks	Units
1.	Concept of Project Management	1. Introduction to project management 2.Project feasibility 3.Network methods and project scheduling
2.	Introduction to Agri Entrepreneurship	1. Concept of agri entrepreneurship 2. Creativity, Innovation and Agro Entrepreneur
3.	Support System for Agri Entreprenuership	1. Sources of Financing for entrepreneurs 2. Preparation of Detail Project Report 3. Structure and Government Policy Support

Theory

Block 1: Concept of Project Management

Unit I: Concept, characteristics of projects, types of projects, project identification, and Project's life cycle. Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.

Unit II: Network Methods: Meaning, Network Analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Project scheduling and resource allocation. Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Payback period, Project implementation; Cost overrun, Project control and information system.

Block 2: Introduction to Agri Entrepreneurship

Unit III: Concept of Agri Entrepreneurship**:** Objective, Introduction to agri entrepreneurship, Entrepreneurial Development Models, Successful Models in Agro Entrepreneurship Intrapreneur, Development of women entrepreneurship with reference to SHGs, Social entrepreneurship

Unit IV: Creativity, Innovation and Agro Entrepreneur: Inventions and Innovation, The Environment and Process of Creativity, Creativity and the Entrepreneur, Innovative Approaches to Agro Entrepreneurship, Business Incubation, Steps and Procedure to start a new business, Business Opportunities in different field of Agriculture and Allied Sectors.

Block 3: Support System For Agri Entrepreneurship

Unit V: Sources of Financing, Structure and Government Policy Support: Estimating

Financial Requirements, Preparation of Detail Project Report, Project Appraisal, Sources of Long-Term Financing, Working Capital Financing, Venture Capitalist, Finance from Banking Institutions, Industrial Policy Resolutions in India, Incentives and Subsidies, Schemes for Incentives, Government Organisations like SIDO, DIC, KVIC, NSIC, SIDBI, NABARD and their role, Sick Industries and their Up gradation policy measures

Teaching methods/activities

- Interactive lectures
- Live project in association with innovative farmers/ agri entrepreneur
- Cases related to agri entrepreneurship
- Guest lectures by bankers, entrepreneurs, academicians and venture capitalist firms
- Assignments
- Presentations of Agri Business Plans

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the fundamentals of project management
- Develop a understanding of agri entrepreneurship opportunities and challenges
- Understand the method of developing a agri based venture through the support system available in the Indian scenario

Suggested Reading

- Arora R and Sood SK. *Fundamentals of Entrepreneurship and Small Business Management.* Kalyani Publishers, Ludhiana.
- Desai V. 2016. *Business Planning and Entrepreneurial Management*, Himalaya Publishing House, Mumbai.
- Ramachandaran K. *Managing a New Business Successfully.* Global Business Press, New Delhi.
- Shukla MB. *Entrepreneurship and Small Business Management*. Kitab Mahal, New Delhi.
- Dandekar VM and Sharma VK. 2016. *Agri-Business and Entrepreneurship Development.* Manglam Publications, New Delhi.
- Zimmerer TW, Scarborough NM. *Essentials of Entrepreneurship and small Business Management,* 5thEdition, PHI Learning Pvt Ltd
- Panigrahi SR and Singh B. 2017. *Agro Entrepreneurship.* Scientific Publishers(India)

ABM 543 Agribusiness Environment and Policy 2+0

Aim of the Course

To expose the students to the environment in which the agri-business is conducted. The course is organized as follows:

No	Blocks	Units
1.	Agribusiness in India	1. Agri business environment in India 2.Major sub sectors of agri business in India
2.	Economic reforms affecting agri agri-business	1. Policies and regulations affecting business in India 2.WTO Agreement on Agriculture and its compliances
3.	Emerging trends in agri Business	1. Reforms in agri output markets 2.International trade in agri business 3. Food safety and quality management

Theory

Block 1: Agribusiness in India

Unit I: Role of agriculture in Indian economy; Problems of agriculture in India; Agribusiness–definition and nature, Structure of Agriculture and linkages among sub-sectors of the agribusiness.

Block 2: **Economic Reforms Affecting Agri Business**

Unit II: Economic reforms: liberalization, privatization and globalization specifically affecting Agri Business; WTO Agreement on Agriculture and its compliances; changes in policies and regulations related to the sub sectors of agribusiness and its impact on agribusiness in India.

Block 3: Emerging Trends in Agri Business

Unit III: Emerging trends in farm supplies, farm production, agricultural finance, agro processing, international trade etc.; reforms in agri output markets: private markets, contract farming, futures trading in agri commodities and e-NAM, etc. Pricing of agricultural outputs, public distribution system, imports and exports. **Unit IV**: Importance of food safety and quality management in agri business; Environmental issues and including carbon markets and Clean Development Management etc.

Unit V: Other major issues: Intellectual property rights, importance of cooperative or collective actions in present scenario with examples of mergers and acquisitions, Farmers Producer Organizations, etc.

Teaching methods/activities

- Lectures
- Role plays

- Case studies as group assignment
- Presentations
- Assignments
- Live projects

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Develop an understanding about the role and problems agriculture and agri business is playing in the Indian economy
- Critically evaluate the major economic reforms that have directly or indirectly affected agri business in India
- Understand the emerging trends and challenges in the field of agri business

Suggested Reading

- Barnard FL, Akridge JT, Dooley FL, Foltz JC and Yeager EA. 2012. *Agribusiness Management*, Routledge, 4th Edition
- Aswathappa K. 2014. *Essentials of Business Environment*. Himalaya Publ.
- Francis Cherunilam 2003. *Business Environment*. Himalaya Publ.
- Kodekodi GK and Viswanathan B. 2009. *Agril. Development, Rural Institution & Economic Policy*, Oxford.

ABM 544 Agri Business Laws and Ethics 2+0

Aim of the course

The objective of this course is to expose the learner to various ethical issues and laws affecting business. Focus will be on understanding provisions of various business laws with reference to agriculture and also ethical practices to conduct the business properly.

The course is organized as follows:

No	Blocks	Units
1	Indian Legal System	1. Indian Contract Act 3. Companies Act
2.	Regulatory environment for Act agri-business	1. Essential Commodities 2. Consumer Protection Act
3.	Business ethics	1. Ethics in agri business functional areas 2. Governance mechanism

Theory

Block 1: Indian Legal System

Unit I: Introduction to Indian legal system, The Indian Contract Act-1872: Contract meaning, types of contract, essentials of a valid contract, offer and acceptance, capacity to contract, free consent, performance of contract.

Unit-II: Law of Negotiable Instruments: Promissory Notes, Bills of Exchange, Cheques and Bank Drafts, Endorsements, Law of Sale of Goods, Sales of Goods Act-1930-: Sale and agreement to sale, types of goods, Transfer of property in goods, mode of delivery of goods, performance of contract of sales, rights of an unpaid seller.

Unit III: Companies Act-1956: incorporation, commencement of business, types of companies, management of company, Memorandum of Association and Articles of Association, prospectus, winding of companies.

Block 2: Regulatory Environment For Agri Business

Unit IV: Essential Commodities Act, Consumer Protection Act, RTI Act, MRTP Act- major provisions and implications. Competition Act-2002, Regulatory environment for International Business

Block 3: Business Ethics

Unit V: Nature and importance of ethics and moral standards; corporations and social responsibilities, scope and purpose of business ethics; Ethics in business functional areas; industrial espionage; solving ethical problems; governance mechanism. Implementing business ethics in a global economy

Teaching methods/activities

- Lectures
- Live projects
- Assignments (Individual and Group)
- Presentations about the ethical practices of the firms in India
- News paper analysis about the contemporary issues

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Learn about the Indian legal system that directly affects the agri business in India
- Know about the regulatory framework in which the agri business is to be conducted and managed
- Understand the importance of practicing business ethics

Suggested Reading

- Mathur SB. 2010. *Business Law.* Tata McGraw Hill Edn. Pvt Ltd.
- Gulshan SS and Kapoor GK. 2003. *Business Law including Company Law*. 10th Ed. New Age Publ.
- Kapoor ND. 2005. *Business Law.* S. Chand & Sons.
- Tuteja SK. 2005. *Business Law for Managers*. S. Chand & Sons.
- Tulsian PC and Tulsian B. 2015. *Business Law.* TMH, New Delhi.
- Singh Avtar. 2017. *Contract and Specific Relief,* Eastern Book Company; Twelfth edition
- Pathak A. 2015. *Legal Aspects of Business.* McGraw Hill Education. 6th Edition.

Course Layout and Structure of Doctoral Degree

Course Code	Course Title	Credit Hours
Major Courses		**12**
ABM 601	Econometrics for Agri Business	3 (2+1)
ABM 602	Research Methods I	3 (2+1)
ABM 603	Agri Input & Output Marketing	3 (2+1)
ABM 604	Research Methods II	3 (2+1)
Minor Courses		**6**
ABM 605	Natural Resource Management	2+0
ABM 606	Knowledge Management	2+0
ABM 607	Value Chain Management in Agribusiness	2+0
Supporting Courses		**5**
ABM 608	Agri-Entrepreneurship and Corporate Governance	1+0
ABM 609	International Food and Agri Business	2+0
ABM 610	Communication for Management Teachers	0+2
Seminars		**2**
	Doctoral Seminar I	1(1+0)
	Doctoral Seminar II	1(1+0)
Research		**75**
	Total	**100**

Minor and Supporting Courses

Disciplines / Subjects

- Finance Management
- Human Resource Management
- Marketing Management
- Production Management
- Natural Resource Management
- Computer Science and Information Technology

It is suggested the student may choose courses out of the courses as part of minor courses related to specific areas of Agri business and aim to build larger understanding of the subject. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/ HOD.

Course Syllabus and Content Contents of Doctoral Degree

ABM 601 Econometrics for Agri-Business 2+1

Aim of the course

The course is mainly designed to solid data base analysis of market and policy variables to back up their business strategies. The emphasis will be given on application rather than theoretical details.

The course is organized as follows:

No	Blocks	Units
1.	Formulation and specification of econometric models	1. Simple Regression Analysis 2. Properties of Regression Coefficients and Hypothesis Testing 3. Multiple Regression Analysis 4. Heteroscedasticity 5. Stochastic Regressors and Measurement Errors 6. Simultaneous Equations Estimation
2.	Estimation and testing of models	1. Modelling Dynamic Processes 2. Autocorrelation 3. Logit and Probit (binary choice models)

Theory

3. Introduction: Correlation theory, Basic concept of regression analysis, assumptions of regression model, theory of OLS, properties of least square estimates, maximum likelihood, hypothesis testing, interval estimation, prediction in linear regression model.
4. Heteroskedasticity and autocorrelation, multicollinearity, specification errors, selection of regressors, dummy variables, autoregressive and distributed models.
5. Set of regression equations, casuality and simultaneity: application.
6. Time series econometrics- stationarity, unit roots and co-integrassion, error-correction model, AR, MA, ARMA, ARIMA processes.
7. Qualitative dependent variables – LPM, Logit and probit models.

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Acquire the basic knowledge of econometrics
- Learn the basics of econometric models and testing its application in the agri business environment

Suggested Reading

- Gujarati, Damodar, *Basic Econometrics*, McGraw-Hill Company
- James H. Stock and Mark W. Watson: *Introduction to Econometrics*, Pearson Education

ABM 602 Research Methods-I 2+1

Aim of the course

The objective of the course is to enable research scholars in developing the knowledge and skills required to specify, evaluate and utilise different types of unstructured and semi-unstructured information. They are required to develop competence in problem formulation, hypothesis generation and method of carrying scientific research in situations where research work plays a critical role. The course is practical in nature and students are expected to learn by doing live projects and studying the latest researches in different fields related to agri business.

The course is organized as follows:

No	Blocks	Units
1.	Overview of Research Methodology	1. Research process 2. Problems and Hypotheses 3. Processing and analysis of data
2.	Introduction to business analytics	1. Types of Business Analytics 2. Introduction to predictive modeling/analytic

Theory

Block 1: Overview of Research Methodology

Unit 1: Translating problems to research issues: Selection of qualitative vs quantitative research definitions, objectives, research methodologies rationale, sample/sources of data, data collection techniques, Questionnaire designing: use of measurement and scaling techniques, reliability testing.

Unit 2: Fieldwork: Data collection, gaining access and entry, ethical considerations, identifying key informants, validation and evaluation of fieldwork, data preparation, field notes and recording

Unit 3: Hypothesis Development and Theoretical Modelling. Business Analytics, Business Intelligence,

Block 2: Introduction To Business Analytics

Unit 4: Types of Business Analytics, Introduction to predictive modeling/analytics. Linear programming, Contemporary applications of marketing research

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Learn about the basics of research methodology
- Understand the application of research for problem solving related to agri business environment

ABM 603 Agri Input and Output Marketing 2+1

Aim of the course

Agricultural Input & Output marketing is a dynamic and competitive field where lot is to be done looking to the gap in technology existing and possible. Changes are taking place in manifolds ranging from farming practices to trading in domestic and international markets. Presence of private players, infrastructure development, impact on prices, concept of e mandietc is becoming more important to understand in current scenario. Scholars will also study the researches and articles to understand interesting changes going on in this field.

The course is organized as follows:

No	Blocks	Units
1.	Introduction to agri input and out output marketing environment	1. Current status of agri input and markets in India 2.Marketing mix for agri inout and output marketing
2.	Evaluation of marketing costs efficiencies	1. Assessment of different cost components and 2. Case studies on various marketing strategies adopted by national and global players

Theory

Block 1: Introduction to Agri Input and Out Marketing Environment

Unit 1: Agriculture input and output marketing environment-Current status, trends, market structure, infrastructure, competition, Government intervention in agricultural inputs and outputs marketing

Unit 2: Buyers/users behavior, Market Segmentation, Product and Pricing, Promotion and advancement in promotional strategies, Marketing Channels for different agri inputs and outputs

Block 2: Evaluation of Marketing Costs and Efficiencies

Unit 3: Evaluation of marketing costs and efficiencies, WTO and Indian Agriculture, Case Studies- Competitive marketing strategies and advancements in agricultural marketing, International agri marketing practices

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Develop a understanding about the existing practices of agri input and output marketing in India
- Acquire a deep learning about assessing the marketing cost and related efficiencies to make the agricultural marketing profitable

ABM 604 Research Method-II 2+1

Aim of the course

Once the students are equipped with the information required for interpretive research, RM II will train the students with advanced analytical tools and their uses. The course is organized as follows:

No	Blocks	Units
1.	Hypothesis testing	1. Analysis of variance and covariance 2. Multidimensional scaling and conjoint analysis
2.	Data Mining, Data Mining Methods	1. Data Mining Methods 2. Business Process Discovery
3.	Applications of Statistical Softwares	1. Modelling with statistical softwares, Report preparation and presentation

Theory

Block 1: Hypothesis Testing

Unit 1: Hypothesis testing, Analysis of variance and covariance, Correlation and regression, Discriminant and Logit analysis, Factor analysis, Cluster analysis, Multidimensional scaling and conjoint analysis.

Block 2: Data Mining

Unit 2: Data Mining, Data Mining Methods—Data Dredging, Data Fishing, Data Snooping and Process Mining—Business Process Discovery, Conformance Checking and Model Enhancement. Arena Modelling.

Block 3: Applications of Statistical Software

Unit 3: Applications of Statistical Softwares like SAS, Modelling with statistical softwares. Report preparation and presentation, International Marketing Research.

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the concepts of hypothesis testing
- Learn the application of statistical analysis softwares by hands on experience in agri business problem solving methods

Suggested Reading

- Cohen L, Lawrence M and Morrison K. 2005. *Research Methods in Education* (5th edition). Oxford: Oxford University Press.
- Denscombes M. 2010. *The Good Research Guide: For small-scale social research projects*. Maiden-Read: Open University Press.
- Dornyei Z. 2007. *Research Methods in Applied Linguistics*. Oxford: Oxford

University Press.

- Kothari CR. 1980. *Research Methodology: Research and Techniques*, New Delhi: New Age International Publishers.
- Kumar R. 2011. *Research Methodology: a step-by-step guide for beginners* (3rd edition).
- Singh YK. 2006. *Fundamental of Research Methodology and Statistics*. New International (P) Limited, Publishers, New Delhi.

ABM 605 Natural Resource Management 2+0

Aim of the course

The course on Natural Resource Management will provide indepth knowledge to the participants to look for ways to make responsible natural resource management decisions which will have an impact on all stakeholders.

The course is organized as follows:

No	Blocks	Units
1.	Introduction to natural resources	1. Types and classification of natural resource 2. Economic resource theory and applications
2.	Overview of Natural Resource their Management	1. NRM sectors product marketing and roles 2. Concept of environmental services 3. Ecotourism Policy and practices

Theory

Block 1: Introduction To Natural Resources

Unit-I Natural resources: Types and classification of natural resource, concept of Economic value, relevance of environmental economics, ecosystems services, direct and indirect economic benefit from – forest ecosystems, mountain ecosystems, mineral and water resources, ecotourism. Valuation and accounting: Supply and demand, conservation and management, cost/ benefit analysis, methods of costing, cost criteria, evaluating alternative projects, operational vs. total costs, determining benefiting vs. comprehensive stakeholders Application of resource accounting Methods of pricing resources- example forest and mineral resources.

Unit-II Economic resource theory and applications: Concept of CPR, open access, Ecological economics-methodology, economic valuation of non market benefits, environmental accounting, population resources and the environment, command and control vs. emission trading, emission trading vs. exposure trading, hotelling principle, future strategies for mineral resources.

Block 2: Overview of Natural Resource Management

Unit-III Natural Resource Management: Initial concept of market and marketing, NRM sectors product marketing and their roles, promoting NRM products- NTFPs, livestock, watershed, fisheries, agriculture and medicinal plants and ecotourism, Role of national and international organizations in the promotion of sustainable natural resource use and management.

Unit IV: Concept of environmental services: Definitions, ecotourism, alternative examples, development of ecotourism in India and outside. Threats due to large scale ecotourism. Payment for Ecosystem Services, the ecotourism dilemmas: High value may also be high impact, bulk ecotourism and problems, stakeholder

challenges, tourist carrying capacity. Ecotourism Policy and practices, national policy frame work, example – Madhya Pradesh & Uttarakhand State case. Successful ecotourism initiative, Criteria and Indicators for sustainable Ecotourism.

Suggested Reading

- Barber E. 1989. *Economics: Natural Resources Scarcity and Development*. Earthscan.
- Harris JM. 2006. *Environmental and Natural Resource Economics: A Contemporary Approach*, 2nd edition. Houghton Mifflin
- Field Barry C. 2008. *Natural Resource Economics: An Introduction*. Waveland Press.
- Honey Martha. 2008. Ecotourism and Sustainable Development: Who Owns Paradise? 2 nd edition. Island Press. 2. Seema Bhat & Syed Liyakhat 2008. Ecotourism Development in India: Communities, Capital and Conservation published by CEE, Ahmedabad

ABM 606 Knowledge Management 2+0

Aim of the course

The objective of the course is to provide the basics of the emerging area of Knowledge Management to students. This course throws light on few important concepts as Knowledge management and Information Technology, Knowledge process, etc.

The course is organized as follows:

No	Blocks	Units
1.	Introduction to knowledge management	1. The Knowledge Economy 2. Knowledge Management and Information Technology
2.	Future of Knowledge Management	1. Knowledge process and Industry perspective 2. Implementation of Knowledge Management:

Theory

Block 1: Introduction to Knowledge Management

Unit 1: The Knowledge Economy: Leveraging Knowledge, Data-Information-knowledge-Wisdom relationship, organizational knowledge, characteristics and components of organizational knowledge –Building knowledge societies- Measures for meeting the challenges of implementing, KM programmes.

Unit 2: Knowledge Management and Information Technology: Role Information Technology in Knowledge Management Systems, Knowledge Management tools, Creative effective Knowledge Management Systems through Information Technology, ERP and BPR, Data Warehousing and Data Mining.

Block 2: Future of Knowledge Management and Industry Perspective Unit 3: Future of Knowledge Management and Industry perspective: Companies on the road to knowledge management, Knowledge Management in Manufacturing and service industry, challenges and future of Knowledge Management.

Unit 4: The Knowledge Process: Universal appeal, Stages of KM Process, Knowledge Capital vs physical capital, Customer Relationship Management, Business Ethics And KM, The Promise of Internet and the Imperatives of the new age.

Unit 5: Implementation of Knowledge Management: Discussion on Roadblocks to success, Business Intelligence and Internet platforms, web Portals, Information Architecture: A three-way Balancing Act, KM, the Indian experience, Net Banking in India. –Role of knowledge Management in Organisational Restructuring. -The Mystique of a Learning Organisation.

Suggested Reading

- Mattison: *Web Warehousing and Knowledge Management*, Tata McGraw-Hill,2009
- Becerra Fernandez: *Knowledge management: An Evolutionary view*, PHI, 2009
- Fernando: *Knowledge Management*, Pearson, 2009
- B. Rathan Reddy: *Knowledge management*, Himalaya, 2009
- Tapan K Panda: *Knowledge Management*, Excel, 2009.
- Barnes: *Knowledge Management systems*, Cengage, 2009.
- Tiwana: *The Knowledge Management tool kit*, 2/e, Pearson Education, 2009.
- Warier: *Knowledge Management*, Vikas Publishing House, 2009
- Sislop: *Knowledge Management*, Oxford University Press, New Delhi, 2009
- Debowski: *Knowledge Management*, Wiley Student Edition, Wiley India, 2007

ABM 607 Value-Chain Management in Agribusiness 2+0

Aim of the course

To recognize the characteristics of Global Food Systems, the multiple variables impacting Global Food Systems, to identify value chain thinking and how it differs from supply chain thinking, the characteristics of agri-food markets, what influences their supply and demand, and what sets them apart from other markets, the role played by external factors such as population and income growth, globalization, climate change, technology, and international tradein global food systems, agribusiness and value chains, to recognize the role the consumer plays in the food system, markets, and value chains

Theory

Unit 1: Global Food Systems and Value-Chains

Characteristics of global food systems; identify the variables impacting global food systems; identify value chain thinking and how it differs from supply chain thinking; identify the role that external factors (for example, population and income growth, globalisation, climate change, technology and international trade) play on global food systems, agribusiness and value chains; and identify the actors in, and characteristics of, value chains, demonstrated with the building of a value chain model.

Unit 2: Agribusiness Market Dynamics

Characteristics of agri-food markets, what influences their supply and demand, and what sets them apart from other markets; identify the role that external factors, such as population and income growth, globalisation, climate change, technology and international trade, play on agri-food markets; interpret the key elements of supply and demand; and recognise the basic characteristics of supply and demand curves.

Unit 3: The Role of the Consumer

Role the consumer plays in the food system, markets and value chains; recognise the consumer characteristics, trends and behaviours that influence value chains; and recognise some of the techniques used in market and consumer research to better understand consumer behaviour.

Suggested Reading

- Acharya SS and Agarwal NL. 2011. *Agricultural marketing in India*. Oxford and IBH.
- Altekar RV. 2006. *Supply Chain Management: Concepts and Cases*. PHI
- Chopra S, Meindl P and Kalra DV. 2016. *Supply chain management: Strategy, Planning, and Operation*, Pearson Education India
- Mohanty RP. 2010. *Indian Case studies in Supply Chain Management*

and other Learning Resources. Oxford.

- Chandrasekaran N. 2010. *Supply Chain Management: Process, system and Practice*. Oxford.
- Singh Sukhpal. *Organic Produce Supply Chains in India-organisation and governance*. Allied Publ.

ABM 608 Agri Entrepreneurship and Corporate Governance 1+0

Aim of the course

The course aims to make students understand the nature of entrepreneurship, and acquaint the students with challenges of starting new ventures and enable then to investigate, understand and internalize the process of setting up a business. Objective is also to enlighten them with the importance of Corporate Good Governance and Business Ethics.

The course is organized as follows:

No	Blocks	Units
1.	Agri Entrepreneurship and Entrepreneurship Feasibility Studies	1. Nature of 2. Starting the venture 3. Functional plans and Sources of finance
2.	Introduction to Business Ethics and	1. Business Ethics Corporate Governance 2. Corporate Governance

Theory

Block 1: Agri Entrepreneurship And Feasibility Studies

Unit I: Nature of Entrepreneurship: Concept, knowledge, skills requirement and functions; characteristic of successful entrepreneurs; ; scenario in India and Abroad, entrepreneurship process; factors impacting emergence of entrepreneurship; managerial vs. entrepreneurial approach and emergence of entrepreneurship, Risk Reduction strategies

Unit 2: Starting the venture: generating business idea – sources of new ideas, methods of generating ideas, SWOT Analysis, environmental scanning, competitor and industry analysis; feasibility study – market feasibility, technical/operational feasibility, financial feasibility; drawing business plan; preparing project report; presenting business plan to investors.

Unit 3: Functional plans: marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning; organizational plan – form of ownership, designing organization structure, job design, manpower planning; Financial plan – cash budget, working capital, proforma income statement, proforma cash flow, proforma balance sheet, break even analysis.

Unit 4: Sources of finance: debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs, Government Grants and Subsidies, Entrepreneurship Promotion Schemes of Department of Industries (DIC), KVIC, SIDBI, NABARD, NSIC, APSFC, IFCI and IDBI etc.; legal issues – intellectual property rights patents, trademarks, copy rights, trade secrets, licensing; franching.

Block 2: Introduction To Business Ethics And Corporate Governance

Unit 5: Necessity for Business Ethics- Salient Issues in Ethics and Commerce-Shadow Economy – Basic Principles in Ethics –Corporate Climate and corporate climate audits – Political Issues – Nature and theory of Ethics, Corporate

Governance- Historical perspective and issues of Corporate Governance –Corporate Governance mechanisms – Corporate Governance Models, – The confederation of Indian Industry's initiative.; Corporate Social Responsibility

Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the concept of agripreneurship and its application for starting a new venture
- Learn the basics of making functional plans like marketing, production and financial
- Acquire the knowledge about business ethics and corporate governance

Suggested Reading

- Robert Hisrich Michael Peters Dean Shepherd Entrepreneurship 10th Ed 2016 by McGraw- Hill Education
- Vasanth Desai: Entrepreneurship, HPH, 2011.
- David Martin: Corporate Governance, Viva, 2010.
- Nandan H: Fundamentals of Entrepreneurship, PHI, 2013.
- Barringer: Entrepreneurship, Pearson, 2015.
- RK Mishra, Gitarani: Corporate Governance, Excel, 2012.
- V. Balachandran and V. Chandrasekaran: Corporate Governance & Social Responsibility, PHI, 2009.
- A.C. Fernando: Business Ethics, Pearson, 2009.
- Laura P Hartman and Abha Chatterjee: Business Ethics, TMH, 2009.
- Tripat Kaur: Values and Ethics in Management, 2/e, Paragon International, 2009.

ABM 609 International Food and Agri Business 2+0

Aim of the course

The objective of the paper is to acquaint the students with the fundamentals of international business, its environment and complexities. The paper provides exposure to multiple dimensions of the field and imparts international perspective to business decisions.

The course is organized as follows:

No	Blocks	Units
1	Global trends in International trade	1. Structure of IB environment 2. Global financial system,
2	Global manufacturing and material	1. International product life cycle, product and management branding decisions; 2. Export assistance and incentives in India 3. Harmonizing accounting difference across countries 4. Ethical dilemmas and social responsibility issues

Theory

Block 1: Global Trends In International Trade

Unit I: Global trends in international trade and finance; dimensions and modes of IB; structure of IB environment; risk in IB; organizational structure for IB; world trading system and impact of WTO; exchange rate systems; global financial system; barriers to IB; international business information and communication.

Unit II: Foreign market entry strategies; country evaluation and selection; factors affecting foreign investment decisions; impact of FDI on home and host countries; types and motives for foreign collaboration; control mechanisms in IB.

Block 2: Global Manufacturing and Material Management

Unit I: Decisions concerning global manufacturing and material management; outsourcing factors; managing global supply chain; International product life cycle, product and branding decisions; managing distribution channels; international promotion mix and pricing decisions; counter trade practices; mechanism of international trade transactions. EXIM policy of India. Export costing and pricing, Export procedures and export documentation. Export assistance and incentives in India.

Unit II: Harmonizing accounting difference across countries; currency translation methods for consolidating financial statements; the LESSARD-LORANGE Model; cross cultural challenges in IB; international staffing decisions; compensation and performance appraisal of expatriate staff; ethical dilemmas and social responsibility issues.

ABM 610 Communication for Management Teachers 0+2

Aim of the course

Communication in management education is not limited to classroom teaching. There are lot of innovative techniques to make teaching and learning interesting, practical and effective. There are various researches are done for methodological and effectiveness aspects. This course will be dealt understanding all the methods of communication for management teaching in learning by doing method and presenting the various researches done in this field.

The course is organized as follows:

No	Blocks	Units
1.	Management education	1. Action gaps in education and latest developments and required skills
2.	Theory and techniques of communication in management	1. Active listening, group communication 2. Emotional perspective in teaching 3. Learning in management education
3.	Case teaching and writing	1. Writing a case and teaching note, Critiquing a research article

Theory

Block 1: Management Education

Unit 1: Management education: Action gaps in education and latest developments and required skills

Block 2: Theory and Techniques of Communication in Management

Unit 1: Communication: Active listening, group communication, Language process Presentation on readings- recorded and graded: Oral presentation & computer assisted presentations

Unit 2: Theory and techniques: Didacticism, Group work & discussion method, Simulation, facilitation skills and styles for experiential learning. Emotional perspective in teaching

Unit 3: Learning in management education: Experiential learning, Action Learning, Group learning, Simulation and games, Role Play, Teaching and learning through Electronic Media

Block 3: Case Teaching and Writing

Case method of teaching: Writing a case and teaching note, Critiquing a research article.

e-Resources and List of Journals

- ✓ Journal of Agribusiness in Developing and Emerging Economies
- ✓ Journal of Agribusiness - Agricultural & Applied Economics
- ✓ American Journal of Agricultural Economics
- ✓ Journal of Small Business Management
- ✓ Australasian Agribusiness Journals
- ✓ Applied Economic Perspectives and Policy
- ✓ Agrekon
- ✓ Academy of Management Perspectives - AOM Journals
- ✓ International Food and Agribusiness Management Review: General Information Agribusiness – an International Journal
- ✓ Global Journal of Food and Agribusiness Management
- ✓ Agricultural Economics Research Review
- ✓ Agricultural Research
- ✓ American Journal of Agricultural Economics
- ✓ Applied Economic Perspectives & Policy
- ✓ Australian Journal of Agricultural & Resource Economics
- ✓ Journal of Agricultural and Resource Economics
- ✓ Journal of Entrepreneurship
- ✓ Journal of Small Business Management
- ✓ Land Economics
- ✓ Agricultural and Resource Economics Review
- ✓ Agricultural Economics
- ✓ AgriMarketing
- ✓ Canadian journal of agricultural economics
- ✓ International Food and Agribusiness Management Review
- ✓ Journal of Agribusiness and Rural Development
- ✓ Journal of Food Law and Policy