Resolution No.: AC/II(23-24).2.RPS4

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

(Affiliated to University of Mumbai)

Syllabus for: Semester III and IV

Program: M. Sc.

Program Code: Botany (RPSBOT)

Specialization: Molecular Biology, Cytogenetics and Plant Biotechnology

(As per the guidelines of NEP 2020- Academic Year 2024-25)

GRADUATE ATTRIBUTES

In the post graduate courses, S. P. Mandali's Ramnarain Ruia Autonomous College is committed to impart conceptual and procedural knowledge in specific subject areas that would build diverse creative abilities in the learner. The College also thrives to make its Science post graduates research/ job ready as well as adaptable to revolutionary changes happening in this era of Industry 4.0.

GA	Description **A student completing Masters in Science program will be able to:**
GA 1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA 2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA 3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA 4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
GA 5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA 6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

PO	PO Description A student completing Masters in Science program in the subject of Botany will be able to:
PO 1	Gain adequate knowledge on major groups of plants -Cryptogams to Phanerogams, learn the inter-relationships, phylogeny and evolutionary concepts, biodiversity in relation to habitat correlate with climate change, land and forest degradation and Paleobotany to trace the evolution of plants
PO 2	Comprehend the concepts of plant taxonomy with respect to principles of ICN, evolution, concept of characters and methods to illustrate evolutionary relationships. Familiarize with the latest classification system and role of BSI
PO 3	Gain core knowledge of foundational concepts of anatomy, developmental botany, ultra-structure and function of cell membranes cyto-genetics, physiology and ecology and their application in contemporary research/biological systems
PO 4	Critically evaluate the functioning of organisms at the genomic and cellular level, Relate physiological adaptations, development and reproduction of higher plants.
PO 5	Outline the utilization of various plant groups, ethnobotanical aspects, active constituents and medicinal uses of plants with special reference to usage as mentioned in different Pharmacopoeia.
PO 6	Apply the skills in handling scientific instruments in planning and executing biological research, demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization
PO 7	Apply the principles of biostatistics and bioinformatics in biological research, evaluate the scientific content, apply the scientific methods in formulating hypothesis and data analysis.
PO 8	Apply the technique of plant tissue culture for the propagation of the plants which is the need in the society /industry, apply the methods of *in vitro* techniques for product enhancement
PO 9	Apply the fundamentals of Nanotechnology, Environmental biotechnology and food biotechnology in various fields
PO 10	Understand and apply the techniques of plant breeding procedures for hybridization, stress tolerance and genetic engineering of plants.
PO 11	Develop critical and logical thinking capacity and prepare themself to qualify various competitive exams like MPSC, UPSC, SET, GATE, CSIR and UGC NET

PROGRAM OUTLINE

			SEMESTER III	
MSc	III	**RPSBOTO601 (Discipline Specific Core)**	**CYTOGENETICS**	**03**
		I	Cytology	
		II	Cytogenetics	
		III	Genetics	
		RPSBOTPO601	Practicals based on **Cytogenetics**	**01**
		RPSBOTO602 (Discipline Specific Core)	**MOLECULAR BIOLOGY- I**	**03**
		I	DNA Replication, Transcription	
		II	RNA Processing and Translation	
		III	Vectors in gene cloning and applications of rDNA technology	
		RPSBOTPO602	Practicals based on **Molecular Biology- I**	**01**
		RPSBOTO603 (Discipline Specific Core)	**MOLECULAR BIOLOGY- II**	**03**
		I	Gene Regulation- I	
		II	Gene Regulation- II	
		III	Cell Signaling	
		RPSBOTPO603	Practicals based on **Molecular Biology- II**	**01**
		RPSEBOTO604 (Discipline Specific Elective)	**Bioprospecting for industrial molecules**	**03**
		I	Bioprospecting for crop protection and anti-microbial products	
		II	Algal biomass for high-value biomolecules	
		III	Bioprospecting for flavours and Fragrances	
		RPSEBOTPO604	Practicals based on **Bioprospecting for industrial molecules**	**01**

		RPSEZOOO604 Discipline Specific Elective)	**Introduction to Model Organisms**	**03**
		I	*Hydra* and *Drosophila*	
		II	*Zebrafish*	
		III	*Caenorhabditis elegans*	
		RPSEZOOPO604	Practicals based on **Introduction to Model Organisms**	**01**
		RPSELSCO604 (Discipline Specific Elective)	**Environmental Biology, Evolution and Astrobiology**	**03**
		I	Environmental Biology	
		II	Current Environmental Issues in India and Biodiversity Management	
		III	Evolution and Astrobiology	
		RPSELSCPO604	Practicals based on **Environmental Biology, Evolution and Astrobiology**	**01**
		RPSRPBOTO605	**RESEARCH PROJECT**	**06**
TOTAL				**22**
			SEMESTER IV	
		RPSBOTE611	**PLANT BREEDING**	**03**
		I	Plant Breeding- I	
		II	Plant Breeding- II	
		III	Molecular Plant Breeding (Transgenic crops) and Plant Genetic Engineering	
		RPSBOTPE611	Practicals based on **Plant Breeding**	**01**
		RPSBOTE612	**PLANT BIOTECHNOLOGY**	**03**
		I	Plant Tissue Culture- I	
		II	Plant Tissue Culture- II	
		III	Nanotechnology	
		RPSBOTPE612	Practicals based on **Plant Biotechnology**	**01**
		RPSEBOTE613 (Discipline Specific Elective)	**Soilless Culture Technology**	**03**
		I	Introduction to Hydroponics	

		II	Various Hydroponic systems	
		III	Fabrication of different Hydroponic systems	
		RPSEBOTPE613	Practicals based on **Soilless Culture Technology**	**01**
		RPSINTBOTE614	**Internship**	**10**
Total				**22**

SEMESTER- III
DISCIPLINE SPECIFIC CORE COURSE
Course Code: RPSBOTO601

Course Title: Cytogenetics

Academic year 2024 - 25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Recall the structure of the cell membrane, its function, regulatory aspects of cell division and PCD.
CO 2	Discuss the techniques of dermatoglyphic analysis.
CO 3	Explain the molecular mechanism of nitrogen fixation.
CO 4	Study the stages of mitosis and meiosis.
CO 5	Interpret the effect of mutagens on the stages of mitosis in a cell.

Detailed Syllabus

RPSBOTO601	Cytogenetics	Credits- 03
UNIT I	**Cytology**	**Hours- 15**
	• Cell Cycle and Apoptosis: Check points during cell cycle-G1 to S, progression of S phase, G2 to M phase, Anaphase check points and components involved as regulators of check points. • Role of cyclins and CDKs, synthesis and degradation of cyclins, structural features of CDKs and cyclins, activation and inactivation of cyclin dependent kinases • Role of RBs, E2Fs, and DP proteins, P53, different types of Cyclin dependent CDKs, CDC25, CAKs, Wee1 proteins, nim-proteins, SCFs, Anaphase Promoting Complexes APC (cyclosomes), • Centrosome activation- structure, duplication of centrosomes, Role of nucleophosmins, organization of mitotic apparatus, binding of tractile fibers to kinetochore complexes, molecular motors involved in movement of chromosomes to equatorial plate and in anaphase movement; cytokinesis by cleavage and phragmoplast formation- different gene products and	

	structures involved and the mechanisms of cytokinesis. • Cell Plate formation, PCD.	
UNIT II	**Cytogenetics**	**Hours- 15**
	• **Karyotype Studies:** Analysis and Nomenclature, Banding Techniques- Giemsa banding, R- banding, C-banding, Techniques of Detecting human syndromes • **Molecular Cytogenetics Methods:** Principle, Technique and Applications of FISH, CGH, SKY • **Dermatoglyphics:** Meaning and terminology. Finger patterns – types, ridge count. Different types of palmer patterns, soles and flexion creases. Methods of observation and printing of dermal ridges. • **Dermatoglyphic analysis:** Its uses and limits. Finger printing in Forensic Analysis. Dermatoglyphic features of syndromes. Abnormal dermatoglyphics	
UNIT III	**Genetics**	**Hours- 15**
	• Molecular basis of transformation, transduction, conjugation; fine structure of the gene, T4 Phage, complementation analysis, deletion mapping, cis-trans tests. *Neurospora* genetics • **Molecular biology of nitrogen fixation:** Genetic engineering of nitrogenase cluster, genetic engineering of nodulation genes	
RPSBOTPO601	Practicals based on **Cytogenetics**	**Credits- 01**
1	Preparation of cytological stains, fixatives and pretreatment agents.	
2	Study of mitotic index.	
3	Squash preparation from pre-treated root tips (colchicines/ Paradichlorobenzene)	
4	Smear preparation from any suitable plant material.	
5	Study of dermatoglyphics analysis.	
6	Giemsa Staining of blood sample.	
7	Tetrad analysis in *Neurospora* – two genes and centromere.	
8	Deletion mapping in Bacteriophage.	

References:

1. The Cell, A molecular approach,. ASM, Washington. Karp Gerald. Cell Biology, John Wiley and Sons
2. Anderson J, Durston B H, Poole 1970. Thesis and assignment writing. Wiley eastern.

3. Bedekar V. H.1982. How to write assignment and research papers, dissertations and thesis. Kanak publications.
4. Kothari– C.R. 2004. Research Methodology –Methodsand Techniques, New Age International LTd. Publishers, New Delhi.
5. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999.Molecular Biology of Cell, Garland Publishing, Inc., New York.
6. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology ofPlants. American Soc. Of Plant Physiologists, Maryland, USA
7. De Robertis, E.D.P. and De Robertis, 2017 E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt. Ltd., New Delhi.
8. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.)Jones and Bartiet Pub. Inc., London.
9. Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA
10. Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2nd Edi.) John Wiley & Sons Inc., USA.
11. Tamarin, R. H. 2001 Principles of Genetics 7th Edi.The McGraw-Hill Companies.
12. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
13. Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

DISCIPLINE SPECIFIC CORE COURSE

Course Code: RPSBOTO602

Course Title: Molecular Biology- I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Distinguish between molecular mechanisms of prokaryotes and eukaryotes.
CO 2	Compare and contrast between various mechanisms of DNA recombination.
CO 3	Comment on the different types of RNAs and their role.
CO 4	Describe the genomic technologies involved in generating recombinant DNA molecules.
CO5	Elaborate on the versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.
CO6	Enlist the applications of recombinant DNA technology in biotechnological research.

Detailed Syllabus

RPSBOTO602	Molecular Biology- I	Credits- 03
UNIT I	**DNA Replication**	**Hours- 15**
	• Molecular details of DNA replication in prokaryotes and eukaryotes. • DNA Repair Mechanisms. • Assembly of raw DNA into nucleosomes. • DNA Recombination- Holliday model for recombination. Transcription- RNA synthesis, classes of RNA and the genes that code for them. • Transcription of protein coding genes in prokaryotes and eukaryotes, mRNA molecule. • Transcription of other genes, rRNA, tRNA. • Capping, Polyadenylation, Splicing mechanisms. • snRNA- Types and significance. • Non-coding RNAs, Ribozymes, Riboswitches, RNA localization.	
UNIT II	**RNA synthesis, Processing and Translation**	**Hours- 15**

	• Transcription- RNA synthesis, classes of RNA and the genes that code for them. • Transcription of protein coding genes in prokaryotes and eukaryotes, mRNA molecule. • Transcription of other genes, rRNA, tRNA. • Capping, Polyadenylation, Splicing mechanisms. • snRNA- Types and significance. • Non-coding RNAs, Ribozymes, Riboswitches, RNA localization. • Translation of genetic message. • Post-translational modifications, localization, chaperones	
UNIT III	**Vectors in gene cloning and applications of rDNA technology**	**Hours- 15**
	• Vectors in gene cloning: General information on retroviral vectors, pUC19, phage, cosmid, BAC and YAC vectors, High and low copy number plasmids and its regulation and advantages. • Use of YAC or YEp of yeast (*Saccharomyces cervisiae*) as effective cloning vectors because of their high copy numbers in production of HBsAg vaccine. • Production of herbicide resistant plants, insect resistant plants, improving seed storage proteins and golden rice. • Strategies to create Transgenic plants with herbicide resistance: Following strategies to be studied in detail with reference to herbicide Glyphosate resistance • Methods of modifying the Diazotrophs (N2 fixing bacteria) by Gene alterations in Rhizobium sp. - Improve nitrogen fixing efficiency and bacteria host plant interaction.	
RPSBOTPO602	Practicals based on **Molecular Biology- I**	**Credits- 01**
1	To understand the concept of reverse transcription and perform amplification of cDNA by PCR.	
2	Perform ligation of DNA and observing the efficiency of ligation reaction through agarose gel electrophoresis.	
3	Southern blot transfer technique.	
4	Determine the restriction endonuclease sites of two restriction enzymes on a circular plasmid and construct a restriction map of the plasmid.	
5	Problems based on: Restriction map analysis and construction of restriction maps.	

References:

1. Lewin B. 2000. Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe S.L 1993 Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
4. Gupta. P.K. 1995. Cytogenetics. Rastogi& Co., Meerut.
5. Glick. B.R. & Thompson. J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boc Raton, Florida.
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14. William. K., Cummings. S., Spencer. M.R.,& Charlotte. A. 2013. Essentials of Genetics. Pearson Books, Delhi.
15. Hartwell L. 2011. Genetics: From Genes to Genomes, Study Guide and Solution Manual. 4th Edition. Nero.
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18. Roy. D. 2009. Cytogenetics. Alfa Science International Ltd., UK.
19. Gupta. P.K. 1995. Cytogenetics. Rastogi& Co., Meerut.
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21. Swanon. M. & Young. 1982. Cytogenetics. Prentice Hall, India

DISCIPLINE SPECIFIC CORE COURSE

Course Code: RPSBOTO603

Course Title: Molecular Biology- II

Academic year 2024 - 25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Compare the expression of gene regulation in prokaryotes and eukaryotes.
CO 2	Explain the various components of an operon system.
CO 3	Classify the different forms of signaling.
CO 4	Illustrate the different signaling pathways.
CO 5	Isolate, separate and quantify plasmid using plasmid isolation kit.
CO 6	Perform restriction enzyme digestion and separate the fragments using AGE technique.

Detailed Syllabus

RPSBOTO603	Molecular Biology II	Credits- 03
UNIT I	**Gene Regulation I**	**Hours- 15**
	• Regulations of gene expression in bacteria – 1) Lactose operon 2) Arabinose operon 3) Tryptophan operon • Regulation of gene expression in bacteriophage λ.	
UNIT II	**Gene Regulation II**	**Hours- 15**
	• Control of gene expression in eukaryotes, Transcriptional control, RNA processing control, mRNA translocation control, mRNA degradation control, protein degradation control • Genetic regulation of development in *Drosophila* Developmental stages in *Drosophila* – embryonic development, imaginal discs, homeotic genes. Study of genetic traits in *Drosophila*.	
UNIT III	**Cell signaling**	**Hours- 15**
	• Hormones and their receptors: cell surface receptor, intracellular receptor, signaling through G-protein coupled receptors, signal relay pathways-signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.	

	• Forms of signaling (paracrine, synaptic, autocrine, endocrine, cell to cell contact)	

PRACTICALS

RPSBOTPO603	Practicals based on **Molecular Biology- II**	**Credits- 01**
1	Isolation of plasmid DNA.	
2	Quantification of plasmid DNA.	
3	Agarose gel electrophoresis separation of plasmid DNA.	
4	Restriction enzyme digestion and separation of fragments.	
5	Transformation of *E. coli* cell by plasmid DNA.	
6	β-galactosidase expression and assay.	

References:

1. De Robertis & De Robertis, 2004. Cell and Molecular Biology. Lippincott. Williams and Wilkins. USA.
2. Freifelder, 1990. Molecular Biology, Narosa Publishing House, New Delhi.
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17. Gupta, P.K. 2000. Gentics.Rasatogi publications, Meerut.
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19. Strickberger (2005). Genetics (III Edn). Prentice Hall of India Pvt. Ltd.

DISCIPLINE SPECIFIC ELECTIVE COURSE
Course Code: RPSEBOTO604
Course Title: Bioprospecting for Industrial Molecules

Academic year 2024- 25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Describe the role of entomotoxic proteins in crop protection.
CO 2	Enumerate the different extraction methods of natural sources for flavours and fragrances.
CO 3	Interpret the role of algae and plant products in bioprospecting.
CO 4	Comment on the economic potential of biological resources for obtaining industrial molecules of pharmaceutical, bioceutical & agricultural value.
CO 5	Elaborate on the plant resources as antimicrobials by testing their antimicrobial activity.
CO 6	Separate proteins using PAGE and check its anit-insecticidal activity.
CO 7	Extract essential oil from a crude material by hydro-distillation.

RPSEBOTO604	Title: Bioprospecting for Industrial Molecules	Credits- 03
UNIT I	**Bioprospecting for crop protection and anti-microbial products**	**Hours- 15**
	• Introduction to Bioprospecting, its significance and recent trends in bioprospecting. • Entomotoxic proteins to control the crop insect pests and mechanism of insecticidal activity: • Lectins, Ribosome-Inactivating Proteins (RIPs), Arcelins, Defensins, Cyclotides (two examples of each) • Use of plant products as antimicrobials: Historical perspective. • Major groups of Plant-derived antimicrobial compounds: o Phenols and Phenolic acids, Terpenes and Essential oils, o Alkaloids (any two examples of each) • Mechanisms of Antimicrobial activity: o Plant extracts with efflux Pump Inhibitory Activity, Bacterial, Quorum Sensing Inhibitory Activity, Biofilm Inhibitory Activity.	
UNIT II	**Algal Biomass for high-value biomolecules**	**Hours- 15**
	Algae in high-value biomolecule production: • Polyphenols • Polysaccharides • Fatty acids • Pigments	
UNIT III	**Bioprospecting for flavours and fragrance**	**Hours- 15**
	Physiological mechanism of biosynthesis of essential oils: • Metabolic cycles of biosynthesis of Phenolic compounds. • Methods of extraction of natural sources for flavours andfragrances. • Designing of flavours and fragrance. • Sensory evaluation.	

PRACTICALS

RPSEBOTPO604	Practicals based on **Bioprospecting for Industrial Molecules**	**Credit- 01**
1	Anti-microbial activity of plant extracts by disc diffusion method/ well diffusion method/ MIC method.	
2	Protein profiling by PAGE (seed proteins).	
3	Applications of proteins to control insect pests.	
4	Fractional distillation of essential oils (mint/citronella/Chafa).	
5	Creation of flavours & fragrances and practical demonstration.	
6	Estimation of fragrance / flavours	
	Application of fragrances in cosmetics, food Agarbatti, Soap, Cream, Talcum Powder etc. Application of flavours in soft drink, tooth powder, jam, ketchup etc.	

References:

1. Ramya Krishnan, Sudhir P. Singh, and Santosh Kumar Upadhyay. 2021. An introductionto Plant Biodiversity and Bioprospecting. Wiley Publications.

2. Surjeet Kumar Arya, Shatrughan Shiva, Santosh Kumar Upadhyay. 2021. Entomotoxic Proteins from Plant Biodiversity to Control the Crop Insect Pests. Wiley Publications.

3. Pankaj Kumar Verma, Shikha Verma, Nalini Pandey, and Debasis Chakrabarty. 2021. Antimicrobial products from plant Biodiversity. Wiley Publications.

4. Dinesh Kumar Yadav, Ananya Singh, Variyata Agrawal, Neelam Yadav. 2021. Algal Biomass: A Natural Resource of High-Value Biomolecules. Wiley Publications.

5. Monica Butnariu. 2021. Plants as Source of Essential Oils and Perfumery Applications. Wiley Publication.

Discipline Specific Elective Course offered by Department of Zoology

Course Code: RPSEZOOO604

Course Title: Introduction to Model organisms

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Will be able to set up Drosophila and zebrafish lab
CO2	Will be skilled trained in maintenance of Drosophila stocks and propagation and zebrafish husbandry
CO 3	Design experiments in genetics, toxicology and behavioural using these model systems. Analyse and interpret the data collected in the laboratory experiments
CO 4	To learn to design experiments using these model organisms.

RPSEZOOO604	Title: Introduction to Model organisms	Credits 3
Unit: I	***Hydra & Drosophila*** • **Hydra as a model organism**: a) Introduction to *Hydra as a model system* b) Advantages of *Hydra* as model organism c) Different types of *Hydras* d) Basic requirement to set up *Hydra* system e) Symbiotic association of *Hydra* with algae f) Setting up Artemia hatchery (temperature, salinity, pH, lifecycle and nutritional value), g) *Hydra* regeneration, h) Different types of cells in *Hydra* • **Drosophila as a model organism**: a) Introduction to *Drosophila* as a model system b) Advantages of *Drosophila* as model organism c) Basic requirement to set up *Drosophila* lab	

	d) Adult morphology e) Embryonic development f) Formation of body axis g) Larval stages and metamorphosis • Importance of *Hydra* & *Drosophila* as a versatile research and education model	
Unit: II	***Zebrafish*** • Introduction to zebrafish as model system • Advantages of zebrafish model organism • Basic requirement to set up zebrafish lab • Setting up zebrafish husbandry • To prepare zebrafish feed and culture *Paramecium* • Nutritional requirements • Handling zebrafish, identify male and female zebrafish • Breeding, Egg collection and study of developmental stages starting from the zygote - cleavage - blastula - gastrula - segmentation, pharyngula, hatching and early larval development. • Importance of zebrafish as a versatile research and education model. • Genetic and morphological homology with humans.	
Unit: III	***Caenorhabditis elegans*** • Introduction to *C. elegans* as model system • Anatomy of *C. elegans* • Lifecycle and different larval forms, • Advantages of *C. elegans* as model organism • Basic requirement to set up *C. elegans* system • Use of *C. elegans* as model system	
RPSEZOOPO604	**Practical Title: Introduction to Model organisms**	**Credit 1**
1.	*Hydra* media preparation.	
2.	Study of *Hydra* regeneration.	
3.	Setting up Artemia hatchery.	
4.	Culturing and maintaining *Drosophila*.	
5.	Study of life cycle and developmental stages of *Drosophila melanogaster.*	

6.	To study different mutants of *Drosophila.*	
7.	To setup zebrafish maintenance system.	
8.	Setting up breeding for zebrafish.	
9.	To study different behavioural patterns of zebra fish: Novel tank test, Mirror biting test, Predator avoidance, Light and dark test.	
10.	Culturing and maintaining *C. elegans.*	

References:

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2. Sunita Joshi, S. and Dhamija, N. (2016) Rediscovering Genetics, IK International, 1st edition, ISBN: 9789384588984
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11. Beckingham, K. M., Armstrong, J. D., Texada, M. J., Munjaal, R. and Baker, D. A.; Drosophila melanogaster : The model organism of choice for the complex biology of multi- cellular organisms. Gravitational and Space Research, 18(2) (2007).

Discipline Specific Elective Course offered by Department of Life Sciences

Course Code: RPSELScO604

Course Title: Environmental Biology, Biodiversity and Evolution

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **At the end of the course students will be able to:**
CO 1	Explain ecological concepts, national and international environmental issues and concepts in evolution which forms the basis of phenomena like antibiotic resistance as well as cancer progression.
CO 2	Apply ecological concepts to their day-to-day life to benefit the environment and use various essential software that will help them in their respective careers.
CO 3	Explain the magnitude and distribution of biodiversity and its economic value. Describe the concepts of bioprospecting, ecotourism, and biodiversity management approaches. Examine the biodiversity of India and the importance of its conservation.
CO 4	Identify the major events and dates that provide the structure for geologic time on Earth.
CO 5	Analyse the age of fossils with the help of radio dating techniques.
CO 6	Explain the concepts of astrobiology, including the planetary habitability, extremophiles, abiogenesis, research on surviving extreme habitats, evolution of advanced life, and the astrobiology of Mars.
CO 7	Arrange data and determine diversity indices for a population study and perform probit analysis for toxicological studies.
CO 8	Identify and explain features of various fossils and aquaculture sepcimens.

Unit	Course/ Unit Title	Credits/ Hours
I	**Unit I: Environmental biology** **Ecosystems:** Types of ecosystems [terrestrial (Tropical evergreen forests, Tropical deciduous forests, Deserts, Chaparral, Temperate grasslands, Savannahs and thorn forests, Temperate deciduous forests, Boreal forests/ Taiga, Tundra) and aquatic (Lentic, Lotic, Oceans, Estuaries, Coral reefs)], Habitat fragmentation and niche overlap, Competitive exclusion principle, resource partitioning, character displacement and resource management and conservation. **Community ecology:** Nature of communities; fundamental properties of biological communities (Productivity, Diversity, Complexity, Resilience, Stability, Structure); levels of species diversity and its measurement (Simpson, Shannon and Sorensen indices); edges and ecotones, Succession, disturbances and invasion. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. **Population ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation, demes and dispersal. **Toxicology:** Basic principles of toxicology including LD50 and ED50, management of acute intoxication.	1/ 15 Hrs

II	**<u>Unit II: Current Environmental Issues in India and Biodiversity Management:</u>** **Biodiversity:** Concept, characterization, generation, maintenance and loss, Magnitude and distribution of biodiversity, economic value, bioprospecting, ecotourism and biodiversity management approaches. Biodiversity of India. **Conservation biology:** Principles of conservation, major approaches to management, conservation strategies. **Forest Conservation –** Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register. **Wild life conservation projects:** Project Tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision. **Environmental issues related to water resource projects** - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States. **Water conservation**- Watersheds, Rain water harvesting and ground water recharge. **National river conservation plan** – Namami Gange and Yamuna Action Plan. Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India. **Soil erosion, desertification and Save Soil Movement.** **Climate change** - adaptability, energy security, food security and sustainability. Carbon sequestration and carbon credits. **Environmental Disasters:** Minnamata Disaster, Love Canal Disaster, Bhopal Gas Tragedy, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011. **Local environmental issues** – Mithi river pollution, Destruction of mangroves, Coastal aquafarming and challenges, Air quality index of Mumbai, Dumping grounds, Urban development projects at Aarey colony and Sanjay Gandhi National Park.	**1/ 15 Hrs**

III	**Unit III: Evolution and Astrobiology** **Emergence of evolutionary thoughts:** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Types of selection; Speciation – Punctuated equilibrium and phyletic gradualism; Modern evolutionary synthesis. Origin of cells and unicellular evolution **Palaeontology and evolutionary history:** Introduction to time scales, origins of unicellular and multicellular organisms; major groups of plants and animals; Mass extinction events; Adaptive radiation, convergent evolution and coevolution; Primate evolution, Carbon dating, fossils. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; origin of new genes and proteins; gene duplication and divergence, molecular taxonomy. **Astrobiology:** Concepts, planetary habitability, extremophiles, abiogenesis, research on surviving extreme habitats, evolution of advanced life, astrobiology of Mars.	**1/ 15 Hrs**

PRACTICALS: RPSELScPO604 (1 credit)

1. Analysing the floral origin of pollen grains in honey.
2. Determination of the Simpson's diversity index/ Shannon index of a given population.
3. Effect of toxicity on *Daphnia* / *C. elegans* / Yeast / Pollen grains and Probit analysis.
4. Effect of space vacuum/ cosmic radiation on bacteria.
5. Identification of fossil specimens.

References:

The Cambridge Encyclopedia of Human Evolution (Cambridge Reference Book) by Steve Jones

- Evolution by Monroe W. Strickberger, CBS publishers and distributors
- Astrobiology: An Introduction by Alan Longstaff, CRC Press.
- Astrobiology: A brief introduction by Kevin W. Plaxco and Michael Gross, The Johns Hopkins University Press.
- Biodiversity, Wilson E.O. (Ed.), National Academy Press, Washington, D. C.
- Understanding Biodiversity by David Zeigler (May 30, 2007): Amazon Press
- Fundamentals of Ecology by E.P. Odum, Cengage publishers

- Ecology and environment by P.D. Sharma, Rastogi publications
- Elements of Ecology by Smith and Smith, Pearson publishers
- Environmental Biology edited by Mike Calver*et al*: Cambridge University Press
- Molecular Environmental Biology by Seymour J. Garte, Lewis Publishers (1994)
- Basic Environmental Toxicology, Lorris G. Cockerham& Barbara S. Shane, CRC Press.
- Environmental Toxicology, David Wright and Pamela Welbourn, Cambridge university press

Course Code: RPSRPBOTO605

RESEARCH PROJECT

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Execute a substantial research-based project.
CO 2	Conduct a literature survey and propose a plan of methodology.
CO 3	Analyze data and synthesize research findings.
CO 4	Apply research findings to advanced research practices.

Modality of Assessment-DSC/DSE

Theory Examination Pattern:

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	Class Test	20
2	Assignment	10
	TOTAL	**30**

B) External Examination (Semester End)- 60%- 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Any 3 out of 4.	15	Unit- I
Q.2	Any 3 out of 4.	15	Unit- II
Q.3	Any 3 out of 4.	15	Unit- III
	TOTAL	**45**	

Practical Examination Pattern:

External (Semester end practical examination):

Particulars	Practical 1

Laboratory work /Viva	50
Total	**50**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department; failing which the student will not be allowed to appear for the practical examinations.

Modality of Assessment- Research Project/ On-Job Training

Overall Examination and Marks Distribution Pattern

Semester- III

Course	RPSBOTO601 RPSBOTO602 RPSBOTO603 RPSEBOTO604		Total of 4 courses		RPSRPBOTO605	Grand Total
	Internal	External	Internal	External	Research Project	
Theory	30	45	120	180	150	450
Practicals	25		100			100

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SEMESTER- IV

DISCIPLINE SPECIFIC CORE COURSE

Course Code: RPSBOTE611

Course Title: Plant Breeding

Academic year 2024 - 25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain the fundamental aspects of plant breeding and hybridization.
CO 2	Enumerate the plant breeding principles for large scale production of high yielding, abiotic and biotic stress resistant plants in agriculture and horticulture.
CO 3	Outline the various applications and achievements of distant hybridization in crop improvement.
CO 4	Apply DNA-based molecular marker aided breeding techniques in plant genetic engineering.
CO 5	Recall the major contributions of plant breeding institutes in India.

Detailed Syllabus

RPSBOTE611	PLANT BREEDING	Credits- 03
UNIT I	**Plant Breeding- I**	**Hours- 15**
	Aims and objectives, plant introductions and acclimatization.	
	Selection – mass, pure line and clonal.	
	Hybridization techniques, hybridization in self-pollinated and cross pollinated plants.	
	Genetic control and manipulation of breeding systems including male sterility and apomixes	
UNIT II	**Plant Breeding- II**	**Hours- 15**
	Distant hybridization: In nature (plant breeding) – Barriers to the production of distant hybrids; Unreduced gametes in distant hybridization; Sterility in distant hybrids; Consequences of segregation in distant hybrids;	
	Applications and Achievements of distant hybridization in crop improvement; Limitations of distant hybrids.	
UNIT III	**Molecular plant Breeding (Transgenic Crops) and Plant Genetic Engineering**	**Hours- 15**
	Natural method of gene transfer (*Agrobacterium* and virus), selectable markers	
	Gene editing-(CRISPR-cas technologies - Biotechnology application)	

	Artificial methods of gene transfer: Direct DNA uptake by protoplast, electroporation, liposome mediated and particle gun transformation	
	Production of Transgenic plants, virus resistant & Herbicide – resistant, plants, Bt Cotton, Golden rice.	
	Production of bio pharmaceuticals in transgenic plants.	
	Edible vaccines & Plantibodies	
	DNA-based molecular marker aided breeding: RAPD, RFLP, AFLP, STS, ISSR, Microsatellites	
	Contribution of plant breeding institutes in India	

PRACTICALS		
RPSBOTPE611	Practicals based on **Plant Breeding**	**Credit- 01**
1	Plant breeder's kit.	
2	Emasculation and hybridization techniques in cross pollinated crops - Hybrid plant production (rose).	
3	Induction of polyploidy using colchicine/ chemical mutagens.	
4	ANOVA – one way and two way.	
5	Randomized Block Design (RBD).	
6	Latin Square.	
7	Coefficient of correlation.	

References:

1) Al Chaudhari, H.K. (1984). Elementary principles of plant breeding Oxford IBH..New Delhi lards R W (1995). Principles of Plant Breeding. John Wiley and Sons, Inc.
2) Allard, R.W, 1960. Principles of plant breeding. John Willeg, New York.
3) Chaudhary, H. K. (2001) Plant Breeding Theory and Practice, Oxford IBH Ltd, New Delhi, India
4) David Allen Sleper, John Milton. (2006). Breeding Field Crops. Blackwell Publishing
5) Dwivedi and Singh (1980) Essentials of Plant Techniques, 2nd Ed., Scientific Publishers. Moan Bhavan Udaipur, India.
6) Gardner, E.J. (1972). Principles of genetics. Willey Eastern Pvt.Ltd.
7) Ghahal G S and Gosal S S (2002). Principles and procedures of Plant Breeding. Narosa Publishing House.
8) Hays, K.K. Immer, F.R. and Smith, D.C. (1985). Methods in plant breeding .Tata McGraw Hill.Newyork.
9) Neal.C.Stopskopf. (1999). Plant Breeding Theory & Practices. Scientific Publ, Jodhpur.
10) Sharma J R (1994). Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers
11) Singh,B.D. 2001. Plant Breeding, Principles and Methods.Kalyani Publications,

12) Swaminathan, M.S, P.K.Gupta and V.Singa. (1983). Cytogenetics of crop plants. Macmillan India Ltd, New Delhi.
13) Sharma J R (1994). Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers
14) Potrykus and G.Spangenberg, 1995 Gene Transfer to plants Springer, Berlin. Heidelberg
15) J. Sambrook, E.F.Fritsch and T.Maniatis 1989. Molecular Cloning - A Laboratory Manual
16) Adrian Slater, Nigel Scott and Mark Flower, 2000 Plant Biotechnology -The GeneticManipulation of Plants,Oxford University Press,).

DISCIPLINE SPECIFIC CORE COURSE

Course Code: RPSBOTE612
Course Title: Plant Biotechnology
Academic year 2024 - 25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain the basic principle of plant tissue culture and justify its significance.
CO 2	Describe the advanced methods of biotransformation for product enhancement.
CO 3	Enlist the applications of transgenic plants in phytoremediation and in vitro germ plasm conservation.
CO 4	Give an account of the basic principles of effective bioreactor design for large scale production of metabolites.
CO 5	Prepare MS basal medium and stock solutions.
CO 6	To induce and maintain callus.
CO 7	Perform the synthesis and characterization of nanotechnology.
CO 8	Summarize the applications of nanoparticles in the field of cosmetics, agriculture and food industry.

Detailed Syllabus

RPSBOTE612	Plant Biotechnology	Credits- 03
UNIT I	**Plant Tissue Culture I**	**Hours- 15**
	Plant improvement through soma-clonal variations.	
	Plant cell culture systems: a potential renewable source of flavours, fragrances, and colorants	
	Metabolic engineering: Production of useful secondary metabolites through regulation of biosynthetic pathway in cell and tissue suspension culture	
	Protoplast culture and Somatic hybridization & its applications.	
	Plant cell cultures as chemical factories: Cell suspension, enhancement of product formation using biotic and abiotic elicitors, immobilization, permeabilization and product recovery.	
	Biotransformation using: Freely suspended plant cells and Immobilized plant cells eg. Vanillin production from *Capsicum* cell cultures	
UNIT II	**Plant Tissue Culture II**	**Hours- 15**
	In vitro storage of Germplasm, Cryopreservation	
	Studies on *Agrobacterium* mediated transformed root cultures.	
	Transgenic plants in phytoremediation	
	Scale –up of secondary metabolites from hairy roots	

	Risk assessment and the regulatory frame work	
	The quest for commercial production from plant cell: scaling up of cell cultures	
	Bioreactors: factors for bioreactor design, pneumatically agitated bioreactors, comparison of bioreactors, operating mode, batch, fed-batch, semi continuous, two stage operation, continuous cultivation. Factors for growth in Bioreactors.	
	Shikonin production by *Lithospemum erythrorhizon* cell cultures.	
UNIT III	**Nanotechnology**	**Hours- 15**
	• Introduction, properties of nano-materials. • Green synthesis of nano-materials, biological methods, use of microbial system & plant extracts, use of proteins & templates like DNA. • Characterization of nanoparticles (FTIR, SEM, TEM, STEM, Scanning Tunneling Microscope, Atomic Force Microscope, UV-Vis,) • Application of nano-materials in food, cosmetics, agriculture, environment management and medicine • Risk of Nanomaterial to human health and Environment	
PRACTICALS		
RPSBOTPE612	Practicals based on **Plant Biotechnology**	**Credits- 01**
1	Preparation of stock solutions.	
2	Preparation of MS basal medium & defined medium.	
3	Callus induction and Regeneration of the callus.	
4	Micropropagation.	
5	Detection and quantification of bioactive compounds from callus and plant source.	
6	Types of Bioreactors.	
7	Synthesis of nanoparticles.	
8	Characterization of nanoparticles by UV spectroscopy.	

References:

1) Bhojwani. S.S. &Razdan. M.K. 1996. Plant Tissue Culture: Theory and Practice (Rev.Ed.). Elsevier Science Publishers, New York.
2) Chawla. H.S 1999. Introduction to Plant Biotechnology. Oxford & IBH.
3) Collin. H.A & Edwards. S. 1998. Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
4) Gamborg& Phillips. Plant Cell, Tissue and Organ Culture. Narosa Publications.
5) Jain. S.M., Sopory. S.K. &Valleux. R.E. 1996. In Vitro Haploid Production in Higher Plants. Volumes 1 to 5. Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecth, Netherlands.
6) Kalyan Kumar De. 1997. Plant Tissue Culture. NCB Agency, Kolkata.

7) Ramawat. K.G. &Merillon. J.M. 2007. Biotechnology: Secondary Metabolites. 2nd Ed. Science Pub., Netherlands.
8) Razdan. M.K. 2003. An Introduction to Plant Tissue Culture. Oxford & IBH, New Delhi
9) ShuklaYM,PatelNJ,JithendraJD,BhatnagarR,Talati JG ,Kathiria KB 2009, Plant Secondary Metabolites, New India Publishing Agency, Gujarat.
10) M Schwarz (2012) Soilless Culture Management by, Springer Publication- ebook
11) Prasad S and Kumar U.(2005) Green House Management for Horticultural Crops. Agrobios India.
12) Cloyd, R.A .(2016) *Greenhouse Pest Management*. CRC. Press.
13) Pant V, Nelson. (1991). Green House Operation and Management. Bali Publ.
14) John Mason (2000) Commercial Hydroponics Publisher Simon & Schuster Australia
15) G. N. Tiwari, R.K. Goyal (2001) Greenhouse Technology: Fundamentals, Design, Modelling and Applications: Narosa Publishing House
16) Nicolas Castilla (2013) Greenhouse Technology and Management CABI Publication ebook
17) George F. Van Patten (2011) Gardening Indoors with Soil & Hydroponics Van Patten Pub

DISCIPLINE SPECIFIC ELECTIVE COURSE

Course Code: RPSEBOTE613
Course Title: Soilless Culture Technology
Academic year 2024 – 25

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Demonstrate the process of setting-up and maintaining hydroponic systems.
CO 2	Perform waste management practices and maintain hygiene.
CO 3	Execute the process of harvesting, post harvesting and marketing the produce.
CO 4	Design a prototype for soilless cultivation.

Detailed syllabus

RPSEBOT E613	Soilless Culture Technology	Credits-03
Unit I	**Hydroponics Systems**	**Hours-15**
	• Introduction to soilless cultivation, Principles of soilless cultivation • Substrates used, selection of the plants, seed germination, harvest of the seedlings for transplanting in to the systems • Growth factors for plant growth – Temperature, humidity, light duration and intensity, aeration, pH, EC • Nutrient solution and its utilization • Different types of hydroponic systems (Nutrient Film Technique, Deep water culture, Ebb and flow, Drip systems, aeroponics, bubbleponics, fogponics, Aquaponics), principles and working of various systems	
Unit II	**Setting up and maintenance of the system**	**Hours-15**
	• Setting up the hydroponic systems • Maintenance of hydroponic systems • Harvesting and post harvest management • identification, and control strategies of Disease in hydroponic production • Hygiene and cleanliness in hydroponic growing • Green house design for soilless cultivation	
Unit III	**Fabrication of different systems**	**Hours-15**
	• Factors to be considered while fabricating a prototype • materials required, equipments needed to design a prototype • Budgeting for fabrication • Marketing and Business plan • Recent Advancements in soilless cultivation.	

PRACTICALS

RPSEBOTP E613	PRACTICALS based on Soilless Culture Technology	01 credit
1	Identification of different soilless media	
2	Identification of various types of soilless systems	
3	Nutrient solution preparation, adjusting EC and pH	

4	Growing plants in NFT – leafy/ fruity vegetables - methi, spinach, lettuce, Pokchoy, Amaranthus, tomato, snake gourd, bhindi.
6	Growing plants in deep water culture/ Ebb and flow/- Fruity vegetables
7	Identification, and control strategies of diseases and pests
8	Fabricating a prototype of a hydroponic/aquaponic/aeroponic systems
9	Analysis of growth of the plants grown in the systems
10	Repairing and maintenance of the systems
11	Business Plan

REFERENCES:

1. M Schwarz (2012) Soilless Culture Management by, Springer Publication- ebook

2. Prasad S and Kumar U.(2005) Green House Management for Horticultural Crops. Agrobios India.

3. Cloyd, R.A .(2016) *Greenhouse Pest Management*. CRC. Press.

4. Pant V, Nelson. (1991). Green House Operation and Management. Bali Publ.

5. John Mason (2000) Commercial Hydroponics Publisher Simon & Schuster Australia

6. G. N. Tiwari, R.K. Goyal (2001) Greenhouse Technology: Fundamentals, Design, Modelling and Applications: Narosa Publishing House

7. Nicolas Castilla (2013) Greenhouse Technology and Management CABI Publication ebook

8. George F. Van Patten (2011) Gardening Indoors with Soil & Hydroponics Van Patten Publishing house

Course Code: RPSINTBOTE614
Course Title: INTERNSHIP

Course outcomes

COURSE OUTCOME	DESCRIPTION on successful completion of this course, learners will be able to;
CO 1	Develop work ethics necessary in a professional setting.
CO 2	Evaluate the internship training experience in terms of their personal, educational and career needs.
CO 3	Explore career alternatives prior to post-graduation.
CO 4	Apply communication, interpersonal and other critical skills in the job interview process.

RPSINTBOTE614	INTERNSHIP	Credits-10
	Students have to complete internship of two and a half months in a reputed company/ Institute. They have to prepare and submit a dissertation based on the work done for the abovementioned period.	

Modality of Assessment-DSC/DSE

Theory Examination Pattern:

C) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	Class Test	20
2	Assignment	10
	TOTAL	**30**

D) External Examination (Semester End)- 60%- 45 Marks
Semester End Theory Examination:

3. Duration – The duration for these examinations shall be of **two hours**.
4. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Any 3 out of 4.	15	Unit- I
Q.2	Any 3 out of 4.	15	Unit- II
Q.3	Any 3 out of 4.	15	Unit- III
	TOTAL	**45**	

Practical Examination Pattern:

External (Semester end practical examination):

Particulars	Practical 1
Laboratory work /Viva	25
Total	**25**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department; failing which the student will not be allowed to appear for the practical examinations.

Overall Examination and Marks Distribution Pattern

Semester- IV

Course	RPSBOTE611 RPSBOTE612 RPSEBOTE613		Total of 4 courses		RPSINTBOTE614	Grand Total
	Internal	External	Internal	External	Internship	
Theory	30	45	90	135	250	475
Practicals	25		75			75

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