Agriculture and Allied Science

Restructured and Revised Syllabi of Post-graduate Programmes

Volume 9 - Animal Production Sciences

- Animal Genetics and Breeding
- Animal Nutrition
- Livestock production and Management
- Livestock Products Technology
- Poultry Science

- DR . BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI, RATNAGIRI.
- VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH PARBHANI
- DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA
- MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI

Compiled By

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

Restructured and Revised Syllabi of Post- Graduate Programmes

For
Animal Production Sciences

Submitted by
Dr.Sanjay Mandakmale
Professor & Broad Subject Co-Ordinator, BSMA
Department of Animal Husbandry & Dairy Science
Mahatma Phule Krishi Vidyapeeth, Rahuri

CONTENTS

Preamble

Livestock plays an important role in Indian economy. About 20.5 million people depend upon livestock for their livelihood. Livestock contribute 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 % of the population in India. India has vast livestock resources. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP. The economy of farmer is greatly influenced by livestock keeping. The farmers in India maintain mixed farming system i.e. a combination of crop and livestock where the output of one enterprise becomes the input of another enterprise thereby realize the resource efficiency. The livestock serve the farmers in four different ways: income, employment, food and social security.

It has become imperative to update the course curricula of Animal Nutrition to make a student of Animal Nutrition conversant with the latest development in the field. Animal Nutrition syllabi to make it up to date with the aim of making it knowledge-based while at the same time making it rewarding from a career point of view. Greater focus is given on the industrial application of nutritional concepts in order to make the students more industry-ready. It also aimed to inculcate a sense of entrepreneurship among animal nutrition students. The continued focus on making better use of local and alternate feed resources strategically to make livestock production economic and rewarding while maintaining the sustainability for various classes of livestock farmers.

The new and restructured Post-Graduate syllabus in respect of LPM contain several innovative and practically applicable courses and extensively revamped course contents, viz., production aspects, business and entrepreneur ship skills, environment and climate change issues, behaviour and welfare aspects of animals, wildlife management and recycling of waste or wealth from waste, etc. To familiarize students on various aspects, viz., scope and limitations of integrated livestock farming system, recent approach and economic feasibility of different integration models, knowledge in principles, planning, technical approach and preparing financial statement in Livestock Business Management and preparing projects for financing, familiarize the students with different farm machines and milking machine, different parts and their functions for better utilization for sustainable production is included in the revised syllabus.

Indian poultry industry has witnessed a radical and robust transformation from backyard poultry farming in villages to environmental controlled house coupled with high end automation. In order to keep pace in the race of advancing poultry farming technology, a realistic update at academic level in poultry science is highly mandatory and demands of the hour. The current designed syllabus provides the students regarding working knowledge in farms, decision making and troubleshooting analytical skills at different stages of poultry production. Emphasis has been given to include the courses on commercial poultry nutrition. As nutrition in poultry production remains important segment and constitutes around 60-70% costs of production. Hence, emphasis has been laid to teach more basic aspects related to commercial aspects so that the cost of production can be minimized with knowledge in estimating the precise nutrient requirements in different poultry species, commercial uses of feed ingredients and use of non-conventional feed ingredients in poultry. Further practical emphasis has also been given to standardize the seasonal changes in feeding practices, use of

advanced analytical techniques for estimating the feed nutrient contest and also to learn other feeding practices for better poultry production and profitability.

Overall the course in Animal Production Sciences has been designed in such a way so as to focus to enhance skills for tackling emerging problems in this sector, increase employment and also focus has been given to cope up the post-covid-19 challenges. The newly designed syllabus will greatly enhance the capacity of the Agricultural graduates in the areas of emerging nature and will meet new education policy requirement of integrated education and research.

Committee on Animal Production Sciences

ICAR-BSMA Broad Subject	ICAR-BSMA Approved Disciplines	Degree Programmes		Broad Subject Coordinator (Chairman of all Disciplines' SubCommittees	Discipline Coordinator (Secretary of respective Discipline Sub-Committee)
Animal Production Sciences	Livestock Production Management	M.Sc. (Agri)	Ph.D. (Agri)	Dr. Sanjay Mandakmale Prof.(AHDS), MPKV, Rahuri Email- mandakmale@gmail.com Mobile-9822359937	Dr.B.M. Thombre, ADP, CoA, Latur (VNMKV, Parbhani) Email- bmthombre@gmail.com Mob-9421195761
	Animal Genetics & Breeding	M.Sc. (Agri)	Ph.D. (Agri)		Dr. D.K. Deokar Asso. Prof.(AHDS), PGI, MPKV, Rahuri Email- deokardk68@gmail.com Mob-9423003364
	Animal Nutrition	M.Sc. (Agri)	Ph.D. (Agri)		Dr.S.D. Chavhan Head, AHDS, Dr.PDKV, Akola Email- sdchavhan@pdkv.ac.in Mob-7588961089
	Livestock Products Technology	M.Sc. (Agri)	Ph.D. (Agri)		Dr.A. T. Shinde Asso. Prof.(AHDS) CoA, Latur Email- anantshinde69@gmail.com Mob-7588571602
	Poultry Science	M.Sc. (Agri)	Ph.D. (Agri)		Dr. S. B. Adhangale Asst. Prof.(AHDS) CoA, Pune (MPKV, Rahuri) Email- drsunilmpkv@gmail.com Mob-9404115955

Implementation of New Curriculum

The universities offering PG programmes in Animal Husbandry, Animal Production Sciences need to be supported for establishing specialized laboratories equipped with state-of-the art equipments for conducting practical classes especially, Livestock Production Management, Animal Genetics & Breeding, Animal Nutrition, Livestock Products Technology, Poultry Science.

One time catch up grant should be awarded to each SAU, offering PG programmes in Animal Husbandry, Animal Production Sciences 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 Animal Husbandry, Animal Production Sciences 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. Programme in Animal Husbandry will be considered at par 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 of Animal Husbandry, Animal Production Sciences 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

1. Livestock Production Management(LPM)
2. Animal Genetics & Breeding(AGB)
3. Animal Nutrition(AN)
4. Livestock Products Technology(LPT)
5. Poultry Science(PS)

Nomenclature of Degree Programme

(a) M.Sc. Programmes

M.Sc. (Agri) in Livestock Production and Management
M.Sc. (Agri) in Animal Genetics & Breeding
M.Sc.(Agri) in Animal Nutrition
M.Sc. (Agri) in Livestock Products Technology
M.Sc. (Agri) in Poultry Science

(b) Ph.D. Programmes

Ph. D. (Agri) in Livestock Production Management
Ph. D. (Agri) in Animal Genetics & Breeding
Ph. D. (Agri) in Animal Nutrition
Ph. D. (Agri) in Livestock Products Technology
Ph. D. (Agri) in Poultry Science

Course 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**

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

  B. Sc. (Hort.)/ B.Sc. (Hons.) Horticulture/ B. Sc. (Forestry)/ B.Sc. (Hons.) Forestry or equivalent degree with four years duration of agriculture related Universities and having the Common Entrance Test in Animal Husbandry, Animal Production Services conducted by competent authority.

  (Note:- In case B.Sc. Agri/B.Sc. (Hons.) Agriculture candidates are not available, B.Sc. Forestry/ B.Sc. Hort. may be considered subjected to completion of deficiency package)

- **Doctoral Degree Programme**

  Master Degree in the concerned Department/Discipline of Animal Husbandry, Animal Production Services and having appearing the Common Entrance Test of Animal Husbandry, Animal Production subject conducted by competent authority.

Sr. No	Name of Department	Specialization in Ph. D Forestry	Eligibility criteria
1.	Livestock Production Management(LPM)	Ph. D. Agri (Livestock Production Management)	M.Sc. Agri (Livestock Production Management)
2.	Animal Genetics & Breeding(AGB)	Ph. D. Agri (Animal Genetics & Breeding)	M.Sc. Agri (Animal Genetics & Breeding)
3.	Animal Nutrition(AN)	Ph. D. Agri (Animal Nutrition)	M.Sc. Agri (Animal Nutrition)
4.	Livestock Products Technology(LPT)	Ph. D. Agri (Livestock Products Technology)	M.Sc. Agri (Livestock Products Technology)
5.	Poultry Science(PS)	Ph. D. Agri (Poultry Science)	M.Sc. Agri (Poultry Science)

Course and Credit Requirements

Course Details	Master's 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**

Minor and Supporting Disciplines

Sr. No.	Name of Minor Disciplines
1	Livestock Production and Management
2	Poultry Sciences
3	Livestock Products Technology
4	Animal Genetics and Breeding
5	Biochemistry
6	Plant Pathology
7	Dairy Science/ Technology
8	Dairy Chemistry
9	Dairy Microbiology
10	Agronomy
11	Soil Science

Sr. No.	Name of Supporting Disciplines
1	Agricultural Statistics
2	Computer Application
3	Bioinformatics
4	Agronomy
5	Soil Science
6	Organic Farming
7	Microbiology/ Plant Pathology

Compulsory Common Non Credit PGS Courses (05 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 Head of Department (HoD)/Board of Studies (BoS).

Deficiency courses to be completed for the students from otherthan B.Sc. (Hons.) Agriculture degree programme:

Course No.	Course Title	Credits (NC)
ANN-401	Livestock Production and Management	1=1+1
ANN-402	Livestock Breeding and Nutrition	1=1+1
ANN-403	Sheep, Goat and Poultry Production Management	1=1+1
AHDS-353	Technology of Milk and Milk Products	1+1=2
F/ASDS 241	Rangeland and Livestock Management	2+1=3
LPM-233	Poultry Production	2=1+1
LPM-355	Livestock Management	2=1+1
DSC-121	Milk and Milk Products	2=1+1
DSC-242	Dairy Microbiology	2=1+1
APT-362	Meat And Meat Product Technology	3=2+1
AGB-121	Principles of Animal Breeding	2=1+1
AGB-122	Principles of Animal Genetics	2=1+1
AN-232	Analytical Techniques in Animal Nutrition	1=0+1
LPM-355	Livestock Management	2=1+1

The deficiency courses to be completed (6 to 10 credits) will be as decided by the Student Advisory Committee.

Course Layout and Structure of Masters Degree

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

1. M.Sc. Agri (Livestock Production Management)

Major Courses:

Course Code	Semester	Course Title	Credit Hours
LPM 501		Cattle and Buffalo Production Management	2+1
LPM 502		Sheep and Goat Production Management	2+1
LPM 504		Climatology and Livestock Production	1+1
LPM 505		Behaviour and Welfare of Farm Animals	1+1
LPM 508		Farm Hygiene and Waste Management	1+1
LPM 509		Integrated Livestock Farming System	1+1
LPM 512		Livestock Business Management	1+1
LPM 514		Poultry Farm and Hatchery Management	1+1
LPM 515		Regional Animal Production Management	1+1
AGB 504		Selection Method & Breeding System	2+1
AGB 506		Conservation of Animal Genetic Resources	2+0
ANN 503		Mineral & Vitamin Nutrition & Feed Additives	2+1
ANN 504		Feed & Fodder Technology	2+1
ANN 510		Non-Conventional Feed Resources	1+1
		A. Major Total	**20 =11+9**
LPM 591		Master's Seminar	1 = 1+0
LPM 599		Master's Research	30 = 0+30

Suggested Minor Courses:

Course Code	Semester	Course Title	Credit Hours
DS 515		Advances in Traditional Dairy Products	3 = 2+1
ANN 505		Ruminant Nutrition	3 = 2+1
ANN 506		Non- Ruminant Nutrition	3 = 2+1
		B. Minor Total	**9 = 6+3**

Note: The minor courses suitable from Department of Agronomy, Organic Farming, Biochemistry, Soil Science and Agricultural Chemistry will be allotted by SAC committee

Supporting Courses:

Course Code	Semester	Course Title	Credit Hours
STAT 511	I	Experimental Design	3 = 2+1
STAT 512	II	Basic Sampling Techniques	3 = 2+1
		C. Minor Total	**6 = 4+2**

2. M.Sc. Agri (Animal Genetics & Breeding)

Major courses

Course Code	Semester	Course Title	Credit Hours
AGB 501		Animal Cytogenetics & Immunogenetics I	2 + 1
AGB 502		Molecular Genetics I	2 + 1
AGB 503		Population and Quantitative Genetics	2 + 1
AGB 504		Selection Method and Breeding System	2 + 1
AGB 505		Biometrical Genetics I	2 + 1
AGB 506		Conservation of Animal Genetics Resources	2 + 0
AGB 507		Cattle and Buffalo Breeding	2 + 1
AGB 508		Sheep and Goat Breeding	2 + 0
AGB 509		Poultry Breeding	2+1
AGB 517		Statistical Methods in Animal Breeding	2 + 1
		A. Major Courses Total	**22 = 16 + 6**
AGB 519		Masters Seminar	1 + 0
AGB 599		Masters Research	30 = 0 + 30

Suggested Minor Courses

Course Code	Semester	Course Title	Credit Hours
ANN 503		Mineral and Vitamins	2 + 1
LPM 509		Integrated livestock farming system	1 + 1
LPM 501		Cattle and Buffalo Production Management	2 + 1
		B. Minor Courses Total	**8 = 5 + 3**

Note : The Minor Courses suitable from Department of Biochemistry, Poultry Science and Agricultural Statistics will be allotted by SAC Committee.

Supporting Courses

Course Code	Semester	Course Title	Credit Hours
STAT 502		Statistical Methods for applied Science	3 + 1
STAT 522		Data analysis Using Statistical Package	2 + 1
		C. Supporting Courses Total	**7 = 5 + 2**

3. M.Sc. Agri (Animal Nutrition)

Major Courses

Course Code	Semester	Course Title	Credit Hours
ANN 501		Nutritional Biochemistry	1=1+0
ANN 502		Energy and Protein Nutrition	2=2+0
ANN 503		Minerals and Vitamin Nutrition and Feed Additives	3=2+1
ANN 504		Feed and Fodder Technology	3=2+1
ANN 505		Ruminant Nutrition	3=2+1
ANN 506		Non-Ruminant Nutrition	3=2+1
ANN 507		Research Methodology in Animal Nutrition	2=0+2
ANN 508		Companion Animal Nutrition	1=1+0
ANN 509		Nutrition of Laboratory, Wild and Zoo Animals	3=2+1
ANN 510		Non-Conventional Feed Resources	2=1+1
ANN 512		Rumen Biotechnology	1=1+0
	Minimum 20 credits courses will be selected from above major courses		
ANN 591	III	Masters Seminar	1 =0+1
ANN 599	III & IV	Master's Research work	30 =0+30

Minor and Supporting Courses Minor Courses: The courses will be selected from major courses of the allied disciplines as mentioned below to meet the minimum credit (08) requirements.

Sr. No.	Name of Disciplines
1	Livestock Production and Management
2	Poultry Sciences
3	Livestock Products Technology
4	Animal Genetics and Breeding
5	Biochemistry
6	Plant Pathology
7	Dairy Science/ Technology
8	Dairy Chemistry
9	Dairy Microbiology
10	Agronomy
11	Soil Science

Supporting Courses:

The courses from following disciplines will be offered based on the requirement (minimum 06 credits)

Sr. No.	Name of Disciplines
1	Agricultural Statistics
2	Computer Application
3	Bioinformatics
4	Agronomy
5	Soil Science
6	Organic Farming
7	Microbiology/ Plant Pathology

Deficiency or back log subject to be completed for the students from other than B.Sc. (Hons.) Agriculture degree programme:

Course No.	Course Title	Credits (NC)
ANN-401	Livestock Production and Management	1=1+1
ANN-402	Livestock Breeding and Nutrition	1=1+1
ANN-403	Sheep, Goat and Poultry Production Management	1=1+1

4. M.Sc. Agri (Livestock Products Technology)

Course No.	Course Title	Credits
LPT 501	Abattoir Practices and Meat Plant Operations	2+1=3
LPT 502	Fresh Meat Technology	1+1=2
LPT 503	Processing and Preservation of Meat	2+1=3
LPT 504	Processing of Milk and Milk Products	1+1 =2
LPT 505	Packaging and Marketing of Livestock Products	1+1=2
LPT 506	Microbiology and Quality Control of Livestock Products	1+1=2
LPT 507	Slaughterhouse By-products Technology	1+1=2
LPT 509	Egg and Egg Products Technology	1+1=2
LPT 510	Market Milk Processing and Dairy Plant Practices	1+1=2
Total		**11+9=20**
LPT 591	Masters Seminar	0+1=1
LPT 599	Masters Research	30

Suggested Minor Courses

Course No.	Course Title	Credits
DS 515	Advances in traditional dairy products	2+1=3
DM 522	Microbial safety and quality	2+2=4
PSC 607	Poultry products technology	2+1=3
Total		**6+4=10**

Note : The Minor Courses suitable from Department of Biochemistry, Microbiology, Food Science, Dairy Science and Agricultural Statistics will be allotted by SAC Committee.

Supporting Courses

Course No.	Course Title	Credits
STAT 501	Mathematics for applied sciences	2+0
BIOCHEM 501	Basic Biochemistry	3+1
STAT 511	Experimental design	2+1

5. M.Sc. Agri (Poultry Science)

Major Courses

Course No.	Semester	Course Title	Credit Hrs.
PSC 501	I	Poultry Breeding and Genetics	2+1
PSC 502	II	Poultry Nutrition and Feeding	2+1
PSC 503	I	Commercial Layer and Broiler Management	2+1
PSC 504	II	Breeder Stock and Hatchery Management	2+1
PSC 505	I	Poultry Health and Biosecurity	2+1
PSC 507	I	Poultry Products Technology	2+1
PSC 508	II	Poultry Economics, Project Formulation and Marketing	2+1
PSC 510	II	Commercial Poultry Nutrition	1+1
PSC 511	I	Poultry Welfare and Waste Management	2+0
PSC 591	II	Masters Seminar	1+0
Total			**18+08=26**
PSC 599	I	Master's Research	0+30=30

***Compulsory Courses**

Suggested Minor Courses

Course No.	Semester	Course Title	Credits
ANN 603	I	Minerals and Vitamin Nutrition Feed Additives	2+1
ANN 610	II	Non Conventional Feed Recourses	1+1
LPM 614	II	Poultry Farm & Hatchery Management	1+1
LPM 608	II	Farm Hygiene and Waste Management	1+1
Total			**05+04=09**

Supporting Courses

Course No.	Course Title	Credits
STAT 501	Mathematics for applied sciences	2+0
BIOCHEM 501	Basic Biochemistry	3+1
STAT 511	Experimental design	2+1

Note : The Minor and supporting Courses suitable from Department of Biochemistry, Animal Nutrition, Livestock Production Management, Livestock Products Technology and Agricultural Statistics will be allotted by SAC Committee.

Course Layout and Structure of Doctoral Degree

1. Ph.D. Agri (Livestock Production Management)

Major Courses :

Course Code	Semester	Course Title	Credit Hours
LPM 601	I	Recent Developments in Large Ruminants Production Management	2+1
LPM 602	I	Recent Developments in Small Ruminants Production Management	2+1
LPM 604	I	Livestock and Environment	1+0
LPM 605	I	Organic Livestock Production	1+0
LPM 606	II	Recent Developments in Welfare of Farm Animals	1+0
LPM 607	II	Entrepreneurship in Livestock Production	1+1
LPM 608	II	Precision Livestock Farming	1+1
AGB 601		Trends In Animal Breeding	2+0
AGB 605		Bioinformatics In Animal Breeding	1+1
ANN 601		Modern Concepts In Feeding of Ruminants	2+0
ANN 603		Recent Concepts In Feeding of Non Ruminant	1+0
ANN 608		Advances in Feed Technology	1+1
		A. Major Total	**13= 9+4**
LPM 691	III	Doctoral Seminar- I	1 = 1+0
LPM 692	IV	Doctoral Seminar- II	1 = 1+0
LPM 699	III & IV	Doctoral Research	75 = 0+75

Suggestive Minor Courses:

Course Code	Semester	Course Title	Credit Hours
ANN 601	I	Modern Concept of Feeding Ruminants	2 = 2+0
PSC 602	II	Recent trends in Commercial Poultry Production	3 = 2+1
AGB 602	II	Trends in Animal Breeding	3 = 2+0
		B. Minor Total	**9 = 6+3**

Suggestive Supporting Courses

Course No.	Course Title	Credits
STAT 604	Advanced Statistical Methods	**2+1**
STAT 612	Advanced Design of Experiments	2+1
BIOCHEM 604	Frontier Topics in Biochemistry	2+0 = 2
MICRO 601	Improvement in fermentation Technology	2+1=3
MICRO 602	Microbial physiology and regulation	2+0=2
FSQ 601	Food Quality and Safety Assessment	1+2=3

PSC 607	Poultry products technology	2+1=3
ANN 608	Advances in Feed Technology	1+1=3

Note: The minor and supporting courses suitable from Department of Agronomy, Organic Farming, Biochemistry, Soil Science and Agricultural Chemistry will be allotted by SAC committee

2. Ph.D. Agri (Animal Genetics & Breeding)

Major courses

Course Code	Semester	Course Title	Credit Hours
AGB 601		Molecular Genetics II	2 + 0
AGB 602		Trends in Animal Breeding	2 + 0
AGB 603		Biometrical Genetics II	2 + 1
AGB 604		Advances in Selection Methodology	2 + 1
AGB 605		Bioinformatics in Animal Breeding	1 + 1
AGB 606		Animal Cytogenetics & Immunogenetics II	2 + 0
AGB 607		Statistical Software in Animal Breeding	1 + 1
		A. Major Courses Total	**14 = 10 + 4**
AGB 691		Doctoral Seminar I	1 + 0
AGB 692		Doctoral Seminar II	1 + 0
AGB 699		Doctoral Research	75 = 0 + 75

Suggested Minor Courses

Course Code	Semester	Course Title	Credit Hours
LPM 601		Recent Development in Large Ruminants in Production management	2 + 1
LPM 602		Recent Development in Small Ruminants in Production Management	2 + 1
		A. Minor Courses Total	**6 = 4 + 2**

Suggestive Supporting Courses

Course No.	Course Title	Credits
STAT 604	Advanced Statistical Methods	**2+1**
STAT 612	Advanced Design of Experiments	2+1
BIOCHEM 604	Frontier Topics in Biochemistry	2+0 = 2
MICRO 601	Improvement in fermentation Technology	2+1=3
MICRO 602	Microbial physiology and regulation	2+0=2
FSQ 601	Food Quality and Safety Assessment	1+2=3
PSC 607	Poultry products technology	2+1=3
ANN 608	Advances in Feed Technology	1+1=3

Note : The Minor and supporting Courses suitable from Department of Agronomy, Biochemistry, Soil Science and Agricultural Statistics will be allotted by SAC Committee.

3. Ph.D. Agri (Animal Nutrition)

Major Courses:

Course Code	Semester	Course Title	Credit Hours
ANN 601		Modern Concepts in Feeding of Ruminants	2=2+0
ANN 602		Forages in Animal Nutrition	1=1+0
ANN 603		Recent Concepts in Feeding of Non-Ruminants	1=1+0
ANN 604		Advances in Rumen Metabolism	1=1+1
ANN 605		Advances in Mineral and Vitamin Nutrition	2=2+0
ANN 606		Advanced Clinical Nutrition	2=1+1
ANN 607		Advanced Techniques in Nutritional Research	1=1+0
ANN 608		Advances in Feed Technology	2=1+1
ANN 609		Toxicants and Anti-Metabolites in Animal Nutrition	1=1+0
ANN 610		Nutrigenomics in Animal Nutrition	1=1+0
ANN 611		Equine Nutrition	1=1+0
	Minimum 12 credits courses will be selected from above major courses		
ANN 691	III	Doctoral Seminar-I	1=0+1
ANN 692	IV	Doctoral Seminar-II	1=0+1
ANN 699		Doctoral Research	75=0+75

Minor Courses: The courses will be selected from major courses of the allied disciplines as mentioned below to meet the minimum credit (06) requirements.

Sr. No.	Name of Disciplines
1	Livestock Production and Management
2	Poultry Sciences
3	Livestock Products Technology
4	Animal Genetics and Breeding
5	Biochemistry
6	Plant Pathology
7	Dairy Science/ Technology
8	Dairy Chemistry
9	Dairy Microbiology
10	Agronomy
11	Soil Science

Suggestive Minor Courses

LPM 607	II	Entrepreneurship in Livestock Production	1+1
PSC 601	I	Applied Poultry Nutrition	2+1

Supporting Courses:

The courses from following disciplines will be offered based on the requirement (minimum 05 credits)

Sr. No.	Name of Disciplines
1	Agricultural Statistics
2	Computer Application
3	Bioinformatics
4	Agronomy
5	Soil Science
6	Organic Farming
7	Microbiology/ Plant Pathology

Suggestive Supporting Courses

Course No.	Course Title	Credits
STAT 604	Advanced Statistical Methods	**2+1**
STAT 612	Advanced Design of Experiments	2+1
BIOCHEM 604	Frontier Topics in Biochemistry	2+0 = 2
MICRO 601	Improvement in fermentation Technology	2+1=3
MICRO 602	Microbial physiology and regulation	2+0=2
FSQ 601	Food Quality and Safety Assessment	1+2=3
PSC 607	Poultry products technology	2+1=3
ANN 608	Advances in Feed Technology	1+1=3

Note : The Minor Courses suitable from Department of Agronomy, Biochemistry, Soil Science and Agricultural Statistics will be allotted by SAC Committee.

4. Ph.D. Agri (Livestock Products Technology)

Major Courses

Course No.	Course Title	Credits
LPT 601	Modern Abattoir Practices and Animal By-Products Technology	1+1=2
LPT 602	Advances in Meat Production and Fresh Meat Technology	1+1=2
LPT 603	Developments in Processed Meat Technology	1+1=2
LPT 604	Current Trends in Processing of Milk And Milk Products	1+1=2
LPT 605	Biotechnological Techniques & Quality Control of Livestock Products	1+1=2
LPT 606	Ethnic and Organic Meat and Milk Products	1+1=2
LPT 607	Industrial & Entrepreneurial Training	0+2=2
LPT 608	Current Trends in Disposal and Utilization of Waste From Meat and Dairy Industry	1+1=2
LPT 609	Advances in Egg and Egg Products Technology	1+1=2
Total		**7+7=14**
LPT 691	Doctoral Seminar I	1+0
LPT 692	Doctoral Seminar II	1+0
LPT 699	Doctoral Research	75

Suggested Minor Courses

Course No.	Course Title	Credits
DM 622	Advances in food safety and dairy products	3+0=3
PSC 603	Developments in poultry processing and products technology	2+1=3
Total		5+1=6

Note : The Minor Courses suitable from Department of Biochemistry, Microbiology, Food Science, Dairy Science and Agricultural Statistics will be allotted by SAC Committee.

Suggestive Supporting Courses

Course No.	Course Title	Credits
STAT 604	Advanced Statistical Methods	**2+1**
STAT 612	Advanced Design of Experiments	2+1
BIOCHEM 604	Frontier Topics in Biochemistry	2+0 = 2
MICRO 601	Improvement in fermentation Technology	2+1=3

MICRO 602	Microbial physiology and regulation	2+0=2
FSQ 601	Food Quality and Safety Assessment	1+2=3
PSC 607	Poultry products technology	2+1=3
ANN 608	Advances in Feed Technology	1+1=3

5. Ph.D. Agri (Poultry Science)

Major Courses

Course No.	Semester	Course Title	Credit Hrs.
PSC 601	I	Applied Poultry Nutrition	2+1
PSC 602	II	Recent Trends in Commercial Poultry Production	2+1
PSC 603	I	Developments in Poultry Processing and Products Technology	2+1
PSC 604	II	Emerging Diseases of Poultry and Health Management	2+1
PSC 606	II	Poultry Economics, Marketing and Integration	2+1
PSC 691	II	Doctoral Seminar I	1+0
PSC 692	I	Doctoral Seminar II	1+0
		Total	**12+5 =17**
PSC 699	II	Doctoral Research	0+75

Suggestive Minor Courses

Course No.	Semester	Course Title	Credits
ANN 603	I	Minerals and Vitamin Nutrition Feed Additives	2+1
ANN 610	II	Non Conventional Feed Recourses	1+1
LPM 614	II	Poultry Farm & Hatchery Management	1+1
LPM 608	II	Farm Hygiene and Waste Management	1+1
Total			**05+04=09**

Suggestive Supporting Courses

Course No.	Course Title	Credits
STAT 604	Advanced Statistical Methods	2+1
STAT 612	Advanced Design of Experiments	2+1
BIOCHEM 604	Frontier Topics in Biochemistry	2+0 = 2
MICRO 601	Improvement in fermentation Technology	2+1=3
MICRO 602	Microbial physiology and regulation	2+0=2
FSQ 601	Food Quality and Safety Assessment	1+2=3
PSC 607	Poultry products technology	2+1=3
ANN 608	Advances in Feed Technology	1+1=3

Note : The Minor and Supporting Courses suitable from Department of Biochemistry, Animal Nutrition, Livestock Production Management, Livestock Products Technology and Agricultural Statistics will be allotted by SAC Committee.

NOTE: The compulsory courses could be allotted as per the facilities available and University Directives

Course Syllabus and Content of Master's Degree in Animal Genetics & Breeding

Course Title : Animal Cytogenetics and Immunogenetics I
Course Code : AGB 501
Credit Hours : 2+1

Why this course?
To provide basic and advanced theoretical and practical training in animal cytogenetics and immunogenetics with an ulterior aim of enhancing animal production.

Aim of the course
This course is aimed to train students in identifying genetic/ chromosomal abnormalities and reviewing genetic mechanisms responsible for the generation of diversity in genes for immunoglobulin, TLR and MHC, etc., facilitating the better application of both classical and molecular cytogenetics and immunogenetics for animal improvement.

Theory

Unit I (7 Lectures)
Physical and chemical basis of heredity; Development in animal cytogenetics and immunogenetics of farm animals; Inborn errors of metabolism and inherited disorders; immunoglobulin and their types; Antigen-antibody interactions; Immune response; ELISA.

Unit II (10 Lectures)
Chromatin structure of eukaryotes; Chromosome number and morphology in farm animals; Karyotyping and banding; Chromosomal abnormalities and genetic syndromes; DNA packing in chromosomes; Types of DNA; FISH chromosome painting and PRINS; SCH and RH panel mapping.

Unit III (10 Lectures)
Genetic variants in blood group systems of farm animals; Major histocompatibility complex: BoLA, BuLA; Genetics of biochemical variants and their applications; Immune response genes and concepts of disease resistance including major genes; Hybridoma and its significance; Concept of immunofertility; TLRs and interleukins.

Unit IV (3 Lectures)
Mutation and assays of mutagenesis; Sister chromatid exchanges.

Practical (15 Classes)
Identification of Barr bodies; *In-vitro* and *in vivo* preparation of somatic metaphase chromosomes; Screening of chromosomal abnormalities; Microphotography and karyotyping; Banding procedures for comparing the chromosomal complement; FISH and PRINS; ELISA; Immunocompetence tests.

Teaching methods

Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

Learning outcome

Upon successful completion, the students will be able to understand the immune response (IR) and its role in disease resistance along with the role of allelic variationsin IR genes in animal production in addition to the advances in the field of animal cytogenetics and immunogenetics.

Suggested Reading

- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics*. Springer.
- Hare WCD and Singh EL. 1999. *Cytogenetics in Animal Reproduction.* CABI.
- Panayi GS and David CS. 1984. *Immunogenetics*. Elsevier.
- Roitt I. 1997. *Essential Immunology.* Blackwell.
- Summer AT and Chandley AC. 1993. *Chromosome Today*. Chapman and Hall.

Course Title : Molecular Genetics in Animal Breeding
Course Code : AGB 502
Credit Hours : 2+1

Why this course?
To provide basic and advanced concepts of molecular genetics and their applicationto different species of animals

Aim of the course
This aim of this course is to study genes and their functions to understand theirrole in animal breeding and selection. Also aimed at the genetics of populations including quantitative genetics and its applications in animal breeding.

Theory

Unit I (8 Lectures)
Basic concepts in molecular genetics; Concepts of proteomics and genomics; Genesis and importance of molecular techniques; Genome organization: physical and genetic map, current status of genome maps of livestock; Gene expression and control.

Unit II (8 Lectures)
Molecular markers and their applications; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA fingerprinting.

Unit III (7 Lectures)
DNA sequencing; Genome sequencing; Genomic Library; Polymerase Chain Reaction (PCR) and its types (PCR-RFLP, AS-PCR, etc.) and applications; Transgenesis and methods of gene transfer; Recombinant DNA technology and applications.

Unit IV (7 Lectures)
Analysis of molecular genetic data; Quantitative Trait Loci (QTL) mapping and its application in animal breeding: Genome scan, candidate gene approach.

Practical (15 Classes)
Extraction and purification of genomic DNA; Gel electrophoresis; Restriction enzyme digestion of DNA and analysis; PCR-RFLP; PCR-SSCP; Bioinformatics tool for DNA sequence analysis; Isolation of RNA; cDNA synthesis; Statistical methods for analyzing molecular genetic data.

Teaching methods
Blackboard; PPT-animations; Web-courses (if available); Hands-on practical training; Application based practical skills; Visit labs specialising in molecular genetics critical discussion of articles in the area.

Learning outcome
Upon successful completion, the students will have an understanding of how genes control biological functions from cellular activities to development, techniques usedto manipulate

gene functions in addition to genomics, proteomics and their applications in livestock improvement.

Suggested Reading

- Akano IE. 1992. *DNA Technology.* IAP Academic Press.
- Brown TA. 2006. *Genome 3*. Garland Science Publishers.
- Clark D and Pazdernik N. 2012. *Molecular Biology,* 2nd ed. Elsevier.
- Micklos DA, Fryer GA and Crotty DA. 2003. *DNA Science.* Cold Spring Harbor.
- Setlow JK. 2006. *Genetic Engineering – Principles and Methods,* Springer.

Course Title : Population and Quantitative Genetics
Course Code : AGB 503
Credit Hours : 2+1

Why this course?
To study the genetic structure of the animal population and the importance of genetic variation and covariation among quantitative traits.

Aim of the course
To impart knowledge on the general structure of animal population and factors affecting it and estimation of genetic and phenotypic parameters of different quantitative traits.

Theory

Unit I (15 Lectures)
Genetic structure of population; Hardy Weinberg Law; Idealized population; Factors affecting changes in gene and genotypic frequencies; Systematic processes; Approach to equilibrium under different situations: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci; Linkage equilibrium and disequilibrium; Combined effect of all forces changing gene frequency.

Unit II (10 Lectures)
Dispersive process - small population: random genetic drift; Effective population size; Regular and irregular inbreeding systems; Founder effect and bottleneck; Effective number of founders and ancestors.

Unit III (10 Lectures)
Quantitative genetics: Gene effects, population mean, breeding value; Variance and its partitioning; Genotype-environment interaction and correlation; Resemblance between relatives.

Unit IV (10 Lectures)
Genetic and phenotypic parameters (heritability, repeatability, correlations): Methods of estimation, uses, possible biases, precision, optimal designs; Scale effects and threshold traits.

Practical (15 Classes)
Estimation of gene and genotypic frequencies under different conditions; Estimation of inbreeding in regular and irregular systems; Estimation of effective population size; Computation of quantitative genetic effects; Estimation of variance components; Computation of heritability, repeatability, genetic, phenotypic and environmental correlations and their standard errors.

Teaching methods
Lectures; PPT-Presentations; MS-Excel for estimation of data.

Learning outcome

Understanding the effect of gene and genotype frequencies on the genetic structure of populations, and estimation of genetic variation and covariation among different quantitative traits.

Suggested Reading

- Bulmer MG. 1980. *The Mathematical Theory of Quantitative Genetics.* Clarendon Press.
- Crow JF and Kimura M. 2009. *An Introduction to Population Genetics.* Harper and Row.
- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics.* Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
- Pirchner F. 1983. *Population Genetics in Animal Breeding*. Springer.

Course Title : Selection Method and Breeding System
Course Code : AGB 504
Credit Hours : 2+1

Why this course?
To explain the methodology of selection and breeding systems for improvement of livestock and poultry.

Aim of the course
To study different methods of selection and factors affecting it, various mating systems and their use in animal genetics and the concepts of recent selection techniques.

Theory

Unit I (6 Lectures)
Types of selection and their genetic consequences; Response to selection: Prediction and improvement.

Unit II (12 Lectures)
Theoretical aspects of accuracy and efficiency of selection bases; Prediction of breeding value using different criteria; Combined selection; Correlated response and efficiency of indirect selection.

Unit III (12 Lectures)
Selection for several traits; Different types of selection indices; Evaluation of short term and long term selection experiments: bidirectional selection, asymmetry of response, selection limit.

Unit IV (15 Lectures)
Different mating systems: assortative mating, inbreeding, out-breeding; Genetic and phenotypic consequences and applications of various mating systems in animal improvement; Heterosis; Selection for general and specific combining abilities; Genetic polymorphism and its application in genetic improvement: Basic concepts of marker-assisted selection (MAS) and genomic selection.

Practical (15 Classes)
Prediction of direct and correlated response; Computation of realized heritability and genetic correlation; Computation of selection index; Estimation of breeding values from different sources of information; Determining the accuracy of selection; Estimation of heterosis for different types of crosses; Estimation of GCA and SCA.

Teaching methods
Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

Learning outcome

Good knowledge of the application of selection methods and mating systems in animal improvement, and application of selection for combining abilities.

Suggested Reading

- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics.* Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
- Tomar SS. 1996. *Text Book of Population Genetics,* vol. I. *Qualitative Inheritance.* Universal Publishers.
- Tomar SS. 2010. *Text Book of Animal Breeding*. Universal Publishers.
- Tomar SS. 2014. *Text Book of Population Genetics,* vol II. *Quantitative Inheritance.* Universal Publishers.

Course Title : Biometrical Genetics I
Course Code : AGB 505
Credit Hours : 2+1

Why this course?
To educate about the various biometrical techniques for data analysis and their applications

Aim of the course
To impart knowledge about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment.

Theory

Unit I (8 Lectures)
Nature and structure of animal breeding data; Source of variation; Adjustment of data; Outliers and their removal; Basic concepts in statistical inference and experimental designs.

Unit II (7 Lectures)
Introduction to matrix algebra; Types of matrices and their operations; Determinants and their properties; Matrix inversion and its applications.

Unit III (15 Lectures)
Multiple regression and correlations; Fisher's discriminant function and its application; D^2 statistics in divergent analysis; Cluster analysis; Fixation index; Genetic distance estimation and phylogeny construction; Linear models and their types; Least-squares (LS) analysis; Generalized LS and weighted LS; BLUE, BLUP; Methods of estimation of variance components: ANOVA, ML, REML, MINQUE, MIVQUE; Bayesian approach.

Unit IV (15 Lectures)
Animal model; Reduced animal model; Sire model; Maternal grandsire model; Maternal effects model; Repeatability model; Random regression model; Threshold model; Multidimensional scaling (MDS) and principal component analysis (PCA); Database management and use of software in animal breeding.

Practical (15 Classes)
Collection, compilation, coding and transformation of animal breeding data; Matrix applications, determinant and inverse of matrices; Building of models for various types of data; Least-squares analysis of data; Estimation of BLUE and BLUP solutions; Formation of numerator relationship, dominance and identical by descent matrix; Estimation of variance components.

Teaching methods
Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom.

Learning outcome
Students will develop skills in analyzing breeding data using different biometrical techniques.

Suggested Reading

- Henderson CR. 1984. *Application of Linear Models in Animal Breeding.* University of Guelph Press.
- Mather K and Jinks JL. 1977. *Introduction to Biometrical Genetics.* Chapman and Hall.
- Searle SR. 2014. *Linear Models.* John Wiley and Sons.
- Singh RK and Chaudhary BD. 2012. *Biometrical Methods in Quantitative Genetic Analysis.*Kalyani Publishers.

Course Title : Conservation of Animal Genetics Resources
Course Code : AGB 506
Credit Hours : 2+0

Why this course?
To study the concepts of conservation of animal genetic resources (AnGR)
Aim of the course
To impart knowledge on AnGR in India and their characterization, concepts and methods of conservation and national and international strategies for conservation of AnGR.

Theory
Unit I (12 Lectures)
Domestic animal diversity in India: Origin, history and utilization; Present status and flow of AnGR and its contribution to livelihood security; Methodology for phenotypic and genotypic characterization of livestock and poultry breeds through systematic surveys; Management of breed; Physical, biochemical and performance traits and uniqueness of animals of a breed; Social, cultural and economic aspects of their owners/ communities rearing the breed.
Unit II (12 Lectures)
Methods for increasing effective population size of endangered breed/ species: Effective number of alleles, inbreeding effective size, variance effective size, minimum viable population size; Methodology for characterization of AnGR; nuDNA and mtDNA based diversity analysis and relationship among the breeds; Concept of conservation: *In-situ* and *ex-situ* (in-*vivo* and *in-vitro*); Models of conservation; Prioritization of breeds for conservation; Strategies for conservation of livestock and poultry genetics resources; Gene bank concept; Preservation of ecosystem.
Unit III (6 Lectures)
Status, opportunities and challenges in the conservation of AnGR; IPR issues on animal genetic resources/ animal products or by-products; Registration of livestock breeds and protection of livestock owner's rights in India; Breed societies and their role in conservation.

Teaching methods
Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

Learning outcome
Conservation strategies of AnGR, their characterization and methods of conservation to protect biodiversity

Suggested Reading

- Nivsarkar AE, Vij RK and Tantia MS. 2000. *Animal Genetic Resources of Indian Cattle and Buffaloes.* ICAR.
- Oldenbroek K. 2007. *Utilisation and Conservation of Farm Animal Genetic Resources.* WA
- Publishers.
- Sahai R and Vij RK. 1997. *Domestic Animal Diversity, Conservation and Sustainable Development.* SI Publishers.
- Van Vleck LD, Pollak E and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

Course Title : Cattle and Buffalo Breeding
Course Code : AGB 507
Credit Hours : 2+1

Why this course?
To educate the concept of cattle and buffalo breeding and improvement in dairy production
Aim of the course
To impart knowledge on different breeds of cattle and buffalo and their economic traits, sire evaluation methods and breeding systems and different cattle and buffalo breeding programmes.

Theory
Unit I (15 Lectures)
History of dairy cattle and buffalo breeding; Evolution of cattle and buffalo breeds and their characteristics; Population dynamics and production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Computation of correction factors for the adjustment of the data; International Committee on Animal Recording (ICAR) and INAPH.
Unit II (12 Lectures)
Progeny testing under farm and field conditions; Evaluation of bulls by different models; Estimation of breeding values of the cows; Nucleus breeding system; Marker- assisted selection and genomic selection.
Unit III (12 Lectures)
Crossbreeding in cattle in India and abroad; Development of new breeds; Conservation of threatened breeds of cattle and buffaloes; Role of breed associationsin dairy improvement; Breeding policy: national and state.
Unit IV (6 Lectures)
Import of exotic germplasm for breeding cattle in the tropics; Appraisal of buffaloand cattle breeding programme; Role of breed associations in dairy improvement.

Practical (15 Classes)
Performance recording; Standardization of records; Estimation of economic traits; Computation of genetic parameters; Genetic gain; Sire evaluation methods; Estimation of heterosis; Culling and replacement.

Teaching methods
Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

Learning outcome

After completion of the course, the students get good knowledge of different breedsof cattle and buffalo and breeding programmes

Suggested Reading

- Chakravarty AK and Vohra V. 2011. *Sustainable Breeding in Cattle and Buffalo. Satish Serial Publications.*
- Lasley JF. 1972. *Genetics of Livestock Improvement*. IBH.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).
- Schmidt GM, Van Vleck LD and Hutjens MF. 1988. *Principles of Dairy Science.* WH Freeman.
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

Course Title : Sheep and Goat Breeding
Course Code : AGB 508
Credit Hours : 2+0

Why this course?
To educate about sheep and goat breeding concepts and development in small ruminants
Aim of the course
To impart knowledge on different breeds of sheep and goat and their economic traits, breeding systems and selection strategies, and different sheep and goat breeding policies.

Theory
Unit I (8 Lectures)
Breeds; Economic traits; Population dynamics and production systems; Prolificacy; Breeding records and standardization; Computation of correction factors.
Unit II (12 Lectures)
Genetic parameters; Selection of males and female; Selection indices for sheep and goat; Breeding systems; Breeding strategies for improvement of production (meat, milk and wool) and reproduction (fertility and fecundity); Inbreeding and its effectson production traits; Group breeding schemes; Development of new breeds; Strategies for introgression of genes (fecundity and growth).
Unit III (10 Lectures)
Breeding policy; Sheep and goat improvement programme in India; Conservation of breeds; Culling and replacement; Equivalent Animal Death Rate (EADR).

Teaching methods
Blackboard; PPT-presentations

Learning outcome
After completion of the course, the students get a good knowledge of different breeds of sheep and goat and their breeding policies
Suggested Reading

- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishers.
- Karim SA. 2010. *Climate Change and Stress Management: Sheep and Goat Production*. Satish Serial Publications.
- Mulugeta A. 2016. *Sheep and Goat Production Text Book*. Lambert Academic Publishers.
- Prasad J. 2018. *Goat, Sheep and Pig, Production and Management*. Kalyani Publishers.
- Ross CV. 1988. *Sheep Production and Management*. Prentice-Hall.

Course Title : Poultry Breeding
Course Code : AGB 509
Credit Hours : 2+1

Why this course?
To educate about advances in poultry breeding practices
Aim of the course
To impart knowledge on different species of poultry and their economic traits, selection criteria and selection indices, and conservation of poultry genetic resources.

Theory
Unit I (10 Lectures)
Origin and history of poultry species: Chicken, turkey, duck and quail; Poultry classes and breeds; Important qualitative traits in poultry including lethal; Economic traits of egg and meat-type chicken and their standardization; Different mating systems.
Unit II (10 Lectures)
Selection criteria and selection indices; Response to selection; Genetic controls; Genotype and environment interaction; Inbreeding and its effects on production traits in egg and meat-type chickens; Development of inbred lines and strains; Strain and line crosses; Introduction to diallel cross; Utilisation of heterosis and reciprocal effect; Recurrent selection, reciprocal recurrent selection and modified RRS; Specialized sire and dam lines; Genetic improvement programs in poultry; Selection strategies for the improvement of layers and broilers; Performance testing of commercial strains; Backyard poultry.
Unit III (4 Lectures)
Industrial breeding; Artificial insemination in chicken; Auto-sexing; Random Sample Test.
Unit IV (6 Lectures)
Biochemical variants and immunogenetics of poultry; Use of molecular genetics in poultry breeding; Quantitative trait loci; Marker-assisted selection and genomic selection; Conservation of poultry genetic resources.

Practical (15 Classes)
Inheritance of qualitative traits; Economic traits of egg-type and meat-type chicken; Procedures of standardization; Estimations of heritability, the correlation between various production traits; Inbreeding co-efficient and heterosis; Selection of sires and dams; Osborne index; Restricted selection index; Collection and evaluation of semen and insemination; Estimation of GCA and SCA.

Teaching methods
Blackboard; PPT-presentations

Learning outcome
Students get acquainted with different poultry species, applications of selection methodology and molecular genetics in poultry for higher productivity.

Suggested Reading

- Brereton G and Roadnight S. 2000. *21st Century Poultry Breeding*. Gold Cockerel Books.
- Crawford RD. 1990. *Poultry Breeding and Genetics.* Elsevier.
- Hutt FB. 2003. *Genetics of Fowl.* Norton Greek Press.
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology.* CABI.
- Singh RP and Kumar J. 1994. *Biometrical Methods in Poultry Breeding.* Kalyani Publishers.

Course Title : Statistical Methods in Animal Breeding
Course Code : AGB 517
Credit Hours : 2+1

Why this course?
To educate about Statistical Methods in Animal breeding
Aim of the course
To impart knowledge on the transformation of data, sampling, standard error and importance, basics of statistical inferences, and analysis of variance.

Theory
Unit I (12 Lectures)
Measures of central tendency; Measures of dispersion; Correlation and regression; Probability; Theory of distributions; Transformation of data; Sampling: Theory, need and properties; Estimators: Concept, standard error and importance.
Unit II (8 Lectures)
Basics of statistical inferences; Parametric tests: *Z, t* and *F* distribution; Non- parametric test: c^2 sign test, run test and rank test; Confidence interval.
Unit III (10 Lectures)
Analysis of variance: One and two way; Experimental designs: CRD, RBD and LSD; Missing plot techniques; Analysis of covariance.

Practical (15 Classes)
Measures of central tendency; Measures of dispersion; Correlation and regression; Transformation of data; Probability; Z, t, F and c^2 tests; CRD, RBD and LSD; Analysis of covariance
Teaching methods
Blackboard; PPT-presentations
Learning outcome
Application of statistical methods in animal breeding
Suggested Reading

- Gianola D and Hammond K. 1990. *Advances in Statistical Methods for Genetic Improvement of Livestock*. Springer.
- Gupta SC and Kapur VK. 2014. *Fundamentals of applied statistics*. Sultan Chand and Sons.
- Gupta SC. 2016. *Fundamentals of Statistics.* Himalaya Publishing House Pvt Ltd.
- Pillai SK and Sinha HC. 1968. *Statistical Methods for Biological Workers*. Ram Prasad and Sons.
- Snedecor GW and Cochran WG. 1989. *Statistical Methods.* Wiley India Publications.

Course Syllabus and Content of Doctoral Degree in Animal Genetics & Breeding

Course Title : Molecular Genetics II
Course Code : AGB 601
Credit Hours : 2+0

Why this course?
To educate about the latest tools and techniques of animal genetics and their uses in animal sciences

Aim of the course
To impart knowledge on the eukaryotic genome, gene editing, gene knock-out and silencing, transgenic animals their benefits in livestock production, and genomic selection.

Theory

Unit I (10 Lectures)
Eukaryotic genome: Gene families, pseudogenes, SnRNPs; Types of RNA including miRNA; Gene conversion; Tandem repeats; Minisatellites and microsatellites; Sequencing of EST.

Unit II (10 Lectures)
Transposable elements; Transcription and RNA processing; Translation; Regulation of gene expression; Differential expression analysis; Serial analysis of gene expression; Selective gene amplification; The proteasome and longevity of proteins; Gene editing; Gene targeting; Gene knock-out and silencing.

Unit III (10 Lectures)
Transgenic animals: Application, ethical issues; Gene therapy; Bio-pharming; Cloning; Genome imprinting; Epigenetic modification; Creation of SNP chips and microarray technology; Next-generation sequencing; Genomic selection.

Teaching methods
Blackboard; PPT-animations; Research article discussion in classroom

Learning outcome
Epigenetic Modification and transgenic animal production

Suggested Reading

- Brown TA. 2006. *Genome 3*. Garland Science Publishers
- Clark DP. 2012. *Molecular Biology*. Academic Cell
- Hugo van den Berg. 2015. *Cell Biology and Molecular Genetics*. IPO Publishers
- Pasternak JJ. 2005. An Introduction to Human Molecular Genetics*: Mechanisms of Inherited Diseases*. Wiley
- Puehler A and Timmis KN. 1984. *Advanced Molecular Genetics*. Springer
- Watson, JD, Tania AB, Bell SP, Gann A, Levine A and Losick R. 2017. *Molecular Biology of the Gene*. Pearson Education Publication

Course Title : Trends in Animal Breeding
Course Code : AGB 602
Credit Hours : 2+0

Why this course?
To acquaint with recent trends in animal breeding and designing of need-based breeding strategies

Aim of the course
To impart knowledge on identification of novel traits and their role in breed improvement programme, development of mixed model equations, formulation of detailed breeding plans and advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

Theory
Unit I (12 Lectures)
Identification of novel traits and their role in breed improvement programme; Development of mixed model equations; Advancement in biometrical methods including artificial neural network and Bayesian approach; Detection of QTL; Ancestry informative markers for admixture analysis.
Unit II (10 Lectures)
Formulation of detailed breeding plans; Breeding for disease resistance and functional traits; Breeding for climate resilience; Inheritance of animal behavior traits; Breeding for animal welfare; Impact analysis of different breed improvement programme in various livestock species.
Unit III (8 Lectures)
Advanced techniques in genetic manipulation for multiplication and improvement of livestock species: Use of sexed semen, gene introgression, and cloning, etc.

Teaching methods
Blackboard; PPTs; Research article discussion in the classroom

Learning outcome
Breeding for disease resistance and functional traits; Breeding for climate resilience

Suggested Reading

- Brah GS. 2016. *Animal Breeding: Principles and Applications. Kalyani Publishers.*
- Lynch M and Walsh B. 1998. *Genetics and Analysis of Quantitative Traits.* Oxford University Press.
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal*

Breeding Values. CABI.

- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).
- Tomar SS. 2010. *Textbook of Animal Breeding*. Universal Publishers.
- Zeggini E and Morris A. 2010. *Analysis of Complex Disease Association Studies.* Academic Press.

Course Title : Biometrical Genetics II
Course Code : AGB 603
Credit Hours : 2+1

Why this course?
To impart knowledge about recent advances in population genetic theory and application in animal breeding.

Aim of the course
To impart knowledge on multivariate analysis, QTL gene mapping, mating designs and other advanced biometrical techniques pertaining to animal breeding.

Theory
Unit I (8 Lectures)
Multivariate analysis; Discriminant function; D^2 analysis; Principal component analysis; Path analysis.
Unit II (8 Lectures)
Mating designs: Basis, diallel, partial diallel, NCD-1, 2, 3 for reciprocal and maternal effects.
Unit III (5 Lectures)
Prediction of recombinant inbred lines using genetic parameters; Advances in genotype-environment interaction and selection indices.
Unit IV (9 Lectures)
QTL mapping; Analysis of SNP data for genomic selection; Advances in the estimation of variance component and prediction of breeding value: Threshold, dominance, random regression and survival models.

Practical (15 Classes)
Discriminant function; D^2 analysis; Principal component analysis; Path analysis; Estimation of GCA and SCA through diallel, partial diallel, NCD-1, 2, 3; Advances in construction of selection indices; QTL mapping; Analysis of SNP data for genomic selection; Advances in estimation of variance components.

Teaching methods
Blackboard; PPTs; Research article discussion in the classroom

Learning outcome
Students can analyze data on Animal Genetics using different Biometrical Techniques

Suggested Reading

- Choudhuri S. 2014. *Bioinformatics for Beginners.* Academic Press.
- Daniel S and Daniel G. 2012. *Likelihood, Bayesian, and MCMC Methods in Quantitative Genetics.* Springer.
- Kute N and Shinde G. 2016. *Principles of Biometrical Genetics*. Daya Publications.
- Marther K. 1997. *Biometrical Genetics*. Springer.
- Michael JK and Harpal SP. 1996. *The Genetical Analysis of Quantitative Traits*. Springer.
- Pawar IS and Singh S. 2010. *Theory and Application of Biometrical Genetics*. CBS Publications.
- Weller JI. 2016. *Genomic Selection in Animals*. John Wiley and Sons.
- Womack JE. 2012. *Bovine Genomics*. John Wiley and Sons.

Course Title : Advances in Selection Methodology
Course Code : AGB 604
Credit Hours : 2+1

Why this course?
To educate about the latest advances in selection theory and their application in animal breeding

Aim of the course
To impart knowledge on design of selection experiments, information on single and multiple trait animal models, construction of various selection indices and their relationship with BLUP including the fundamentals of MAS and gBLUP.

Theory
Unit I (8 Lectures)
Fundamental theorem of natural selection; Selection in finite populations; Effect on genetic structure and variance; Design of selection experiments for testing selection theory\
Unit II (6 Lectures)
Measurement of genetic and environmental trends; Advances in selection indices: Multistage, restricted and retrospective selection indices.
Unit III (6 Lectures)
Empirical evaluation of selection theory: genetic slippage, limits to the selection, asymmetry of response, selection experiments, the effect of selection on variance.
Unit IV (10 Lectures)
Selection for threshold traits; Selection under single and multiple trait animal models; Direct and correlated response through various selection indices;
Relationship between BLUP and selection index; Selection using markers and entire genome; Methods for analysing GS data like RR-BLUP, Bayes-1, 2 and 3, etc.

Practical (15 Classes)
Determination of culling levels and selection intensity; Estimation of direct and correlated response; Estimation of relative economic values; Construction of various selection indices; Prediction of breeding value using advance methods; QTL analysis using LDMAS and LEMAS.

Teaching methods
Blackboard; PPT; Research article discussion in classroom

Learning outcome

They will be acquainted with all the theoretical techniques of the advanced selection methodology

Suggested Reading

- Balakrishnan N, Nagaraja HN and Kannan N. 2007. *Advances in Ranking, Multiple Comparisons and Reliability*. Springer.
- Cameron ND. 1997. *Selection Indices and Prediction of Genetic Merit in Animal Breeding*. CABI.
- Daniel S and Daniel G. 2012. Likelihood, Bayesian and MCMC *M*ethods in *Q*uantitative *G*enetics. Springer.
- Draper NR and Smith H. 1998. Applied *R*egression *A*nalysis. J Wiley and Sons.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding*. CABI.
- Legarra A, Lourenco DAL and Vitezica ZG. 2018. *Bases for Genomic Prediction*. INRA (Free Online).
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*, CABI.

Course Title : Bioinformatics in Animal Breeding
Course Code : AGB 605
Credit Hours : 1+1

Why this course?
To educate about basic concepts of bioinformatics and their applications in animal breeding

Aim of the course
To impart knowledge on the concepts of bioinformatics, information resources forprotein and genome databases, genetic characterization and selection using bioinformatic tools, and modern bioinformatic tools like GWAS.

Theory
Unit I (4 Lectures)
Overview of bioinformatics; Database concepts; Algorithms; Information resources for protein and genome databases: GenBank, EMBL, SWISSPROT, PROSITE.
Unit II (5 Lectures)
Nucleotide and protein sequence analysis; Pair-wise and multiple sequence alignments; Phylogeny; Big SNP data analysis methods; Micro-array processing; Clustering; Software for secondary database search and analysis.
Unit III (6 Lectures)
Genetic characterization; Use of bioinformatics tools for identifying QTL and selection of elite germplasm; GWAS; Development of DNA chips; NGS data analysis.

Practical (15 Classes)
Database development; Algorithms; Nucleotide and protein sequence analysis; Pair- wise and multiple sequence alignments; Phylogeny and dendrogram; Micro-array processing; Clustering; Secondary database search and analysis; Genetic characterization; Identification of QTL; GWAS; NGS data analysis.

Teaching methods
Blackboard; PPT-animations; Research article discussion in the classroom

Learning outcome
Nucleotide and protein sequence analysis and phylogenetic analysis

Suggested Reading

- Attwood TK and Parry-Smith DJ. 2001. *Introduction to Bioinformatics*. Benjamin-Cummings Publishing Company.
- Bishop M. 1999. *Genetics Databases.* Elsevier.

- Jiang R, Zhang X and Zhang MQ. 2013. *Basics of Bioinformatics.* Springer.
- Luke A. 1997. *DNA Sequencing: From Experimental Methods to Bioinformatics*. BIOS Scientific Publishers.
- Ramsden J. 2009. *Bioinformatics: An Introduction*. Springer.
- Stekel D. 2003. *Microarray Bioinformatics.* Cambridge University Press.
- Wu CH and McLarty JW. 2000. *Neural Networks and Genome Informatics*. Elsevier Science.
- Xiong J. 2006. *Essential Bioinformatics*. Cambridge University Press.

Course Title : Animal Cytogenetics and Immunogenetics II
Course Code : AGB 606
Credit Hours : 2+0

Why this course?
To educate about the advances in cytogenetics and their application in animal genetics and breeding

Aim of the course
To impart knowledge on somatic cell genetics, stem cell genetics, image analysis of advanced karyotyping techniques, and molecular cytogenetics and gene mapping techniques.

Theory
Unit I (8 Lectures)
Structure of eukaryotic chromosomes; Evolution of karyotype; Various *in- vitro* cell culture techniques; Cell lines and utility; Genotoxicity
Unit II (10 Lectures)
Somatic cell genetics; Stem cell genetics; Molecular cytogenetics and gene mapping; Linkage mapping; ISH; FISH; Radiation hybrid mapping; Fibre-FISH; PRINS; Positional cloning; Spectral karyotyping
Unit III (12 Lectures)
Image analysis; Chromosome painting; Chromosome walking; Micro-dissection of chromosomes; Structure and functions of major histocompatibility complex; T Cell receptor; CD4; Interleukins; Toll-like receptors and their functions

Teaching methods
Blackboard; PPT-animations; Research article discussion in the classroom

Learning outcome
Students get a good grip on different gene mapping techniques and image analysis

Suggested Reading

- Agarwal S and Naik S. 2008. *Fundamentals of Immunogenetics Principles and Practices.* IBD Publisher.
- Christiansen FT and Tait BD. 2012. *Immunogenetics: Methods and Applications in Clinical Practice.* Springer.
- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics.* Springer.
- Litwin SD. 1989. *Human Immunogenetics.* CRC Press.
- Tyagi R. 2009. *Textbook of Cytogenetics.* Discovery Publishers.

Course Title : Statistical Software in Animal Breeding
Course Code : AGB 607
Credit Hours : 1+1

Why this course?
To educate about the standard statistical software packages in animal breeding

Aim of the course
To impart knowledge on the use of software for computation of different statistical data

Theory
Unit I (4 Lectures)
Data preparation and job control commands for statistical analysis of data; Introduction to statistical and standard software packages.
Unit II (6 Lectures)
Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis.
Unit III (5 Lectures)
Graphic features of the software packages; Linear programming using appropriate software package; Least-squares analysis; Data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modelling.

Practical (15 Classes)
Data preparation and generation; Import and export of data from spreadsheet and database packages; Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis; Graphic features of the software packages; Use of software for linear programming problem; Least-squares analysis; Use of software for neural networks and fuzzy logic models for prediction.

Teaching methods
Blackboard; PPTs; Research article discussion in the classroom

Learning outcome
Students get an idea on the availability of different statistical and standard software packages and their application in Animal Breeding.

Suggested Reading

- Balding DJ, Bishop M and Cannings C. 2001. *Handbook of Statistical Genetics*. J Wiley and Sons.
- Boldman K, Kriese LA, Van Vleck LD, Van Tassell CP and Kachman SD. 1995. *Manual for Use of MTDFREML*. ARS, USDA (Free online).
- Dempfle L. 1990. *Statistical Aspects of Design of Animal Breeding Programs*. Springer.
- Freund RJ, Mohr D and William WJ. 2010. *Statistical Methods*. Academic Press.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding.* University Guelph Press.
- Isik F, Holland J and Maltecca C. 2017. Genetic *Data Analysis for Plant and Animal Breeding*. Springer.
- Lynch M and Walsh B. 1990. *Genetics and Analysis of Quantitative Traits.* Oxford.

Course Syllabus and Content of Master's Degree in Animal Nutrition

Course Title	**: Nutritional Biochemistry**
Course Code	**: ANN 501**
Credit Hours	**: 1+0**

Why this course?
Biochemistry is the mother of all sciences. To understand the mechanism of nutrientmetabolism a clear understanding of the various biochemical events is essential for a student specializing in animal nutrition.

Aim of the course
To help to develop the concepts of biochemical pathways involving nutrient metabolism.

Theory

Unit I (12 Teachings)
Classification of carbohydrates and their functions. Digestion and metabolism of carbohydrate in ruminants and non-ruminants. Carbohydrate synthesis.

Unit II (8 Teachings)
Classification and properties of fats and their functions. Digestion and metabolism of fat in ruminants and non-ruminants. Fat synthesis

Unit III (12 Teachings)
Classification, structure, properties and function of proteins, amino acids and nucleic acids. Digestion and metabolism of proteins and other nitrogenous compounds in ruminants and non-ruminants. Protein synthesis. Control of metabolism

Teaching Schedule
Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Classification of carbohydrates and their functions. Digestion and metabolism of carbohydrate in	12

	ruminants and non-ruminants. Carbohydrate synthesis	
2.	**Unit II** Classification and properties of fats and their functions. Digestion and metabolism of fat in ruminants and non-ruminants. Fat synthesis	08
3.	**Unit III** Classification, structure, properties and function of proteins, amino acids and nucleic acids. Digestion and metabolism of proteins and other nitrogenous compounds in ruminants and non-ruminants. Protein synthesis. Control of metabolism	12
	Total	**32**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome

Understanding of biochemical basis of nutrient metabolism.

Suggested Reading

- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of The Chicken*, 4th ed. University Books.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG.2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Nelson DL and Cox MM. 2017. *Lehninger Principles of Biochemistry*, 7th ed. Macmillan Learning.

Course Title	**: Energy and Protein Nutrition**
Course Code	**: ANN 502**
Credit Hours	**: 2+0**

Why this course?

Energy and protein constitute the major nutrients driving the maintenance and production in farm animals. A clear understanding of underlying concepts is keyto the application of the same under practical feeding situation.

Aim of the course

To understand the metabolic pathways involved in energy and protein utilization including their requirements for various classes of animals for different physiological functions.

Theory

Unit I (8 Teachings)

Measures of feed energy. Partitioning of feed energy. Energy balance, Fasting catabolism. Direct and indirect calorimetry. Efficiency of energy and protein utilization.

Unit II (12 Teachings)

Rumen degradable protein (RDP), and rumen undegradable protein (UDP) and fermentation kinetics. Protein turnover. Quantification of microbial protein synthesis. Protein quality determination in ruminants and monogastrics. Supplementary value of amino acids. NPN metabolism, urea fermentation potential and metabolizable protein. Amino acids imbalance, antagonism and toxicity.

Unit III (12 Teachings)

Feeding standards: comparative appraisal and limitations. Determination of energy and protein requirements. Nutrients metabolism with special reference to milk, meat and wool production. Energy and protein requirement for maintenance, growth, pregnancy and lactation in farm animals.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Measures of feed energy. Partitioning of feed energy. Energy balance, Fasting catabolism. Direct and indirect calorimetry. Efficiency of energy and protein utilization	08
2.	**Unit II** Rumen degradable protein (RDP), and rumen undegradable protein (UDP) and fermentation kinetics. Protein turnover. Quantification of microbial protein synthesis. Protein quality determination in ruminants and monogastrics. Supplementary value of amino acids. NPN metabolism, urea fermentation potential and metabolizable protein. Amino acids imbalance, antagonism and toxicity	12
3.	**Unit III** Feeding standards: comparative appraisal and limitations. Determination of energy and protein requirements. Nutrients metabolism with special reference to milk, meat and wool production. Energy and protein requirement for maintenance, growth, pregnancy and lactation in farm animals	12
	Total	**32**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome

Development of comprehensive knowledge of basic nutrition involving energy and protein.

Suggested Reading

- Blaxter K. 1989. *Energy Metabolism in Animal and Man*. Cambridge University Press.
- Bondi A. 1987. *Animal Nutrition*. Wiley InterScience.
- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- Crampton EW and Harris LE. 1969. *Applied Animal Nutrition*. WH Freeman.
- Dryden GM. 2008. *Animal Nutrition Science*, 1st ed. CAB International.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Singh UB. 1987. *Advanced Animal Nutrition for Developing Countries*. Indo-Vision.

Course Title : Minerals and Vitamin Nutrition and Feed Additives
Course Code : ANN 503
Credit Hours : 2+1

Why this course?

Mineral and vitamins are key drivers of intermediary metabolism besides playingan important role in health and production

Aim of the course

To impart knowledge on sources, functions, analysis, signs of deficiency and signsof toxicity of various minerals and vitamins

Theory

Unit I (12 Teachings)

General role of minerals, factors affecting mineral requirements. Macro-minerals and micro-minerals, their, distribution, metabolism, physiological functions, deficiencies andminerals. excesses, and sources and requirements. Probable essentials.

Unit II (6 Teachings)

Mineral interactions. Chelated minerals and concept of nano-minerals. Bioavailability studies in minerals. Impact of minerals on reproduction, fertility, and immunity. Soil-plant-animal-human relationship, development of area-specific minerals. Toxic minerals; their role in health and production of farm animals. Newly recognized trace minerals.

Unit III (10 Teachings)

Definition, history, classification, chemistry, functions, deficiencies and excesses, requirements and sources of water-soluble and fat-soluble vitamins. Role of vitamins in energy metabolism. Vitamin-mineral interrelationship. Vitamin toxicosis. Roleof vitamins in reproduction, fertility and immunity.

Unit IV (4 Teachings)

Feed additives and nutraceuticals. Probiotics, prebiotics and synbiotics; eubiotics. Feed enzymes. Phytochemical feed additives; polyphenols and essential oils; organicacids and acidifiers.

Practical (16 Classes)

General principles of mineral estimation. Sampling and processing techniques. Use of atomic absorption spectrometry and ICP in mineral

estimation. Estimation of macro- and micro-minerals. Formulation of mineral mixture for various species. Estimation of some important vitamins (vitamin A, E and C). Purified diets for mineral and vitamin studies. Calculation of mineral and vitamin requirements.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** General role of minerals, factors affecting mineral requirements. Macro-minerals and micro-minerals, their, distribution, metabolism, physiological functions deficiencies and minerals. excesses and sources and requirements. Probable essential minerals	12
2.	**Unit II** Mineral interactions. Chelated minerals and concept of nano-minerals. Bioavailability studies in minerals. Impact of minerals on reproduction, fertility, and immunity. Soil-plant-animal-human relationship, development of area-specific minerals. Toxic minerals; their role in health and production of farm animals. Newly recognized trace minerals	06
3.	**Unit III** Definition, history, classification, chemistry, functions, deficiencies and excesses, requirements and sources of water-soluble and fat-soluble vitamins. Role of vitamins in energy metabolism. Vitamin-mineral interrelationship. Vitamin toxicosis. Role of vitamins in reproduction, fertility and immunity	10
4.	**Unit IV** Feed additives and nutraceuticals. Probiotics, prebiotics and synbiotics; eubiotics. Feed enzymes. Phytochemical feed additives; polyphenols and essential oils; organic acids and acidifiers	04
	Total	**32**

Practical

Sr. No.	Topic	No. of Practical (s)
1	General principles of mineral estimation	2
2	Sampling and processing techniques.	2
3	Use of atomic absorption spectrometry and ICP in mineral estimation.	2
4	Estimation of macro- and micro-minerals.	2
5	Formulation of mineral mixture for various species.	2
6	Estimation of some important vitamins (vitamin A, E and C).	2
7	Purified diets for mineral and vitamin studies.	2
8	Calculation of mineral and vitamin requirements	2
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome

- Comprehensive knowledge about mineral and vitamin metabolism and theirrequirements for farm animals
- Capacity for estimation of various minerals and vitamins using advanced analytical techniques

Suggested Reading

- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- McDowell RL. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- McDowell RL. 2003. *Minerals in Animal and Human Nutrition*, 2nd ed. Elsevier Science.
- Suttle NF. 2010. *Mineral Nutrition of Livestock*, 4th ed. CAB International.

Course Title	**: Feed and Fodder Technology**
Course Code	**: ANN 504**
Credit Hours	**: 2+1**

Why this course?

Processing of feed and fodder are important means to augment the utilization for efficient animal production.

Aim of the course

To understand various technological options available for processing of classes of food, feeds and fodders and their potential application in feeding management offarm animals.

Theory

Unit I (6 Teachings)

Various feed mill equipment and their handling; layout and operations in feed mill (small, medium and large feed plants); automated feed mill: merits and demerits. Procurement of feed ingredients: specification and guidelines. Quality control of feed ingredients and finished feeds. BIS standard.

Unit II (6 Teachings)

Principles and process of material handling, weighing, grinding, mixing, pelleting, packaging and other major processing operations. Crumbling, flaking, popping and extrusion. Premixes. Codex Alimentarius, HACCP.

Unit III (6 Teachings)

Classification of feed and fodders, cultivation practices of feed and fodder (cereals, legumes, seasonal, annual and perennial fodder crops)

Unit IV (6 Teachings)

Feed and fodder processing and preservation techniques. Densification, chemical and biological treatment of feeds/ fodders. Fodder conservation through hay and silages; Microbiological evaluation of processed and preserved feeds; Effect of preservation on the nutritional value of feed

Unit V (8 Teachings)

Feed storage and godown management; goods sanitation and hygiene of go-down. Traditional and modern farm-level storage structures. Factors affecting feedstuffs during storage. Liquid feed ingredients. Storage losses; insect pests and rodents control measures; Mycotoxins in feedstuffs and its control measures.

Practicals:
Quality control and inspection of feed materials. Qualitative tests for adulterantsurea, urease, thiram. Identification of insect pests and fungi in stored products.Feed microscopy. Formulation and preparation 62ixing6262. Quality evaluation of silage and hay, Laboratory preparation of silage. Visit to feed plant: Hands-on training on preparation of feed and mineral 62ixing62. Preparation of project reporton plant layout and design, problems related to feasibility, record-keeping in different sections of a feed mill.

Teaching Schedule
Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Various feed mill equipment and their handling; layout and operations in feed mill (small, medium and large feed plants); automated feed mill: merits and demerits. Procurement of feed ingredients: specification and guidelines. Quality control of feed ingredients and finished feeds. BIS standard	06
2.	**Unit II** Principles and process of material handling, weighing, grinding, mixing, pelleting, packaging and other major processing operations. Crumbling, flaking, popping andeXtrusion. PremiXes. CodeX Alimentarius, HACCP	06
3.	**Unit III** Classification of feed and fodders, cultivation practices of feed and fodder (cereals, legumes, seasonal, annual and perennial fodder crops)	06
3.	**Unit IV** Feed and fodder processing and preservation techniques. Densification, chemical and biological treatment of feeds/ fodders. Fodder conservation through hay and silages; Microbiological evaluation of processed and preserved feeds; Effect of preservation on the nutritional value of feed	06

5.	**Unit V** Feed storage and godown management; goods sanitation and hygiene of go-down. Traditional and modern farm-level storage structures. Factors affecting feedstuffs during storage. Liquid feed ingredients. Storage losses; insect pests and rodents control measures; Mycotoxins in feedstuffs and its control measures	08
	Total	**32**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Quality control and inspection of feed materials.	2
2	Qualitative tests for adulterantsurea, urease, thiram.	2
3	Identification of insect pests and fungi in stored products.	2
4	Feed microscopy. Formulation and preparation premixes. Quality evaluation of silage and hay,	2
5	Laboratory preparation of silage l	2
6	Visit to feed plant	2
7	Hands-on training on preparation of feed and mineral mixture	2
8	Preparation of project reporton plant layout and design, problems related to feasibility, record-keeping in different sections of a feed mil	2
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome

Practical understanding and application of feed processing technologies

Suggested Reading

- Dryden G. 2008. *Animal Nutrition Science*. CAB International.
- Kundu SS, Mahanta SK, Singh S and Pathak PS. 2016. *Animal Feed Technology*. Satish Publishers
- Perry TW, Cullison AE and Lowrey RS. 2003. *Feeds and Feeding*, 6th ed. Pearson.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Schofield EK (Ed.). 2005. *Feed Manufacturing Technology V*. American Feed Industry Association, Arlington.

Course Title : Ruminant Nutrition
Course Code : ANN 505
Credit Hours : 2+1

Why this course?
Ruminants possess unique digestive capabilities involving rumen microbes that utilize diverse feed resources which are otherwise not fit for monogastric animals.

Aim of the course
To develop an understanding of the rumen metabolism and its manipulation for improving nutrient utilization for enhancing ruminant production.

Theory

Unit I (6 Teachings)
Functional anatomy of the digestive system of ruminants. Introduction to rumen microflora and fauna. Development of rumen. Feeds and fodders for ruminant feeding.

Unit II (6Teachings)
Water requirements. Nutrient requirements and feeding of calves, heifers, dry, pregnant and lactating cows, buffaloes, sheep and goat. Peculiarities of digestive physiology, nutrition and feeding management of camels.

Unit III (06 Teachings)
Voluntary feed intake. Determination of digestibility, factors affecting digestibility. Manipulation of rumen fermentation.

Unit IV (6 Teachings)
Concept of complete feed and total mixed ration. Precision feeding. Phase feeding. Limiting nutrients and strategic feeding of high yielding ruminants. Concept of by-pass nutrients and their impact on production, reproduction and immune status.

Unit V (8 Teachings)
Nutritional approaches for increasing the functional properties of milk: role ofCLA, omega fatty acids. Different systems of feeding buffalo for beef production. Feeding during stress and natural calamities. Feeding management of migratory/ nomadic small ruminants.

Practical (16 Classes)

Design and planning of feeding experiments. Identification of feed and fodder basedon its composition. Ration formulation for large and small ruminants for different physiological stages. Estimation of digestibility and nutritive value of feeds and fodders by metabolism trial in dairy cattle. Determination of nutritive value of pastures by the use of range techniques. Collection and processing of rumen liquor. Estimation of rumen metabolic profile (pH, ammonia, lactate, and TVFA, etc.). Estimation of purine derivatives.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Functional anatomy of the digestive system of ruminants. Introduction to rumen microflora and fauna. Development of rumen. Feeds and fodders for ruminant feeding	06
2.	**Unit II** Water requirements. Nutrient requirements and feeding of calves, heifers, dry, pregnant and lactating cows, buffaloes, sheep and goat. Peculiarities of digestive physiology, nutrition and feeding management of camels.	06
3.	**Unit III** Voluntary feed intake. Determination of digestibility, factors affecting digestibility. Manipulation of rumen fermentation	06
4.	**Unit IV** Concept of complete feed and total mixed ration. Precision feeding. Phase feeding. Limiting nutrients and strategic feeding of high yielding ruminants. Concept of by-pass nutrients and their impact on production, reproduction and immune status	06
5	**Unit V** Nutritional approaches for increasing the functional properties of milk: role of CLA, omega	08

	fatty acids. Different systems of feeding buffalo for beef production. Feeding during stress and natural calamities. Feeding management of migratory/ nomadic small ruminants	
	Total	**32**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Design and planning of feeding experiments.	2
2	Identification of feed and fodder basedon its composition.	2
3	Ration formulation for large and small ruminants for different physiological stages.	2
4	Estimation of digestibility and nutritive value of feeds and fodders by metabolism trial in dairy cattle.	2
5	Determination of nutritive value of pastures by the use of range techniques.	2
6	Collection and processing of rumen liquor.	2
7	Estimation of rumen metabolic profile (pH, ammonia, lactate, and TVFA, etc.).	2
8	Estimation of purine derivatives	2
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome

In-depth knowledge of feeding ruminants in light of their metabolic peculiaritiesFeed evaluation based on an assessment of various rumen functions

Suggested Reading

- Church DC. 1988. *The Ruminant Animal: Digestive Physiology and Nutrition*, 2nd ed. Prentice-Hall.
- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Givens D, Axford R and Owen E. (Ed.). 2000. *Forage Evaluation in Ruminant Nutrition*. CAB International.
- Hynd PI. 2019. *Animal Nutrition: From Theory to Practice*. CAB International.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Moran J. 2005. *Tropical Dairy Farming: Feeding Management for Small Holder DairyFarmers in the Humid Tropics*. Landlinks Press
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 7th rev. ed. National Research Council. National Academies Press.
- NRC. 2016. *Nutrient Requirements of Beef Cattle*, 8th rev. ed. National Academies of Sciences, Engineering, and Medicine. National Academies Press.
- NRC. 2007. *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids*. National Research Council. National Academy Press.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition andFeeding*, 5th ed. Wiley.
- Shirley RL. 2012. *Nitrogen and Energy Nutrition of Ruminants*. Academic Press.10.
  Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

Course Title : Non-Ruminant Nutrition
Course Code : ANN 506
Credit Hours : 2+1

Why this course?
The nutritional attributes of non-ruminants differ among various species as wellas their characteristic digestive physiology.

Aim of the course
To impart knowledge on the nutrient metabolism of various classes of monogastric animals involving poultry, swine, equines and rabbits under different physiological stages.

Theory

Unit I (12 Teachings)
Feeding of poultry for meat and egg production. Ideal protein concept. Standard ileal digestible amino acids. Nutrient requirements for broilers and layers. Feeding of breeder hens; nutritional factors affecting hatchability. Feeding systems for poultry. Feed additives for poultry. Nutritional approaches for designer egg and meat production. Nutritional disorders in poultry and the role of nutrition in diseasesprevention. Water intake and quality in poultry production.

Unit II (10 Teachings)
Nutrition and feeding of swine in different stages of growth and production. Nutritional factors affecting the quality of the products: lean meat production. Water intake and quality in pig production.

Unit III (10 Teachings)
Feeding of equines. Feeding of rabbits. Hindgut fermentation and its importance. Nutrient requirements of equines. Special features of equine feeding management. Nutritional management of colic and other health disorders. Nutrient requirementsof rabbits for wool and meat production. Nutrition-related disorders in rabbits.

Practical (16 Classes)
Design and planning for poultry and swine feeding eXperiments. Calculation of nutrient requirements for broilers and layers. Formulation and compounding of general and least-cost rations, determination of the nutritive value of poultry and swine feeds by balance eXperiments. Formulation of rations for horses and rabbits. Visit poultry and piggery units, feed and fodder stores. Calculation of different measures of protein quality.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Feeding of poultry for meat and egg production. Ideal protein concept. Standard ileal digestible amino acids. Nutrient requirements for broilers and layers. Feeding of breeder hens; nutritional factors affecting hatchability. Feeding systems for poultry. Feed additives for poultry. Nutritional approaches for designer egg and meat production. Nutritional disorders in poultry and the role of nutrition in diseasesprevention. Water intake and quality in poultry production	12
2.	**Unit II** Nutrition and feeding of swine in different stages of growth and production. Nutritional factors affecting the quality of the products: lean meat production. Water intake and quality in pig production	10
3.	**Unit III** Feeding of equines. Feeding of rabbits. Hindgut fermentation and its importance. Nutrient requirements of equines. Special features of equine feeding management. Nutritional management of colic and other health disorders. Nutrient requirements of rabbits for wool and meat production. Nutrition-related disorders in rabbits.	10
	Total	**32**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Design and planning for poultry and swine feeding experiments.	2
2	Calculation of nutrient requirements for broilers and layers.	2

3	Formulation and compounding of general and least-cost rations,	2
4	Determination of the nutritive value of poultry and swine feeds by balance experiments.	2
5	Formulation of rations for horses and rabbits.	2
6	Visit poultry and piggery units, feed and fodder stores.	2
7	Calculation of different measures of protein quality	3
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome

Knowledge of practical feeding management of various classes of non-ruminant species.

Suggested Readings

- Adamo G and Costanza A (Eds.). *Rabbits Biology, Diet and Eating Habits and Disorders*. Nova Biomedical.
- Cheeke PR. 1987. *Rabbit Feeding and Nutrition*. Academic Press, Inc.
- Chiba LI (Ed.). 2012. *Sustainable Swine Nutrition*. Wiley-Blackwell.
- de Blas C and Wiseman J. (Eds.). 2010. *Nutrition of the Rabbit*, 2nd ed. CAB International.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Frape D. 2010. *Equine Nutrition and Feeding*, 4th ed. Wiley-Blackwell.
- Hynd PI. 2019. *Animal Nutrition: From Theory to Practice*. CAB International.
- Leeson S and Summers JD. 2009. *Commercial Poultry Nutrition*, 3rd ed. Nottingham University Press.
- Leeson S and Summers JD. 2019. *Scott's Nutrition of The Chicken*, 4th ed. CBS Publishers and Distributors.

- NRC. 2007. *Nutrient Requirements of Horses*, 6th Rev. ed. National Research Council. National Academy Press.
- NRC. 1994. *Nutrient Requirements of Poultry*, 9th Rev. ed. National Research Council. National Academy Press.
- NRC. 2012. *Nutrient Requirements of Swine*, 11th Rev. ed. National Research Council. National Academy Press.
- Varga M. 2013. *Textbook of Rabbit Medicine*, 2nd ed. Butterworth-Heinemann.

Course Title : Research Methodology in Animal Nutrition
Course Code : ANN 507
Credit Hours : 0+2

Why this course?
Nutritional evaluation involving feed analysis and nutrient metabolism is vital inthe interpretation of the outcomes of nutritional studies.
Aim of the course
Preparedness in part of the students to understand the basics of various analyticaltechniques and their application in nutritional research.

Practical
Unit I (6 Classes)
Principles of animal experimentation. Common statistical tools for nutritional research.
Unit II (20 Classes)
Preparation of standard solutions. Proximate analysis of feeds and fodders. Cell- wall partitioning using Van Soest methods. Markers in digestibility determination. *In-vitro*/ *in sacco* determination of digestibility and digestion kinetics. Determination of energy content of feed, faeces and urine using bomb calorimeter. Determination of blood metabolic profile.Unit III (6 *Classes*)Introduction and principles of GC, HPLC, AAS, ICP, tracer technique, flame photometer, NIR, SF_6, rumen-simulation technique, and amino acid analyzer.

Practical

Sr. No.	Topic	No. of Practical (s)
1	**Unit I** Principles of animalresearch	06
2	**Unit II** Preparation of standard solutions. Proximate analysis of feeds and fodders. Cell- wall partitioning using Van Soest methods. Markers in digestibility determination. *In-vitro*/ *in sacco* determination of digestibility and digestion kinetics. Determination of energy content of feed, faeces and urine using bomb calorimeter. Determination	20

	of blood metabolic profile.	
3	Unit III Introduction and principles of GC, HPLC, AAS, ICP, tracer technique, flame photometer, NIR, SF_6, rumen-simulation technique, and amino acid analyzer	06
	Total	**32**

Teaching methods/ activities

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on training of laboratory techniques

Learning outcome

Capacity building of the students to undertake animal nutrition research.

Suggested Reading

- Bate ST and Clark RA. 2014. *The Design and Statistical Analysis of Animal Experiments*. Cambridge University Press.
- Hofmann A and Clokie S (Eds.). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology*, 8th ed. Cambridge University Press.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Pounis G. 2018. *Analysis in Nutrition Research*. Academic Press.

Course Title : Companion Animal Nutrition
Course Code : ANN 508
Credit Hours : 1+0

Why this course?
The philosophy of companion animal nutrition is altogether different from that of the farm animals.

Aim of the course
To impart knowledge in the fundamental and applied aspects of the nutrient metabolism for ensuring health and wellbeing of companion animals.

Theory

Unit I (4 Teachings)
Philosophy of companion animal nutrition. Digestion and absorption of nutrients in dogs and cats. Nutrient requirements for dogs and cats during different life stages: energy, protein, fat, minerals and vitamins. Critical nutrients for cats.

Unit II (4 Teachings)
Common feed ingredients and supplements for pets. Homemade diets. Commercial pet foods: types and nutritional profile. Processing techniques in pet food manufacturing. Pet food evaluation and quality control.

Unit III (4 Teachings)
Feeding management for dogs and cats of different age groups, viz., pregnancy, lactation, neonatal puppies and kitten, growth, adult maintenance, stress and geriatrics including feeding behaviour. Water requirements.

Unit IV (4 Teachings)
Deficiencies and eXcesses of nutrients. Nutritionally responsive disorders: inherited disorders of nutrient metabolism, diabetes mellitus, obesity, urinary tract health and kidney diseases. Parenteral nutrition for hospitalized pets.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Philosophy of companion animal nutrition. Digestion and absorption of nutrients in dogs and	4

	cats. Nutrient requirements for dogs and cats during different life stages: energy, protein, fat, minerals and vitamins. Critical nutrients for cats	
2.	**Unit II** Common feed ingredients and supplements for pets. Homemade diets. Commercial pet foods: types and nutritional profile. Processing techniques in pet food manufacturing. Pet food evaluation and quality control	4
3.	**Unit III** Feeding management for dogs and cats of different age groups, viz., pregnancy, lactation, neonatal puppies and kitten, growth, adult maintenance, stress and geriatrics including feeding behaviour. Water requirements	4
4	**Unit IV** Deficiencies and excesses of nutrients. Nutritionally responsive disorders: inherited disorders of nutrient metabolism, diabetes mellitus, obesity, urinary tract health and kidney diseases. Parenteral nutrition for hospitalized pets	4
	Total	**32**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome

Understanding of the nutritional concepts for feeding management of companion animals.

Suggested Reading

- Buffington C, Holloway C, Abood S. 2004. *Manual of Veterinary Dietetics*. Elsevier.

- Case LP, Daristotle L, Hayek MG, Raasch MF. 2010. *Canine and Feline Nutrition: A Resource for Companion Animal Professionals*, 3rd ed. Elsevier.
- Case LP. 2005. *The Dog: Its Behavior, Nutrition, and Health*, 2nd ed. Blackwell Publishing.
- McNamara JP. 2013. *Principles of Companion Animal Nutrition*, 2nd ed. Pearson.
- NRC. 2006. *Nutrient Requirements of Dogs and Cats*. National Research Council. National Academy Press.

Course Title : Nutrition of Laboratory, Wild and Zoo Animals
Course Code : ANN 509
Credit Hours : 2+1

Why this course?
The nutrition of laboratory animals is important to ensure their health performance making them ready for use in biomedical research. On the contrary, wild and zoo animals as a part of the ecosystem call for an entirely different approach in terms of their nutritional management.

Aim of the course
To understand the mechanism involved in the nutrient metabolism in laboratory and wild animals and their diverse applications for effective health management and wellness.

Theory

Unit I (12 Teachings)
Digestive structure and functions of laboratory animals: rats, mice, and guinea pigs. Nutritional requirements of various species of laboratory animals. Feeding of laboratory animals. Concept of purified diets in laboratory animals. Nutrition of non-human primates.

Unit II (10 Teachings)
Natural dietary habits of zoo animals. Feeding schedules of various classes captive and zoo animals and birds. Feeding orphan and neonates. Role of nutrition in the management of health disorders in zoo animals. Feeding of sick and old animals: parenteral nutrition.

Unit III (10 Teachings)
Feeding habits, and behaviour of wild animals. General aspects of digestive physiology of herbivores and carnivores. Nutrition of semi-wild animals like mithun and yak. Nutritive characteristics of forages for wild animals. Adequacy of forage plants for wild and zoo animals.

Practical (16 Classes)
Formulation and preparation of hygienic, balanced diets and feeding of laboratory animals. Characteristics of ration formulation and feeding schedules wild and zoo animals. Visit zoological parks and wildlife sanctuary, and collection of information on the feeding schedule of different categories of captive animals.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Digestive structure and functions of laboratory animals: rats, mice, and guinea pigs. Nutritional requirements of various species of laboratory animals. Feeding of laboratory animals. Concept of purified diets in laboratory animals. Nutrition of non-human primates	12
2.	**Unit II** Natural dietary habits of zoo animals. Feeding schedules of various classes captive and zoo animals and birds. Feeding orphan and neonates. Role of nutrition in the management of health disorders in zoo animals. Feeding of sick and old animals: parenteral nutrition	10
3.	**Unit III** Feeding habits, and behaviour of wild animals. General aspects of digestive physiology of herbivores and carnivores. Nutrition of semi-wild animals like mithun and yak. Nutritive characteristics of forages for wild animals. Adequacy of forage plants for wild and zoo animals	10
	Total	**32**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Formulation and preparation of hygienic, balanced diets and feeding of laboratory animals.	4
2	Characteristics of ration formulation and feeding schedules wild and zoo animals.	4
3	Visit zoological parks and wildlife sanctuary, and collection of information on the feeding schedule of different categories of captive animals	8
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome

Understanding of nutritional management of the laboratory, wild and zoo animals

Suggested Reading

- Barboza PS, Parker KL and Hume ID. 2008. *Integrative Wildlife Nutrition*. Springer.
- Clemons DJ and Seeman JL. 2011. *The Laboratory Guinea Pig*, 2nd ed. CRC Press/ Taylorand Francis.
- Gordon IJ and Prins HHT. 2008. *The Ecology of Browsing and Grazing*. Springer.
- Lane-Patter W and Pearson AEG. 1971. *The Laboratory Animal: Principles and Practice*, 2nd ed. Academic Press.
- NRC. 1995. *Nutrient Requirements of Laboratory Animals*, 4th rev. ed. National Research Council. National Academy Press.
- NRC. 2003. *Nutrient Requirements of Nonhuman Primates*. National Research Council. National Academy Press.
- NRC. 2011. *Guide for the Care and Use of Laboratory Animals*, 8th ed. National Research Council. National Academy Press.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Robbins C. 1993. *Wildlife Feeding and Nutrition*, 2nd ed. Elsevier.
- Weichbrod RH, Thompson GAH and Norton JN (Eds.). 2018. *Management of Animal Care and Use Programs in Research, Education, and Testing*, 2nd ed. CRC Press/ Taylor and Francis.

Course Title : Non-Conventional Feed Resources
Course Code : ANN 510
Credit Hours : 1+1

Why this course?
Exploration of alternative feed resources for farm animals is a continuous process considering the scarcity of quality feeds and fodders for efficient livestock production.

Aim of the course
To build-up concepts involving the availability and potential use of various classesof non-conventional feed resources including ameliorative measures to ensure feedand food safety.

Theory

Unit I (8 Teachings)
Present and future feed requirements and current availability for livestock and poultry. Use of non-conventional feeds; By-products of agricultural, industrial, food processing units and forest by-products. Slaughterhouse by-products, aquatic weeds. Permissible levels of inclusion of various non-conventional feeds in the ration of different kinds of livestock. Formulation of economical rations using the non- conventional feed.

Unit II (5 Teachings)

Classification of toxic principles in animal feedstuffs. Chemico-physical properties of various anti-nutritional factors (ANFs). Rumen microbial adaptation to various ANFs. Effect of anti-nutritional factors on health and production indifferent species of livestock.

Unit III (3 Teachings)
Detoxification of toxin principles by various physical, chemical and biological techniques. Insecticide and pesticide residues, heavy metals residues in feeds and fodders.

Practical (16 Classes)
Qualitative methods for the presence/ detection of ANFs in feedstuffs. Estimationof mycotoxins in various feeds and fodders. Estimation nitrates, HCN, oxalates, protease inhibitors, tannins, saponins, gossypol, mimosine and heavy metals.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Present and future feed requirements and current availability for livestock and poultry. Use of non-conventional feeds; By-products of agricultural, industrial, food processing units and forest by-products. Slaughterhouse by-products, aquatic weeds. Permissible levels of inclusion of various non-conventional feeds in the ration of different kinds of livestock. Formulation of economical rations using the non- conventional feed	08
2.	**Unit II** Classification of toxic principles in animal feedstuffs. Chemico-physical properties of various anti-nutritional factors (ANFs). Rumen microbial adaptation to various ANFs. Effect of anti-nutritional factors on health and production indifferent species of livestock	05
3.	**Unit III** Detoxification of toxin principles by various physical, chemical and biological techniques. Insecticide and pesticide residues, heavy metals residues in feeds and fodders	03
	Total	**16**

Practical

Sr. No.	Topic	No. of Practical (s)
1	Qualitative methods for the presence/ detection of ANFs in feedstuffs.	4
2	Estimationof mycotoxins in various feeds and fodders.	4
3	Estimation nitrates, HCN, oxalates, protease inhibitors, tannins, saponins, gossypol, mimosine and heavy metals	8
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome

Comprehensive knowledge on the integration of alternative feed resources inpractical farm animal production.

Suggested Reading

- Devendra C. 1985. *Non-conventional Feed Resources in Asia and the Pacific*, 2nd ed. APHCA, FAO.
- FAO. 1995. *Tropical Feeds and Feeding Systems*. Proceedings of the First FAO Electronic Conference. Food and Agriculture Organization of the United Nations, Rome.
- FAO. 2004. *Assessing Quality and Safety of Animal Feeds*. Food and Agriculture Organizationof the United Nations, Rome.
- Liner IE. 1980. *Toxic Constituents of Animal Food Stuffs*, 2nd ed. Academic Press.
- Singh UB. 1987. *Advanced Animal Nutrition for Developing Countries*. Indo-Vision.
- Speedy A and Sansoucy R. 1991. *Feeding Dairy Cows in the Tropics*. Food and Agriculture Organization of the United Nations, Rome.
- *Select articles from journals*

Course Title : Introductory Clinical Nutrition
Course Code : ANN 511
Credit Hours : 1+0

Why this course?
Nutrition forms the basis of health and therefore could be strategically used for prevention and/ or therapeutic management of various diseases.
Aim of the course
To understand the role of nutrients in the development of various disease processesTo elucidate the potential of various nutrients and nutraceuticals in amelioration and management of disease of diverse nature.

Theory
Unit I (8 Teachings)
Metabolic disorders and peri-parturient diseases: milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement, mastitis. Nutrient parasite interaction. Enterotoxaemia
Unit II (8 Teachings)
Nutritional amelioration of biotic and abiotic stress: heat and cold stress, transportation stress. Potential plant toxicity to grazing animals. Toxicity of grazing animals: signs of poisoning. Nitrite poisoning, toxic effects of goitrogens, glucosinolates. Nutritional management of reproductive disorders.

Teaching Schedule
Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Metabolic disorders and peri-parturient diseases: milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement, mastitis. Nutrient parasite interaction. Enterotoxaemia	08
2.	**Unit II** Nutritional amelioration of biotic and abiotic stress: heat and cold stress, transportation stress.	08

	Potential plant toxicity to grazing animals. Toxicity of grazing animals: signs of poisoning. Nitrite poisoning, toxic effects of goitrogens, glucosinolates. Nutritional management of reproductive disorders	
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome

Understanding of nutritional management of health disorders.

Suggested Reading

- Constable P, Hinchcliff KW, Done S and Gruenberg W. 2016. *Veterinary Medicine*, 11th ed. Saunders Ltd.
- Knight AP and Walter R. 2001. *A Guide to Plant Poisoning of Animals in North America*. Teton New Media.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Select articles from Journals

Course Title	**: Rumen Biotechnology**
Course Code	**: ANN 512**
Credit Hours	**: 1+0**

Why this course?

Rumen being a distinctive digestive organ typical to ruminants harbouring diverse microbial communities offers opportunities for their manipulation using molecularbiological approaches.

Aim of the course

To understand the basics of rumen metabolism employing molecular biology tools

Theory

Unit I (8 Teachings)

Rumen ecology. Manipulation of rumen fermentation for better utilization of fibrous feeds and reduction in methane production. Biotechnological applications for lignin degradation. Role of feed additives, chemicals, antibiotics and probiotics and theireffect on rumen metabolism. Degradation of anti-nutritional factors in the rumen.

Unit II (8 Teachings)

Genetic manipulation, DNA recombinant technology for improvement in rumen fermentation. Factors influencing the fate of introduced microbes. Metagenomics for microbial diversity: concept and application.

Teaching Schedule

Theory

Sr. No.	Topic	No. of Teaching (s)
1.	**Unit I** Rumen ecology. Manipulation of rumen fermentation for better utilization of fibrous feeds and reduction in methane production. Biotechnological applications for lignin degradation. Role of feed additives, chemicals, antibiotics and probiotics and their effect on rumen metabolism. Degradation of anti-nutritional factors in the rumen	08
2.	**Unit II** Genetic manipulation, DNA recombinant technology for improvement in rumen fermentation. Factors influencing	08

	the fate of introduced microbes. Metagenomics for microbial diversity: concept and application	
	Total	**16**

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome

Basic knowledge of molecular biology as applicable to rumen functions.

Suggested Reading

- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- Dijkstra J, Forbes J and France J. 2005. *Quantitative Aspects of Ruminant Digestion andMetabolism*. CAB International.
- Kebreab E, Dijkstra J, Bannink A, Gerrits W and France J. 2006. *Nutrient Digestion and Utilization in Farm Animals*. CAB International.
- Millen DD, Arrigoni MDB and Pacheco RDL. (Eds.). 2016. *Rumenology*. Springer Nature.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

Course Syllabus and Content of Doctoral Degree in Animal Nutrition

Course Title : Modern Concepts in Feeding of Ruminants
Course Code : ANN 601
Credit Hours : 2+0

Why this course?
The feeding management of ruminants is undergoing rapid changes because of scientific and technological advances to augment productivity.

Aim of the course
To understand the emerging concepts involving feeding management of high producing ruminant animals.

Theory
Unit I (20 Teachings)
Developments in ruminant digestive physiology. Advanced concepts in the determination of energy and protein requirements. Importance of energy and protein quality for milk and meat production. Recent concepts in protein and energy systems like CNCPS, net energy, metabolizable and available protein. Methods of estimation of energy and protein values of feeds for different physiological functions of livestock. Kinetics of nutrient metabolism. Hindgut fermentation. Efficiency of nutrient utilization for different production purposes. Hormonal regulation of nutrient partitioning.
Unit II (12 Teachings)
Concept of limiting amino acids for high yielders. Strategic feeding of high yielding dairy cows and meat-producing ruminants. Concept of phase feeding and precision feeding. Feeding during the transition period. Bypass nutrient technology. Rumen manipulation to optimize productivity and reduce methanogenesis.

Teaching methods
- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome

Knowledge of the newer concepts for its application in the feeding management of ruminants.

Suggested Reading

- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 7th rev. ed. National Research Council. National Academies Press.
- NRC. 2016. *Nutrient Requirements of Beef Cattle*, 8th rev. ed. National Academies of Sciences, Engineering, and Medicine. National Academies Press.

Course Title : Forages in Animal Nutrition
Course Code : ANN 602
Credit Hours : 1+0

Why this course?
Forages are the principal component of the animal feeding system and therefore their effective utilization is the key for efficient animal production.

Aim of the course
To impart knowledge on the fodder management including different forage production systems and their utilization.

Theory

Unit I (10 Teachings)
Forages in ruminant production. Improvement in productivity of fodders and pasture: feed-food crops, silvi-pasture, horti-pasture, shrubs. Use of conserved forages in ruminant feeding. Factors affecting the nutritive value of cultivated and conserved forages. Hydroponics as an alternate to green fodder production.Top feeds, fodder trees and their effective utilization. Tree leaves as a source of condensed tannins: role in protein protection and GI parasite control.

Unit II (6 Teachings)
Methods in forage evaluation: calculated *in-vitro* DOMD and ME by using *in-vitro* gas production technique. Pasture consumption and evaluation studies.

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
Understanding of various aspects of forage production, fodder evaluation and theirintegration into the different animal production system.

Suggested Reading

- Givens D, Axford R and Owen E. (Ed.). 2000. *Forage Evaluation in Ruminant Nutrition*. CAB International.

- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Minson D. 1990. *Forage in Ruminant Nutrition*. Academic Press.
- Shirley RL. 2012. *Nitrogen and Energy Nutrition of Ruminants*. Academic Press.

Course Title : Recent Concepts in Feeding of Non-Ruminants
Course Code : ANN 603
Credit Hours : 1+0

Why this course?
Increased consumer awareness has necessitated a relook into the feeding management of food animals leading to the production of safe and healthy food.

Aim of the course
To derive knowledge regarding the nutritional manipulation of food animals for the production of quality food for human consumption.

Theory

Unit I (18 Teachings)
Latest concepts in nutrition and feeding in different phases of broiler, layer and breeder stocks. In-ovo and early chick nutrition. Nutritional disorders in modern poultry production and their amelioration. Nutritional factors affecting egg quality and hatchability in poultry. Feeding strategies for the production of designer eggs and meat. Omega fatty acids. Recent trends in amino acid nutrition. Advances in new generation feed and feed additives.

Unit II (14 Teachings)
Nutrition and feeding of pigs in various stages of production. Modern concepts in amino acids nutrition in swine production. Emerging concepts in feeds and feed additive for pigs. Role of vitamins and minerals in health and disease. Nutritional manipulation for lean meat and designer pork production. Carcass modifiers.

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
Comprehensive knowledge on the scope of nutritional management of non-ruminant animals for the production of healthy food.

Suggested Reading

- Chiba LI (Ed.). 2012. *Sustainable Swine Nutrition*. Wiley-Blackwell.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Hendriks WH, Verstegen MWA and Babinszky L. (Eds.). 2019. *Poultry and Pig Nutrition: Challenges of the 21st Century*. Wageningen Academic Publishers.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of The Chicken*, 4th ed. University Books.
- Lewis AJ and Southern LL. 2000. *Swine Nutrition*, 2nd ed. CRC Press.

Course Title : Advances in Rumen Metabolism
Course Code : ANN 604
Credit Hours : 1+1

Why this course?
An in-depth of the understanding of the rumen function is key to devise strategies for augmenting the efficiency of production besides ensuring environmental sustainability.

Aim of the course
To understand the metabolic aspects of rumen function and its application for eco- friendly ruminant production.

Theory

Unit I (8 Teachings)
Rumen development. Rumen microflora: classification and their role in fermentation and digestion, microbial interactions, rumen kinetics, the nutrient requirement of rumen microbes. Dynamics of nitrogen metabolism in the rumen.

Unit II (8 Teachings)
Manipulation of rumen fermentation: physical, chemical and biological approaches. Trans-faunation and defaunation. Concept of metagenomics in rumen manipulation. Green-house gas production from rumen and mitigation strategies

Practical (16 Classes)
Rumen microbial and protozoal count. Estimation of rumen microbial protein. Estimation of nitrogen-fractions in rumen liquor. Volatile fatty acid fractionations. Rumen enzymes assay. EXtraction of nucleic acids and quantification of rumen microbes by PCR.

Teaching methods
- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome
Comprehensive knowledge of various concepts of rumen metabolism for

efficient ruminant production

Suggested Reading

- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- Dijkstra J, Forbes J and France J. 2005. *Quantitative Aspects of Ruminant Digestion andMetabolism*. CAB International.
- Kebreab E, Dijkstra J, Bannink A, Gerrits W and France J. 2006. *Nutrient Digestion and Utilization in Farm Animals*. CAB International.
- Millen DD, Arrigoni MDB and Pacheco RDL. (Eds.). 2016. *Rumenology*. Springer Nature.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

Course Title : Advances in Mineral and Vitamin Nutrition
Course Code : ANN 605
Credit Hours : 2+0

Why this course?
Molecular mechanisms driving the metabolism of minerals and vitamins have opened up a new vista in the nutrition of farm animals.

Aim of the course
To understand advances in mineral and vitamin metabolism for its application in ensuring optimized health and efficient production in farm animals.

Theory

Unit I (18 Teachings)
Role of minerals in nutrient metabolism. Mineral absorption, transport, metabolism and its regulation. Bio-availability of macro and micro minerals: factors affecting the bioavailability; bio-markers for mineral status. Mineral interactions. Dietary cation-anion difference (DCAD). Identification and correction of deficiencies and toxicities of minerals. Mineral tolerance in animals. Mineral requirements for growth, reproduction and lactation. Mineral toxicities concerning livestock feeding and their amelioration. Methods of mineral supplementation.

Unit II (14 Teachings)
Chemical nature of fat-soluble and water-soluble vitamins. Role of vitamins in nutrient metabolism. Advances in physiological functions and metabolism of vitamins. Vitamin deficiency: clinical signs and their management. Antimetabolites to vitamins. Hypervitaminosis. Vitamins as antioxidants. Role of vitamins in immunity and stress. Dietary supplementation of vitamins: forms, storage and stability.

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
Knowledge on the latest understanding of mineral and vitamins and its application in practical feeding conditions.

Suggested Reading

- McDowell RL. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- McDowell LR. 2003. *Minerals in Animal and Human Nutrition*, 2nd ed. Elsevier Science B.V.
- Suttle N. 2010. *The Mineral Nutrition of Livestock*, 4th ed. CAB International.

Course Title : Advanced Clinical Nutrition
Course Code : ANN 606
Credit Hours : 1+1

Why this course?
Approaches involving preventive, therapeutic and convalescent nutrition have been recognized as a sustainable means of ensuring health and wellbeing of animals besides the production of safe and healthy food.

Aim of the course
To understand the disease-induced alterations in nutrient metabolism and the potential of select nutrients to prevent and/ or support disease management in prone animals.

Theory

Unit I (12 Teachings)
Metabolic disorders in farm animals. Modern concepts in the metabolic alterations leading to production diseases, viz., milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacementand mastitis Optimum nutrition for peri-parturient dairy animals.

Unit II (10 Teachings)
Metabolic effects of infection: metabolism of carbohydrates, fats, protein and aminoacids and minerals during various infection and inflammatory diseases. Role of cytokines in nutrient homeorrhesis. Nutrition-immunity interaction: Role of nutrients (fats, amino acids, minerals and vitamins) in the immune response. Metabolic alterations during abiotic stress and feeding management during stress situations.

Unit III (10 Teachings)
Nutritional manipulation and feeding of sick and hospitalized animals. Preventiveand therapeutic nutrition. Optimum nutrition for the management of diseases of the hepatic, renal and gastrointestinal system. Convalescence diet. Feeding management of pre- and post-operated animals.

Practical (16 Classes)
Assessment of immunity: humoral immune response, cell-mediated immune response. Assessment of antioXidant status: SuperoXide dismutase, Catalase, Glutathione peroXidase, reduced glutathione (GSH), lipid peroXides. Formulationof diet for sick and diseased animals.

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning Outcome

Understanding the potential of nutrition for prophylaxis and therapeutic purposes.

Suggested Reading

- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- Constable P, Hinchcliff KW, Done S and Gruenberg W. 2016. *Veterinary Medicine*, 11th ed. Saunders Ltd.
- Naylor JM and Ralston SL. 1991. *Large Animal Clinical Nutrition*. Mosby Inc.
- Walker S, Beckett G, Rae P and Ashby P. 201. *Clinical Biochemistry: Teaching Notes*, 9th ed. Wiley-Blackwell

Course Title : Advanced Techniques in Nutritional Research
Course Code : ANN 607
Credit Hours : 1+1

Why this course?
Cutting edge technologies in analytical science have revolutionized food science research.

Aim of the course
To become conversant with the use of advanced techniques in nutritional research.

Theory

Unit I (16 Teachings)
Good laboratory practices. Analytical equipment in animal nutrition research. Estimation of minerals using atomic absorption spectrophotometer and ICP. Principles and applications and of GC, HPLC, amino acid analyzer, SF6, and electron microscopy. Remote sensing and geographic information system (GIS) in animal nutrition research. Analysis of feeds and fodders using NIR. Faecal inoculumas an alternative to rumen liquor for *in-vitro* studies.

Practical (16 Classes)
RUSITEC. Estimation of minerals by atomic absorption spectrophotometer. Estimation of mycotoxins, oxalate, nitrates and tannin. Fatty acid analysis. Vitamin estimation.

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

Learning outcome
Skill development in terms of efficient use of modern analytical techniques related to animal nutrition research.

Suggested Reading

- Kaneko J, Harvey J, Bruss M.(Eds.) 2008. *Clinical Biochemistry of Domestic Animals*, 6th ed. Academic Press.
- Krishna 2012. *Livestock Nutrition- Analytical Techniques*. New India Publishing Agency.

Course Title : Advances in Feed Technology
Course Code : ANN 608
Credit Hours : 1+0

Why this course?
The translation of nutritional knowledge for its wider application involves industrial- scale technological adaptations.

Aim of the course
To understand the basic as well as applied aspects of various feed processing technologies.

Theory

Unit I (10 Teachings)
Good manufacturer practices (GMP) in feed plants. Planning and designing of feed plants of different capacities. Recent developments in feed processing: particle size reduction, pelleting, extrusion, expanding, conditioning, micronizing. Post pelleting applications. Automation in feed processing. Flow charts for preparation of feeds for various species. Mixer efficiency test, pellet durability test. Densification of bulk feeds. Silos of various capacity, silage preparation and silage additives. Laws and regulations of the feed manufacturing industry. Introduction to labour laws and standards, planning and production programme. Record-keeping.

Unit II (6 Teachings)
Roughage processing. Whole plant processing. Solid-state fermentation technology. Preparation of complete feeds and its processing. Formulation of premixes. Carriers and diluents. Liquid feed handling. Latest concepts in feed microscopy. Qualitative tests for rancidity.

Teaching methods

- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
Skill development in terms of increased employment and entrepreneurship

Suggested Reading

- Langham J. 2013. Recent Advances in Animal Feed Technology. Random Exports.
- Moughan PJ and Hendricks WH. (Eds.). 2018. Feed Evaluation Science. Academic publishers.
- Perry TW, Cullison AE and Lowrey RS. 2003. Feeds and Feeding, 6th ed. Pearson.
- Schofield EK (Ed.). 2005. Feed Manufacturing Technology V. American Feed Industry Association, Arlington.

Course Title : Toxicants and Anti-Metabolites in Animal Nutrition
Course Code : ANN 609
Credit Hours : 1+0

Why this course?
In-feed anti-metabolites in incriminating factor poses a threat not only to the animal health but also for human health and safe food production.

Aim of the course
To impart knowledge on the various toxicants and anti-metabolites in the feeding system and their amelioration.

Theory
Unit I (12 Teachings)
Classification of toxicants in animal feeds. Plant origin toxicants, microbial origin toxicants, acquired toxicants (heavy metals, pesticide residues, drug residues), and their effects on animal health and production. Ameliorative measures. Detoxification of plant origin toxicants. Residual effects on animal products and the environment.
Unit II (4 Teachings)
Anti-metabolites in animal feedstuffs. Effects of anti-metabolites on animal health and production. Anti-vitamins

Teaching methods
- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
Safe use of animal feed resources for ensuring food safety.

Suggested Reading

- Cheeke PR and Shull LR. 1985. *Natural Toxicants in Feeds And Poisonous Plants*. AVIPublishing Company Inc.
- FAO. 2004. *Assessing Quality and Safety of Animal Feeds*. Food and Agriculture Organization of the United Nations, Rome.
- Gremmels JF (Ed.). 2010. *Animal Feed Contamination Effects on Livestock and Food Safety*. Woodhead Publishing Ltd.
- Keeler RF, Van Kampen KR and James LF. 1978. *Effects of*

Poisonous Plants on Livestock. Academic Press.

- Knight AP and Walter R. 2001. *A Guide to Plant Poisoning of Animals in North America*. Teton New Media.
- Liner IE. 1980. *Toxic Constituents of Animal Food Stuffs*, 2nd ed. Academic Press.
- Osweiler G. (Ed.) 2011. *Ruminant Toxicology*. *An issue of Veterinary Clinics: Food Animal Practice*. Elsevier.

Course Title : Nutrigenomics in Animal Nutrition
Course Code : ANN 610
Credit Hours : 1+0

Why this course?
The establishment of a functional relationship between nutrition and gene expression has become recognized as a tool to unravel the mechanisms involving the role of nutrition in health and disease.

Aim of the course
To impart the knowledge on the basics of nutrigenomics and its application in nutrition.

Theory

Unit I (4 Teachings)
Basic concepts of genetics and molecular biology. Nucleic acid structure and replication, transcription and translation.

Unit II (8 Teachings)
Introduction to nutrigenomics and nutrigenetics. Nutritional regulation of gene expression. Introduction to epigenetics, and its influence on early life nutrition and health.

Unit III (4 Teachings)
Concepts of proteomics and metabolomics. Microbiome and diseases of nutritional importance. Dietary influences on the microbiome.

Teaching methods
- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
Development of concepts on nutrigenomics.

Suggested Reading

- Carlberg C, Ulven SM and Molnár F. 2016. *Nutrigenomics*. Springer
- Caterina RDE, Martinez, JA and Kohlmeier M.(Eds.) 2020. *Principles of Nutrigenetics and Nutrigenomics*. Elsevier Inc.
- Dodds JW and Laverdure DR. 2015. *Canine Nutrigenomics - The New Science of Feeding Your Dog for Optimum Health*. Dogwise Publishing.
- Select articles from Journals

Course Title : Equine Nutrition
Course Code : ANN 611
Credit Hours : 1+0

Why this course?
Nutrition of equines calls for special attention considering their use for mankind.
Aim of the course
To impart a comprehensive knowledge on the nutrition of horses and other equids.

Theory
Unit I (8 Teachings)
Digestive function and metabolism of nutrients. Nutrient requirements of equines in different physiological stages. Feed ingredient for horses. Digestive disorders.
Unit II (8 Teachings)
Feeding foal, yearlings, mares and stallions for production and reproduction. Feeding for performance and nutrient metabolism during exercise. Nutritional management of race-horses. Diet formulation for all classes of horses.

Teaching methods
- Classroom Teachings using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

Learning outcome
In-depth knowledge of equine nutrition including its application.

Suggested Reading

- Frape D. 2010. *Equine Nutrition and Feeding*, 4th ed. Wiley-Blackwell.
- Geor R, Harris P and Coenen M (Eds). 2013. *Equine Applied and Clinical Nutrition*. Saunders, Elsevier.
- NRC. 2007. *Nutrient Requirements of Horses*, 6th Rev. ed. National Research Council. National Academy Press.
- Pagan JD. (Ed.). 2009. *Advances in Equine Nutrition IV*. Kentucky Nutrition Research.

Course Syllabus and Content of Master's Degree in Livestock Production and Management

Course Title : Cattle and Buffalo Production Management
Course Code : LPM 501
Credit Hours : 2+1

Why this course

Important species of livestock are a source of employment and cater to nutritional demands and socio-economic upliftment of people.

Aim of the course

To acquaint students with basic aspects of dairying in India comparing with developed countries, problems and prospects of dairying, detailed aspects of care and management of different categories of dairy cattle and buffaloes.

Theory

Unit I (2 Lectures)

Development of dairy industry in India and the world. Present status and future prospects of dairying in India and the world. SWOT analysis of the dairy sector in different agro-climatic zones. Production systems in vogue under Indian conditions. Breeds of cattle and buffalo with more emphasis on breeds of economic importance.

Unit II (6 Lectures)

Housing/ Shelter management. Housing and equipment requirements for different classes of cattle and buffaloes. Layout plans and construction details for different sized farms in different climatic zones of India. Ventilation and lighting systemsin dairy farms.

Unit III (8 Lectures)

Feed and fodder resources used for feeding cattle and buffaloes. Scientific techniqueand regimen of feeding and watering of different categories of cattle and buffaloes. Feed and fodder requirements of different categories of cattle and buffaloes. Supply of green fodder round the year. Enrichment of poor quality roughages. Non- conventional feeding resources. Pasture management.

Unit IV (8 Lectures)

Traits of economic importance and their inter-relationships. Selection and methods of breeding. Reproduction management - Pre-natal and post-natal care and management of dams. Care of neonates and young calves. Management strategies for reducing mortality in calves, optimizing age at first calving and calving interval. Improving breeding efficiency of dairy animals.

Unit V (8 Lectures)

Farm management - Routine management practices and farm labour

management. Milking management - Machine milking and hand milking. Clean milk production- Techniques of harvesting clean milk, cooling and transportation. Different laws and practices governing the dairy sector to produce quality products on par with international standards. Health management of dairy animals. Summer and winter management of dairy animals. Draughtability and management of draught animals.

Practical (14 Classes)

Visits to different sized dairy farms and assessment of routine managemental practices. Analysis of various farm records for economic evaluation. Computation of practical and economical rations. Layout plans and housing details. Housing, milking, calf, heifer and adult management. Dairy Cattle and Buffalo judging and body condition scoring (BCS). Project preparation for commercial farms.

Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits.

Learning outcome

By the end of this course, the student will come out with practical knowledge of cattle and buffalo production management aspects, entrepreneurship skills.

Suggested Reading

- Arora SP. 1997. *Feeding of Dairy Cattle and Buffaloes*. Kalyani Publication.
- Dutta G. 1994. *Care and Management of Dairy Cattle and Buffaloes*, 3rd ed. ICAR.
- Flanders F and Gillespie J. 2015. *Modern Livestock and Poultry Production*, 9th ed. Delmar Cengage Learning Edition.
- Gupta PR. 2017. *Dairy India-2017*, 7th ed. Dairy India Yearbook, Thomson Press Ltd.
- ICAR. *Livestock Production and Management* - ICAR eCourse PDF eBook (online free).
- Phillips CJC. 2011. *Principles of Cattle Production*. CABI Publishing.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Thomas CK, Sastry NSR and Ravikiran G. 2012. *Dairy Bovine Production*, 2nd ed. Kalyani Publishers.
- Tyler HD and Ensminger ME. 2006. *Dairy Cattle Science*, Pearson Prentice Hall Publishing.
- Selected articles from journals.

Course Title : Sheep and Goat Production Management
Course Code : LPM 502
Credit Hours : 2+1

Why this course?
To know the production and management of small ruminants. Important species of livestock provide employment and supplementary income besides meeting the nutritional demands and are of commercial importance.

Aim of the course
To acquaint students on the status of sheep and goat farming in India, principles of housing and feeding, breeding management to improve the reproductive efficiency and detailed account on care and management of different classes of sheep and goat.

Theory

Unit I (2 Lectures)
Population structure and importance. Sheep farming under different systems of management. Advantages and limitations of sheep and goat farming. Genetic resources of sheep and goats with special emphasis on breeds of economic importance.

Unit II (6 Lectures)
Shelter management. Housing and equipment requirements for different classes of sheep and goats. Designing feeders and waterers. Layout plans and construction details for different size farms in different agro-climatic zones of India.

Unit III (8 Lectures)
Feed and fodder resources for small ruminants. Common property resources (CPR's) and their management. Principles and systems of feeding and watering different categories of sheep and goat. Pasture utilization and improvement.

Unit IV (8 Lectures)
Breeding Management, Traits of economic importance and their inter-relationship. Breeding seasons. Selection of breeding animals. Methods of detection of heat, use of teaser, flushing, tupping. Estrous synchronization, Natural Service, artificial insemination and off-season breeding in small ruminants. Care and management of pregnant animals and breeding stock. Culling.

Unit V (4 Lectures)
Disease Management. Prevention and control measures including vaccination, deworming, dipping and spraying, etc. Transportation of small ruminants.

Unit VI (4 Lectures)
Meat, Methods of slaughter, dressing percentage. Wool: Shearing methods.

Importance of wool, wool quality. Goat fibers: mohair, pashmina - Marketing of goat fibers/ wool. Milk, Milking, avoidance of goaty odour in milk, clean milk production and its therapeutic uses.

Practical (14 Classes)

Visits to modern sheep and goat farms and critical analysis of various managerial practices under different conditions. Study of practical housing management. Diseases control management. Shearing management. Record keeping and economics of sheep and goat farming for mutton/ chevon, wool/ fibre and milk. Preparation of project for commercial farming. Daily and periodical farm operations. Dipping and vaccination.

Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits

Learning outcome

By the end of this course, the students get practical exposure to different aspectsof sheep rearing, production and management.

Suggested Reading

- Bhat PN and Khan BU. 2009. *Goat Production*. Studium Press (India) Pvt. Ltd.
- Bhatt PN and Arora CL. 2009. *Sheep Production*. Studium Press (India) Pvt. Ltd.
- Devendra C and McLeroy GB. 1982. *Goat and Sheep Production in Tropics*. Longman.
- Devendra C and Burns M. 1983. *Goat Production in the Tropics*. CABI Publishing.
- Gupta JL. 2006. *Sheep Production and Management*. BS Publ.
- ICAR. 2014. *Handbook of Animal Husbandry*, 3rd ed. ICAR.
- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishing Agency.
- Kaushik SK. 2017. *Sheep Production*. ICAR Publ.
- Peacock CP. 1996. *Improving Goat Production in the Tropics: A Manual for Development Workers*, OXFam, UK.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management.* ISAPM Publication.
- Solaiman SG. 2010. *Goat Science and Production*. Wiley-Blackwell.
- *Selected articles from journals.*

Course Title : Climatology and Livestock Production
Course Code : LPM 504
Credit Hours : 1+1

Why this course?
This course is important to know the climatic changes that affect the health and production of livestock and vice versa.

Aim of the course
To familiarize students on climate, weather, various climatic factors and their rolein production and health of animals in both temperate and tropics, micro and macroclimatic conditions of the animal house and assessing the heat tolerance of bovines.

Theory

Unit I (4 Lectures)
Climatology and agro-climatic regions of India. Study of climatic factors and their measurement. Climatic stress in livestock (heat stress/ cold stress): effects, measurement and amelioration. Temperature-humidity index and thermo-neutral zone. Adaptation and acclimatization.

Unit II (4 Lectures)
Light: natural and artificial, photoperiod, mechanism of light action and responses. Application in livestock production.

Unit III (4 Lectures)
Performance of livestock introduced in different climates. Micro-climate modificationin animal houses. Livestock and global warming.

Unit IV (4 Lectures)
Climate-resilient livestock production systems. Natural disasters-effects on livestockand mitigation measures.

Practical (14 Classes)
Visit modern weather forecast stations. Assessment of climate: Microclimatic conditions within the animal house, Measurement of Temperature, Relative humidity, wind velocity and intensity of light. Ambient temperature. Construction of climographs and hythergraphs. Heat tolerance test in bovines.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits.

Learning outcome
The student is expected to know the different climatic conditions and adaptations for better production and managing livestock.

Suggested Reading

- Collier RJ and Collier JL. 2012. *Environment Physiology of Livestock*. Wiley-Blackwell Co.
- Lal DS. 1998. *Climatology*. Sharda Pustak Bhavan, Allahabad.
- McDowell RE. 1972. *Improvement of Livestock Production in Warm Climates*. WH Freeman.
- Payne WJ and Wilson RT. 1999. *An Introduction to Animal Husbandry in the Tropics*. Blackwell Publishing, USA.
- Rainwater MCF. 1962. *Animal Climatology*. Indian Veterinary Research Institute, Izatnagar.
- Sejian V, Gaughan J, Baumgard L and Prasad C. 2015. *Climate Change Impact on Livestock: Adaptation and Mitigation*, 5th ed. Springer.
- Siddhartha K and Roger B. 1996. *Atmosphere, Weather and Climate*. ELBS.
- *Selected articles from journals.*

Course Title : Behaviour and Welfare of Farm Animals
Course Code : LPM 505
Credit Hours : 1+1

Why this course?
Improving the behaviour of livestock for better productivity and welfare.

Aim of the course
To acquaint students on principles of farm animal behaviour concerning environmental influence, group formation, social behaviour and behavioural adaptations under domestication.

Theory

Unit I (4 Lectures)
Introduction to Animal behaviour. Evolution of animal behaviour: Theories of animal behaviour. Importance of animal behaviour studies. Physiological basis of behaviour. Natural selection, proximate and ultimate causes, fitness, optimality theory, selfish genes, kin selection, and game theory. Influence of genetic, environmental and physiological influence. Daily and seasonal cycles of behaviour. Patterns of behaviour. Favourable and unfavourable behaviours of domestication.

Unit II (4 Lectures)
Ethogram construction for general behaviour management – interpretation - behaviour assisted animal management - flight zone, Animal learning and training-conditioning- operant and classical, animal behaviour based housing designs – Methods of studying animal behaviour- Vices – causes and prevention.

Unit III (2 Lectures)
Group formation. Social relationships like hierarchy and aggression, the process of socialization, locality and behaviour. Behavioural characters for management practices.

Unit IV (6 Lectures)
Animal welfare – concepts – animal rights – animal freedoms – animal welfare organizations Measurement of animal welfare: - indicators of animal welfare- improvement of animal welfare through selection- the welfare of livestock incommercial farms and captivity, environmental enrichment- Welfare of livestock during various management activities such as handling, transportation, etc., Legislation and regulations of animal welfare – welfare and economics.

Practical (14 Classes)
Behavioral characters for manage mental practices. Behavioral adaptations under domestication. Analysis of behavior in relation to climate. Analysis of social behaviour. Preparation of ethogram (time budgeting).

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
The student will apply the understanding of animal behavior to draw conclusions about animal welfare, Consider how common management practices for livestock influence behaviour and welfare, Interpret and critically evaluate scientific literaturein the field of animal behaviour

Suggested Reading

- Agarwal VK. 2013. *Animal Behaviour* (Ethology) S. Chand and Company
- Albright JL and Arave CW. 1997. *The Behaviour of Cattle*. CAB International.
- Arora MP. 1995. *Animal Behaviour*. WB London.
- Benson BJ and Rollin BE. 2004. *The Well-being of Farm Animals: Challenges and Solutions*.Blackwell Publishing, USA.
- Bouenger EG. 1994. *Animal Behaviour*. WB London.
- Broom DM and Fraser AF. 2007 *Domestic Animal Behaviour and Welfare*, 4th ed. CABI.
- Fraser AF and Broom DM. 1990. *Farm Animal Behaviuor and Welfare*. CAB international
- Hafez ESE. 1969. *The Behaviour of Domestic Animals*, 2nd ed. Balliere, Timdall and Cassell.
- Houpt KA. 2018. *Domestic Animal Behavior for Veterinarians and Animal Scientists*. 6th ed. Wiley Blackwell.
- Kumar V. 1996. *Animal Behaviour*. WB London.
- Selected articles from journals.

Course Title : Farm Hygiene and Waste Management
Course Code : LPM 508
Credit Hours : 1+1

Why this course?
Maintenance of farm hygiene and proper waste management promotes animal health

Aim of the course
To familiarize students on principles of air and water hygiene concerning impurities and inclusions of water, collection and disposal of waste from the animal house, modern techniques in manure disposal and biosecurity measures to be adapted for hygienic production of livestock products.

Theory

Unit I (4 Lectures)
Animal air hygiene. Measure air pollutants and their sources. Factors affecting outdoor and indoor pollution. Methods to control these factors.

Unit II (4 Lectures)
Water Hygiene. Sources of drinking water-Impurities and inclusions. Hygienic requirements and standards for drinking water. Purification of water. Water conservation.

Unit III (4 Lectures)
Manure, Quantity of manure voided by domestic animals. Animal excreta a factor in the spread of disease. Hygienic and economic disposal of farm wastes. Drainage in livestock farms. Lagoons, Sewers, septic tanks, drains and traps.

Unit IV (2 Lectures)
Environmental protection act: Air (Prevention and control of pollution) act and water (Prevention and control of pollution) act.

Unit V (2 Lectures)
Factors affecting environmental pollution and their effect on livestock and livestock products for human consumption. Controlling measures thereof.

Practical (14 Classes)
Assessment of air pollutants on animal health and production. Collection of water samples: Physical, chemical, bacteriological and microscopic examination. Bio-security measures. Modern techniques used in the disposal of farm wastes. Value- added products from farm wastes. Visit water filtration plants and study of filtration systems (rapid and slow-sand, etc.). Testing of drains in livestock farms.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome

By the end of the course, the students know the practical knowledge and experiences in hygiene and waste management and control methods.

Suggested Reading

- Baba MD. 2007. *Environmental Changes and Natural Disasters*. New India Publ.
- Overcash MR. 1983. *Livestock Waste Management*. CRC Press.
- Thapliyal DC and Misra DS. 1996. *Fundamentals of Animal Hygiene and Epidemiology*. International Book Distr. Co.

Course Title : Integrated Livestock Farming Systems
Course Code : LPM 509
Credit Hours : 1+1

Why this course?
To know the Integration of livestock farming systems which in turn helps improvesthe overall profitability of the livestock system.

Aim of the course
To familiarize students on various aspects, viz., scope and limitations of integrated livestock farming system, recent approach and economic feasibility of different integration models for sustainable production

Theory

Unit I (4 Lectures)
Classification of livestock-based farming systems. Principles, Scope, drivers and tradeoffs in integrated livestock farming systems. Sustainability and ecological advantages of integrated livestock farming systems and their economic importance.

Unit II (4 Lectures)
Integration of various components of farming systems. Livestock-fish, arable farming, plantation crops and different livestock enterprises (cattle, buffalo, sheep, goat,pig, rabbit, poultry, beekeeping, silkworm, etc.) along with the bio-gas plant, FYM, vermicompost, solar and wind energy utilization

Unit III (4 Lectures)
New approach for changing farming systems in the light of global warming, carbon sequestration and mitigation of GHGs (reducing carbon and water footprints)

Unit IV (4 Lectures)
Project formulation and evaluation of various integrated livestock enterprises in light of reducing poverty, livelihood diversification, environmental sustainability and resource conservation.

Practical (14 Classes)
Visit modern integrated livestock farming units. Critical analysis of different subunits, economic analysis and preparation of feasibility reports

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
By the end of the course, the students are expected to know with different integratedfarming systems and their application in the field of their study.

Teaching methods

Blackboard, power point, presentations, ICT, Group discussions and farm visits

Learning outcomes

By the end of the course, the students are expected to know with different integrated farming systems and their application in the field of their study.

Suggested Reading

- Ghosh B. 2007. *Integrating Crops and Livestock*, 1st ed. Gene-Tech Books.
- Little DC and Edwards P. 2003. *Integrated Livestock-fish Farming Systems.* FAO.
- Mukherjee TK, Moi PS, Panandam JM and Yang YS. (Eds.) 1992. *Integrated Livestock Fish Production Systems*. FAO/ IPT Workshop on Integrated Livestock-Fish Production Systems, University of Malaya, Kuala Lumpur.Raman KV and Balaguru T. (Eds.). 1992. *Farming Systems Research in India: Strategies for Implementation*. NAARM, Hyderabad.
- Rangasamy A and Annadurai K. 2002. *Farming System in the Tropics*. Kalyani Publishers.
- Renard C. (Ed.). 1997. *Crop Residues in Sustainable Mixed Crop/ Livestock Farming Systems*. CABI.
- Speirs M and Opsen O. 1992. *Indigenous Integrated Farming System in the Sahel*. World Bank.
- Sunil Kumar and DR Palsaniya DR and Kiran Kumar T. 2017. *Farming systems: Issues and Strategies*. Satish Serial Publishing, New Delhi.
- Selected articles from journals.

Course Title : Livestock Business Management
Course Code : LPM 512
Credit Hours : 1+1

Why this course?
Study of livestock business management will improve marketing of livestock and livestock products and enhance the profitability

Aim of the course
To acquaint students with knowledge in principles, planning, technical approach and preparing financial statement in Livestock Business Management and preparing projects for financing.

Theory

Unit I (3 Lectures)
Management principles, Planning Techniques, strategic planning, organization structure, co-ordination and controlling techniques, Approaches to management.

Unit II (5 Lectures)
Key economic concepts, factors of production, farm enterprises, cost of production, opportunity cost, value of production, gross margin, farm profit, net farm family income, substitution, and efficiency: return to scarce resources, risk. SWOT analysis for different livestock species and products, Livestock production economics, theory of supply and demand, production relationships, production function, cost input variables, profit maximization.

Unit III (4 Lectures)
Economics and the market, market intelligence, newer concepts in marketing, market research and opinion polling, advertising research, market surveillance, etc.

Unit IV (3 Lectures)
Marketing channels, Marketing of livestock and livestock products and laws governing them, Pricing strategies, supply chain management, marketing agencies.

Practical (14 Classes)
Accounting records, fund flow statement, Cost and benefit analysis. Budgeting and control. Preparation of financial statements, depreciation accounting methods, trend and variance analysis, cost-volume profit analysis. Financial planning and forecasting. Estimation of working capital requirement. Break even analysis. Visit to livestock business firms and banks. Preparing projects for financing.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
By the end of course the students gain knowledge in planning and handling business records.

Suggested Reading

- Acharya RM and Kumar P. 2013. *Dairy Production and Business Management*. Satish Serial Publishing, New Delhi.
- Bardhan D. 2013. *Textbook on Livestock Economics, Marketing and Business*. Satish Serial Publishing House.
- Bhaskaran S and Mohanty S. 2007. *Marketing of Livestock and Livestock Products in India*. ICFAI University Press.
- Das N. 2009. *Forage for Sustainable Livestock*. Satish Serial Publishing House.
- Gangadhar KS. 2009. *Livestock Economics: Marketing, Business Management and Accountancy*. New India Publishing Agency.
- George RP and Raj Kamal PJ. 2015. *Farm Economics, Entrepreneurship and Marketing*. Satish Serial Publishing, New Delhi.
- Kahan D. 2008. *Economics for Farm Management Extension*. FAO, Rome.
- Koontz H and O'Donnel C. 1999. *Essentials of Management*. Tata McGraw Hill.
- Kotler P. 2000. *Marketing Management - Analysis, Planning and Control*. Prentice Hall of India.
- Maheswari SN. 1998. *Management Accounting*. Tata McGraw Hill.
- Massie JL. 1995. *Essential of Management*. Prentice Hall of India.
- Moran J. 2009. *Business Management for Tropical Dairy Farmers*. Land Links Publishing.
- Srinivasan NP. 1998. *Management Accounting*. Sterling Publications.
- Selected articles from journals.

Course Title : Poultry Farm and Hatchery Management
Course Code : LPM 514
Credit Hours : 1+1

Why this course?
Poultry rearing provides employment opportunities and is an important component of food security

Aim of the course
To impart knowledge on housing, flooring and management of poultry. They also learn incubation and hatching of eggs.

Theory

Unit I (4 Lectures)
Poultry housing systems - cage vs floor system, litter management and lighting for poultry, rearing turkey, duck and quails, backyard poultry.

Unit II (4 Lectures)
Management of chicks, growing, laying and breeding flocks, broiler production, selection and culling of laying flocks. Health management. Management of birds during disease outbreaks.

Unit III (3 Lectures)
Procuring, care and pre-incubation storage of hatching eggs - Method of incubation, sanitation disinfection and management of hatchery. Biosecurity in poultry farms

Unit IV (2 Lectures)
Embryonic development and factors affecting fertility and hatchability of eggs.

Unit V (3 Lectures)
Chick sexing, packing and hatchery business - Transporting management of farm and hatchery waste.

Practical (14 Classes)
Observation and recording of Poultry Farm management - Brooding of chicks; selection of laying flocks - Disease preventive measures - Selection and care of hatching eggs; incubator operation, fumigation and candling setting and hatching, packaging of chicks - Waste management - Marketing of products.
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
By the end of the course, the students gain knowledge on poultry farm management, brooding and hatching management including health.

Suggested Reading

- Ensminger ME. 1992. *Poultry Science*. International Book Distr. Co.
- Hued LM. 2003. *Modern Poultry Farming*. Greenworld.
- Powell-Owen W. 2008. *Poultry Farming and Keeping*. Daya Books.
- Prasad J. 2005. *Poultry Production and Management*. Kalyani Publication
- Singh RA. 1996. *Poultry Production*. 3rd ed. Kalyani Publication

Course Title : Regional Animal Production Management
Course Code : LPM 515
Credit Hours : 1+1

The course content will be developed as per the need of the university

Course Syllabus and Content of Doctoral Degree in Livestock Production and Management

Course Title : Recent Developments in Large Ruminants ProductionManagement
Course Code : LPM 601
Credit Hours : 2+1

Why this course?
Large ruminants are a source of employment and cater to nutritional demands and socio-economic upliftment of people.

Aim of the course
To know modern trends on housing, feeding, health and milking management in dairy bovines.

Theory

Unit I (2 Lectures)
Present status of dairying in India *vis-à-vis* Global and south Asian scenarios, Production dynamics, Recent policy initiatives in dairy development. Conservationof indigenous germplasm

Unit II (4 Lectures)
Advances in housing management, viz., design, layout, construction materials, costof construction suits to various agro-climatic zones of India. Low-cost houses for large ruminants. Ideal shelter management practices for better productivity, Advances in manure and waste disposal.

Unit III (6 Lectures)
Recent approaches in breeding and reproductive Management of dairy animals, Optimization of reproductive traits, Estrus synchronization, MOET, Sexed semen, Cloning and IVF.

Unit IV (4 Lectures)
Recent approaches in Feeding, Phased feeding, Transition period, Hydroponic fodder, Eco-feeding, standards for drinking water and water hygiene.

Unit V (4 Lectures)
Advances in health management of dairy animals, preventive measures for production-related diseases, bio-security measures, etc.

Unit VI (4 Lectures)
Milking management, automation, Sanitary and phytosanitary standards for the production of quality milk, post-harvest processing.

Unit VII (4 Lectures)
Establishing a Dairy Enterprise suitable for various economic strata with different sizes, SWOT analysis. Computerization of dairy enterprises, Best management practices.

Unit VIII (4 Lectures)
Advances in herd management and data analysis, Advances in the management aspects of buffaloes, salvaging of buffalo calves, Advances in work animal management.

Practical (14 Classes)
Critical analysis of various types of managerial practices at farms. Preparation of layout and designs for construction of sheds of various sizes in different agro- climatic zones. Cost analysis of dairy bovine housing. Organization of milking machines. Dairy Cattle and Buffalo judging – BCS. Farm record analysis. Project report preparation for commercial dairy farms.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
By the end of the course, the student gain knowledge and eXperience in different aspects of advanced methods of large ruminants management in different fields of housing, feeding, breeding and milking of dairy animals.\

Suggested Reading

- Clarence HE. 2007. *Dairy Cattle and Milk Production*. Daya Publ. House.
- Moran J and Chamberlain P. 2017. *Blueprints For Tropical Dairy Farming: Milk Production in Developing Countries*. CSIRPO Publishing.
- Moran J. 2013. *Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics*. Landlinks Press.
- Singh U, Kumar S, Kumar A, Deb R and Sharma A. 2013. *Advances in Cattle Research*. Satish Serial Publishing House, New Delhi.
- Thomas CK, Sastry NSR and Ravi Kiran. 2012. *Dairy Bovine Production*, 2nd ed. Kalyani Publishers.

Course Title : Recent Developments in Small Ruminants Production Management
Course Code : LPM 602
Credit Hours : 2+1

Why this course?
Small ruminants are an important source of livelihood security to rural masses and study/ application of recent advances will improve the profitability of small ruminant rearing.

Aim of the course?
To familiarize the students with advanced methods of housing, feeding, breeding, reproduction and health management.

Theory

Unit I (4 Lectures)
Relevance of small ruminants in the Indian economy. Population and production dynamics of small ruminants. Systems of rearing. Needs and possibilities for research in future.

Unit II (8 Lectures)
Recent approaches in breeding and reproductive management. Management during the breeding season, Mating seasons and their control. Recent approaches in reproductive biotechnologies, MOET, Cloning, transgenic, genomics and accelerated lambing.

Unit III (6 Lectures)
Recent approaches in feeding management, Pasture and grazing management, Phase feeding, Feed resources and feeding techniques under different systems.

Unit IV (6 Lectures)
Recent approaches in housing systems with reference to different agro-climatic zones and rearing systems.

Unit V (6 Lectures)
Prospects of management under stall-fed conditions, management of small ruminates during scarcity periods, Migratory pattern and flock management. Recent approaches in exploiting goat's, milk quality, safety and production aspects of dairy goats. Wool/ fibre production and its quality.

Unit VI (2 Lectures)
Recent approaches in health care management, Parasitic control in present ecological and environmental changes.

Practical (14 Classes)
Critical analysis of various farm practices, Preparation of layout and designs for construction of sheds of various sizes in different agro-climatic zones. Cost analysis of housing. Organization of shearing. Sheep and goat judging – BCS. Farm record

analysis. Disease control management. Scorecard and grading of wool. Project reportpreparation for commercial sheep and goat units.

Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome

The students gain knowledge and eXperience on different advance management aspects of small ruminants.

Suggested Reading

- Devendra C and McLeroy GB. 1983. *Goat and Sheep Production in the Tropics*. Agrodok.
- Gupta JL. 2006. *Sheep Production and Management*. CBS.
- Jansen C and van den Burg K. 2004. *Goat Production in the Tropics*. 4th ed. © Agromisa Foundation, Wageningen.
- Karim SA. 2008. *Small Ruminant Production in India*. Satish Serial Publishing, New Delhi.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Selected articles from journals

Course Title : Livestock and Environment
Course Code : LPM 604
Credit Hours : 1+0

Why this course?
There is an urgent need for governments and institutions to develop and enact appropriate policies, at the national and international levels, that focus more on and account for livestock–environment interactions.

Aim of the course
To impart knowledge related to the application of technologies that improve the efficiency of land use and feed use can mitigate the negative effects of livestock production on biodiversity, ecosystems and global warming. Technologies that increase livestock efficiency include improved breeds, improved grazing-land management, improved herd-health management, etc.

Theory
Unit I (4 Lectures)
Effect of livestock on the environment- Role of ruminants in global warming, Slaughterhouse waste, Tannery waste, Stray and fallen animal impact. Strategiesfor mitigation of methane emission from the livestock sector, animal waste management. A life cycle assessment of the environmental impacts of livestock in different production systems.
Unit II (4 Lectures)
Effect of environment on livestock and quality of products: Heat and cold stress, Pollution, Heavy metals, Pesticide residues, etc., Management of micro and macro-environment with respect to animal well-being,
Unit III (4 Lectures)
Concept of Water, Carbon footprints and carbon sequestration of farm animals and products. Thermal load indices, Livestock comfort zones. Carbon trading, mechanisms and opportunities in the livestock sector.
Unit IV (4 Lectures)
Selection of breeds of livestock for hot climate. Recent advances in shelter management practices under the impending climate change scenario. Climate and reproduction. Environment and diseases.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions.

Learning outcome
By the end of the course, the students gain knowledge about the interaction

between livestock and the environment. They also acquire knowledge of the greenhouse effect and mitigation.

Suggested Reading

- Cheeke PR. 1993. *Impacts of Livestock Production on Society, Diet/ health, and the Environment*. Interstate Publishers.
- FAO. 2009. *Livestock in the Balance*, FAO, Rome.
- ICAR. 2014. *Handbook of Animal Husbandry*. ICAR, New Delhi.
- Mudgal VD, Singhal KK and Sharma DD. 2003. *Advances in Dairy Animal Production*, 2nd ed. International Book Distributing Co.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Sejain V, Naqvi SMK, Ezeji T, Lakritz J and Lal R. 2012. *Environmental Stress and Amelioration in Livestock Production*. Springer
- Sirohi SK, Walli TK, Singh B and Singh N. 2013. *Livestock Greenhouse Gas: Emissions and Options For Mitigation*. Satish Serial Publishing, New Delhi.
- Selected articles from journals

Course Title : Organic Livestock Production
Course Code : LPM 605
Credit Hours : 1+0

Why this course?
Organic livestock production offers an effective means of satisfying consumer demand for healthy and safe foods and reducing the environmental pressure of agricultural production. There is a need to know the organic production of livestock products and by-products.

Aim of the course
To impart knowledge on key considerations, organic farming standards, certifying agencies, the role of organic livestock farming in environmental protection and biodiversity enhancement and economics of organic livestock products.

Theory
Unit I (2 Lectures)
Historical background and origin, Organic livestock farming vis-a-vis conventional livestock farming, the current status of organic farming in India and world- objectives and importance of organic livestock farming. Opportunities and Problems of organic livestock farming in India.
Unit II (6 Lectures)
Key consideration, selection of animals, housing, feeding, breeding, health care, record keeping, processing and labelling and marketing. Conversion of livestock farm into an organic farm. ITKs used in organic livestock production.
Unit III (4 Lectures)
Organic farming standards in India and the world. IFOAM basic standards, WHO/ FAO Codex Alimentarius, NSOP of India, etc. Role of organic livestock farming in environmental Protection and biodiversity enhancement.
Unit IV (4 Lectures)
Accreditation of inspection and certification agencies. Organic certification mark. Guidelines for organic certification of livestock modalities in the certification of organic products. The economic value of organic livestock products, pricing strategy and marketing of organic products.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions

Learning outcome
By the end of the course, the student will be acquainted with organic livestock production, economics and marketing of organic products.

Suggested Reading

- Balasubramaniam R, Balakrishnan K and Sivasubramaniam K. 2013. *Principles and Practices of Organic Farming.* Satish Serial Publishing House, New Delhi.
- ICAR. 2014. *Handbook of Animal Husbandry*. ICAR, New Delhi.
- Paajanen T. 2011. *The Complete Guide to Organic Livestock Farming*. Atlantic PublishingGroup Inc.
- Katherine M. 2009 *The Organic Dairy Handbook*. Northeast Organic Farming Association.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian*

Experience in its Management. ISAPM Publication.

- Singh M, Sharma DK and Mishra UK. 2011. Organic Dairy Farming. Satish Serial Publishing House, New Delhi.
- Selected articles from journals

Course Title : Recent Developments in Welfare of Farm Animals
Course Code : LPM 606
Credit Hours : 1+0

Why this course?
Now there are big movements on ethical animal production all over the World. Hence a doctoral student of LPM has to be prepared on this issue too.

Aim of the course
To familiarize students with the concept and practice of ethical livestock production and production from content ended animals - Animal Welfare Management;

Theory

Unit I (2 Lectures)
Ethology: species-specific behaviour, changing with the season, physiological condition of animals, as a guide to animal welfare; not driving animals beyond their natural capacity, for better performance;

Unit II (6 Lectures)
Amelioration of climatic stress and avoidance of unnecessary injury, pain and stress to animals in animal houses, during handling, before and during slaughter, carting bullocks, feeding, milking, shearing, transportation, etc., including deprivance of quality feeds and water; this being a common feature;

Unit III (4 Lectures)
Providing safety, healthcare, feed and water to unproductive animals let off to free roam and injured or orphaned pets, birds and others; monkeys being common – Good management of goshalas and safe shelters for such animals – Conversion of their wastes into VAP to meet part costs of running shelters; Education of the general public, especially children to avoid wanton harm to animals via *Lectures* in schools, TV and radio talks, leaflets, etc.

Unit IV (4 Lectures)
Evaluation of animal welfare measures as an 'instrument' of good animal husbandry, production of quality products and enhanced income to farmers.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
By the end of this course, the student will be familiarized with species-specific behaviour, amelioration of climatic stress and evaluation of animal welfare measures.

Suggested Reading

- *Animal Rights and Animal Welfare Publications* 1896-2009. https://www.lib.ncsu.edu/ findingaids/mc00440
- Appleby MC, Mench JA, Anna Olsson I and Hughes BO. 2018. *Animal Welfare*. CABI.
- AWBI. Animal Protection Laws, Newsletters, etc. of Animal Welfare Board of India; http:// www.awbi.org/section/4/publications/2
- GoI Gazzete. *Order on Animal Welfare* - http://www.moef.nic.in/legis/awbi/awbi18.html
- Phillips C. 2009. *The Welfare of Animals*: *The Silent Majority*. Springer.
- Webster J. 2005. *Animal Welfare: Limping Towards Eden*. Blackwell Publishing.
- Selected articles from journals.

Course Title : Entrepreneurship in Livestock Production
Course Code : LPM 607
Credit Hours : 1+1

Why this course?
Livestock production has huge scope vis a vis income generation. Study of concepts of entrepreneurship will ensure awareness towards the possibilities of taking livestock production as a business unit.

Aim of the course
To understand livestock entrepreneurship, concept, incubation centre, PPP perspective in the animal husbandry sector, business communication, inter-personnel skills for establishing an enterprise.

Theory

Unit I (2 Lectures)
Understanding livestock entrepreneurship, Concept and characteristics of Entrepreneurship, Role of entrepreneur in relation to enterprise, Functions of the entrepreneur in the economy,

Unit II (4 Lectures)
Process of entrepreneurship development. Barriers in entrepreneurship. The institutional interface in the development of entrepreneurship, incubation centres, startups, PPP Prospective in the animal husbandry sector.

Unit III (6 Lectures)
Essential criteria for the development of entrepreneurship in livestock sector -basic requirements for entrepreneurship initiatives in livestock and allied sectors (i.e. techno-economic feasibility of the enterprises under different conditions, training and management skills, business acumen, business communication, inter-personnel skills for establishing an enterprise, etc.).

Unit IV (4 Lectures)
Entrepreneurial training/ development programmes at the State and National level, Livestock Insurance, Bank and Government support for entrepreneurship, Financial credit and financial management: general principles and practices, analyzing project appraisals and reports, capital, expenditure decisions, reinvestment and payback.

Unit V (2 Lectures)
Preparing projects for bank appraisal, banking requirements, Assessing project profits, Procurement management quality issues, standardisation, grading and packaging.

Practical (14 Classes)
Visit incubation centres, extrapolation of existing financial models in livestock entrepreneurship, Approach to the preparation of Entrepreneurial Project on livestock, Bankable project for a dairy enterprise (small/ large dairy unit), Bankable project for a sheep/ goat/ Ram lamb enterprise, Bankable project for a pig-enterprise, Bankable project for a Broiler enterprise (small/ medium/ large unit), Bankable project for a layer-enterprise

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
The student acquires knowledge in entrepreneurship initiatives in livestock and allied sectors, financial management and assessment of project profit.

Suggested Reading

- George RP and Raj Kamal PJ. 2015. *Farm Economics, Entrepreneurship and Marketing*. Satish Serial Publishing, New Delhi.
- Kahan D. 2012. *Entrepreneurship in Farming*. FAO, Rome.
- Zama MMS, Rashid M and Kumar S. 2014. *Handbook of Livestock Entrepreneurship*. Narendra Publishing House.
- Selected articles from journals.

Course Title : Precision Livestock Farming
Course Code : LPM 608
Credit Hours : 1+1

Why this course?
Precision Livestock Farming is a combination of developing animal sensing (sensors) tools and decision-making process at the farm level. This information is very much needed for the students in the present technology of the world.

Aim of the course
To educate the students with a concept of precision in livestock farming, implementation of the sensor system, automation, use of software and analysis

Theory

Unit I (2 Lectures)
Concepts of Precision Livestock Farming-Scope and limitations. Utilities of Precision tools in Livestock Farming, the present level of usage of precision tools in India

Unit II (6 Lectures)
Implementation of sensor systems and ICTs in animal health, productivity and welfare, Animal identification and tracking- Radio frequency identification (RFID), Livestock identification and traceback system (LITS), etc. Geo-tagging, Virtual fencing, GPS and GIS in the exploration of feeding resources and grasslands.

Unit III (6 Lectures)
Automation in water resource management. Development and evaluation of early warning and disease support systems for animal health and welfare.

Unit IV (2 Lectures)
Use of software's for database creation of the livestock farms, computation and analysis.

Practical (14 Classes)
GPS/ GIS Application in the exploration of breeding tracts of livestock, forage and grassland profiles. Exposure visit to precision livestock farms with automation, use of tools in reproduction and health care, use of different software in farm routines.

Teaching methods
Blackboard, power point presentations, ICT, Group discussions and farm visits

Learning outcome
By the end of this course, the students will gain knowledge in precision livestock farming.

Suggested Reading

- Halachmi I. 2015. *Precision Livestock Farming Applications*. Wageningen Academic Pub.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Selected articles from journals.

Course Syllabus and Content of Master's Degree in Livestock Products Technology

Course Title : Abattoir Practices and Meat Plant Operations
Course Code : LPT 501
Credit Hours : 2+1

Why this course?
Human Resource Development (Manager, Supervisor, Meat inspector and other Technocrats) for Slaughterhouses and Meat processing plants.

Aim of the Course
To impart knowledge about the handling of meat animals, layout and design of abattoir, sanitation and basics of slaughterhouse practices and meat plant operations.

Theory

Unit I (12 Lectures)
Handling and transportation of meat animals including poultry - Pre-slaughter handling and care of food animals – Ante-mortem inspection - Humane slaughter - Principles and methods of stunning - Ritual methods of the slaughter of food animals and poultry - Machinery for slaughter and dressing of food animals - Post- mortem inspection - Handling, disposal and condemnation of unfit materials.

Unit II (11 Lectures)
Abattoir - layout, designing, organization and operation - Maintenance of meat andpoultry processing plants - Record keeping - Legislations and regulations for establishment and operation of slaughterhouses and meat processing plants.

Unit III (11 Lectures)
Sanitation of slaughterhouse - Sanitary practices in meat plant and its benefits - Solid and liquid waste management of slaughterhouse - Different methods of effluent treatment and designs of effluent treatment plants - State and Central Pollution Control Board norms.

Practical (17 classes)
Design and outlay of modern abattoir including poultry processing and effluent treatment plants for different capacities - Judging and grading of food animals - Procedure for the slaughter of food animals and poultry - Ante-mortem and post-mortem inspection - Recording of carcass data - carcass yield, meat bone ratio, etc.

Measurement of effluent characteristics - pH, BOD, COD, suspended solids, etc. Visit slaughterhouse, poultry processing and effluent treatment plants - DPR for the establishment of an abattoir.

Teaching methods

- Classroom teaching, practical demonstration in Divisional laboratory/ slaughter unit.
- Visit municipal slaughterhouse and meat plants.
- Demonstration of charts, video films and models.

Learning Outcome

Gaining knowledge of abattoir practices and operations to be carried out in meat plants.

Suggested Reading

- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th Ed. John Wiley and Sons Ltd.,UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences* Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Sahoo J, Sharma DK and Chatli M. 2011. *Practical Handbook on Meat Science andTechnology*, 1st ed., Daya Publishing House.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham Univ. Press.
- Warriss P. 2010. *Meat Science: An Introductory Text*, 2nd ed. Oxford Press.

Course Title	**: Fresh Meat Technology**
Course Code	**: LPT 502**
Credit Hours	**: 1+1**

Why this course?

Human Resource Development for Meat processing Sector

Aim of the Course

To impart knowledge about the status of the meat industry, muscle structure and composition, carcass handling, grading and fabrication.

Theory

Unit I (10 Lectures)

History, current development and prospects of meat and poultry industry in India Skeletal muscle development – pre- and post-natal- Structure and chemistry of muscle including poultry – Muscle Proteins - sarcoplasmic and myofibrillar proteins. Stromal proteins – Types of muscle fibres - Post mortem changes – Rigor mortis

Conversion of Muscle to meat - Pre and post-slaughter factors affecting meat quality – Defects during the conversion of muscle to meat – PSE/ DFD/ Cold Shortening – Off odour development.

Unit II (7 Lectures)

Composition and nutritive value of meat and poultry - Qualities of fresh meat –pH, WHC, colour, odour, juiciness, texture/ tenderness and firmness - Chilling, ageing and conditioning of meat - Electrical stimulation - Carcass evaluation, gradingand fabrication- Tenderization of meat.

Practical (17 Classes)

Evaluation/ estimation of physicochemical properties of fresh meat pH, colour, water holding capacity, ERV, shear force value, glycogen, R-value and myoglobin Proximate analysis of meat - Estimation of drip loss - Determination of sarcomere length, fibre diameter and myofibrillar fragmentation index - Fractionation of sarcoplasmic, myofibrillar and stromal proteins - Carcass evaluation and grading Meat cutting, retail and wholesale cuts.

Teaching methods

- Classroom teaching, practical demonstration and analysis in Divisional laboratory/ slaughter unit.
- Visit slaughterhouses, meat plants and retail units

- Use of Audio-visual Capsules.

Learning Outcome

Acquiring knowledge on quality attributes of fresh meat, factors affecting these attributes, composition and nutritive value of meat.

Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed., Kend All/ Hunt Publishing Company, IOWA.
- Bender A. 1992. *Meat and Meat Products in Human Nutrition in Developing Countries*. FAO, Rome.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, INC.
- Jensen WK, Devine C and Dikeman M. 2004. Encyclopedia of Meat Sciences Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Lawrie RA and Ledward DA. 2006. *Lawrie's Meat Science*, 7th ed. Woodhead Publishing Limited, Cambridge, England.
- Pearson AM. 1994. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Springer, New York.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham University Press.

Course Title	**: Processing and Preservation of Meat**
Course Code	**: LPT 503**
Credit Hours	**: 2+1**

Why this course?

Human Resource Development for Meat and Poultry Processing Industry and Entrepreneurship development

Aim of the Course

To impart knowledge about processing and preservation of meat including poultry meat, fundamentals of sensory evaluation and techniques for sensory evaluation of meat products.

Theory

Unit I (8 Lectures)

Basic principles of meat preservation – dehydration, chilling, freezing, freeze-drying, thermal processing, direct microbial inhibition, irradiation, use of chemicals and antimicrobials - Curing and smoking - Hurdle technology concept.

Unit II (17 Lectures)

Principles of Meat Processing - Meat and non-meat ingredients and their roles. Additives - Processing techniques - comminution, chopping, blending, marination, massaging, tumbling, etc. - Cooking methods including microwaving – Development of meat products including ham, bacon, tandoori and barbeque - Emulsion formation – factors affecting emulsion formation - Emulsion based meat products - sausages, nuggets and patties - Enrobed, restructured, fermented and intermediate moisture meat products – Ready-to-cook, ready-to-eat and shelf-stable meat products – Canned and retort meat products – Traditional and ethnic meat products - Functional meat products.

Unit III (9 Lectures)

Sensory evaluation – Sensory physiology, types, methods, quality attributes - Factorsinfluencing sensory measurements - Types of sensory panels - Selection of sensory panellists- Sensory evaluation tests- Layout and designing of sensory evaluation laboratory.

Practicals (17 Classes)

Estimation of tyrosine value, nitrite content, TBARS value, peroxide value - Preparation of Meat Products - Minced meat products - Emulsion based meat products – sausages, nuggets and patties - Ham and Bacon - Meat Pickles – Enrobed, restructured, fermented and shelf-stable meat products - Canned/ retorted Meat Products - Traditional and ethnic Meat Products - Kebabs - Sensory

evaluation of meat products - Subjective and objective method of sensory evaluation - differential, descriptive, training tests, etc. – Test practices and training in thesensory lab - Determination of emulsion stability - Cooking yield - Texture Profile Analysis.

Teaching methods

Classroom teaching, practical performance in Divisional Pilot Processing Plant.
Visit of Meat and Poultry Processing Unit.
Demonstration videos

Learning Outcome

Theoretical and practical understanding of meat preservation, processing and sensory evaluation of the meat products.

Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Amerine MA, Pangborn RM and Roessler EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press, New York.
- Barbut S. 2005. Poultry Products Technology. CRC Press.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. InterstatePublishers, INC.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Lawless HT and Heymann H. 2010. *Sensory Evaluation of Food - Principles and Practices,* 2nd ed, Springer-Verlag, New York Inc.
- Mountney GJ and Parkhurst CR. 2017. *Poultry Products Technology*, 3rd ed. Food Products Press, New York.
- Pearson AM and Gillett TA. 1996. *Processed Meats*, 3rd ed. Chapman and Hall, Inc, NewYork.
- Sharma BD, Wani S and Sharma N. 1997. *Sensory Evaluation Manual for Meat and Meat Products*. IVRI Publication.
- Toldrá F. 2010. *Handbook of Meat Processing*. Wiley-Blackwell.

Course Title : Processing of Milk and Milk Products
Course Code : LPT 504
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor and other Technocrats) for Milk Processing Industry, Cooperatives, etc.

Aim of the Course
To impart knowledge about the organization of dairy plants, basic milk operations, cleaning and sanitization of milk processing plants, milk products processing and applications of membrane technologies in dairy industries.

Theory

Unit I (6 Lectures)
Basic concepts of dairy plant organization and operation - collection, chilling, transportation - Heat treatments of Milk - Cleaning and sanitization of Dairy plants - Composition, nutritional, physico-chemical and functional properties of milk - Standards for milk and milk products.

Unit II (7 Lectures)
Manufacture of milk products - Flavoured Milk - Drying of milk and milk products - Evaporated and condensed milk - Milk powders – Butter - Ice cream and other frozen desserts - Manufacture of different fermented milk products - Manufacture of cheddar, mozzarella, cottage and processed cheese - Manufacture of indigenous milk products – paneer, Channa, Khoa, Ghee, Dahi and Shrikhand - Rheology of milk products - Dairy by-products.

Unit III (4 Lectures)
Membrane filtration technology- principles and concepts - Manufacturing and functional properties of casein - Caseinates- Co-precipitates - Whey protein concentrates (WPC) - Lactose- Dairy whiteners.

Practical (17 Classes)
Platform tests - Determination of fat, SNF, TS, protein, lactose and ash contents of milk - Preparation of butter, ice cream, cheese – Cheddar, Mozzarella and Cottage Cheese, Khoa, Paneer, Channa, Ghee, Dahi, Yoghurt, Casein, Caseinate, co-precipitate, flavoured milk - Determination of degree of browning - Measurement of rheological properties of different milk products - Evaluation of sensory quality of milk and milk products - Visit dairy plants.

Teaching methods

- Classroom teaching and laboratory practical.
- Visit the milk processing plant.
- Use of Audio-visual Capsules

Learning Outcome

Gaining knowledge of handling and processing of milk and milk products.

Suggested Reading

- Aneja RP, Mathur BN, Banerjee AK and Chandan RC. 2002. *Technology of Indian MilkProducts*. Dairy India.
- Chandan RC, Kilara A and Shah NP. 2008. *Dairy Processing and Quality Assurance*, 1st ed. Willey–Blackwell.
- Davis JG. 2010. *Milk Testing: A Laboratory Control of Milk*. Agribios.
- MIF. 2005. *Analysis of Milk and its Products: A lab Manual*, 2nd ed. Milk Industries Foundation. Biotech Books, Delhi
- Singh S. 2014. *Dairy Technology*, Vol. 1 and 2. New India Publishing Agency.
- Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.
- Varnam AH and Sutherland JP. 1994. *Milk and Milk Products Technology*. Chapman and Hall, UK.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed. Taylor and Francis Group.
- Web BH, Johnson AH and Alford JA. 1987. *Fundamental of Dairy Chemistry*, 3rd ed. Westport AVI Publ.

Course Title : Packaging and Marketing of Livestock Products
Course Code : LPT 505
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor, Marketing Executives and other Technocrats) for Packaging Industry and Business Planning.

Aim of the Course
To impart knowledge about properties of different packaging material, techniques used in packaging of different livestock products, marketing channels and value chain of processed products.

Theory

Unit I (10 Lectures)
Principles of packaging - objectives and functions - Product characteristics affecting packaging requirements - Packaging materials and their characteristics - Different packaging systems for fresh, cured, dehydrated, freeze-dried and shelf-stable products of milk, meat and chicken - Aseptic packaging of milk - UHT milk - Vacuum packaging – MAP and role of different gases - Retort pouch processing - Active and intelligent/ smart (biosensors) packaging - Edible and biodegradable packaging - Nanotechnology for food packaging - Recycling of packaging materials. Labelling requirements – Barcoding and its importance - Packaging standards and regulations – Economics of different packaging systems.

Unit II (7 Lectures)
Marketing of Livestock Products - Types of markets - Marketing channels of live meat animals and Poultry - Existing systems - constraints and possible solutions. Value Chain of meat, poultry and processed products - strategies and interventions for better profitability – Meat retailing and establishment of retail outlets for meat and poultry - FSSAI, APEDA, EIA, GOI/ WTO regulations for the domestic market, import and export of livestock products.

Practical (17 Classes)
Different packaging materials and their properties - Determination of thickness, bursting strength, piercing strength, water vapour transmission rate, gas transmission rate, headspace gas analysis - Vacuum, shrink, MAP and retort packaging of meat and milk products - Visit milk and meat processing plants - Study of the value chain of livestock products including online marketing.

Teaching methods

- Classroom teaching, Practical demonstration in the laboratory.
- Visit market and packaging units.
- Demonstration using video films and models.

Learning Outcome

Developing an understanding of packaging and marketing of livestock products.

Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Robertson GC. 2012. *Food Packaging- Principles and Practices*, 3rd ed. CRC Press.
- *Selected Articles from Journals.*

Course Title : Microbiology and Quality Control of Livestock Products
Course Code : LPT 506
Credit Hours : 1+1

Why this course?
Human Resource Development for Quality Control of Livestock Products
Aim of the Course
To develop an understanding about microbial spoilage of different livestock products, quality control and legal standards.

Theory
Unit I (9 Lectures)
Microorganisms associated with spoilage of livestock products - Factors affecting microbial growth - Contamination of livestock products - Microbial spoilage of meat, poultry, eggs, milk and their products - Physical and chemical changes produced by microbes in milk, meat, eggs and their products - Meat and milk-borne infections and intoxications - Control of microbial growth in livestock products - Antimicrobial resistance (AMR).
Unit II (8 Lectures)
Introduction to Good Laboratory Practices (GLP), Good Hygienic practices (GHP) and Good Manufacturing Practices (GMP), Sanitary and Phytosanitary measures (SPS) and Food Safety System Certification (FSSC) - Quality Control – Quality Assurance - principles and practices - Quality Management Systems – Food Safety and Standards Act (FSSAI, 2006 Act) - Codex regulation for food products safety - ISO 9001 - ISO 22000 - HACCP concepts - Risk-based quality assessment - Microbial quality control - FSSAI/ BIS standards for milk, meat and poultry, Chemical residues in livestock products and their effects on the health of the consumer.

Practical (17 Classes)
Basic requirements for setting up of quality control laboratory - Sampling methods for the microbiological examination of different processing plants, products and equipment - Development of HACCP plan for milk and meat processing plants - Microbial evaluation of market samples of milk, meat and egg – Total Viable Count, coliform, etc. - Pathogens of Public Health importance - *E. coli, Salmonella, Staphylococcus aureus, Campylobacter* - Rapid detection methods of food pathogens.

Teaching methods
- Classroom teaching with laboratory analysis.

- Sampling and survey of market, butchers shop, milk and meat processing plants.
- Visits to units having HACCP and ISO certification.

Learning Outcome

Acquiring knowledge on microbiology, quality control and legal standards for different livestock products.

Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Bell C, Neaves P and Williams AP. 2005. *Food Microbiology and Laboratory Practices*, 1st ed. Blackwell Publishing.
- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th ed. John Wiley and Sons Ltd., UK.
- Frazier WC and Westhoff DC. 2013. *Food Microbiology*, 5th ed. McGraw Hill Publication.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jay JM, Loessner MJ and Golden DA. 2006. *Modern Food Microbiology*, 7th ed. Springer.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Pearson AM and Dutson TR. 1995. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Aspen Publishers, Inc, Maryland, USA.

Course Title : Slaughterhouse By-products Technology
Course Code : LPT 507
Credit Hours : 1+1

Why this course?
Human Resource Development for better utilization of animal by-products and pollution control
Aim of the Course
To impart knowledge about the utilization and processing of animal by-products.

Theory
Unit I (6 Lectures)
Status and scope of slaughterhouse by-products utilization - Trade practices - Planning, design and layout of by-products plant - Classification of by-products - edible and inedible - Rendering methods and products - Yield and characteristics of rendered fat and meat cum bone meal.
Unit II (6 Lectures)
Utilization of blood, horns and hooves, intestine, bones, feathers, bristles, glandular by-products and ruminal contents - Value-added by-products from slaughterhouse and poultry processing plants - Processing of animal by-products for pet foods - High-value low volume by-products – collagen sheets, scaffolds, bone morphogenic proteins, biopeptides, biodiesel, etc.- Legislation and regulations related to animal by-products.
Unit III (5 Lectures)
Flaying - Classification and factors affecting the quality of hides and skin - Physical and chemical characteristics of hide and skin - Grading and processing of hide and skin for the manufacture of leather - Preparation and quality control of gelatineand glue.

Practical (17 Classes)
Preparation of casing, neatsfoot oil, gelatin and glue - Demonstration of preparationof carcass meal, meat meal, bone meal, blood meal, feather meal, slime meal - Grading of casings - Collection and preservation of glandular by-products - Preparation of pet foods -Visit local by-products processing units - Quality evaluation of rendered animal fat.

Teaching methods
- Classroom teaching, practical demonstration of different by-products preparationin the Divisional laboratory/ slaughter unit

- Visit of municipal slaughterhouse and tanneries.
- Use of Audio-visual Capsules.

Learning Outcome

Gaining knowledge on proper utilization of slaughterhouse by-products

Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Mann I. 1962. *Animal By-products: Processing and Utilization*. FAO, Rome.
- Ockerman HW and Hansen CL. 1999. *Animal By-product Processing and Utilization*. CRC Press.

Course Title : In-Plant Training
Course Code : LPT 508
Credit Hours : 0+2

Why this course?
Development of Entrepreneurial Skill and Human Resources for Meat and Milk Industry

Aim of the Course
To impart industrial exposure and develop entrepreneurial skill among postgraduate students.

Practical (*34 sessions/ Hours equivalent to 34 credit hours of practical*)
LPT students shall undergo in-plant training in any one of the specialized area of Livestock Products Technology in an institute/ industry – private or public sector. After completion of the training, the student will submit a training report. The evaluation will be based on attendance, report submission and viva-voce examination.

Teaching methods
- Deputation to slaughterhouse/ meat/ milk processing plants
- Use of Audio-visual Capsules.

Learning Outcome
Students after undergoing training will have a good understanding of the functioning of the industry and capable of starting their own enterprises.

Suggested Reading
- Interaction with Industry Persons.
- *Selected articles from Journals.*

Course Title : Egg and Egg Products Technology
Course Code : LPT 509
Credit Hours : 1+1

Why this course?
Human Resource Development for Egg Processing Industry/ Plants
Aim of the Course
To impart knowledge about the status of egg production, composition, nutritive value, preservation, grading, processing packaging and marketing of eggs and egg products.

Theory
Unit I (9 Lectures)
Status of egg production and processing in India - Structure, composition, nutritive value and functional properties of eggs - Grading, preservation, packaging and marketing of shell eggs - Quality evaluation of shell eggs and factors influencing egg quality - Defects and Spoilage of eggs.
Unit II (8 Lectures)
Layout and design of egg processing Unit - Principles and procedures involved in pasteurization, chilling, freezing, desugarization and drying of egg products - Quality standards of egg products - Packaging of egg products - Designer egg products.

Practical (17 Classes)
Evaluation of physical, chemical, functional and microbial quality of egg and egg products - Preservation of eggs - Preparation of value-added egg products - Visit egg-processing plant.

Teaching methods
- Classroom teaching, practical demonstration in Divisional laboratory.
- Visit egg processing plant.

Learning Outcome
Gaining knowledge on composition, nutritive value, preservation and marketing of eggs. Quality maintenance and development of designer egg products.
Suggested Reading

- Romanoff AL and Romanoff AJ. 1949. *Avian Egg*. John Wiley and Sons.
- Stadelman WL and Cotterill OJ. 2002. *Egg Science and Technology*, 4th ed. CBS.
- *Selected articles from Journals.*

Course Title : Market Milk Processing and Dairy Plant Practices
Course Code : LPT 510
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor and other Technocrats) for Milk Processing Industry and Dairy Plants.

Aim of the course
To impart knowledge about procurement of milk, assessment of milk quality, legislation for quality control, milk processing techniques, the layout of milk processing and dairy effluent plants and preparation of special milk.

Theory

Unit I (5 Lectures)
Organization of procurement and pricing plans of raw milk - Operation of automatic milk collection stations - Reception of milk at Raw Milk Reception Dock (RMRD)Assessing raw milk quality - Sanitary handling of milk - Milk standards and legislations.

Unit II (6 Lectures)
Unit operations in milk processing plants - Clarification – Bactofugation - Different chilling methods - Standardization - Homogenization (theories, methods and effects) Heat treatments (thermization, boiling, pasteurization, sterilization (UHT and In-container) - Separation technologies (Microfiltration, Ultrafiltration, reverse osmosis, diafiltration, nanofiltration etc).

Unit III (2 Lectures)
Distribution methods for liquid milk - Consumer pricing - Traceability - Handling of unsold and returned milk- - Adulteration of milk and detection - Residues in milk and preventive steps

Unit IV (4 Lectures)
Fortified, special and functional market milk - A1 and A2 milk Design and layout of dairy plants of different capacities - Dairy by-products - Treatment of Dairy Effluents.

Practical (17 Classes)
Platform tests - Principles of rapid milk analyzers including milko-tester and operation of automatic milk collection stations - Raw milk quality, somatic cell count, bacteriological count - Estimation of homogenization efficiency - Assessment of efficiency of pasteurization, sterilization and boiling- Detection of adulterants.

Teaching methods
Classroom teaching and laboratory analysis.
Visit milk processing plants.

Learning Outcome
Acquaintance with the processing of market milk and other dairy plant practices.

Suggested Reading

- FAO. 2013. *Milk and Dairy Products in Human Nutrition*. FAO, Rome.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed., Taylor and Francis Group.

Course Syllabus and Content of Doctoral Degree in Livestock Products Technology

Course Title : Modern Abattoir Practices and Animal By-ProductsTechnology
Course Code : LPT 601
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor and other Technocrats) for Slaughterhouses, Tanneries and other by-products industries.

Aim of the Course
To impart knowledge about advances in abattoir practices and animal by-products utilization.

Theory

Unit I (5 Lectures)
Current scenario of slaughterhouses and processing plants in India - Establishment and operation of a modern abattoir - Basic machinery and tools of slaughterhouse- Automation/ Robotics in meat and by-product processing – Latest developments in the evaluation of carcass quality – Chilling and freezing of carcass - Maintenance of cold storages.

Unit II (8 Lectures)
Latest machinery and tools used in by-products processing plant - New technologies for utilization of animal by-products as food, feed, pharmaceuticals and other miscellaneous products - Leather chemistry and processing technology - Latest Techniques in handling, preservation, tannery procedure, manufacture and testing of leather - Value addition in leather processing - Developments in gelatin, glue and natural casings production - Characterization, processing, yield and quality control of rendered fat and meat cum bone meal.

Unit III (4 Lectures)
Organization, layout and operation of dry and wet rendering plants. Latest trends in the disposal of slaughterhouse effluents and control of environmental pollution. Designs and function of effluent treatment plants.

Practical (17 Classes)
Plan and outlay of various components of a modern abattoir. Designs of

ETP. Estimation of TS (suspended and dissolved) BOD and COD from abattoir effluents. Ante-mortem inspection of food animals, methods of stunning, stunning instruments. Slaughter and dressing of food animals. Electrical stimulation of carcasses. Post mortem inspection of carcasses of food animals - Visit municipal slaughterhouse, by-product processing plant, Effluent treatment plant and tanneries.

Teaching methods

Learning Outcome

Understanding of latest techniques employed in abattoir practices and slaughterhouse by-products utilization.

Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*, 1st ed. Jaya Publishing House.
- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th ed. John Wiley and Sons Ltd., UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham University Press.
- Warriss P. 2010. *Meat Science: An Introductory Text*, 2nd ed. Oxford Press.
- *Selected articles from Journals.*

Course Title : Advances in Meat Production and Fresh Meat Technology
Course Code : LPT 602
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor and other Technocrats) for Meat Industry

Aim of the Course
To impart knowledge about the latest trends in meat production, the ultrastructure of muscle fibres, strategies for improving meat production and traceability of meat products.

Theory

Unit I (7 Lectures)
Current status of meat production trends in India - Government policies - economics and viability – Traceability in the meat industry – Strategies for augmenting meat production - Salvaging male buffalo calf - Non-conventional meat resources.

Unit II (10 Lectures)
Pre- and Post-natal development of Muscle fibres - Genetic, nutritional and physiological aspects of muscle development - Ultrastructure of skeletal muscle - Modern tools for fibre typing of muscle - Chemical and biochemical aspects of rigor mortis and fresh meat quality – Odour, colour, water holding capacity - Texture profile - Artificial tenderization - Myofibrillar, sarcoplasmic and connective tissue proteins - Cytoskeletal proteins - Lipid profile - Meat in human nutrition - Meat and health issues.

Practical (17 Classes)
Economics of establishing commercial meat animal production Unit - Extraction of sarcoplasmic and myofibrillar proteins and their fractionation - Estimation of Collagen content of Meat - Histochemistry of muscle tissues - Muscle fibre typing- Meat tenderization techniques.

Teaching methods
- Classroom teaching, practical demonstration in laboratory/ slaughter unit
- Visit municipal slaughterhouse and meat plants
- Use of Audio-visual capsules.

Learning Outcome
Knowledge of latest trends in meat production and fresh meat technology.

Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed.Kendall Hunt Publishing Company, Iowa.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, Inc.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Lawrie RA and Ledward DA. 2006. *Lawrie's Meat Science*, 7th ed. Woodhead Publishing Limited, Cambridge, England.
- Pearson AM and Dutson TR. 1997. *Advances in Meat Research. Healthy Production and Processing of Meat, Poultry and Fish Products*, Vol. 11. Springer.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham Univ. Press.
- *Selected articles from Journals.*

Course Title : Developments in Processed Meat Technology
Course Code : LPT 603
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor and other Technocrats) for Meat Processing Industry
Aim of the Course
To impart knowledge about the advances in the technology for processing of meat and development of value-added meat products.

Theory
Unit I (5 Lectures)
Current trends in meat processing techniques - Functional properties of the tissue component in meat processing - Approaches for new product development - Latest equipment used for processing of meat products - Indigenous and heritage meat products - Curing and smoking - purpose, composition and methods of smoking - Liquid smoke - Processing of Ham, bacon, sausages, patties, meatloaves and tandoori chicken- Novel meat products - Non-thermal processing - Irradiation techniques - Canning/ retorting.
Unit II (8 Lectures)
Marination, massaging, tumbling and flaking techniques - Restructured/ reformed, intermediate moisture, fermented, enrobed, shelf-stable and dried meat products - Meat analogues and substitutes - Thermal processing of meat- Enzymatic and non-enzymatic browning reactions - Protein changes in processed meat products - Lipidchanges - Protein and lipid interaction - Protein and carbohydrate interaction - Bioactive peptides.
Unit III (4 Lectures)
Functional and designer meat products - Role of omega-3 fatty acids in animal foods - Role of n-3 in PUFA enriched and CLA enriched meat and eggs - Packaging of meat and meat products - smart, active, intelligent packaging - Developments in sensory evaluation of meat products.

Practical (17 Classes)
Evaluation of texTural characteristics of meat products – Estimation of emulsifying capacity, emulsion stability- Estimation of Nitrosamines and PAHs - Preparation of emulsion-based, restructured, enrobed, cured and smoked, dried, fermented, intermediate moisture, ready to eat, and shelf-stable meat products-objective and subjective evaluation of meat products.

Teaching methods
Classroom teaching, practical performance in Divisional Pilot Processing Plant.
Visit Meat Processing Unit.
Demonstration by videos.

Learning Outcome
Acquaintance with the knowledge of the latest techniques used in meat processingand packaging and development of functional meat products.

Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Barbut S. 2005. *Poultry Products Technology*. CRC Press.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing- Improving Quality*. Woodhead Publishing Ltd., UK.
- Pearson AM and Gillett TA. 1996. *Processed Meats*, 3rd ed. Chapman and Hall, Inc, New York.
- Toldrá F. 2010. *Handbook of Meat Processing*. Wiley-Blackwell.
- *Selected articles from Journals.*

Course Title : Current Trends in Processing of Milk And Milk Products
Course Code : LPT 604
Credit Hours : 1+1

Why this course?
Human resource development (Manager, Supervisor and other Technocrats) for themilk processing industry

Aim of the Course
To impart knowledge about current trends in the processing of milk and milk products and their effect on physico-chemical and nutritional quality of milk, the scope of mechanization in the production of indigenous milk products and advancesin the utilization of dairy by-products.

Theory

Unit I (8 Lectures)
Principles and practices of production of quality raw milk - Advances in methods of chilling of milk - Thermal processing of milk – Principles and methods - types of UHT processing plants - Advances in the packaging of milk and milk products - Rheology of milk products - Preservatives, antioXidants, antibiotics and different toXic residues in milk - Advances in bacteriological and physico-chemical analysis of milk and milk product – Different legal and voluntary standards for milk and milk products - A1 and A2 milk and their significance.

Unit II (4 Lectures)
Bacteriological, physical, chemical and nutritional effects of processing on milk - New concepts in milk processing – radiation, microwave processing and conductionheating of milk – By-products from the dairy industry and their utilization.

Unit III (5 Lectures)
Innovative mechanization in the manufacture of Indigenous dairy products - Advances in the utilization of dairy by-products - preservation of milk products - Application of immobilized enzymes in dairy products – Latest trends in cleaning and sanitation of dairy plant

Practical (17 Classes)
Quality evaluation of milk and milk products - Preparation of novel and indigenous milk products and their economics of production, quality and sensory evaluation - Use of Starter cultures - Maintenance of cultures - Demonstration of membrane processing technology - Preparation of DPR for Dairy plants of different capacities.

Teaching methods

- Classroom teaching and laboratory analysis.
- Visit the milk processing plant.
- Use of Audio-visual Capsules.

Learning Outcome

Gaining knowledge of advances in the processing of milk and milk products.

Suggested Reading

- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Herrington BL. 2000. *Milk and Milk Processing*. Green World Publishers.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed. Taylorand Francis Group.
- *Selected articles from Journals.*

Course Title : Biotechnological Techniques and Quality Control of Livestock Products
Course Code : LPT 605
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor and other Technocrats) for production of high-quality livestock products and their quality assurance.

Aim of the Course
To impart knowledge about advances in the application of biotechnological techniques for improving the production and quality of livestock products. To familiarize with the agencies responsible for maintaining the quality of livestock products, quality standards and legislations

Theory

Unit I (10 Lectures)
Biotechnological tools for microbial testing of food - Industrial cell culture – Bioreactor types and design – Upstream and downstream processing - Bacterial food additives and supplements - Characteristics and application of microbial starters in milk and meat fermentation - Biotechnology in production of designer livestock products - Bio-production of flavours and colour and their application in dairy products - Enzyme applications in dairy technology. - Utilization of nanotechnology in livestock products - Biotechnology for food safety - Cultured meat - Biotechnologyin meat species identification.

Unit II (7 Lectures)
Importance of quality control for livestock products - Concept and application of HACCP - BIS, FSSAI and AGMARK standards - GMP and total quality managementin the processing of livestock products - ISO-9000, ISO-14000 and ISO-22000 -Codex regulations of food product safety.

Practical (17 Classes)
Demonstration of the latest biotechnological techniques including DNA and protein-based techniques. Operation of bioreactors - Gene identification and characterization. Visit Milk/ Meat processing plants for an understanding of HACCP and other quality management systems.

Teaching methods
- Laboratory analysis.
- Visit of ISO and HACCP certified food processing plant.

- Use of Audio-visual Capsules.

Learning Outcome

Gaining knowledge on the application of biotechnology for augmenting productionand quality assurance.

Suggested Reading

- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- *Selected articles from Journals.*

Course Title : Ethnic and Organic Meat and Milk Products
Course Code : LPT 606
Credit Hours : 1+1

Why this course?
Improving the production, processing and marketing of ethnic and organic meat and milk and their products.

Aim of the Course
To impart knowledge about the production of ethnic and organic meat and milk products.

Theory

Unit I (9 Lectures)
Historical developments, present scenario and prospects of ethnic meat and milk products in various parts of India - Ethnic meat products - haleem, biryani, chettinad recipe, pork vindaloo, Kebab, Goan sausages, Kashmiri wazwan and meat products of North Eastern Region (NER) - Ethnic milk products – churpi, kalari, kunda, etc.

Constraints in promoting ethnic meat products - Approaches for development and commercialization of ethnic meat products - Fermented and non-fermented ethnic milk and meat foods – Impact of Globalization and role of WTO in promoting ethnic meat and milk products from India.

Unit II (5 Lectures)
Entrepreneurship Development for Ethnic meat and milk Products – Formulation, composition, quality, safety and shelf life of ethnic meat and milk products of India Geographical indicators for recognition of ethnic meat and milk products.

Unit III (3 Lectures)
Organic meat and milk products - introduction, registration, certification, marketingand scope.

Practical (17 Classes)
Preparation of ethnic meat products - haleem, biryani, chettinad recipe, pork vindaloo, Kebab, Goan sausages, Kashmiri wazwan and meat products of NER/ local region, Preparation of Ethnic milk products – churpi, kalari, Kunda, etc. - Composition, physico-chemical and microbial quality of ethnic milk and meat products - Packaging and marketing of ethnic milk and meat products.

Teaching methods

- Classroom teaching, practical demonstration in the laboratory

- Through the study of reports published by Govt. agencies time to time

Learning Outcome

To acquaint with the knowledge for the production of ethnic and organic meat and milk products.

Suggested Reading

- Books on Indian Food.
- *Selected articles from Journals*

Course Title : Industrial and Entrepreneurial Training
Course Code : LPT 607
Credit Hours : 0+2

Why this course?
Human Resource Development for catering to livestock products and related industry.

Aim of the Course
To prepare students to venture into various start-ups for self-reliant enterprises.

Practical (34 Classes)
Preparation of basic feasibility report including raw material availability, marketingpotential, economic viability and regulatory requirements for different livestock products related industry. Entrepreneurial training in an industrial establishment related to livestock products (17 sessions/ Hours equivalent to 17 credit hours of practical).Preparation of Detailed project reports (DPR) for the establishment of livestock products enterprises, viz. slaughterhouses, milk and meat processing plants, effluent treatment and byproducts utilization plants, etc..

Teaching methods
- Visiting processing units
- Web surfing

Learning Outcome
Students envisioned having adequate knowledge and skills for setting up livestock products enterprises.

Suggested Reading
- *Selected articles from Journals.*
- Through Interaction with Industry personnel.

Course Title : Current Trends in Disposal and Utilization of WasteFrom Meat and Dairy Industry
Course Code : LPT 608
Credit Hours : 1+1

Why this course?
Human Resource Development (Manager, Supervisor, Meat inspector and other Technocrats) for better utilization of animal wastes and effluent treatments.

Aim of the Course
To impart knowledge about disposal and handling of wastes from the meat and dairy industry, Agencies involved and their norms for pollution control from meat and dairy industries.

Theory

Unit I (8 Lectures)
Terminologies used in solid and liquid waste management systems - Public health significance - Classification, composition, functional elements and sources of solid waste from Meat and Dairy Processing plants and their management - Aerobic and anaerobic systems of liquid waste management.

Unit II (9 Lectures)

Waste handling, separation, storage, processing and utilization of Solid waste - Common solid waste disposal methods like rendering, composting, deep burial and incineration - Scope for zero waste management - Properties of dried sludge and its utilisation as manure - Economical aspects of waste treatment and disposal - Utilization of meat and dairy processing wastes - Application of nanotechnology in waste management - State and Central Pollution Control Board norms.

Practical (17 Classes)

Visit Sewage and Effluent Treatment Plants - Estimation of pH, dissolved oxygen, TSS, BOD and COD - Estimation of micronutrients in treated effluents - Designand schematic layout of various solid and liquid waste treatment plants.

Teaching methods

- Classroom teaching
- Visit Sewage Treatment Plant

Learning Outcome

Gaining knowledge on advances in the utilization of wastes from the meat and dairy industry.

Suggested Reading

- *Selected articles from Journals.*
- Through Interaction with personnel of Municipal Corporation and Pollution Control Board.

Course Title : Advances in Egg and Egg Products Technology
Course Code : LPT 609
Credit Hours : 1+1

Why this course?
Human Resource Development for Egg Processing Industry and Egg Processing Plants
Aim of the Course
To impart knowledge about the status of egg production, composition, nutritive value, preservation, grading, processing packaging and marketing of eggs and egg products.
Theory
Unit I (5 Lectures)
Advanced preservation techniques for egg and egg products - Maintenance of qualityof eggs - Microbiology of egg - Spoilage of eggs and its prevention.
Unit II (8 Lectures)
Preparation of fast foods and role of egg in fast foods chains - Egg breaking and processing plants - lay-out and organization Preservation methods viz pasteurization, desugarization, freezing, dehydration, etc. – process and methods - Quality estimation of egg and egg products - Designer egg and egg products.
Unit III (4 Lectures)
Specifications, Standards and marketing of egg and egg products - Quality controlof egg products.

Practical (17 Classes)
Evaluation of physical, chemical and functional quality of egg and egg products -Detection of egg rots - Evaluation of microbiological quality of egg and egg products - Preservation techniques of eggs - Preparation of convenient, dehydrated and value- added egg products -Visit a modern egg processing plant

Teaching methods
- Classroom teaching, practical demonstration in the laboratory.
- Visit the egg processing plant.

Learning Outcome
Gaining knowledge on composition, nutritive value, preservation and marketing of eggs. Quality maintenance and development of designer egg products.

Suggested Reading

- Romanoff AL and Romanoff AJ. 1949. *Avian Egg*. John Wiley and Sons.
- Stadelman WL and Cotterill OJ. 2002. *Egg Science and Technology*, 4th ed. CBS.
- *Selected articles from Journals.*

Course Syllabus and Content of Master's Degree in Poultry Science

Course Title : Poultry Breeding and Genetics
Course Code : PSC 501
Credit Hours : 2+1

Aim of the course
To impart knowledge on different systems of breeding, selection methods, design and implementation of the breeding programme in developing egg-type and meat-type birds. Modern tools in poultry breeding.

Theory
Unit I (12 Lectures)
Genetic classification of Poultry – Origin and breed characteristics of poultry- Mendel's laws of inheritance related to poultry - Qualitative and Quantitative traits in Poultry breeding – Additive and Non-additive – Dominance, Incomplete dominance, Epistasis and complementary gene actions – Lethals and mutations in poultry – Sex-linked, Sex limited and Sex influenced traits – Economic traits – Partitioning of variance - Heritability – Quantitative inheritance – Phenotype, Genotype and environment interactions.
Unit II (10 Lectures)
Systems of Breeding – Systems of Mating – Selection methods – Breeding programme for developing egg-type, meat type and rural poultry strains - Developing hybrids - Breeding and management of other species of Poultry- Formation and Management of inbred pure lines, grandparent and parent stock - Industrial breeding.
Unit III (12 Lectures)
Artificial insemination in chicken –Autosexing–Random Sample Test - Use of molecular genetics in poultry breeding-Quantitative trait loci and marker-assisted selection- Conservation of poultry genetic resources.

Practical (17 Classes)
Breeds of poultry – Estimation of qualitative and quantitative traits in poultry – Exercises on individual and family selection – Constructing multi-traits selection index and Osborne index-Estimating heritability – Breeding program for developing commercial hybrid layers, broilers and Japanese quail– Breeding programmes for rural poultry - Semen collection, evaluation, dilution and insemination in chicken and turkey – Breeding records –Use of computers to maintain breeding records

and for selection– Estimation of effective population size, rate of inbreeding, response to selection and genetic and phenotypic responses.

Teaching methods

- Classroom teaching with laboratory support and farm visits
- Use of computers for quantitative genetic analysis

Learning outcome

Gaining knowledge on poultry breeding and genetics

Suggested Reading

- Crawford RD. 1990. *Poultry Breeding and Genetics*. Elsevier.
- Falconer DS. 1997. *Introduction to Quantitative Genetics*. Benjamin Cummings.
- Hutt FB. 1949. *Genetics of the Fowl*. McGraw-Hill
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology*. CABI.
- Singh RP and Kumar J. 1994. *Biometrical Methods in Poultry Breeding*. Kalyani Publications

Course Title : Poultry Nutrition and Feeding
Course Code : PSC 502
Credit Hours : 2+1

Aim of the course
Teaching about nutrients and their functions, nutrient requirements of poultry and factors influencing the same. Imparting knowledge of different types of feeds and feeding methods.

Theory
Unit I (8 Lectures)
Digestive system, digestion, metabolism and absorption of nutrients in poultry – Factors influencing the feed consumption in birds – Macro and micro-nutrients – Protein and amino acids - Nutrient requirements for various species of poultry – Factors influencing the nutrient requirements - Partitioning of energy - Calorie: protein ratio – Nutrient interrelationships.
Unit II (12 Lectures)
Feed ingredients composition - Feed storage techniques - Milling and quality control- Processing of feed – Types and forms of feeds and feeding methods - Commonly occurring antinutrients and toXicants in poultry feed ingredients – MycotoXins and their prevention – Feeding chicks, growers, layers, broilers and breeders – Principles of computing feed – Balanced feeds - Least cost feed formulation and programming – Feeding in different seasons and stress conditions - Nutritional and metabolic disorders in poultry.
Unit III (8 Lectures)
Systems of feeding – restricted, forced, controlled and phase feeding -Use of Additives and Non-additives- enzymes, probiotics, prebiotics, antibiotics, herbs and other performance enhancers – Utilization of non-conventional feedstuff - Feeding of ducks, turkeys, Japanese quails and Guinea fowls.
Unit IV (6 Lectures)
Organic, functional, designer and SPF feed production - Production of feeds free from drug residue, pesticide residue and toXins – Regulations for Import and EXport of feed and feed supplements.

Practical (17 Classes)
Physical and sensory evaluation of feed ingredients- sampling techniques for ingredients and compounded feed-Estimation of proXimate principles of feed and feed ingredients – Computing various poultry feed formulae based on commonly available feed ingredients – Computer applications in feed formulations -

Estimationof Aflatoxin, Calcium, Phosphorus, Sand, Silica and Salt – Mash, pellet and crumblefeed preparation – Feeding procedures. Visit to feed mills –Hands-on training in feed analytical lab.

Teaching methods
Classroom teaching with laboratory support and feed mill visits
Use of computers in feed formulations

Learning outcome
Gaining knowledge on poultry nutrition and feeding

Suggested Reading

- Bell DD and Weaver WD JR. 2002. *Commercial Chicken Meat and Egg Production,* 5th ed. Kluwer Academic Publishers.
- ICAR. 2013. *Nutrient Requirements of Poultry*. ICAR Publication.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of the Chicken*. University Books.
- Leeson S and Summers JD. 2008. *Commercial Poultry Nutrition,* 3rd ed. University Books.
- Singh RA and Panda B. 1992. *Poultry Nutrition*. Kalyani Publishers.

Course Title : Commercial Layer and Broiler Management
Course Code : PSC 503
Credit Hours : 2+1

Aim of the course
To impart knowledge on different systems of rearing and management of commercial layer and broilers for maximum egg and meat production

Theory
Unit I (10 Lectures)
Development of Poultry Industry in India and the World – Systems of layer and broiler farming – Location and layout of the farm – Systems, types and design of houses – Poultry farm equipment - Automation in poultry houses and its maintenance - Environmentally controlled houses and their management -Deep litter and cage system of management- Litter materials -All in All out and Multiple batch systems of rearing layers and broilers –Brooding management - Lighting programme for egg-type and meat-type birds- Water quality standards, watering and water sanitation - Biosecurity and health management – Production indices for broilers and layers – Integration in broiler and layer production.
Unit II (12 Lectures)
Cages and modified cages for egg-type birds – Feeding management in layers - Medication and vaccination schedules and procedure for layers –Brooder, grower, pre-layer, layer and cockerel management – Management of layers during peak egg production and maintaining the persistency in production – Strategies to prolong the egg production beyond 72 weeks of age - Factors causing uneven growth and low egg production - Monitoring egg production curve - Culling of unproductive birds – Record keeping –Management during different seasons – Induced moulting.
Unit III (10 Lectures)
Management of broilers during different seasons -Mash, crumble and pellet feeding of Broilers – Weekly growth rate, feed conversion and livability in broilers- Sex separate feeding – Feeding broilers for optimum growth rate and feed efficiency – Broiler farm records - Broiler farm routine, medication and vaccination schedule – Transport of broilers - Regulations and specifications for the production of export quality broilers.

Practical (17 Classes)
Layer farm layout– Design of different chick, grower and layer houses, their specifications – Selection and culling of layers, debeaking, dubbing, deworming, delicing, vaccination and other farm routines and operations – Farm sanitation,

disinfection and waste disposal – Visit commercial layer farms including environmental controlled houses – Record keeping – Calculating Hen day egg production, Hen housed egg production and other economic traits – Calculating the cost of production of eggs and meat and economics–Location and layout for a broiler farm – Broiler house design – Visit to commercial broiler farms including environmental controlled houses – Broiler brooding, Medication, vaccination, transportation and farm routines - Record keeping - Calculating the cost of production of broilers – Feeding of broilers at different ages – Working-out feed efficiency.

Teaching methods

- Classroom teaching with farm visits
- Using different housing models
- Using Audio-visual capsules
- Demonstration of different management practices at farms

Learning outcome

Gaining knowledge of commercial broiler and layer production

Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed.Kluwer Academic Publishers.
- Narahari D. 1997. *Commercial Broiler Production*. Emkay Publishers.
- Rajini RA. 2012. *Simply Poultry Science.* Alpha Publishers.
- Sapcota D, Narahari D and Mahanta JD. 2017. *Avian Poultry Production*, 2nd rev ed. New India Publishing Agency.
- Scanes CG, Brant G and Ensminger ME. 2003. *Poultry Science*, 4th ed. Prentice-Hall.
- Sreenivasaiah PV. 2015. *Textbook of Poultry Science*. Write and Print Publications.

Course Title : Breeder Stock and Hatchery Management
Course Code : PSC 504
Credit Hours : 2+1

Aim of the course
To impart knowledge about care and management of breeders and hatchery operations.

Theory
Unit I (9 Lectures)
Different types of commercial breeder flocks –Special care of breeder chicks – Breeder male and female management – Feeding the breeder flocks: Separate sex feeding, feed restriction in broiler breeders. Management for improving fertility and hatchability, Management of parent and grandparent farms - Management of pure lines – Artificial Insemination - Care and management of Hatching eggs.
Unit II (4 Lectures)
Vaccination of layer and broiler parents - Nutrient supplementation – Seasonal management of breeders – Lighting management in breeder farms - Flock testing and culling.
Unit III (12 Lectures)
Natural and Artificial incubation –Stages of embryonic development -Incubation principles – Location of hatchery – Layout and design of hatchery - hatchery equipment– Hatchery management - Ventilation and temperature control –Pre-incubation storage, Fumigation and sanitation – Hatchery operations, routine and schedule – Egg candling -Packaging and transportation of hatching eggs and chicks, hatchery troubleshooting- Factors affecting fertility and hatchability - Biosecurity and hatchery waste disposal – Control of vertically transmissible and hatchery borne diseases – Special incubator management during hot summer – Hatchanalysis.
Unit IV (9 Lectures)
SPF egg production - Import and export regulations – Maintaining Salmonella and Mycoplasma free breeding flock –Application of HACCP and Good Management Practices (GMP) in hatchery management for better chick quality.

Practical (17 Classes)
Layout and blueprints for breeder farm and hatchery –Incubator management – Candling - Hatchery sanitation, fumigation procedures and hatchery hygiene – Pedigree hatching – Hatchery waste disposal and recycling – Calculating the cost of production of hatching eggs and day-old-chicks, management of bangers– Attending breeder farm routines and operation – Flock testing and culling of

reactors– Analyzing hatchability results – Use of computers in hatchery operations - Economics of setting up of layer and broiler hatchery. Vaccinating day-old chicks and concept of in-ovo vaccination, visit to commercial breeder farm and hatchery.

Teaching methods

- Classroom teaching with breeder farm and hatchery visits
- Using Audio-visual capsules

Learning outcome

Gaining knowledge of breeder flock and hatchery management

Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Leeson S and Summers JD. 2009. *Broiler Breeder Production*. Context Products.
- Sreenivasaiah PV. 2006. *Scientific Poultry Production: A Unique Encyclopaedia*. International Book Distributing Co.
- Taylor LW. 2003. *Fertility and Hatchability of Chicken and Turkey*. John Wiley and Sons.

Course Title	**: Poultry Health and Biosecurity**
Course Code	**: PSC 505**
Credit Hours	**: 2+1**

Aim of the course

To impart knowledge about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment. Biosecurity measures in the control of common poultry diseases.

Theory

Unit I (7 Lectures)

Common bacterial diseases: *Salmonella, Pasteurella, E.coli,* Fowl typhoid, Mycoplasma, Infectious *Coryza, Gallibacterium, Clostridium*

Unit II (9 Lectures)

Common Viral diseases: Newcastle, Infectious bronchitis, Infectious laryngeotracheitis, Marek's, Fowl poX, Infectious Bursal disease, Egg drop syndrome-76, Avian Encephalomyelitis, Avian influenza, Duck viral hepatitis, Chicken Infectious Anaemia, etc.

Unit III (8 Lectures)

Common Fungal, parasitic and metabolic diseases: Aspergillosis, MycotoXicosis, Fatty liver haemorrhagic syndrome(FLHS), Gout, Ascites, leg weakness - Coccidiosis, Ecto- and endo-parasitic infestation of poultry, etc.

Unit IV (5 Lectures)

Diagnosis, vaccination, prevention, treatment and control of various poultry diseases.

Unit V (5 Lectures)

Principles of biosecurity - Locational, structural and operational biosecurity in Poultry farms – Water sanitation and control of water-borne diseases – Quarantine of poultry - Farm sanitation and disinfection procedures.

Practical (17 Classes)

Ante-mortem and Post-mortem eXamination of birds – Sample collection – Despatch of samples – Processing of samples and detection of pathogens/ etiological agents-Different sanitizers and disinfectants available and their uses. Care and contraindication of using different products. Personal hygiene and isolation – Different vaccines and routes of administration – Methods of medication – Water quality analysis, Field visit to poultry diagnostic lab.

Teaching methods

- Classroom teaching with laboratory diagnosis
- Post-mortem examination
- Using Audio-visual capsules

Learning outcome

Gaining knowledge on poultry health and bio-security

Suggested Reading

- Gordon RF and Jordan FTW. 1982. *Poultry Diseases*. ELBS
- Pattison M, McMullin P, Bradbury JM and Alexander D. 2008. *Poultry Diseases*, 6th ed. Elsevier.
- Saif YM. 2008. *Diseases of Poultry*. Blackwell Publishing House.
- Thyagarajan D. 2011. *Diseases of Poultry*, Satish Serial Publishing House.
- Vegad JL. 2015. *Poultry Diseases Farmers. A Guide for Farmers and Poultry Professionals*. International Book Distributing Co.

Course Title	**: Management of Other Avian Species**
Course Code	**: PSC 506**
Credit Hours	**: 3+1**

Aim of the course

Care and management of different breeds, varieties of poultry other than chicken, methods of rearing and common diseases affecting them and their control measures.

Theory

Unit I (15 Lectures)

Breeds and varieties of Turkey, Duck, Goose, Guinea fowl, Japanese quail, Emu and Ostrich – Incubation periods and incubation procedure for different species – Production standards - Housing, cage and equipment for other avian species under different systems of rearing.

Unit II (15 Lectures)

Management and rearing of Turkey, duck, goose, Guinea fowl, Japanese quail, emu and ostrich- Feeding standards and feeding, watering and rearing systems and procedure for different species of poultry - Breeding programmes for egg and meat production in different species.

Unit III (10 Lectures)

Different types of pet birds - Management and rearing of pet birds of regional importance (Pigeon, budgerigar, parakeets, love birds, macaws, doves, parrots, etc.) – Housing for pet birds, their habitat, feeding and breeding under captivity.

Unit IV (8 Lectures)

Common diseases affecting other avian species and their control – Regulations for import and export of different species of poultry – Prevention of exotic diseases through the import of live birds.

Unit V (3 Lectures)

Concept and definition of organic poultry – status, certification and guidelines for organic poultry production – Government policies on organic poultry farming.

Practical (17 Classes)

Layout and design of housing and cages for other species of poultry. Visit commercial Japanese quail, turkey and duck farms. Incubation and care of hatching eggs and young ones – Rearing practices followed by duck, quails and turkey farmers under field conditions - Sexing of pet birds – Preparing project reports for different species and calculating the cost of production – Feeding pet birds and their chicks.

Teaching methods

- Classroom teaching with farm visits
- Visit pet bird farms
- Using Audio-visual capsules

Learning outcome

Gaining knowledge on rearing different poultry species other than chicken

Suggested Reading

- Cherry P and Morris T. 2011. *Domestic Duck Production: Science and Practice*. CABI
- CPDO. *Duck – Management Guide*. Central Poultry Development Organization Publication (online resource)
- CPDO. *Turkey – Management Guide*. Central Poultry Development Organization Publication (online resource)
- Mayer J and Donnelly TM. 2012. *Clinical Veterinary Advisor: Birds and Exotic Pets*. Elsevier.
- Pathak N. 2013. *Poultry and Ratite Nutrition*. Narendra Publishing House.
- Sapcota D, Narahari D and Mahanta JD. 2017. *Avian Poultry Production*, 2nd rev ed. New India Publishing Agency.
- Scanes CG, Brant G and Ensminger ME. 2003. Poultry Science, 4th ed. Prentice-Hall.

Course Title	**: Poultry Products Technology**
Course Code	**: PSC 507**
Credit Hours	**: 2+1**

Aim of the course

Composition and nutritive value of eggs and chicken meat, grading and preservation methods of eggs and meat, functional and value-added poultry products.

Theory

Unit I (15 Lectures)

Physical and chemical composition and nutritive value of eggs and meat – Grading of eggs and meat by different standards - Egg quality deterioration - Factors affecting egg quality – Handling, processing, packaging materials, packaging, transport and marketing of eggs.

Unit II (8 Lectures)

Quality control of poultry meat – Preservation of egg and meat-Functional and value-added egg and meat products – Further processing of eggs and meat – Various egg and meat fast foods.

Unit III (11 Lectures)

Sanitary and phytosanitary measures to ensure food safety – Pre and Post oviposition value addition to the eggs and Post-processing value addition to the meat for eXport– Microbial safety of poultry products – Import and eXport of poultry products – Further processing of poultry for eXport – Implementation of GMP and HACCP procedures for food safety – CodeX regulations for poultry products safety – Traceability and branding of poultry products.

Practical (17 Classes)

Measuring internal and eXternal egg qualities – Measurement of meat quality - Preservation of table eggs, grading of eggs – Processing of chicken – Further processing of poultry – Preservation of poultry meat – Preparation of various eggs and poultry meat products and fast foods – Preservation, packaging and transport – Quality control of value-added poultry products – Measures of microbial safety of poultry products for eXport, visit to poultry processing plant.

Teaching methods

- Classroom teaching with laboratory analysis
- Visit egg and meat processing plants
- Using Audio-visual capsules

Learning outcome
Gaining knowledge of poultry products technology

Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*. Jaya Publishing House.
- Mead G. 2004. *Poultry Meat Processing and Quality*. Elsevier
- Mountney GJ and Parkhairst CR. 1995. *Poultry Products Technology*, 3rd ed. AVI Publ.
- Romanoff AL and Romanoff AJ. 1949. *The Avian Egg*. CAB international
- Sim JS and Nakai S. 1994. *Egg Use and Processing Technologies: New Developments*. CAB International.
- Stadelman WJ and Cotterill OJ. 1995. *Egg Science and Technology*, 4th ed. CRC Press.

Course Title .	**: Poultry Economics, Project Formulation and Marketing**
Course Code	**: PSC 508**
Credit Hours	**: 2+1**

Aim of the course

To study about measures of performance efficiency in poultry farms and its allied sector, components of project reports and preparation of viable projects related to poultry Industry.

Theory

Unit I (10 Lectures)

Glossary of terms used in poultry economics and projects – Measures of performance efficiency in the broiler, layer, breeder and other poultry species, hatcheries and other poultry-related operations – Production standards and goals for layer, broiler and breeders.

Unit II (12 Lectures)

Planning poultry enterprise – Minimum viable units - Bank norms for poultry projects – Poultry insurance– Methods to improve the production efficiency and reduce the production cost - Components of project reports and preparing projects and return on investment.

Unit III (12 Lectures)

Integration in Poultry production and marketing – Marketing channels for eggs and meat - Cost of production of the egg, broiler, hatching egg, day-old chick and compounded feed –New regulations on cage rearing of layers. Traceability and branding of poultry products. Export norms for poultry products.

Practical (17 Classes)

Preparing different poultry projects for bank finance – Calculating the cost of production of various products under various systems-case study – Preparation of Balance sheet, break-even points, Cost: Benefit ratio and other farm economic indices- Preparation of feasibility and viability reports.

Teaching methods

- Classroom teaching with calculations
- Using Audio-visual capsules

Learning outcome

Gaining knowledge of poultry marketing and project preparations.

Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Narahari D and Asha Rajini R. 2005. *Poultry Economics and Projects*. Pixie Publication India (P) Ltd.

Course Title	**: Commercial Poultry Nutrition**
Course Code	**: PSC 510**
Credit Hours	**: 1+1**

Aim of the course

To impart knowledge on advanced poultry nutrition with respect to commercial egg and meat production

Theory

Unit I (7 Lectures)

Breed specific nutrient requirements. Factors influencing the digestibility of nutrients – Reasons to assist the birds for digestion – Gut health management.

Unit II (4 Lectures)

Commercial use of feed ingredients by the industry – their drawbacks - Use of different feed additives and supplements: Enzymes, prebiotics, probiotics, postbiotics, phytobiotics, nucleotides, acidifiers, emulsifiers, and essential oils, etc. – Trace minerals: organic, inorganic and nanoparticles – Pre-digested proteins.

Unit III (6 Lectures)

Unconventional feed ingredients: Merits and demerits – Measures to counteract the demerits – Responsible use of them for reducing the cost of production – Least cost feed formulation – Phase feeding for layers and broilers – Juvenile nutrition.

Practical (17 Classes)

Analytical methods for quick estimation of proximate principles and other nutrients – Use of latest technologies like NIR – Force-feeding, Challenge feeding – Factors preventing the birds from optimum feeding: Particle size, feed milling technologies,etc.– Seasonal variations in feeding practices, in-ovo feeding, visit to commercial poultry nutrition lab and feed mill.

Teaching methods/ activities

- Classroom teaching with laboratory support and feed mill visits
- Use of computers in feed formulations

Learning outcome

Gaining knowledge on advances in poultry nutrition

Suggested Reading

- ICAR. 2013. *Nutrient Requirements of Poultry*. ICAR Publication.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of the Chicken*. University Books.
- Leeson S and Summers JD. 2008. *Commercial Poultry Nutrition*, 3rd ed. University Books.
- Singh RA and Panda B. 1992. *Poultry Nutrition*. Kalyani Publishers.

Course Title : Poultry Welfare and Waste Management
Course Code : PSC 511
Credit Hours : 2+0

Aim of the course
To provide knowledge on the concept of poultry welfare and safe disposal of wastes generated from poultry farms

Theory
Unit I (14 Lectures)
Concept of poultry welfare – Different freedoms to the birds – Present housing systems with relation to the welfare – Welfare and productivity – Feed restriction– Economics - Welfare cages – Welfare in relation to country's requirement. Precautions and requirements before, during and after transport of birds from one place and another, thermal imaging, assessment of welfare in poultry
Unit II (20 Lectures)
Waste generated from poultry farms and hatcheries – Male chicks disposal - Hazardsof waste for humans and environment – Spread of diseases – Fly problems –Leaching of toxic substances in groundwater – Emission of gases – Dust and smell problem – Disposal of carcasses – Means to mitigate the hazardous effects of wastes – Composting of manure and dead birds - Generation of biogas, electricity, rendering plant products for feeding other species – Wastewater recycling – Usage of slurry – Preparation of bio-fuel pellets, methods of recycling poultry feathers.

Teaching methods
- Classroom teaching
- Visit various waste disposal units

Learning outcome
Gaining knowledge on the welfare of poultry and methods for safe disposal of poultry wastes

Suggested Reading

- Collins E (Ed.). 1999. *Poultry Waste Management Handbook*. NARES Series 132. Natural Resources.
- DAHD. 2015. *Poultry Farm Manual*. Department of Animal Husbandry, Dairy and Fisheries, GOI.
- Mench JA. 2017. *Advances in Poultry Welfare*. Woodhead Publishing
- Overcash MR, Humenik FJ and Miner RJ. 1983. *Livestock Waste Management*. CRS Press.

Course Syllabus and Content of Doctoral Degree in Poultry Science

Course Title : Applied Poultry Nutrition
Course Code : PSC 601
Credit Hours : 2+1

Aim of the course
Teaching about nutrients and their functions, nutrient requirements of poultry and factors influencing the same. Different methods and forms of feeds and feeding of poultry.

Theory
Unit I (10 Lectures)
Developments in the nutrient requirement for egg and meat-type chicken - Concepts in various poultry feeding procedures and methods for optimal production - Factors influencing the nutrient requirements, feed intake and feed efficiency in poultry - Nutritional deficiencies - Protein and energy utilization – Digestibility of nutrients– Ileal digestibility of amino acids - Vitamins, minerals and their interactions in poultry rations.
Unit II (10 Lectures)
In vivo - juvenile nutrition for optimal growth rate and feed efficiency – Care in grower and pre-layer feeding - Nutrition and feeding of layers/ breeders during peak egg production - Nutritional requirements for higher egg production, broiler meat production, fertility and hatchability and other special purposes.
Unit III (10 Lectures)
Feeding of broilers for uniform growth and feed efficiency – Feeding to enhance egg quality and nutrients – Nutritive and non- nutritive feed additives in feed production– organic, functional and designer feed. Advances in feed milling technology – Specialty feed production to produce microbial safe foods, SPF eggs and organic foods.
Unit IV (4 Lectures)
HACCP implementation in feed quality control – Production of feed free from antibiotics, mycotoxins and pesticide residues.

Practical
Computation of specific and functional feeds – Estimation of available carbohydrate/ Metabolizable energy, Aflatoxin, anti-nutritional factors and other toxins in the feed. Evaluation of various feeds for its quality – Field methods of feed quality control including feed microscopy – Estimation of carotenes, cholesterol and

peroxides. Quality control of functional poultry feeds – Maintaining the feed quality from production to consumption.

Teaching methods
Classroom teaching with laboratory support and feed mill visits
Use of computers in feed formulations

Learning outcome
Gaining advanced knowledge in poultry nutrition.

Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- ICAR. 2013. *Nutrient Requirements of Poultry*. ICAR Publication.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of the Chicken*. University Books.
- Leeson S and Summers JD. 2008. *Commercial Poultry Nutrition*, 3rd ed. University Books.
- Singh RA and Panda B. 1992. *Poultry Production*. Kalyani Publishers.
- *Selected articles from journals.*

Course Title : Recent Trends in Commercial Poultry Production
Course Code : PSC 602
Credit Hours : 2+1

Aim of the course
To impart knowledge on different systems of poultry rearing, care and management of commercial layers/ broilers for optimal egg and meat production.

Theory
Unit I (7 Lectures)
Global trends in poultry production - Advances in broiler production in India – concepts in egg production – Latest concepts in breeder management – advances in hatchery operations for higher hatchability and chick quality – Use of artificial intelligence in poultry production.
Unit II (8 Lectures)
Optimal microclimatic condition in poultry houses and cages for higher production – Management of poultry in environmentally controlled houses – Management of poultry under adverse climatic conditions – advances in the management of other species of poultry - Behavioural patterns of poultry in different growing systems.
Unit III (7 Lectures)
Advanced management techniques for egg and meat production - advances in lighting management, feeding management, litter management and manure management.
Unit IV (5 Lectures)
Factors influencing egg production in different species of poultry – Factors influencing growth rate and egg production - Automation in poultry production.
Unit V (7 Lectures)
Regulations for cage-free egg production and organic chicken production – Functional feeds for functional foods – Production of HACCP and GMP certified table eggs, meat, chicks, hatching eggs and other value-added products for export. Advances in Biosecurity, welfare and waste management - Role of integration in poultry production.

Practical (17 Classes)
Performance study in the commercial layer, broiler, Japanese quail, duck, turkey and other species of poultry farms by Interpretation of the farm records – Management routines of different species of poultry - calculating the cost of production – Estimation of microclimatic conditions and comparing the productive traits– Modern poultry house and cage design for optimal efficiency and cost reduction.

Teaching methods

- Classroom teaching with farm visits
- Use of Audio-visual capsules

Learning outcome

Gaining knowledge of advanced commercial poultry production practices

Suggested Reading

- Bell DD and Weaver WD, Jr. 2002. *Commercial Chicken Meat and Egg Production*, 5th ed. Kluwer Academic Publishers.
- Sreenivasaiah PV. 2006. *Scientific Poultry Production: A Unique Encyclopaedia*. International Book Distributing Co.
- Online sources of equipment manufacturers
- *Selected articles from journals.*

Course Title : Developments in Poultry Processing and Products Technology
Course Code : PSC 603
Credit Hours : 2+1

Aim of the course
Composition and nutritive value of eggs and chicken meat, grading, packaging and preservation methods of eggs and meat, functional and value-added poultry products, marketing of eggs and poultry meat.

Theory
Unit I (9 Lectures)
Global trends in egg and poultry processing -Indian scenario of poultry processing industry - Nutrients and Non-nutrient components in regular and value-added poultry products – various measures of egg and meat quality control – advances in value addition to poultry products.
Unit II (12 Lectures)
Concepts in poultry meat and egg preservation – Newer concepts in meat tenderization, canning, dehydration, curing, irradiation, etc. - Modified atmospherepackaging and other packaging techniques – Other processed products - Room temperature preservation of poultry fast foods by multi hurdle technology – Further processing to produce ready to eat products.
Unit III (5 Lectures)
Egg powder production - Egg desugarization - pasteurization – Functional properties of eggs – Industrial uses of eggs – Marketing trends in poultry meat and eggs.
Unit IV (8 Lectures)
Improving the product quality to meet Codex and European standards – Standards for the egg, meat and their products -Production of immunoglobulins, lecithin, lysozyme, sialic acid and other pharmaceutical products from eggs – Sanitary and phytosanitary measures for food safety.

Practical (17 Classes)

Preparation of value-added products suitable for preservation at room temperature– Further processing – Barbecuing and Tandoori preparation – preparation of local specific poultry meat and egg products – Meatballs, meat patties, etc. - Quality estimation of egg, meat and their products - Preservation of meat and eggs -Measuring the microbial quality of poultry foods.

Teaching methods

- Classroom teaching with laboratory analysis
- Preparation of value-added meat and egg products
- Use of Audio-visual capsules

Learning outcome

Gaining knowledge of advanced poultry products and processing technology.

Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*. Jaya Publishing House.
- Mead G. 2004. *Poultry Meat Processing and Quality*. Elsevier.
- Mountney GJ and Parkhairst CR. 1995. *Poultry Products Technology*, 3rd ed. AVI Publ.
- Owens CM. 2010. *Poultry Meat Processing*. CRC Press.
- Stadelman WJ and Cotteril OJ. 1995. *Egg Science and Technology*, 4th ed. CRC Press.
- *Selected articles from journals.*

Course Title : Emerging and Reemerging Diseases of Poultry and Health Management
Course Code : PSC 604
Credit Hours : 2+1

Aim of the course
To study about common diseases and disorders of poultry, their diagnosis, vaccination, prevention and treatment, emphasis on control of emerging poultry diseases of zoonotic importance, disease diagnostic techniques.

Theory
Unit I (6 Lectures)
Concepts of disease prevention in poultry – Emerging and re-emerging avian diseases
-Factors influencing immunosuppression/ immunity – Enhancing immunity in poultry.
Unit II (10 Lectures)
Water sanitation, hatchery sanitation procedures - Control of vertically transmissible diseases, hatchery borne diseases – non-infectious, metabolic and parasitic diseases in poultry and their control – Mycotoxins and their control.
Unit III (12 Lectures)
Stress alleviation – prevention and control of bacterial and viral diseases in poultry – Biosecurity measures – Control measures of problematic re-emerging diseases of poultry like Ranikhet, Avian influenza, Marek's disease, Infectious bursal disease, Infectious Bronchitis, Infectious laryngotracheitis, etc.
Unit IV (6 Lectures)
Flock management for Specific pathogen-free egg production – Maintaining the HACCP standards in poultry farms – developments in the EXIM policies for flock health – Concept of compartmentalization and zoning as per terrestrial code, geographical information system in disease control.

Practical (17 Classes)
Studying the Immune status of birds – Egg inoculation techniques in laboratory diagnosis – differential diagnosis of various poultry diseases by post-mortem, andlaboratory techniques – Molecular diagnosis of diseases - Antibiotic sensitivity test– Designing Vaccination schedule for different poultry species – Disinfection and sanitation - Ectoparasite control, medication procedures.

Teaching methods
- Classroom teaching with laboratory techniques
- Post-mortem examination and sample collection
- Use of Audio-visual capsules

Learning outcome
Gaining knowledge of the emerging disease of poultry and health management.

Suggested Reading

- Davison F, Kaspers B and Schat KA. 2008. *Avian Immunology*. Elsevier

- Pattison M, McMullin P, Bradbury JM and Alexander D. 2008. *Poultry Diseases*, 6th ed. Elsevier.
- Thyagarajan D. 2011. *Diseases of Poultry*. Satish Serial Publishing House.
- Vegad JL. 2015. *Poultry Diseases Farmers. A Guide for Farmers and Poultry Professionals*. International Book Distributing Co.
- *Selected articles from journals.*

Course Title : Applied Poultry Breeding
Course Code : PSC 605
Credit Hours : 1+1

Aim of the course
To impart knowledge about different systems of breeding, selection methods and implementation of the breeding programme in developing egg and meat type hybrids. Modern tools in poultry breeding.

Theory
Unit I (7 Lectures)
Gene and genotypic frequency - Sex-linked, limited and influenced traits-Auto sexing- Qualitative and quantitative traits and its inheritance in poultry- methods of selection – family selection – selection for multi characteristics and construction of selection indices –Reciprocal recurrent selection – Recurrent selection, Marker assisted selection – Random bred control populations - Selection limit - Osborne's index – construction of selection index for multiple traits - Use of molecular genetics in poultry breeding.
Unit II (5 Lectures)
Exploitation of additive and non-additive gene action for commercial poultry production - Heterosis – Exploitation of hybrid vigour for commercial production of layers and broilers - Formation of synthetic lines – Development of strains in poultry - Comparative efficiency of different selection methods in poultry.
Unit III (5 Lectures)
Modern methods in commercial layer and broiler breeding, performance testing –Pure line-breeding – Inbreeding and hybridization - Diallele mating. Pedigree hatching. Genotype × Environment interaction.

Practical (17 Classes)
Construction of selection index – Analysis of breeding data collected from breeding records – Estimation of qualitative and quantitative inheritance - Estimation of variance, heritability and standard error of heritability by different methods – Repeatability - analysis of heritability for different traits – Estimation of inbreeding coefficient – Artificial insemination in poultry.
Teaching methods
- Classroom teaching with breeding farm visits
- Utilizing computer for quantitative genetic analysis
- Use of Audio-visual capsules

Learning outcome
Gaining knowledge on applied poultry breeding methods

Suggested Reading

- Crawford RD. 1990. *Poultry Breeding and Genetics.* Elsevier.
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology*. CAB International.
- Singh R and Kumar J. 1994. *Biometrical Methods in Poultry Breeding*. Kalyani Publishers.
- *Selected articles from journals.*

Course Title : Poultry Economics, Marketing and Integration
Course Code : PSC 606
Credit Hours : 2+1

Aim of the course
To study about measures of performance efficiency in poultry farms and its allied sectors, hatcheries and developing poultry projects.

Theory
Unit I (11 Lectures)
Present practices and future trends in the production of egg and meat – Present trends in consumption – Demand and supply - Seasonal variations in production and consumption. Marketing channels-procedures of marketing for eggs and meat- Market intelligence -Advertising and branding of poultry products.
Unit II (14 Lectures)
Various poultry enterprises – choice of production size of business – input and output analysis – calculating cost of various inputs – calculating cost of production – Break-even point analysis - Price determination – Role of NECC, BroMark and other marketing agencies - Least demand and supply indices of performance – Performance targets and achievements - marketing and business management - market managerial skills and human resource development - cost and financial management.
Unit III (9 Lectures)
Future trends in broiler and egg production – Factors influencing the profit margin in poultry enterprises – Role of integration in Poultry business – Different typesof integration.

Practical (17 Classes)
Study of marketing channels of egg and meat, calculating the cost of production ofeggs, meat, day-old chick and feed – Calculating marketing costs - Preparing other related poultry projects. Use of social media in popularizing poultry and poultry products – Study of successful business models in the poultry sector.

Teaching methods
Classroom teaching and interaction with the poultry industry
Use of Audio-visual capsules

Learning outcome
Gaining knowledge of market intelligence and marketing techniques
Suggested Reading

- Narahari D and Asha Rajini R. 2005. *Poultry Economics and Projects*. PIXIE Publications India (P) Ltd.
- Vashisht K. 2006. *Practical Approach to Marketing Management*. Atlantic.
- Online sources of NABARD website4.
- *Selected articles from journals.*

Course Title : Diversified Poultry Production
Course Code : PSC 607
Credit Hours : 2+1

Aim of the course
To provide knowledge on care and management of different breeds, varieties of poultry other than chicken, methods of rearing and common diseases affectingthem and their control measures.

Theory
Unit I (9 Lectures)
Commercial hybrid strains of ducks for egg and meat production – Feeding and management – Housing – Specific diseases of ducks, prevention and their control– Slaughter and processing of ducks – Economics of production of ducks, indigenous duck production system including polythene duck pond.
Unit II (8 Lectures)
Varieties of Japanese quail for meat and egg production – Cage and deep litter system of rearing of quails – Feeding and management – Housing – Emerging diseases affecting Japanese quail – Nutritive value of Japanese quail meat and egg- Economics of production of Japanese quail.
Unit III (9 Lectures)
Varieties/ breeds of Turkey, Guinea fowl, Geese, Emu and Ostriches – System of rearing – Feeding and management – Housing – Emerging diseases and theirprevention – Nutritive value of Turkey, Geese and Guinea fowl – By-products of Geese, Emu and Ostriches.
Unit IV (8 Lectures)
Scope and constraints in the marketing of diversified poultry products – Rearing and management of common pet birds and other birds of regional importance – Common diseases affecting pet birds and their prevention and treatment - Economics of production of different pet birds.

Practical (17 Classes)
Layout and design of housing for other species of poultry. Visit commercial Japanese quail, turkey and duck farms. Incubation and care of hatching eggs and young ones– Rearing practices followed for duck, quails and turkey farmers under field conditions – Designing of aviaries for pet birds - Different types of feed prepared for pet birds – Vaccination and medication for diversified poultry species - Preparingproject reports for different species and calculating the cost of production.

Teaching methods
- Classroom teaching and visit to other avian species farms
- Use of Audio-visual capsules

Learning outcome
Gaining advanced knowledge of diversified poultry production

Suggested Reading

- Cherry P and Morris T. 2011. *Domestic Duck Production: Science and Practice.* CAB International.
- CPDO. *Duck – Management Guide*. Central Poultry Development Organization Publication (online resource)

- CPDO. *Turkey – Management Guide*. Central Poultry Development Organization Publication(online resource)
- Pathak N. 2013. *Poultry and Ratite Nutrition*. Narendra Publishing House.
- Thiyagarajan D. 2012. *Scientific Turkey Farming*. SSPH, New Delhi.

E Resources and List of Journals

Name of Journal

Annual Review of Immunology
Archives of Animal Nutrition
Archives of Gynecology and Obstetrics
Asian Fisheries Science
Asian Journal of Animal Sciences
Asian Journal of Dairy and Food Research (Journal of Dairying, Foods and Home Sciences)
Asian Journal of Medical and Pharmaceutical Researches
Asian Journal of Pharmaceutics
Australian Journal of Zoology
Australian Veterinary Journal
Avian Biology Research
Avian Diseases
Avian Pathology
BMC Veterinary Research
Biology of Reproduction
British Journal of Nutrition
British Poultry Science
Bulletin of Marine Science
Clinical Genetics
Clinical Microbiology Reviews
Clinical and Experimental Immunology
Current Research in Nutrition and Food Sciences
Current Topics in Medicinal Chemistry
Current Topics in Microbiology and Immunology
Equine Veterinary Education
Equine Veterinary Journal
European Journal of Wildlife Research
Exploratory Animal and Medical Research
Frontiers in Veterinary Science
Immunology Letters
Indian Journal of Animal Health
Indian Journal of Animal Nutrition
Indian Journal of Animal Production and Management
Indian Journal of Animal Research
Indian Journal of Animal Sciences
Indian Journal of Poultry Science
Indian Journal of Veterinary Pathology
Indian Journal of Veterinary and Animal Science Research
International Journal of Dairy Technology
International Journal of Zoology and Applied Biosciences
Journal of Animal Breeding and Genetics

Journal of Animal Ecology
Journal of Animal Feed Science and Technology
Journal of Animal Health and Production
Journal of Animal Physiology and Animal Nutrition
Journal of Animal Research
Journal of Animal Science
Journal of Animal Science and Biotechnology
Journal of Animal Science and Technology
Journal of Aquatic Animal Health
Journal of Avian Biology
Journal of Avian Medicine and Surgery
Journal of Food Safety
Journal of Livestock Biodiversity
Journal of Livestock Sciences
Journal of Nutrition
Journal of Poultry Science and Technology
Journal of Veterinary Internal Medicine
Journal of Veterinary Medical Education
Journal of Veterinary Science
Journal of World's Poultry Research
Lab Animal
Laboratory Animals
Livestock Research International
Poultry Science
Productions Animales
Reproduction in Domestic Animals
The Indian Journal of Small Ruminants
The Indian Journal of Veterinary Research
The Indian Journal of Veterinary Sciences & Biotechnology (The Indian Journal of Field Veter

The Journal of Bombay Veterinary College