RAMAKRISHNA MISSION VIVEKANANDA UNIVERSITY
Headquarters at
Ramakrishna Math & Ramakrishna Mission, Belur Math, Howrah, West Bengal: 711 202

INTEGRATED RURAL DEVELOPMENT & MANAGEMENT (IRDM)
FACULTY CENTRE
at
Ramakrishna Mission Ashrama, Narendrapur, Kolkata: 700 103

Two year M. Sc in ‘Agricultural Biotechnology’

PROPOSED COURSE CONTENT (with effect from academic year 2013-14)
### Semester-I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ABT 101</td>
<td>Fundamentals of Crop Production</td>
<td>(4+3)</td>
</tr>
<tr>
<td>ABT 102</td>
<td>Fundamentals of Crop Improvement</td>
<td>(3+2)</td>
</tr>
<tr>
<td>ABT 103</td>
<td>Cell Biology</td>
<td>(2+1)</td>
</tr>
<tr>
<td>ABT 104</td>
<td>Plant Physiology</td>
<td>(1+1)</td>
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<tr>
<td>ABT 105</td>
<td>Biostatistics – I</td>
<td>(2+1)</td>
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<tr>
<td>ABT 106</td>
<td>Molecular Biology</td>
<td>(2+0)</td>
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<tr>
<td>ABT 107</td>
<td>Plant Tissue Culture</td>
<td>(2+2)</td>
</tr>
<tr>
<td>ABT 108</td>
<td>Spiritual and cultural Heritage of India-I</td>
<td>(2+0)</td>
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**Total:** $18 + 10 = 28$

### Semester-II

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<tr>
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<tbody>
<tr>
<td>ABT 201</td>
<td>Fundamentals of Crop Protection</td>
<td>(4+3)</td>
</tr>
<tr>
<td>ABT 202</td>
<td>Plant Biochemistry</td>
<td>(2+1)</td>
</tr>
<tr>
<td>ABT 203</td>
<td>Biostatistics – II</td>
<td>(1+1)</td>
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<tr>
<td>ABT 204</td>
<td>Microbiology</td>
<td>(3+2)</td>
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<tr>
<td>ABT 205</td>
<td>Genetic Engineering</td>
<td>(2+0)</td>
</tr>
<tr>
<td>ABT 206</td>
<td>Molecular Tools and Techniques</td>
<td>(0+2)</td>
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<tr>
<td>ABT 207</td>
<td>Spiritual and cultural Heritage of India-II</td>
<td>(2+0)</td>
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<tr>
<td>ABT 208</td>
<td>Seminar-I</td>
<td>(0+1)</td>
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**Total:** $14+ 10 = 24$

### Semester-III

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<tr>
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<th>Credits</th>
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<tbody>
<tr>
<td>ABT 301</td>
<td>Immunology</td>
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<tr>
<td>ABT 302</td>
<td>Bioinformatics</td>
<td>(1+1)</td>
</tr>
<tr>
<td>ABT 303</td>
<td>Molecular Breeding</td>
<td>(2+1)</td>
</tr>
<tr>
<td>ABT 304</td>
<td>Genomics and Proteomics</td>
<td>(2+0)</td>
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<tr>
<td>ABT 305</td>
<td>Transgenic in Crop improvement</td>
<td>(2+0)</td>
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<tr>
<td>ABT 306</td>
<td>Environmental Biotechnology</td>
<td>(3+2)</td>
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<tr>
<td>ABT 307</td>
<td>Organizational/ Industrial Placement</td>
<td>(0 + 9)</td>
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<tr>
<td>ABT 308</td>
<td>Seminar –II: Proposed Plan of Dissertation Work</td>
<td>(0+1)</td>
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**Total:** $12+15 = 27$

### Semester-IV

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<tr>
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<tbody>
<tr>
<td>ABT 401</td>
<td>Seminar-III</td>
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<tr>
<td>ABT 402</td>
<td>Dissertation work</td>
<td>(0+24)</td>
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**Total:** $0 + 24 = 25$
Semester-I [Total: 18 (T) + 10 (P) = 28 Credits/ 560 hours]

ABT 101: Fundamentals of Crop Production- (4+3) credits

Theory: 4 credits/ 80 hours

1. Basics of Agronomy: History of agricultural development in India. Current production, utilization and growth trends of agricultural commodities in India and abroad. Sub-disciplines in agriculture, Agroclimatic zones of India and West Bengal, Basic concepts of Agro-meteorology: Crop Seasons; Weather forecasting, Classification of field crops and crop sequence, Tillage and Tilth, Tillage implements — Primary and Secondary tillage implements, Seeds and sowing: characteristic of good quality seed; Selection of seed, quality seed production, Types of Pure seed, seed dormancy. Viability of seeds, Seed vigour, Seed treatment; Seed certification, Hybrid seed production, Seed germination, Seed storage, Seed health, Types of sowing: Direct sowing, transplanting: time of sowing/planting; Depth of sowing, Yield of individual plant and community; Biological and economic yield, Optimum Plant population and environment, Factors affecting optimum plant population; Maintaining optimum plant population, planting pattern, gap filling and resowing, Concept of crop rotation; Essentials of a good rotation, planning the rotation; Examples of good rotation; Water management: Importance of water, in crops. Water requirement of crops, ET and crop yield, Scheduling of irrigation, Method of irrigation; measurement of irrigation water. Qualities of irrigation water; Drainage – excess water, Agricultural drainage Post harvest technologies. 31 hours

2. Basics of Horticulture and Medicinal plant: Sub disciplines of horticulture, Techniques for horticultural plant propagation through Cutting, Budding, Grafting, use of different hormones in promotion of roots, Common medicinal plants, their medicinal uses and general cultivation practices. 16 hours

3. Basics of Soil Science: Basic concept of soil, Soil formation, Soil Components, Soil elements, soil texture, structure, Soil organic matter, Soil water, C: N ratio and its importance, Problem soils and reclamation, Plant nutrients, essentiality criteria, role of essential nutrients, Soil testing, Fertilizer and manure 21 hours

4. Organic Farming: concept, principles and methodology, Quality, certification, Marketability and export of Organic product, Different low cost input like Panchagavya, Amritpani, preparation of cow dung and cattle urine, Govt scheme and programme to promote organic farming, concepts of biodynamic agriculture: BD500 and 501 12 hours

Practical: 3 credits/ 60 hours

1. Identification of seeds, crops, implements etc 4 hours
2. Crop production practices of major crops (rice, potato, pulses/oilseeds) 10 hours
3. Practice of techniques for horticultural plant propagation in different types of plants 6 hours
4. Visit to any seed production farm. 6 hours
5. Seed germination test. 2 hours
6. Seed viability test.  2 hours
7. Soil sampling, Soil testing (pH, EC, Org C, N, P, K).  12 hours
8. Fertilizer calculations.  2 hours
9. Preparation and use of Panchagavya, Amritpani, Poudhsanjibani, Homemade pesticides and fungicides etc.  4 hours
10. Study of common medicinal plants and their effective parts  4 hours
11. Methods of extraction of bio-reactive compound of some medicinal plants  6 hours

**ABT 102: Fundamentals of Crop Improvement (3+2) credits**

**Theory: 3 Credits/ 60 hours**

1. Basics of plant genetics: Early concepts of inheritance, Mendelian Genetics, Extra chromosomal inheritance, Chromosome and its structure, Genetic fine structure analysis, Gene interaction, Linkage and crossing over, Polygenic interaction, Chromosomal Aberration, Sex determination, differentiation and Sex-linkage, Sex-influenced and Sex-limited traits; Mutation and mutagenic agents, Concepts in population genetics, Hardy-Weinberg law; Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Transposon.  36 hours
2. Basics of plant breeding: Breeding in Agricultural development, Plant introduction and domestication, Centre of origin, Concept about Germplasm and its conservation, Gene bank (field and seed), role of IBPGR, Reproduction of Flowering plants, Pollination and fertilization, Male sterility & incompatibility  14 hours
3. Breeding method for crop improvement: Selection (Mass and Pure line), hybridization and handling of hybrid population in relation to self and cross fertilized crops, Hybrid vigour and heterosis exploitation, Stress (biotic and abiotic) resistance breeding.  10 hours

**Practical: 2 Credits/ 40 hours**

1. Study of floral morphology of different crops (Self- and cross pollinated crops).  8 hours
2. Laboratory exercises in probability and chi-square.  2 hours
3. Chromosome mapping using three point test cross.  2 hours
4. Induction of mutation through EMS.  2 hours
5. Numerical problems on Hardy Weinberg Equilibrium.  2 hours
6. Analysis of components of genetic variation.  4 hours
7. Practical technique of hybridization.  8 hours
8. Handling of Statistical package for genetic analysis (Genetic parameters, heritability, genotypic and phenotypic correlation, Path analysis, D² analysis).  12 hours

**ABT 103: Cell Biology (2+1) credits**

**Theory: 2 Credits/ 40 hours**

1. Prokaryotic and eukaryotic cell architecture.  2 hours
2. Membrane structure and function: Structural models; composition and dynamics; Transport of ions and macromolecules; pumps, carriers and channels; Endo and Exocytosis; membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata. 6 hours

3. Cell organelles: Nucleus- structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Cell cycle and control mechanisms; Mitochondria- Structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution. Structure and function of Golgi apparatus, ER, Peroxisomes, Glyoxisomes, Vacuoles. 10 hours

4. Cell division: Mitosis and Meiosis, Cell cycle checkpoint. 6 hours

5. Plant Meristem Organisation and Differentiation: Organization of Shoot Apical Meristem (SAM); organization of Root Apical Meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Embryo and Endosperm development; growth and differentiation. 8 hours

6. Cell signaling and cell transduction: The basic elements, Extracellular messengers and their receptors, Protein coupled receptors and second messenger, Calcium as an intracellular messenger, Apoptosis. 8 hours

Practical: 1 Credit/ 20 hours
1. Preparation and use of fixatives. 2 hours
2. Preparation of stain for chromosome study. 2 hours
3. Pretreatment in cytology. 1 hour
4. Mounting media. 1 hour
5. Permanent slide preparation. 2 hours
6. Pyronin- Methyl green staining. 2 hours
7. Feulgen- Light green solution. 2 hours
8. Observation of mitotic cell division. 4 hours
9. Observation of meiotic cell division. 4 hours

ABT 104: Plant Physiology (1+1) credits

Theory: 1 Credit/ 20 hours
1. Plant physiology and its significance in agriculture. 1 hour
2. Plant cell water relation, properties of water- physical and chemical, Transpiration and its mechanism. 2 hours
3. Outline of plant nutrients relating to its role and deficiency symptoms, Hydroponics and its utility. 2 hours
4. Photosynthesis- C₃, C₄ and CAM mechanism, Photorespiration. 4 hours
5. Respiration- Aerobic and anaerobic, salt respiration. 4 hours
6. Stress physiology related to drought, salinity and metal toxicity. **4 hours**
7. Photoperiodism and vernalization related to flowering. **1 hour**
8. Basic concept of plant growth regulators and its role in agriculture, Growth retardant. **2 hours**

**Practical: 1 Credit/ 20 hours**

1. Determination of osmotic potential / O.P of a plant cell. **2 hours**
2. Determination of rate of transpiration from a given leaf. **2 hours**
3. Determination of stomatal frequency of a given leaf. **2 hours**
4. Role of ABA and Cytokinin on stomatal behavior. **2 hours**
5. Separation of chlorophyll and its estimation by spectrophotometer. **2 hours**
6. Determination of rate respiration by respiroscope. **2 hours**
7. Determination of rate of respiration by the application of respiratory inhibitors. **2 hours**
8. Determination of osmotic potential of potato tuber on wet weight basis. **2 hours**
9. Effect of PEG on seed germination behavior. **2 hours**
10. Effect of NaCl on seed germination behavior. **2 hours**

**ABT105: Biostatistics – I (2+1) credits**

**Theory: 2 Credits/ 40 hours**

1. Agricultural Statistics- Meaning and importance, its Characteristics. Analysis and interpretation of data: Data- Definition, types (Qualitative vs. Quantitative) Presenting quantitative Data - Graphical presentation (Bar diagram, Histogram, Frequency Polygon, Ogive, Pie chart etc.); Tabular presentation (Simple, Bivariate, Multivariate). **8 hours**
2. Measures of Central Tendency: Mean- definition, properties, advantage and disadvantages, use; Median- definition, properties, advantage and disadvantages, use; Mode- definition, properties, advantage and disadvantages, use. Interpretation and Conclusion. **4 hours**
3. Measures of Dispersion: Range, Mean deviation, Quartile deviation, Standard deviation, Variance etc: Deviation and use; Skewness and Kurtosis, Interpretation and Conclusion. **4 hours**
4. Correlation and regression: Definition, Simple correlation coefficients its properties, Rank Correlation coefficients, Partial correlation coefficients, multiple correlation coefficients, Regression analysis, concepts of regression line and its utility, interpretation and conclusion. **8 hours**
5. Elementary concept of Normal Distribution, Binomial distribution and Poison distribution. **6 hours**
6. Hypothesis-Definitions, Types, Sources, Utility, and Characteristics of good hypothesis, Z-test, t-test, F-test, χ² test: definition and application. **10 hours**

**Practical: 1 Credit/ 20 hours**

1. Graphical presentation (Bar diagram, Histogram, Frequency Polygon, Ogive, Pie
chart etc.); Tabular presentation. 2 hours
2. Practical on mean, median and mode. 4 hours
3. Analysis of measures of dispersion and skewness and kurtosis. 4 hours
4. Analysis of correlation and regression. 4 hours
5. Study on Z-test, t-test, F-test, $\chi^2$ test. 2 hours
6. Use of Computer in Research (Concepts only)-, entry; Data Presentation and Analysis using appropriate Software: Statistical Packages. 4 hours

ABT 106: Molecular Biology (2+0) credits

Theory: 2 Credits/ 40 hours
1. Historical development of Molecular Biology. Nucleic acid as genetic material with experimental evidence. 4 hours
2. Nucleic acids: DNA structure: Watson and Crick model, A, B, Z and Triplex DNA; DNA contents and C-Value paradox, denaturation, renaturation and cot curve. Physical and Chemical properties of DNA. RNA: Structure, types and function. 7 hours
3. DNA replication: In prokaryotes and Eukaryotes; Enzymes and accessory proteins and their structure and function; fidelity, proofreading, processivity; replication of single stranded circular DNA, DNA repair: Enzymes, photo reactivation, nucleotide excision repair, mismatch correction, SOS response. 9 hours
4. Transcription: prokaryotic transcription, transcription unit, promoters- constitutive and inducible, operators, eukaryotic transcription- RNA polymerases structure, types and function; general transcription factors, Post transcriptional modification: RNA processing (processing of mRNA, tRNA and rRNA), RNA splicing. 7 hours
5. Translation: structure and function of ribosome; genetic code, properties of genetic code, Wobble hypothesis, Translational frame shifting and RNA editing; protein synthesis in prokaryotes and eukaryotes ( initiation, elongation and termination). Post translational modification and transport of proteins. 7 hours
6. Regulation of gene expression in prokaryotes and eukaryotes. 6 hours

ABT 107: Plant Tissue Culture (2+2) credits

Theory: 2 Credits/ 40 hours
1. History of plant cell and tissue culture, Application of tissue culture in crop improvement, Culture media, Sterilization technique, Totipotency, types of culture, Micro propagation. 12 hours
2. Organogenesis (direct and indirect), Embryogenesis (direct and indirect), Somaclonal and gametoclonal variation, somatic embryos and artificial seeds- cryopreservation. 8 hours
3. Meristem culture vis-à-vis virus elimination, Protoplast culture vis-à-vis wide hybridization, protoplast fusion, somatic hybrids, protoplast viability test, Embryo culture and embryo rescue, Anther culture vis-à-vis dihaploids, Cell suspension culture and secondary metabolites, hardening techniques. 20 hours
Practical: 2 Credits/ 40 hours
1. Laboratory set up 2 hours
2. Sterilization of glass goods, plasticwares, media and plant materials 2 hours
3. Formulation and preparation of media for shoot and root initiation. 4 hours
4. Handling of plant material (explants), inoculation of plant material. 4 hours
5. Sub culturing. 4 hours
6. Direct organogenesis using suitable explants. 4 hours
7. Indirect organogenesis using suitable explants. 4 hours
8. Suspension culture development from calli. 4 hours
9. Somatic embryogenesis from calli. 4 hours
10. Embryo culture, Anther culture. 4 hours

ABT 108: Spiritual and cultural Heritage of India-I (2+0)
1. Shanti Mantras and some selected vedic hymns-Shraddha Suktam, Sangha mantra etc. (2 hours)
2. Swami Vivekananda's Message to the Youth: It is youth who will transform this nation, Take up an ideal and give your whole life to it, Stand on your own feet, Awaken the spirit of 'Rajas' within you, Believe in yourself, Be bold and fearless, Expand your heart, Be open to learning from anyone, Develop a gigantic will. (12 hours)
3. Swami Vivekananda's Message to Reformers: Liberty is the first condition for growth, Affirm; Do not condemn, Don't lead but serve, Act with unselfish motives, create 'sanction' from the people, The Indian Nation will rise only when the self-esteem of the masses is raised, Real social reform will happen when the people learn to help themselves. (13 hours)
4. Swami Vivekananda's message to Educationists: manifest the infinite knowledge within, man-making education, strengthen faith and pride in ourselves as a nation, focus on character-building assimilation of ideas, enable the student to learn, enable individuals to find solutions to the challenges of life, give ideas and culture, develop the power of concentration. The condition necessary for the teacher, the taught and for effective transfer of learning. (13 hours)

Semester-II [Total: 14 (T) + 10 (P) = 24 Credits/ 480 hours]

ABT 201: Fundamentals of Crop Protection (4+3) credits

Theory: 4 credits/ 80 hours.

1. Basics of Agril. Entomology, Acarology, and Nematology: Concepts of pests, Type of pests and related group of pesticides, Basic knowledge of insect, life cycle, and metamorphosis, major insect orders and their characteristics, Important insect pests of some important field crops and horticultural crops, Mite: Characteristics, causes of mite pest outbreak, some important species of mite and their damage symptom, predatory mite, Economic importance of nematodes, their damage symptoms and control, IPM with
special reference to Chemical control, biological control, Botanical pesticides, Non-insecticidal-chemicals for pest control: Antifeedent, repellant, attractant, hormonal, semio-chemicals, Insect resistance. 31 hours

2. Basics of Plant Pathology: Fungus: characteristics of important phyla: Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Oomycota, Hypochytriomycota, Plasmodiophoromycota; mode of action, Important fungal diseases of some important field crops and horticultural crops; Phytopathogenic bacteria: importance, mode of action, Important bacterial diseases of some important field crops and horticultural crops; Virus: Symptomatology of important plant viral diseases, transmission, host virus interaction, virus vector relationship, Plant viral diseases of some important field crops and horticultural crops, Disease management with special reference to chemical control, Biological control, antagonistic fungi and bacteria, Disease resistance. 31 hours

3. Basics of weed science and their control: Weed biology and ecology, weed classification, crop-weed competition, allelopathy, weed indices. Principles of weed management (preventive, control and eradication), Herbicides: classification based on chemical nature, method and time of application; selectivity; mode and mechanism of action of herbicides; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures. Weed control through bio-herbicides, mycoherbicides and allelochemicals, herbicide resistance in weeds and crops; herbicide rotation. Weed management in major crops and cropping systems, parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control Integrated weed management. 18 hours

Practical: 3 credits/ 60 hours
1. Dose calculation and application of chemical pesticides. 4 hours
2. Identification of different types of damage/ symptoms by insect pest/ diseases. 6 hours
3. Collection of insect pest, natural enemy, damaged plant parts and preservation. 4 hours
4. Collection and dry preservation of diseased specimens of important crops. 4 hours
5. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters. 6 hours
6. Identification of different plants with properties of insecticidal action, Production procedure of botanical pesticides. Testing on target group, and isolation of Azadirichitin. 6 hours
7. Isolation, mother culture development, production, formulation and testing efficiency in laboratory of antagonistic fungi and Bacteria. 8 hours
8. Isolation, mother culture development, production, formulation and testing efficiency in laboratory of entomo-pathogenic fungi and Bacteria. 8 hours
9. Multiplication of parasitoids, Predators and coccinellids etc. 10 hours
10. Identification of important weeds of agricultural crops and preparation of weed herbarium. 4 hours
ABT 202: Plant Biochemistry (2+1) credits

Theory: 2 Credits/ 40 hours

1. Scope and importance of biochemistry in agriculture; fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waal forces; general introduction to physical techniques for determination of structure of biopolymers. 6 hours
2. Chemistry, Structure, function and metabolism of biomolecules-carbohydrates, amino acids, proteins, lipids and nucleic acid. 15 hours
3. Enzyme catalysis – general principles of catalysis; Enzyme properties and classification; Mechanism of enzyme action; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, isozymes. 10 hours
4. Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers. 6 hours
5. Vitamins : Classification, importance and biological function, deficiency symptom. 3 hours

Practical: 1 Credit/ 20 hours

1. Estimation of reducing Sugar. 2 hours
2. Estimation of non-reducing sugars. 2 hours
3. Estimation of Protein content. 2 hours
4. Estimation of oil. 2 hours
5. Estimation of saponification value and acid value of oil. 2 hours
6. Practical on chromatographic technique-TLC, Column, HPLC, HPTLC etc. 8 hours
7. Estimation of enzyme. 2 hours

ABT 203: Biostatistics – II (1+1) credits

Theory: 1 Credit/ 20 hours

1. Sampling: Meaning and Significance, Types, different Sampling methods, Sampling errors and biases. 6 hours
2. Design of Experiments: Definition, importance etc., Principles of design of experiments, Concepts of Uniformity trial and contour map. 2 hours
3. Completely Randomized Design (CRD): Definition, model, Lay out, Analysis of Variance (ANOVA), Advantages and Disadvantages. 2 hours
4. Randomized Block Design (RBD): Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. 2 hours
5. Latin Square Design (LSD): Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. 2 hours
6. Split Plot Design: Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. 3 hours
7. Factorial Design: Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. **3 hours**

**Practical: 1 Credit/ 20 hours**

1. ANOVA of Completely Randomized Design (CRD). **2 hours**
2. ANOVA of Randomized Block Design (RBD). **2 hours**
3. ANOVA of Latin Square Design (LSD). **2 hours**
4. ANOVA of Split Plot Design. **4 hours**
5. ANOVA of Factorial Design. **4 hours**
6. Analysis of variance using appropriate Software: Statistical Packages. **6 hours**

**ABT 204: Microbiology (3+2) credits**

**Theory: 3 credits/ 60 hours**

1. The History of Microbiology, Microbial classification, Microbes and Agriculture. **4 hours**
2. Microbial cell culture techniques: Laboratory status, Different media for fungi, bacteria, actinomycetes etc; Isolation of target organism from plant parts, soil etc. including surface sterilization, dilution etc; for incubation- moist chambering etc, Sterilization of medium, glass wares etc.; Transfer of culture to media. **8 hours**
4. Microbial Nutrition- The Common Nutrient Requirements; Requirements for Carbon, Hydrogen, and Oxygen; Nutritional Types of Microorganisms, Requirements for Nitrogen, Phosphorus, and Sulfur, Growth Factors, Uptake of Nutrients by the Cell, Culture Media, Isolation of Pure Cultures, Colony Morphology and Growth, Chemotaxis, Bacterial Endospore. **8 hours**
5. Microbial growth, Measurement of Microbial Growth, The Chemostat, The Turbidiostat, Influence of Environmental Factors on Growth, Quorum Sensing and Microbial Populations-Control of Microorganisms by Physical and Chemical Agents. **8 hours**
6. Soil microbiology: microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil, Siderophores, Soil microbial biomass; Soil enzymes; Plant growth promoting rhizobacteria. **10 hours**
7. Mushroom: importance of mushroom as food, edible-non-edible mushroom species; spawn production, culture of mushroom, processing of mushroom. **10 hours**

**Practical: 2 credits/ 40 hours**

1. Sterilization and preparation of media, Enumeration of bacteria and fungi from environmental samples – soil and plant parts (moist chambering). **6 hours**
2. Techniques for pure culture - streaking, pour plate and spread plate. **6 hours**
3. Differential, Negative, and Spore Staining techniques. **6 hours**
4. Micrometry. **4 hours**
5. Determination of ammonification. **4 hours**
6. Determination of Nitrification. **4 hours**
7. Determination of microbial denitrification. **2 hours**
8. Practice of mushroom production technology, spawn production and processing. **8 hours**

**ABT 205: Genetic Engineering (2+0) credits**

**Theory: 2 Credits/ 40 hours**

1. Host restriction and modification system, Restriction enzymes and cutting of DNA. DNA ligase and ligation of DNA molecules, DNA modifying enzymes : Kinase, Alkaline phosphatase, Terminal transferase etc., Linkers and Adapters **8 hours**
2. Gene cloning: cloning vector, Salient features and uses of most commonly used vector i.e.; Plasmid, Bacteriophage, Phasemid, Cosmid, BAC,YAC, PAC and cloning stratigies, Shuttle vector, Expresson vectors, Chromosome walking, Probe preparation and labeling, radio labeling and non radio labeling. Gene libray: Genomic library and cDNA library, Identification of desired cloned gene by Colony hybridization, plaque hybridization and Immunological assay. **10 hours**
3. DNA estimation, Electrophoresis-Agarose electrophoresis,Sodium dodesyl sulphate gel electrophoresis (SDS-PAGE). Polymerase Chain Reaction(PCR), DNA sequencing. Blotting technique: Southern, Northern and western blotting. **14 hours**
4. Gene transfer: Agrobacterium mediated gene transfer; Ti plasmid, Ri plasmid and T DNA, Cointegrate vector and binary vector, Transformation technique, Marker gene, Reporter gene, Virus mediated gene transfer, Direct gene transfer: Electroporation, Particle Bombardment, Microinjection, Macroinjection, Chemical method. **8 hours**

**ABT 206: Molecular Tools and Techniques (0+2) credits**

**Practical: 2 Credits/ 40 hours**

1. Handling of laboratory instruments. **4 hours**
2. Isolation of plant genomic DNA. **2 hours**
3. Isolation of bacterial genomic DNA. **2 hours**
4. Isolation of fungal genomic DNA. **2 hours**
5. Isolation of plasmid DNA – mini preparation. **4 hours**
6. Estimation of DNA using Spectrophotometer. **2 hours**
7. Agarose gel electrophoresis. **2 hours**
8. Sodium Dodecyl Sulphate gel electrophoresis (SDS-PAGE). **4 hours**
9. Purification of DNA from Agarose gel. **2 hours**
10. Restriction digestion of DNA and DNA ligation. 4 hours
11. Preparation of competent cell. 2 hours
12. Cloning of DNA. 6 hours
13. Isolation of mRNA and cDNA preparation. 4 hours

**ABT 207: Spiritual and cultural Heritage of India-II (2+0)**

1. Selected vedic hymns: Medha Suktam, Durga Suktam, Acharyopadesha etc. (2 hour)
2. Swami Vivekananda's message on women's empowerment: the ideal of woman as mother, womanhood personified in Sita, as warrior, eligibility for the highest knowledge, common humanity grounds, respecting the women, all round education of women, develop their own solutions. (12 hours)
3. Swami Vivekananda's message on the uplift of the masses: Dedicate yourself, develop faith in equality and oneness of man, educate the masses, solution to the caste problem. (13 hours)
4. Swami Vivekananda's message on restoring our national glory: India's ideal is spirituality, India's mission is spiritual regeneration of the world, India's solution to life's challenges, India must share the spiritual knowledge with the West and gain material knowledge from them, India is readying for its time under the sun. (13 hours)

**ABT 208: Seminar-I (0+1) credit**

Semester-III [Total: 12 (T) + 15 (P) = 27 Credits]

**ABT 301: Immunology (2+1) credits**

Theory: 2 Credits/ 40 hours

1. Overview on immune system: innate and acquired immunity, Organ and cells of immune system- Primary and secondary lymphoid organs. Humoral immune response and cell mediated response, ADCC; Cytokines –properties, structure and uses. Interferons, Immunoglobulin – Basic structure, Class and subclass. Molecular organization of immunoglobulin, Immunoglobulin super family. 10 hours
2. Major Histocompatibility complex: MHC genes, types, MHC and immune responsiveness and disease susceptibility, HLA typing. Cellular distribution of MHC expression. T cell receptor; structure, function overview on TCR mediated Signalling. 8 hours
3. Antigen processing and presentation; Antigen presenting cells and their role. Exogenous antibody and endogenous antibody; Antigen-antibody interaction-precipitation and agglutination reaction, Immunodiffusion test, Immunelectrophoresis, B cell maturation, activation and differentiation. B cell receptor. T cell receptor. T cell maturation, activation and differentiation. Signal transduction with T cell activation. 10 hours
4. Vaccines- role and properties of adjuvants, recombinant DNA and protein based vaccine, chimeric and hybrid monoclonal antibody and its application. 4 hours
5. Introduction to the basic principle of molecular technology and techniques used in pathogen detection. Method of diagnosis: principle of ELISA and its role in viral detection, microarray based detection, hybridization based detection and detection through PCR, Complement system. **8 hours**

**Practical: 1 Credit/ 20 hours**

1. Preparation of buffer and reagents. **2 hours**
2. Immunoblotting, immunoelectrophoresis and fluorescent antibody test. **4 hours**
3. Enzyme immunoassays including ELISA, western blotting. **4 hours**
4. Extraction and identification of DNA/RNA of pathogenic organism. **4 hours**
5. Restriction hybridoma technique and production of monoclonal antibodies. **6 hours**

**ABT 302: Bioinformatics (1+1) credits**

**Theory: 1 Credit/ 20 hours**

1. Introduction to Bioinformatics: What is Bioinformatics? Functions of Bioinformatics. What does Informatics mean to Biologists? What Questions can Bioinformatics answer? Database and NCBI Data Model: Public Biological Databases, NCBI Data Model, NCBI function, Types of Database, Some common terms used in the Gene Bank flat file, Authors, Locus Name, Accession Number, gi Number, Patents. **6 hours**

2. Structure Database: The Notion of Three-dimensional Molecular Structure Data. PDB: Protein Data Bank at the research Collabatory for Structural Bioinformatics (RCSB), Database Searching, PDB File Retrieval, mmCIF File Retrieval, and links. MMDB: Molecular Modeling Database, Structure File Formats. Database Structure Viewers, MMDB Viewer: Cn3D Mage, CAD and VRML, Structure Similarity Searching, Nucleic Acid Structure Polymorphism, Genome Sequencing/ Comparative Genomics. **6 hours**

3. Bioinformatics Tools- Internet: Data Mining & Retrieve, Entrez, Locus Link, BLAST, Motifs, Gene prediction & phylogeny, Phylogenetic tree, Role of bioinformatics in genomics, Genome mapping and Mapping Database and Proteomics, Concept on Micro arrays. **8 hours**

**Practical: 1 Credit/ 20 hours**

1. Introduction to major databases **6 hours**
   - Nucleotide Database
   - Protein Database
   - Structure Database
2. Use of FASTA format, Blast tool **4 hours**
3. Use of Bioinformatics tools-RasMol, RasTop, Cn3D **4 hours**
4. Use of EMBOSS Tools **4 hours**
5. Case study on Rice **2 hours**
**ABT 303: Molecular Breeding (2+1) credits**

**Theory: 2 Credits/ 40 hours**

1. DNA marker: Definition, importance, types: RAPD, ISSR, SSR, RFLP, AFLP etc, advantages and limitation, identification of linked marker. **12 hours**
2. Marker Assisted Selection (MAS): Concept, procedure, advantages, Practical achievements, merits and demerits. **8 hours**
3. Breeding of Transgenic crop; concepts, main features, transgenic breeding vs conventional breeding, procedure, merits and demerits. **8 hours**
4. Quantitative trait loci: concepts, importance, concepts of RILS and NILS, Procedure of QTL development, practical achievement. **12 hours**

**Practical: 1 Credit/ 20 hours**

1. Study of RAPD marker, ISSR marker, SSR marker. **12 hours**
2. Phylogenetic relationship study based on molecular marker. **4 hours**
3. Linkage and associationship analysis. **8 hours**

**ABT 304: Genomics and Proteomics (2+0) credits**

**Theory: 2 credits/ 40 hours**

1. Structural genomics: Classical ways of genome analysis, large fragment genomic libraries, physical mapping of genomes, genome sequencing – principles and translation to large scale projects; recognition of coding and non-coding sequences and gene annotation; comparative genomics. **10 hours**
2. Identification and classification using molecular markers- 16s rRNA typing/ sequencing, EST’s and SNP’s. **2 hours**
3. Functional genomics: DNA chips and microarray technology and their use in transcriptome analysis; mutants and RNA in functional genomics; metabolomics and ionomics for elucidating metabolic pathways etc. **8 hours**
4. Proteomics: protein structure, function and purification. Protein analysis (includes measurement of concentration, amino acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; microscale solution isoelectric focusing; peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and differential display proteomics , protein-protein interaction, Yeast two hybrid system. **12 hours**
5. Pharmacogenetics: High throughput screening in genome for drug discovery-identification of gene targets, pharmacogenetics and drug development, Application of genomics and proteomics in agriculture, human health and industry. 8 hours

**ABT- 305: Transgenic in Crop improvement- (2+0) Credits**

**Theory: 2 Credits/ 40 hours**

1. Concepts, principles and scope of transgenic technique vis-à-vis Biotechnology. Commercial status of transgenic plant, regulatory procedure for commercial approval of transgenic crop, biosafety concern of transgenic crops. 10 hours
2. Herbicide resistance; Glyphosate, sulphonyl urea, phosphinothricin, atrazine etc. Insect resistance: Bt toxin, synthetic Bt toxin, protease inhibitor, lectins etc. Antisense RNA technology vis-a-vis Delay of fruit ripening. 14 hours
4. Transgenic for quality like improved storage, male sterility, golden rice. Production of antibiotics and pharmaceuticals in plants, Transgenic plants as bioreactor. 6 hours

**ABT 306: Environmental Biotechnology (3+2) credits**

**Theory: 3 credits/ 60 hours**

1. Environmental Biotechnology: concept and scope, Bio-monitoring & Biodegradation: concept, factors, methods. 6 hours
2. Bioremediation- In situ and ex-situ, advantages and disadvantages; Bioremediation of contaminated ground water and phytoremediation of soil metals, microbiology of degradation of xenobiotics, applications of biosensors in environmental pollution, Effluent treatments for industries by biotechnology (tannaries, paper and pulp, food, fertilizer and pesticides etc.), Treatment strategies for polychlorinated biphenyls, pesticides, oil, toxic pollutants, heavy metal pollution, contaminated soil, biomedical wastes, biological techniques in controlling air pollution, Bioleaching/Bio-mining. 14 hours
3. Application of Biotechnology in solid waste management: Composting; Vermiculture; Effective micro-organism technology, Biogas, sanitary landfill technology. 10 hours
4. Biological treatment of waste water: primary, secondary and tertiary treatment (stabilization pond, aerated lagoon, activated sludge process, trickling filter, anaerobic treatment etc), biofilms, role of microphyte and macrophytes in water treatment, Root-zone-treatment. 6 hours
5. Bioenergy: biofuel, bioethanol, biohydrogen production. 4 hours
6. Biodegradation of agricultural chemicals and use of biofertilizer [free living, symbiotic
7. (rhizobial, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria, taxonomic classification, nodule formation, competitiveness and quantification of N\textsubscript{2} fixed phosphate solubilizing bacteria and fungi, including mycorrhiza; Xenobiotics and bioaccumulation, Microbial transformation/degradation of pesticides, eutrophication control. **8 hours**

8. Bioprocess technology: principles, Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Microbial processes-production, optimization, screening, strain improvement; **6 hours**

9. Bioreactors, Biodegradable Plastics, Biosurfactants, bioscrubbers **2 hours**

10. Biotechnology in forestry and wasteland development. **2 hours**

11. Conservation of biodiversity through biotechnology. **2 hours**

**Practical: 2 credits/ 40 hours**

12. Visiting effluent treatment plants **6 Hours**

13. Biogas processes **2 Hours**

14. Application of bioremediation **6 Hours**

15. Compost and vermicompost production **10 Hours**

16. Study of bioreactor and its use in sewage treatment **2 Hours**

17. Isolation and production of N fixing biofertilizers **4 Hours**

18. Isolation and production of PSB **4 Hours**

19. Production of Azolla **2 Hours**

20. Production of VAM **2 Hours**

21. Production of BGA **2 Hours**

**ABT-307: Organizational/ Industrial Placement (0 + 9) credits**

**ABT 308: Seminar –II: Proposed Plan of Dissertation Work (0+1) credits**

**Semester-IV [Total: 0 (T) + 24 (P) = 25 Credits]**

**ABT 401: Seminar-III (0+1) credits**

**ABT 402: Dissertation work (0+24) credits**

**Optional Papers**

**ABT-309: Entrepreneurship Development and Marketing (2+2) credits**

**Theory: 2 credits/ 40 hours**

1. Entrepreneurship: Concept, Importance of entrepreneurship- development study, Motivation to entrepreneurship- development & its need. **6 hours**
2. Steps towards entrepreneurship development: Knowledge about Business Opportunity Guidance, SWOT analysis, Market Survey & Marketability analysis, Preparation of project, Role of promoting Agencies – Bank, WBFC etc, Govt. formalities and license etc, Management: Personnel, Material, Marketing & Finance, Cash flow, Break even point, Working capital assessment 28 hours

3. Access to information technology for entrepreneurship development. 6 hours

Practical: 2 credits/40 hours.

1. Study of market: Customer survey; Product Survey. 12 hours
2. Visit to an entrepreneurial site. 12 hours
3. Performance management, Monitoring and evaluation of Project, Skill development. 12 hours
4. Project preparation. 4 hours

ABT-310: Agricultural Extension (1+1) Credits

Theory: 1 credit/20 hours

1. Fundamentals of Extension: Extension - meaning, origin and development, philosophy, function; Extension and Agricultural Biotechnology; contribution of Extension in agricultural development; Extension and Transfer of Technology. 4 hours
2. Agro-Technology and Technology Transfer: Technology, agro-technology, forms of technology, appropriate technology, criteria for judging appropriate technology; transfer of technology; technology transfer, system of agricultural technology transfer in India. 4 hours
3. Extension Methods for Communicating Technology: Basics of Communication as applicable to Extension; effective Communication to promote Biotechnology – spoken, written and audio-visual; Extension teaching methods-individual, group and mass; selection of teaching methods; audio-visual aids. 4 hours
4. Technology Diffusion: Adoption and Diffusion of agro-technologies 2 hours
5. Planning for agro-technological intervention: Farming System Research and Extension approach - Technological need assessment; Targeting of clients for offering agro-technology, Diagnosis, On-farm experimentation and assessment; Participatory Technology Development 4 hours
6. Capacity building in Extension – training of farmers/extension personnel- types, training need identification (TNA), training implementation and evaluation 2 hours

Practical: 1 credit/20 hours

1. Preparation and application of extension teaching methods/A-V aids; preparation of farm publications for agro-technologies 6 hours
2. A village study on adoption of biotechnological practices – (i) Assessment of agricultural situation of a village and suggest suitable agro-technology for on-farm trial/Result demonstration; (ii) Assessment of general constraints of adoption of recommended technologies and its probable solution (visit to village, group discussion, questionnaire survey, PRA) followed by presentation and submission of report. 2 days field work
ABT-311: Pharmacognosy and phytochemistry of Medicinal and Aromatic Plants
(3+2) credits
Theory: 3 credits/60 hours
1. Scope and practice of MAP, Classification of crude drugs . 6 hours
2. Phytochemistry: General method associated with phytochemical investigation of metabolic pathways and the origin of secondary metabolites. 6 hours
3. Pharmacopoeil and related drugs of biological origin: Hydrocarbons and their derivatives, Carbohydrates, Proteins (amino acids), Fat and Fatty acids, Organic acids (for food sector) , Glycosides, Alkaloids, Resins, Tanin, Phenol, Coumarin, Colouring agent and flavouring (for health drink under food sector), Fixed oil, Volatile oil and Miscellaneous products. 10 hours
4. Non medical toxic plants: Pesticides, Hallucinogens, Allergens, Teratogens, Heterosides. Fibers, Surgical dressings and Switchers: Pharmaceutical aids and technical products. 8 hours
5. Principles related to the commercial production: Standardization of natural products, Growth regulators, Quality control: Plant tissue culture, Biological conversion, Clonal propagation, Phytochemical variations. Plants in complementary and traditional system of medicines. Traditional plant medicines as a source of new drugs. 20 hours
6. Chemical and physical analysis of MAP: - By paper chromatography, Thin layer chromatography and column chromatography, Physical analysis by optical rotation method & UV light. 10 hours

Practical: 2 Credits/ 40 hours

Organoleptic study:-

1. Macroscopic study (Whole plant parts and un organized drugs like Guggul, Asafoetida, Black catechu, White Catechu, gum, Mucilage, Tragacanth, Colocynth) 4 hours
2. Microscopic study of Drug plants.
   i. Quantitative microscopy
   ii. Anatomical characteristics of Rauwolfia, Cinchona, Termenelia, Mint Fennel, Cinnamomum, Digitalis, Ipecacuahna, Hyoscyamus, Neem, Clove, Asoka, Holarrhena. 8 hours

Physical analysis of drug plants:-
1. UV, optical rotation, Extractive value, Ash value of powdered drug 6 hours

Chemical analysis of drug:
1. Selection of solvents for extraction of following Phytochemicals − Alkaloids (Holarrhena, Datura), Ghycosides and Phenols (Senna, Aloe), Tannins (T.chebula, Asoka), Essential oil (Mint, Fennel, Clove, Cinnamomum), Oleoresin (Ginger, Turmeric) 4 hours
2. Separation of phytochemicals by Chromatography method − paper, Thin layer, Column. Gel analysis of protein (work out) 6 hours
3. Demonstration of HPTLC, GC, MASS, SPECTRO PHOTO METER. 2 hours
4. Preparation of home remedies (Syrup, Tincture, Ointment, Pills, Decoction). 4 hours
5. Cultivation practices of MAP. 6 hours

ABT-312: Organic Farming: (3+4) credits
Theory: 3 credits/ 60 hours

1. Organic Farming: Concept, definition, principles, scope and importance in modern world, need of the nation, history of evolution of the concept of organic farming, holistic approach. 4 hours
2. Soil Fertility and Ecology: Agricultural ecology, creation and protection of biodiversity, national biological diversity act (2002), impact of organic farming on global warming. 2 hours
3. Integrated Nutrient Management: i) Limitation and adverse effects of chemical-fertilizer intensive crop growth technology (Green revolution), Need for integrated nutrient management (challenge of nutrient excess and depletion), efficient use of fertilizers. ii) Symptoms due to deficiency of nutrients; available and fixed nutrients in soil solution; soil pH and availability. iii) Advantages and disadvantages of chemical and organic farming, iv) Integrated Nutrient Management: concept, economic consideration, feasibility, advantages, v) Components (sources): soil, mineral fertilizers, organic /biological sources, INM in principal crops (rice, wheat, Maize, pulses, oilseed, cotton, etc. 6 hours
4. Organic Crop Agronomy: Organic agricultural management towards sustainability, Low cost or no cost package of technologies for growing vegetables, field crops and fruit plants. (A Brief discussion on the main points explained in the first year) 2 hours
5. Organic Crop Protection: Basic principles, organic and bio-pesticides, plant extracts used as bio-pesticide; neem: the panacea for organic farming; other botanicals pesticides etc, virus, bacteria and fungi as bio-pesticide. 3 hours
Role of beneficial fungi in the control of plant diseases, organic control of nematodes to minimise plant deformities, natural control of pests through creation of biodiversity. 3 hours
6. Natural Farming: Concept, definition, basic principles, advantages and constraints in natural farming, Experience of Mr M Fukuoka in Japan, no-till farming, effects of no-till farming on physical,chemical and biological health of soil. 4 hours
7. Heritage Agriculture: An introduction to Heritage agriculture with reference to Vrikshayurveda, some ancients books on agriculture and their relevance to sustainable agriculture. 4 hours
8. Eco-friendly farming systems in practice -- Ecological farming, sustainable farming, biological farming, regenerative agriculture, permaculture. 4 hours
9. Integrated Organic Farming System: Concept, an approach for sustainable livelihood of small and marginal farmers, different sub-systems, economy and ecology, examples of successful organic model farms in India and other countries. 6 hours
10. Quality Control , Certification, Organic Farming Worldwide — Need of the certification((A Brief discussion on the main points explained in the first year), policy, government schemes and projects, quality control of organic products, pioneers of organic farming, global scenario, successful Experiments in Cuba and Ethiopia, future trends in organic farming. 6 hours
11. Economics and Marketing: Economic viability, the challenge of ongoing organic production, Farm Production and profit, cost-benefit ratio in organic farming vis-a-vis inorganic farming, two case studies. 4 hours
Micro-economics Aspects: Output mix, output value, Input mix, input value, Benefits for farmers, employment generations. 2 hours
Organic Market--- Growth, constraints and opportunities, Fair trade and trade development, Export prospects for India. 2 hours
12. Adoption and Success: Organic agriculture an attractive alternative, not a miracle solution, the farming system context, basic recommendations for initiating adoption of organic farming, factors affecting adoption of organic farming, balance sheet to decide adoption, a case study for a successful organic farm. **4 hours**

13. Research and Extension: A holistic interdisciplinary approach, disciplinary research, socio-economic and policy research, research on production system management, redesign agricultural systems. **2 hours**

14. Values, ethics and spirituality in organic farming- an overview. **2 hours**

**Practical: 4 credits/ 80 hours**

1. Cultivation and keeping record of yield contributing factors of at least four organic crops using low cost inputs. Cost benefits calculation for cultivation of crops in a plot for one year. **16 hours**

2. Study of crop rotations for low, medium and upland of WB under rainfed and irrigated conditions. **2 hours**

3. Preparation of plan for a model organic farm of 1 acre. **4 hours**

4. Visit to an organic farm (if possible). **6 hours**

5. Detection of nutrient deficiency symptoms in field, fertilizer scheduling and balanced fertilizers application from organic and inorganic sources. **4 hours**

6. Visit of a village to study the factors affecting adoption of organic farming and presentation on it. **12 hours**

7. To study the marketing aspects viz demand, supply, price and sellers of organic products. **12 hours**

8. (Students will visit different markets in group and prepare a report on it. Each group will visit one market.). To organise a field level demonstration of a organic crop in a village. (Atleast two visits). **12 hours**

9. Mini project on some suitable topic. **12 hours**