

# CURRICULUM & SYLLABUS

## B.Sc. (Agriculture)



**Orissa University of Agriculture and Technology  
Bhubaneswar**

**CURRICULLUM AND SYLLABUS**  
**FOR**  
**BACHELOR'S PROGRAMME**  
**IN**  
**AGRICULTURE**

Approved by Academic Council vide Resolution No.6327, Dtd.27.12.2003

**Orissa University of Agriculture and Technology**  
**Bhubaneswar – 751 003**

NOTE

As per the recommendation of the IV Deans' Committee, the Indian Council of Agricultural Research has revised the Course Programme for B.Sc. Ag. (Hons.). The salient features of the course are given below.

1. The B.Sc. Ag. (Hons.) course shall be of 4 years duration. The minimum and maximum residential period for the course shall be 8 and 16 semesters, respectively.
2. The system of education shall be semester system of 110 working days consisting of 95 net instructional days (NID) and 15 examination days.
3. The course programme consists of 16 credits.
4. The maximum permissible course workload will be 23 credits per semester.
5. Each course unit shall be of 100 marks. A mid-term examination of each course unit shall be conducted at the middle of the semester internally. The final examination will be conducted for 50 % of marks at the end of the semester in which the course is offered. Setting of questions will be done externally. The practical will be conducted internally. The mark distribution is given as follows.

Sl. No.	Type of course	Mark distribution			Total
		Mid-term Theory (Internal)	Practical (Internal)	Final Theory/ Practical (External)	
1.	Theory + practical	20	30	50	100
2.	Theory	50	-	50	100
3.	Practical	-	50	50	100

6. Ten (10) points grading system shall be adopted and each student shall be required to secure 50 per cent marks for passing a subject both in theory and practical separately and Overall Grade Point Average (OGPA) of 5.50 for obtaining a degree. The student will be detained when he fails in more than two subjects. He will be under scholastic probation if he fails in two or less subjects. He will clear the subjects within a month after registration to the next semester otherwise he is to be detained.
7. Experiential Learning: A student has to register 20 credits with major load in one area of electives and rest from among one/ two areas of electives in the seventh semester.
8. Rural Agricultural Work Experience (RAWE): The duration of the RAWE is 16 weeks with a weightage of 20 credits. Under this programme, the students will undergo the training as follows.

i) Orientation	–	1 week
ii) Village attachment	–	12 weeks
iii) Research Station/ KVK/ Agro-based industries activities etc.	–	2 weeks
iv) Project report preparation and examination	–	1 week
<b>Total</b>	<b>=</b>	<b>16 weeks</b>

The minimum attendance for RAWE programme is 85%. Students shall complete the record work based on daily field observation notebooks and weekly diaries maintained by them. They will be evaluated by course coordinator as well as by a designated evaluation committee.

**Department-wise Courses for B.Sc.(Ag.)**

Sl. No.	Discipline	Course No.	Credit Hours
<b>I. Agronomy</b>			
1.	Introductory Agriculture	AG 111	1 (1+0)
2.	Principles of Agronomy	AG 112	3 (2+1)
3.	Agricultural Meteorology	AM 121	2 (1+1)
4.	Water Management	AG 123	3 (2+1)
5.	Field Crops-I	AG 214	3 (2+1)
6.	Field Crops-II	AG 226	3 (2+1)
7.	Rainfed Agriculture	AG 215	1 (1+0)
8.	Weed Management	AG 227	2 (1+1)
9.	Practical Crop Production-I	CP 211	1 (0+1)
10.	Practical Crop Production-II	CP 322	1 (0+1)
11.	Farming Systems and Sustainable Agriculture	AG 318	2 (1+1)
12.	Organic Farming	AG 329	3 (2+1)
	<b>Total</b>		<b>25 (15+10)</b>
<b>II. Genetics &amp; Plant Breeding</b>			
1.	Principles of Genetics	PBG 111	3 (2+1)
2.	Principles of Plant Breeding	PBG 212	3 (2+1)
3.	Cytogenetics and Crop Improvement	PBG 223	2 (1+1)
4.	Breeding of Field & Horticultural Crops	PBG 324	3 (2+1)
	<b>Total</b>		<b>11 (7+4)</b>
<b>III. Soil Science &amp; Agricultural Chemistry</b>			
1.	Introduction to Soil Science	AC 111	3 (2+1)
2.	Soil Chemistry, Soil Fertility ad Nutrient Management	AC 122	3 (2+1)
3.	Agricultural Microbiology	AC 213	2 (1+1)
4.	Manures, Fertilizers and Agrochemicals	AC 224	3 (2+1)
5.	Biochemistry	AC 325	3 (2+1)
	<b>Total</b>		<b>14 (9+5)</b>
<b>IV. Horticulture</b>			
1.	Production technology of Vegetables	Hort 111	3 (2+1)
2.	Production technology of Flowers	Hort 212	2 (1+1)
3.	Production technology of Fruit Crops	Hort 223	3 (2+1)
4.	Production technology of Spices, Aromatic, Medicinal and Plantation Crops	Hort 314	3 (2+1)
5.	Post-harvest Management and Value Addition of Fruits and Vegetables	Hort 325	2 (1+1)
	<b>Total</b>		<b>12 (7+5)</b>
<b>V. Entomology</b>			
1.	Insect Morphology and Systematics	ENT 211	3 (2+1)
2.	Insect Ecology and Integrated Pest Management	ENT 222	3 (2+1)
3.	Crop Pests, Stored Grain Pests and their Management	ENT 313	3 (2+1)
	<b>Total</b>		<b>9 (6+3)</b>
<b>VI. Plant Pathology</b>			
1.	Fundamentals of Microbiology	PPT 111	2 (1+1)
2.	Plant Pathogens and Principles of Plant Pathology	PPT 122	3 (2+1)
3.	Diseases of Field Crops and their Management	PPT 223	3 (2+1)
4.	Diseases of Horticultural Crops and their Management	PPT 314	3 (2+1)
5.	Mushroom Cultivation	PPT 315	1 (0+1)
	<b>Total</b>		<b>12 (7+5)</b>

<b>VII.</b>	<b>Nematology</b>		
1.	Introductory Nematology	NEM 121	2 (1+1)
2.	Crop Nematode Management	NEM 212	2 (1+1)
	<b>Total</b>		<b>4 (2+2)</b>
<b>VIII.</b>	<b>Agricultural Economics</b>		
1.	Principles of Agricultural Economics	AE 121	2 (2+0)
2.	Agricultural Finance and Co-operation	AE 212	2 (1+1)
3.	Agricultural Marketing, Trade and Prices	AE 223	2 (1+1)
4.	Production Economics and Farm Management	AE 314	2 (1+1)
5.	Fundamentals of Agri-Business Management	AE 325	2 (1+1)
	<b>Total</b>		<b>10 (6+4)</b>
<b>IX.</b>	<b>Agricultural Extension Education</b>		
1.	Dimensions of Agricultural Extension	EE 121	2 (1+1)
2.	Fundamentals of Rural Sociology and Educational Psychology	EE 222	2 (2+0)
3.	Entrepreneurship Development and Communication Skills	EE 313	2 (1+1)
4.	Extension Methodologies for Transfer of Agricultural Technology	EE 324	2 (1+1)
	<b>Total</b>		<b>8 (5+3)</b>
<b>X.</b>	<b>Agril. Statistics</b>		
1.	Statistics	AS 311	2 (1+1)
2.	Introduction to Computer Application	AS 222	2 (1+1)
	<b>Total</b>		<b>4 (2+2)</b>
<b>XI.</b>	<b>Plant Physiology</b>		
1.	Crop Physiology –I	PP 121	2 (1+1)
2.	Crop Physiology –II	PP 212	3 (2+1)
	<b>Total</b>		<b>5 (3+2)</b>
<b>XII.</b>	<b>Seed Science &amp; Technology</b>		
1.	Principles of Seed Science & Technology	ST 211	2 (1+1)
2.	Seed Production technology and Quality Control	ST 322	2 (1+1)
	<b>Total</b>		<b>4 (2+2)</b>
<b>XIII.</b>	<b>Agriculture Biotechnology</b>		
1.	Principles of Plant Biotechnology	ABT 311	3 (2+1)
	<b>Total</b>		<b>3 (2+1)</b>
<b>XIV.</b>	<b>Soil Science &amp; Agril. Chemistry and Forestry</b>		
1.	Environmental Science	ES 311	2 (1+1)
	<b>Total</b>		<b>2 (1+1)</b>
<b>XV.</b>	<b>Agricultural Engineering</b>		
1.	Fundamentals of Soil, Water and Conservation Engineering	SWE 111(A)	3 (2+1)
2.	Farm Power and Machinery	FMP 121 (A)	2 (1+1)
3.	Protected Cultivation and Post-Harvest Technology	ASC 321 (A)	2 (1+1)
4.	Renewable Energy	FMP 322 (A)	2 (1+1)
	<b>Total</b>		<b>9 (5+4)</b>
<b>XVI.</b>	<b>Animal Production</b>		
1.	Live Stock Production and Management	VAP 111 (A)	3 (2+1)
	<b>Total</b>		<b>3 (2+1)</b>
<b>XVII.</b>	<b>Non Credit Courses</b>		
1.	Physical Education	PE 111/NCC 111/NSS 111	1 (0+1)
2.	Comprehension and Communication Skills in English	SE 121	2 (1+1)
	<b>Total</b>		<b>3 (1+2)</b>

<b>XVIII. Pre-requisite Courses</b>			
1.	Mathematics	BM 111 (A)	3 (2+1)
		BM 122 (A)	3 (2+1)
	<b>Total</b>		<b>6 (4+2)</b>
	Botany	BB 111 (A)	3 (2+1)
	Zoology	BZ 121 (A)	3 (2+1)
	<b>Total</b>		<b>6 (4+2)</b>
<b>XIX. Rural Agricultural Work Experience</b>			
		RAWE 421	20 (0+20)
	<b>Total</b>		<b>20 (0+20)</b>
<b>XX. Experiential Learning (Multidiscipline)</b>			
1.	Agronomy	CP-411, 412, CP -413	
2.	Soil Science & Agril. Chemistry	CP-413, 414	
3.	Horticulture	Hort-411,412,413,414,415,416 PHT-414,415 CA-411,412,413,414,415	
4.	Entomology	CPT-411,412,413,414,416,417	
5.	Plant Pathology	CPT-411,412,413,415,416	
6.	Nematology	CPT-411,413	
7.	Agril. Economics	ABM-412,413,414,415,416 SS- 415,416,417	
8.	Agril. Extension Education	ABM-411,416 SS-411,412,413,414,415	
9.	Seed Sci. & technology	CP-415, CA-417	
10.	Agril. Biotechnology	BS-411,412,413,414,415,416	
11.	Forestry	CA-416	
12.	Agril. Processing and Food Engineering	PHT- 411,412,413,414,416,Hort.415	

# AGRICULTURE

## 1. AGRONOMY

### 1. Introductory Agriculture

1(1+0)

**Theory:** Art, Science and business of crop production. Factors affecting crop production. Brief history of agricultural development:- Chronological Agricultural Technology development in India. Indian Agriculture, Agricultural growth, Balance sheet (DATA). Diversity in Physiography, Soil groups, Marine, Livestock and Water. Dry land agriculture; Farming Systems approach; value addition requirements in new technology; Women in Agriculture: multifaceted roles and tasks, work stress factors, Nutritional and rural life standards, role in house hold design making, drudgery reduction for farm women, women friendly agricultural technology. Empowerment of women; Group dynamics for farm women and rural women- the nucleus of agricultural extension and training.

#### Reference Book:

1. History of Agriculture in India, Vol.I-IV – (Ed.) M.S. Randhawa
2. Rainfed Agriculture in India: Research and development Scenario. J. Venkataswarelu
3. Concise History of Science in India, Agriculture - S.P. Rayachaudhury, D.M. Bose, S.N. Sen and B.V.A. Subbarayappa
4. Women in Agriculture – B. Wasnik

### 2. Principles of Agronomy

3(2+1)

**Theory:** Meaning and scope of Agronomy: National and International Agricultural Research Institutes located in India, Agro-climatic zones of India and Orissa. Classification of crops. Crop rotation principles and advantages, cropping pattern, cropping schemes, multiple cropping and mixed cropping principles and advantages, intercropping types and advantages and assessment. Relay cropping, paira cropping and crop interactions. Crop growth and development, and factors affecting yield. Crop stand establishment, planting geometry and its effect on growth and yield. Selection of seed, sowing methods, tillage and it's objectives, types and effect of tillage on soil, tillage implements and harvesting. Yield and it's estimation. Soil fertility and productivity, maintenance of fertility, essential elements, their sources and availability and uptake by crops. Manures and fertilizers- organic and inorganic, green manuring, bio-fertilizers, balanced fertilizers, principles governing time and method of fertilizer application, integrated nutrient management.

**Practical:** Identification of field crops and under utilized crops and their growth stages; Study of tillage implements; Practice of ploughing; Practice of puddling; Study of seeding equipments; Different methods of sowing; Study of manures, fertilizers and green manure crops / seeds (including calculations); Study of inter-cultivation implements and practice; Practice of methods of fertilizer application; Preparation of fertilizers mixture and spray solutions; Compost making; Participation in ongoing field operations.

#### Reference Book:

1. Principles of Agronomy - T.Y. Reddy and G. H. Sankar Reddi
2. Principles of Agronomy - S. R. Reddy
3. The Nature and Properties of Soil - N.C.Brady and Ray R. Weil
4. Manures and Fertilizers - K. S. Yawalkar, J.P. Agrawal and S. Bokde
5. Soil Conditions and Plant Growth – E.W.Russel and E.J. Russell

### 3. Agricultural Meteorology

2(1+1)

**Theory:** Agricultural meteorology: Weather and climate, micro-climate, weather elements, Earths' atmosphere, Composition and structure, solar radiation, Nature, properties, depletion, solar constant and energy balance, Atmospheric, temperature, factors affecting, horizontal and vertical distribution, variations, climate change : causes, effect on ecosystem, crop production, remedial measures and global warming, Air Pressure variations; Wind: factors affecting, cyclones and anticyclones and general circulation, Atmospheric humidity, vapour pressure and saturation, Process of condensation, formation of dew, fog, mist, snow, rain and hail; Formation and classification of clouds, Introduction to monsoon, Basics of weather forecasting, Introduction to remote sensing and their application. Crop weather relationship, evapotranspiration. Agro climatic zones of India and Orissa.

**Practical:** Site selection for Agromet observatory; Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine duration and solar radiation; Measurement of wind direction and speed and relative humidity; Study of weather forecasting and synoptic charts: Study of remote sensing.

**Reference Book:**

1. Agrometeorology and remote sensing - D.D. Sahu
2. Text book of Agricultural Meteorology - Edited by M.C. Varshney
3. Introduction to Agrometeorology - H.S.Mavi
4. Crops and Weather – S. Venkataraman and A. Krishnan (ICAR)
5. Climate, Weather and Crops in India – D. Lenka

**4. Water Management and Micro Irrigation****3(2+1)**

**Theory:** Irrigation: definition and objectives, water resources and irrigation development in India and Orissa; Soil plant water relationships; Methods of soil moisture estimation, soil water movement, evapotranspiration and crop water requirement; effective rainfall, scheduling of irrigation; Methods of irrigation: surface and subsurface, Micro irrigation, sprinkler and drip irrigation; Irrigation efficiency and water use efficiency, conjunctive use of water, irrigation water quality and its management. Water management of different crops (rice, wheat, maize, groundnut, sun flower, mustard, pulses, sugarcane, cotton, potato, mango, banana and tomato); Agricultural drainage, Onfarm water management.

**Practical:** Determination of bulk density; Determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; Determination of field capacity by field method; Determination of permanent wilting point; Measurement of irrigation water through flumes and weirs; Calculation of irrigation water requirement (Problems); Determination of infiltration rate; Demonstration of furrow method of irrigation; Demonstration of check basin and basin method of irrigation; Visit to farmers field and cost estimation of drip irrigation system; Demonstration of filter cleaning, fertigation, injection and flushing of laterals; Erection and operation of sprinkler irrigation system; Measurement of emitter discharge rate, wetted diameter and calculation of emitter discharge variability; Determination of EC, pH, carbonates, bicarbonates, Ca<sup>++</sup> and Mg<sup>++</sup> in irrigation water (quality parameters)

**Reference Book:**

1. Irrigation Principles and Practices - O.W. Israelsen and V.E. Hansen
2. Irrigation and Drainage - D. Lenka
3. Irrigation, Theory and Practices - A. M. Michael
4. Agricultural Drainage : Principles and Practices – U.S. Kadam
5. Micro-irrigation for cash crops – M.L. Choudhary
6. Handbook on pressurized irrigation techniques – A. Phocaides (FAO)

**5. Field Crops-I****3(2+1)**

**Theory:** Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of kharif crops, Cereals – rice, maize, sorghum, pearl millet and minor millets; Pulses : pigeonpea, mungbean, urdbean and horsegram; Oilseeds: groundnut, sesame, niger and soybean; Fibrecrops: cotton, jute, mesta and sun hemp; and Forage crops: sorghum, maize, bajra, guinea grass, deenanath grass, hybridnapier, para grass, cowpea, rice bean and stylosanthes. Grass land management.

**Practical:** Rice nursery preparation and transplanting/seed bed preparation and sowing of Kharif crops; Calculations on seed rate; Sowing of soybean, pigeonpea, mungbean, maize, groundnut, and cotton; Effect of seed size on germination and seedling vigour of soybean/groundnut; Effect of sowing depth on germination of groundnut; Identification of weeds in rice, maize and soybean fields and study of weed control experiments in these crops; Top dressing of nitrogen in maize and rice and study of fertilizer experiments on rice, maize, sorghum and millets; Study of yield contributing characters, yield calculations, harvesting and yield estimation of above crops; Study of crop varieties and important agronomic experiments; Study of forage experiments. Judging the maturity stage of kharif crops viz: rice maize pulses and oilseed crops

**Reference Book:**

1. Modern Techniques of raising field crops - Chida Singh
2. Crop management under rainfed and irrigated condition - S.S.Singh
3. Agronomy of field crops - S.R.Reddy
4. Text book of field crop production - Edited by R. Prasad (ICAR)



## 6. Field Crops- II

3(2+1)

**Theory:** Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of rabi crops; Cereals: wheat, barley; Pulses: chickpea, lentil, peas, french bean; Oilseeds: rapeseed and mustard, sunflower, safflower and linseed; Sugar crops: sugarcane and sugar beet, Commercial crops: potato and tobacco, Forage crops: berseem, Lucerne, Japanese mustard and oat, Medicinal and aromatic crops such as mentha, lemon grass, citronella, palma rosa, pacheoli, aswagandha and Aloe vera.

**Practical:** Seed bed preparation and sowing of wheat, sugarcane and sunflower; Calculations on seed rate; Top dressing of nitrogen in wheat and study of fertilizer experiments on wheat and mustard; Identification of weeds in wheat and grain legumes, application of herbicide and study of weed control experiments; Morphological characteristics of wheat, sugarcane, chickpea and mustard; Yield contributing characters of wheat; Yield and quality analysis of sugarcane; Judging the maturity stage of rabi crops. Important agronomic experiments of rabi crops and visit to research stations related to rabi crops.

### Reference Book:

1. Modern Techniques of raising field crops - Chida Singh
2. Crop management under rainfed and irrigated condition - S.S.Singh
3. Agronomy of field crops - S.R.Reddy
4. Text book of field crop production - Edited by R. Prasad (ICAR)

## 7. Rainfed Agriculture

1(1+0)

**Theory:** Dry land farming-definitions, constraints-climate, soil, technological and socio-economic, geological distribution of dry land of India. Drought- definition, effect on plant growth, drought management. Principles of dry farming, crop management practices, intercropping, conservation tillage, agronomic practices for moisture conservation and alternate land use system. Contingent crop planning for different agro climatic zones of the state. Watershed management- definition, objective, factors affecting the operation of water shed, data required for management planning, land use planning according to capability, water harvesting and recycling, mechanical and biological measures for soil and water conservation. Management practices –conservation structures, pasture development, agro forestry, cropping pattern for crop lands, animal husbandry and pisciculture. Evaluation of water-shed –cost: benefit analysis.

### Reference Book:

1. Dryfarming in India - U.S.Sree Ramulu
2. Dryland Agriculture – G. Subbareddy
3. Watershed Management - V.V. Narayan, G. Shastry and U.S. Pattanaik
4. Soil Erosion and conservation - R.P. Tripathi and H.P. Singh
5. Watershed Management for dryland agriculture – M.C. Oswal

## 8. Weed Management

2(1+1)

**Theory:** Weeds: Introduction, harmful and beneficial effects, classification, propagation dissemination and persistence ; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to adjuvants and their use in herbicides; Introduction to selectivity of herbicides, Transformation of herbicides in the soil, compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control, herbicide resistance management and residual effect of herbicides in the environment.

**Practical:** Identification of weeds; Survey of weeds in crop fields and other habitats; Weed vegetation analysis, Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides and their manufacturing companies; Study of herbicide formulation and phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits to experimental field and problem areas.

**Reference Book:**

1. Modern weed management - O.P.Gupta
2. Principles of Weed science - V.S. Rao
3. Weed management - V.N. Saraswat, V. M. Bhan and N.T. Yaduraju (ICAR)
4. All about weed control - S. Subramaniam, A.Mohamed Ali and R. Jaykumar

**9. Practical Crop Production-I****1(0+1)**

**Practical:** Crop planning, raising field crops like rice maize, groundnut, pulses in multiple cropping systems: Field preparation, seed treatment, nursery raising, sowing, nutrient management, water management, weed management and management of insect pests and diseases of crops harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of a group of students.

**10. Practical Crop Production-II****1(0+1)**

**Practical:** Crop planning, raising field crops like wheat, summer rice, mustard, rabi groundnut, sugarcane, potato, rajmashes in multiple cropping systems: Field preparation, seed treatment, nursery raising, sowing, nutrient management, water management, weed management and management of insect-pests and diseases of crops harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of a group of students.

**11. Farming Systems and Sustainable Agriculture****2(1+1)**

**Theory:** Sustainable agriculture: Introduction, definition, goal and current concepts, factors affecting ecological balance and ameliorative measures; Land degradation and conservators of natural resources, LEIA & HEIA; Irrigation problems, waste lands and their development; Organic farming: definition, principles and components; soil health management; Farming systems: definition, principles and components, IFS models for wetland, irrigated dry land and rainfed situations. Precision farming, contract farming. Farming system models for different categories of farmers.

**Practical:** Preparation of cropping scheme for irrigated situations; Preparation of cropping scheme for dryland situations; Study of existing farming systems in nearby villages; Preparation of integrated farming system model for wetlands; Preparation of integrated farming system model for dry lands; Preparation of enriched Farm Yard Manure; Preparation of Vermicompost NADEP compost; Visit to urban waste recycling unit; Study of profitable utilization of agricultural wastes; Visit to poultry and dairy units to study resource allocation, utilization and economics; Visit to an organic farm to study various components and utilization; Study of degraded lands.

**Reference Book:**

1. Fundamental Approaches in sustainable agriculture - J.P. Sharma
2. Farming System in Tropics - A. Rangaswami
3. Farming System: Theory and Practice – S.A. Solaimalai

**12. Organic Farming****2(1+1)**

**Theory:** Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports.

**Practical:** Preparation of quality compost material, Study of earthworm and methods of vermicomposting. Production and use of BGA and azolla, use of Rhizobium, Azotobacter and Azospirillum, Phosphate solubilizing bacteria Phosphate solubilizing mycorrhiza. Vegetable and medicinal crops nursery raising. Raising of vegetable crops organically through nutrient, diseases and pest management; macro quality analysis, grading, packaging, post harvest management.

**Reference Book:**

1. Organic Farming : Theory and Practice - S.P.Palaniappan and K.Aannadurai
2. A Hand book of Organic Farming - A.K. Sharma
3. Hand book of Organic Farming and Biofertilizers - A.C.Gaur
4. Organic farming for sustainable Horticulture – P. Parvatha Reddy
5. Organic Agriculture – J.C. Tarafdar

## 2. GENETICS AND PLANT BREEDING

### 1. Principles of Genetics

3(2+1)

**Theory:** Mendel's laws of inheritance and exceptions to the laws; Types of gene action, Multiple alleles, Pleiotropism, Penetrance and expressivity; Quantitative traits, Qualitative traits and differences between them; Multiple factor hypothesis; Cytoplasmic inheritance, its characteristic features and difference between chromosomal and cytoplasmic inheritance; Mutation and its characteristic features; Methods of inducing mutations and C / B technique; molecular basis of gene mutation; Mechanisms of sex determination; Gene expression and differential gene activation; operon concept and Fine structure of Gene; DNA and its structure, function, types, modes of replication and repair; RNA and its structure, function and types; Transcription, Translation, Genetic code and outline of protein synthesis; Crossing over and factors affecting it; Mechanism of crossing over and Cytological proof of crossing over; Linkage, Types of linkage and estimation of linkage; Hardy-Weinberg equilibrium; Changes in gene and genotype frequencies; Genetic disorders and gene therapy.

**Practical:** Gametogenesis and fertilization; Monohybrid ratio and its modifications; Dihybrid ratio and its modifications; Trihybrid ratio; Chi-square analysis and Interaction of factors; Epistatic factors, Supplementary factors and Duplicate factors; Complementary factors, Additive factors and Inhibitory factors; Blood grouping and PTC test in human; Linkage – Two point test cross; Linkage – Three point test cross; gene order and genetic map.

#### Reference Book:

1. Genes - B. Lewin
2. Fundamentals of Genetics - B. D. Singh
3. Genetics - M. W. Strickberger
4. Principles of Genetics - E.W. Sinnott, L.C. Dunn, T.Dobzhansky
5. Principles of Genetics - E. J. Gardner, M. J. Simmons and D. P. Snustad

### 2. Principles of Plant Breeding

3(2+1)

**Theory:** Classification of plants. Aims and objectives of Plant Breeding; Modes of reproduction, Sexual, Asexual, Apomixis and their classification; Significance in plant breeding; Modes of pollination, genetic consequences, differences between self and cross pollinated crops; Variation – heritable and non-heritable, Methods of breeding – introduction and acclimatization. Selection, Mass selection, Johannson's pure line theory, genetic basis of pure line selection; Hybridization, Aims and objectives, types of hybridization; Methods of handling of segregating generations, pedigree method, bulk method, back cross method and modified methods; Incompatibility and male sterility and their utilization in crop improvement; Heterosis - inbreeding depression, various theories of Heterosis, exploitation of hybrid vigour development of inbred lines, single cross and double cross hybrids; Population improvement programmes, recurrent selection, synthetics and composites; Methods of breeding for vegetatively propagated crops; Clonal selection; Mutation breeding; Ploidy breeding; significance in crop improvement.

**Practical:** Botanical description and floral biology; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Plant Breeder's kit; Hybridization techniques and precautions to be taken; Floral morphology, selfing, emasculation and crossing techniques of Rice, Sorghum, Maize, Wheat, Bajra, ragi; Sugarcane, coconut, Groundnut, Castor, Safflower, Sesamum, Redgram, Bengalgram Greengram, Soybean, blackgram, Chillies, Brinjal, Tomato, Bhendi, Onion, Bottle gourd, Ridge gourd, Cotton, Mesta, Jute and Sunhemp; Study of male sterility and incompatibility in field plots.

#### Reference Book:

1. Principles of Plant Breeding - R.W. Allard
2. Plant Breeding Principles and Methods - B. D. Singh
3. Plant Breeding - (Ed.) V. L. Chopra
4. Plant Breeding. Analysis and Exploitation of Variation - D. Roy

### 3. Cytogenetics and Crop Improvement

2(1+1)

**Theory:** History of cytogenetics, plant cell culture and contents; Ultra structure of cell and cell organelles and their functions; Study of chromosome structure, morphology, number and types (Lamp brush chromosome, Polytene chromosome, artificial chromosome); Karyotype and Idiograms; Mitosis and meiosis – their significance and differences between them; Numerical aberrations of chromosome - Polyploidy and evolution of crop species like Cotton, wheat, Triticale and Brassicas; Structural aberrations of chromosomes - deficiency, duplication, inversion and translocation; Elements of molecular cytogenetics (FISH & GISH techniques). Induction of haploids and Polyploids – their role in crop improvement and development of new crops; Balanced tertiary trisomic (BTT) in hybrid seed production; Alien additions and substitution lines – significance in crop improvement.

**Practical:** Microscopy (Light microscopes and electron microscopes); Cytological techniques – fixation and staining, smear and squash techniques; preparation of micro slides and identification of various stages of mitosis and meiosis ; Study of pollen grain variation (size) in different crops and pollen sterility; Induction of polyploidy using colchicines; Induction of chromosomal aberration using chemicals.

#### Reference Book:

1. Elements of Cytology - N.S.Cohn
2. Cell Biology - C. B. Powar
3. Introduction to Cytogenetics - G. Prasad
4. Cytogenetics of Crop Plants - M. S. Swaminathan, P. K Gupta, and U. Sinha
5. Cytogenetics - C. P. Swanson, T. Merz, and J. Young

### 4. Breeding of Field & Horticulture Crops

3(2+1)

**Theory:** Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Hardy-Weinberg Law; Study in respect of origin, distribution of species, wild relatives and forms, Cereals, (rice, wheat, maize, finger millet); Pulses (redgram, greengram, blackgram, soybean); Oilseeds (Groundnut, sesame, sunflower, mustard) etc. Fibers (Cotton, jute) etc. Vegetables (Tomato, bhindi, chilli, cucumbers); Flowers crops (Chrysanthemum, rose, galardia & marigold); Fruit crops (guava, mango, banana, papaya); Major breeding procedures for development of hybrids / varieties of various crops; Plant Genetic Resources their conservation and utilization in crop improvement; Ideotype concept in crop improvement; Breeding for resistance to biotic and abiotic stresses; Mechanisms of resistance in plant to pathogens and pest; Definition of biometrics, assessment of variability i.e., additive, dominance and epistasis; Genotype x Environment interaction and influence on yield/performance. IPR and its related issues.

**Practical:** Emasculation and Hybridization techniques; Handling of segregating generations- pedigree methods; Handling of segregating generations - bulk methods; Handling of segregating generations - back cross methods; Field lay out of experiments; Field trials, maintenance of records and registers; Estimation of Heterosis and inbreeding depression; Estimation of Heritability, GCA and SCA; Estimation of variability parameters; Parentage of released varieties/hybrids; Problems on Hardy-Weinberg Law; Study of quality characters; Sources of donors for different characters; Visit to seed production and certification plots; Visit to AICRP trials and programmes; Visit to grow out test plots; Visit to various research stations; Visit to other institutions

#### Reference Book:

1. Plant Breeding - (Ed.) V. L. Chopra
2. Breeding Field Crops - J. M. Poehlman
3. Crop Breeding & Genetics - S.G.Ram and H. G. Singh.

### 3. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

#### 1. Introduction to Soil Science

3(2+1)

**Theory:** *Soil* : Pedological and edaphological concepts, Origin of the earth, Earth's crust: Composition: Rocks and minerals, Weathering, soil formation factors and processes, components of soils, Soil profile, soil physical properties, soil texture, textural classes, particle size analysis, soil structure, classification, soil aggregates, significance, soil consistency, soil crusting, Bulk density and particle density of soils & porosity, their significance and manipulation, soil compaction, soil colour, elementary knowledge of soil classification and soils of India; soil water, Retention and potentials, soil moisture constants, movement of soil water, Infiltration, Percolation, Permeability, Drainage, Methods of determination of soil moisture. Thermal properties of soil, soil temperature, Soil air, Gaseous exchange, influence of soil temperature and air on plant growth; Soil colloids, properties, Nature, Types & significance; Layer silicate clays, their genesis and sources of charges, adsorption of ions, ion exchange, CEC and AEC ,factors influencing ion exchange and its significance. Soil organic matter, composition, decomposability, Humus, Fractionation of organic matter, carbon cycle, C:N ratio, Soil biology, Biomass, Soil Organisms & their beneficial & harmful roles.

**Practical:** Determination of Bulk density & Particle density, Aggregate analysis, Soil strength, soil moisture determination, Soil moisture constants-Field capacity, Infiltration rate, Water holding capacity, Soil Texture & Mechanical analysis-Soil temperature, Analytical chemistry-Basic concepts, Techniques & calculations-collection & processing of soil for analysis-Organic carbon, pH, EC, Soluble cations and anions-Study of a soil profile-Identification of rocks and minerals.

#### Reference Book:

1. The nature and properties of soils-N.C.Brady and Ray R.Weil
2. A text book of Soil Science – T.D. Biswas & S.K. Mukherjee
3. Fundamentals of Soil Science – Indian Society of Soil Science
4. Conception, Application of Pedology – J.L. Sehgal
5. Soil Physics – B.P.Ghildyal and R.P.Tripathy
6. Introduction to soil Physics –D. Hillel

#### 2. Soil Chemistry, Soil Fertility and Nutrient Management

3(2+1)

**Theory:** Soil as a source of plant nutrients, Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Measures to overcome deficiencies and toxicities, problem soils-acid ,salt affected and calcareous soils, characteristics, nutrient availabilities, Reclamation-mechanical, chemical and biological methods, Fertilizer and insecticides and their effect on soil water and air, irrigation water-Quality of irrigation water and its appraisal. Indian standards for water quality. Use of saline water for agriculture. Soil fertility-Different approaches for soil fertility evaluation. Methods, soil testing-Chemical methods, critical levels of different nutrients in soil. Plant analysis-DRIS methods, critical levels in plants, Rapid tissue tests, Indicator plants, Biological method of soil fertility evaluation. Soil test based fertilizer recommendation to crops. Factors influencing nutrient use efficiency ( NUE) in respect of N,P,K,S, Fe and Zn fertilizer. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions.

**Practical:** Principles of analytical Instruments and their calibration and application, colorimetry and flame photometry. Estimation of available N,P,K,S and Zn in oils, pH, EC, soluble cations and anions in soil water extracts, Lime requirement and gypsum requirement of problem soils, Estimation of N,P and K in plants.

#### Reference Book:

1. Chemistry of the soils – F. Bear
2. Soils and soil fertility – C.M. Thomson and F.R. Troeh
3. Soil fertility and fertilizers – S.L.Tisdale, W.L.Nelson, J.D. Beaton and J.L. Havlin

### 3. Agricultural Microbiology

2(1+1)

**Theory:** Soil microbiology, Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur. Biological nitrogen fixation, Microflora of Rhizosphere and phyllosphere microflora, microbes in composting, microbiology of water, Microbiology of food; microbial spoilage and principles of food preservation. Beneficial microorganisms in Agriculture; Biofertilizer (Bacterial, Cyanobacterial and fungal), microbial insecticides, Microbial agents for control of plant diseases, Biodegradation, biogas production

**Practical:** Acquittance with microbial equipments and their use. Enumeration of microbial population in soil. Isolation, multiplication and preservation of bacteria. Gram staining of bacteria and measurement of microbial growth. Microscopic study of heterocyst in BGA. Experiments on ammonification, nitrification, denitrification, organic matter decomposition and evolution of CO<sub>2</sub> in soil, Experiment in urea hydrolysis. Morphological study of nitrogen fixing nodules. Methods of application of Biofertilizers in the field.

#### Reference Book:

1. Introduction to soil Microbiology – M Alexander
2. Agricultural Microbiology – G. Rangaswami and Bagyaraj
3. Soil microorganism and plant growth – N.S. Subbarao
4. Biofertilizers in Agriculture – N.S. Subbarao.

### 4. Manures, Fertilizers and Agrochemicals

3(2+1)

**Theory:** Introduction-Raw materials-Manures- Bulky and concentrated-FYM, Composts-Different methods, Mechanical compost plants, Vermicomposting, Green manures, oil cakes, sewage and sludge-Biogas plant slurry, plant and animal refuges, Fertilizers-classification, Manufacturing processes and properties of major nitrogenous(ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate) Phosphatic(single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), Potassic and complex fertilizers, their fate and reactions in the soil, Secondary and micronutrients fertilizers, Amendments, Fertilizer control order, fertilizer storage, Biofertilizers and their advantage, Organic chemistry as prelude to agro-chemicals, Diverse types of agrochemicals, Botanical insecticides(Neem), pyrethrum, synthetic pyrethroids, Synthetic organic insecticides, major classes, properties and uses of some important insecticides under each class, Herbicides-Major classes-Properties and uses of 2,4 -D, atrazine, glyphosate, butachlor, benthio carb, Fungicides-Major classes- Properties and uses of carbendazim, carboxin, captan, tridemorph and copper oxychloride-Insecticides Act, plant growth regulators.

**Practical:** Total nitrogen and phosphorus in manures/composts-Ammonical and nitrate nitrogen-water soluble P<sub>2</sub>O<sub>5</sub>, potassium, calcium, sulphur and zinc contents of fertilizers. COD in organic wastes-Adulteration in fertilizer, Argentimetric and iodometric titrations-their use in the analysis of lindane, metasystox, endosulphan, malathion, copper and sulphur fungicides-Compatibility of fertilizers with pesticides.

#### Reference Book:

1. Soil fertility and fertilizers-S.L.Tisdale, W.L.Nelson, J.D. Benton and J.L. Havlin
2. Manures and Fertilizers – K.S. Yawalker, J.B. Agarwal and S. Bokde
3. Soil Fertility, Theory and Practice –J.S. Kanwar
4. A text Book of fertilizers – R.K.Basak
5. Toxicology of insecticides-F. Matsumura
6. Insecticides, action & metabolism-R.D.O'Brien
7. Chemistry of insecticides & fungicides- V.S.Sreeramulu

### 5. Biochemistry

3(2+1)

**Theory:** Biochemistry – Introduction and importance. Plant cell, cell wall and its role in livestock, Food and paper industries, Bio-molecules – structure, properties and applications: Amino acids, peptides and proteins – Plant proteins and their quality. Enzymes – Factors affecting the activity, classification, immobilization and other industrial applications. Lipids- acyl lipids, their industrial application in soaps, detergents, paints, vanishes, lubricants, adhesives, plastics, nylon, bio-diesel, biodegradable plastics etc. Carbohydrates; nucleotides and nucleic acids, metabolic energy and its generation – Metabolism – Basic concepts, glycolysis, citric acid cycle, pentose phosphate pathway, oxidative phosphorylation, fatty acid oxidation, general reaction of amino acid degradation.

Biosynthesis – carbohydrates, lipids, proteins and nucleic acids, metabolic regulation. Secondary metabolites, terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.

**Practical:** Amino acid models (atomic): Paper electrophoresis for the separation of plant pigments; protein denaturation – heat, pH, precipitations of proteins with heavy metals, protein estimation by Lowry method; enzyme kinetics, competitive inhibition, enzyme

**Reference Book:**

1. Principles of Biochemistry – A.L. Lehninger
2. Elementary Biochemistry – E. T. Mertz
3. Outlines of Biochemistry – E.E. Conn, P.K.Stump, G.Bruening and R.H. Doi
4. Plant Biochemistry- J. Bonner and J. E. Verner
5. Principles of Biochemistry – A.C. Deb

## 4. HORTICULTURE

### 1. Production Technology of Vegetables

3(2+1)

**Theory:** Importance and scope of the vegetable cultivation, classification of vegetables, types of vegetable farming, Study of vegetable crops with respect to their origin, distribution, climate and soil requirement, sowing and planting, varieties, nutrient requirement, irrigation, inter-cultural operations, harvesting, important insect pests diseases and disorders crop improvement and seed production techniques of Solanaceous vegetables (tomato, Brinjal and chilli, Capsicum) Cole crops (cauliflower and cabbage and Knolkhol), Cucurbits (Pumpkin, Cucumber, gourd and melons). Legumes (pea, beans, Cowpea and Guanj), Okra, Bulb crops (onion and garlic), Root crops (radish, turnip, beet and carrot), Potato, Topical tuber crops (sweet potato yams, colocasia, cassava and amorphophallus) Leafy vegetables (amaranthus, basela, spinach and fenugreek), perennials (drum stick, curry leaf).

**Practical:** Raising of vegetable seedlings in the nursery, seed germination planning and layout of kitchen garden. Identification of vegetable seeds and plant parts, Seed rate, fertilizer calculation Physiological disorders, transplanting, irrigation, weeding and inter-cultural operations of vegetable crops. Use of growth regulators in vegetable crops, seed extraction of tomato, brinjal, visit to commercial vegetable farms, Research Stations, Vegetable Markets.

#### Reference Book:

1. Vegetable Crops - T.K.Bose and M.G.Som
2. Vegetable for the tropical region - Prem Nath, S. Velayadhan and D.P.Singh
3. Technology for vegetable production and improvement - P.Hazra and M.G.Som.
4. Principles of Vegetable production - S.P.Singh
5. Text book of Vegetable Tuber Crops and spices - S.Thamburaj and N. Singh

### 2. Production Technology of Flowers

2(1+1)

**Theory:** Scope and importance of ornamental horticulture Garden and its parts. Types and styles of ornamental garden, planning of ornamental garden, use of trees, shrubs, climbers house plants and seasonal flowers in the garden cultivation practices with respect to origin, distribution, climate and soil. Planting material requirement, varieties nutrition, irrigation, inter-cultural operation, plant protection measures, harvesting and post harvest management of flower crops like rose, tuberose, marigold, gladiolus and chrysanthemum. Production technology of house plants and their use in interior decoration.

**Practical:** Identification of different groups of ornamental plants (Trees, shrubs, climbers, house plants, palms seasonal etc.), Development of garden features. Layout of lawn and its maintenance. Care and maintenance of indoor plants. Training and pruning of Rose. Pinching, disbudding and dishooting of chrysanthemum and dahlia, planning and layout of gardens and garden designs for public and private gardens. Prolonging the shelf life of cut flowers. Visit to parks, gardens nursery and commercial flower growing areas.

#### Reference Book:

1. Floriculture in India - G.S.Randhawa and A. Mukopadhyay
2. Complete gardening in India - K.S.G.Gopalswami
3. Commercial flowers - T.K.Bose and L.P.Yadav
4. Text Book of Floriculture and Land scaping - N.Roychowdhury and H.P.Mishra

### 3. Production Technology of Fruit Crops

3(2+1)

**Theory:** Importance and scope of fruit crops in India, Present status, area and production, geographical distribution, important varieties, propagation methods, soil and climatic requirements. Layout and planting, manuring, irrigation, inter-culture, training and pruning, intercropping, plant protection and management of physiological disorders of mango, banana, citrus, guava, pineapple, papaya, sapota, aonla, ber, litchi, jackfruit, and custard apple.

**Practical:** Identification of major and minor fruits crops fruit nursery management –rearing and maintenance of grafts/seedling, lifting and packing of plants, Orchard lay out and planting, orchard management practices-cultivation, weed management, pruning and training, manuring, irrigation and special care etc. Use of plant



Bio-regulator harvesting and marketing of fruit . Visit to commercial orchards Tissue culture lab, and Horticulture Research Stations.

**Reference Book:**

1. Commercial Fruits - S.P.Singh
2. A text book of pomology Vol-II ( Tropical fruits ) - T.K.Chattopadhaya
3. A text book of pomology Vol-II (Sub- tropical fruits ) - T.K. Chattopadhaya
4. Fruits tropical and sub-tropical - T.K.Bose
5. Fruits - R. Singh
6. Fruits Physiology and production – A. Singh

**4. Production technology of spices, aromatic, medicinal and plantation crops**

**3(2+1)**

**Theory:** Scope importance present status and future prospects of Medicinal, aromatic and plantation crops. Origin , distribution varieties cultivation, processing ,marketing and storage active in grediedients, extraction of days and essential oils of important medicinal, aromatic and plantation crops like Aswagandha, Sarpagandha, Kalmegh, Aloe, Sweet flag, Belladonna, Cinchona, glory lily, ipecac Gudmar,Sandal wood, Tulsi, roosffia, Senna, Perisnkle, eucalyptas, henna, Kewda , Guduchi, Jasmine, Vanilla, cashew, coconut, arecanut, oil palm Tea, Coffe, Rubber, Cocoa and and other important plant species .Oil extraction and purification, processing technology and value addition, classification of drugs and essential oils .

**Practical:** Identification of medicinal, and Plantation crops. Planting care management, harvesting and processing of medicinal, aromatics and plantation crops including pest-disease control. Extraction of oil from aromatic plants. Visit to plantation commercial sites of plantation and industries, collections of samples and preparation of herbarium.

**Reference Book:**

1. A Text book of plantation crops - K.M.Pillai.
2. Spices and plantation crops - J.S.Singh.
3. Medicinal Plants - A.K.Shrivastava
4. Major spices and condiments crop management and Post harvest technology - J.S.Pruthy.
5. Spices (Horticulture Science Series -5) (Ed.)K.V.Peter
6. Aromatic Plants and Essential Oils – M.S. Viridi, S. Malviya and T. Ramasami

**5. Post harvest management and value addition of fruits and vegetables**

**2(1+1)**

**Theory:** Importance of post harvest technology in fruits and vegetables ,maturity indices, harvesting and post harvest handling of fruits and vegetable, pre harvest factors affecting quality of post harvest shelf life of fruits and vegetables, Factor responsible for determination of harvesting of fruits and vegetables. Chemicals use for harvesting and delaying ripening of fruits and vegetables. Methods of storage, Methods of packaging and packaging materials and transport containers, cushioning materials and shrink wrapping. Importance and scope of fruit and vegetable preservation in India, principles of preservation by heat , low temperature, chemicals and fermentation, preservation through canning, bottling , freezing, dehydration, drying and radiations preparation of Jam, Jellies, marmalades, preserves, chutneys, pickles, ketchup , sauce, puree, syrups, juices, squashes and cordials, spoilage of canned products. Preservatives, colors permitted and prohibited in India.

**Practical:** Determination of stage of maturity of fruits and vegetables ,studies on composition of fruits and vegetables, estimation of sugar, pectin etc. in fruits and vegetables , Treatment of fruits and vegetables for longer shelf life by chemical and physical methods . Identification of instruments and equipments. Study of chemicals and preservatives used in the preservation laboratory, preparation of Juice, squash, cordials and pulp concentrate. Preparation of Jam, Jelly and marmalade. Sun drying and dehydration of fruits and vegetables. Visit to cold storage units in the state. Low temperature and zero energy cool chamber storing of fruits and vegetables.

**Reference Book:**

1. Fruit and Vegetable Preservation, Principles and practices - R.P. Srivastava and S. Kumar.
2. Fruit and Vegetable preservation – G. Lal and Siddhapa.
3. Commercial fruits and vegetables products - W.V. Cruess.
4. Post harvest technology of Horticulture Crops - (Ed.) K.V. Peter

## 5. ENTOMOLOGY

### 1. Insect Morphology and Systematic

3(2+1)

**Theory:** History of Entomology in India. Factors for insects abundance. Classification of Phylum Arthropoda up to classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts and legs. Wing venation, modifications and wing coupling apparatus. Structure of male and female genitalia. Sensory organs. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system in insects. Types of reproduction in insects, Systematics: Taxonomy-importance, history and development and binomial nomenclature, Definitions of Biotype, Sub-species, species, Genus, Family and Order. Classification of class Insecta upto Orders. Orthoptera, Acrididae, Dictyoptera, Mantidae, Odonata, Isoptera, Termitidae, Thysanoptera, Thripidae, Hemiptera, Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Neuroptera, Chrysopidae, Lepidoptera, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Coleoptera, Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae, Hymenoptera, Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Diptera, Cecidomyiidae, Trypetidae, Tachinidae, Agromyziidae.

**Practical:** Methods of collection and preservation of insects including immature stages: External features of Grasshopper/ Blister beetle; Types of insect antennae, mouthparts and legs, Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper): Dissection of male and female reproductive systems in insects (Grasshopper), Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance.

#### Reference Book:

1. Insects, Structure and Function - R.F. Chapman
2. A General Text book of Entomology - A.D. Imms
3. General and Applied Entomology - B.V. David and T.N. Anantha Krishnan.

### 2. Insect Ecology and integrated Pest Management including Beneficial Insects

3(2+1)

**Theory:** Insect Ecology: Introduction, Environment and its components. Effect of a biotic factors- temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents, Effect of biotic factors- food competition, natural and environmental resistance, Concepts of Balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem. Pest Surveillance and pest forecasting, Categories of pests, IPM: Introduction, importance, concepts, principles and tools of IPM- Host plant resistance, Cultural, Mechanical, Physical, Legislative, Biological (Parasites, predators & transgenic plant, pathogens such as bacteria, fungi and viruses) methods of control. Chemical control- importance, hazards and limitations, Classification of insecticides, toxicity of insecticides and formulations of insecticides, Study of important insecticides, Botanical insecticides - neem based products, Cyclodiens, Organophosphates, Carbamates, Synthetic Pyrethroids, Novel insecticides, Pheromones, Nicotiny insecticides, Chitin synthesis inhibitors, Phenyl pyrazoles, Avermectins, Macrocytic lactones, Oxadiazines, Thiourea derivatives, Pyridine azomethines, pyrroles etc. Nematicides, Rodenticides, Acaricides and fumigants. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Practices, scope and limitations of IPM, Insecticides Act- 1968- Important provisions. Application techniques of spray fluids, phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Beneficial insects: parasites and predators used in pest control and their mass multiplication techniques. Important groups of micro-organisms, bacteria, viruses and fungi used in pest control and their mass multiplication techniques. Important groups of micro-organisms, bacteria, viruses and fungi used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers, their importance, Non insect pests- mites, nematodes, rodents and birds, Vermiculture.

**Practical:** Visit to meteorological observatory/ automatic weather reporting stations; Study of terrestrial and pond ecosystems of insects; Studies on behaviours of insects and orientation (repellency, stimulation, deterancy); Study of distribution patterns of insects, sampling techniques for the estimation of insect population and damage; Pest Surveillance through light traps, pheromone traps and field incidence; Practicable IPM practices, Mechanical and physical methods: practicable IPM practices, cultural and biological methods; Chemical control, Insecticides and their formulations; Calculation of doses/ concentrations of insecticides; Compatibility of pesticides and

phytotoxicity of insecticides; IPM case studies; Identification of common phytophagous mites and their morphological characters; Identification of common plant parasitic nematodes and their morphological characters; Identification of rodents and bird pests and their damage; Identification of earthworms in vermiculture- visit to vermiculture unit; Other beneficial insects, pollinators, weed killers and scavengers.

**Reference Book:**

1. Elements of Economic Entomology - B. Vasantharaj David
2. Integrated Pest Management, Concepts and Approaches - G.S. Dhaliwal and R. Arora
3. Agricultural Entomology and Pest Control (ICAR) - S.Pradhan
4. Entomology and Pest Management - Larry, P. Pedigo
5. Insects and mites of crops in India (ICAR) - M. R. G. K. Nair
6. Botanical Pesticides in integrated pest management - M. S. Chari and Ramaprasad

**3. Crop pests, Stored Grain Pests and Their Management**

**3(2+1)**

**Theory:** *Stored grain pests:* Coleopteran and Lepidopteran pests, their biology and damage, preventive and curative methods, Distribution, biology, nature and symptoms of damage, and management strategies of insect and non insect pests of rice, sorghum, maize, ragi (*Eleusine coracana*), wheat, sugarcane, cotton, mesta, sunhemp, pulses, groundnut, castor, ginger, safflower, sunflower, mustard, brinjal, bhendi, tomato, cruciferous and cucurbitaceous vegetables, potato, sweet potato, colocasia, moringa, amaranthus, chillies, mango, citrus, grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut, tobacco, coffee, tea, turmeric, betel vine, onion, coriander garlic, curry leaf, pepper, ginger and ornamental plants.

**Practical:** Identification of pests, their damage, symptoms and management of rice, sorghum, maize, wheat, sugarcane, cotton, pulses, Solanaceous and Malvaceous vegetables, cruciferous and cucurbitaceous vegetables, chilli, mango, citrus and sapota.

**Reference Book:**

1. Integrated pest management, Concepts and Approaches - G. S. Dhaliwal and R. Arora
2. A Textbook of Applied Entomology 'Vol. I' - K. P. Srivastava
3. Elements of Economic Entomology - B. Vasantharaj David
4. Crop Protection: Management strategies - D. Prasad
5. Agricultural insect pests and their control - V. B. Awasthi
6. A textbook of Plantation Crops - K. M. Pillai

## 6. PLANT PATHOLOGY

### 1. Fundamentals of Microbiology

2(1+1)

**Theory:** History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, protection against infections. Applied areas of Microbiology: Metabolism in bacteria; ATP generation, chemoautotrophy, photo autotrophy, respiration, fermentation. Bacteriophages: structure and properties of Bacterial viruses- Lytic and Lysogenic cycles: virioids, prions. Bacterial genetics; Gene expression; Genetic recombination: transformation, conjugation and transduction, genetic engineering, Plasmids, episomes, genetically modified organism.

**Practical:** General instruction, Familiarization with instruments, materials, glassware etc. in a microbiology laboratory: Practice of Aseptic methods: I- Evaluation of aseptic techniques with Nutrient broth tubes, II-Evaluation of aseptic technique with a Nutrient agar plate. Methods of Sterilization and preparation of media I-Preparation of nutrient broth, nutrient agar plates, nutrient agar slant and nutrient agar stab; II-Sterilization of glassware by Dry heating; III-Sterilization of nutrient broth by Filtration: Plating methods for Isolation and Purification of bacteria I- Isolation of bacteria by Streak plate method. II- Isolation of aerobic spore forming bacteria by Enrichment using Streak plate method. III- Checking of purity of a bacterial culture by Streak plating method. Identification of bacteria by staining methods and Biochemical tests: I-Morphological examination of bacteria by simple and different staining. II-Different biochemical tests for identification of bacterial culture; Enumeration of bacteria: I- Enumeration of bacteria by stain slide method. II- Enumeration of bacteria by most probable number method. III- Enumeration of bacteria by pour plate method and spread plate method.

#### Reference Book:

1. Microbiology - M. J. Pelczar, E.C.S. Chan, N.R. Kreig
2. Microbiology - N. P. Saxena and D. K. Awasthi
3. Microbiology - R.P. Singh

### 2. Plant Pathogens and Principles of Plant Pathology

3(2+1)

**Theory:** Introduction, important plant pathogenic organisms, different groups, fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, viruses, virioids, algae, protozoa and phanerogamic parasites with examples of disease caused by them. General characters of fungi: Definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction in fungi (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi, Key to divisions and sub-divisions. Introduction: Definition and objectives of plant Pathology. History of Plant Pathology. Terms and concepts in Plant pathology. Survival and dispersal of plant pathogens. Phenomenon of infection: pre-penetration, penetration and post penetration. Pathogenesis: Role of enzymes, toxins, growth regulators and polysaccharides. Defense mechanism in plants- Structural and Bio-chemical (pre and post infection). Plant disease epidemiology. Plant disease Forecasting- Remote sensing-General principles of plant disease management- Importance, general Principles- avoidance exclusion, protection- plant Quarantine and Inspection- quarantine Rules and Regulations Cultural Methods- Rouging, eradication of alternate and collateral hosts, crop rotation, manure and fertilizer management, mixed cropping, sanitation, hot weather ploughing, soil amendments, time of sowing, seed rate and plant density, irrigation and drainage. Role and mechanisms of biological control and PGPR. Physical Methods- Heat and Chemical methods- Methods of application of fungicides. Host plant resistance- Application of biotechnology in plant disease management- Development of disease resistant, transgenic plants through gene cloning. Integrated plant disease management (IDM) - Concept advantages and importance.

**Practical:** Plant disease symptom identification and preservation of disease samples. Isolation techniques for plant pathogens. Study of Pythium, Phytophthora and Albugo: Study of Sclerospora, Peronosclerospora. Pseudoperonospora, Peronospora, Plasmopara and Bremia: Study of genera Mucor and Rhizopus. Study of Oidium, Oidiopsis, Ovulariopsis, Erysiphae, Phyllactinia, Uncinula and Podosphaera: Study of Puccinia (different stage). Uromyces, Hemilia: Study of Sphaelotheca, Ustilago and Totyosporium: Study of Agaricus, Pleurotus and Ganoderma: Study of Septoria, Colletotrichum. Pestalotiopsis and Pyricularia: Study of Aspergillus, Alternaria, Stemphyllium, Cercospora, Phaeoisariopsis, Rhizoctonia and Sclerotium. Demonstration of Koch's postulates. Study of different groups of fungicides and antibiotics. Preparation of fungicides- Bordeaux mixture, Bordeaux paste, Chestnut compound: Methods of application of fungicides- seed, soil and foliar; Bio-assay of fungicides- poisoned food techniques, inhibition zone technique and slide germination technique; Bio-control of plant pathogens- dual culture techniques, seed treatment. Visit to quarantine station and remote sensing laboratory.

**Reference Book:**

1. Plant Pathogens : The Fungi - R. S. Singh
2. An Introduction to Fungi- H. C. Dubey
3. Principles of Plant Pathology - R. S. Singh
4. Plant Pathology - R. S. Mehrotra

**3. Diseases of Field Crops and Their Management****3(2+1)**

**Theory:** Economic importance, symptoms, cause, epidemiology, disease cycle and integrated management of disease of rice, sorghum, bajra, maize, wheat, sugarcane, turmeric, ginger, tobacco, groundnut, sesamum, sunflower, cotton, redgram, blackgram, greengram, tea, soyabean.

**Practical:** Study of symptoms, etiology, host-parasite relationship and specific control measures of the following crop diseases. Presentation of disease samples survey and collection of diseases of rice, sorghum; diseases of wheat, bajra and maize; diseases of sugarcane, turmeric and tobacco; diseases of groundnut, castor and sunflower; diseases of sesamum and cotton; diseases of redgram, greengram, blackgram, bengalgram and beans; Field visits at appropriate time during the semester.

**Note:** Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester.

**Reference Book:**

1. Plant Diseases - R. S. Singh
2. Plant Pathology - P. D. Sharma
3. Diseases of Crop Plants - G. Rangaswami

**4. Diseases of Horticultural Crops and Their Management****3(2+1)**

**Theory:** Economic Importance, symptoms, causal organism, disease cycle and integrated management of diseases of citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, apple chilli, brinjal, bhendi, potato, crucifers, cucurbits, tomato, beans, onion, coconut, oil palm, betelvine, mulberry, coffee, tea, rose, chrysanthemum and jasmine.

**Practical:** Diseases of beans, citrus, guava and sapota; Disease of papaya, banana, pomegranate and beri; Diseases of mango, grapes and apple; Diseases of chilli, brinjal and bhendi; Diseases of potato, tomato and crucifers; Diseases of cucurbits, onion and betelvine; Diseases of oil palm, coconut, tea and coffee ; Diseases of rose, chrysanthemum and jasmine. Field visits at appropriate time during the summer.

**Note:** Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester.

**Reference Book:**

1. Diseases of Vegetables - R. S. Singh
2. Diseases of Fruits and Vegetables and their Management - T. S. Thind
3. Diseases of Crop Plants - G. Rangaswami

**5. Mushroom Cultivation****1(0+1)**

**Practical:** Historical development and importance of cultivated, medicinal and poisonous mushroom. General morphology of different mushrooms. Methods of isolation and purification of mushroom for development of mother culture. Methods for preparation of spawn. Methods of cultivation of *Volvariella*, *Pleurotus* and milky mushroom. Care of mushroom beds. Study of contaminants and diseases limiting mushroom production. Mushroom processing and preservation. Development of small unit model for mushroom cultivation.

**Reference Book:**

1. Mushroom Cultivation in India - B.C.Suman and V.P.Sharma
2. Mushroom Growing for Everyone - G. Roy
3. Mushroom Production and Processing - V.N.Pathak, N.Yadav and M.Gaur

## 7. NEMATOLOGY

### 1. Introductory Nematology

2(1+1)

**Theory:** Introduction on Nematode. Economic Importance of Nematodes, History of Phytonematology, Structure of a typical plant parasitic nematode. General morphology on various organ systems and organelles. Modification of stoma and oesophagus in soil and plant nematodes. Biology of nematode, Classification of economically important nematode genera up to family level with identification marks.

**Practical:** Study of Nematological laboratory appliances, study of binocular stereoscopic and Research Microscopes, collection of soil and plant samples, Extraction of nematodes from soil by Cobb's sieving and decantation technique followed by modified Baermann technique, killing and fixing of nematodes, processing and mounting of nematodes, mouth parts and *oesophagus* of soil and plant nematodes. Identification of *Hoplolaimus*, *Helicotylenchus*, *Tylenchorhynchus*, *Criconemella*, *Caloosia*.

#### Reference Book:

1. Text book on Introductory Plant nematology – R.K. Walia and H.K. Bajaj
2. A Treatise on Phytonematology – P.P. Reddy
3. Introduction to Plant Nematology – V.H. Dropkin

### 2. Crop Nematode Management

2(1+1)

**Theory:** Association of plant parasitic nematodes in various crop plants. Classification of nematodes based on feeding habits. Feeding processes in phytonematodes. Symptomatology Economically important nematodes affecting Rice, wheat, important vegetables, fruit and ornamentals with their symptom, biology, spread of the disease and integrated nematode management.

**Practical:** Isolation of Plant parasitic nematodes from plant parts, collection and preservation of nematode disease specimens, staining and presentation of root-knot nematode infected root sample, Experiment technique used in Pathogenicity studies of root-knot nematode, Clinical study of *Meloidogyne*, *Rotylenchulus*, *Tylenchulus*, *Anguina*, *Aphelenchoides*, *Hirschmanniella*, *Pratylenchus*, *Radopholus*, *Xiphinema*. Study of nematicides, bio-pesticides, oilcakes and their method of application.

#### Reference Book:

1. Nematode Pests of Crops - D.S. Bhatti and R.K. Walia
2. Text Book on Introductory Plant Nematology - R.K. Walia and H.K. Bajaj.
3. Nematode Pest Management - An appraisal of Eco-friendly approaches - G. Swarup, D.R. Dasgupta and J.S. Gill

## 8. AGRICULTURAL ECONOMICS

### 1. Principles of Agricultural Economics

2(2+0)

**Theory:** Introduction to economic theory: Micro Economics: Definition, subject matter, division of economics, scope and importance of economics. Basic terms and concepts used in economics. Demand theory : Characteristics of human wants, classification of wants, law of diminishing marginal utility, law of equi-marginal utility, consumer's surplus, meaning and kinds of demand, law of demand, elasticity of demand and measurement of elasticity of demand. Production and supply: Nature and factors of production, meaning, importance and characteristics of land, meaning and characteristics of labour, labour efficiency, importance of capital, capital formation, stages of capital formation. Organization: Importance and functions of entrepreneur, different forms of business organization definition, meaning and law of supply. Market: Characteristics of perfect and various imperfect markets, equilibrium conditions of firm, price determination under perfect competition. Macro economics: concepts, importance and measurement of national income. Inflation: Kinds of inflation, causes and consequences of inflation and role of monetary and fiscal policy to check inflation. Public finance: meaning of public finance, distinction between public and private finance, importance and functions of public finance, sources of govt. finance. Public expenditure: classification of public expenditure, principles of public expenditure, importance and role of public expenditure on economy. Public revenue: canons of taxation, characteristics of a good tax system, kinds of taxes, advantages and disadvantages of different types of taxes, incidences of taxation.

#### Reference Book:

1. Elementary economic theory - K.K. Dewett and J.D. Verma
2. International Economics - B. Mishra
3. Fundamentals of Agricultural Economics - A.N. Sadhu and A. Singh
4. Economics - Paul A. Samuelson and W.D. Nordhans

### 2. Agricultural Finance and Cooperation

2(1+1)

**Theory:** Agricultural finance: nature and scope, time value of money, compounding and discounting. Agricultural credit: meaning, definition, need, classification. Credit analysis: 3R's 5C's and 7P's of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks. Lead bank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, Insurance and Credit Guarantee Corporation of India. Assessment of crop losses, determination of compensation. Crop insurance, advantages and limitations in application, estimation of crop yields. Agricultural cooperation: philosophy and principles. History of Indian cooperative Movement, pre-independence and post independence periods, cooperation in different plan periods, cooperative credit structure: PACS, FSCS. Reorganization of cooperative credit structure in Orissa, Successful cooperative systems in Gujarat, Maharashtra, Punjab etc.

**Practical:** Factors governing use of capital and identification of credit needs; Time value of money, Compounding and discounting; Tools of financial management, Balance sheet, Income statement and cash flow analysis; Estimations of credit needs and determining unit costs; Preparations and analysis of loan proposals; Types of repayment loans; Study of financial institutions: PACS, DCCB, Apex Banks, RRB, CBs, NABARD.

#### Reference Book:

1. Agril. Finance – W.E. Lee, M.D. Bohelje, A.G. Nelson and W.G. Murray
2. Managing Agril. Finance : Theory and Practice - A.S. Kahlon and K. Singh
3. Agricultural Finance and Management - S. Reddy and R. Ram
4. Agril. Finance : Theory and Practice - J.P. Singh

### 3. Agricultural Marketing, Trade and Prices

2(1+1)

**Theory:** Agricultural Marketing: Concepts and Definition, Scope and subject matter, Market and Marketing: Meaning, Definitions, Components of a market, Classification. Market structure, Conduct, performance. Marketing structure, market functionaries or agencies. Producer's surplus: Meaning, Types of producers surplus, marketable surplus. Marketed surplus, importance, factors affecting marketable surplus. Marketing channels: Meaning, definition, channels for different products. Market integration, meaning, definition, types of market integration. Marketing efficiency: meaning, definition, marketing costs, margins and price spread, factors affecting the cost of marketing, reasons for higher marketing costs of farm commodities, ways of reducing marketing costs. Theories of

international trade: Domestic trade, free trade, international trade, GATT, WTO, implications of AOA, market access, domestic support, export subsidies, EXIM-policy and ministerial conferences. Cooperative marketing. State trading. Ware housing corporation; central and state, objectives, functions, advantages. Food corporation of India: objectives and functions. Quality control, agricultural products, AGMARK, price characteristics of agricultural product process, meaning, need for agricultural price policy. Risk in marketing: meaning and importance, types of risk in marketing, speculations and hedging, futures trading, contract farming.

**Practical:** Identification of marketing channels; study of Rythu Bazars, Regulated markets; study of unregulated markets; study of livestock markets; price spread analysis; visit to market institutions, NAFED; study of SWC,CWC and STC; analysis of information of daily prices; marketed and marketable surplus; of different commodities.

**Reference Book:**

1. Agricultural Marketing in India - S.S. Acharya and N.L. Aggarwal
2. Agricultural Price Policy - S.S. Acharya and N.L. Aggarwal
3. Marketing of Agricultural Products - R.L. Kohls and N. Josesh Uhl
4. Agricultural Price Analysis - G.E. Shephard

**4. Production Economics and Farm Management**

**2(1+1)**

**Theory:** Production economics: Definition of production economics, assumptions in study of production economics, meaning of perfect competition and price determination under perfect competition. Production and cost functions, law of diminishing return and three stages of production, deriving cost function from production function. Factor-product relationship: economic efficiency condition, methods of determining the optimum amount of input and output, short run equilibrium derived demand of inputs, opportunity costs. Factor-factor relationship: methods determining least cost combination of two variable inputs, elasticity of factor substitution, iso-cline, expansion path and profit maximization. Product-product relationship: Enterprise combinations in agriculture, methods determining maximum revenue combination of enterprises and equi-marginal principle. Farm Management: Definition, scope, functions of farm management science, nature and characteristics of farm management science, various farm management decisions, farm planning and budgeting partial and complete budget, steps in farm planning and budgeting, types and system of farming. Linear programming: assumptions, advantages and limitations of linear programming.

**Practical :** Mathematical problems relating to production and cost function, factor-product, factor-factor and product-product relationship, methods of calculation of depreciation, preparation of enterprise budget, calculation of cost  $A_1$ ,  $A_2$ ,  $A_3$ ,  $B_2$  etc. farm business income, family labour income, net income using farm management data, preparation of farm plans.

**Reference Book:**

1. Fundamentals of Farm Business Management – S.S. Johl and T. Kapur
2. Production Economics – J.P. Doll and F. Orazem
3. Economics of Farm Management in India – A.S. Kahlon and K. Singh

**5. Fundamentals of Agri- Business Management**

**2(1+1)**

**Theory:** *Agribusiness*: Meaning, definition, structure of agribusiness, (input, farm product sectors). Importance of agribusiness in the Indian economy, agricultural policy, agribusiness management, distinctive features, importance of good management, definitions of management. Management functions, planning, meaning, definition, types of plans (purpose or mission, goals or objectives, strategies, policies, procedures, rules, programmes, budget) characteristics of sound plan, steps in planning, organization, staffing, directing, motivation, ordering, leading, supervision, communication, control. Capital management, financial management of agribusiness: importance of financial statements, balance sheet, profit and loss statement, analysis of financial statements, agro-based industries: importance and need, classification of industries, types of agro-based industries, institutional arrangement, procedure to set up agro-based industries, constraints in establishing agro-based industries. Marketing management: meaning, definitions, marketing mix, 4Ps of marketing. Mix, market segmentation, methods of market, product life cycle. Pricing policy, meaning, pricing method, prices at various stages of marketing; project, definitions, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation, appraisal and evaluation techniques, NPW, BCR, IRR, N/K ratio, sensitivity analysis, characteristics of agricultural projects: preparation of project reports for various activities in agriculture and allied sectors: dairying, poultry, fisheries, agro-industries etc.



**Practical:** Study of input markets: seed, fertilizers, pesticides. Study of output markets, grains, fruits, vegetables, flowers. Study of product markets, retail trade commodity trading, value added products. Study of financing institutions cooperatives commercial banks, RRBs, agribusiness finance limited, NABARD; Preparations of projects, feasibility reports; project appraisal techniques; case study of agro-based industries.

**Reference Book:**

1. An Introduction to Food and Agribusiness - G.A. Baker
2. Marketing Management – P. Kotler
3. Principle and Practice of Management - L.M. Prasad

## 9. AGRICULTURAL EXTENSION EDUCATION

### 1. Dimensions of Agricultural Extension

2(1+1)

**Theory:** Education- Meaning, Definition, Types- Formal, Informal and Non-formal education and their Characteristics. Extension Education and Agricultural Extension- Meaning, Definition, Concepts, Objectives and Principles. Rural development - Meaning, Definition, Concepts, Objectives, Importance and Problems in rural development. Developmental programmes of pre-independence era- Sriniketan, Marthandam, Gurgaon experiment and Gandhian constructive programme. Development programmes of Post independence era, Firka Development, Etawah- Pilot project and Nilokheri Experiment. Community Development Programme- Meaning, Definition, Concepts, Philosophy, Principles, Objectives, Differences between Community Development and Extension Education. National Extension service. Panchayat Raj system-Meaning of Democratic- Decentralization and Panchayat Raj, three tiers of Panchayat Raj system. Power, Functions and Organizational setup. Agricultural Development Programmes with reference to year of start, objectives & salient features- Intensive Agricultural District Programme (IADP) , High Yielding Varieties Programme(HYVP) , Institution Village Linkage Programme(IVLP) , Watershed Development Programme (WDP), National Agricultural Technology Project(NATP) , ATMA, ATIC, Social Justice and Poverty alleviation programmes- Integrated Tribal Development Agency( ITDA), Integrated Rural Development Programme (IRDP) , Swarna Jayanthi Gram Swarajgar Yojana (SGSY) , Prime Minister Employment Yojana (PMEY). New trends in extension, privatization. Women Development programmes- Development of Women and Children in Rural Areas (DWCRA), Rashtriya Mahila Kosh(RMK), Integrated Child Development Scheme (ICDS) and Mahila Samridhi Yojana (MSY). Reorganized extension system (T & V System)- Salient features, Fort night Meetings, Monthly workshops, Linkages, Merits and Demerits. Emergence of Broad Based Extension (BBE.).

**Practical:** Visits to a village and kisan mandal to study the ongoing development programmes. Visits to Panchayat Raj Institutions to study the functioning of Gram Panchayat (GP) & Zilla Praja Parishad (ZPP). Visit and study the District Rural Development Agency (DRDA). Participation in monthly workshops of Training and Visit (T&V) System. Visit to Watershed Development Project area. Visit to a village to study the Self Help Groups (SHGs) of DWCRA. Visit to a voluntary organization to study the developmental activities. Organizing PRA techniques in a village to identify the agricultural problems. Visit to villages.

#### Reference Book:

1. Education & Communication for Development- O.P.Dahama & O.P. Bhatanagar
2. Extension Communication & Management- G.L.Ray
3. Defining Agricultural Extension for 1990s- D.C. Misra
4. Agricultural Extension- A.W. Van Den Ban & H.S. Hawkins
5. Hand book of Extension Education- O.S.Rathore *et al*
6. Rural Extension Hand book- V. Singh & M.S. Vasistha
7. New Dimension and Approaches in Extension – J. Vasanthakumar

### 2. Fundamentals of Rural Sociology and Educational Psychology

2(2+0)

**Theory:** Extension Education and Agricultural Extension - Meaning, Definition, Scope and Importance. Sociology and Rural Sociology, Meaning, Definition, Scope, Importance of Rural Sociology in Agricultural Extension and Interrelationship between Rural Sociology & Agricultural Extension . Indian Rural Society, Important characteristics. Differences and Relationship between Rural and Urban societies. Social Groups- Meaning, Definitions, Classification, Factors considered in formation and organization of groups, Motivation in group formation and Role of Agricultural Extension. Social Stratification- Meaning, Definition, Functions, Basis for stratification, Forms of Social stratification Characteristics and - Differences between Class & Caste System. Cultural concepts, Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions- Meaning, Definition and their Role in Agricultural Extension. Social Values and Attitudes- Meaning , Definition. Types and Role of Social Values and Attitudes in Agricultural Extension. Social Institutions – Meaning, Definition, Major institutions in Rural society, Functions and their Role in Agricultural Extension. Social Organizations- Meaning, Definition, Types of Organizations and Role of Social organization in Agricultural Extension. Social Control- Meaning, Definition, Need of social control and Means of Social control. Social change- Meaning, Definition. Nature of Social change, Dimensions of social change and factors of social change. Leadership- Meaning, Definition, Classification, Roles of a leader, Different methods of Selection of Professional and Lay leaders. Training of Leaders- Meaning , Definition, Methods of training, Advantages and Limitations in use of local leaders in

Agricultural Extension. Psychology and Educational Psychology-Meaning, Definition, Scope and Importance of Educational Psychology in Agricultural Extension, Intelligence- Meaning, Definition, Types, Factors affecting intelligence and Importance of intelligence in Agricultural Extension. Personality – Meaning, Definition, Types, Factors influencing the Personality and Role of personality in Agricultural Extension. Teaching- Learning process-Meaning and Definition of Teaching, Learning, Learning experience and Learning situation . Elements of learning situation and its characteristics. Principles of learning and their implication for teaching.

**Reference Book:**

1. Introductory Rural Sociology- J.B. Chitamber
2. An Introduction to Sociology- Vidya Bhusan & D. R. Sachdev
3. Introductory Psychology - C.T. Morgan & R.A. King
4. Educational Psychology- C.E. Skinner
5. Rural Sociology & Psychology in Extension Education- N.K.Tripathi
6. Extension Education- A. Adivi Reddy

**3. Entrepreneurship Development and Communication Skills**

**2(1+1)**

**Theory:** Entrepreneurship Development : Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business / entrepreneurial environment . Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development , importance of planning, monitoring , evaluation and follow up, managing competition, entrepreneurship development programs, SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs, Export and ‘Import, Policies relevant to agriculture sector. Venture capital Contact farming and joint ventures, public-private partnership. Overview of agri inputs industry. Characteristics of Indian agricultural processing and export industry. Social Responsibility of ‘Business Communication Skills: Structural and functional grammar: meaning and process of communication, verbal and non-verbal communication: listening and note taking, writing skills, oral presentation skills, field diary and lab record, indexing , footnote and bibliographic procedures, Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting, individual and group presentations, impromptu presentation, public speaking, Group discussion, Organizing seminars and conferences.

**Practical:** Listening and note taking , writing skills, oral presentation skills, field diary and lab record, indexing, footnote and bibliographic procedures, Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting, individual and group presentation.

**Reference Book:**

1. Fundamentals of Entrepreneurship- S.K.Mohanty
2. Participatory Planning and Project Management in Extension Sciences- M.M.Adhikary
3. The Entrepreneurs Hand Book- J. Mancuso
4. Agricultural Communication- A reference Manual (FAO) - B.E. Swanson *et al*
5. Development Communication for Agriculture- R.K.Samanta
6. Market Led Extension – Dimensions & Tools- F.M.H.Kalee *et al*

**4. Extension Methodologies for Transfer of Agricultural Technology**

**2(1+1)**

**Theory:** Communication- Meaning, Definition, Models, Elements and their Characteristics. Types and Barriers in communication. Extension Programme Planning- Meaning, Definitions of Planning, Programme, Project, Importance, Principles and Steps in Programme Development Process, Monitoring and Evaluation of Extension Programmes. Extension Teaching methods- Meaning, Definition, Functions and Classification. Individual contact methods- Farm and Home visit, Result Demonstration. Field trials – Meaning, Objectives, Steps, Merits and Demerits, Group contact methods – Group discussion, Method demonstration, Field Trips – Meaning, Objectives, Steps, Merits and Demerits. Small group discussion techniques - Lecture, Symposium, Panel, Debate, Forum, Buzz group. Workshop, Brain Storming, Seminar and Conference. Mass contact Methods – Campaign, Exhibition, Kisan Mela, Radio & Television- Meaning, Importance, Steps, Merits & Demerits, Factors influencing in selection of Extension Teaching Methods and Combination (Media Mix) of Teaching methods. Innovative Information sources – Internet’ Cyber Cafes, Video and Tele conference, Kisan call centres, Consultancy clinics. Agricultural Journalism - Meaning, Scope and Importance, Source of news, Types, Merits and Limitations. Diffusion and Adoption of Innovations – Meaning, Definition, Models of adoption Process, Innovation – Decision Process –

Elements, Adopter categories and their characteristics, Factors influencing adoption process. Capacity building of Extension Personnel and Farmers- Meaning , Definition, Types of training, Training to farmers, farm women and Rural youth – FTC and KVK.

**Practical:** Simulated exercises on communication Identifying the Problems. Fixing the Priorities and selecting a most important problem for preparation of a project. Developing a project based on identified problem in a selected village. Organization of Group discussion and Method demonstration. Visit to KVK / FTC. Planning and Writing of scripts for Radio and Television. Audio Visual aids- Meaning, Importance and Classification . Selection, Planning, Preparation, Evaluation and Presentation of visual aids. Planning & Preparation of visual aids- Charts, Posters, Over Head Projector, (OHP) Transparencies, Power Point Slides, Planning and Preparation of Agricultural Information materials – Leaflet, Folder, Pamphlet, News Stories, Success Stories, Handling of Public Address Equipment (PAE) System, Still camera, Video Camera and Liquid Crystal Display (LCD) Projector.

**Reference Book:**

1. Innovative Extension Approaches in Technology Transfer - B.S. Hansra *et al*
2. Extension Communication & Management- G.L. Ray
3. Text Book on Agricultural Communication Process & Methods - A.S. Sandhu
1. 4. Diffusion of Innovations - E.M. Rogers
4. Diffusion of Agricultural Innovations in Village India - S. Das Gupta
5. Farm Journalism - J. Balailal & K.P. Mitra
6. The Process of Communication - D.K. Berlo

## 10. AGRICULTURAL STATISTICS

### 1. Statistics

2(1+1)

**Theory:** *Introduction:* Definition of Statistics and its use and limitations; Frequency Distribution and Frequency Curves; Measures of Central Tendency: Characteristics of Ideal Average, Arithmetic Mean; Median, Mode, Merits and Demerits of Arithmetic Mean; Measures of Dispersion: Standard Deviation, Variance and Coefficient of Variation; Probability: Definition and concept of probability; Normal Distribution and its properties; Introduction to Sampling: Random Sampling; the concept of Standard Error; Tests of Significance- Types of Errors, Null Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis; Large Sample Test- SND test for Means, Single Sample and Two Samples; Small Sample Test for Means - Student's t-test for Single Sample, Two Samples and Paired t test. F test; Chi-Square Test in 2x2 Contingency Table, Yates' Correction for continuity; Correlation: Types of Correlation and identification through Scatter Diagram, Computation of Correlation Coefficient 'r' and its testing. Linear Regression: of Y on X and X on Y. Inter-relation between 'r' and the regression coefficients, fitting of regression equations. Experimental Designs: Basic Designs, Completely Randomized Design (CRD), Layout and analysis with equal and unequal number of observations, Randomized Block Design (RBD), Layout and analysis, Latin Square Design (LSD), Layout and analysis.

**Practical:** Construction of Frequency Distribution Tables and Frequency Curves; Computation of Arithmetic Mean for Un-Grouped and Grouped data; Computation of Median for Un-Grouped and Grouped data; Computation of Mode for Un-Grouped and Grouped data; Computation of Standard Deviation, Variance and Coefficient of Variation for Un-Grouped and Grouped data; SND test for Means, Single Sample; SND test for Means, Two Samples; Student's t-test for Single Sample; Student's t-test for Two Samples; Paired t test and F test; Chi-Square Test in 2x2 Contingency Table, Yates' Correction for continuity; Computation of Correlation Coefficient 'r' and its testing; Fitting of regression equations- Y on X and X on Y; Analysis of Completely Randomized Design (CRD); Analysis of Randomized Block Design (RBD); Analysis of Latin Square Design (LSD).

#### Reference Book:

1. A First Course in Statistics with Applications- AKPC Swain
2. A Text Book of Agricultural Statistics – R.Rangaswamy
3. Fundamentals of Statistics, Vol. I & II – A.M.Goon, M.K.Gupta and B.Dasgupta

### 2. Introduction to computer application

2(1+1)

**Theory:** Introduction to Computers, Anatomy of Computers, Input and Output Devices. Units of Memory, Hardware, Software and Classification of Computers. Personal Computers, Types of Processors, booting of computer, warm and cold booting. Computer Viruses, Worms and Vaccines. Operating System – DOS and WINDOWS. Disk Operating System (DOS): Some fundamental DOS Commands, FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD and DELTREE, Rules for naming files in DOS and Types of files. WINDOWS: GUI, Desktop and its elements, WINDOWS Explorer, working with files and folders; setting time and date, starting and shutting down of WINDOWS. Anatomy of a WINDOW, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars. Applications – MSWORD: Word, processing and units of document, features of word-processing packages. Creating, Editing, Formatting and Saving a document in MSWORD; MSEXCEL: Electronic Spreadsheets, concept, packages. Creating, Editing and Saving a spreadsheet with MSEXCEL. Use of in-built Statistical and other functions and writing expressions. Use of Data Analysis Tools, Correlation and Regression, t-test for two-samples and ANOVA with One-way Classification. Creating Graphs. MS Power Point: Features of Power Point Package. MSACCESS: Concept of Database, Units of database, creating database; Principles of Programming: Flow Charts and Algorithms, illustration through examples. Internet: World Wide Web (WWW), Concepts, Web Browsing and Electronic Mail.

**Practical:** Study of Computer Components; Booting of Computer and its Shut Down; Practice of some fundamental DOS Commands, TIME, DATE, DIR, COPY, FORMAT, VOL, LABEL, PATH; Practicing WINDOWS Operating System, Use of Mouse, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars; WINDOWS Explorer, Creating Folders, COPY and PASTE functions; MSWORD: Creating a Document, Saving and Editing; MSWORD, Use of options from Tool Bars, Format, Insert and Tools (Spelling & Grammar) Alignment of text; MSWORD, Creating a Table, Merging of Cells, Column and Row width; MSEXCEL: Creating a Spreadsheet, Alignment of rows, columns and cells using Format tool bar; MSEXCEL: Entering Expressions through the formula tool bar and use of inbuilt functions, SUM, AVERAGE, STDEV; MSEXCEL: Data Analysis

using inbuilt Tool Packs, Correlation & Regression; MSEXCEL: Creating Graphs and Saving with & without data; MSACCESS: Creating Database, Structuring with different types of fields; MS Power Point: Preparation of slides on Power Point; Transforming the data of WORD, EXCEL and ACCESS to other formats; Internet Browsing: Browsing a Web Page and Creating of E-Mail ID

**Reference Book:**

1. Computer Studies – a First course – J. Shelly and R. Hunt.
2. Programming in BASIC – E.Balagurusamy
3. Microsoft Windows XP Manual.
4. Microsoft Office XP Manual.

## 11. PLANT PHYSIOLOGY

### 1. Crop physiology-I

2(1+1)

**Theory:** Introduction, Importance in Agriculture, Seed Physiology, Seed Structures, morphological, Physiological and biochemical changes during seed development. physiological maturity, Morphological and physiological changes associated with physiological maturity in crops. Harvest maturity, seed viability and vigour. Factors affecting seeds viability and vigour. Methods of testing seed viability and vigour. germination, utilization of seed reserves during seed germination. Morphological, physiological and biochemical changes during seed germination. Factors affecting seed germination. Post harvest physiology-seed dormancy, definition, types of seed dormancy. Advantages and disadvantages of seed dormancy. Causes and remedial measures for breaking seed dormancy. Optimum condition for seed storage, factors Influencing seed storage (ISTA standards). Crop water relationship, physiological Importance of water to plants, water potential and its components, measurement of water Status in plants. transpiration, significance, transpiration in relation to crop productivity. water use efficiency WUE in C<sub>3</sub>, C<sub>4</sub> and CAM plants. Factors affecting WUE. photosynthesis, energy synthesis significance of C<sub>3</sub>, C<sub>4</sub> and CAM pathways. relationship of photosynthesis and crop productivity, photorespiration. Factors affecting photosynthesis and productivity. Method of measuring photosynthesis. Photosynthetic efficiency. Respiration and its significance, brief account of growth respiration and maintenance respiration, alternate respiration, salt respiration, wound respiration-measurement of respiration.

**Practical:** Preparation of solutions, measurement of water status in roots, stems and leaves, measurement of water potential by Chardakov's method, measurement of Osmotic potential by Plasmolytic method, measurement of water potential by Gravimetric method, measurement of absorption spectrum of chloroplastic pigments and fluorescence, measurement of chlorophyll a, b and total chlorophyll, measurement of carotenoid pigments, measurement of stomatal frequency and index, measurement of respiration, study of leaf anatomy of C<sub>3</sub>, and C<sub>4</sub> plants, measurement of transpiration, imbibitions of seed, optimum conditions of seed germination. Seed viability test, breaking of seed dormancy by chemical and mechanical methods, yield analysis, seed Vigour test.

#### Reference Book:

1. Principles of seed technology - G.N.Kulkarni
2. Plant physiology - R.G.S. Bidwell
3. A text book of plant physiology - C.P.Mallick and A.K.Srivastav
4. The germination of seeds - A.M. Mayer and A.Poljakoff-Mayber
5. Plant physiology - R.K.Shinha
6. Plant Physiology - K.N.Vatia and A.N.Parasar
7. The physiology and biochemistry of seed development, dormancy and germination - A.A.Khan
8. Seed Physiology – K. Vanangamudi *et al*

### 2. Crop physiology-II

3(2+1)

**Theory:** Nutriophysiology – definition-Mengels classification of Plant nutrients-physiology of nutrient uptakes – function of plant nutrient – deficiency and toxicity symptoms of plant nutrients – foliar nutrients – foliar nutrition – hydroponics. Growth and development, definition, determinate and indeterminate growth, monocarpic and polycarpic species with examples. Measurement of growth, growth analysis, growth characteristics, definition and mathematical formulae. Translocation of assimilates. Phloem loading, apoplastic and symplastic transport of assimilates. Source and sink concept. Dry matter partitioning. Harvest index of crops. Photoperiodism and vernalization in relation to crop productivity. Plant growth regulators, classification, occurrence, biosynthesis, mode of action of auxin, gibberellins, cytokinins, ABA, ethylene. Novel plant growth regulators, commercial application of plant growth Regulators in agriculture. Senescence and abscission, definition, theories of mechanism And control of senescence – physiological and biological changes and their significance. Fruit ripening, metamorphic changes – climacteric and non-climacteric fruits, hormonal Regulation of fruit ripening (with ethrel, CCC, polaris, paclobuterozole). Stress Physiology – drought, submergence and anoxia. Temperature stress, salt stress, radiation Stress. Environmental pollutants – heavy metals – air pollution and green house effect on Crop productivity.

**Practical:** Growth analysis, calculation of growth parameters, determination of leaf area by Various methods, study the effect of plant growth regulators on plant growth, senescence Of plant parts, determination of chlorophyll stability index, determination of soil water Potential. Quantitative and qualitative test of mineral nutrients in plant sample, study. The mineral nutrient deficiency by hydroponics.

**Reference Book:**

1. Stress physiology - J.Levitt
2. Plant growth regulator potential and practice - T.H.Thomas
3. Plant physiology - P.S.Gill
4. Plant physiology - S.S.Purohit
5. Plant physiology - R.G.S. Bidwell
6. A text book of plant physiology - C.P.Mallick and A.K.Srivastav
7. Physiology of crop plants - F.P.Gardener, R.B.Pearce & R.L.Mitchell
8. Mineral nutrition of higher plants - Horst Marschner
9. A hand book on mineral nutrition and diagnostic technique for nutritional disorders of crops - G.Pathmanabham



## 12. SEED SCIENCE & TECHNOLOGY

### 1. Principles of Seed Science and Technology

2(1+1)

**Theory:** Seed Technology – scope and importance, development of seed industry in India, difference between seed and grain, categories of agricultural seeds. Development of crop varieties and hybrids, their evaluation and release at National and State level. Seed quality – concept, quality characteristics. Seed development and maturation, accumulation of food reserves in seeds. Seed germination – types of seed germination, factors affecting germination, changes in seeds associated with germination, field emergence and stand establishment. Seed viability – difference between seed viability and germination, viability nomograph. Seed vigour – concept, factors affecting seed vigour, significance of assessing seed vigour. Seed dormancy – merits and demerits of dormancy in seeds, intensity and duration of dormancy, types of seed dormancy, causes, methods of breaking dormancy, induction of dormancy. Seed longevity and deterioration – orthodox and recalcitrant seeds, factors influencing the life span of seeds, symptoms of seed deterioration, possible causes of seed deterioration, seed invigoration. Seed testing – objectives, development of organisations for seed testing at international and national level, establishment of a seed testing laboratory. Seed health – pathogens, insects and other organisms causing damage to sowing quality of seed and their management. Seed legislation: Seeds Act 1966, seed law enforcement – duties and powers of seed inspectors, offences and penalties, Seeds (Control) Order 1983, other issues related to seed quality regulation. Intellectual Property Rights, patenting, WTO, Plant Breeders Rights.

**Practical:** Identification of different agricultural seeds, Seed structure of typical monocot and dicot seeds, Seed sampling and handling of seed samples, Moisture estimation, Purity analysis, Determination of ODV, Germination test, Seed viability test, Assessment of seed vigour, Genetic purity testing – laboratory methods and field plot test, Seed health testing for pathogens and insect damage.

#### Reference Book:

1. Seed Technology – R.L. Agrawal
2. Principles of Seed Technology – G.M. Kulkarni
3. Structure Development and Reproduction in Angiosperms – V. Singh, P.C. Pande & D.K. Jain
4. Principles of Seed Science & Technology – L.O. Copeland & M.B. KcDonald

### 2. Seed Production Technology and Quality Control

2(1+1)

**Theory:** Seed production: Introduction, importance of seed production, classes of seed, seed policy, seed demand forecasting and planning for certified, foundation and breeder seed production, deterioration of crop varieties, factors affecting deterioration and their control, maintenance of genetic purity during seed production, production of nucleus & breeder seed, maintenance and multiplication of pre-release and newly released varieties in self and cross-pollinated crops, general principles of seed production in open-pollinated varieties and hybrids. Seed Processing: Objectives, planning, layout and establishment of seed processing plant, sequence of seed processing operations, Seed Drying – need, methods, principle of forced air seed drying, components and operation of seed dryers, types of seed dryers, Seed cleaning and grading – pre-conditioning equipments and their use, basic seed cleaning using the air screen machine, its working principle, different upgrading equipments and their use, Seed treatment – importance of seed treatment, types of seed treatments, equipment used for seed treatment (Slurry and Mist-o-matic treaters), Seed packing – types of packaging materials, criteria for their selection, Seed storage – stages of seed storage, factors affecting seed longevity during storage, conditions required for good storage, general principles of seed storage, constructional features for good seed warehouse, control of temperature and relative humidity in storage, measures for pest and disease control. Seed certification: procedure for seed certification, field inspection and field counts, seed inspection, minimum seed certification standards. Seed marketing: marketing structure, marketing organization, sales generation activities, promotional media, pricing policy, factors affecting seed marketing.

**Practical:** Study of foundation and certified seed production techniques (varieties and hybrids) in rice, wheat, maize, green gram, black gram, arhar, groundnut, rapeseed and mustard, sesamum, cotton, jute, potato, tomato, brinjal, chillies, okra and onion. Visit to seed production plots of above crops. Visit to seed processing plant, Varietal identification in seed production plots, Planting ratios, isolation distance, roguing, etc.

#### Reference Book:

1. Seed Technology – R.L. Agrawal
2. Principles of Seed Certification and Testing – N.P. Nema
3. Principles of Seed Science & Technology – L.O. Copeland & M.B. KcDonald
4. Seed Processing – B.R. Gregg, A.G. Law, S.S. Viridi & J.S. Ballis.

## 13. AGRICULTURAL BIOTECHNOLOGY

### 1. Principles of Plant Biotechnology

3(2+1)

**Theory:** Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of In-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement.

**Practical:** Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis techniques.

#### Reference Book:

1. Introduction to Plant Biotechnology – H.S. Chawala
2. Plant Biotechnology – A. Slater *et al.*
3. Handbook of Plant tissue culture – ICAR
4. Plant tissue Culture : Theory and Practice – S.S. Bhojwani and M.K. Razdan

## 14. SOIL SCIENCE & AGRIL. CHEMISTRY AND FORESTRY

### 1. Environmental Science

2(1+1)

**Theory:** Scope and importance of environmental studies, Natural resources: Renewable and renewable resources, forest, water, food, energy and land resources, Ecosystems: Definition, concept, structure and functions. Producers, consumers and decomposers of an ecosystem, Energy flow in the ecosystem. Types of ecosystems, Bio-diversity; Definition, classification, threats to biodiversity and its conservation, Environmental pollution; causes, effects and control of air, water, soil, thermal, noise and marine pollution, causes, effects and management of soil nuclear hazards and industrial wastes, Disaster management, Floods, earthquakes, cyclones and land slides. Social issues and the environment, unsustainable to sustainable development. The Environment protection Act. The Air Act. The water Act. The wildlife protection Act and Forest Conservation Act. Woman and child welfare, HIV/AIDS and Role of information technology on environment and human health.

**Practical:** Collection, processing and storage of effluent samples; Determination of Bio-Chemical oxygen demand(BOD) in effluent sample; Determination of Chemical oxygen demand (COD) in effluent sample; Estimation of dissolved oxygen in effluent samples; Determination of sound level meter; Estimation of respirable and non respirable dust in the air by using portable dust sampler; Determination of total dissolved

#### Reference Book:

1. Air Environment and Pollution – S.S. Purohit
2. Water Pollution causes, effects and control – P.K. Goel
3. Biodiversity and Forest genetic resource – D.N. Tiwari
4. Biodiversity : Planning for sustainable Development – J. Singh
5. Text Book of Ecology and Environment – S.C. Joshi
6. Environmental Engineering – G. Kiely
7. Environmental Engineering – B.K. Nanda and T. Biswal

## 15. AGRICULTURAL ENGINEERING

### 1. Fundamentals of Soil, Water and Conservation Engineering

3(2+1)

**Theory:** Surveying: survey equipment, chain survey, cross staff survey, plotting procedure, calculations of area of regular and irregular fields. Levelling - levelling equipment, terminology, methods of calculation of reduced levels, types of levelling, contouring. Irrigation, classification of projects, flow irrigation and lift irrigation. Water source, Water lifting devices - pumps (shallow and deep well), capacity, power calculations. Irrigation water measurement- weirs, flumes and orifices and methods of water measurement and instruments. Water conveyance systems, open channel and underground pipeline. Irrigation methods - drip and sprinkle irrigation systems. Soil and water conservation - soil erosion, types and engineering control measures.

**Practical:** Acquaintance with chain survey equipment; Ranging and measurement of offsets; Chain triangulation; Cross staff survey; Plotting of chain triangulation; Plotting of cross staff survey; Levelling equipment - dumpy level, levelling staff, temporary adjustments and staff reading; Differential leveling; Profile leveling; Contour survey grid method; Plotting of contours; Study of centrifugal pumping system and irrigation water measuring devices; Study of different components of sprinkler irrigation systems; Study of different components of drip and sprinkle irrigation systems; Uniformity of water application in drip and sprinkle systems; Study of soil and water conservation measures.

#### Reference Book:

1. A Text Book of Surveying and Levelling – P.C. Purnima
2. Land & Water Management Engineering – V.V.N. Murty
3. Soil Erosion and Conservation – R.P. Tripathy and H.P. Singh

### 2. Farm Power and Machinery

2 (1+1)

**Theory:** Farm power in India: sources, I.C engines, working principles, two stroke and four stroke engines, I.C. engine terminology, different systems of I.C. engine. Tractors, Types, Selection of tractor and cost of tractor power. Tillage implements: Primary and Secondary tillage implements, Implements for intercultural operations, seed drills, paddy transplanters, plant protection equipment and harvesting equipment; Equipment for land development and soil conservation.

**Practical:** Study of different components of I.C. Engine; Study of working of four stroke engine; Study of working of two stroke engine; Study of M.B. plough, measurement of plough size different parts, horizontal and vertical suction, determination of line of pull etc.; Study of disc plough; Study of seed-cum-fertilizer drills-furrow opener, metering mechanism and calibration; Study, maintenance and operation of tractor; Learning of tractor driving; Study, maintenance and operation of power tiller; Study of different parts, registration alignment and operation of mower. Study of different inter cultivation equipment in terms of efficiency, field capacity; Repairs and adjustments and operation of sprayers; Repairs and adjustments and operation of dusters; Study of paddy transplanters.

#### Reference Book:

1. Principles of Farm Machinery – Roy Bainer, R.A. Kepner, E.L. Barger
2. Farm Machinery and Equipment – C.P. Nakra
3. Elements of Farm Machinery – J. Sahay

### 3. Protected Cultivation and Post Harvest Technology

2 (1+1)

**Theory:** Green house technology, Introduction, Types of Green Houses; Plant response to Green house environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future. strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics. Threshing, threshers for different crops. parts, terminology, care and maintenance. Winnowing, manual and power operated winnowers, care and maintenance. Groundnut decorticators, hand operated and power operated decorticators. principles of working, care and maintenance. Maize shellers & castor shellers. Drying, grain drying, types of drying, types of dryers. Storage, grain storage, types of storage

structures. Fruits and vegetables cleaning, machinery for cleaning of fruits and vegetables, care and maintenance. Grading, methods of grading, equipment for grading of fruits and vegetables, care and maintenance. Size reduction. equipment for size reduction care and maintenance. Evaporation, Principle, types of evaporators, quality standards - F AQ, AST A, FPO, FDA.

**Practical:** Study of different types of green houses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses: The study of fertigation requirements for greenhouses crops and estimation of E. C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization: Visit to commercial green houses: Study of threshers, their components, operation and adjustments: Winnowers, their components, operation and adjustments; Study of different components of groundnut decorticator; Study of maize shellers; Study of castor shellers: Study of improved grain storage structure; Study of dryers; Study of cleaners & graders.

**Reference Book:**

1. Elements of Agricultural Engineering – Dr. J. Sahay
2. Principles of Agricultural Processing – P.H. Panday
3. Post Harvest Technology of Cereals, Pulses and Oilseeds – A. Chakravorty
4. Principles of Agricultural Engineering – A.M. Michael & T.P. Ojha
5. Unit Operations in Agricultural Process Engineering – K.K. Singh & K. M Sahay
6. Greenhouse Technology – G.N. Tiwary & R.K. Goel

**4. Renewable Energy**

**2 (1+1)**

**Theory:** Energy sources, Introduction, Classification, Energy from Biomass, Types of biogas plants, constructional details, Biogas production and its utilization, Agricultural wastes, Principles of combustion, pyrolysis and gasification, Types of gasifiers, Producer gas and its utilization. Briquettes, Types of Briquetting machines, uses of Briquettes, Shredders. Solar energy, Solar flat plate and focussing plate collectors, Solar air heaters, Solar space heating and cooling, Solar energy applications / Solar energy gadgets, Solar cookers, Solar water heating systems, solar grain dryers, Solar Refrigeration system, Solar ponds, Solar photo voltaic systems, solar lantern, Solar street lights, solar fencing, Solar pumping systems. Wind energy, Types of wind mills, Constructional details & application of wind mills. Liquid Bio fuels, Bio diesel and Ethanol from agricultural produce, its production & uses.

**Practical:** Constructional details of KYIC & Janatha type biogas plants; Constructional details of Deen Bandu type biogas plants; Field visit to biogas plants; Constructional details of different types of gasifiers; Testing of gasifiers; Briquette preparation from biomass; To study and find the efficiency of solar cooker; To study and find the performance of a solar still; To study and find the performance of a solar dryers; Study and working of solar photovoltaic pumping system; Study and performance evaluation of domestic solar water heater; Study and performance evaluation of solar lantern; Study and performance evaluation of solar street light; To study the performance of different types of wind mills; Field visit to wind mills; To study the processing of Bio-diesel production from Jatropha.

**Reference Book:**

1. Non Conventional Energy Sources – G.D. Raj
2. Energy Technology (Nonconventional, Renewable and Conventional) – S.Rao, Dr. B.B. Parulekar
3. Non Conventional Energy Resources – D.S. Chauhan, S.K.Srivastava
4. Fundamentals of Renewable Energy Sources – G.N. Tiwari and M.K. Chosal

## 16. ANIMAL PRODUCTION

### 1. Livestock Production and Management

3(2+1)

**Theory:** Place of livestock in the national economy, different livestock development programmes of Govt. of India. Important exotic and Indian breeds of cattle, buffalo, sheep, goat and swine. Measures and factors affecting fertility in livestock, reproductive behaviour like oestrus, parturition, farrowing etc. Milk secretion, milking of animals and factors affecting milk yield and composition. Selection and breeding of livestock for higher milk and meat production. Feeding and management of calves, growing heifers and milch animals and other classes and types of animals, housing principles, space requirements for different species of livestock. Disease control measures, sanitation and care, breeding, feeding and production records. Breed characteristics of poultry, their methods of rearing, breeding, feeding and management, incubation, hatching and brooding, vaccination and prevention of diseases, preservation and marketing of eggs, its economics and keeping quality. Cost of production of milk, economical units of cattle, buffalo, sheep, goat and swine.

**Practical:** Identification, handling and restraining of animals; Judging and culling; Feeding and ration formulation; Hatching, housing and management of poultry; Visit to livestock farms and Economics of livestock production.

#### Reference Book:

1. A Textbook of Animal Husbandry – G.C. Benerjee
2. Livestock Production and Management – N.S.R. Sastri, C.K. Thomas, R.A. Singh
3. Essentials of Animal Production and Management – R. Singh
4. A Handbook of Animal Husbandry – ICAR
5. A Textbook of Livestock Production Management in Tropics – D.N. Verma

## 17. NON-CREDIT COURSES

### 1. Comprehension and Communication Skills in English

2 (1+1)

**Theory:** *Comprehension:* Text for comprehension, Current English for Colleges, By N.Krishnaswamy & T.Sriraman, Macmillan India Limited, Madras, 1995; War Minus shooting - 'The sporting spirit George Orwell (a) Reading Comprehension (b) Vocabulary - Synonyms- Antonyms - Often confused words and (c) Two exercises to help the students in the enrichment of vocabulary based on TOEFL and GRE and other competitive examinations. A Dilemma - A layman looks at science Raymond B. Fosdick (a) Reading Comprehension (b) Vocabulary - Homonyms and Homophones (c) Exercises on Figurative Language & Idiomatic Language (E.g.: dust and ashes, doorstep of doom, boundaries of knowledge, Apple of one's eye, in a fix etc). 5&6 You and Your English- Spoken English and Broken English G.B.Shaw (a) Reading Comprehension (b) Language study, Functional Grammar, Agreement of verb with subject. Written Skills: Mechanics of good letter, Effective business correspondence, Personal Correspondence. Preparation of Curriculum vitae and Job applications. The Style, Importance of professional writing -Choice of words and Phrases, precision, conciseness cliches, redundancy. jargon, foreign words. Precis writing and synopsis writing. Interviews, Types of interviews, purpose, different settings, as interviewer, interviewee, physical makeup and manners, appearance, poise, speech, self reliance, Evaluation process. Review or feedback.

**Practical:** Listening Comprehension: Listening to short talks, lectures, speeches (scientific, commercial and general in nature) Practical: listening to at least two tape, recorded conversations aimed at testing the listening comprehension of students: Communication: Spoken English, oral communication, importance stress and intonation.

**Practical:** Spoken English practice by using audiovisual aids, the essentials of good conversations, oral exercises in conversation practice (At the Doctor, at the Restaurant, at the Market Yard); Oral Presentation of Reports: Seminars and conferences, features of oral presentation, regulating speech, physical appearance, body language posture, eye contact, voice, audience, preparation of visual aids. Practical: One presentation by individual on the given topic related to agriculture like W T 0, Developing new technologies in Agriculture, Bio fertilizers etc.; Evaluation of a Presentation: evaluation sheet, other strategies to be considered for evaluating a presentation, Practical: Mock evaluation of a presentation: Dyadic communication, face to face conversation, Telephonic conversation, rate of speech, clarity of voice, speaking and listening politeness, telephone etiquette, Practical: Practice of Telephonic conversation; Reading skills, using Dictionary, reading dialogues, rapid reading, intensive reading, improving reading skills: Meetings: purpose, procedure participation, chairmanship, physical arrangements, recording minutes of meeting; Practice of Presentation by using power point and LCD projector; Conducting Mock interviews - testing initiative, team spirit, leadership, intellectual ability - potential for development, memory, motivation, objectives, aptitude etc., Group Discussions and Debates on current topics; Review or Feed Back: Practical examination.

### 2. NSS/NCC / Physical Education

1(0+1)

**Practical:** *NSS:* Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, nonformal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act.Environment enrichment and conservation, health, family welfare and nutrition. *NCC:* Introduction to NCC, defence services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour. ceremonial drill, weapon training - rifle bayonet, light machine gun, sten machine carbine. Introduction and characteristic stripping. assembling and cleaning, loading. unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading. conventional signs, grid systems, use of service protractor, prismatic compass and its use, self defence, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defence, leadership and NCC song. *Physical Education:* Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules regulations of important games, skill development in anyone of the games, football, hockey, cricket, volleyball, badminton, throw ball, tennis. Participation in one of the indoor games, badminton, chess and table tennis. Rules and regulations of athletic events, participation in anyone of the athletic events, long jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-to-day activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience.

**Note:** Warming up and conditioning exercises are compulsory before the commencement of each class.