

Deccan Education Society's
FERGUSON COLLEGE, PUNE
(AUTONOMOUS)

SYLLABUS UNDER AUTONOMY

SECOND YEAR M.Sc. (Botany)
SEMESTER – III

SYLLABUS M.Sc. (Botany)
w.e.f. Academic Year 2017-2018

Course Structure for M.Sc.-II - Botany

Semester	Course Code	Title of the Course	Credits	Core / Elective	Internal / External
III	BOT5301	Angiosperms and Evolution	4	Core	I / E
	BOT5302	Developmental Botany and Economic Botany	4	Core	I / E
	BOT5303	Plant Biotechnology	4	Core	I / E
	BOT5304	Industrial Botany I	2	Elective	I / E
	BOT5305	Industrial Botany II	2	Elective	I / E
	BOT5306	Industrial Botany III	2	Elective	I / E
	BOT5307	Botany Practical V	4	Core	I / E
	BOT5308	Botany Practical VI	4	Core	I / E
	BOT5309	Summer Training (Self Learning)	1	Core	I
Note : Students should choose two Elective subjects out of the given three Electives					
IV	BOT5401	Biostatistics and Bioinformatics	4	Core	I / E
	BOT5402	Plant Interactions and Immunology	4	Core	I / E
	BOT5403	Plant Pathology	4	Core	I / E
	BOT5404	Industrial Botany IV	2	Elective	I / E
	BOT5405	Industrial Botany V	2	Elective	I / E
	BOT5406	Industrial Botany VI	2	Elective	I / E
	BOT5407	Botany Practical VII	8	Core	I / E
	BOT5408	Techno-Commercial Case Study (Self Learning)	1	Core	I
Note : Students should choose two Elective subjects out of the given three Electives					

Extra Credits for M.Sc.-II - Botany

Semester	Course Code	Title of the Course	Credits	Internal / External
III	XCS0007	Introduction to Cyber Security - III / Information Security - III	1	I
	XSD0008	Skill Development - III	1	I
IV	XCS0009	Introduction to Cyber Security - IV / Information Security - IV	1	I
	XSD0010	Skill Development - IV	1	I

PAPER CODE: BOT5301

PAPER – I: Angiosperms & Evolution

[Credits - 4: No. of Lectures 60]

Units	Title and Contents	No. of Lectures
Basic Systematics		
Unit - I	Introduction to Systematics 1. Principles and methods in taxonomic research 2. Botanical survey of India	7
Unit - II	Tools of taxonomy 1. Floras, Monographs, Herbaria, Botanical Gardens (national and international), computers (Websites like Tropicos, The plant list, IPNI) GPS, GIS. 2. Morphological features used in classification, identification. Taxonomic Keys and types	8
Classification of Angiosperms		
Unit - III	International Code of Botanical Nomenclature : Salient features-Principles, Important Rules and Recommendations, Provisions for the governance of the Code, Appendices	4
Unit – IV	Classification systems Artificial - Linnaeus Natural – Bentham and Hooker, Bessey Phylogenetic – Cronquist, Takhtajan APG systems of classification Robert Thorne’s classification system	11
Study of Taxonomy		

Unit - V	Morphological variations, systematic position, interrelationship, phylogeny and economic importance of following families: Moraceae, Asteraceae, Verbenaceae, Rubiaceae, Lamiaceae, Acanthaceae, Leguminosae, Euphorbiaceae, Phyllanthaceae, Araceae, Cyperaceae, Poaceae, Arecaceae, Commelinaceae, Orchidaceae	8
Unit - VI	Phytogeography and Biodiversity : Phytogeographic regions of India, Endemism, hotspots and hottest hotspots. Endemism in Western Ghats, Plant explorations in India, invasions and introductions. Biodiversity, magnitude, assessment, importance, conservation, utilization	7
Evolution		
Unit - VII	Emergence of evolutionary thought Steps and preview of evolution, Lamarkism, Darwinism-neodarwinism. Concepts of variation, adaption, struggle for fitness and natural selection, Spontaneity of mutations, the evolutionary synthesis, Fossils- Formation, Nature, Types, Geological time scale	5
Unit - VIII	Origin of cells and unicellular evolution: Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, Concepts of Oparin and Halden, Experiment of Miller (1953), The first cell, evolution of prokaryote, origin of eukaryotic cells, evolution of unicellular eukaryotes, anaerobic metabolism, photosynthesis and aerobic metabolism, RNA world theory	4
Unit - IX	Molecular Evolution: Concepts of natural evolution, molecular clocks, molecular tools in phylogeny, classification and identification, protein and nucleotide sequence analysis, origin of new genes and proteins, gene duplication and divergence	4

Unit - X	The mechanism of evolution: Concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, adaptive radiation and modification, isolation mechanism, speciation, allopatric and sympatricality, parapatric, convergent evolution, sexual selection, co-evolution	2
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References:

1. Cook T (1903). The Flora of Presidency of Bombay, Vol. I (Indian Reprint) Bishen Singh, Mahendra Pal Singh, Dehradun.
2. Stewart W N and Rothwell G W (2005). Paleobotany and the Evolution of Plants, 2nd
3. Cronquist A J (1988). Evolution and Classification of Flowering Plants, 2nd edn, N Y Botanical Garden.
4. Davis P H and Heywood V H (1963). Principles of Angiosperm Taxonomy, Oliver and Boyd.
5. Eames A J (1961). Morphology of Angiosperms, McGraw Hill Book Co.
6. Erdtman G (1966). Pollen Morphology and Plant Taxonomy of Angiosperms (An introduction to Palynology I), Hafner Pub. Co. London.
7. Hickey M and King C (2000). The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK.
8. Jain S. K. and Rao R. R. Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.
9. Jones S B and Luchinger A E (1986). Plant Systematics 2nd edn, McGraw Hill BookJudd et al. (2007) 10. Plant Systematics – A phylogenetic approach. Sinauer Pub. 3rd edition
11. Kubitzki K (1977). Flowering Plants Evolution and Classification of Higher Categories. Plant Systematics – Evolution Supplement I.
12. Kuijt J. (1969). The biology of parasitic flowering plants. California University Press.
13. Lawrence G H M (1951). Taxonomy of Vascular Plants, Macmillan.
14. Mabberly T J (1997). The Plant Book 2nd edn Cambridge University Press, Cambridge.
15. Naik V N (1984). Taxonomy of Angiosperms, TMH, New Delhi.
16. Radford A E (1986). Fundamentals of Plant Systematics, Harper and Row N Y.
17. Simpson M. Plant Systematics Academic Press, 2nd edition.
18. Singh G (2004). Plant Systematics, 2nd edn, Oxford and IBH, New Delhi.
19. Sivrajan V V (1984). Introduction to Principles of Plant Taxonomy, Oxford and IBH, New Delhi.
20. Smith P M (1976). The Chemotaxonomy of Plants, Edward Arnold Pub. Ltd.
21. Sporne K R (1974). Morphology of Angiosperms, Hutchinson University Library, London.
22. Stace C A (1989). Plant Taxonomy and Biosystematics.

PAPER CODE: BOT5302

PAPER –II: Developmental Botany and Economic Botany

[Credits -4: No. of Lectures 60]

Units	Title and Contents	No. of Lectures
Vegetative development		
Unit - I	Processes basic to plant development Competence, determination, commitment, specification, induction, differentiation, dedifferentiation and redifferentiation. Morphogenetic gradients, cell fate and cell lineages. Polarity and symmetry, cell- cell interaction. Juvenility and transition to adult phase Programmed cell death, aging and senescence.	5
Unit - II	Vegetative development Meristem types and activities of meristem. Organization of shoot and root apical meristems. Regulation of meristem size, lateral organ initiation from root and shoot meristems. Leaf development, plastochron, phyllotaxy, development of trichomes and stomata Vascular elements – differentiation of xylem, phloem Secondary growth – cambium, structure of wood Secretory tissues – Nectaries, laticifers, resin ducts	10
Reproductive development		
Unit - III	Transition from vegetative to reproductive phase Morphological and histochemical changes in shoot apex, floral meristems and floral development	3
Unit – IV	Sporogenesis and fertilization	7

	<p>Development of stamen, anther, sporogenous tissue, tapetum, microsporogenesis, pollen and male gametophyte.</p> <p>Development of carpel, ovule, placenta, sporogenous tissue, integuments, megasporogenesis, female gametophyte</p> <p>Interaction between pollen and pistil, pollen tube guidance, self-incompatibility, double fertilization and triple fusion, role of synergids, endosperm development</p>	
Unit - V	<p>Embryogenesis</p> <p>Stages of embryogenesis, structure and organization of embryo, suspensor, fruit development, structure of seed, germination</p> <p>Apomixis - apospory, diplospory and adventive embryony, autonomous and pseudogamous endosperm development</p> <p>Androgenesis and gynogenesis in vitro</p>	5
Molecular and physiological basis of plant development		
Unit - VI	<p>Molecular genetics</p> <p>Embryogenesis mutants, establishment of body plan</p> <p>Root, shoot and leaf development</p> <p>Transition to flowering and flower development-ABCE Model</p>	9
Unit - VII	<p>Light mediated regulation–</p> <p>Photoreceptors- phytochromes (role in photomorphogenesis and photoperiodism), cryptochromes, phototropins</p> <p>Circadian rhythms</p>	3
Unit - VIII	<p>Hormonal regulation-</p> <p>Perception, signalling and regulation of gene expression by hormones</p> <p>Role of hormones in germination, growth and flowering.</p>	3
Economic Botany		
Unit - IX	<p>Source, method of cultivation and economic uses</p> <p>Cereals&Millets - rice, wheat,sorghum, pear millet</p> <p>Legumes and nuts- black gram, moth bean, cowpea, peanut, almonds, green almonds, cashew nut, walnut</p> <p>Vegetables- sweet potato, beet, carrot, turnip, cabbage, tomato, cucurbits, bitter gourd</p>	7

	Fruits- mango, citrus, grapes, banana, guava, papaya, date, apple, pear, plum, peach	
Unit - X	<p>Source, method of cultivation and economic uses</p> <p>Plant fibres- cotton, flax, coir</p> <p>Wood and Cork – babul, mulberry, deodar, pinewood, red sandalwood, teak, salwood, cork</p> <p>Fatty oils- safflower oil, soybean oil, sunflower oil, mustard oil, castor oil, peanut oil</p> <p>Essential oils- eucalyptus oil, jasmine oil, lavender oil, clove oil, rose oil, turpentine oil</p>	4
Unit - XI	<p>Source, method of cultivation and economic uses</p> <p>Spices- Asafoetida, turmeric, ginger, cinnamon, saffron, cardamom, nutmeg</p> <p>Sugar industry and its byproducts</p> <p>Rubber and its products</p> <p>Tea and coffee industry</p>	4

References:

1. Bhojwani S. S. and Bhatnagar S. P. (1999). The embryology of angiosperms. Vikas Pub. House.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms Kluwer Academic Publishers.
3. Fahn A. (1989) plant anatomy (Third edn) Pergamon Press
4. Gilbert (2006). Developmental biology (8th Edition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
5. Graham C.F. and Wareing P.F. (1984). Developmental Controls in Animals and Plants
6. Blackwell Scientific Publications.
7. Jerny Burgess (1985) An Introduction to Plant Cell Development. Cambridge University Press.
8. Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House, New Delhi.
9. Krishnamurthy K.V. (1988) Methods in Plant Histochemistry
10. Lewis Wolpert (2002), Principles of Development (2nd edition). Oxford University Press.
11. Lyndon R.F. (1990) Plant Development- The Cellular Basis. UNWIN HYMAN
12. Raghavan V. (2000) Developmental Biology of Flowering Plants. Springer Verlag.
13. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH.
14. Wareing P. F. and Philips I. D. J. (1981) Growth and Differentiation in plants. Pergamon Press
15. Wada M., Shimazaki K., Iino M. (2005). Light sensing in plants. Springer.

16. Davies P. J. (2004) Plant hormones. Kluwer.

17. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiology, Maryland

18. S N Panday. Economic Botany

19. V Verma. Economic Botany

20. Bendre. Economic Botany

21. Hill. Economic Botany

PAPER CODE: BOT5303

PAPER –III- Plant Biotechnology

[Credits -4: No. of Lectures 60]

Units	Title and Contents	No. of Lectures
Fundamental Biotechnology		
Unit - I	Fundamental Techniques in Biotechnology Polymerase chain reaction (PCR), methods of PCR, applications of PCR Genomic and cDNA libraries Screening of libraries by Southern, Northern, Western, Blotting techniques and applications DNA sequencing and genome sequencing techniques	10
Unit - II	Molecular markers and their applications Molecular markers: Different types of molecular markers, Genic and random markers, Hybridization-based techniques-RFLP and PCR based techniques – RAPD, AFLP, SSR polymorphism, microsatellite-primed PCR, single nucleotide polymorphism (SNP) Applications of molecular markers: Diversity studies, DNA fingerprinting, population structure studies, phylogenetic relationships	5
Gene Expression		
Unit - III	Techniques used to study gene expression at transcription level Northern hybridization, subtractive hybridization, differential display of mRNA, SAGE, cDNA-AFLP, DNA microarrays, Gene-tagging and plasmid rescue, promoter and enhancer traps	5
Unit – IV	Alterations in gene expression Site-directed mutagenesis, insertional mutagenesis, knock out	5

	mutants, targeting induced local lesions in genomes (TILLING)	
Unit - V	Gene silencing Gene inhibition at RNA level - antisense, co-suppression, miRNAs and siRNAs, silencing mechanisms	5
Plant Tissue Culture		
Unit - VI	Basics of Plant Tissue Culture Major landmarks in the development of Plant Tissue Culture Nutritional requirements of the explants in PTC, role of PGRs and additives. Micropropagation – Stages, pathways. Organogenesis and Embryogenesis – Direct and indirect, zygotic and somatic Protoplast Culture & Somatic hybridization - Isolation, culture, fusion, selection. Somatic hybrids (symmetric and asymmetric), cybrids Somaclonal variation – introduction, types, causes, selection methods,	10
Unit - VII	Applications Production of disease/virus free plants, production of useful mutants/somaclonal variants, production of haploids and triploids, synthetic seeds, embryo rescue, production of secondary metabolites, Micropropagation. Germplasm conservation (Slow growth storage, cryopreservation) Advantages of tissue culture technique over conventional methods of crop Improvement.	5
Agriculture Biotechnology		
Unit - VIII	Case studies for the followings: Transgenics for Abiotic stress tolerance (Salt and drought stress resistance) Transgenics for Biotic stress resistance (fungal, insect, nematode and viral diseases) Transgenics for Herbicide resistance	8

Unit - IX	<p>Case studies for the followings:</p> <p>Transgenics for production of biopharmaceuticals and other useful products –Plant derived vaccines, plantibodies, and pharmaceutical proteins, etc.</p> <p>Transgenics for biofortification& quality improvement of proteins, lipids, carbohydrates, & vitamins</p> <p>Transgenics for lignin modification</p> <p>Concerns related to GMOs.</p>	7
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References:

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant reviews, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).
4. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture : Theory & Practice (Elsevier)
5. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
6. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
7. Rai M (2009) – Fungal Biotechnology (IK International)
8. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
9. H K Das Textbook of Biotechnology 4th edition

PAPER CODE: BOT5304

PAPER –IV- Industrial Botany I (Microbial Technology) (Elective)

[Credits -2: No. of Lectures 30]

Units	Title and Contents	No. of Lectures
Algal and Bio-pesticide Technology		
Unit - I	Algal Technology Introduction to Algal Technology Resource potential of algae, commercial utility of algae- food and feed, pigments, Pharmaceuticals and nutraceuticals, fine chemicals, fuel and biofertilizers, seaweeds extracts as biofertilizers, distribution of economically important algae in India Algal Products SCP- <i>Spirulina</i> mass cultivation and its applications, biodiesel from algae, advantages over other sources of biodiesel, cultivation and extraction methods, liquid seaweed fertilizers – method of preparation and applications.	7
Unit - II	Biopesticide Technology Concept and significance of bio-pesticide; types of biopesticides and their applications, Herbal- Azadiractine, rotenone and pyrethrins Insect predators/parasites- Lady bird beetle, <i>Trichogramma</i> Fungal- <i>Trichoderma</i> , its isolation, mass multiplication and applications Bacterial- <i>Bacillus thuringiensis</i> 5. Viral- Nuclear Polyhydrosis Virus (NPV), Helicoverpa Nuclear Polyhydrosis Virus (HNPV)	8

Fermentation Technology

Unit - III	<p>Introduction</p> <p>Major landmarks in fermentation technology, Major commercial products of fermentation, Lay out of Fermentation Industry, fermenters- design and construction, basic functions, types of fermenters, operation, aseptic operation and use of computer in fermenters, types of fermentation processes, batch fermentation, fed-batch fermentation, continuous fermentation, Solid state fermentation, Common media used in fermentation, scale up of fermentations, industrial processes- upstream and down-stream processes, strain improvement of microbes</p>	6
Unit – IV	<p>Industrial products:</p> <p>Alcohol and Beverages– Sources and methods of production of alcohol, beer and wine.</p> <p>Organic acids- Sources and methods of production of vinegar and citric acid</p> <p>Antibiotics-Sources and production of Penicillin.</p>	5
Unit - V	<p>Food Industry</p> <p>SCP - advantages and disadvantages, production of yeast biomass, production of mycoproteins, traditional fungal foods (Shoyu, Miso, Sake, Tempeh), production of Button mushroom, (<i>Agaricus</i>) Paddy straw mushroom (<i>Volvariella</i>) and Dhingri mushroom (<i>Pleurotus</i>)</p> <p>Biofertilizers- N₂ fixing and phosphate solubilizers.</p>	4

References:

1. A Text Book of Microbiology, Dube and Maheshwari
2. A Text Book of Biotechnology. R C Dube
3. Insecticide control act 1985 Gazette of India
4. Fertilizer control act 1985 Gazette of India
5. Biopesticides for sustainable agriculture: prospects and constraints, Editor(s): Nutan Kaushik
6. Microbiology, Presscott

PAPER CODE: BOT5305

PAPER –IV- Industrial Botany II (Plant Tissue Culture) (Elective)

[Credits -2: No. of Lectures 30]

Units	Title and Contents	No. of Lectures
Plant Tissue Culture for Secondary Metabolite Production		
Unit - I	Culture Systems Scope and applications of in vitro secondary metabolite production. Types of culture systems used for secondary metabolite production	3
Unit - II	Improving secondary metabolite production in culture Regulation of secondary metabolite pathways and compartmentalization Manipulation of nutrient media, precursor additions Immobilization of cells Elicitation using biotic and abiotic elicitors Biotransformation Screening and selection of high secondary metabolite producing cell lines.	7
Unit - III	Bioreactors Bioreactors- Types of bioreactors, growth, product analysis and scaling up	3
Unit - IV	Pathway engineering Enhancing secondary metabolite production through genetic manipulation of biosynthetic pathways	2
Industrial Plant Tissue culture		
Unit – V	Basic requirements Laboratory design, maintenance of plant tissue culture laboratory,	3

	sterilization practices in plant tissue culture laboratory.	
Unit – VI	Case studies of micropropagation Micropropagation of banana, sugarcane, lily, orchids and gerbera with respect to: Selection of elite plants Preparation of explants Surface sterilization Initiation of cultures Subculture In-vitro rooting/ In-vivo rooting Acclimatization of tissue cultured raised plants Market potential (National, International)	7
Unit - VII	Economic Aspects Transporting of ex-agar plantlet, rooting of ex-agar plantlet Economics of micropropagation of banana, sugarcane, lily, orchids and gerbera Preparation of bankable techno-commercial reports of micropropagation of banana, sugarcane and Lily	5

References:

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant reviews, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).
4. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture : Theory & Practice (Elsevier)
5. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
6. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
7. Rai M (2009) – Fungal Biotechnology (IK International)
8. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
9. H K Das Textbook of Biotechnology 4th edition
10. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH.

PAPER CODE: BOT5306

PAPER –IV- Industrial Botany III (Intellectual Property Rights & Entrepreneurship and Management) (Elective)

[Credits -2: No. of Lectures 30]

Units	Title and Contents	No. of Lectures
Intellectual Property Rights		
Unit - I	Patenting and Intellectual rights Introduction to intellectual property right (IPR) - Concept, history, kinds, importance, IPR in India and world, Genesis and scope, some important examples. Patents- Introduction, rights, criteria, procedure for obtaining patents, infringement Copyright- Introduction, works protected under copyright law, rights, transfer of copyrights and infringement. Trademarks and trade secrets- Introduction, types, rights, protection of goodwill, infringement, passing off, defenses, domain name, trade secrets. Geographical indications- Introduction, justification, international position, multilateral treaties, national level, Indian position.	6
Unit - II	Protection of traditional knowledge Introduction, concept of traditional knowledge, holders, issues concerned, Bio-prospecting and Bio-Piracy, Sui-Generis regime, Traditional knowledge on the International Arena, at WTO, at national level, Traditional knowledge of Digital Library Industrial designs and Integrated Circuits- Introduction, rights, assignments, Infringements, defenses of design infringement, integrated circuits. Protection of Plant Varieties- Plant Varieties Protection- Objectives, justification, International position, Plant variety protection in India, rights of farmers, breeders and researchers, national gene bank,	9

	<p>benefit sharing, Protection of Plant Varieties and Farmer's Rights Act, 2001.</p> <p>IPR in Agriculture, Biotechnology, Pharmacy and Software</p> <p>Plant Entry Quarantine (PEQ) and Phytosanitary Certificate</p> <p>Patent drafting</p>	
Entrepreneurship and Management		
Unit - III	<p>Entrepreneurship</p> <p>Entrepreneur: Concept, characteristics of entrepreneur, types and functions of entrepreneur, difference between entrepreneur and a manager.</p> <p>Entrepreneurship Development Programmes (EDPs) - Need, objectives, course contents and curriculum, phases and evaluation of EDPs, Project Identification and Selection (PIS) -Meaning of project and report, project identification, project selection, contents of project reports, preparation of project report.</p> <p>Institutional Finance to Entrepreneurs- Commercial banks, other financial institutions- IDBI, IFSI, ICKI, LIC, UTI, SFC's SIDBI, and EXM Bank</p> <p>Institutional Support to Entrepreneurs -Need of institutional support, institutional support to small entrepreneurs- NSIC, SIDCO, SSIB, SSIDC, SISI's, DICS, Industrial Estates, NABARD</p>	8
Unit – IV	<p>Management</p> <p>The Business – Its Nature and Scope</p> <p>Meaning, characteristics, objectives and scope of business, difference between business and profession, interrelationship between industry, commerce and trade</p> <p>Fundamentals of Management</p> <p>Meaning, characteristics, difference between management and administration, management process, working capital management, inventory management, human resource management, production and operation management, marketing management. Accounting- need, meaning, objectives, journal, ledger, trial balance, final accounts- profits and loss accounts, balance sheet</p>	7

References:

1. Entrepreneur Developments, S. S. Khanka, S. Chand., 2005
2. A Text Book of Microbiology, Dube and Maheshwari
3. A Text Book of Biotechnology. R C Dube
4. N. K. Acharya Textbook on intellectual property rights, Asia Law House (2001)
5. Manjuka Guru and M. B. Rao. Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003)
- 6 .P. Ganguli, Intellectual Property Rights: Unleashing the knowledge Economy, Tata McGraw-Hill (2001)
7. Arthur Raphael Miller, Micheal H. David; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000)
13. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

PAPER CODE: BOT5307**Practicals based on Angiosperms, Evolution, Developmental Botany and Industrial Botany****[Credits -4: No. of Practicals:20]**

Units	Title and Contents	No. of Practicals
Unit - I	Angiosperms and evolution (Any 7) 1. Study of at least 12 locally available families of flowering plants 4P 2. Identification of genus and species of locally available wild plants 1P 3. Preparation of botanical keys 1P 4. Study of types of fossils 1P 5. Geological Time Scale 1P	7
Unit - II	Developmental Botany and Economic Botany (Any 7) 1. Isolation of shoot apical meristems from seedling, young and mature vegetative plant. 1P 2. Tracing the course of stomatal development and observations on stomatal types. 1P 3. Study on Microsporogenesis, megasporogenesis and male and female gametophyte developmental stages 1P 4. Dissection of haustorial endosperm 1P 5. Dissection of embryo of dicot and developmental stages of embryogenesis 1P 6. Histochemical analysis and comparison between vegetative SA and reproductively induced SA. 2P 7. Study of any four cereals, legumes oil seeds, vegetables, fruits, fibres, wood, essential oils w.r.t. botanical name, common name and applications. 2P	7

Unit - III	Industrial Botany I (Any 3) 1. Study of any six sea weeds with applications & Study of any four bio-pesticides and their market products. 1P 2. Study of establishment of culture of <i>Aspergillus</i> and estimation of citric acid by titration method. 2P 3. Study of any eight fermentation products of commercial importance from local market with reference to source and applications. 1P 4. Mass cultivation of <i>Spirulina</i> . 2P 5. Wine production from grapes. 2P	3
Unit - IV	Industrial Botany II (Any 3) 1. Case study of Micropropagation of banana, sugarcane and <i>Lilium</i> . 1P 2. Immobilization of yeast cells and study of enzyme activities in immobilized cells. 2P 3. Effect of plant growth regulators on various explants for callus induction. 2P	3
Unit – V	Industrial Botany III (Any 3) 1. Visit to management institute and preparation of report. 1P 2. Searching and drafting a patent. 2P	3
<p>Note: Field trips within and around the Campus, compilation of field notes and preparation of herbarium sheets of such plants.</p> <p>Report of at least 10 plant species from each of the following categories: Medicinal Plants. b) Endemic plants. c) Exotic weeds.</p>		

PAPER CODE: BOT5308**Practicals based on Plant Biotechnology****[Credits -4: No. of Practicals:20]**

Units	Title and Contents	No. of Practicals
Unit – I	Fundamental techniques of Biotechnology (Any 10) 1. Isolation of DNA and RNA from plant tissues and electrophoresis. 4P 2. Restriction digestion and electrophoresis of plant genomic DNA, Southern blotting and Southern hybridization. 3P 3. Separation and detection of specific proteins using Western blotting. 3P 4. Technique of RT-PCR. 3P	10
Unit - II	Plant Tissue Culture (Any 10) 5. Preparation of sterilized medium. 2P 6. Callus culture. 1P 7. Organ/ Anther Culture. 1P 8. Protoplast isolation and culture 1P 9. Somatic Embryogenesis. 2P 10. Presentation of research paper related to transgenics. 1P 11. Transformation of plant tissues using <i>Agrobacterium rhizogenes</i> . 4P	10

PAPER CODE: BOT5309

Summer Training (Self Learning Credit)

(Credit – 1)

Duration: minimum 4 weeks

The necessary details for Summer Training course are as follows:

A student can complete Training in any Biotech industry / Agro based Industry/ Research institute/ Academic institute / with a research project of a teacher / an expert funded by any funding agency for a minimum period of 4 weeks.

Student has to submit a training report at the beginning of third semester.

The student must include the project completion certificate issued by the respective industry/research institute/educational institute in the report. A student will submit three hard bound copies: Student Copy, Department copy, CoE copy of the work carried out during project work.

The Project Report should include followings:

- Introduction
- Review of Literature
- Aims and Objectives
- Material and Methods
- Observations
- Result and Conclusion
- Bibliography

Internal Assessment will be done by teacher co-ordinator for 25 marks as following:

Sr. No.	Criteria	Marks
1	Project report	10
2	Analysis of Result & Conclusion	10
3	Viva	5

Deccan Education Society's
FERGUSON COLLEGE, PUNE
(AUTONOMOUS)

SYLLABUS UNDER AUTONOMY

SECOND YEAR M.Sc. (Botany)
SEMESTER – IV

SYLLABUS M.Sc. (Botany)
w.e.f. Academic Year 2017-2018

PAPER CODE: BOT5401

PAPER –I: Biostatistics and Bioinformatics

[Credits -4: No. of Lectures 60]

Units	Title and Contents	No. of Lectures
Basic Biostatistics		
Unit - I	Introduction to Statistics Measures of central tendency – mean, mode, median and their properties, Measures of dispersion – variance, standard deviation, coefficient of variance, Symmetry and skewness, measures of skewness, kurtosis. Sampling and sampling distributions – concept of sample and population.	7
Unit - II	Sampling and sampling distribution Methods of sampling: Simple sampling, random sampling (SRSWR, SRSWOR), stratified sampling	2
Unit - III	Correlation and regression Concept of correlation, positive correlation, negative correlation, Graphical method of studying types and correlation – Scatter diagram, Karl-Pearson’s coefficient of correlation, Spearman’s rank correlation coefficient Regression – Equations of regression line using least square method, regression estimate and its standard error	6
Experimental Statistics		
Unit - IV	Design of experiments Principles of design – randomization, replication, local control, treatment group and control group Guidelines for designing the experiments, size of plot, number of replications. Completely randomized design (CDR), randomized block design (RBD)	4

Unit – V	Analysis of variance Analysis of variance table (ANOVA), standard error, critical difference for pairs of treatments, Tukey’s test for pairwise comparison of treatments	3
Unit - VI	Testing of hypothesis Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test, chi-square test: chi square test for goodness of fit, independence of attributes, non-parametric test, Mann–Whitney U test	8
Bioinformatics		
Unit - VII	Introduction to Bioinformatics Introduction and definition, history and scope, applications of bioinformatics in various fields. Basic concepts of sequence similarity, identity and homology. Definitions of homologues, orthologues and paralogues.	5
Unit - VIII	Databases Nucleic acid sequence databases (NCBI, EMBL,DDBJ), protein sequence databases (SWISS-PROT, TrEMBL, PIR, Uniprot), Literature databases (PubMed, MEDLINE, BMC,PLOS), Metabolic pathway databases (KEGG, MetaCyc, EcoCyc)	5
Unit - IX	Structural Databases Study of PDB,NDB, PubChem databases with respect to- basic concepts of derived databases, sources of primary data and basic principles of the method for deriving the secondary data, organisation of data, contents and formats of database entries, identification of patterns in given sequences and interpretation of the same.	5
Unit - X	Sequence Analysis a. Pair wise comparison of DNA and protein sequences, dynamic programming algorithms, FASTA and BLAST. b. Multiple sequence alignments, progressive methods, iterative	5

	methods, localized alignments	
Unit - XI	Phylogenetic Relationships Determining phylogenetic relationships using DNA and protein sequences (CLUSTAL, PHYLIP)	3
Unit - XII	Scoring Matrices Basic concept of scoring matrix, Matrices for nucleic acid and protein sequences, PAM and BLOSUM series.	3
Unit - XIII	Protein structure prediction and drug discovery Molecular visualisation of protein, protein conformation and visualisation tool (RASMOL), drug discovery. Role of bioinformatics in drug discovery, target discovery, lead discovery, docking and prediction of drug quality.	4

References:

1. Lab Math – Adams, D.S. I.K. Internations Pvt Ltd. New Delhi, 2004
2. Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989
3. Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983
4. Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H. , John Wiley, New York, 2001
5. Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
6. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003
7. Bioinformatics and Molecular Evolution – Higgs PG and Attwood, TK

PAPER CODE: BOT5402

PAPER –II: Plant Interactions and Immunology

[Credits -4: No. of Lectures 60]

Units	Title and Contents	No. of Lectures
Plant –Plant and Plant- Animal interactions		
Unit - I	Plant- Plant Interactions Allelopathy in plants Parasitic association in plants Epiphytic plants	7
Unit - II	Plant- Animal Interactions Herbivores–insect-plant interactions, grazing animals–physical and biochemical interactions, Plant signalling and defense against herbivores Carnivorous plants – morphological features, specialized biochemical mechanisms for nutrient processing	8
Symbiotic associations		
Unit - III	Lichens & Mycorrhizae	6
Unit – IV	Endophytic Associations Algae, fungi, bacteria	3
Unit - V	Other Associations Nodulating bacteria and legumes relationships Algae and coral relationships Fungi and insect relationships	6
Pollination and Dispersal Biology		
Unit – VI	Pollination types & Mechanisms	4

	Flower structure with reference to pollination mechanisms, mimicry, thermogenesis.	
Unit - VII	Pollinators Bees, beetles, butterflies, birds, mammals	4
Unit – VIII	Co-evolution of pollinators and plants Fig-fig wasps' interaction, humming bird-plant interactions.	3
Unit - IX	Seed Dispersal Mechanisms Fruit and seed morphology relevant to seed dispersal	4
Immunology		
Unit – X	Overview of Immune System, Plant Allergens and Toxins Introduction to immune system. Immune system cells, tissues and organs. Antigens, Antibodies, organization and expression of immunoglobulin genes. T-cell receptor, T-cell generation, activation and differentiation. B-cell generation, activation and differentiation.	6
Unit - XI	Types of Immunity Innate immunity, Acquired immunity (Humoral and Cellular) and passive immunity. Structure of MHC molecule and antigen presentation	4
Unit - XII	Complement System Three pathways of complement activation. Regulation and function of complement	4
Unit - XIII	Hypersensitive Reactions Hypersensitive reactions I, II and II with examples	1
References:		
1. Walter Larcher 1995 “Physiological Plant Ecology”. 3rdEds. Springer – Verlag, New York Berlin Heidelberg		
2. ZdenekLastuvka, Barbara Politycka, S. S. Narwal, Jana Kalinova 2007, “Coactions and Competition in Higher Plants”, Scientific Publisher (India).		

3. Malcolm C. Press, Jonathan D. Graves 1995, "Parasitic Plants", Chapman & Hall, 2-6 Boundary Row, London.
4. Peter Scott 2008, "Physiology and Behaviour of Plants". John Wiley & Sons Ltd.
5. R.S. Mehrotra. Introduction to Mycology. Wiley Eastern.
6. Hans Lamberts and Thijs L. Pons Plant Physiological Ecology, Springer Publication.
7. Kuby, Immunology.

PAPER CODE: BOT5403

PAPER –III: Plant Pathology

[Credits -4: No. of Lectures 60]

Units	Title and Contents	No. of Lectures
Introduction to Plant Pathology		
Unit - I	Plant Pathology Milestones in plant pathology Plant pathology and its objectives Nature and concept of plant disease, classification of plant diseases Causes of plant diseases, symptoms of plant diseases, disease cycle	6
Unit - II	Diseases Bacterial and mollicutes diseases of plants. Viral diseases of plants Diseases caused by viruses. Nematodal diseases of plants	6
Unit - III	Plant Disease Epidemics Plant disease epidemiology and forecasting of plant disease epidemics. Effect of plant diseases on human affairs	3
Pathogenesis		
Unit - IV	Pathogenesis Penetration, infection and spread of diseases	4
Unit – V	Effect of pathogen on Plant Physiological functions	4
Unit - VI	Enzymes and toxins in Plant Diseases	4
Unit - VII	Pathogenecity of Biotrophic and Necrotrophic Pathogens	4

Disease Development

Unit - VIII	<p>Environmental Factors and Disease Development</p> <p>Effect of temperature, humidity, soil pH, soil texture, light, CO₂ and O₂ levels, nutrients and disease development</p>	4
Unit - IX	<p>Plant Defense Mechanisms</p> <p>Pre-existing defense, defense through lack of essential factors, induced structural and biochemical defense</p>	3
Unit - X	<p>Genetics and Molecular Biology of Pathogen Interactions</p> <p>Genetics of host parasitic interactions, vertical and horizontal resistance, pathogenesis genes, avirulence genes, host- R genes.</p>	6
Unit - XI	<p>Post Harvest Diseases</p> <p>Concept of post-harvest diseases of fruits, vegetables and seeds</p>	2
Disease Management And Related Aspects		
Unit - XII	<p>Disease Management</p> <p>Diagnostic methods for detecting pathogens</p> <p>Control of disease using fungicides and other chemicals</p> <p>Bio-control agents for controlling disease</p> <p>Disease control using biological and chemical activators of resistance</p>	8
Unit - XIII	<p>Plant Disease Assessment</p>	2
Unit - XIV	<p>Improving Resistance in Plants</p> <p>Breeding methods for improving resistance in plants</p> <p>Biotechnology and its role in plant pathology</p>	5

References:

1. Plant Pathology by R. S. Mehrotra, first edition, McGraw-Hill Education publication, 1982.
2. Plant Pathology by George N Agrios, fifth edition, Academic Press, London, 2005.
3. Plant Nematode: Morphology, Systematics, Biology and Ecology by M. R. Khan, first edition, Science Publishers, 2008.

4. Plant Pathogenesis and Resistance by Jeng-Sheng Huang, first edition, Springer, Netherlands, 2001.
5. Plant Pathology by R. S. Mehrotra and Ashok Agarwal, second edition, Tata McGraw Hill Education, 2003.
6. Biocontrol of Plant Diseases by P. C. Trivedi, first edition, Aavishkar Publishers and Distributors, 2007.
7. Concise Encyclopedia of Plant pathology by P. Vidhyasekaran, first edition, CRC Press, 2004.
8. Topics in Mycology and Pathology by L. N. Nair, first edition, New Central BookAgency Kolkata, 2007.
9. Fundamentals of plant pathology by A.K. Sinha, Kalyani Publishers
10. Disease of crops plants of India by Rangswami and Mahadevan, Prentice Hall Publication

PAPER CODE: BOT5404

PAPER –IV: Industrial Botany IV (Herbal Technology and Gardening)

[Credits -2: No. of Lectures 30]

Units	Title and Contents	No. of Lectures
Herbal Technology		
Unit - I	Phytotechnology Introduction, concepts and prospects Phyto-technology- value addition to biodiversity through chemo prospection Traditional Medicinal plants mentioned in Ayurveda with their application	8
Unit - II	Dyes Natural dyes for cotton and silk industry –Tecomella leaves, Katha and Ravenchi wood, Seeds of Bixa, Babul flowers Medicinal herbs for dying hair and in cosmetics	4
Unit - III	Essence Aromatic plants as important sources of essence	3
Floriculture and Gardening		
Unit - IV	Green House Technology Selection of land, infrastructure, types, maintenance, media used, Selection of propagules of crop, hardening, harvesting and post harvest processing, marketing	5
Unit – V	Floriculture significance, importance, scope, prospects and role of floriculture in developing country, its scope for domestic and export market, factors	5

	affecting flower production, production of cut flowers and maintaining its quality, prolonging of vase life, packaging of cut flowers, cultivation of carnation, Gerbera, <i>Chrysanthemum</i> , <i>Gypsophilla</i> , orchids	
Unit - VI	Gardening Principles of garden design Styles of gardening Indoor gardening Landscape gardening- Bio-aesthetic planning, landscaping of highways, railway stations and railway lines, bank of rivers and canal, city, town and country sides, educational institutes and factories	5
References: 1. Hand book of horticulture, ICAR, New Delhi 2. Floriculture in India, Randhawa and Mukhopaddhay 3. Gardening in India, Bose and Mukherjee, Oxford 4. Introductory ornamental horticulture, Arora, Kalyani publishers 5. Gardening in India, Bose and Mukherjee, Oxford		

PAPER CODE: BOT5405

PAPER –V: Industrial Botany V (Phytopharma Technology)

[Credits -2: No. of Lectures 30]

Units	Title and Contents	No. of Lectures
Cultivation of Medicinal Plants		
Unit - I	Conventional Propagation Methods for Cultivation of Medicinal Plants	1
Unit - II	Factors affecting Cultivation of Medicinal Plants (I) Exogenous (II) Endogenous factors (III) Nutrients (IV) Soil and Soil fertility (V)Pest and Pest control (VI) Plant Growth Regulators (VII) Diseases management of medicinal and aromatic plants	4
Unit - III	Methods of Cultivation Systemic method of Cultivation and post harvest technology of medicinal plants cultivated in India (i) Senna (ii) Opium (iii) Ashwaghandha (iv)Lemon Grass (v)Turmeric (vi)Ginger	6
Unit - IV	Micropropagation of Medicinal Plants Culture media, explants, incubation conditions, stages of micropropagation, acclimatization and field trials (Case study- <i>Vinca rosea</i> , <i>Adhathoda vasica</i> and <i>Withania somnifera</i>)	4
Evaluation of crude drugs, processing and marketing		
Unit – V	Evaluation of crude drugs Evaluation of crude Drugs with respect to authenticity of raw material: Concept, considerations, parameters. Pharmacopoeia and other guidelines (FDA). Comparative study of IP, European Pharmacopoeia, BP / Ayurvedic	6

	Pharmacopoeia of India	
Unit - VI	<p>Pharmacognostic Evaluation of Medicinal Plants</p> <p>Geographical distribution, commercial varieties, adulterants and substitutes, cultivation, collection, macroscopic and microscopic characters, chemical constituents, chemical tests, therapeutic uses, commercial products if any.</p> <p>Root Drugs: <i>Aconitum napellus</i> Linn., <i>Gentiana lutea</i> Linn.</p> <p>Rhizome Drugs: <i>Rauwolfia serpentina</i> Benth., <i>Acorus calamus</i> Linn.</p> <p>Stem Drugs: <i>Ephedra</i> sps. , <i>Quassia amara</i> Linn.</p> <p>Bark Drugs: <i>Cinchona</i> sps. , <i>Saraca asoka</i> (Roxb.) De Wild.</p> <p>Leaf Drugs: <i>Ocimum sanctum</i> Linn. , <i>Adhatoda vasica</i> Nees.</p> <p>Flower Drugs: <i>Woodfordia floribunda</i> Salisb., <i>Eugenia caryophyllata</i> Thumb.</p> <p>Fruit Drug: <i>Tamarindus indica</i> Linn. , <i>Corriandrum sativum</i> Linn.</p> <p>Seed Drugs: <i>Strychnos nux-vomica</i> Linn. , <i>Plantago ovata</i> Forskal</p>	8
Unit - VII	Preparation of Monograph of crude drug	1
<p>References:</p> <ol style="list-style-type: none"> 1. Pharmacognosy, Willium C. Evans, Saunders publications. 2. Textbook of Pharmacognosy, P. E. Wallis, CBS publishers and distributors. 3. Text book of Pharmacognosy, S. B. Gokhale, C. A. Kokate, A. P. Purohit, Nirali Publications 		

PAPER CODE: BOT5406

PAPER –VI: Industrial Botany VI (Post Harvest Technology & Biofuel Technology)

[Credits -2: No. of Lectures 30]

Units	Title and Contents	No. of Lectures
Post Harvest Technology		
Unit - I	Fruits and their potential in industry 1. General account of tropical and subtropical fruits a) Introduction b) World fruit production and contribution to gross domestic product (GDP) c) Global consumption of tropical and subtropical fruits d) International trade in tropical and subtropical fruit 2. Postharvest biology of tropical and subtropical fruits a) Introduction b) Diversity in fruit characteristics c) Maturation and ripening d) Quality attributes e) Environmental factors affecting deterioration f) Biological factors affecting deterioration g) Pathological disorders and insect infestation h) Biotechnological approaches for improving quality and postharvest life	7
Unit - II	Preservation and processing of fruits Maturity and harvesting indices- harvesting, conditioning, quality, the cold chain, centralized packing operations, ripening, processing Principles of conventional methods of preservation- cold storage, sun drying Fruit preparation for preservation purposes Refrigeration and freezing	8

	Drying Manufacturing and canning of fruit beverages and purees Manufacturing of jams and jellies	
Biofuel Technology		
Unit – III	Concept of Biofuels Environmental implications of fossil fuel, concept of biofuel, alternatives for fossil fuels – ethanol, vegetable oil, biodiesel Bio-hydrogen- Application and future prospects Methanogenesis from agro industrial residues	7
Unit - IV	Bioethanol Technology Sources for bioethanol production- sugar crops, starch crops, cellulosic feed stock bioethanol production- sugar-to-ethanol process, starch-to-ethanol process, cellulose-to-ethanol process, bio-ethanol form lignocelluloses, distillation to dehydration process, technology applications of bioethanol, spark ignition engines, compression ignition engines, fuel cells, standardization of bioethanol	5
Unit - V	Lipid Derived Biofuels Sources - oil seed crops, microalgae, animal fats, waste oils Fuel productions- oil extractions, oil refining, transesterification, properties and use of lipid biofuels, economy of lipid biofuels	3

References:

1. Post-harvest handling of tropical fruit, B R Champ, E. Highley & G. I. Johnson (eds), Australian Centre for International Agricultural Research
2. Post-harvest technology of fruits and vegetables: Handling, processing, fermentation and waste management, L R Verma and V K Joshi, Indus Publishing Company.
3. Postharvest biology and technology of tropical and subtropical fruits: Volume 1: Fundamental issues, Edited by E Yahia, Universidad Autónoma de Querétaro, Mexico, Woodhead Publishing Series in Food Science, Technology and Nutrition No. 206
4. Processing of Fruits and Vegetables for Value Addition, Vijay Sethi, B.C. Dekka, Vijay Sethi, ShrutiSethai, ShrutiSethi, Indus Publishing.
5. Handbook of Fruits and Fruit Processing, Y.H. Hui, John Wiley & Sons.
6. Advances in Fruit Processing Technologies, Sueli Rodrigues, Fabiano Andre NarcisoFernandes, CRC

Press.

7. Quality Control in Fruit and Vegetable Processing, Issue 39, Food & Agriculture Org.
8. Small Scale Food Processing: A Guide to Appropriate Equipment, Peter Fellows, Ann Hampton, Intermediate Technology Publications.
9. Biofuel Technologies- Recent Developments, Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Springer publication
10. Biofuel technology Handbook, Dominik Rutz, Rainer Janseen, WIP Renewable Energies, Germany

PAPER CODE: BOT5407

PAPER –VII: Project

[Credits -8]

Duration : Minimum 200 Hrs

The necessary details for Industrial Training course are as follows:

A student can complete Project Work in any Biotech industry / Agro based Industry/ Research institute/ Academic institute / with a research project of a teacher / an expert funded by any funding agency for a minimum period of 200 Hours.

1. There will be a teacher coordinator for a group of 10 students. A teacher coordinator is responsible to :

- Maintain a weekly status / progress report of the student.
- Keep in touch with the reporting authorities from industry for each student.
- Help the students to solve their difficulties.
- Arrange the meeting and presentations as per requirement.
- Guide each student for preparing final project report.
- Keep complete documentation record for each student separately.
- Internal assessment of each student with the help of confidential feedback from guide for 50 marks

The workload for this teacher coordinator is proposed as four hours per week.

2. Guidelines for submitting the final project report

The student must include the project completion certificate issued by the respective industry/research institute/educational institute in the report. A student will submit three hard bound copies: Student Copy, Department copy, CoE copy of the work carried out during project work.

The Project Report should include followings:

- Introduction
- Review of Literature
- Aims and Objectives
- Material and Methods
- Observations
- Result and Conclusion
- Bibliography

3. Scheme of Assessment :

➤ Continuous Internal Assessment

Evaluation for internal 100Marks will be done by the Internal Teacher Coordinator and Guide.

Description	Marks
Weekly Reports and Assessment Report from Guide	50
Final Project Report writing	25
Presentation Demo	25

➤ **End Semester Assessment**

Evaluation for external 100 Marks will be done by a panel of three consisting of One Subject Expert, One External Examiner (External from other college) and One Internal Examiner. Each examiner is expected to assess each student for 100 marks independently and average of the three scores is to be considered as the final ESE score (out of 100).

Description	Marks
Selection of topic & objectives	10
Work skill	10
Statistical Analysis of result	10
Interpretation of result	10
Communication skill	10
Presentation	20
Project report	20
Viva	10

- The internal examiner(s) will be responsible for submitting the total marks out of 200 to examination section.
- The final grade (to be printed on the mark list) is to be calculated on the basis of UGC 10 point scale.

Note:- A student who has obtained Grade F will have to carry out this project once again for a complete semester (minimum 200 Hours).

PAPER CODE: BOT5408

PAPER –VII: Techno-Commercial Case study

[Credit -1]

A student has to visit at least four units of the followings and submit detailed report:

1. Biofertilizer Unit
2. Mushroom cultivation unit
3. Green house unit
4. Floriculture unit
5. Plant nursery unit
6. Garden designing and maintenance unit
7. Fruit processing unit
8. Bio-pesticide unit
9. Biomass briquette unit
10. Biofuel units
11. Plant tissue culture industries
12. Farmhouse management
13. Pomoculture units
14. Organic farming
15. Fresh vegetables and flower supply unit
16. Herbal product industry
17. Forest department unit
18. Medicinal plant garden
19. Effluent treatment plant
20. Solid waste management unit

Internal Assessment will be done by teacher co-ordinator for 25 marks as following:

Sr. No.	Criteria	Marks
1	Study report	10
2	Photographs	10
3	Viva	5