

Semester III		
Course No.	Course Title	Credit
AS -233	Livestock Production and Management	2+1
BT-236	Recombinant DNA Technology	2+1
BOT-232	Plant Physiology	2+1
MATH-233	Biomathematics	2+1
ICT-231	Information and Communication Technology	1+1
ECON-231	Economics and Marketing	2+1
*ENT./Pl.PATH- 231/ **AS-234	Fundamentals of Crop Protection/ Livestock Product Technology	2+1/ 2+1
*PB-232/ **AS 235	Breeding of Field Crops/ Animal Health Care	2+1
NCC-233/NSS-233	NCC/NSS	0+1 NC
Total		15+8(23) +1 NC=24
Semester IV		
Course No.	Course Title	Credit
EDBM -241	Entrepreneurship Development and Business Management	1+1
BIOCHEM- 241	General Biochemistry	3+1
BT-247	Introductory Bioinformatics	2+1
BT-248	Plant Genetic Transformation	2+1
BT/ECE-241	Fundamentals of Electronics and Instrumentation in Biotechnology	1+1
BT-249	Classical and Molecular Cytogenetics	2+1
MICRO-242	Microbial Genetics	2+1
PHY-241	Biophysics	2+1
NCC-244/NSS-244	NCC/NSS	0+1 NC
Total		15+8 (23)+1NC =24

SEMESTER-III

Course No : **AS-233**

Course Title : **Livestock Production and Management**

Credits : **3(2+1)**

Semester : **III**

Theory

UNIT I

Livestock history in India: Vedic, medieval and modern era; Demographic distribution of livestock and role in economy; Introductory animal husbandry; Breeds of livestock; Cattle, Buffalo, Sheep, Goat and Pig; Important traits of livestock; General management and feeding practices of animals; Handling and restraining of animals; Housing systems. Importance of grasslands and fodders in livestock production; Common farm management practices including disinfection, isolation, quarantine and disposal of carcass; Common vices of animals and their prevention; Diseases and parasite control & hygiene care.

UNIT II

History and economic importance of poultry; Poultry breeds; Reproductive system of male and female birds; Formation and structure of eggs; Important economic traits of poultry, Egg production, Egg weight, Egg quality; Fertility and Hatchability, Plumage characteristics and comb types.

Care and management of chicks, grower and layers/broiler; Brooding management; Hatchery practices; Poultry Diseases, control and hygiene care;

Practical

Visit to livestock farms/demonstration centres; Breeds of cattle, buffalo, sheep, goat and Pigs; Familiarization with body parts of animals; Handling and restraining of cattle, buffalo, sheep, goat and swine; Male and female reproductive system and Artificial Insemination; Feeding of livestock; Methods of identification: marking, tattooing, branding, tagging; Milking methods; Record Keeping

Visit to the Poultry farm; Poultry breeds; Body parts of chicken, duck, quail and turkey; Housing, equipment, nesting and brooding requirements; Male and female reproductive system; Methods of identification and sexing; Hatchery layout and equipment; Identification of diseases and control of parasites, Vaccination; Maintenance of farm records;

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
UNIT – I		
1	Livestock history in India (Importance of Livestock in Vedic, Medieval and modern era)	3
2	Demographic distribution of Livestock Zoological/topographical/utility classification	2
3	Importance of Livestock in national economy	2
4	Introductory animal husbandry, its role and importance	3
5	Breed of livestock (with their characteristics, productive and reproductive traits and purpose of raring) Major breeds of bovine	3
6	Major breeds of buffaloes, Sheep and Goats	4
7	Important traits of livestock	3
8	General management	3
9	Feeding practices of livestock (Feeding standards, thumb rule, Dry matter requirement of animal)	3
10	Housing system (modern, closed, semi-closed for cattle, buffalo, sheep and goat)	3
11	Care of new born calf, young one of sheep and goats	3
12	Handling and restraining of animals	3
13	Importance of grassland and fodder in livestock production	3
14	Common/Daily farm management practices including culling, flushing, disinfection, isolation, washing, grooming, quarantine and disposal of carcass.	3
15	Importance of culling in livestock and flushing in sheep and goats	3
16	Common vices of animals	3
17	Preventive measures for hygiene care, Vaccination programme of different livestock	3
18	Major diseases in livestock (cattle and buffalo) with their symptoms and control measures	3
19	Major diseases in sheep and goat with their symptoms and control measures	3
UNIT - II		
20	History and economic importance of poultry, common terminology in poultry	3
21	Different poultry breeds and their classification	3
22	Reproductive system of male and female birds	3
23	Study of digestive system of birds, cattle and difference between their digestive system	3
24	Formation and structure of egg,	3
25	Egg production, weight, quality, grading of egg	3
26	Fertility and hatching of egg	3
27	Plumage characteristics and comb type	3
28	Care and managements of chicks, grower, layers/broiler	4

29	Feeding for poultry and classification of feeds	4
30	Different terminology used in poultry and introduction to common equipments used in poultry managements	4
31	Management in poultry including brooding management, housing of poultry and hatchery practices	4
32	Hygiene care, poultry diseases, symptoms and preventive and curative measures, Vaccination programme and importance of vaccination programme in poultry	4
		100

Practical Exercise

Exercise No.	Title
1	Visit to live stock farm/demonstration centres of cattle, buffalo, sheep, goat and pigs and observation on the different breeds and their management.
2	External body parts of cattle, goat and pigs and their important functions
3	Method of handling and restraining of cattle, buffalo, sheep, goat swine and poultry
4	Study of male and female reproductive systems of cattle
5	Artificial Insemination
6	Preparation of feeding schedule and feeding of different categories of cattle, buffalo, sheep, goat, swine and poultry
7	Method for identification of animals
8	Milking method
9	Record keeping on dairy farm
10	Visit to poultry farm
11	External body parts of chicken, duck, quail and turkey
12	Housing system of poultry
13	Method for identification and sexing of poultry
14	Male and female reproductive systems of poultry
15	Identification of diseases and control measures in poultry, Vaccination programme in poultry
16	Study of hatchery layout and different equipments in poultry business; Maintenance of poultry farming record

Text Books:

1. Banerjee GC. 1989. Text Book of Animal Husbandry. Oxford and IBH.
2. Parsad Jagdish. 2001. Poultry Production and Management. Kalyani Publishers.
3. Singh RA. 1990. Poultry Production. Kalyani Publishers.
4. Thomas CK & Sastry N.S.R. 2013. Livestock Production Management. Kalyani Publishers.

Reference Books:

1. ICAR. 1962. Handbook of Animal Husbandry. ICAR Publication.
2. Sastry NSR & Thomas CK. 1991. Dairy Bovine Production. Kalyani Publishers.

Course No : **BT-236**

Course Title : **Recombinant DNA Technology**

Credits : **3(2+1)**

Semester : **III**

Theory

UNIT I

Recombinant DNA technology; Restriction endonucleases: Types and uses; DNA ligases; Vectors: plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, expression vectors, shuttle vectors, binary plant vectors, co-integrating vectors.

UNIT II

Competent cells; Gene isolation and cloning; Genetic transformation of *E. coli*; Gel electrophoresis; Preparation of probes; Southern blotting; Northern blotting; Western blotting; PCR and gene amplification.

Practical

Orientation to recombinant DNA lab; preparation of stock solutions and buffers; Plasmid DNA isolation; Genomic DNA isolation; Quality and quantity determination of DNA; restriction digestion of DNA; Agarose gel electrophoresis, SDS-PAGE; PCR; Genetic transformation of *E. coli*; Screening of recombinant DNA clones in *E. coli*.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1	Recombinant DNA Technology: Introduction	4
2	Milestones, Steps, Tools used in Recombinant DNA Technology	4
3	Techniques in Recombinant DNA Technology and application	4
4	Restriction Endonucleases: Definition, Discovery, Source of Restriction enzyme, Nomenclature.	4
5	Types and uses, Cleavage Pattern, Examples and application	4
6	DNA ligases: Definition, Classification , types Ligase mechanism, Example : <i>E. coli</i> DNA ligase	2
7	Vectors: Definition, types, Properties of good vectors	2
8	Plasmids: Definition, Types, example : pBR 322 & pUC 19,	2
9	Cosmids: Definition, basic feature of cosmid, structure, properties	2
10	Phagemids: Definition, structure, properties	2
11	BACs: Basic features, structure, properties	2
12	PACs: Basic features, structure, properties	2
13	YACs: Organization of YAC vector, properties	2
14	Transposon: Discovery, Classification, Class I (retrotransposons), Class II (DNA transposons), examples.	2
15	Expression vectors: Definition, properties and example	2
16	Shuttle vectors: Definition and Properties and example	2
17	Binary plant vectors: transfer of DNA (binary system) , development of primary system and example	2
18	co-integrate vectors	2
UNIT II		

19	Competent cells; Definition & methodology	5
20	Gene isolation : Definition & methodology	5
21	Cloning: Definition & methodology	5
22-23	Genetic transformation of E. coli: Definition, types, methodology, screening	8
24-25	Gel electrophoresis; Definition, types, principles methodology of Agarose gel electrophoresis	5
26	Preparation of probes: methodology,	3
27-28	Southern blotting: methodology and Diagram, Applications and Advantages	6
29	Northern blotting; methodology and Diagram	4
30	Western blotting; Steps involved in the process, Diagram	4
31-32	PCR: Definition, types, stages of PCR, Amplification and its application	9
Total:		100

Practical Exercise

Exercise No.	Title
1	Orientation to recombinant DNA lab; lab rules and introduction to RDT laboratory. Introduction to various instruments used and their working principle.
2	Preparation of stock solutions and buffers; Preparation of solutions of different molarities, normalities, percentages etc. Preparation of stocks of various acid and bases, phosphates buffer, citrate buffer, carbonate buffer.
3-4	Plasmid DNA isolation; Isolation of Plasmid DNA from Bacterial source.
5-6	Genomic DNA isolation; Isolation of Genomic DNA from Plant Source using liquid Nitrogen
7	Quality and quantity determination of DNA; Qualitative and quantitative analysis of DNA using Spectrophotometer.
8-9	Restriction digestion of DNA; Digestion of DNA isolated from different sources with different restriction enzymes and visualization of bands on Agarose gel by electrophoresis,.
10	Agarose gel electrophoresis, Electrophoresis of Plasmid, Plant, Animal, Bacterial DNA and Ladder . Calculation of Molecular weight.
11-12	SDS-PAGE; To perform SDS PAGE of DNA isolated from Plant.
13-14	PCR; To perform any gene amplification (Transgene Detection and RAPD). Preparation of chemicals , addition using micropipette in PCR tubes, Programming of PCR Machine and Visualization of Bands on Gel by electrophoresis.
15	Genetic transformation of E. coli; Preparation of Competent cells of E.Coli and their Plasmid transformation using Heat shock method.
16	Screening of recombinant DNA clones in E. coli.: Blue white screening

Text Book

1. Brown TA. 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.
2. Singer M & Berg P. 1991. Genes & Genome. University Science Books.

Reference book:

1. Watson JD, Gilman M., Witkowski J & Zoller M. 1992 Recombinant DNA: A Short Course. 3rd Ed. WH Freeman and Co, Ltd.
2. Winnacker EL. 2003. From Genes to Clones: Introduction to Gene Technology. 4th Ed. Panima Publishers.

Course No : **BOT-232**
Credits : **3(2+1)**

Course Title : **Plant Physiology**
Semester : **III**

Theory

UNIT I

Plant physiology, its scope in agriculture; Osmosis, imbibition, water absorption, water translocation and transpiration; Stomatal mechanisms; Physiological role and deficiency symptoms of major and minor elements, Absorption and translocation of minerals.

UNIT II

Concepts of photosynthesis, photorespiration, respiration and translocation of photoassimilates; Dynamics of growth; Stress physiology; Nitrogen and sulphur metabolism; Plant growth regulators: Their biosynthesis and physiological roles, seed germination & seed dormancy, senescence, vernalization.

Practical

Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis; Ascent of sap, transpiration; Deficiency symptoms of nutrients in crop plants; Plant growth analysis; Quantitative and qualitative estimation of plant pigments; Experiments on photosynthesis and respiration; Effects of plant growth regulators on plant growth and seed germination; Experiments on seed dormancy; Relative water content and plant water potential; Proline estimation.

Teaching Schedule- Theory with weightage (%)

Lecture No	Topics	Weightage (%)
1	Introduction to Plant Physiology and its importance in Agriculture	5
2	Osmosis, imbibition and water potential in plant	5
3	Absorption of water and path of water.	5
4	Translocation of water in plants	5
5	Transpiration- Definition, types, structure of stomata, physiology of stomata, factors affecting transpiration.	5
6-7	Mineral nutrition of plants. Classification of mineral elements, criteria of essentiality. Mechanism of absorption and translocation of mineral element	5
8	General and specific role of mineral elements and deficiency symptoms	5
9-10	Photosynthesis : Definition, pigments involved, structure of chloroplast, light reaction- Photolysis of water,	10
11-12	Emerson effect, Pigment system I and II, Cyclic and non cyclic electron transfer, Significance of light reaction.	5
13-14	Dark reaction- C ₃ , C ₄ and CAM plants, factors affecting photosynthesis, Photorespiration	5
15	Photorespiration – Definition, mechanism and significance, difference between C ³ and C ⁴ plants.	5
16-17	Respiration- Definition, types, glycolysis, TCA cycle and electron transport chain	5
18-19	Translocation of photoassimilates and sink source relationship phloem	5

	loading and unloading	
20-21	Plant growth regulators, Definition, types, biosynthesis physiological role	10
22-23	Dynamics of Growth : Definition, types of growth, measurement of growth, growth analysis	4
24-25	Stress physiology – Definition, types – study of water, temperature and salinity stress and mechanism of tolerance	4
26-27	Seed dormancy – Definition, causes and methods of breaking dormancy	4
28-30	Senescence – Definition , types, biological significance , mechanism of senescence	4
31-32	Vernalization- Definition, technique and mechanism of vernalization	4
	Total	100

Practical Exercise

Lecture No	Title
1.	Study of Diffusion and imbibitions
2.	Study of osmosis and plasmolysis
3.	Study of water potential in plants
4.	Study of relative water content of leaf
5.	Study of ascent of sap and measurement of root pressure
6.	Measurement of rate of transpiration
7.	Study of deficiency symptoms of nutrients in crop plants by Hoagland solution method .
8.	Study of plant growth by direct method and indirect method- growth analysis methods.
9.	Study of separation of photosynthetic pigment by solvent extraction methods.
10.	Estimation of plant pigment by quantitative method – colorimetric method.
11.	Measurement of rate of photosynthesis by different methods.
12.	Study of respiration and respiratory quotient.
13.	Study of use of PGR in fruit ripening.
14.	Study of seed germination.
15.	Study of dormancy and methods of breaking dormancy.
16.	Estimation of proline content in plant tissue

Text Books:

1. Verma V. 2007. Textbook of Plant Physiology, Ane Books, India.
2. Pandey SN & Sinha BK. 2001. Plant Physiology, Vikas Publishing House, New Delhi.
3. Amar Singh. 1967. Practical Plant Physiology. Kalyani Publisher, Ludhiana
4. Malik CP. Plant Physiology 2005, Kalyani Publisher, Ludhiana
5. Chore CN, Ghadekar SR & Patil RK. 2008 Crop Physiology; Agromet Publisher, Nagpur
6. Taiz L. & Zeiger E. 2010. Plant Physiology. 5th Ed. Sinaur Asso. Inc, USA.
7. Noggle GR & Friz G. 2013. Introductory Plant Physiology. PHI Learning Pvt Ltd, New Delhi.
8. Malik CP & Srivastava AK. 2005 A Text Book Plant Physiology. Kalyani Publisher, Ludhiana.
9. Devlin RM & Witham FH. 1986. Plant Physiology. CBS Publisher & Distributors, Delhi.

Reference Books:

1. Dhumal KN, More TN and Munnali MR. Plant Physiology; Nirali Prakashan, Pune
2. Shrivastava HS. 1996. Plant Physiology; Rustogi Publications, Meerut.
3. Mukharji S and Ghosh AK. 2005. Plant Physiology. New Central Book Agency, Kolkatta
4. Chandra Datta S.1993. Plant Physiology. Wiley Eastern Ltd, Daryaganj, New Delhi.
5. Kumar A & Purohit SS. 2005. Plant Physiology –Fundamentals &Applications; Agrobios (India), Jodhpur.
6. Sinha RK. 2007. Modern Plant Physiology. Narosa Publishing House, Panchshil Park, New Delhi

Course No : **ICT- 231** Course Title : **Information & Communication Technology**
 Credits : **2(1+1)** Semester : **III**

Theory

UNIT I

IT and its importance; IT tools; IT-enabled services and their impact on society; Computer fundamentals; Hardware and software; Input and output devices; Word and character representation.

UNIT II

Features of machine language, assembly language, high-level language and their advantages and disadvantages; Principles of programming - algorithms and flowcharts.

UNIT III

Operating systems (OS) - definition, basic concepts; Introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN); Wide area network (WAN); Internet and World Wide Web; HTML and IP.

UNIT IV

Introduction to MS Office - Word, Excel, Power Point; Audio visual aids - definition, advantages, classification and choice of A.V. aids; Criteria for selection and evaluation of A.V aids; Video conferencing; Communication process, Berlo’s model, feedback and barriers to communication.

Practical

Exercises on binary number system; Algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: web browsing, creation and operation of email account; Analysis of data using MS Excel; Handling of audio visual equipments; Planning, preparation, presentation of posters, charts, overhead transparencies and slides; Organization of an audio visual programme.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	Introduction to Computers, Definition: Hardware, Software & firmware. Type’s of software.	2
2	Data Representation, Number systems (Binary, Hexadecimal). Difference between ASCII&UNICODE (Different EncodingSchemes)	3
3	Primary, Secondary Memory, Units usedfor measurement of memory, Input Outputdevices	8
4	Operating Systems, definition andtypes	2
5	FileManagement.	3
6	Applications used for document creation&Editing, Data presentation usingslides.	2
7	Use of Spreadsheets for statisticalanalysis, evaluating mathematical & logicalexpressions.	20

8	Use of Spreadsheets for Interpretation and graph creation.	10
9	Database, concepts and types, uses of DBMS/RDBMS in Agriculture	5
10	Database design, creation,	10
11	Database, concepts and types, uses of DBMS/RDBMS in Agriculture	5
12	Database design, creation,	10
13	Preparation of presentation. Import export operations, using numerical tabular data/text/graph/slides within different applications using cut-paste.	5
14	Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information	5
15	Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting Farm decisions.	5
16	Communication process, Berlo's model, feedback and barriers to communication.	5
Total:		100

Practical Exercise

Exercise	Title
1	Study of Computer Components, accessories
2	Practice of important DOS Commands
3	Introduction of different operating systems such as MS-Windows, Unix/ Linux, Creating, Files & Folders, File Management.
4	Word-Processing –1
5	Word Processing –2
6	Presentation
7	Spreadsheet-1
8	Spreadsheet-2
9	Spreadsheet-3
10	DBMS/RDBMS Creating, Updating database
11	Querying/Retrieving data, relation
12	Introduction to World Wide Web (WWW). Demonstration of Agri-information system.
13	Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools
14	Introduction of Geospatial Technology for generating valuable information for Agriculture.
15	Hands on Decision Support System
16	Introduction of programming languages. Preparation of contingent crop planning.

Text Books/ Websites:

- 1) Sinha PK and Sinha P. 2007. Computer Fundamentals by, 6th ed. BPB Publications, New Delhi..
- 2) Panse VG and Sukhatme PV. 1985. Statistical Methods for Agricultural Workers, ICAR, NewDelhi.
- 3) http://www.tutorialsforopenoffice.org/category_index/base.html
- 4) <http://mkisan.gov.in/downloadmobileapps.aspx>
- 5) <http://www.nrsc.gov.in/Agriculture>
- 6) <http://iasri.res.in/>
- 7) <http://communicationtheory.org/berlos-smcr-model-of-communication/>

Course No : **ECON-231**

Course Title : **Economics and Marketing**

Credits : **3(2+1)**

Semester : **III**

Theory

UNIT I

Economics – Terms and definitions; Consumption, demand, price and supply; Factors of production; Gross Domestic Product; Role of Biotechnology/ Agriculture sector in national GDP.

UNIT II

Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence.

UNIT III

Basic guidelines for preparation of project reports; Bank norms; Insurance; SWOT analysis; Crisis management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value added products; Identification of marketing channel; Calculation of price spread; Identification of market structure; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

Teaching Schedule-Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1-2	Economics:, Meaning -Definition : Adam Smith, Marshall, Robbins Subject matter of Economics: Economic activities, (Wants, efforts , satisfaction), Traditional view & Modern view & approaches.	8
3-4	Basic Terms, Goods (Classification, types) utility – Meaning -forms of utility, value, wealth, and Price.	8
5-6	Consumption – Meaning, types of consumption, Engles law, Standard of living, factors affecting Standard of living, factors affecting consumption	4
7-8	Demand – Meaning, definition, kinds of demand, demand schedule, demand curve, Law of demand, exception to law of Demand, Extension and Contraction, increase decrease in demand.	5
9-10	Elasticity of demand – Meaning, types & methods of measurement of elasticity of demand (3 methods), factors affecting elasticity of demand	3
11-12	Supply – Definition, Kinds of supply, Supply schedule, Law of Supply, Extension & Contraction of supply, Increase & decrease of supply, factors affecting supply.	5
13-14	Elasticity of supply – Meaning, elastic, inelastic supply, Measurement	3

	of elasticity of supply & its importance.	
15	Production – Meaning, factors of production: Land, Labour, Capital & Management	3
16-17	National Income –Concepts of National Income: GNP, NNP,PI Methods of measurement of National Income its Importance.	8
18-19	Role of Bio-technology in the National Income and GDP.	3
	UNIT- II	
20-21	Market –Meaning, Definition, Marketing, meaning, definition, Role & scope of Marketing.	4
22-24	Classification of Markets, Marketing functions and its Classification.	16
25-26	Marketing channels – Meaning, and types of marketing channels, price spread- meaning, marketing efficiency, constraints in marketing of Biotech Products.	16
27	Market intelligence- meaning and its importance	4
	UNIT- III	
28	Project : Meaning, Definition, types of projects, project cycles	4
29-30	Basic guidelines for preparation of project proposals- Introduction, overview of project, project description, technical feasibility, commercial feasibility, cost estimates, finance (Requirement), financial feasibility, managerial aspects and project benefits. Bank norms, insurance – Definition, meaning, its importance	4
31-32	SWOT – Analysis- Biotech projects, Crisis management- meaning, importance.	2
Total		100

Practical Exercise

Exercise No	Title
1	Techno –economic parameters for preparation of Biotech Projects
2- 3	Preparation of Bankable proposal for Biotech projects (Statements)
4	Study of different- marketing channels for different Biotech Products.
5-6	Study of price spread and producer’s share in consumer’s rupee, marketing cost & margin for different Biotech Products.
7-8	Study of the market structure
9-10	Visit to various markets in the area
11-12	Visit to different market institutions (NAFED, APMC, Marketing Society)
13	Study of SWC, CWC & STC institution (History, objectives, functions & reference)
14	Study of price behavior of Biotech Products
15-16	Study of the Producer’s Surplus for different Biotech Products.

Text Books:

1. Dewett KK and Varma JD. 2013. Elementary Economic Theory. , S. Chand and Company Pvt. Limited, New Delhi.
2. Acharya SS and Agrawal NL. 2008. Agricultural Marketing in India Oxford and IBH Publishing Company Pvt. Limited, New Delhi.

Reference Books:

1. Dewett KK. 2009. Modern Economic Theory S. Chand and Company Pvt. Limited, New Delhi.
2. Reddy SS Raghuram P and Shastri NK. 2005. Agricultural Economics. Oxford and IBH Publishing Company Pvt. Limited, New Delhi.
3. Reddy SS and Raghuram P. 2015 Agricultural Finance and Management. Oxford and IBH Publishing Company Pvt. Limited, New Delhi.
4. Barde SD and Karmakar KG. 1995. Agricultural Project Management for Banks, Popular Prakashan Pvt. Limited Mumbai.

Course No: **ENT-PL.PATH - 231** Course Title : **Fundamentals of Crop Protection**
 Credits: **3(2+1)** Semester : **III**

Theory

UNIT I

Insects - their general body structure; Importance of insects in agriculture; Life cycle of insects; Insects diversity; Feeding stages of insects and kinds (modifications) of mouth parts; Concepts in population build-up of insects – GEP, DB, EIL, ETH and pest status; Causes of insect-pests out break; General symptoms of insects attack; Principles and methods of insect-pests management; Integrated Pest Management concept; Bioecology and management of important pests of major crops and storage products.

UNIT II

Importance and scope of plant pathology; Concept of disease in plants; Nature and classification of plant diseases; Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites; Pathogenesis due to obligate and facultative parasites; Variability in plant pathogens; Conditions necessary for development of disease epidemics; Survival and dispersal of plant pathogens; Management of key diseases and nematodes of major crops.

Practical

Familiarization with generalized insect’s body structure and appendages; Life stages; Acquaintance with insect diversity; Identification of important insect-pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms of damage; Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silk worms; Acquaintance with various pesticidal formulations; Principles and working of common plant protection appliances; Calculation for preparing spray material; Acquaintance to plant pathology laboratory equipment; Preparation of culture media for fungi and bacteria; Demonstration of Koch's postulates; Study of different groups of fungicides and antibiotics and methods of their evaluation; Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and their characteristic symptoms.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
UNIT I		
1	Introduction ; Definition of Insect, Entomology Importance of insects in agriculture Insect dominance	2
2	Insect diversity: Classification of insects	2
3	Insect’s general body segmentation: Head, thorax and abdomen	2
4	Feeding stages of insects, Structure and modifications of insect mouth parts	2
5	Growth and Metamorphosis : Life cycle of insects	2
6	Concept of population buildup of insect: Population, `Population dynamics, characteristics of population,	3

	factors affecting populations (Abiotic and biotic)	
7	Classification of pests and causes of insect-pests outbreak	4
8	Types of damage to plants by insects or General symptom of insect attack	3
9	Principles and methods of insect-pest management Natural control, Applied control	3
10	Cultural, mechanical, physical, biological, legal, chemical methods of pest control, recent trends in pest control	4
11	Concept of Integrated pest management, merits, demerits and constraints of IPM Concept of GEP, DB, EIL, ETL, etc	4
12	Insect-pests of cereals (Paddy, sorghum, bajara, wheat and maize), pulses (Pigeonpea and chickpea), oilseeds (Groundnut, sunflower, safflower and soybean) and their management	5
13	Insect-pests of cotton, sugarcane and their management	5
14	Insect-pests of fruit crops (Mango, citrus, grape, banana, pomegranate and coconut) and their management	3
15	Insect-pests of vegetables (Potato, tomato, brinjal, okra, cruciferous and cucurbita) and their management	3
16	Insect-pests of spices, condiments (Black paper, turmeric and ginger) and their management, insect-pests of stored grains and their management	4
UNIT II		
17	Plant pathology: Definition, objectives, Importance and scope	4
18	Concept of disease and disease triangle	3
19	Nature and classification of plant diseases.	4
20-21	Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, etc.	6
22-23	Importance and general characters of nematodes, viruses, viroids, algae, protozoa and phanerogamic plant parasites.	6
24-25	Pathogenesis due to obligate and facultative parasites.	4
26	Variability in plant pathogens.	5
27-28	Plant disease epidemics: elements, factors (host pathogen, environment) and measurement of epidemics	6
29-30	Survival and dispersal of plant pathogens	4
31-32	Management of major diseases and nematodes of major crops.	7
Total:		100

Practical Exercise

Exercise No.	Title
1	Study of generalized insect's body structure and appendages Dissection of mouth parts (Cockroach/grasshopper, red cotton bug and honeybee)
2	Study of life stages of insect (Types of larvae and pupae) Study of Important features of agriculturally important insect Orders with examples: Isoptera, Orthoptera, Hemiptera, Thysanoptera, Neuroptera, Diptera, Coleoptera, Lepidoptera, Hymenoptera
3	Identification of important insect-pests of cereals (Paddy, sorghum, bajara, wheat and maize) and pulses (Pigeonpea and chickpea) and their symptoms of damage
4	Identification of important insect-pests of oilseeds (Groundnut, sunflower, safflower and soybean), cotton and sugarcane and their symptoms of damage
5	Identification of important insect-pests of fruit crops (Mango, citrus, grape, banana, pomegranate and coconut) and vegetable crops (Potato, tomato, brinjal, okra, cruciferous and cucurbita) and their symptoms of damage
6	Identification of important insect-pests of spices, condiments (Black paper, turmeric and ginger) and stored grain and their symptoms of damage
7	Acquaintance with useful insects: Predators, Parasitoids, Pollinators Acquaintance with useful insects: Honey bees, Silkworms and Lac insects
8	Acquaintance with various pesticidal formulations
9	Principles and working of common plant protection appliances Calculation for preparing spray material
10	Acquaintance to plant pathology laboratory equipment.
11	Preparation of culture media for fungi and bacteria.
12	Demonstration of Koch's postulates for major plant pathogens.
13	Diagnosis and identification of important diseases of cereals, oilseeds and pulses and their characteristic symptoms
14	Diagnosis and identification of important diseases of cotton and sugarcane and their characteristic symptoms.
15	Diagnosis and identification of important diseases of fruit and vegetable crops and their characteristic symptoms.
16	Study of different groups of fungicides and antibiotics and methods of their laboratory evaluation.

Text Books:

1. Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
2. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.
3. Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches*. Kalyani Publ., New Delhi.
4. Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management*. Kalyani Publ., New Delhi.
5. Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
6. David BV & Ramamurthy VV. 2011. *Essentials of Economic Entomology*. Namrutha Publ., Chennai.

Text Book of Plant Pathology

1. Schumann G.L. & Darcy C. 2009.. Essential Plant Pathology, APS Press, USA.
2. Agrios GN. 2005. Plant Pathology. 5th Edition. Elsevier Academic Press Publication.
3. Singh RS 2010. Introduction to Principles of Plant Pathology, 4th ed.. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Mehrotra RS & Agrawal A. 2003. Plant Pathology. 2nd ed. McGraw Hill Education (India) Private Limited, New Delhi.

Course No : **AS 234** Course Title : **Livestock Product Technology**
 Credit : 3 (2+1) Semester : **III**

Theory

UNIT I

Composition and nutritive value of milk and factors effecting composition of milk; Physiochemical properties of milk; Determination of microbial load in milk and milk products; Milk Processing: Collection, chilling, standardization, pasteurization and homogenization; Toxins and pesticide residues in milk and milk products; Organic milk food products; Bureau of Indian Standards for milk and milk products; Sanitation in milk plant.

UNIT II

Retrospect and prospects of meat industry in India; Structure and composition of muscle (including poultry), nutritive value of meat, Meat adulteration, preservation of meat, Physico – chemical and microbiological quality of meat and meat products. Laws governing national, international trade in meat and meat products, organic meat food products, food products of genetically modified animals.

Practical

Sampling of milk, estimation of fat, solids not fat (SNF) and total solids, Platform tests, cream separation, Microbiological quality of milk, meat and meat products. Chilling/freezing of meat, meat products, preservation of meat and meat products. Visit to modern milk and meat processing units.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	Composition of milk- Constituents of milk, Livestock species wise distribution of fat, protein, lactose, ash, total solids in milk.	7
2	Nutritive value of milk: Contribution of milk to nutrient intake (% total), Nutrients in Milk -Vitamins and minerals (B Vitamins, Calcium, Iodine, Phosphorus, Potassium), Macronutrients (Protein, Carbohydrate, Fat)	7
3	Factors effecting composition of milk: Factors Affecting Milk Fat Content Breed/Genetics, Environment/Management, Health/Physiology, Nutrition	10
4	Factors Affecting Milk Protein Content Breed/Genetics, Environment/Management, Health/Physiology, Nutrition	
5	Factors Affecting Milk Mineral Content Breed/Genetics, Environment/Management, Health/Physiology, -Nutrition	
6	Physiochemical properties of milk: Acid–Base Equilibria, The pH and Buffering properties of Milk, Titratable Acidity, Oxidation–Reduction Equilibria, Surface and	5

	Interfacial Tension, Light Absorption and Scattering, Refractive Index, Freezing Point, Density, Newtonian Behaviour, Non-Newtonian Behaviour in Milks and Creams, Effects of Technological Treatments on the Viscosity of Milk	
7	Determination of microbial load in milk and milk products: -Direct Microscopic Count (DMC) Method -The Standard Plate Count (SPC) of raw milk - The Preliminary Incubation Count (PI) - The Lab Pasteurized Count (LPC) - The Coliform Count (Coli Count)	3
8	Dye Reduction Test:- -Methylene Blue Reduction (MBR) Test -Resazurin Reduction (RR) Test -Coliform Test -Yeast and Mould Count	2
9	Milk Processing: Collection: (Collection from small producers, Bulk collection) Chilling,	3
10	Standardization, Pasteurization and Homogenization	4
11-12	Toxins and pesticide residues in milk and milk products: Toxins residues in milk	5
	Pesticide residues in milk & milk products	
13-14	Toxins residues in milk	4
	Pesticide residues in milk products	
15-16	Organic milk food products:	5
17-18	Bureau of Indian Standards for milk and milk products: Food Safety Standard Authority of India e.g. BIS, FSSAI, HACCP (Law, regulation, provision, Licencing etc.) Sanitation in milk plant:	8
19-21	Retrospect and prospects of meat industry in India: Present status of meat industry in Maharashtra and India	4
22-23	Structure and composition of muscle (including poultry)	6
24-25	Nutritive value of meat, Meat adulteration, Preservation of meat	7
26-27	Physico – chemical and microbiological quality of meat and meat products.	5
28-29	Laws governing national, international trade in meat and meat products,	5
30-31	Organic meat food products-	5
32	Food products of genetically modified animals-	5
	Total:	100

Practical Exercise

Exercise No.	Name of the Title
1	Sampling of milk,
2	Platform tests of milk
3	Determination of acidity in milk
4	Determination of specific gravity of milk
5	Determination of fat in milk
6	Determination of total solids in milk by Gravimetric method
7	Estimation of protein in milk
8	Standardization of milk.
9	Bacteriological examination of milk.
10	Bacteriological examination of meat.
11	Bacteriological examination of meat products.
12	Chilling/freezing of meat, meat products.
13	Preservation of meat and meat products.
14	Detection of adulterants, preservatives and neutralizers in milk.
15	Detection of preservatives and neutralizers in milk.
16	Visit to modern milk and meat processing units.

Text Books:

1. Aberle ED, Forrest JC, Gerrard DE & Mills EW. 2012. Principles of Meat Science. 5th Eds. Kendall Hunt Publishing.
2. Ledward DA & Lawrie RA. 2006. Lawrie's Meat Science, 7th Eds. Woodhead Publishing.
3. Sharma BD. 1999. Meat and Meat Products Technology: Including Poultry Products Technology. Jaypee Bros. Medical Publishers.

Reference Books:

1. Sukumar De. 2001. Outlines of Dairy Technology. Oxford University Press.
2. Varnam A & Sutherland JP. 2001. Milk and Milk Products: Technology, Chemistry and Microbiology. Springer Science & Business Media.

Course No : **MATH-233**
Credits : **3(2+1)**

Course Title : **Biomathematics**
Semester : **III**

Theory

UNIT-I

Rolle's theorem; Lagrange's theorem; Taylor's and Maclaurin's series; Functions of two or more independent variables, Partial differentiation, Euler's theorem on homogeneous function, change of variable; Jacobian, maxima and minima of two or more than two variables eigen values and eigen vectors of a matrix; Reduction formulae, definite integrals and its applications.

UNIT-II

Solution of ordinary differential equation of first degree and first order and their application for determination of volume of blood and drug distribution; Epidemic models, Simultaneous differential equation of first order and their applications to predator models; Linear differential equations of higher order and their applications to simple biological problem; Numerical methods for solving algebraic and transcendental equations.

Practical

Taylor's and Maclaurin's expansions; Partial differentiation; Euler's theorem; Change of variable, total derivative, implicit function, maxima and minima, eigen values and eigen vectors of matrix, reduction formulae, definite integrals and their properties; Epidemic models, predator models; Determination of volume of blood and drug distribution; Ordinary differential equation of first order, linear differential equation of higher order and their applications to biological problems, numerical methods.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
Differential Calculus		
1	Rolle's theorem.	3
2	Lagrange's theorem	3
3	Taylor's series	3
4	Maclaurin's series	3
5	Functions of two or more independent variables	3
6	Partial differentiation	3
7	Partial derivatives of higher orders.	3
8	Homogeneous function	3
9	Euler's theorem on homogeneous function	3
10	Change of variable	4
Matrices		
11	Characteristic Equation of a matrix	3

12	Repeated and non repeated Eigen values of a matrix	3
13	Eigen vectors of a matrix	3
Integral Calculus		
14	Reduction formulae	3
15	Definite integrals	3
16	Examples on definite integrals.	3
Differential Calculus		
17	Definition, order and degree of differential equation	3
18	Equations of first order and first degree	3
19	Solution of ordinary differential equation of first order and first degree	3
20	Variable separable method	3
21	Linear differential equation	3
22	Equations reducible to Linear differential equation	3
23	Exact differential equation	3
24	Simultaneous differential equation of first order	3
25	Solution of Simultaneous differential equation of first order	3
26	Linear differential equations of higher order	4
Numerical Methods		
27	Introduction, Definition of algebraic and transcendental equations with examples.	4
28	Solution of the equations graphically	4
29	Bisection method	3
30	Newton Raphson method or successive substitution method.	3
31	Rule of false position (Regula falsi)	3
32	Iteration method	3
Total:		100

Practical Exercise

Exercise No.	Title
1	Applications of Rolles theorem
2	Applications of Lagranges theorem
3	Applications of Taylor's series
4	Applications of Maclaurin's series
5	Applications of Partial differentiation
6	Euler's theorem
7	Application: Jacobian
8	Maxima and Minima
9	Applications of Eigen values and Eigen vectors
10	Applications of Integrations

11	Applications of ordinary differential equation of first order and first degree and their application for determination of volume of blood and drug distribution.
12	Linear differential equations of higher order and their applications to simple biological problem
13	Simultaneous differential equation of first order.
14	Simultaneous differential equation of first order and their applications to predator models
15	Numerical methods for solving algebraic equations.
16	Numerical methods for solving transcendental equations.

Text Books

- 1) Grewal BS. 2015. Higher Engineering Mathematics. 43rd Ed. Khanna Publishers Delhi.
- 2) Rastogi SK. 2008. Biomathematics. Krishna Prakashan Media Pvt. Ltd.

Reference Books

- 1) Srivastava AC & Srivastava PK. 2011. Engineering Mathematics.Vol.I . PHI Learning Pvt. Ltd.
- 2) Srivastava AC & Srivastava PK. 2011. Engineering Mathematics.Vol.III . PHI Learning Pvt. Ltd.

Course No : **PB-232**
Credits : **3(2+1)**

Course Title : **Breeding of Field Crops**
Semester : **III**

Theory

Unit I

Application of genetic, cytogenetic and biotechnological techniques in breeding of: Wheat, triticale, rice, maize, bajra, barley, sorghum, cotton, sugarcane, important pulses, oilseeds and forage crops including their origin and germplasm sources.

Unit II

Problems and present status of crop improvement in India with emphasis on the work done in state National and International centres of crop improvement.

Unit III

Classes of seed; seed production and maintenance; seed storage; seed certification.

Practical

Emasculation and hybridization techniques; Handling of segregating generations : pedigree method, bulk method, back cross methods; Field layout of experiments; Field trials, maintenance of records and registers; Estimation of heterosis and inbreeding depression; Estimation of heritability; Parentage of released varieties/hybrids; Study of quality characters; Sources of donors for different characters; seed sampling; seed quality; seed viability; seed vigour; seed health testing; Visit to seed production plots.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1-2	Wheat: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
3	Triticale: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
4-5	Rice: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
6-7	Maize: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
8	Bajra: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
9	Barley: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
10-11	Sorghum: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
12-13	Cotton: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
14	Sugarcane: Centers of origin, Distribution of species, wild relatives,	3

	application of genetic, cytogenetics and biotechnological techniques in breeding	
15	Chickpea: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
16	Pigeonpea: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
17	Green gram and Black gram: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
18	Groundnut: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
19	Soybean: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
20	Sunflower: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
21	Safflower: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
22	Linseed: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
23	Napier Grass: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
24	Berseem: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding:	3
25	Lucern: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding:	3
UNIT II		
26-27	Problems and present status of crop important in India. Work done in State, National and International centers of crop improvement	6
UNIT III		
28	Classes of seed : Nucleous, Breeder Foundation and Certified seed	3
29	General principles of seed production (Agronomic and Genetic)	5
30	Seed storage: General principles of storage and factors affecting seed longevity during storage	5
31-32	Seed certification, phases of certification, procedure for seed certification, field inspection.	6
Total :		100

Practical Exercise

Exercise No.	Title
1.	Study of emasculation and hybridization techniques
2.	Handling of segregating generation by pedigree method
3	Handling of segregating generation bulk method
4	Handling of segregating generation by back cross method
5	Layout of the field experimente
6	Field trials, maintenance of record and registers
7	Estimation of heterosis and inbreeding depression
8	Estimation of heritability
9	Parentages of released hybrid/verities
10	Study of quality characters
11	Sources of donors for different characters
12	Seed Sampling and testing procedure
13	Seed viability test
14.	Seed and Seedling vigour test
15	Seed health testing
16	Visit to seed production plot

Text Books:

1. Hari Har Ram. 2011. Crop Breeding and Biotechnology. Kalyani Pub. New Delhi.
2. Poehlman JM and Borthakur D. 1969. Breeding Asian Field crops: with special Reference to Crops of India. Oxford and IBH Pub. Co.
3. Singh BD. 2015. Plant Breeding Principle and Methods. Kalyani Pub. New Delhi.

Reference Books:

1. Chahal GS and Gosal SS. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approach. Narosa Publishers House. New Delhi.

Course No. : **AS 235**
Credits : 3 (2+1)

Course Title : **Animal Health Care**
Semester : **III**

Theory

UNIT I

Introduction to animal health; history of disease diagnosis and medicine; classification of diseases; Introduction to fore stomach disorders in ruminants.

UNIT II

Introduction to important diseases of respiratory, urinary, musculoskeletal and cardiovascular system of domestic animals. Introduction to common metabolic, bacterial, viral, parasitic and blood protozoan diseases of domestic animals. Importance of animal health in relation to public health.

Practical

Introduction to veterinary hospital; methods of sample collection; introduction to common disease diagnostic tests in animals; vaccination schedule in domestic animals. Microscopic examination of parasites. Clinical diagnostics: urine, blood, milk, sputum, faeces examination.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
UNIT – I		
1	Introduction to animal health	2
2	History of disease diagnosis and medicine	3
3	Classification of diseases	4
4-6	Introduction to fore stomach disorders in ruminants -Simple indigestion, Rumen impaction in sheep, Indigestion in calves fed milk replacers, ruminal lactic acidosis, rumen overload, Ruminal parakeratosis, tympany, Traumatic reticuloperitonitis, Vagus indigestion, Diaphragmatic hernia, Traumatic pericarditis, Traumatic splenitis and hepatitis, Impaction of the omasum, etc.	8
UNIT – II		
7-9	Respiratory diseases of animals - Diseases of the lungs- Pulmonary congestion and edema, Pulmonary hypertension, Atelectasis, Acute respiratory distress syndrome, Pulmonary hemorrhage, Pulmonary emphysema, Pneumonia- Aspiration, embolic, thrombosis, pulmonary, neoplasms, etc. Diseases of the pleura and Diaphragm- Hydrothorax and hemothorax, Pneumothorax, Diaphragmatic hernia, thump in horses, Pleuritis (pleurisy), Equine pleuropneumonia, etc. Diseases of the upper respiratory tract.	10
10-12	Urinary diseases of animals - diseases of the kidney, bladder	8

	ureters and urethra, Congenital defects of the urinary tract, etc.	
13-14	Musculoskeletal diseases of animals- Diseases of muscles, bones and joints. Congenital defects of muscles, bones, and joints, etc	5
15-16	Cardiovascular system of domestic animals and diseases- Arrhythmias, Diseases of the heart, pericardium, cardiac neoplasia, Diseases of the blood vessels, etc.	8
17-18	Common metabolic diseases of domestic animals- milk fever, Downer cow syndrome, Acute hypokalemia in cattle, Transit recumbency of ruminants, Lactation tetany of mares, Hypomagnesia tetany of animals and calves, Ketosis, acetonemia, Pregnancy toxemia in sheep, Fatty liver in cattle, Equine hyperlipemia, Steatitis, Neonatal hypoglycaemia, Postparturient hemoglobinuria, Rhabdomyolysis of horses, myonecrosis and myoglobinuria in horses, equine Cushing's disease, Disorders of thyroid function.	10
19-22	Common bacterial diseases of domestic animals- Diseases associated with Streptococcus, staphylococcus spp., Corynebacterium, Listeria, Erysipelothrix, Bacillus spp. Diseases associated with Clostridium spp. Diseases associated with Salmonella, Pasteurella, Brucella, Moraxella species, etc. Diseases associated with Fusobacterium and Bacteroides spp, Pseudomonas, Burkholderia spp, Campylobacter spp, Leptospira Borrelia spp. Mycoplasma spp.	12
23-26	Common viral diseases of domestic animals- Viral diseases with involvement of whole body; viral diseases affecting and showing signs involving different systems, viz, alimentary tract, respiratory, nervous, skin, etc.	10
27-28	Common parasitic diseases of domestic animals- Diseases associated with nematodes, cestodes and trematodes Diseases associated with arthropods	8
29-31	Common blood protozoan diseases of domestic animals- Babesiosis, Coccidiosis, Sarcocystosis/ sarcosporidiosis, Neosporosis, Cryptosporidiosis, Giardiasis, Toxoplasmosis, Equine protozoal myeloencephalitis, Theilerioses, Diseases associated with Trypanosomes- trypanosomiasis, surra, dourine, etc.	12
32	Importance of animal health in relation to public health	
Total		100

Practical Exercise

Exercise No.	Title
1	Introduction to veterinary hospital
2	Methods of sample collection
3-5	Introduction to common disease diagnostic tests in animals
6-8	Vaccination schedule in domestic animals
9-10	Microscopic examination of parasites
11-12	Clinical diagnostics: urine for disease diagnosis
13-14	Clinical examination of blood and milk for animal disease diagnosis
15	Clinical examination of Sputum and nasal secretions for respiratory infections
16	Faecal examination for diagnosis of parasitic diseases

Text Books:

1. Blood DC & Henderson JA. 1968. *Veterinary Medicine*. Bailliere Tindall publishers.
2. Chakrabarti A. 2007. *Textbook of Clinical Veterinary Medicine*. Kalyani Publishers.

Reference Books:

1. Bradford P & Smith DVM. 2014. *Large Animal Internal Medicine*. 5th ed. Mosby Publishers.
2. Stephen J, Ettinger DVM, Edward C & Feldman DVM. 2010. *Textbook of Veterinary Internal Medicine Expert Consult*. 7th ed. Saunders Publishers.

Course No. : NSS 233
Credits : 1 (0+1)

Course Title : National Service Scheme III
Semester : III

Syllabus:

Vocational skill development

To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

Issues related environment

Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

Disaster management

Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.

Entrepreneurship development

Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production oriented project

Planning, implementation, management and impact assessment of project

Documentation and data reporting

Collection and analysis of data, documentation and dissemination of project reports

Practical Exercises

Exercise No.	Topic	Weightages (%)
1.	<u>Vocational skill development</u> To enhance the employment potential and to set up small business enterprises skills of volunteers,	6
2.	<u>Vocational skill development</u> A list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities.	6
3.	<u>Vocational skill development</u> Each volunteer will have the option to select two skill-areas out of this list	6
4.	<u>Issues related environment</u> Environmental conservation, enrichment and sustainability,	6
5.	<u>Issues related environment</u> Climatic change, natural resource management (rain water harvesting, energy conservation, forestation,	6
6.	<u>Issues related environment</u> waste management	7
7.	<u>Issues related environment</u> waste land development and soil conservations)	7
8.	<u>Disaster management</u> Introduction and classification of disaster, rehabilitation	7

9.	<u>Disaster management</u> Management after disaster;	7
10.	<u>Disaster management</u> role of NSS volunteers in disaster management.	6
11.	<u>Entrepreneurship development</u> Definition, meaning and quality of entrepreneur;	6
12.	<u>Entrepreneurship development</u> Steps in opening of an enterprise and role of financial and support service institution.	6
13.	<u>Formulation of production oriented project</u> Planning, implementation,	6
14.	<u>Formulation of production oriented project</u> Management and impact assessment of project	6
15.	<u>Documentation and data reporting</u> Collection and analysis of data,	6
16.	<u>Documentation and data reporting</u> documentation and dissemination of project reports	6
Total		100

SEMESTER-IV

Theory

Entrepreneurship Development and Business Communication

Entrepreneur- Meaning and definition of Entrepreneur, Characteristics of entrepreneurs; Entrepreneurship Development- Concept and process of entrepreneurship development; Achievement motivation and entrepreneurship development, Government policy and programs and institutions for entrepreneurship development, SWOT Analysis, Marketing Management for Agri Business-Agricultural Marketing, meaning and the objectives of marketing & marketing Management, market promotion techniques, Rural Marketing- The meaning and the objectives of rural marketing, Characteristics of rural markets, Procurement- Procurement Objective, Importance of Procurement, Constraints of Procurement- Agricultural commodities, Types of Purchasing, Supply chain management and Total quality management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise, Developing different skills for entrepreneurship-Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Writing skill- Business letter, letters of enquiry, quotation, orders and tenders, complaint letter and success story

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1-2	Entrepreneur- Meaning and definition of Entrepreneur, Characteristics of entrepreneurs; Entrepreneurship Development- Concept and process of entrepreneurship development	12
3-4	Achievement motivation and entrepreneurship development Entrepreneurship development programmes- concept and objectives	10
5	Government policies, programmes and institutions for entrepreneurship development	06
6	SWOT Analysis: Generation, incubation and commercialization of ideas and innovations Entrepreneurial behaviour – Concept, dimensions, factors affecting entrepreneurial behaviour	06
7-8	Marketing Management for Agri Business- Agricultural Marketing,	14

	meaning and the objectives of marketing & marketing Management, market promotion techniques. Opportunities and challenges in Agribusiness. Communication. Good communication qualities of successful entrepreneur and effective treatment of message for successful business communication Advertisements – Meaning, types, forms, functions	
9	Rural Marketing- The meaning and the objectives of rural marketing, Characteristics of rural markets	08
10- 11	Procurement- Procurement Objective, Importance of Procurement, Constraints of Procurement- Agricultural commodities, Types of Purchasing, Supply chain management, Time management and Total quality management	12
12- 13	Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise	12
14- 15	Developing different skills for entrepreneurship- Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill	12
16	Writing skill- Business letter, letters of enquiry, quotation, orders and tenders, complaint letter and success story	8
Total:		100

Practical Exercise

Exercise No.	Title
1.	Assessing entrepreneur potential
2.	Assessment of problem solving ability
3.	Exercises in creativity
4.	Conducting market survey to know the demands for different products
5.	Preparing advertisements for popularization of products and news writing
6.	Time audit through planning
7.	Identification and selection of business idea
8.	Preparation of business plan and proposal writing
9.	Conduct of SWOT analysis
10.	Group discussion and debates on current topics
11.	Meetings – Purpose, procedure, participation, chairmanship, physical arrangements, recording and writing of minutes of meeting
12.	Writing skills- Write Business letter, letters of enquiry, quotation, orders and tenders, complaint letter and success story
13.	Visit to agribased industries
14.	Visit to District Small Scale Industry Development Corporation office
15.	Visit to entrepreneurship development institute
16.	Visit to entrepreneurs /case study of successful entrepreneurs (project report)

Reference Books:

1. Akhouri MMP, Mishra SP and Sengupta R. 1989. Trainers Manual on Developing Entrepreneurial Motivation. NIESBUD, New Delhi.
2. Betty GB. 1979. Entrepreneurship, Playing to Win. Taraporewala, Mumbai

3. Entrepreneurship Development Institute in India. 1987. Developing New Entrepreneurs, EDII, Ahmedabad, NISIET, Library : 338.93/EDI/87/25104.
4. Mancuso J. 1974. The Entrepreneurs Handbook, Vol.I& II, Artech House Inc. USA.
5. Patel VG. 1987. Entrepreneurship Development in India and its relevant Developing Countries, Entrepreneurship Development Institute of India. Ahmedabad, NISIET, Library : 338.93 (540)/PAT/87/25103.
6. Singh AK, Singh LR and Berman R.2006. Dimensions of Agricultural Extension. Aman Publishing House, Meerut.
7. Mondal S. and Ray GL. 2009. Text Book of Entrepreneurship and Rural Development. Kalyani Publishers, Ludhiana. ISBN 978-81-272-5599-2
8. Mohanty SK. 2009. Fundamentals of Entrepreneurship. Prentice Hall of India Pvt. Ltd. New Delhi.
9. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publications. New Delhi.
10. Desai V. 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House, New Delhi.
11. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
12. Nandan H. 2011. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.
13. Chole RR. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur.
14. Singh AK. 2009. Entrepreneurship Development and Management. Lakshmi Publications Ltd.
15. Ray GL. 2005. Extension Communication and Management. Kalyani Publication. New Delhi.
16. Chole R.R., Kapse P.S. and Deshmukh P.R. (2012)Entrepreneurship Development and Communication Skills Scientific Publishers, Jodhpur

Course No : **BIOCHEM-241** Course Title : **General Biochemistry**
 Credits : **4(3+1)** Semester : **IV**

Theory

UNIT I

Introduction and importance; Cell structure; Bio molecules: Carbohydrates, lipids, proteins and nucleic acids-structure, functions and properties; Enzymes: Classification, factors affecting activity; Structure and role of water in biological system; Acids, bases and buffers of living systems; The pK of biomolecules; Vitamins and hormones.

UNIT II

Bioenergetics; Metabolism-basic concept: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation; General reactions of amino acid degradation; Biosynthesis - carbohydrates, lipids, proteins, nucleic acids.

UNIT III

Secondary metabolites: Terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids; Extraction and characterization of lipids by TLC; Determination of acid, iodine and saponification values of oil; Extraction, quantitative estimation and separation of sugars by paper chromatography; Determination of phenols; Determination of free amino acids and proteins.

Teaching Schedule- Theory with weightage (%)

No. of lectures	Topics	Weightage (%)
1	Scope and importance of biochemistry	2
2	Cell structure: plant cell, animal cell different organelles structure function.	4
3	Structure of water, acid-base concept	4
4	Buffer and pH, hydrogen bonding, hydrophobic, electrostatic and van der Waals forces	3
5-7	Bioenergetics: Fundamentals of thermodynamic principles applicable to biological processes, bioenergetics.	4
8-10	Bio molecules: Classification, structure and functions of carbohydrates	6
11-12	Classification, structure and functions of lipids	5
13-14	Classification, structure and functions of amino acids and proteins	5
15-16	Nucleic acids-structure, functions and properties	5
17-18	Enzymes: Classification, factors affecting enzyme activity: Substrate concentration, enzyme concentration, temperature and	5
19-20	Mechanism of enzyme action : Ribonuclease A, chymotrypsin, lysozyme	4
21	Structure, biological functions and classification of vitamins	3
22	Hormones: animals, plants and insects	4
23-26	Metabolism - basic concept, catabolism, anabolism. Metabolism of carbohydrates- glycolysis, TCA cycle, pentose phosphate pathway, glyoxylate cycle.Fatty acid oxidation.	12

27	Electron transport chain and oxidative phosphorylation	3
28-29	Classification, structure and functions of lipids Metabolism of lipids	4
30-31	Classification, structure and functions of amino acids and proteins. Metabolism of proteins	3
32-33	Metabolism of nucleic acids	3
34-35	General reactions of amino acid degradation	4
36-37	Secondary metabolites role and classification	4
38-39	Terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.	4
40-42	Recombinant DNA technology	3
43-45	Secondary metabolites: Terpenoids	4
46-48	Alkaloids, phenolics their applications in food and pharmaceutical industries.	2
Total:		100

Practical Exercise

Exercise No.	Title
1.	Preparation of standard solutions and buffers
2.	Qualitative tests for carbohydrates
3	Qualitative tests for amino acids and proteins
4	Extraction of oil from oil seeds by Soxhlet method
5.	Determination of acid and saponification value of oil
6.	Determination of iodine value of oil.
7.	Estimation of free amino acids by ninhydrin method
8.	Estimation of protein by Folin- Lowry method
9.	Quantitative estimation of total and reducing sugars by Nelson-Somogyi method
11-12	Separation of amino acids and sugars by paper chromatography
13.	Estimation of total phenol content
14.	Estimation of ascorbic acid from fruits
15.	Isolation of DNA from plant tissue
16.	DNA quantification

Text Books:

- 1 Bhatia SC. 1984. Biochemistry in Agricultural Sciences. Shree Publication House, New Delhi.
- 2 Purohit SS. 2009. Biochemistry - Fundamentals and Applications. Agrobios, Jodhpur.
- 3 Singh M. 2011. A Textbook of Biochemistry. Dominant Publishers & Distributors, New Delhi.
- 4 Veerkumari L. 2007. Biochemistry. MIP Publishers, Chennai.
- 5 Jain JL, Jain S and Jain N. 2005. Fundamentals of Biochemistry. S. Chand & Company Ltd. New Delhi.
- 6 Rastogi SC. 2003. Biochemistry. Tata McGraw-Hill Education, New Delhi.
- 7 Rama Rao AVSS. 2002. A Textbook of Biochemistry. 9th Ed. Illustrated Publisher, Sangam Books Limited, New Delhi.

Reference Books: (Theory):

- 1 Conn EE and Stumpf PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.
- 2 Voet D and Voet JG. 2011. Biochemistry. 4th Ed. John Wiley and Sons, Inc. NY, USA.
- 3 Goodwin TW and Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. Pergaman Press.
- 4 Nelson DL and Cox MM. 2012. Lehninger's Principles of Biochemisry, 6th Ed . Macmillan Learning, NY, USA.
- 5 Berg JM, Tymoczko JL, Stryer L and Gatto GJ. 2002. Biochemistry, 7th Ed. W.H. Freeman and Company, NY, USA
- 6 Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Estern Ltd. New Delhi.
- 7 Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
- 8 Nath RL. 1990. Practical Biochemistry in Clinical Medicine. Academic Pub.
- 9 Sen AR, Pramanik NK and Roy SK. 2001. A treatise on Analysis of Food, Fats and Oils. Oil Technologists Association of India (EZ) Kolkata.
- 10 Sadasivam S and Manickam A. 1996. Biochemical Methods. 2nd ed. New Age International (P) Ltd. Publisher, New Delhi.

Course No : **BT-247**
Credits : **3(2+1)**

Course Title : **Introductory Bioinformatics**
Semester : **IV**

Theory

UNIT I

Introduction to bioinformatics; Development and scope of bioinformatics; Applications of computers in bioinformatics: Operating systems, hardware, software, Internet, www resources, FTP.

UNIT II

Primary databases: Nucleotide sequence databases (GenBank, EMBL), protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam;

Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.

UNIT III

Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment, concept of local and global alignment; Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman); Tools of MSA: ClustalW, TCOffee; Phylogeny; Introduction to BLAST and FASTA.

Practical

Basic computing: Introduction to UNIX, LINUX; Nucleotide information resource: EMBL, GenBank, DDBJ, Unigene; Protein information resource: SwissProt, TrEMBL, Uniprot; Structure databases: PDB, MMDB; Search Engines: Entrez, ARSA, SRS; Similarity Searching: BLAST and interpreting results; Multiple sequence alignment: ClustalW; Structure visualization of DNA and proteins using Rasmol.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1	Introduction to bioinformatics; Definition, History	2
2	Development and scope of bioinformatics	3
3-4	Applications of computers in bioinformatics	5
5	Operating systems	2
6-7	Hardware, Software	3
8-9	Internet, www resources, FTP	5
UNIT II		
10- 12	Biological Databases and their classification; Primary databases: Nucleotide sequence databases (GenBank, EMBL)	10
13-14	Protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam;	10
15-16	Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH	5
17	Structure databases: Retrieving information from these databases.	5
18-19	File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.	10

UNIT III		
20-21	Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment,	6
22	Concept of local and global alignment	6
23- 25	Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman) application of these algorithms in different biological problems.	10
26-27	Tools of MSA: ClustalW, TCoffee; Use of these tools for MSA of DNA and protein sequences. Save output file in phylip format.	
28-30	Phylogeny; terminologies in phylogeny, applications, and methods of phylogenetic analysis	10
31-32	Introduction to BLAST and FASTA. Different BLAST Programmes: their application in terms of nucleic acid and protein sequence. Significance of E Value.	08
Total:		100

Practical Exercise

Exercise No.	Title
01	To learn Basics computer operating System
02	To study UNIX, LINUX operating systems
03	To study the Primary nucleotide database : EMBL, GenBank, DDBJ
04	To study the protein primary database : Unigene; Protein information resource: SwissProt, TrEMBL
05	To study the protein secondary databases : Uniprot, CATCH, SCOP
06	To study the protein Structural databases: PDB, MMDB
07	To study the information retrieval System using search engines : Entrez, ARSA, SRS;
08	Blast analysis of unknown nucleotide sequence
09	Blast analysis of unknown protein sequence
10	Multiple Sequence alignment using ClustalW
11	Prediction of primary structure of protein : Translation
12	Prediction of primary structure of protein (amino-acid and atomic compositions, pI, extinction coefficient, etc.)
13	Secondary structure prediction of protein sequence using APSSP: Advanced Protein Secondary Structure Prediction Server
14	Secondary structure prediction of protein sequence Ramachandran Plot
15	Tertiary structure prediction of protein sequence using Cn3D and swissPDB viewer
16	Molecular visualization of protein structures

Text Books:

1. Baxevanis AD & Ouellette BFF.2001.Bioinformatics: A practical guide to the analysis of genes and proteins.John Wiley and Sons.
2. Mount DW. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.
3. Xiong J.2006. Essential Bioinformatics.Cambridge University Press.

Course No : **BT-248** Course Title : **Plant Genetic Transformation**
 Credits : **3(2+1)** Semester : **IV**

Theory

UNIT I

History of plant genetic transformation; Generation of gene construct and maintenance; Genetic transformation: *Agrobacterium* mediated, biolistic, electroporation, liposome, Polyethylene glycol, *in planta* methods.

UNIT II

Selection and characterization of transgenic plants using selectable and reportable markers; PCR; qRT-PCR; Southern, Northern, ELISA and Western techniques; Application of genetic transformation: for quality, yield, biotic, and abiotic stresses; Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions, Preparation of competent cells of *Agrobacterium tumefaciens*; Restriction mapping of plasmid, Construction of binary vector and its transfer to an *Agrobacterium* strain; Confirmation of transformed bacterial colonies; *Agrobacterium tumefaciens* mediated and biolistic plant transformation; Colony hybridization.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1-3	History of plant genetic transformation:- History, Major Discoveries Definition and applications.	7
4	Generation of gene construct : Selection/ isolation/Identification of interest,	5
5	Methodology, competent cell preparation, Different Vectors used, Enzymes required, Purification , confirmation of construct	8
6	Maintenance:- Bacterial transformation	4
7	Culture maintenance method	2
8-9	<i>Agrobacterium</i> mediated Genetic transformation: Introduction, Principle, Methodology and Application	7
10	Genetic transformation using biolistic gun and electroporation: Introduction, Principle, Methodology and Application	5
11	Genetic transformation using liposome, Polyethylene glycol: Introduction, Principle, Methodology and Application	2
12	<i>In planta</i> transformation methods : Methodology	2
13	Genetic transformation in Maize: Introduction, Principle, Methodology and Application	2
14	Genetic transformation in Brinjal etc. Introduction, Principle, Methodology and Application	2
UNIT II		
15	Selection and characterization of transgenic plants using selectable	5

	and reportable markers:- Introduction and Definition	
16-18	Different markers used for characterization, Methodology, Applications	8
19	PCR; Introduction, Instrumentation, Principle and application.	5
20-22	qRT-PCR :- Introduction and Principle, Instrumentation, Application	8
23	Southern Hybridisation: Introduction, Instrumentation, Principle and application	3
24	Northern Hybridisation: Introduction, Instrumentation, Principle and application	3
25	ELISA: Introduction, Instrumentation, Principle and application	3
26	Western Hybridisation: Introduction, Instrumentation, Principle and application	3
27	Application of genetic transformation: for quality improvement,:	4
28-29	Application of genetic transformation: biotic, and abiotic stresses	3
30	Biosafety aspects of transgenic plants and regulatory framework :- Definition, Environmental safety.	3
31	Food safety to human and animal health, Risk Management, Biosafety Framework, Hazzard, Biosafety levels, containment.	3
32	EPA Act 1986, 1989 Rule , Recombinant DNA guidelines, Implementing agency, statutory Bodies, Grant of approvals, penalties etc.	3
Total		100

Practical Exercise

Exercise No.	Title
1	Preparation of stock solutions, CTAB, EDTA, EtBr, TAE, TBE, Tris HCL Loading dye, LB Medium/ broth etc.
2	Preparation of competent cells of <i>Agrobacterium tumefaciens</i>; protocol, <i>Agrobacterium</i> competent cell preparation
3-5	Restriction mapping of plasmid, Digestion of plasmid DNA with different restriction enzyme and visualization of bands on gel by electrophoresis.
6-8	Construction of binary vector and its transfer to an <i>Agrobacterium</i> strain; ligation by using ligase enzyme and transformation to <i>Agrobacterium</i> .
9-11	Confirmation of transformed bacterial colonies; PCR, Selective marker and scorable marker, Hybridization methods etc.
12	<i>Agrobacterium tumefaciens</i> mediated transformation of plants
13	Biolistic gene gun method of plant transformation
14	Confirmation of transformed plantlets
15-16	Colony hybridization. Probe based detection

Text Books:

1. Grierson D. 2012. Plant Genetic Engineering. Springer Netherlands.
2. Primose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing.
3. Sambrook J and Russel D. 2001. Molecular Cloning: A Laboratory Manual. 3rd Ed Cold Spring Harbor Laboratory Press.

Reference Books:

1. Green MR & Sambrook J. 2014. Molecular Cloning: A Laboratory Manual. 4th Ed. 3 Vol Sets. Cold Spring Harbor Laboratory Press.
2. Stewart NC Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc.

Course No: **BT/ECE-241** Course Title : **Fundamentals of Electronics & Instrumentation in Biotechnology**
 Credits : **2(1+1)** Semester : **IV**

Theory:

UNIT I

Electronics PN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltage multiplier circuit; Construction and working of bipolar transistor, load line concept, analysis and design of various biasing methods of NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor with common emitter configuration; Concept of generalized instrumentation system; Transducers for the measurement of temperature using thermometer and thermocouple, linear displacement measurement using LVDT; Force measurement using the strain gauge.

UNIT II

Principles and working of laboratory equipments: Table top, refrigerated and ultra centrifuges; Laminar air flow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers; Gel electrophoresis, 2-D gel electrophoresis, gel documentation, gel driers; ELISA readers; Freeze driers/lyophilizers; Spectrophotometers; Gene pulser; Particle gun; Plant growth chambers; Thermal cyclers; Realtime PCR; DNA synthesizer; DNA sequencer; Microscopes: Light, stereo, phase contrast and inverted.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1	PN Junction Diode: Introduction to Semiconductors, Junction Theory, Formation of Depletion Region, Junction Potential, Working Principle, Characteristics and Applications.	6
2	Diode as a Circuit Element: Symbol, Forward and Reverse Biasing of Diode, Voltage drop across Diode, Breakdown Voltage, Volt-Ampere (V-I) Characteristics of a Diode.	6
3	Diode Applications :- DC Power Supply, Rectification, Types of Rectifiers, Half Wave Rectifier (HWR), Full Wave Rectifier (FWR), Full Wave Bridge Rectifier, Performance Parameters of Rectifiers and Inter-comparison, Clippers, Clampers, Voltage Multipliers.	7
4	Bipolar Junction Transistor: Introduction, Construction, Types - NPN and PNP, Operation and Working Principle, Characteristics, Regions of Operation, Transistor Configurations (CE,CB,CC), Applications.	6
5	Load Line Concept: DC and AC Load Lines, Load Lines for Common Configurations (CE,CB,CC), Analysis of Load Lines.	6
6	Concept of Generalized Instrumentation System : Definition and concept	2

	Transducers :- Resistance Temperature Detector (RTD), Thermistor, Thermocouple, Comparison of common types of Temperature Transducers, Displacement Transducer – LVDT, Strain Gauge for Force Measurement.	4
7	PN Junction Diode: Introduction to Semiconductors, Junction Theory, Formation of Depletion Region, Junction Potential, Working Principle, Characteristics and Applications.	6
8	Diode as a Circuit Element: Symbol, Forward and Reverse Biasing of Diode, Voltage drop across Diode, Breakdown Voltage, Volt-Ampere (V-I) Characteristics of a Diode.	7
UNIT II		
	Principles and working of laboratory equipments:	
9	Table top, refrigerated and ultra centrifuges; Properties of dextop centrifuge Applications of table top centrifuge. Principles of working, Sedimentation. Ultra Centrifuge : Features, Speed and criteria of UF centrifuge. Resolution power. Process of UF. Parts of centrifuge.	6
10-11	Laminar air flow; Construction. Types of Laminar air flow; Vertical, Horizontal. Uses of LAF	5
	Autoclaves: Construction operation criteria for different materials.	3
	pH meter : Definition importance of maintaining pH for culturing microbes. working of pH meter. Calibration of pH meter.	5
12	Fermenters: Criteria for ideal fermentors. Types of bioreactors, construction of fermentors, Applications with examples.	2
	Temperature control shakers	2
	Gel electrophoresis: Factors affecting electrophoretic mobility, Types of gels, electrophoretic mobility in gels, principle, electrophoretic procedures, Detection recovery and estimation. Applications of gel electrophoresis	2
13-14	2-D gel electrophoresis: SDS Agarose, gel electrophoresis, native page, Principle and procedure. Iso-electric focusing. Applications of electrophoretic techniques in detection of different bio-molecules.	3
	gel documentation, gel driers	2
	ELISA readers : Definition, Use in drug discovery and bioassay validation. Use in biotechnological industry. Absorbance, fluorescence, Time resolved fluorescence, Luminescence.	4
	Freeze driers, BOD shakers , lyophilizers; Gene pulser; Particle gun; Plant growth chambers ,Thermal cyclers; Real time PCR; DNA synthesizer; DNA sequencer: Principle and methodology	4
15-16	Microscopes: Light: Principle, types of lenses construction applications, stereo ; Magnification, illumination differences to normal compound microscope. Phase contrast: Definition, Working principle, Diagrammatic representation. Applications. Inverted microscope : Construction Principle and biological applications: Fluorescence, Illumination etc.	6
	Spectrophotometers: Basic principles Instrumentation for UV visible, IR spectro-photometry. Application of UV visible spectro-photometry Qualitative and quantitative analysis of biomolecules.	6
Total :		100

Practical Exercise

Exercise No.	Title
1-2	To familiarize laboratory equipment and its equipment working; Forward and reverse VI Characteristics of a PN junction diode;
3-4	To study half wave, full wave and bridge rectifier using diode; Clipper, Clamper and Voltage multiplier circuit;
5-6	To determine input V-I Characteristics of bipolar transistor for common emitter configuration;
7-8	To determine output V-I Characteristics of bipolar transistor for common emitter configuration; -
9-10	To analyse a biasing circuits for CE transistor;
11-12	To design and test a biasing circuits for CE transistor;
13-14	To study the measure of temperature using the available sensor;
15-16	To measure displacement with the available sensor; To study force with the available sensor.

Text Books:

1. Gupta JB. 2009. Basic Electronics. SK Kataria & Sons.
2. Manhas P & Thakral S. 2010. Digital Electronics. SK Kataria & Sons.
3. Sharma Sanjay. 2012. Electronics Devices & Circuits. SK Kataria & Sons.

Reference Books:

1. Golding EW & Widdis FC. 1969. Electrical Measurements and Measuring Instruments. Pitman.
2. Malvino A and Bates D. 2006. Electronics Principles. Tata McGraw-Hill Education.

Course No : **BT-249** Course Title : **Classical and Molecular Cytogenetics**
 Credits : **3(2+1)** Semester : **IV**

Theory

UNIT I

Introduction and history; Mitosis and meiosis; Structure of chromatin; Chromosome structure and chromosome landmarks; Specialized chromosomes; Differential staining of the chromosomes- Q-banding, G banding, C banding, R banding; *In situ* hybridization- FISH, GISH.

UNIT II

Changes in chromosome number: aneuploidy- monosomy, trisomy and tetrasomy, haploidy and polyploidy- autopolyploidy and allopolyploidy; Methods of doubled haploid production; Structural aberrations of chromosomes: deletions, duplications, inversions and translocations; locating genes on chromosomes; Genome analysis.

Practical

Preparation of chromosome stains; Pollen fertility; Preparation of mitotic and meiotic slides of plant/animal cells; Preparation of karyotypes; C/G banding of the chromosomes; Genomic *in situ* hybridization; Microphotography.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1	Introduction and history: Definition, scope,	3
2	Application, major discoveries and scientists.	3
3-4	Mitosis and meiosis Overview of mitosis and meiosis, Phases of cell cycle	6
5	Differences between mitosis and meiosis	3
6	Stages of mitosis and meiosis.	3
7-8	Structure of chromatin:- Introduction, Chromatin structure and hierarchy, Centromere, telomere and origin of replication	6
9-10	Nucleosome: Introduction, structure and hierarchy	6
11	Chromosome structure:- History of discovery	3
12	Chromosome in prokaryotes and eukaryotes	3
13	Chromosome landmarks;Visible Chromosomal Landmarks: Chromosome size, Centromere position, Position of nucleolar organizers,	3
14	Chromomere patterns, Heterochromatin patterns, Banding patterns	3
15	Specialized chromosomes; Lampbrush chromosomes,	3
16	Polytene chromosomes, Accessory Chromosome.	4
17	Differential staining of the chromosomes- Q-banding, G banding- History, introduction, procedure and applications	2
18	C banding, R banding:- History, introduction, procedure and applications.	4
19	<i>In situ</i> hybridization-FISH and GISH: Probes – RNA and DNA, Introduction, principle and procedure and application	4
20	GISH: - Introduction, principle and procedure and application	3

UNIT II		
21-22	Chromosomal aberrations: aneuploidy- monosomy, Trisomy and tetrasomy, haploidy and polyploidy	7
23	Autopolyploidy and allopolyploidy; with example	3
24-25	Methods of doubled haploid production; <i>In-vitro</i> Androgenesis, Gynogenesis	6
26	Parthenogenesis	3
27	Structural aberrations of chromosomes: deletions, duplications: Definition and diagrammatic representation.	3
28	Inversions and translocations: Definition and diagrammatic representation	3
29	Locating genes on chromosomes: identification and location of specific gene on chromosome	4
30	Genome analysis: Cytogenetic location.	3
31-32	Molecular location: High-throughput sequencing, Illumina (Solexa) sequencing, Ion Torrent Assembly: Assembly approaches, Finishing. Annotation Sequencing pipelines and databases	6
Total:		100

Practical Exercise

Exercise No.	Title
1-2	Preparation of chromosome stains: Giosma, Acetocarmin, vital stain etc
3-4	Pollen fertility by staining
5-6	Preparation of mitotic and meiotic slides of plant/animal cells;
7	Preparation permanent slide of all of mitotic and meiotic stage
8-9	Preparation of karyotypes; onion cells/ plant cells karyotyping staining
10-12	C/G banding of the chromosomes; by using standard protocol
13-14	Genomic <i>in situ</i> hybridization; by using standard protocol
15-16	Microphotography. Photographing of microscoping slides , crops, insects etc.

Textbook:

1. Gupta PK. 2007. Cytogenetics. Rastogi publications.
2. Khush GS. 1973. Cytogenetics of Aneuploids. Academic Press.

Reference Books:

1. Becker K, Hardin J. 2004. The World of Cell. 5th Ed. Pearson Edu.
2. Carroll M. 1989. Organelles. The Guilford Press.
3. Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.
4. Mahabal Ram. 2010. Fundamentals of Cytogenetics and Genetics. PHI Learning Pvt. Ltd.
5. Yao-Shan Fan. 2002. Molecular Cytogenetics: Protocols and Applications. Humana Press.

Course No : **MICRO-242** Course Title : **Microbial Genetics**
 Credits : **3(2+1)** Semester : **IV**

Theory

UNIT I

Microorganisms as tools for genetic studies; Genetic variability in microorganisms; Genetic analysis of representative groups of bacteria, fungi and viruses; Random and tetrad spore analysis; Recombination and chromosomal mapping; Complementation - intergenic and intragenic.

UNIT II

Bacterial plasmids; Structure, life cycle, mode of infection and their role in genetic engineering; Transfer of genetic material in bacteria: Conjugation, transformation and transduction; Genetics of bacteriophage: T4, lambda and M13 - fine structure of gene, life cycle, mode of infection; Mutation: types, mutagens, DNA damage and repair; Transposable elements; Lac operon; Yeast genetics.

UNIT III

Concept and application of recombinant DNA technology; Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

Practical

Conjugation and transformation in bacteria; Spontaneous and auxotrophic mutation; Chemical and UV mutagenesis in fungi and bacteria; Complementation in fungi; Identification of mutants using replica plating technique; Isolation of genomic DNA from *E. coli*; Isolation and curing of

plasmid; Identification of plasmid by electrophoresis / antibiotic plates.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT-I		
1	Microorganisms as tools for genetic studies: General description, Microbes as tools for use in molecular biology, controlled matings, genetic engineering.	5
2-3	Genetic variability in microorganisms; Genetic analysis of representative groups of bacteria, fungi and viruses: Genotyping methods- 1)DNA banding pattern based methods, 2) PCR amplification, (3) DNA hybridization–based methods using nucleotide probes, (4) DNA sequencing-based methods to study the polymorphism of DNA sequences, (5) differentiation of isolates on the basis of presence or absence of particular genes and (6) high resolution melting analysis–real–time monitoring of melting process of PCR amplified polymorphic DNA fragment.	10
4-5	Random and tetrad spore analysis	5

6-8	Recombination and chromosomal mapping: Crossing over, cytological basis, Holliday model of recombination, molecular mechanism of recombination in bacteria. Chromosome mapping: two factor crosses, three factor crosses, interference, ordered and unordered tetrad data, somatic cell hybridization.	10
9-11	Complementation- intergenic and intragenic: Introduction, Intergenic vs intragenic complementation, Complementation test, Complementation group, Complementation Studies, Complementation Analysis.	5
UNIT-II		
12-13	Bacterial plasmids: Types- i) F plasmid, ii) R plasmid, iii) Col plasmid, iv) Digredative plasmid, v) Vir plasmid Structure: Modular organization, Life cycle and mode of infection of Agrobacterium: Molecular biology of Agrobacterium infection, Ti and Ri plasmid, organization of vir region, transfer of T- DNA, integration of T-DNA to plant genome, vectors derived from pTi and their role in genetic engineering	10
14-16	Transfer of genetic material in bacteria: Conjugation: Definition, history, mechanism of DNA transfer during conjugation, high frequency recombination (Hfr) strain, Significance. Transformation: Definition, history, Griffith's experiment, process of transformation, Significance. Transduction: Definition, history, Types-generalized and specialized, process of transduction, Significance.	10
17-20	Genetics of bacteriophage: T4: Fine structure of gene- ds DNA genome Life cycle- Lytic Mode of infection- by binding OmpC porin proteins and Lipopolysaccharide (LPS) on the surface of <i>E. coli</i> cells Lambda : Fine structure of gene- 48,490 base pairs of dslinear DNA. Life cycle- , lytic or lysogenic. M13: Fine structure of gene- sscircular DNA Mode of infection	10
21-24	Mutation: Types- Substitution, insertion, deletion and frameshift mutation, Mutagens- 1) Physical Mutagens- Ionizing radiations such as X-rays, gamma rays and alpha particles, 2) Chemical Mutagens- Mustard gas, Nitrous acids, Acridine dies and base analogues, 3) Biological Agents- Transposons, viruses, bacteria, DNA damage and repair: Introduction, Mechanism- 1) Photo reactivation, 2) excision repair, 3) Post replication recombination repair. Transposable elements: Genetic instability and discovery of transposable elements, transposable elements in bacteria, transposable elements in eukaryotes, genetic and evolutionary significance of transposable elements.	10
25-27	Lac operon: Regulatory genes, Mechanism. Yeast genetics: DNA ~60% A+T, histones; Transcriptional silencing, silent mating type cassettes, telomeres, and rDNA, 16 chromosomes, genome sequence, Centromeres, Telomeres (TG ₁₋₃) _n , Replication origins (ARS elements)	10
UNIT-III		
28-29	Concept and application of recombinant DNA technology: Introduction and application of recombinant DNA technology in agriculture,	5

	pharmaceutical, food, health industries, etc.	
30-32	Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health: Strain improvement: 1) Mutant selection, selective isolation of mutant, 2) Recombination-sexual reproduction, parasexual cycle, protoplast fusion, 3) Recombinant DNA technology- Recombinant proteins, metabolic engineering.	10
Total:		100

Practical Exercise

Exercise No.	Title
1	Culture techniques for isolation of single colonies of bacteria <i>Escherichia coli</i> – by streaking, serial dilution technique etc.
2	To study bacterial conjugation
3	Preparation of Competent <i>E. coli</i> cells and Plasmid transformation by Heat shock method
4	Induction of mutation by physical mean UV mutation
5	Induction of mutation by chemical mean
6	Induction of mutation by biological mean
7	Study of Mutation rate
8	Isolation, and production of auxotrophic mutant.
9	Complementation in fungi
10	Identification of mutants using replica plating technique
11	Isolation of genomic DNA from <i>E. coli</i> ;
12	Isolation and curing of plasmid;
13	Identification of plasmid by electrophoresis / antibiotic plates.
14-15	PCR based identification techniques
16	Bacteriophage Lambda infection and plaque study.

Text Book:

1. Gardner JE, Simmons MJ & Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.
2. Maloy A & Friedfelder D. 1994. Microbial Genetics. Narosa.
3. Scaife J, Leach D & Galizzi A 1985. Genetics of Bacteria. Academic Press.
4. William Hayes 1981. Genetics of Bacteria. Academic Press.
5. Maloy SR, Cronan Jr. JE & Freifelder D. 2006. Microbial Genetics. 2nd Edition. Narosa Publishing House, New Delhi.
6. Srtickberger MW. 2005. Genetics, 3rd Ed. Prentice Hall of India Private Ltd. New Delhi.
7. Singh BD. 2006. Genetics, 2006, 1st Ed. Kalyani Publishers, New Delhi.
8. Lewin B. 2006. Genes IX. Pearson Prentice Hall, Pearson Education Inc., New Jersey.

Reference Books:

1. Birge EA. 1981. Bacterial and Bacteriophage Genetics. Springer Verlag.
2. Freifelder D. 2005. Molecular Biology. 2nd Ed. Narosa Publishing House, New Delhi.

Course No : **PHY-241**
Credits : **3(2+1)**

Course Title : **Biophysics**
Semester : **IV**

Theory

UNIT I

Quantum mechanics; Electronic structure of atoms; The wave particle duality, wave length of de-Broglie waves; Phase and group velocity; Some basic concepts of quantum mechanics; Schrodinger's wave equations; Particle in a box; Quantum mechanical tunneling; Ist and IInd law of thermodynamics; Enthalpy; Entropy; Statistical and thermodynamic definition of entropy; Helmholtz free energy, Equilibrium thermodynamic; Near-equilibrium thermodynamic; Gibbs free energy; Chemical potential; Thermodynamic analysis of membrane transport.

UNIT II

Hydration of macromolecules; Role of friction; Diffusion; Sedimentation; The ultracentrifuge; Viscosity; Rotational diffusion; Light scattering, Small angle x-ray scattering; Ultraviolet and visible spectroscopy; Circular dichroism(CD) and optical rotatory dispersion(ORD); Fluorescence spectroscopy; Infrared spectroscopy; Raman spectroscopy; Electron spin resonance; NMR spectroscopy; Light microscopy.

UNIT III

Electron optics; Transmission electron microscope (TEM); Scanning electron microscope(SEM); Preparation of the specimen for electron microscopy; Image reconstruction; Electron diffraction; Tunnelling electron microscope; Atomic force microscope; Crystals and symmetries, crystal systems, point group and space groups; Growth of crystals of biological molecules; X-ray diffraction.

Practical

Refractive index and dispersive power of the prism using spectrometer; Calibration of prism spectrometer; Newton's rings; Polarimeter; Diffraction grating; Resolving power of telescope and grating; Ostwald viscometer; Planck's constant using photovoltaic cell; Photospectrometer; Photoelectric effect; Stefan's constant; Thermal diffusivity in metals.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1-2	Electronic structure of atom, Wave particle Duality, Wavelength of De-broglie wave, Phase & group velocity	5
3-4	Schrodinger's wave equations- Time Dependent & Time independent	6
5	Particle in a box, Quantum mechanical tunneling,	6
6-8	I & II Law of Thermodynamics, Enthalpy, Entropy, Helmholtz free energy, Equilibrium thermodynamic, Near equilibrium thermodynamic,	8
9-10	Gibbs Free energy, Chemical potential, Thermodynamic analysis of membrane transport.	4

UNIT-II		
11-13	Hydration of macromolecules, Role of friction, Diffusion, sedimentation, Ultracentrifuge	8
14-15	Viscosity, Rotational diffusion, Light scattering, Small angle X-ray scattering	6
16-18	Ultraviolet & Visible spectroscopy, Circular dichroism (CD) & Optical rotary dispersion (ORD),	8
19-20	Fluorescence spectroscopy, Infrared spectroscopy, Raman spectroscopy, NMR spectroscopy	8
21	Electron spin resonance, Light microscopy.	6
UNIT-III		
22-23	Electron optics, Transmission electron Microscope (TEM), Scanning electron microscope (SEM)	8
24	Preparation of specimen for electron microscopy, Calibration of prism spectrometer, Newton's ring	6
25-26	Polarimeter, Diffraction grating, Resolving power of Telescope & Grating	8
27-29	Ostwald's Viscometer, Planck's constant using Photovoltaic cell	8
30-32	Photo spectrometer, Photoelectric effect, Stefan's constant, Thermal Diffusivity in metals	5
Total:		100

Practical Exercises

Exercise No.	Title
1-2	Refractive index and dispersive power of the prism using spectrometer
3-5	Calibration of prism spectrometer;
6-8	Calibration of Newton's rings, Polarimeter and Diffraction grating
9-10	Resolving power of telescope and grating;
11-12	Study of Ostwald viscometer; Planck's constant using photovoltaic cell
13	Study of Photospectrometer
14	Study of Photoelectric effect
15	Study of Stefan's constant
16	Study of Thermal diffusivity in metals

Text Books:

1. Chang R. 2005. Physical Chemistry for the Biosciences. University Science Books.
2. Glaser R. 2012. Biophysics: An Introduction. Springer.
3. Pattabhi V & Gautam N. 2002. Biophysics. Narosa Publishing House.
4. Cotterill R. 2002. Biophysics: An Introduction. John Wiley & Sons.
5. Srivastava PK. 2006. Elementary Biophysics: An Introduction. Narosa Publishing House.

Course No. : **NSS 244**
Credits : **1 (0+1)**

Course Title : **National Service Scheme IV**
Semester : **IV**

Syllabus:

Youth and crime

Sociological and psychological factors influencing youth crime, cyber crime, peer mentoring in preventing crime and awareness for juvenile justice

Civil/self defence

Civil defence services, aims and objectives of civil defence; needs and training of self defence

Resource mobilisation

Writing a project proposal of self fund units (SFUs) and its establishment

Additional life skills

Positive thinking, self confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

Practical Exercises

Exercise No.	Topic	Weightages (%)
1.	Youth and crime Sociological and psychological factors influencing youth crime,	7
2.	Youth and crime Cyber crime,	7
3.	Youth and crime Peer mentoring in preventing crime	6
4.	Youth and crime Awareness for juvenile justice	6
5.	Civil/self defence Civil defence services,	6
6.	Civil/self defence Aims of civil defence;	6
7.	Civil/self defence Objectives of civil defence;	6
8.	Civil/self defence Needs and training of self defence	6
9.	Resource mobilisation Writing a project proposal of self fund units (SFUs)	7
10.	Resource mobilisation Self fund units (SFUs) establishment	7
11.	Self fund units (SFUs) Work Management	6
12.	Self fund units (SFUs) Training Programme	6
13.	Additional life skills Positive thinking,	6
14.	Self confidence and esteem,	6
15.	Setting life goals and working to achieve them,	6
16.	Management of stress including time management.	6
Total		100

Suggested Reading:

- i) Khwaja Ghulam Saiyidain. 1961. National Service Scheme: A Report.. Published by Ministry of Education, Govt. of India.
- ii) Kaikobad NF and Kapil KK. 1971. Training and consultancy needs in national service scheme, Published by Tata Institute of Social Sciences.
- iii) National Service Scheme: guide-lines to project-masters. 1971. Andhra University, Dept. of Sociology & Social Work. Published by Dept. of Sociology & Social Work, Andhra University.
- iv) National Service Scheme in Gujarat: An Evaluation Report for the Year 1986-87, by Tata Institute of Social Sciences Training Orientation & Research Centre (NSS), India, India. Dept. of Youth Affairs and Sports. Published by The Centre, 1987.
- v) National Service Scheme in Maharashtra: An Evaluation Report for the Year 1986-87, by Tata Institute of Social Sciences Training Orientation & Research Centre (NSS), India, India Dept. of Youth Affairs and Sports. Published by The Centre, 1988.
- vi) Dilshad MB. 2001. National Service Scheme in India: A Case Study of Karnataka.. Published by Trust Pub.