National Institute of Plant Science Technology (NIPST)

(Inter School Centre)

(*An Institute established for Excellence in Teaching and Research in Plant Science based Eco-technologies)*

Learning Outcomes based Curriculum Framework (LOCF) for Post Graduate Programme

M.Sc. Botany and Plant Science Technology

Under the CSS scheme for University

EFFECTIVE FROM 2021 ADMISSIONS

MAHATMA GANDHI UNIVERSITY
KOTTAYAM, KERALA – 686 560

Preface

Mahatma Gandhi University

Mahatma Gandhi University is an Indian collegiate public University based in Kerala, established in 1983, approved by UGC, and accredited with NAAC "A" Grade, 3.24 CGPA. With its academic excellence, the University has bagged Chancellor's Award twice for the best University (2015-16 and 2017-18) within the state of Kerala. It has also secured 30th position in NIRF ranking (April 2019) and 11th position in India Today-MDRA ranking, 2018. CSIR has ranked the University 13th for its intellectual productivity and NISTADS has rated it as 19th in terms of h-index.

At present, Mahatma Gandhi University offers research programs in forty disciplines through its own Schools and approved Research Centers. It has close collaboration for academic, research and extension programs with a number of national agencies and institutions including the UGC, DST-FIST, DRS, ISRO, COSIT, DIT, DST (Nano Mission), CSIR, DAAD, STEC, ICMR, BARC and MOEF. The University is also involved in active collaboration with research institutions of international reputation such as the Max Planck Institute of Technology, Germany; Brown University, USA; University of Nantes, France; California Institute of Technology, USA; University of Toronto, Canada; Catholic University, Belgium; Heidelberg University, Germany; the Institute of Political Studies, Rennes, France; Trent University, Canada; IPF Dresden, Germany; University of Paris and University of Strasbourg.

Mahatma Gandhi University has made immense strides in the fields of inter disciplinary teaching and research. The faculty comprises of outstanding scholars, many of whom have made original contributions in their respective fields of specialization. The faculty and research scholars of several departments have gained widespread recognition for the commendable quality of their research publications. The web enabled University library has large collection of books, journals, e-journals and online theses. The digital library provides open access to itsenviable collection of digitized Ph.D. dissertations. All these work in tandem with the academic business transacted by the University, making the whole experience a holistic one. The University has a well-established instrumentation facility with many sophisticated equipment functioning at the various departments and also at the platform provided by the common InterUniversity Instrumentation Centre (IUIC).

The University has well established and internationally reputed facility and academic expertise in various areas like Nanoscience, Environmental science, Bioscience, Chemical science, Physics, Arts and Humanities. The Centre for Nanoscience and Nanotechnology focus on the enhancement of research and higher studies in the cutting edge areas of Nanoscience and Nanotechnology. The Centre is motivated to thrust its research and development focusing on developing novel materials and devices prospering the outrage of Nanoscience. With a vision to consolidate the existing and to pay focus attention to the frontier areas of Environmental Science, the University has established the School of Environmental Sciences as a Centre of learning for advanced studies in different branches of environmental science. The major mandate of the school is to develop appropriate technologies and skilled human resource for sustainable utilization, management and conservation of natural resources. The school has established a Centralized Remote Sensing and GIS facility, the first of its kind in a university in the state, with the support of Indian Space Research Organization (ISRO). It has also established a regional center, the High range Environmental Research center (HERC) at Nedumkandam, Idukki district. The school has a live laboratory named as "Jeevaka" which consists of areas with rich biodiversity within the Mahatma Gandhi University Campus.

Vision and Mission of MGU

Vision of Mahatma Gandhi University

"Mahatma Gandhi University envisions to excel in the field of higher education and cater to the scholastic and developmental needs of the individual, through continuous creation of critical knowledge base for the society's sustained and inclusive growth."

Mission of Mahatma Gandhi University

- **To conduct and support undergraduate, postgraduate and research-level programmes of quality in different disciplines**
- **To foster teaching, research and extension activities for the creation of new knowledge for the development of society**
- **To help in the creation and development of manpower that would provide intellectual leadership to the community**
- **To provide skilled manpower to the professional, industrial and service sectors in the country so as to meet global demands**
- **To help promote the cultural heritage of the nation and preserve the environmental sustainability and quality of life**
- **To cater to the holistic development of the region through academic leadership**

Preamble

OUTCOME BASED EDUCATION (OBE)FROM THE ACADEMIC YEAR 2021-22

MAHATMA GANDHI UNIVERSITY

NATIONAL INSTITUTE OF PLANT SCIENCE TECHNOLOGY (NIPST)

1. Introduction

A high priority task in the context of education in India is improvement of quality of higher education for equipping young people with skills relevant for global and national standards and enhancing the opportunities for social mobility. Mahatma Gandhi University has initiated an Outcome Based Education (OBE) for enhancing employability of graduates through curriculum reforms based on a learning outcomes-based curriculum framework, upgrading academic resourcesand learning environment.

Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The fundamental premise underlying the learning outcomes-based approach to curriculum development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes, expressed in terms of knowledge, understanding, skills, attitudes and values. Outcomes provide the basis for an effective interaction among the various stakeholders. It is the results-oriented thinking and is the opposite of input-based education where the emphasis ison the educational process.

Benefits of OBE

The OBE Framework is a paradigm shift from traditional education system into OBE system where there is greater focus on programme and course outcomes. It guarantees that curriculum, teaching and learning strategies and assessment tools are continuously enhanced through a continuous improvement process. All decisions including those related to curriculum, delivery of instruction and assessment are based on the best way to achieve the predetermined outcomes. Traditionally, educators have measured learning in terms of standardized tests. In contrast, outcome-based education defines learning as what students can demonstrate that they know.

Benefits of OBE

*More directed & coherent curriculum.

*Graduates will be more “relevant” to industry & other stakeholders (more well-rounded Graduates)

*Continuous Quality Improvement is in place.

*OBE shifts from measuring input and process to include measuring the output (outcome)

Outcome Based Education (OBE) process

OBE is a comprehensive approach to organize and operate a curriculum that is focused on and defined by the successful demonstrations of learning sought from each learner. The term clearly means focusing and organizing everything in an education system around "what is essential for all learners to be able to do successfully at the end of their learning experiences".

OBE is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a programme or a course. By the end of educational experience, each student should haveachieved the outcomes.

Learning Outcomes based Curriculum Framework (LOCF) for Post Graduate Programmes-

IQAC MG University

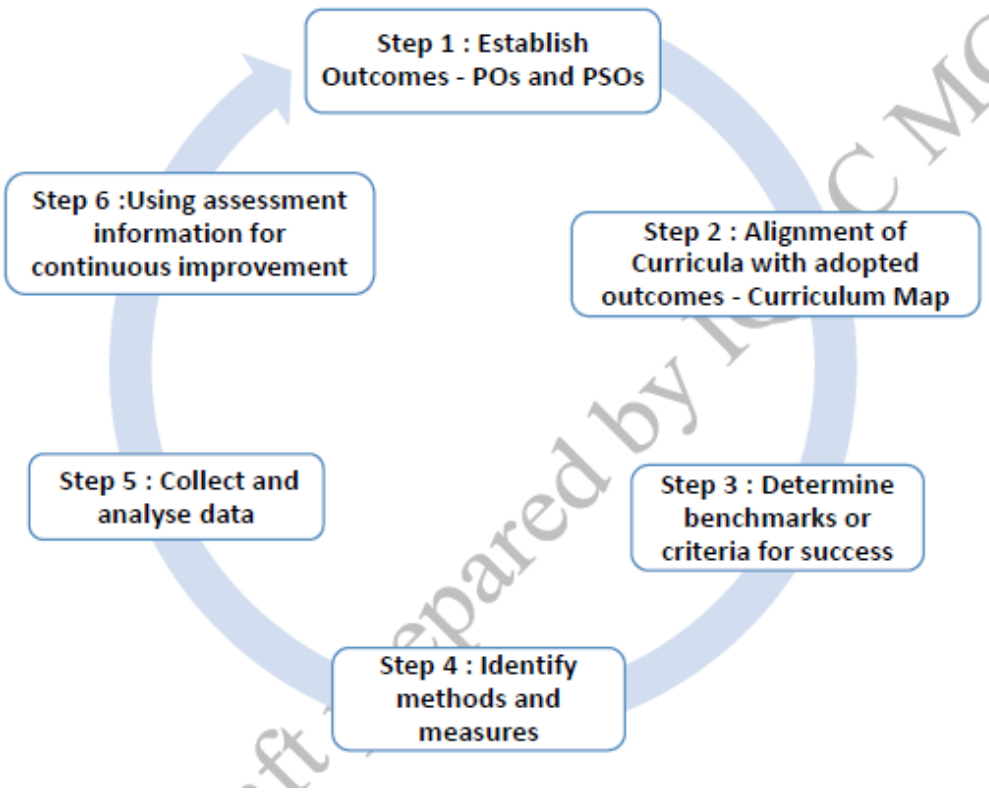
One of the main objectives of OBE is to ensure continuous improvement of programmes in terms of maintaining the relevance in curriculum as well as responding to the requirements of the stakeholders. In other words, it ensures that Post graduate programme next year is better than post graduate programme this year, offered by a department.

An OBE system has been proposed and to be implemented at various Departments of Mahatma Gandhi University, as a quality-assurance approach to improve teaching and learning outcomes and processes. This OBE plan incorporates the "outcomes assessment" process to be followed in the departments. OBE should be a key driver of the curriculum management in all the departments of the university.

The OBE is a 6-step process as shown in the figure

Figure: OBE Process

The process is presented as a cycle or a loop. The cycle represents the continuous nature of assessing learning outcomes.



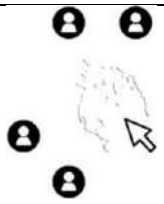
As envisaged by the IQAC of Mahatma Gandhi university, an OBE based curricular framework has been proposed for the inter-school center National Institute of Plant Science Technology (NIPST) from the academic year 2021-22 which is presented hereafter.

National Institute of Plant Science Technology (NIPST)

This will be a unique University Institute enrolling students through competitive examinations at the National level in the campus of Mahatma Gandhi University for advanced education in plant science, promoting research in **Interdisciplinary areas of 'Plants and their Environment Relations'** towards developing '**Plant-based Eco-technologies'.** The Institute will inspire students to apply their creative talents to research potentials of the rich botanical wealth of Kerala in the development of globally significant technologies useful in sustainable agricultural, phyto-medicinal, bio-fuel, bio-based industrial and eco-remediation purposes. Instead of keeping science and technology as watertight compartments in conventional programmes, this institute will enable science students to end up their post graduation to a productive research on plant-based eco-technology and entrepreneurship based on the technology that they develop. Overall, the Institute aims at boosting entrepreneurship in the country through productive research in plant science.

The institute will have advanced instrumental as well as experimental facilities for plant scientists to pursue excellence in all branches of plant science and is expected to contribute to the talent pool of researchers and specialized technicians in plant-based technologies. Technologies to be focused in the programme include those for plant medicines, nutraceuticals, sustainable agriculture, Phytoremediation and all kinds of bio-fuels. In addition to advanced research laboratories for the above-mentioned technologies, the institute will have a medicinal garden, field experimental station, regional herbarium and museum of plant resources of the Western Ghats.

Major goal of this programme is to attract academically bright undergraduate and graduate students at National Level to study and do productive research on the vast plant wealth of the country, and to support entrepreneurship in the field. This centre will help students to study and explore the potential plant wealth of the nation; apply creatively and positively plant science for sustainable economic growth of the nation and becoming a leader of eco-technologies in the world.

	Mahatma Gandhi University **Graduate attributes**	
	**Critical thinking and analytical reasoning**	Capability to analyze, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.
	**Scientific reasoning and Problem solving**	Ability to analyze, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualize into researchand apply one's learning to real life situations.
	**Multidisciplinary/ Interdisciplinary/ Transdisciplinary approach**	Acquire interdisciplinary /multidisciplinary/ transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary-approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.
	**Intra and Interpersonal skills**	Ability to work effectively and respectfully with diverse teams;facilitate collaborative and coordinated effort on the part of a group,and act together as a group or a team in the interests of a common cause and work efficiently as a memberof a team; lead the team to guide people to the right destination, in a smooth and efficient way.
	**Digital literacy**	Capability to use ICT in a variety of learning situations, demonstrate ability to access, choose, collect and evaluate, and use a variety of relevant information sources; structure and evaluate those data for decision making.

	**Global Citizenship**	Building a sense of belonging to a common humanity and to become responsible and active global citizens. Appreciation and adaptation of different sociocultural setting and embrace and promote equity.
	**Social competency**	Possess knowledge of the values and beliefs of multiple cultures, appreciate and adapt to a global perspective; and capability to effectively engage in a multicultural society and interact respectfully, manage and lead with diverse groups.
	Equity, Inclusiveness and Sustainability	Appreciate and embrace equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand andappreciate diversity
	**Lifelonglearning**	Continuous acquisition of knowledge and skills. Learn, unlearn and re-learn based on changing ecosystem. “Learning how to learn”, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Mahatma Gandhi University
Programme Outcome

Programme Outcomes (PO)

PO 1: Critical Thinking and Analytical Reasoning
Capability to analyse, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.

PO 2 : Scientific Reasoning and Problem Solving
Ability to analyze, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualize into research and apply one'slearning to real life situations.

PO 3: Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary-approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills
Ability to reflect and express thoughts and ideas effectively in verbal and nonverbal way; Communicate with others using appropriate channel; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner and articulate in a specific context of communication.

PO 5: Leadership Skills
Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating a goal, building a team who can help achieve the goal, motivating and inspiring team members to engage with that goal, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility
Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability
Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified

citizens; able to understand and appreciate diversity, managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning
Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work and living as a dignified person in the society.

PO 9: Networking and Collaboration
Acquire skills to be able to collaborate and network with scholars in an educational institution, professional organizations, research organizations and individuals in India and abroad.

PO 10: Lifelong Learning
Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

The MSc programme in Botany and Plant Science Technology is innovative and unique in the sense that it seeks to create a talent pool of highly competent and motivated applied plant scientists who will be capable of applying their knowledge of plants in cutting edge plant-based technologies useful in sustainable agriculture and phytoremediations or bioremediations of environmental problems.

Programme specific outcomes of M.Sc. Botany and Plant Science Technology

PSO1. Develop **good academic standard** through deep theoretical knowledge and practical competence in the physiological, cellular, and biochemical functions and organization of biological systems at molecular and functional level.

PSO2. Acquire good skill in instrumentation, techniques, analysis of biomolecules and its fate for understanding the biological systems/ processes.

PSO3. Execute the gathered **technical knowhow** to carry out PCR works, production of metabolites from Plant/microbial cells, bioinformatics, designing of plant-based eco technologies for environmental management for sustainable development.

PSO4. Nurture excellent **research aptitude** enabling students to design, execute, analyze a research problem with statistical tools and bring a meaningful scientific conclusion maintaining **scientific ethics**.

PSO5. Attain the ability to communicate/present effectively a chosen subject/research problem in writing and verbally with **societal consciousness.**

Rubrics selected for OBE implementation

1. **Overall performance** in each course of the semester on a continuous basis

2. Response to **critical theoretical questions** in each course

3. Procedural approach adopted towards **lab oriented critical questions** in eachpractical course

4. Response to **socially relevant issues and recent trends** in each course

5. **Aptitude to research** and **specific research problem** in each course

PART 1Task Description

1. Written Examination
2. Assignment
3. Seminar
4. Practical Exam
5. Viva voce

PART II Scale

Excellent, Satisfactory, Needs improvement (remedial practices recommended)

PART III Dimensions

Written Examination-Content, Communicating
Assignment -Content, level of Comprehension
Seminar-Content, Performance
Practical exam- Conduct of practical, Observation and recording
Viva voice -Response to questions, Attitude

PART IV Description of the dimensions

Content-Brief and meaningful
Comprehension- Precise and effective
Communicating- Direct and orderly
Procedure adopted- Scientific Suitability and easiness
Conduct of practical-Accuracy and reproducibility
Observation and recording- Sharp and systematic
Response to questions- Analytical approach and level of accuracy
Attitude- Positive and self-inspiring

SCHEME OF M.Sc. BOTANY AND PLANT SCIENCE TECHNOLOGY

FIRST SEMESTER SCHEME

PLM21C01	Research Methodology, Computer Applications and IPR	3
PLM21C02	Cell Biology& Biochemistry	3
PLM21C03	Microbiology and Immunology	3
PLM21C04	Angiosperm Systematics Part-I	3
PLM21E05	Organic and Natural Farming*	4
PLM21E06	Environmental monitoring and management*	4
PLM21E07	Allelopathy and Biological Weed and Pest Control*	4
PLM21C08	Laboratory Course 1	4

SECOND SEMESTER SCHEME

PLM21C09	Phycology	3
PLM21C10	Bryology, Pteridology & Gymnosperms	3
PLM21C11	Mycology and Plant Pathology	3
PLM21C12	Angiosperm Systematics Part-II	3
PLM21E13	Phytochemistry*	4
PLM21E14	Applied Marine Phycology*	4
PLM21C15	Laboratory course 2	4

THIRD SEMESTER SCHEME

PLM21C16	Molecular Biology &Genetic Engineering	3
PLM21C17	Plant Physiology & Biophysics	3
PLM21C18	Anatomy, Embryology and DevelopmentalBiology of Plants	3
PLM21C19	Genetics, Plant Breeding, Tissue culture, Evolution	3
	Open Course	4
PLM21C20	Laboratory course 3	3
PLM21C21	Laboratory course 4	3

FOURTH SEMESTER SCHEME

PLM21C22	Ecology, Conservation & Phytogeography	3
	Elective Course to be selected from the optionsgiven below	
PLM21E23	Remote Sensing of biomass and biodiversity resources*****	4
PLM21E24	Horticulture*****	4
PLM21E25	Entrepreneurship and Business in Biology*****	4
PLM21C26	Laboratory course 5	3
PLM21C27	Major Research Project	8

FIRST SEMESTER

FIRST SEMESTER SCHEME

PLM21C01	Research Methodology, Computer Applications and IPR	3
PLM21C02	Cell Biology& Biochemistry	3
PLM21C03	Microbiology and Immunology	3
PLM21C04	Angiosperm Systematics Part-I	3
PLM21E05	Organic and Natural Farming*	4
PLM21E06	Environmental monitoring and management*	4
PLM21E07	Allelopathy and Biological Weed and Pest Control*	4
PLM21C08	Laboratory Course 1	4

MAHATMA GANDHI UNIVERSITY

PLM21C01: Research Methodology, Computer Applications and IPR

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	M.Sc. Botany & Plant Science Technology					
Course Name	**Research Methodology, Computer Applications and IPR**					
Type of Course	Core					
Course Code	**PLM21C01**					
Course Summary & Justification	This course deals with basics of Research methodology application of statistical methods to conduct research in the areas of biology and basics in computer applications.					
Semester	**First**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding on defense responses Knowledge in any branch of Life science					

COURSEOUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will able to understand the techniques used to identify select,process and analyze information about a topic.	R/U	4
2.	Students will able to learn the recent advances in discipline of Biostatistics	R/U	5
3.	Students will able to analyse the basics of computer application	U/ An	2
4.	Students will become able to identify the correlation	U/A	3

	between subdiscipline of biology and computer science		
5.	Students will get theoretical and technical skills in bioinformatics and Biostatistics	U/A	3
6.	Students can learn about IPR	R/U	5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	Goals of research, essential qualities of a researcher, methods of research, logical scientific methods, different types of inductive logical methods, different types of inductive logical methods, method of causal connections, method of difference, method of concomitant variation, method of residues, method of agreement, joint method of agreement and difference. Other logical methods, method of description and classification, evolutionary methods. Various types of research, data and methods of data collection.	10	1	4	1,2
2	Review of literature, primary and secondary source, National institutions useful in search of literature- NISCAIR- Library resources – Journals/periodicals, reviews- abstracts treaties- monographs- searching of web resources- electronic data bases- Critical review of literature identification of research gaps- Defining or selection or identification of a research topic or problem, formulation of a hypothesis, significance of hypothesis, types of hypothesis, relevance and assumptions in research, developing of a research plan execution of research works, exploration, description- diagnosis experimentation meaning and nature of experimental research, treatments, Variation and Variables, simple populations, general laboratory techniques, rules and regulations, safe measures.	20	1	4	3,2
3.	Biostatistics: Collection and Presentation of Experimental data – Measures of Central Tendency: Arithmetic Mean, Median, Mode, Position of averages, Geometric Mean, Harmonic mean and percentile – Measures of Dispersion: Range, Inter quartile range, variance, standard deviation and standard error. Correlation and Regression:	10	2,5	5,3	3,4

	Correlation coefficient – Types of correlation – Regression Simple and Linear regression – Biological significance of correlation and regression – Tests of significance: Basis of statistical inference – Student's 't' test for mean, difference of means and test for correlation and regression coefficients – Chi-square test – Analysis of variance and comparison of means. Experimental Design - Different types of design, sampling techniques, statistical analysis softwares.				
4	-Introduction to computer fundamentals, MS-Office, computer aided graphical applications and data analysis, SPSS, M-stat, R. Reference management software. **Bioinformatics:**Introduction to Bioinformatics and its scope, Biological databases- primary, secondary and composite; nucleotide sequence database - Genbank, ENA, DDBJ; protein sequence database- PDB, SWISS PROT. ormation retrieval from Biological database; Search Tools - BLAST, FASTA. quence alignment – pairwise and multiple; local and global; tools used for multiple sequence analysis – clustal x and clustal omega plications of bioinformatics in evolutionary studies – molecular phylogenetics, molecular clock Molecular phylogeny and phylogenetic trees.	10	3,4	2,3	8,9
5	About Intellectual Property and Intellectual Property Right, Choice of intellectual property protection, IPR and Plant Genetic Resources (PGR), GATT and TRIPs. Patenting of biological material: International conventions, international corporations, obligation with, patent applications, implication of patenting of higher plants, patenting transgenic organisms and isolated genes, patenting of genes and DNA sequences, Plant breeders right (PBRs) and Farmers Rights, Traditional Knowledge.	10	6	5,7	7,10
	Total Credits	**3**			

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

1. 1. Gupta S P (1984). Statistical methods. S.Chand Publication.
2. 2.Pranab Kuamr Banerjee (2013). Introduction to Biostatistics. S Chand Publication.

Further Reading:

3. Daniel Wayne W (2010). Biostatistics Basic Concepts and Methodology for the Health Science. Wiley

4. Jerrold Zar H (2014). Biostatistics Analysis. Pearson

3. 5. Aurther M lesk (2014). Introduction to Bioinformatics-4th Ed. OUP

4. 6. Michael Waterman (1995) Introduction to Computational Biology: Maps, sequences and genomes, Springer.

MAHATMA GANDHI UNIVERSITY

PLM21C02: Cell Biology and Biochemistry

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Cell Biology and Biochemistry**					
Type of Course	Core					
Course Code	**PLM21C02**					
Course Summary & Justification	Deals with the concept and structure of cells and to gain knowledge in the metabolic process in biological life.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of cell biology and Biochemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	o study the basic structure and function of cells	E	1
2	ent should understand the tissues and organisms that cell compose	R/ E	1
3	ent will understand the chemical process happening at a molecular level	U	3
4	study the components like proteins,lipids and organelles	An	3
5	Help the students to analyse the microscopic and molecular levels physiological properties structure and organelles	E	2
6	Helps to study the bascis of cells	An/ C	1

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**DNA Rr Introduction to cell**- History of cell biology, Cell theory, Evolution of the cell, Ultra-structure of Prokaryotic and eukaryotic cell, Morphology, structure and function of different kinds of plant and animal cells; plasma membrane - structure, models and functions, Chemical composition; structure and function of membrane protein, carbohydrate, lipids – membrane transport – active and passive – osmosis and diffusion - sites for ATP ion carriers, channels and pumps, receptors and signals. **Cell organelles:** Morphology, structure, biogenesis and function of different cell organelles - Cytoskeleton, organization and role of microtubules, intermediate filaments and microfilaments, molecular motor movements and their role in flagellar and other movements – intracellular transport of macromolecules.	10	1,2	1	1,2
2	**Celldivision and cell cycle**. - meiosis and mitosis, Overview of the Cell cycle and its control, molecular mechanisms for regulating mitotic events, role of cyclins and cyclin dependent kinases, Check points in cell cycle regulation. Differences between cell division in plant cell and animal cell. Cell biology of Cancer: Apoptosis – major factors that affect apoptosis - molecular causes of cancer, cellular genes involved in cancer – oncogenes and tumour suppressor genes with examples; Different types of biological pathways leading to cancer development; therapeutic targets and drugs used in treatment of cancer.	20	3,6	3,1	3,4
3.	**Carbohydrates and Lipids in living systems:** Structure, classifications and functions of carbohydrates monosaccharides, disaccharides and polysaccharides – Sugars in living systems – significance of pentoses and trioses; Sugar derivatives - Sugar acids, sugar alcohols, deoxy sugars, amino sugars, glycosides and their functions, Glycosidic linkages, Heteropolysaccharides, Glycosaminoglycans and Glycoproteins – metabolism of glucose – glycolysis, TCA cycle, glycogenesis, glycogenolysis and gluconeogenesis, photophosphate shunt, ETC. Lipids in living systems:Structure, properties and Classification of fatty acids – saturated, unsaturated and poly-unsaturated, short chain, medium chain and long chain fatty acids. Triglycerides, phospholipids, prostaglandins, prostacyclins and leukotrienes, sphingolipids and glycolipids, gangliosides, rancidity, acid value, saponification value and iodine number. Plant and animal sterols – structure and	10	4	3	3,5

	functions of cholesterol. Lipid peroxidation and antioxidants. Lipoproteins – classification and composition				
4	**Amino acids and proteins:** Structure and classification of amino acids. Chemical properties of amino acids; Amino acid derivatives; Non-protein amino acids. Biological amines and their functions; small peptides, cyclic peptides and their biological functions. Proteins: Different types; classifications, physicochemical properties of proteins; structural organization of proteins, primary structure of proteins, Ramachandran plot, secondary structure (α-helix, β-strand, β-sheet, turns and loops), tertiary structure (ion-ion, ion-dipole and dipole-dipole interactions), quaternary structure, protein folding, globular and fibrous proteins, structure of heamoglobin and myoglobin.	10	4,5	3,2	3,6
5	**Enzymes and Nucleic acids:** Classification and Nomenclature, units of activity, coenzymes and metal cofactors, temperature and pH effects, Michaelis-Menten Kinetics, inhibitors and activators, active site and mechanism of enzyme action, isoenzymes, allosteric enzymes.Purine and pyrimidine bases, nucleosides and nucleotides, double helical structure of DNA, polymorphism of DNA (A, B, Z forms), RNA structure, major classes of RNA – mRNA, rRNA, tRNA, sn RNA, hn RNA – structure and biological functions ribozyme, denaturation and renaturation of DNA, DNA supercoiling, chromatin structure. Protein- Nucleic acid interactions, salient features of nucleic acid recognition by proteins.	10	5,6	2,1	3,7
	Total Credits of the Course	3			

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. 1.Fritjof Capra (1997), The Web of Life, Anchor Books, New York

Further Reading:

1. Maly IV Edited (2009) Systems Biology, Springer
2. Hans-Jorg Edited (2008) Supramolecular systems in biomedical field
3. Denis Noble (2006) The Music of Life, Oxford University Press
4. Savada et al (2010) Life – the Science of Biology 9th Edition, WH Freeman
5. Jeremy et al (2002) Principles of Biochemistry, WH Freeman
6. Lehninger et al (2008) Principles of Biochemistry, WH Freeman
7. Voet et al (2013) Biochemistry, John Wiley and Sons
8. Murray et al (2000) Harper's Biochemistry, Appleton & Lange
9. Dixon et al (1979) The Enzyme, Longman Group
10. Thomas M Davlin (2010) Text book of Biochemistry with clinical correlations, John Wiley and Sons
11. Sadasivam S and A Manickam (1996) Biochemical Methods, New Age International
12. Thimmaiah SK (2004) Standard Methods of Biochemical Analysis, Kalyani Publishers
13. Sawhney SK & Randhir Singh (2010) Introductory Practical Biochemistry, Narosa Publishers

MAHATMA GANDHI UNIVERSITY

PLM21C03: Microbiology and Immunology

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	**Msc** Botany & Plant Science Technology					
Course Name	**Microbiology and Immunology**					
Type of Course	Core					
Course Code	**PLM21C03**					
Course Summary & Justification	Study deals with different aspects of the immune system like cells structures And the basic aspects of microbiological techniques					
Semester	first					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding of microbes and immunology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	ents get the knowledge about deadliest organisms which are responsible to numerous disease	U/A	1
2	To learn food safety and its management	A	1
3	Helps the students to study about immune system	A/An	1
4	To perform microbiological techniques	A	2

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module	Module Content	CO No.	Hours

No		Hrs	CO No.	PSO	PO
1	**Basic Microbiology:** History and Development of Microbiology, Scope and Relevance of Microbiology. Ultra-structure and Characteristics of Microorganisms : Prokaryotic Cell An overview of morphology of bacteria, bacterial cell wall, Archaeal cell walls, Cell membrane, Cytoplasmic matrix, The nucleoid, Extra chromosomal nuclear material, Intra cytoplasmic structures, Protein secretion in prokaryotes, Structures external to the cell wall, Comparison of Prokaryotic and Eukaryotic cell. Bacterial staining, Microbial growth and nutrition, Cultivation and preservation of bacteria. Bacterial classification. Sterilization and disinfection, Antibiotics and drug resistance, Antimicrobial sensitivity testing – microbiology of soil and water - Coli form count – MPN**;** Genetic recombination in prokaryotes, mutation, DNA repair, Bacterial plasmids. Pathogenicity and virulence factors of microbes; Detection and diagnosis of bacterial plant pathogens – major bacterial plant diseases; symbiotic association – Rhizobium and root nodules - associated interactions.	10	1,2	1	1
2	**Introduction to viruses and fungi**: Discovery of Viruses – history of virology- structure and properties of Viruses – viral symmetry – reproductive cycles - Classification of virus, cryptogram, and cultivation of viruses. Baltimore system of Virus Classification - Genetic Content of viruses – transduction, Virions and prions General characteristics; Classification and life cycle of fungi, affinities with plants and animals; thallus organization; Cell wall composition and nutrition - reproduction. Harmful and beneficial importance of fungi. Common fungal parasites for plant and animals. Single Cell Proteins.	10	1,4	1,2	1,3
3.	**Introduction to Immunology:**Historical perspective and importance of Immunology in health and disease. Cells and organ involved in immune sytem. Nonspecific resistance (Innate immunity) Overview of resistance, Definition, Ubiquity, Anatomical barriers, Physiochemical mediators and cell types of innate immunity, Receptors (TLR, Scavange receptor etc.) of the innate immunity, Signal transduction pathways in activation of innate immunity, Phagocytosis and Inflammation.Specific resistance (Adapative immunity)-Definition, Connection between innate and adapative immunity, Types of adapative immnity, Antigens, Definition, Types and properties, Bcell epitopes, Tcell epitopes, Immunogenicity and antigenecity, Adjuvants and mechanisms in enhancing antigenecity, Types of immune	20	3	1	2,3

	response.Immunoglobulins Definition, Basic structure classes and subclasses,Physicochemical and biological properties, Antigenic determinants on immunoglobulins, Antibody mediated effector functions : Enhancement of phagocytasis (opsonization), Activation of complement, Killing of target cell by ADCC, Transcytosis, Theories of antibody formation, Monoclonal and genetically engineered antibodies. Organisation of immunoglobulin genes, Expression of Ig genes, Genetic regulation of immunoglobulin, Generation of Antibody Diversity and Gene rearragement class switching.				
4	Antigen Antibody interactions, General properties of Ag-Ab interaction, Importance in host and in laboratory, Principles and applications of in in vitro Ag.Ab interactions, Different types of serological tests (Precipitation, Agglutination, CFT, Immunofluorescence, RIA, ELISA, Flowcytometry). Organisation of MHC, Gene of MHC, MHC molecules, Regulation of MHC expression, MHC and Immune receptors, Self MHC restriction, MHC and disease susceptibility, MHC and Transplantation.	10	3	1	4,5
5	**Application of Immunology :** Compliment pathways, cytokines and its characteristics, Tumor immunology, Autoimmune diseases, Hypersensitivity and allergy, classification of hypersensitivity, Immunodeficiency diseases.	10	3	1	8,9
	Total Credits of the Course	3			
Books for Reference					

Compulsory Reading:

1. 1. Microbiology by Pelezar,Michael J

2. Further Reading:

3. 1.Joanne Willey et al. (2013). Prescott's Microbiology-9th Ed., McGraw-HillEducation.

4. 2.Microbiology-an Introduction-(8th Edn), Authors-Tortora, G.J., Funke, B.R., Case,C.L.

5. 3.General Microbiology, Authors -Stainer, Ingharam, Wheelis and Painter.

6. 4.Microbial Physiology, Authors -Moat and Foster.

7. 5.A Text book of Microbiology, Authors -P. Chakraborty.

8. 6.Textbook of Microbiology, Authors -Dubey and Maheshwari.

9. 7.Microbiology, A Practical Approach. Authors -Patel and Phanse

10. 8.Immunology by Kuby (Free man publication)

11.9.Immunology and immunotechnology by Ashim k. Chakravarty (Oxford universityPress)

12. 10.Immunology by C. Fatima
13. 11.Essentials of immunology by Roitt (Blackwell scientific publication)
14. 12 Immunology by Benacera
15. 13 Infection & Immunity by John Playfair & Gregory Bancroft (Oxford university Press)

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **B. Semester End examination – 60 marks**

MAHATMA GANDHI UNIVERSITY

PLM21C04: - Angiosperm Systematics Part-I

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Angiosperm Systematics Part-I**					
Type of Course	Core					
Course Code	**PLM21C04**					
Course Summary & Justification	This course deals with the taxonomy of flowering plants that reflects new knowledge about plant relationships discovered through phylogenetic studies.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding of taxonomy					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Helps the students to study the taxonomical groups	E	1
2	Helps to study the major classifications	U/ An	4
3	Helps students to identify live plants	R	5
4	Helps to make herbarium	S	2
5	Helps to classify the plants based on family	E	1
6	Provide field exposure	An/ C	2

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	. Hrs	CO No	PSO	PO
1	**Classification of Angiosperms** -Historical background of Angiosperm taxonomy and the classification of plant classificatory systems (artificial, natural, and phylogenetic), A detailed study on the systems of classification proposed by: Carolus Linnaeus; Bentham and Hooker; Engler and Prantl; Armen Takhtajan; and Angiosperm Phylogeny Group.	20	1,2	1,2	1,3
2	**Plant Nomenclature** Historical aspects of plant Nomenclature (Polynomial and Binomial Systems), Importance of deciphering the information content of Latin binomials. Emergence of the ICBN; its structure, aims, principles, rules and recommendations. Hierarchicalsystem of taxonomic ranks recognized by the ICBN, Authorship,priority of publication, and name changes and abbreviations. Criteria for valid publication.	10	2,6	4,2	3,10
3.	**Sources of taxonomic information, modern trends and phylogeny of angiosperms**: Morphological, anatomical, cytological, biochemical (chemotaxonomy), and molecular (molecular taxonomy). Numerical taxonomy and phylogenetic systematic. Exhaustive study on the phylogeny of Angiosperms.	10	3,5	5,1	3,2
4	**Methods of Identification in plant systematic studies and databases:** Importance of explorative field collections in plant systematics and documentation of data. Preparation and maintenance of herbarium specimens. Herbarium operations and Data Information systems. Floras, Monographs, and Journals related to research in plant systematics. Taxonomic Keys (Indented and Bracketed), Botanic Gardens, Role of BSI in the advancement of plant systematics.	20	3,4	5,2	3
	Total Credits of the Course	3			

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	Mode of Assessment
	A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. 1. Judd, Campbell, Kellogg. Stevens. 2003. Phylogeny & Evolution of Vascular Plants. Sinaurer Associates Inc. Publishers Sunderland. Massachusetts. USA

2. Gurucharan Singh (2005) Plant Systematics 2nd Edition, Oxford & IBH

Further Reading:

2. 1. Cole AJ (1969) Numerical Taxonomy, Academic Press.
3. 2.Davis PH, Heywood VM (1973) *Principles of Angiosperm Taxonomy*, RE Kereiger Publ.
4. 3 Harrison HJ (1971), New Concepts in Flowering Plant Taxonomy, Heiman Educational Books
5. 4 Cronquist A (1981), System of classifications of flowering plants, Columbia University Press
6. 5 Naik VV (1984), Taxonomy of Angiosperms, Tata McGraw Hill Publ. Co. Ltd.
7. 6 Radford AE (1986), Fundamentals of Plant Systematics, Harper & Row Publ.
8. 7 Davis PH and VH Heywood (1991) Principles of Angiosperm Taxonomy, Today and Tomorrow Publ.
9. 8 Stace CA (1989), Plant Taxonomy and Biosystematics, Etwaed Arnold
10. 9 Woodland DW (1991), Contemporary Plant Systematics, Prentice Hall
11. 10 Sivarajan VV (1991), Introduction to Principles of Plant Taxonomy, Oxford IBH
12. 11 Takhtajan AL (1997) Diversity and Classification of Flowering Plants, Columbia Univ. Press.

MAHATMA GANDHI UNIVERSITY

PLM21E05: - Organic and Natural Farming

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Organic and Natural Farming**					
Type of Course	Elective					
Course Code	**PLM21E05**					
Course Summary & Justification	The course deals with how the use of natural resources for cultivation					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	Basic knowledge in biology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	ents will acquire knowledge about natural farming	A	1
2	ents gain knowledge about the use of chemical and natural pesticides in agriculture sectors.	S	1
3	To get better understanding about the organic agricultural farming	S/E	3
4	learn about the environmental benefits of organic agriculture	R/A	3
5	understand about the ecological services	S/A	2
6	To understand between the chemical farming and organic farming	S/E	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill			

(S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Introduction to natural and organic farming:** Natural, Ecological and organic farming – definition, concepts, and practices – management, principles, methods, merits and demerits. Components - Organic farming for sustainable agriculture - Features of organic orchards.	15	1	1,2	1
2	**Integrated organic farming:** Integrated organic farming - concept, ideal planning for small and marginal farmers of rain fed regions - low cost production technologies for growing vegetables, field crops and fruit plants; Introduction of indigenous technical knowledge (ITK) and resource conserving techniques (RCT); Multi cropping systems, mixed cropping, rotation and integrated cropping methods and their advantages in organic and natural farming; Certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies, Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic products. **Agronomy of organic and natural farming:** Soil organic matter- decomposition, C: N ratios, mineralization and immobilization processes, humus, role of organic matter in soil quality – natural way to prevent soil degradation and erosion, types and control measures. Soil related water pollution- sources, different pollutants in soils and their managements	15	2,4	1,3	6
3.	**Plant nutrient management:** Essential plant nutrients- criteria of essentiality, functions for plant growth, mechanisms for movement and uptake of ions in soils and plants - forms of nutrients in soils, deficiency symptoms on plants, luxury consumption, nutrient interactions and chelated micronutrients. Soil fertility, evaluation and management for plant growth, soil testing and fertilizer recommendations. Fertilizers and manures- classifications, NPK fertilizers, their reactions in soils, green mannuring, recycling of organic wastes, composting. Manures – bulky and concentrated – FYM – Compost – rural, urban, vermicompost and coirpith; Enrichment of organic manures; Sewage and sludge; Green manures – potentials and limitations;Quality parameters of organic manures and specifications – Biofertilizers - Soil micro flora – nutrient transformations - Integrated Nutrient Management (INM) and Integrated Plant Nutrient Supply System (IPNS) - NPOP,	15	3	3	10

	organic produce quality considerations, certification, labelling, accreditation process and marketing.				
4.	**Biopesticides and biological control agents:** Types of biocontrol agents- biological agents and pheromones, control of weeds, diseases and insect pests and field sanitation - competition, predation, antibiosis and fungistasis; Botanical insecticides- useful and beneficial insects like honeybee, lac insect, silkworm and pollinators. Biological control - concepts and potentialities for managing soil borne pathogens. Types of biological interactions, competition, mycoparasitism; Mycorrhizal associations, operational mechanisms and its relevance in biological control - biopesticides available in market - quality control system of biocontrol agents,Biodynamic products, Biodynamic composting, ,Liquid manure,Influence of Biodynaic products on crop production.	15	5,6	3	7
	Total Credits of the Course	4			

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Allan Wild (1988) Russel's Soil Conditions and Plant Growth Longman group U.K.
2. Burges A and Raw F (1967) Soil Biology, Acad. Press, New York

Further Reading:

1. Balasubramaniyan P and Palaniappan SP (2001) Principles and Practices of Agronomy, Agrobios Publishers, Jodhpur

2.Chatterjee BN et al (1989) Cropping Systems - Theory and Practice. Oxford and IBHPublication, New Delhi
3. Dahama AK (2007) Organic Farming for Sustainable Agriculture. 2nd Edn. Published by AGROBIOS (India) Jodhpur
4. Das PC (1993) Manures and Fertilizers Kalyani Publishers, New Delhi.
5. Department of Commerce, Ministry of Commerce and Industry, Govt. of India. (2000) National Standards Programme for Organic Production and Organic Products
6. Gehlot D (2005) Organic Farming: Standards, Accreditation, Certification and Inseption, AGROBIOS (India) Jodhpur
7. Gupta PK (2006) Vermicomposting for Sustainable Agriculture, AGROBIOS (India) Jodhpur
8.Gupta PK (2007) Soil, Plant, Water and Fertilizer Analysis Published by AGROBIOS (India), Jodpur
9.Palaniappan and Annadurai (2008) Organic Farming- Theory and Practise, Scientific Publ.
10.Rao S (1977) Soil Microorganism and Plant Growth, Oxford & IBH.
11. Sadasivam S and Manickam A (1992) Biochemical Methods for Agricultural Sciences Wiley Eastern Limited and Tamil Nadu Agricultural University, Coimbatore.
12. Sharma AK (2005) Biofertilizers for Sustainable Agriculture, AGROBIOS (India) Jodhpur
13.Sharma AK (2006) A Hand Book of Organic Farming, AGROBIOS (India) Jodhpur
14.Tandon HLS (1993) Methods of Analysis of Soils, Plants Waters and fertilizers, Fertilizer Development and Consultation Organization
15. Durai MV (2014) A hand book of soil, plant, water, fertilizer and manure analysis, New India Publ. Agency

MAHATMA GANDHI UNIVERSITY

PLM21E06: ENVIRONMENTAL MONITORING AND MANAGEMENT

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Environmental monitoring and management**					
Type of Course	Elective					
Course Code	**PLM21E06**					
Course Summary & Justification	rse on environmental Monitoring and management deals with principles and scope of environment science. The objective of the course content is to create a sound awareness about the environment impact and its monitoring and Predict the consequences of human actions on the web of life, global economy and quality of human life					
Semester	First					
Total StudentLearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	Basics of ecosystem and ecology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	velop critical thinking for environmental protection and conservation of biodiversity, sustainable development.	A	1
2	Helps to understand complex environmental-economic social challenges	S	1
3	derstand the current environmental problems and preventing the future ones.	S/E	4

4	Create an insight to the strategies and methodologies of environmental impact assessment	S/E	3
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Hrs.	CO No	PSO	PO
1	**Environmental Management** (a) Concepts, strategies and basic principles of environment management. Management of physical, social, and economic environment. Concepts and scope of environmental planning, regional planning and management. Cost-benefit analysis and Resource economics. (b) Environmental modeling: Simulation modeling, input-output modeling, Linear programming, Software and resource management. (c) Tool box for environmental management – An overview of Ecological foot prints, SEA, Ecological Economics, conflict resolution strategies. Eco-funds. (d) Environmental auditing and Standards - Eco labeling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental management systems (EMS) - ISO 14000, 14001 and 26001; OHSAS 18001	8	1	1	1,2
2	**Ecosystem Management** -(a) An overview - Population, Resources and Ecosystem management - Exponential growth in human numbers and the implications. (b) Major management concepts and methodologies: The five basic laws of Ecology and their relevance for ecosystem management; paradigm shifts in the management of Ecosystems - influence of economics in ecology. (c) Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas. (d) Environmental planning and management of; waste lands, reclaimed lands, mining areas, human settlements, industrial lands and agricultural lands. (e) Eco-restoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management.	15	2,3	1,4	3,4
3.	**Solid waste Management** - Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing, resources recovery and recycling, incineration, pyrolysis, aerobic and anaerobic systemscomposting, vermicomposting and sanitary landfills and biodigesters (Biogas). Management of plastic and e-waste. Better management strategies (any two model case studies).	7	2	1	5,6
4	**Environmental Impact Assessment**-- (a) Introduction, definition, history, aim, principles, concept and scope. Baseline data collection, Methods and steps – Ad hoc method, checklist method, matrices, Map overlays method, network method, index method. (b) Impact assessment and impact evaluation: E1A Processes, Stages, E1A Statement. Environment management plan - Risk assessment and disaster management programme. National Policy on EIA. M G	15	4	3	7,8

	University M Sc Botany syllabus 2012 Admission onwards 86 (c) Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; Environmental Clearance Process in India; Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial, thermal power, nuclear power and multipurpose river valley projects. EIA case studies. Life Cycle Assessment (LCA) and its significance.				
5	**Environmental laws and policies** --(a) Historical background of environmental law and policy in India. (b) The salient features of the following acts and rules: The water (Prevention and control of pollution) act, 1974; The air (Prevention and control of pollution) act, 1981; The environmental (Protection) act, 1986; The public liability insurance act, 1991; The wildlife protection act, 1972; The forest conservation act, 1980; The biodiversity act, 2002; The hazardous wastes (Management and handling) rules, 1989; The noise pollution (Regulation and control) rules, 2000. Manufacture, storage and import of hazardous chemicals rules 1989, Biomedical waste (Management and Handling) rules 1998.	15	3	4	9,10
	Total Credits of the Course	4			

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10

	marks B. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

1. Agarwal N K (2004). Essentials of GPS. Spatial Networks Pvt. Ltd.

2. Agarwal N K (2002). Eco-informatics. APH Publishing Corporation

Further Reading:

Asit K Biswas et.al., (1987). EIA for Developing Countries. United Nations University, Tokyo. 4. Carter L (1996). Environmental Impact Assessment. McGraw Hill.

5. Coronel C, Morris S, Rob P (2009). Database Systems: Design, Implementation and Management (IX Edn). Course Technology.

6. Eagles P F J (1987). The planning and Management of Environmentally Sensitive areas. Longman Group Ltd.

7. Elachi C (1978). Introduction to Physics and Techniques of Remote sensing. John Wiley Pub. 8. Floyd F, Sabins W H Jr. (1987). Remote Sensing, Principles and Interpretation (II Edn). Freeman & Company.

9. Gadgil M, Guha R (1995). Ecology and Equity: The Use and Abuse of Nature in Contemporary India. Penguin India.

10. Gadgil M, Guha R (1998). The Fissured Land: An Ecological History of India. Oxford University Press.

11. Goldsmith B (Ed) (1992). Monitoring for Conservation and Ecology. Chapman and Hall.

12. Jorgensen S E (1996). Applications of ecological modeling in environmental management. Elsevier Sci. Co.

13. Jorgensen S E, Chon T S, Recknage F A (2009). Handbook of Ecological Model and Informatics. WIT Press.

14. Kang-tsung C (2000). Introduction to GIS. Tata McGraw Hill.

15. Knight R L, White L (2009). Conservation for a new generation redefining natural resources management. Island Press.

16. Lawrence D P (2003). Environmental Impact Assessment: Practical Solutions to Recurrent Problems. John Wiley and Sons.

17. Lillesand T M, Kiefer R F (1994). Remote Sensing and Image interpretation. John Wiley & Sons.

18. Maguire D, Batty M, Goodchild M (Eds.) (2005). GIS, Spatial Analysis, and Modeling. Esri Press.

19. Meadows D, Randers J, (2004). Limits to Growth: The 30 Year Update. Earthscan.

20. Meffe G K, L Nielson, R Knight, Schenborn (2002). Ecosystem management: Adaptive, Communitybased Conservation. Plenum Press.

21. Miller GT Jr. (2004). Environmental Science. Thomson, California.

22. Milner-Gulland E J, Marcus Rowcliffe (2007). Conservation and sustainable use: A handbook of techniques. Oxford University Press.

23. Peter Calow (Ed) (1998). Handbook of Environmental Impact Assessment. Mc Graw Hills Inc.

24. Pullin A S (2002). Conservation Biology. Cambridge University Press.

25. Rao D P (Ed) (1998). Remote Sensing for Earth Resources. Association of Exploration Geophysicist, Hyderabad.

26. Simon Dresner (2008). The Principles of Sustainability Solutions. Earthscan paperbacks, The Ecological Footprint Atlas 2010. Oakland: Global Footprint Network.

27. Miller G T Jr. (2005). Advantage Series: Sustaining the Earth: An Integrated Approach. (VII Edn). Thomson/Brooks Cole.

28. Westman W E (1995). Ecology, Impact Assessment and Environmental Planning. John Wiley and sons.

29. World Commission on Environment and Development (1987). 'Our Common Future'. Oxford University Press.

	MAHATMA GANDHI UNIVERSITY
	PLM21E07:- Allelopathy and Biological Weed and Pest Control

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Allelopathy and Biological Weed and Pest Control**					
Type of Course	Elective					
Course Code	**PLM21E07**					
Course Summary & Justification	The course helps to understand the basis of sustainable agriculture and to know how the pest and weeds can be control.					
Semester	First					
Total StudentLearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	Bascis in organic farming					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Helps to understand about the allelochemicals	**U**	1
2.	To gain knowledge about pharmaceuticals importance of allelopathy	**U/A**	4
3.	Helps to attain the knowledge in plant plant interactions	**E**	3
4.	Helps to understand about Pest management	**An**	4
5.	To know about the controlling methods of pests and weeds	**C/S**	1

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module	Module Content	CO No.	Hrs

No		Hrs	CO No.	PSO	PO
1	**Definition & history** - difference between allelospoly, allelopathy and allelomediation, methodology to establish allelopathy, environment hormones, general nature of allelochemics – retention, transformation and transport, mechanisms and process involved in the production of allelochemics. **Sources and release of allelochemicals** and methods of isolation bioassay and identification– volatilization, leaching, root exudation, decomposition of plant residues; Mode of action of allelochemics.	15	1	1	1,2,3
2.	**Natural Products as allelochemics** - water-soluble organic acids, simple unsaturated lactones, Long-chain fatty acids and polyacetylenes, Naphthoquinone, anthroquinones and complex quinones , Simple phenols , Benzoic acid and derivates, Cinnamic acid and derivates, Flavonoids , Tannins, Terpenoids and steroids , Amino acids and polypetides , Alkaloids and cyanohydrins, Sulphides and glucosides, Purines and nucleotides, Coumarins, Thiocyanates, Lactones, Actogenins.	15	2	4	3,4
3.	**Mode of action of allelochemicals**: direct and indirect actions, interactions in mineral uptake, cytology and ultra structure, phytohormones and balance, membranes and membrane permeability, photosynthesis and photosynthetic inhibitors, influence on respiration, protein synthesis, enzyme activity, conducting tissue, water relations, genetic material – factors affecting the production of allelochemics, allelopathy and soil microbes.	15	3	3	3,5
4	Application of allelopathy studies - understand the problems in improving the production of manipulated ecosystems, explanation for a specific vegetational pattern, understand the effect of weeds on crops, crops on weeds and crops on crops – biological weed control – role of allelopathy in weed science – application in weed control.	15	4,5	4,1	3,6
	Total Credits of the Course	**4**			

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	Mode of Assessment
	C. Continuous Internal Assessment (CIA)

	1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks D. **Semester End examination – 60 marks**

REFERENCES

.

1. 1 Aldrich JD (1984)Weed-crop ecology: Principles and practices, Breton Publishers
2. 2 Rizvi SJH & V Rizvi Edited (1992) Allelopathy: Basic and applied aspects. Chapmann & Hall Publishers
3. 3 Chou CH & GR Waller Edited (1989) Phytochemical Ecology: Allelochemicals, Mycotoxins and Insect Pheromones and Allomones. Institute of Botany. Academia Sinica Monographs Series No 9. Taipei
4. 4 Dale Walters (2010) Plant Defense: Warding off attack by pathogens, herbivores and parasitic plants, Wiley Blackwell
5. 5 Rice EL (1984) Allelopathy. 2nd edition. Academic Press
6. Inderjit and Mukerji KG Edited (2006) Allelochemicals: Biological Control of Plant Pathogens and Diseases, Springer
7. 6 Zeng et al Edited (2008) Allelopathy in Sustainable Agriculture and Forestry, Springer
8. Francisco A Macias et al (2003) Allelopathy: Chemistry and Mode of Action of Allelochemicals

MAHATMA GANDHI UNIVERSITY

PLM21C08: Laboratory Course 1

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Laboratory Course 1**					
Type of Course	Core					
Course Code	**PLM21E08**					
Course Summary & Justification	e course includes training on sterilization and disinfection techniques, morphological, cultural and biochemical study of microbes and antibiotic sensitivity tests. The content of the course also include serological techniques. The technical knowhow of basic microbiological and serological methods is essential for post graduate programmes in all branches of Biosciences and also helps to identification of plant families.					
Semester	First					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg: Authentic learning Collaborative learning Independent learning	5	5	50		60
Pre-requisite	Theoretical knowledge inMicrobiology and Immunology Basic laboratory skills					

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will acquire skills in practices on sterile and safety precautions in a microbiology laboratory	R/U/A	2
2	Students will be able to examine morphological, physiological and biochemical properties of bacteria	U/A	1,2
3	Students will be able to perform and interpret the various serological tests in a diagnostic laboratory	C/S	2,3

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*					
Module No	**Module Content**	**Hrs**	**CO No.**	**PSO**	**PO**
1	**Biostatistics** 1. 1.Analysis of data to find the mean, median and mode 2. 2.Analysis of a data for mean deviation and standard deviation 3. 3.Test significance of given data using t-test, F-test Chi-squarerest and ANOVA. 4. 4.Analysis of set of data for correlation/regression. 5. 5.Determine probability for different types of events. 6. 6.Statistical software: Systat/R/Genstat/SPSS **Bioinormatics** 7.Familiarizing with the different data bank mentioned in the syllabus. 8.Blast search. 9.Multiple sequence alignment using CLUSTAL X (give DNA orprotein sequence).	15	3	2,3	1,2,3
2	**Cell Biology** study of cell types – different kinds of animal and plant cells. Preparation of slides from root tip/shoot tips/animal tissue for studyof mitosis calculation of mitotic index. Study of meiosis in *Rhoeo*/*Chlorophytum/animal tissues* by smear preparation. Study of giant chromosomes in Drosophila/Chironomus- Orcein staining of salivary gland chromosomes of Chironomas or Drosophila. Isolation of cell organelles: succinate dehydrogenase activity assay (Mitochondria), acid phosphatase activity assay (Lysosomes), acetocarmine staining (Nucleus) and Microscopic observation(Chloroplast). **Practicals (Biochemistry)–** **1.** Preparation of Solutions and buffers: pH, different types of buffers, molarity and normality of solutions. **2.** Qualitative tests for carbohydrates: Test for reducing sugars (Pentose, hexose and ketose sugars), non-reducing sugar and polysaccharides.	15	1,3	2,3	3,4

	3. Quantitative tests for carbohydrates: Nelson-Somogys, Anthrone and DNS methods, Isolation and estimation of starch from potato. 4. Qualitative tests for lipids: Solubility test, acid-value, iodine value and saponification value of fats. 5. Quantitative tests for proteins: Lowry's or Biuret methods. 6. Extraction and separation techniques: Extraction and separation of Phytochemicals or amino acids by Paper or Thin layer chromatography				
3.	1. 1.Staining techniques: simple and differential staining (Gram staining and acid fast staining), special staining (granule, capsule and spore staining) 2. 2.Slide culture technique 3. 3.Lactophenol Cotton Blue staining 4. 4.Pure culture techniques: Spread plate, Pour plate and Streak plate technique 5. 5.Isolation and enumeration of bacteria and fungi from soil, air and water 6. 6.Determination of Antimicrobial activity 7. 7.Gel diffusion test: Radial Immuno diffusion test. Ouchterlony double immuno diffusion test. 8. 8.WIDAL test for typhoid fever 9. 9.ASO latex agglutination 10. 10.ELISA test	15	1,2	2,1	5,6
4	**Taxonomy Practical-1** 1. **Vegetative and floral morphology of angiosperms:** The students should familiarize with all the relevant technical terms by collecting and examining fertile plant specimens. 2.Workout nomenclatural problems regarding priority and author citations.	15	1,2	2,1	3,7
	Total Credits of the Course	**3**			
Books for Reference **1.** Karp G (2010). Cell and Molecular Biology: Concepts and Experiments. VIEdition, John Wiley & Sons. Inc					

2. Thomas M Davlin (2010) Text book of Biochemistry with clinical correlations, John Wiley and Sons 3. Thimmaiah SK (2004) Standard Methods of Biochemical Analysis, Kalyani Publishers 4. **2.**	
Compulsory Reading:	
Optional Further Reading **3.**	

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks **B. Semester End Practical examination – 60 marks**

SECOND SEMESTER

SECOND SEMESTER SCHEME

PLM21C09	Phycology	3
PLM21C10	Bryology, Pteridology & Gymnosperms	3
PLM21C11	Mycology and Plant Pathology	3
PLM21C12	Angiosperm Systematics Part-II	3
PLM21E13	Phytochemistry*	4
PLM21E14	Applied Marine Phycology*	4
PLM21C15	Laboratory course 2	4

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PLM21C09: - Phycology

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Phycology**					
Type of Course	Core					
Course Code	**PLM21C09**					
Course Summary & Justification	Course deals with the algae and helps to understand the features of algae					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg: Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Knowledge in Biology at Graduate level**					

COURSE OUTCOMES (CO)

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Helps to understand the unique and general features of Algae	R/U/A	1
2	Helps to identify the external morphology internal structure and reproduction of different types of algae	U/A	2
3	Helps to examine the possible applications in phycology	U/An/Ap	4
4	Provide a basic knowledge about algae	An/Ap	1
5	Provide the ability to identify algal structures	R/U/A/An/Ap	2
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),			

Interest (I) and Appreciation (Ap)					
COURSE CONTENT					
Module No	**Module Content**	**CO No.**	**Hrs**	**PSO**	**PO**
1	**Introduction -** History of algal studies in India – classifications – detailed study of the classification by FE Fritsch and GM Smith-Modern trends and criteria for algal classification.	10	1	1	1
2	**General Features of Major Classes of Algae:** Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products. Range of structure of thalli and the evolution of thalli; Reproduction in algae - different methods of reproduction, evolution of sex organs - major patterns of life cycle and post fertilization stages in Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta - Fossil algae.	20	2,4,5	2,1	4,6,10
3.	**Biochemistry of Algae:** Biochemistry of algal cell wall; algal biomolecules —carbohydrates, lipids and proteins in algae; chemistry of pyrenoids, pigments, oil and proteins and amino acids of algae – chemistry of algal hydrogen production.	10	2	2	7,8
4	**Algal biotechnology:** Methods and techniques of collection, preservation and staining of Algae - Algal culture - importance, methods and algal culture media – algal bioreactors – mass production of algal biomass – application of biotechnology in algal strain improvements – algal genomic DNA, Plastid and mitochondrial DNA – algal molecular taxonomy.	10	3	4	3,5
5	**Ecological and Economic importance of Algae**. Productivity of fresh water and marine environment; Algae in symbiotic association, Algae in polluted habitat, Algal blooms, algal bioremediation – algae as eco-indicators -algae as food, fodder, biofertilizer, medicine, industrial uses, and fuel from algae. Harmful effects of algae - Use of Algae in experimental studies.	10	3	4	3,2,9
	Total Credits of the Course	**3**			
Books for Reference					

Bold HC and Wynne MJ Wall (1985) Introduction to the algae: structure and reproduction. 3rd Edition, Prentice Hall Lee RE (2009) Phycology. 4th edition. Cambridge University Press Fritsch F E (Vol. I, II) (1977) The structure and reproduction of Algae, Cambridge University Press Pringsheim EG (1949) Pure culture of Algae, Cambridge University Press	
Compulsory Reading: Van der Hock DG Mann and Johns, H. M. (1995)An Introduction to Phycology, Cambridge University Press Barsanti, Laura and Paolo Gualitieri (2005) Algal-Anatomy, biochemistry and Biotechnology. Taylor and Francis, London, New York Becker EW (1994) Microalgae- Biotechnology and Microbiology, Cambridge University Press	
Optional Further Reading Trivedi PC (2001) Algal Biotechnology, Pointer Publishers, Jaipur, India Stein JR (1978) Hand Book of Phycological Methods Vol I & Vol II, Cambridge University Press	

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks

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PLM21C10: - Bryology, Pteridology & Gymnosperms

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Bryology, Pteridology & Gymnosperms**					
Type of Course	Core					
Course Code	**PLM21C10**					
Course Summary & Justification	This course deals with scientific study of bryophytes,Pteridophytes and the flowering plants.The course will helps to understand about types of plants.					
Semester	Second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics in Botany**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	lps to understand the general characters and the structure of plant body in bryophytes.	R/U	1
2	lps to understand the types of pteridophyes and the stellar evolutions	U	1,2
3	Helps to understand about the seed producing plants	U/E/A	3
4	Helps to understand the evolutionary development of the seeds	An/E	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Hrs	CO No	PSO	PO
1	**Bryology:** Introduction to bryophytes, their fossil history and evolution. Concept of algal and pteridophytic origin of Bryophytes, General characters of bryophytes, History of classification of bryophytes; Variations in theThallus structure and Reproduction of Bryophytes: Comparative structural organization of gametophytes and sporophytes - asexual and sexual reproductive structures - spore dispersal mechanisms and germination of the following groups with reference to the types mentioned in the practical (a) Hepaticopsida (Sphaerocarpales, Marchantiales, Jungermanniales and Calobryales) (b) Anthocerotopsida (Anthocerotales) (c) Bryopsida (Sphagnales, Polytrichales and Bryales).	10	1	1	1,10
2	**Evolutionary trends, Ecology and Economic importance of Bryophytes** – evolutionary tendency of gametophytes and sporophytes – fossil bryophytes. **Ecology of Bryophytes**(a) their **w**ater relations - absorption and conduction, xerophytic adaptations, drought tolerance, dessication and rehydration, ectohydric, endohydric and myxohydric bryophytes (b) Ecological significance of Bryophytes - role as pollution indicators; Economic Importance - Bryophytes used as medicines, food, fuel. Bryophytes as an experimental material/model organism (*Physcomitrella patens*).	10	1	1	6,7
3.	**Pteridology: General introduction and classification of Pteridophytes:** origin, general characteristics and classification of Pteridophytes. The geological time scale and a study of fossil Pteridophytes (Rhinia, Horneophyton, Lepidodendron, Calamites, Cladoxylon, Sphenophyllales, Coenopteridales). **Detailed study of primitive pteridophytes:** Distribution, habitat, range, external and internal morphology of sporophytes, spores, mechanism of spore dispersal, gametophytic generation, sexuality, and embryogeny of the following classes of primitive Pteridophytes with reference to the genera mentioned: 1. **Psilopsida** (a) Rhyniales; *Rhynia;* **2.Psilotopsida** (a) Psilotales; *Psilotum;* **3.Lycopsida** (a) Protolepidodendrales; *Protolepidodendron* (b) Lycopodiales; *Lycopodium*, (c) Isoetales; *Isoetes* (d) Selaginellales; *Selaginella*; **4.Sphenopsida** (a) Hyeniales (b)	20	2	1,2	3,10,5

	Sphenophyllales; *Sphenophyllum* (c) Calamitales; *Calamites*(d) Equisetales; *Equisetum.*				
4	**Morphology, anatomy and reproduction inPteropsida** (i) Primofilices (a) Cladoxylales; *Cladoxylon* (b) Coenopteridales. (ii) Eusporangiatae (a) Marattiales; *Angiopteris* (b) Ophioglossales; *Ophioglossum*. (iii) Osmundales; *Osmunda*. (iv) Leptosporangiatae (a) Marsileales; *Marsilea* (b) Salviniales; *Salvinia, Azolla* (c) Filicales; *Pteris, Lygodium, Acrostichum, Gleichenia, Adiantum.* **Comparative study of Pteridophytes:** Stelar organization, soral and sporangial characters, gametophytes and sporophytes of Pteridophytes from an evolutionary perspective,. Telome theory of Zimmerman and Enation theory of Bower. **Ecological and Economic importance:** Role in soil formation, phytoremediation, importance as ornamentals – major ornamental species	10	2	1,2	2,8
5	**Gymnosperms: Introduction:** Origin, general characteristics, distribution and classification of Gymnosperms, Distribution of living gymnosperms in India. **Vegetative and reproductive structures of Gymnosperms:** Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned); (a) Class Progymnospermopsida: *Aneurophyton* (b) Class Cycadopsida: *Heterangium, Lyginopteris, Lagenostoma, Glossopteris, Medullosa, Caytonia. Bennettites, Williamsoniella, Nilsonia, Cycas, Zamia, Pentoxylon* (c) Class Coniferopsida: General account of families under Coniferales, range of form and structure of stem, leaves; range of form, structure and evolution of female cones in coniferales such as *Pinus, Taxodium, Cupressus, Podocarpus, Agathis, Araucaria, Taxus and Ginkgo* (d) Class Gnetopsida: *Gnetum.* **Gametophyte development and economic importance of Gymnosperms:** General account of male and female gametophyte development in Gymnosperms (Cycas); Economic significance of Gymnosperms. **Paleobotany:** Fossils and ideal conditions for fossilization, Kinds of fossils-impressions, casts, molds, petrifactions and coal ball. Geological time scale-era, period, epoch, evolution of the different flora. Brief study of the following fossils-Lepidodendron, Lepidocarpon and Calamites. Importance of Paleobotany.	10	3,4	3,4	1,9, 4
	Total Credits of the Course	3			

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading

1.Schefield WB (1985) Introduction to Bryology, Mermilan Publishing Company. New York
2.Chopra RN, PK Kumar (1988) Biology of Bryophytes,Wiley Eastern Ltd
3.Rashid A (1981) An Introduction to Bryophyta, Vikas publishing house Pvt. Ltd
4.Richardson DHS (1981), Biology of Mosses, Blackwell Scientific publications, Oxford
5.Vashishta BR, AK Sinha and A Kumar (2003) Bryophyta, S Chand & Co. Ltd
6.Udak R (1976) Bryology in India, Chronica Botanica Co

Further Reading:

1. Pandey B P (1994) Bryophyta, *S* Chand and Co. Ltd
Goffinet B and AJ Shaw (2009), Bryophytic Biology2nd Ed., Cambridge University Press
Dyer AF and JG Duckett Edited (1984), The experimental Biology of Bryophytes, Academic Press
. 2 Bonver FO (1935) Primitive land plants, MacMillan & Co. Ltd
. 3 Campbell D (1940) The evolution of land plants, Stanford University Press

MAHATMA GANDHI UNIVERSITY

PLM21C11: - Mycology and Plant Pathology

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Mycology and Plant Pathology**					
Type of Course	Core					
Course Code	**PLM21C11**					
Course Summary & Justification	The course deals with the fungal ecology and the diseases in plants.The course will helps to understand basics of ecology and the plant pathogens.					
Semester	second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of botany					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	lps to identify and classify the fungal phyla and classes	U	1
2	ovide the students to gain knowledge about the fungal infections.	An	3
3	lps the students about the mechanisms by which diseases develop in individual plants and in plant populations.	R/A	2
4	Helps to identify the major infections in plants and their management	I/U	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill			

(S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**ion to fungi, and fungal stramenopiles; their morphology and reproduction:** General characteristics of 'true fungi' and fungal stramenopiles; their life cycle pattern and their phylogenetic relationship with plants and animals, Chemotaxonomic value of Lysine biosynthetic pathway in mycology.	10	1	1	1,6
2	**Classification of fungi and fungal stamenopiles down to the ordinal rank:-Kingom Fungi –** Chytridomycota, Zygomycota, Ascomycota and Basidiomycota.**Kingdom Stramenopila** – Oomycota	20	1	1	2,7, 10
3.	**Fungal-plant associations and Economic importance of fungi:** **(a) Lichen:** Occurrence; General characteristics; Growth forms and range of somatic organization; nature of association of photobionts and mycobionts and their reproduction. Physiological aspects of lichen thalli. **(b) Mycorrhiza:** Ectomycorrhiza,, Endomycorrhiza and their significance. Common fungal parasites of plants. **(c) Economic importance :** Role of fungi in the decomposition of organic matter - coprophilous fungi, cellulolytic fungi, lignolytic fungi;Fungi as food – single cell proteins, fungi as food spoiler – food toxicity – aflatoxins; role of fungi in fermentation – bioreactors - fungal antibiotics and vitamins, drugs and hallucinogens.	10	1,2	1,3	3,4, 9
4	**Plant Pathology –**Introduction to Viral, Bacterial and Fungal Diseases in plants,defence mechanisms in plants: structural and biochemical. Fungal deterioration of fruits and vegetables - control measures, Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defence response to plants. **Major microbial diseases in plants** (a) Cereals: Rice - blast disease, bacterial blight; Wheat - black rust disease (b) Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease (c) Fruits: Banana - bacterial leaf blight, leaf spot; Mango - Anthracnose; Citrus canker; Papaya – mosaic (d) Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease (e) Oil seeds: Coconut - grey leaf spot, bud rot disease (f) Rubber -	20	2,3,4	3,2, 4	3,5, 8

	abnormal leaf fall, powdery mildew (g) Sugarcane - red rot; root knot nematode (h) Cash crops: Arecanut - nut fall disease (i) Tea - blister blight; Coffee – rust.				
	Total Credits of the Course	3			

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1 Ananthanarayan R and CKG Paniker (2009) Text book of Microbiology 8th Edition, Universities Press

2 Flores E and A Hrrero Edited (2014) Cell biology of Cyanobacteria, Caister Academic Press

Remaut H and R Fronzes (2014), Bacterial Membranes, Bacterial Membranes –Structural and Molecular Biology, Caister Academic Press

3 Ullrich M (2009) Bacterial Polysaccharides, Caister Academic Press

4 John GH et al Edited (1993) Bergey's manual of determinative bacteriology, Baltimore

5 George MG Edited (2001)Bergey's manual of systematic bacteriology, Springer

6 Benson HJ (2012) Benson'smicrobiological applications : laboratory manual in general microbiology, McGraw-Hill

Further Reading:

1 Allen IL and Hubert AL Edited (1982) CRC handbook of microbiology, CRC Press

2 Collins CH et al Edited (1989) Collins and Lyne's microbiological methods 6th Edition, Butterworths

. 3 Vasanthakumary R (2007) Text Book of Microbiology, BI Publ. Pvt Ltd
. 4 Wagner EK and Hewlett JM (2004) Basic Virology, Blackwell Science
. 5 Alexopoulos CJ (1977) Introductory Mycology, Blackwell
. 6 Jim Deacon (2006) Fungal Biology(IV Edn), Blackwell Publishing
. 7 Nair LN (2010), Methods of microbial and plant biotechnology,New Central Book agency
. 8 Dube HC (1983) An introduction to fungi, Vikas Publ. New Delhi.
. 9 Nair MC and S Balakrishnan (1986) Beneficial fungi and their utilization, Sci. Publ. Jhodpur
. 10Webster J and Weber R (2007) Introduction to Fungi, Cambridge University Press
. 11 Sethi IK and Walia SK (2011) Text book of Fungi and Their Allies, Macmillan Publ.
. 12 Sharma PD (2011) Plant Pathology, Rastogi Publication, Meerut, India.

MAHATMA GANDHI UNIVERSITY

PLM21C12: -Angiosperm Systematics Part-II

SchoolName	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Angiosperm Systematics Part-II**					
Type of Course	Core					
Course Code	**PLM21C12**					
Course Summary & Justification	The course deals with the importance of angiosperms and its economic uses. This study will helps for attain knowledge in the pharmaceuticalsapplications of the area					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic knowledge in plant morphology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Helps the student to study the economic relevance of angiosperms	R/U	1
2.	Helps to understand the major classification system of angiosperms	R/U	1
3.	To understand the major reproduction process in angiosperms	R/I	4
4.	Helps to understand the morphological characteristics of each family	U	2
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	Bentham and Hooker System of Classification	10	2	1	7
2	**Detailed exposition of phenotypic Characters, Phylogeny and economic importance of the following families belonging to Polypetalae.** 1.Ranunculaceae, 2. Magnoliaceae, 3. Menispermaceae, 4. Annonaceae, 5. Brassicaceae s.s, 6. Polygalaceae, 7. Caryophyllaceae, 8. Clusiaceae, 9. Dipterocarpaceae, 10. Malvaceae s.s, 11. Sterculiaceae, 12. Tiliaceae, 13. Rutaceae, 14. Meliaceae, 15. Vitaceae, 16. Sapindaceae, 17. Fabaceae, 18. Rosaceae, 19. Rhizophoraceae, 20. Melastomaceae, 21. Myrtaceae, 22. Cucurbitaceae, 23. Aizoaceae, 24. Apiaceae	20	3,4	4,2	3,6, 10
3.	**Detailed exposition of phenotypic characters, phylogeny and economic importance of the following families belonging to Gamopetalae, Monochlamydeae and Monocotyledoneae.** Rubiaceae, 2. Asteraceae, 3. Sapotaceae, 4. Oleaceae, 5. Apocynaceae s.s, 6. Asclepiadaceae, 7. Gentianaceae, 8. Boraginaceae, 9. Convolvulaceae, 10. Solanaceae, 11. Scrophulariaceae, 12. Acanthaceae, 13. Verbenaceae, 14. Lamiaceae, 15. Amaranthaceae, 16. Nyctaginaceae, 17. Aristolochiaceae, 18. Lauraceae, 19. Loranthaceae, 20. Euphorbiaceae, 21. Orchidaceae, 22. Zingiberaceae, 23. Cannaceae, 24. Musaceae, 25. Cyperaceae, 26. Poaceae.	20	3,4	4,2	3,5, 9
4	**Principles and Applications of Ethnobotany** Introduction, history and development of ethnobotanical studies, methods in Ethnobotanical study, traditional Botanical Knowledge and subsistence and role of ethnobotany in sustainable development.	10	1	1	4,8
	Total Credits of the Course	3			

REFERENCES

Compulsory Reading:

1. Paye GD (2000) Cultural Uses of Plants: A Guide to Learning about Ethnobotany, The New York Botanical Garden Press.
2. Hooker JD, The flora of British India(Vol. I – VII),
3 Gamble JS, Flora of the Presidency of Madras (Vol. I – III).

4 Cronquist A (1981) An integrated system of classification of flowering plants, Columbia University Press
5 Heywood VH, Moore D M Edited (1984) Current concepts in Plant taxonomy
6 Radiford AE (1986) Fundamentals of plant systematic, Harper & Row.

Further Reading:

1. Rendle AE (1970) Classification of flowering plants, Vikas Co.
2. Stace CA (1989) Plant Taxonomy and Biosystematics(II Edn), CBS Publ.
3. Woodland DW (1991) Contemporary Plant Systematics, Prentice Hall.
4. Sivarajan VV (1991*)*, Introduction to Principles of Plant Taxonomy, Oxford IBH.
5. Takhtajan AL (1997), Diversity and Classification of Flowering Plants, Columbia

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. Semester End examination – 60 marks

MAHATMA GANDHI UNIVERSITY

PLM21E13: - Phytochemistry

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Phytochemistry**					
Type of Course	Elective					
Course Code	**PLM21E13**					
Course Summary & Justification	The course will benefits the student to enhance the knowledge in different pathways of primary and secondary metabolism in plants.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg: Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Knowledge in Botany at Graduate level**					

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will get the knowledge about the major biosynthetic classes.	R/U/A	1
2	Helps student to gain knowledge to identify the plant substances with medicinal importance	U/A	2
3	Students can study about phytochemical analysis	R/U	3

4	Will get the information about the importance of pharmacological benefits in plants	An/U	4	

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),Interest (I) and Appreciation (Ap)

Module No	Module Content	Hrs	CO No.	PSO	PO
1.	**Extraction:**Introduction, definition, factors influencing the choice of extraction, principles of extraction methods; Selection and purification of solvents for extraction; Types (Conventional and advanced techniques) of extraction and their merits and demerits.	15	1	1	1,7
2.	**Glycosides and Vitamins*:*** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of cardiac glycosides - digoxin, Anthracene glycosides - Sennosides.**Vitamins*:*** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Ascorbic acid. **Steroids:**Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of cholesterol.	15	1,4	1,4	2,6,8
3.	**Terpenoids and Natural Pigments*:*** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure , chemistry , structural elucidation of Citral, Menthol and Zingiberene; ***Natural Pigments:*** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure , chemistry , structural elucidation of Carotene, Lycopene, Bixin , Chlorophyll, Quercetine and Indigotine.	15	1,4	1,4	3,4,9
4.	**Natural products as markers for new drug discovery:**The Role of natural products as potential new drug discovery, Selection and optimization of lead compounds for further development with suitable examples. Methods of isolation,(including industrial methods) purification and characterization of following natural products: Citric acid, Pectin, Sennosides, Lawsone, Phyllanthin, Bacosides, Lycopene, Hesperidin, Diosgenin, Curcumin, Lemon grass oil and Caffeine.	15	2,3	2,3	3,5,10

Total Credits	**4**	

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. Semester End examination – 60 marks

MAHATMA GANDHI UNIVERSITY

PLM21E14: - Applied Marine Phycology

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Applied Marine Phycology**					
Type of Course	Elective					
Course Code	**PLM21E14**					
Course Summary & Justification	This course deals with the scientific study f algae living exclusively in marine ecosystems.This course will helps the students to get a broad nature of marine algae.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg: Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Knowledge in Botany at Graduate level**					

COURSE OUTCOMES (CO)

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Helps to understand the broad nature of marine algae.	R/U/A	1
2	Helps to gain knowledge about the algae derived pigments and its health benefits	U/A	3,4
3	Helps to know about the extraction of bioactive compounds from marine algae	U/A	3

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),Interest (I) and Appreciation (Ap)*					
COURSE CONTENT					
Module No	**Module Content**	**Hrs**	**CO No.**	**PSO**	**PO**
1.	Introduction to Marine habitat and marine algal wealth – classification of marine algae; biochemical composition ofdifferent economically significant groups – proteins, amino acids, lipids, glycerol, vitamins, pigments, chlorophyll, carotenoids, phycobilins – toxic marine algae – algicides; measure of primary production , factors influencing primary production of marine algae – assessment of fishery resources on the basis of algal resources – marine food chain.	15	1	1	2,7
2	Culture of Marine Micro algae –nutrition – factors affecting growth; algal growth kinetics, isolation methods – development of monocultures and auxenic cultures – massculture of marine micro-algae – statistical designing, modelling and optimization in mass production, open pond design and management; Photobioreactors – design considerations, Fermentors – heterotrophic production – maintenance of mass cultures – biomass harvesting and processing techniques – preservation methods – production of industrial species of microalgae – case studies – national status of marine microalgal production –culture of macro-algae - bioprocess engineering of seaweed tissue culture – maintenance of macro-algal culture – advances in seaweed culture.	15	1	1	1,5, 10
3	Process and products from Marine algae: Marine algae in human and animal nutrition, aquaculture and cosmetics, high value products from algae – polysaccharides, lipids, pigments, hydrocarbons, bioplastics, other chemicals – production, recovery and application. Biofertilizers from marine algae – production procedures; Stable isotope biochemicals from marine algae; Antimicrobials toxins and other bioactive compounds; Marine algae in bioremediation, algal immobilization and application, Marine algae for enhancement of marine productivity, climate stabilization and food security.	15	1,2	1,3,4	3,6,8

4	Marine algae and bioenergy: bio-fuels from marine micro- algae, biodiesel from algal biomass – screening methods, analysis of lipids, optimization of production, extraction of oil; methods for conversion to biodiesel; Biochemical, genetic and metabolic engineering of the lipid metabolism; Marine algae for hydrogen production – induction and	15	3	3	4,9

	analysis of hydrogen production, strategies to enhance hydrogen production; Marine algae useful in Methane production – Marine algae for bio-ethanol – process and methods for analyses; Bio-energy from Macro-algae – selection of species, biomass processing, butanol production – by-products from algal bio-fuel production – economic importance of bio-energy from marine algae – concept of marine bio-refinery.		
	Total Credits	**4**	

References

1. Richmond A (2004) Handbook of microalgal culture: Biotechnology and applied phycology, Blackwell Sciences Ltd
2. Anderson RA (2005) Algal culturing techniques, Elsevier Academic Press
Becker EW (1994) Microalgae: Biotechnology and Microbiology, Cambridge University Press
3. Cohen Z (1999) Chemicals from Microalgae, Taylor & Francis Ltd
4. Graham LE and Wilcox LW (2000) Algae, Prentice Hall
5. Chen F and Jian Y (2001) Algae and their biotechnological Potential, Kluwer Academic Publ.
6. Chapman VJ and DJ Chapman (1980) Seaweeds and their uses, Methuen and Co Ltd
7. Jefford CW, KL Rinehart and LS Shield (1988) Pharmaceuticals and the Se, Technomic Publ.
8. Riley JP and Skirrow G (1975) Chemical Oceanography Vol IV, Academic Press.

Teaching & Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) Internal Tests of maximum 20 marks Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present inthe seminar - Maximum marks 10 Write a detailed report on a given topic based on research findings and literature search – 10 marks

	Semester End examination – 60 marks

MAHATMA GANDHI UNIVERSITY

PLM21C15 - Laboratory course 2

School Name	National Institute of Plant Science Technology(NIPST)					
Programme	Msc Botany & Plant Science Technology					
Course Name	**Laboratory course 2**					
Type of Course	Core					
Course Code	**PLM21C15**					
Course Summary & Justification	This practical course will helps the students to identify the basic structures of algae ,bryophytes and pteridophytes.Angiosperm taxonomy practicals will helps the students to identify the familial characteristics of each plant family.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg: Authentic learning Collaborative learning Independent learning	5	5	50		60
Pre-requisite	**Knowledge in Botany at Graduate level**					

COURSE OUTCOMES (CO)

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will get an experience in the field collection of algae.	S	2,3

2	Will get knowledge for the Angiosperm family identification	U/A	2		
3	Students will able to distinguish the basic structures of Bryopyhytes ,pteridophytes and gymnosperms	S/A	2, 3		
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),Interest (I) and Appreciation (Ap)					
COURSE CONTENT					
Module No	**Module Content**	**Hours**	**CO No.**	**PSO**	**PO**
1.	1. Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts 2. Field collection of algal specimens. **3.** Isolation and monoculture of algae**.**	15	1	2,3	2,1
2	**Bryology :** Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation: *Riccia, Targionia, Cyathodium, Marchantia, Lunularia, Dumortiera, Reboulia, Pallavicinia, Aneura, Fossombronia, Porella, Anthoceros, Notothylas, Sphagnum, Pogonatum.* ents are expected to submit a report of field collection of bryophytes to familiarize with the natural habitat and diversity of Bryophytes in the region. **Pteridology :** Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera: *Psilotum, Lycopodium, Isoetes, Selaginella, Equisetum, Angiopteris, Ophioglossum, Osmunda Marsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia, Pteris, Adiantum, Polypodium and Asplenium;* Study of fossil Pteridophytes with the help of specimens and permanent slides **Gymnosperm :** 1. Study of the morphology and anatomy of vegetative and reproductive parts of Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria and Gnetum. 2. Study of fossil gymnosperms through specimens and	15	3	2,3	5,7,8

	permanent slides. 3. Conduct field trips to familiarise various gymnosperms in nature and field identification of Indian gymnosperms and submit a report.				
3	**Mycology** Critical study of the following fungal species by preparing suitable micro-preparations; *Saprolegnia, Phytophthora, Albugo, Mucor, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Puccinia, Pleurotus, Auricularia, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Graphis, Parmelia,Cladonia, Usnea.* Isolation of fungi from soil and water by culture plate technique. Estimation of mycorrhizal colonization in root. Collection and identification of common field mushrooms (5 types). **Lichens** y of thallus and reproductive structures of different lichens. **Plant Pathology** rbarium specimens of bacterial diseases, Viral diseases and Fungal diseases.	15	3	2,3	5,7, 8
4	**Taxonomy Practical** 1. In the laboratory record, each family should be represented by a minimum of two different species with suitable sketches and description in technical terms. 2. Identification of taxa down to the species rank using the keys presented in the Flora of the Presidency of Madras. 3. Preparation of dichotomous keys based on 4 randomly chosen specimens belonging to different taxa. 4. Students should familiarize with most of the economically and ethnobotanically important plants	15	2	2	3,6, 10

	belonging to families prescribed in the syllabus.				
	Total Credts	**4**			
References **1.** Stein JR (1978) Hand Book of Phycological Methods Vol I & Vol II, Cambridge University Press **2. George MG Edited (2001) Bergey's manual of systematic bacteriology, Springer** **3. Benson HJ (2012) Benson's microbiological applications : laboratory manual in general microbiology, McGraw-Hill** **4.** Nair LN (2010), Methods of microbial and plant biotechnology, New Central Book agency					

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks **B. Semester End Practical examination – 60 marks**

THIRD SEMESTER

THIRD SEMESTER SCHEME

PLM21C16	Molecular Biology &Genetic Engineering	3
PLM21C17	Plant Physiology & Biophysics	3
PLM21C18	Anatomy, Embryology and Developmental Biology of Plants	3
PLM21C19	Genetics, Plant Breeding, Tissue culture, Evolution	3
	Open Course	4
PLM21C20	Laboratory course 3	3
PLM21C21	Laboratory course 4	3

MAHATMA GANDHI UNIVERSITY

PLM21C16: - Molecular Biology & Genetic Engineering

SchoolName	National Institute of Plant Science Technology (NIPST)					
Programme	M.Sc. Botany and Plant Science Technology					
Course Name	**Molecular Biology & Genetic Engineering**					
Type of Course	Core					
Course Code	**PLM21C16**					
Course Summary & Justification	1. Molecular Biology and Genetic Engineering is one of the most dynamic and attractive courses in all branches of applied life sciences 2. The syllabus content in this paper is designed with an objective to train the students in both theoretical and practical aspects of the subject s will also enable the students to get an idea about the latest developments taking place in this subject					
Semester	Third					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of cell and molecular biology, Basics of tools and techniques of genetic engineering					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Completing this course the students will be able to Explain the processes of replication, transcription and translation and analyse the importance of these processes in health and disease	E	1
2.	Explain the concepts of gene regulation in prokaryotes and RNA world	R/ E	1
3.	Analyse the use of different tools and techniques of gene cloning in E coli and explain the applications of DNA technology	U	3

4.	Ability to develop a protocol for cloning a gene from a selected organism	A	4
5.	Ability to explain verbally and orally the concepts of molecular biology and genetic engineering	E	2
6.	Ability to write a research proposal based on the concepts discussed in the course	An/ C	5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Introduction to molecular Biology:** History and scope of molecular biology- Historical developments of molecular biology; Nucleic acids as genetic material- Organization of eukaryotic genome- components of eukaryotic chromatin- chromatin and chromosome structure- DNA-super coiling - DNA replication- Prokaryotic and eukaryotic DNA replication- Enzymes and necessary proteins in DNA replication-Telomeres, telomerase and role of telomerase in aging and cancer- Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases- general and specific transcription factors- regulatory elements- mechanism of transcription regulation- Transcription termination Post transcriptional modifications-Translation- Genetic code- Prokaryotic and eukaryotic translational machinery – cell signalling, cell communication and protein trafficking. Molecular basis of mutations- DNA repair mechanisms.	10	1	1,4	2,3
2	**Genomes, Vectors and recombinant DNA technology:** The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast- Gene transfer in microorganisms; DNA sequencing; DNA modifying enzymes and vectors- types of vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplifications, Molecular markers and their applications; Molecular tools for the detection of plant pathogens. Molecular probes- Different molecular methods for the identification of pathogens. Molecular Biology of disease resistance and plant microbial interactions. Gene-for-gene	20	2	1,2,3	1,3

	interaction - quorum sensing; Genomics, transcriptomics and proteomics.				
3.	Isolation and purification of DNA (genomic and plasmid) and RNA - Phosphodiester, phosphotriester and phosphite-triester method of DNA synthesis (Brief study only) Phosphoramidite method, automated DNA synthesis - Artificial genome synthesis -Procedure of cDNA synthesis, reverse transcriptase PCR. **Modern cloning vectors:** M13, pUC, artificial chromosomes – YAC, BAC, PAC, HAC – important features, construction and applications of each. **Gene library** Genomic and cDNA library - Procedure for the construction of a genomic library using phage λ system - Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing, immunological screening. Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping. **Gene therapy:** Approaches to gene therapy - somatic cell and germline therapy, vectors used in gene therapy - *In vivo* and *ex vivo* therapy , Problems and fears associated with gene therapy	10	3,4	1,4	2,3
4	**Plant transformation and advanced transgenic technology:** *(a) Agrobacterium tumefaciens* mediated gene transfer in plants - details of vector system based on *A.tumefaciens*, binary vector and cointegrate vector - Steps involved in *Agrobacterium* mediated gene transfer to plants (b) Plant transformation by direct transfer of DNA (Vectorless methods) - microprojectiles, electroporation, microinjection, chemica, lipofection (c) Details of the creation of Bt plants, Golden rice, *Flavr Savr* Tomato. **Advanced transgenic technology -** Inducible expression systems – examples, site-specific recombination for *in vivo* gene manipulation, gene targeting, gene silencing using antisense RNA and RNAi. *In vitro* mutagenesis - site-directed mutagenesis.	10	5	3,4	3,4,5
5	**Protein engineering and Biosensors** Applications of protein engineering, protein modification by site-directed mutagenesis - combinatorial methods. **Biosensors: Design** and operation, types. Applications - medical, food and agriculture, industrial, pollution monitoring. GMOs as biosensors. **Applications of rDNA technology:** Uses of GM microbes: Bacteria and yeast - producing useful proteins, basic genetic research, Applications of GM animals in basic research, producing novel proteins; disease studies, prevention and cure of diseases Uses of transgenic plants:	10	6	4,5	1,2,8

	Herbicide, insect and disease resistance, stress resistance. Genetic engineering for increasing nutritional and other novel qualities in plants.		
	Total Credits	**3**	

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

Lewin B (2007) Genes IX, Jones & Bartlet

Malacinski GM and Freifelder D (1998) Essentials of Molecular Biology 3rd Edition, Jones & Bartlett Publishers.

Primrose SB (2001) Molecular Biotechnology, 2nd edition, Wiley & Blackwell

Watson JD et al (2008) Molecular Biology of the Gene 6th Edition, Pearson Education International

Further Reading:

Jocelyn EK et al (2012) Lewin's Genes XI, 11th Edition, Jones and Barlett Pub., USA

Robert F Weaver (2011) Molecular Biology, 5th Edition, McGraw-Hill.

Gurr SJ et al(1998) Molecular Plant Pathology, Oxford University Press

Chrispeels MJ and DE Sadava (2003) Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers

Marshell G and D Walters(1996) Molecular Biology in Crop Protection, Kluwer Academic Publishers
. Lodish H et al (2012) Molecular Cell Biology, 7th Edition, WH Freeman & Co

MAHATMA GANDHI UNIVERSITY

PLM21C17: - Plant Physiology & Biophysics

School Name	**National Institute of Plant Science Technology (NIPST)**					
Programme	**Msc Botany and Plant Science Technology**					
Course Name	**Plant Physiology & Biophysics**					
Type of Course	Core					
Course Code	**PLM21C17**					
Course Summary & Justification	1. Plant physiology is the study of plant function and behaviour, encompassing all the dynamic processes of growth, metabolism, reproduction, defence, and communication that account for plants being alive. 2. Plant physiology is the first and foremost line of defense and medium of interaction with the environmental and climatic conditions. 3. Biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. 4. Biophysics covers all scales of biological organization, from molecular to organismic and populations.					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of plant morphology and systems Basics in biological instrumrnt					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	dents will be able to understand internal activity of plants.	U	1
2	alys eke physical and chemical processes in plants	An	2
3	dents can develop strategies to enhance crop agriculture	S/A	4

4	dents can evaluate how plants convert the light energy into molecules and make research proposals on improving plant yield	E/C	3
5	e study of plants at molecular level helps to understand phenomena and create experiments to develop stress tolerant plant varities	C/I	3
6	Students can pursue research on increasing the productivity of plants	Ap	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**DNA Rr Water and ionic relations in Plant life:** The Physical and Chemical Attributes of water which qualify it as the "Solvent of life" (Intermolecular hydrogen bonds, high specific heat capacity, high latent heat of vaporization, tensile strength cohesion, adhesion, and capillarity), Quantitative study of diffusion, osmosis and bulk flow. Concept of water potential (ψ_w) ; its derivation from the chemical potential of water (μ_w); and its components (ψ_s, ψ_p,ψ_m, and ψ_g), Uptake and translocation of water through the soil-plant –atmosphere continuum. Apoplast, Symplast and transmembrane pathways Root Pressure, Cohesion- Tension theory, Cavitation and Embolism. **Membrane Transport:** Components of plant cell membrane transport systems-Pumps, Channels and cotransporters, A detailed study of transmembrane electrochemical potential. **ATP ases -** F-type, PMH^+-, and H^+-PPase. **Ion channels -** K^+ - and Ca^{2+} channels. Water transport through aquaporins.	10	1	1	1,3
2	**Intermediary metabolism:** A comprehensive study of the given primary metabolic pathways without compromising biochemical and biophysical aspects: Gluconeogenesis in plants, Biosynthesis of fatty acids, triacylglycerols and plant cell membrane lipids. **Aerobic respiration –** glycolysis, oxidative decarboxylation of pyruvate. Citric acid cycle, plant mitochondrial electron transfer and ATP synthesis. **Photo synthesis -** General concepts, Key experiments in understanding photosynthesis, Organization of photosynthetic Apparatus and light-Absorbing Antenna Systems, Mechanisms of electron and proton transport	15	1,2	1,2	2,3

	(chemiosmotic hypothesis) and ATP synthesis in chloroplasts Calvin-Benson Cycle. C_2 Oxidative photosynthetic carbon cycle, C_4 Carbon cycle and crassulacean Acid Metabolism (CAM). Accumulation and partitioning of photosynthates, formation and mobilization of starch in chloroplasts, Sucrose biosynthesis. **Nucleic acid metabolism:** Biosyntheses of purines and pyrimidines. **Nitrogen metabolism:** Nitrate and Ammonium assimilation; GS-GOGAT pathway; and Aminoacid biosynthesis. **Sulphate assimilation:** reduction of sulphate to cysteine; synthesisof methionine from cysteine.				
3.	**Terpenoids** - Definition, classification and their important ecological roles in plants, biosynthesis of IPP and DMAPP via mevalonate pathway, Cyanogenic glycosides and their role as plant defence compounds, Glucosinolates (a brief account). **Alkaloids** - History of human use of alkaloids, role of physiologically active alkaloids in plant chemical defences (Examples to bediscussed must include Vincristine, Strychnine, Quinine, Nicotine, Morphine, Coniine, Codeine, Cocaine, Caffeine,Atropine Hyoscyamine, and Ajmaline. **phenolic compounds:** Definition, classification and evolution of phenolics, benefits of phenolics to humans, Phenyl propanoidand phenyl propanoid acetate pathways. **Phyytoalexins –** Their structural and functional characteristics.	10	4,5	3	3,5
4	**Plant hormones:** Biosynthesis, storage, breakdown and transport of phytohormones; their physiological effects and mechanisms of action. Seed development and germination. **Phototo-morphogenesis:** photo-receptors, phytochrome. **Physiology of flowering:** photoperiodism and vernalization. **Biotic stress:** Physiological and biochemical perturbations caused water deficit, flooding, salinity, high temperature and freezing. HSPs, ROS, compatible solutes and antioxidative enzymes – SOD, Ascorbate peroxidise, Catalase and Glutathione peroxidise.	20	3	4	3,6
5	Principles of microscopy – Types of microscopes - simple and compound; Stereomicroscope, Phase contrast microscope, Fluorescence microscope, Polarization microscope, confocal microscope and electron microscope (TEM & SEM). Specimen preparation for transmission electron microscopy: Material collection, fixing, dehydration, embedding, sectioning (glass knife preparation, grid preparation, ultra-microtome) and	5	6	4	3,7

	staining Micrometry; Photomicrography and microphotography. **Spectroscopy** – electromagnetic spectrum – spectrophotometry – uv-spectrophotometers – colourimetry – IR – NMR – X-Ray Diffraction.**Instrumentation for Separations** (1) Centrifuges (Table top centrifuge and ultra centrifuge) (2) Chromatography: Principles and application; paper, TLC, Column chromatography, GC, HPLC (3) Electrophoresis - AGE- SDS PAGE.		
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Fritz N & Noggle R (1987) Introductory Plant Physiology, Prentice Hall
2. Sharma PD (2002) Plant Physiology
3. WG Hopkins and NPA Huner (2009) Introduction to PlantPhysiology, Wiley
4. Taiz L and E Zeiger (2010) Plant Physiology, Sinauer Associates
5. Nilsen ET and DM Orcutt (1996) The Physiology of Plants Under Stress - Abiotic Factors, wiley
6. Peter Scott (2008) Physiology and Behaviour of Plants,Wiley-Blackwell

Further Reading:

1. Holbrook M N and M Zwieniecki (2005)Vascular Transport in Plants, Academic Press
2. Dey PM and JB Harborne(1997)Plant Biochemistry, Academic Press
3. Heldt H and B Piechulla (2010) Plant Biochemistry, Academic Press
4. Gleason F and Chollet R(2011)Plant Biochemistry, Jones and Bartlett Publishers
5. Wilson and Walker (2000)Principles and Techniques of Practical Biochemistry, Cambridge
6. David T Plummer (2008) An Introduction to Practical Biochemistry, TATA McGraw Hill.

7. Sopory AP et al (2010) Abiotic stress Adaptation in Plants-Physiological, Molecular and Genomic Foundation, Springer
8. David S. Seigler (1998), Plant Secondary Metabolism, Springer

MAHATMA GANDHI UNIVERSITY

PLM21C18: - Anatomy, Embryology and Developmental Biology of Plants

SchoolName	**National Institute of Plant Science Technology (NIPST)**					
Programme	**M.Sc. Botany and Plant Science Technology**					
Course Name	**Anatomy, Embryology and Developmental Biology of Plants**					
Type of Course	Core					
Course Code	**PLM21C18**					
Course Summary & Justification	As a part of botany (the study of plants), plant anatomy focuses on the structural or body parts and systems that make up a plant. In a broader sense, plant embryology studies not only embryonic development but also the formation of the generative sphere, the formation of sex cells in the generative sphere, and fertilization. Microtechniques involves the methods and procedures used to study the structure, vital activity, d evelopment, chemical composition, and physical properties of cells, tis sues, and organs by means of optical microscopes.					
Semester	Third					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding of different parts of plants, how to use a microscope					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Studying plant anatomy allows a student to conceptually integrate organismal structure and function	U/A	1
2	This study helps students to reveal relationships between structure, function, taxonomy, ecology and developmental genetics	A	3

3	Students will be able to evaluate on the genetics of vascular plant development	E	2
4	Students will be able to prepare specimens both temporary and permanent for microscopic examinations	S/C	2
5	Students will develop knowledge in microscopic techniques	A/I	2
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	Scope and significance of plant anatomy, interdisciplinary relations – history of the studies. Applications of anatomy in systematics (histotaxonomy) and Pharmacognosy. Stages of development of primary meristem and theories of apical organization, origin of branches and lateral roots – root-stem transition - primary thickening meristem (PTM) in monocots. Reproductive apex in angiosperms. **Secondary growth in plants:** (a) Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity (b) Secondary xylem and phloem: Ontogeny, structure and function. Lignification patterns of xylem (c) Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation (d) Anomalous secondary growth in dicots and monocots (e) Wood: Physical, chemical and mechanical properties (f) Plant fibers: Distribution, structure and commercial importance of coir, jute, and cotton.	17	1	1	8
2	**Leaf, Node, Floral, Fruit and Seed anatomy:** (a) Leaf: Initiation, plastochronic changes, ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Krantz anatomy, anatomical peculiarities in CAM plants. Leaf abscission (b) Nodal anatomy: Unilacunar, trilacunar and multilacunar nodes, nodal evolution. **Ecological anatomy and Applied anatomy** Morphological and structural adaptations in different ecological groups - hydrophytes, xerophytes, epiphytes and halophytes. Secretory tissues in plants: Structure and distribution of secretory trichomes (*Drocera, Nepenthes*), salt glands, colleters, nectaries, resin	13	1	1	3,7

	ducts and laticifers. Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis.*				
3.	Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development. Sporogenesis and Gametogenesis - Embryo sac development and double fertilization in plants; embryogenesis, establishment of symmetry in plants; seed formation and germination. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development (ABC Model) in *Arabidopsis* and *Antirrhinum*- Programmed cell death, aging and senescence.	11	1,3	2,3	3,5,10
4	Principles and techniques of killing and fixing; properties of reagents, fixation images; properties and composition of important fixatives - Carnoy's Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle-Erliki fluid,Dehydration, clearing, embedding and sectioning (a) Dehydration: Principles of dehydration, properties and uses of important dehydrating and clearing agents - alcohols, acetone, xylol, glycerol, chloroform, dioxan. Dehydration Methods: (i) Tertiary-butyl alcohol method (ii) Alcohol-xylol method. (b) Embedding: Paraffin embedding. (c) Sectioning: Free hand sections – Prospects and problems; Sectioning in rotary microtome - sledge microtome and cryotome. **Staining**: (a) Principles of staining; classification of stains, protocol for preparation of; (i) Natural stains -Haematoxylin and Carmine (ii) Coal tar dyes – Fast green, Orange G, Safranine, Crystal violet, Cotton Blue and Oil Red O. (b) Techniques of staining: (i) Single staining; Staining with Safranine or crystal violet (ii) Double staining; Safranine-Fast green method, Safranine-Crystal violet method (iii) Triple staining; Safranine-Crystal violet-Orange G	11	4	2	2,4,9

	method. (c) Histochemical localization of starch, protein, lipid and lignin.				
5	Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method. Staining of whole mount materials (haematoxylin, fast green or Safranine-fast green combination) Significance of whole mounts (b) Techniques of smear, squash and maceration. (c) Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerine jelly and Lactophenol. Cleaning, labeling and storage of slides	8	3,4	2	7,6
	Total Credits of the Course	3			

Books for Reference

Compulsory Reading:

1. Fahn (1982) Plant Anatomy, John Willey
2. Eames AJ and Mc Daniels LH (1994) An Introduction of Plant Anatomy.Tata Mc. Graw Hill Company Limited
3. Edred J & Henry C (1976) The seeds of dicotyledons (vol. I, II), Cambridge University Press
4. Ella Werker (1997) Seed Anatomy, Borntreager
5. Johanson DA (1940) Plant microtechnique, McGraw Hill co.
6. John E Sass (1967), Botanical Microtechnique, Oxford IBH Publ. Company.

Gray (1964) Handbook of Basic Microtechnique, McGraw Hill co.

Further Reading:

1. Elizabeth G Cutter (1978) Plant anatomy part I & II, Clive and Arnald Ltd
2. Elizabeth G Cutter (1978), Applied Plant Anatomy, Clive and Arnald Ltd
3. Esau K (1965) Vascular differentiation in plants, Rirehant and Winston, Inc.
4. Esau K (1977) Anatomy of seed plants, Wiley and sons.
5. Fahn A (1997) Plant anatomy, Aditya Publishers.
6. Chowdhuri () Edited; Indian woods (6 volumes). Forest research institute, Dehradun
7. Ingrid Roth (1977) Fruits of Angiosperm, Gebruder Borntreager
8. Metcalf C R, Chalk L (1983) Anatomy of the dicotyledons: Wood structureand conclusion of the general introduction, Oxford University press
9. Prasad MK, M Krishna Prasad (1983), Outlines of Microtechnique. Emkay Publications.
10. Geoffrey AM (1976) Practical electron microscopy, John Willey and sons.
11. Krishnamurthy KV (1987) Methods in Plant Histochemistry, S Viswanathanprinters, Anand

book depot, Madras.

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **B. Semester End examination – 60 marks**

MAHATMA GANDHI UNIVERSITY

PLM21C19: - Genetics, Plant Breeding, Tissue culture & Evolution

SchoolName	**National Institute of Plant Science Technology (NIPST)**
Programme	**MSc Botany and Plant Science Technology**
Course Name	**Genetics, Plant Breeding, Tissue culture & Evolution**
Type of Course	Core
Course Code	**PLM21C19**
Course Summary & Justification	Genetics is the scientific study of genes and heredity—of how certain qualities or traits are passed from parents to offspring as a result of changes in DNA sequence. Plant breeding is the science driven creative process of developing new plant varieties that goes by various names including cultivar development, crop improvement, and seed improvement. Breeding involves the creation of multi-generation genetically diverse populations on which human selection is practiced to create adapted plants with new combinations of specific desirable traits. Tissue culture (TC) is the cultivation of plant cells, tissues, or organs on specially formulated nutrient media. Under the right conditions, an entire plant can be regenerated from a single cell. In biology, evolution is the change in the characteristics of a species over several generations and relies on the process of natural selection. Evolution relies on there being genetic variation in a population which affects the physical characteristics (phenotype) of an organism.
Semester	Third

Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120

Pre-requisite	**Basics of** DNA structure, cells and tissues

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**

1	Students will have understanding about genes and will be able to compare genomes of different species and uncover similarities and differences	U/An	1
2	Students will be able to explain the occurrence of certain diseases in a family by pedigree analysis	A	2
3	Plant breeding studies will help students to obtain work in fields, forest, greenhouses etc	S	3
4	Students will be able to pursue research on developing and propagating various tissue culture plants	Ap/I	4
5	Students can explain the striking similarities among vastly different forms of life, the changes that occur within populations, and the development of new life forms	E	4
6	To learn about the process of scientific inquiry	U/I	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	History of Genetics; Mendelian principles; Non-Mendelian Gene interactions, Multiple alleles, maternal influence - penintrance and gene expressions - cytoplasmic inheritance - Chromosomal theory of inheritance - Linkage- Linkage maping and gene maping; Mechanisms of sex determination; Sex-linked, sex-influenced and sex-limited traits; Intergenic and intragenic complementation and recombination of genome; Mutations. Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Concepts of eugenics, epigenetics, Genetic disorders and behavioural genetics.	10	1,2	1,2	1,2, 3
2	Introduction to plant breeding: History, objectives, potential achievements and opportunities. Plant genetic resources: Importance of plant genetic resources and diversity in plant breeding, collection, evaluation and conservation of germplasm. Breeding methods for self and cross pollinated crops and asexually propagated crops; Heterosis breeding; Aspects of molecular breeding. Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; male-sterility and self incompatibility; Inbreeding depression; Land races, pure line selection and mass selection; Pedigree selection, bulk method and its modification; Hybrid breeding, Clonal selection. Mutation breeding: use of polyploidy and distant hybridization in plant breeding; Release and registration of new varieties, quality seed - classes, production practices and maintenance of pure seed,	10	3	3	3,4

	seed purity standards – terminator seeds and the impact.				
3.	History of plant cell and tissue culture; Tissue culture conditions and culture media; various types of tissue cultures; *in vitro* differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation. Micro propagation; Anther and microspore culture; Somaclonal variation; *in vitro* mutagenesis; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds. Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids. Applications of plant tissue culture in plant breeding and crop improvements.	20	4	4	3,5
4	Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin - Haldane, Miller-Urey Experiments - The RNA world - Idea of Panspermia - The First Cell - Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Anaerobic metabolism - origin of photosynthesis and aerobic metabolism. Geological Timescale, Major events in evolutionary timescale. Anthropocene. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilization and its significancePre-Darwanian, Lamarck, Darwin and Wallace - Post Darwanian theories of evolution. Concepts of variation, adaptation, struggle, fitness and natural selection - spontaneity of mutation and the evolutionary synthesis. Neutral Evolution, Molecular Evolution - Neutralist versus Selectionist - Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium), Rose Mary and Peter Grant (Molecular evolution in Darwinian finches); Debates in evolutionary biology; Primate Evolution and Human Origins, Stages in Primate evolution - Prosimii, Anthropoidea and Hominids; Factors in human origin, hominid fossils; Cytogenetic and molecular basis of origin of man - African origin of modern man - Mitochondrial Eve, Y chromosomal Adam, early migration, hunter- gatherer societies - Evolution of human brain-communication, speech and language - Evolution of culture.	10	5	4	6,7
5	Gene pool, gene frequency, Hardy-Weinberg Law - Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect - Isolating mechanisms and speciation - Micro, Macro and Mega evolution. Co-evolution, Developmental and Evolutionary Genetics; The idea of Evo-Devo, Heterochrony, Heterotopy, Heterometry and	10	6	5	9,10

	Heterotypy. Developmental genes and gene co-option. Evolution of plasticity and complexity. Evolution of sex, Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, QTL mapping, genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity.		
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Griffiths AJF et al (1996) An Introduction to Genetic Analysis 6th Edition, W.H. Freeman, New York.
2. Jain HK (1999) Genetics - Principles, Concepts and Implications. Oxford and 1BH Publishing
   Co. Pvt. Ltd., New Delhi.
3. Bhojwani SS (1983) Plant Tissue Culture: Theory and Practice. Elsevier
4. Christou P & Klee H (2004) Handbook of Plant Biotechnology. John Wiley & Sons
5. Dixon RA (2003) Plant Cell Culture, IRL Press.
6. Allard RW (1960) Principles of Plant Breeding. John Wiley & Sons, New York.
7. Arthur W (2011) Evolution – A Developmental Approach.Wiley-Blackwell, Oxford,UK
8. Camilo J C and Francisco JA (2007) Human Evolution-Trails from the Past, Oxford University Press
9. Campbell BG (2009) Human Evolution, Transaction Publishers, NJ, USA

Further Reading:

1. George EFet al (2008) Plant Propagation by Tissue Culture, Agritech Publ.
2. Gupta PK (2004) Biotechnology and Genomics, Rastogi Publ
3. Herman EB (2008) Media and Techniques for Growth, Regeneration and Storage. Agritech Publ
4. Pena L (2004) Transgenic Plants: Methods and Protocols. Humana Press
5. Pierik RLM (1997) In vitro Culture of Higher Plants, Kluwer
6. Singh BD (2007) Biotechnology: Expanding Horiozon. Kalyani.
7. Rana RS et al Edited (1994) Plant Genetic Resources: Exploration, Evaluation and Maintenance, NBPGR, New Delhi.
8. Charles WF and Janson BW (2006) Evolutionary Genetics-Concepts and Case Studies, Oxford University Press, NY. USA
9. Carroll SB (2005) Endless Forms Most Beautiful: The New Science of Evo-Devo, WW Norton, New York
10. Cleveland PH Jr, Larry SR and Allan L (2011) Integrated Principles of Zoology(11^{th} edn.), McGraw-Hill, NY, USA.
11. Dan G and Li WH (2000) Fundamentals of Molecular Evolution 2^{nd} edn., Sinauer Associates Inc.MA, USA
12. Elliott S (2008) Evidences and Evolution: The Logic Behind the Science, Cambridge University Press, UK.
13. Futuyma DJ (1986) Evolutionary Biology (2^{nd} edn.) Sinauer Associates Inc. MA, USA
14. Gould SJ (2002) The Structure of Evolutionary Theory, Harvard University Press, MA, USA
15. Hall BK and Hallgrimsson B (2008) Strickberger's Evolution (4^{th}edn), Jones and Bartlett Pub, London, UK.
16. Hall BK and Olsen WM (Ed) (2007) Keywords and Concepts in Evolutionary Developmental Biology. Discovery Publishing House, New Delhi
17. Kimura M (1983) The neutral theory of molecular evolution, Cambridge University Press

MAHATMA GANDHI UNIVERSITY

PLM21C20: Laboratory course 3

SchoolName	**National Institute of Plant Science Technology (NIPST)**					
Programme	**MSc. Botany and Plant Science Technology**					
Course Name	**Laboratory course 3**					
Type of Course	Core					
Course Code	**PLM21C20**					
Course Summary & Justification	The course is intended to provide experience to students in handling protein and DNA, its isolation, quantification and separation using electrophoresis. Also, the course focusses on the technique of PCR technology and proposes a training in PCR technique to equip the students for the present demand in the modern diagnostic methods.					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	50		60
Pre-requisites	Theoretical knowledge in molecular biology and genetic engineering Basic laboratory skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	On completing the course, the students will be able to isolate nucleic acids and proteins from tissues/microorganisms	A	2,3
2	On completing the course, the students will be able to evaluate quantity and quality of nucleic acids	S	3
3	The students will be able to conduct PAGE and will be able to separate proteins using PAGE	S/E	3
4	e students will be able to amplify a DNA fragment selectively using the PCRtechnique	S/E	2,3,4

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	Plasmid DNA extraction from bacteria and its quantification by using UV spectrophotometer. Genomic DNA isolation from plant cell, chloroplast and mitochondria. Agarose gel Electrophoresis and elution of DNA.	20	1	2, 3	1, 3
2	Isolation of plasmids and its purification Restriction enzyme digestion, ligation, transformation and screening of transformants. Restriction mapping of genomic and plasmid DNA. Bacterial transformation Extraction and quantification of protein by Bradford method. SDS-PAGE analysis, Western Blot analysis, PCR.	20	1,2,5	2, 3	2, 3
3.	Estimation of total proteins – Lowry's methods. Estimation of total phenols Estimation of Proline Identification of CAM plants Determination of Hill activity Absorption spectra and quantification of total chlorophyll and carotenoids in 5 plant species.	10	1,3	2, 3	3, 4
4.	1. Micrometry - Calibrate the ocular micrometer stage micrometer on a light microscope and measure the size of an object (e.g., diameter of spore/pollen grains, width of algal filaments). 2. Separation – using Centrifuge/Chromatography. 3. Spectrophotometric and colourimetric estimations – estimation of nitrogen and phosphorus in soils/plant tissues. 4. Separation Techniques: separation of amino acids by paper chromatography; Separation of amino acids/lipids/sugars/plant pigments by TLC; Separation of plant pigments by column chromatography.	10	1,2	2,3	5,6
	Total Credits of the Course	3			

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks **B. Semester End Practical examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Molecular cloning by Sambrook , Fritsch and Maniatis, Cold Spring harbour laboratories
2. Biochemical Methods Sadasivam and Manickam
3. Gel electrophoresis of proteins : A practical approach(second edition)B D H Ames and Rickwood D(eds) Oxford University press
4. Practical skills in Biomolecular Sciences, Weyers Jonathan, Reed Rob, Jones Allen, Holmes A D, Pearson publications

Further Reading:

MAHATMA GANDHI UNIVERSITY

PLM21C21: Laboratory course 4

SchoolName	**National Institute of Plant Science Technology (NIPST)**					
Programme	**MSc. Botany and Plant Science Technology**					
Course Name	**Laboratory course 4**					
Type of Course	Core					
Course Code	**PLM21C21**					
Course Summary & Justification	The course is intended to provide experience to students in handling specimen preparation of plant parts, prepare temporary and permanent slides, basic techniques of plant breeding. General techniques for tissue culture will also be learned by students					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	50		60
Pre-requisites	Theoretical knowledge in plant morphology. Basic laboratory skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	On completing the course, the students will be able to perform basic tissue culture practices in laboratory	A	1
2	On completing the course, the students will be able to perform different methods of plant breeding on live plants	S	2
3	The students will be able to solve problems in genetics	S/E	3
4	e students will be able to prepare temporary and permanent slides of plant tissues.	S/E	2

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	Study the anomalous primary and secondary features in, *Amaranthus, Boerhaavia,Mirabilis*, *Nyctanthes*, *Piper* and *Strychnos.* 2. Study of stomata, trichomes, and laticifers - Determination of stomatal index. 3. Study the anatomical peculiarities of C4 and CAM plants (Leaf/Stem). 4. Study of nodal patterns. 5. Preparation of histotaxonomic key. 6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem)	20	2	2	1,2
2	Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous. 2. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs). 3. Study of pollen morphology. 4. Pollen germination study. 5. Embryo excision from young seeds.	20	2	2	3,4
3.	Preparation of semi permanent slides (b) Preparation of permanent slides (c) Preparation of whole mounts (d) Maceration (e) Preparation of fixatives (FAA, Carnoys'fluid) (f) Preparation of dehydration series (Alcohol, Acetone, TBA) (g) Preparation of paraffin blocks (h) Preparation of serial sections	20	4	2	5,6

	(i) Free hand sections (single/double stained) (j) Serial sections (single/double stained) (k) Wood sections and whole mounts				
4	Problems in Genetics – monohybrid cross, dihybrid corss, gene interactions, linkage – 2 point and 3 point cross. Floral biology in self and cross pollinating crop species; selfing and crossing techniques in major field crops. Preparation of Tissue culture media; handling and sterilization of plant material; inoculation, sub culturing and plant regeneration. Anther, pollen culture, synthetic seed preparation and embryo rescue. Suspension cultures and production of secondary metabolites. Protoplast isolation, culture and fusion.	10	1,3	1,3	7,8
	Total Credits of the Course	3	60		

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** C. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks D. **Semester End Practical examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Bhojwani SS (1983) Plant Tissue Culture: Theory and Practice. Elsevier
2. Christou P & Klee H (2004) Handbook of Plant Biotechnology. John Wiley & Sons

Further Reading:

FOURTH SEMESTER

FOURTH SEMESTER SCHEME

PLM21C22	Ecology, Conservation & Phytogeography	3
	Elective Course to be selected from the options given below	
PLM21E23	Remote Sensing of biomass and biodiversity resources*	4
PLM21E24	Horticulture*	4
PLM21E25	Entrepreneurship and Business in Biology*	4
PLM21C26	Laboratory course 5	3
PLM21C27	Major Research Project	8

MAHATMA GANDHI UNIVERSITY

PLM21C22: Ecology, Conservation & Phytogeography

SchoolName	National Institute of Plant Science Technology (NIPST)					
Programme	M.Sc. Botany and Plant Science Technology					
Course Name	**Ecology, Conservation & Phytogeography**					
Type of Course	Core					
Course Code	**PLM21C22**					
Course Summary & Justification	The course is designed to equip students in perceiving, understanding and analyzing environmental problems from an ecological perspective, and a critical analysis of the existing control measures from a holistic perspective.					
Semester	Fourth					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of biology in undergraduate level					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will be able to understand and communicate effectively the sustenance of natural biological systems on the earth	R/U/A	1
2.	They will acquire skills in explaining all kinds of interrelationships in natural biological systems	U/A	2
3.	Students will be able to explain environmental degradation and pollution as outcomes of ignorant and irresponsible human actions	U/An/Ap	5
4.	Students will be able to understand the significance of biodiversity and its conservation in the sustenance of natural ecosystems	An/Ap	4,5

5.	Overall, students will be skillful in analyzing as well as designing and maintaining of environmental sustainability of all kinds of developmental activities	R/U/A/An/ Ap	2,3
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Introduction to Ecology and the different approaches to study -** Definition, history and scope of ecology, ecology vs environmental science,inter-disciplinary nature of environmental science. **Physical environment -** Biotic and abiotic environment, their interactions. Concepts and dynamics of Ecosystems: Types – Freshwater, marine and terrestrial. Components of ecosystem, application of Law of thermodynamics, food chain, food web, trophic levels, ecological pyramids and recycling - energy flow and transaction. Productivity and Biogeochemical cycles. Development and evolution of ecosystems. Ecosystem management. **Population Ecology** Characteristics of populations- community structure and attributes, levels of species diversity and its measurement; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Nature of communities; community structure and attributes; levels of species diversity and its measurement; edge effect and ecotone. Species interactions - types of interactions, interspecific competition, herbivory, carnivory, symbiosis.	10	1	1	1,2,3
2	**logical succession** The concept, definition and reasons of succession. Classification of succession: Changes – autogenic and allogenic, primary and secondary, autotrophic and heterotrophic Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities, ecological balance and survival thresholds. **Environmental pollution** . Definition and classification b. **Water pollution -**Water quality parameters and standards, different types of pollutants and their consequences, types of water pollution, prevention and control, water shed management,	20	2,3	2,5	3,4

	waste water treatment, waste water treatment with aquatic macrophytes. c. **Air pollution -** Air quality standards and index, ambient air monitoring using high volume air sampler, types and sources of air pollutants, air pollution and human health hazards, control of air pollution d. **Noise pollution -** hazardous noise levels, sources, prevention. e. **Radioactive and thermal pollution -** Causes and hazardous effects, effective management. Concept of solid wastes and waste management strategies. **Pollution Control -** Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. Use of bioreactors in waste management **Global environmental issues -** Factors responsible for climate change, *El-Nino* and *La Nina* phenomenon and its consequences. Environmental laws, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in India.				
3.	**Concept aim and principles of conservation** Objectives, definition of biodiversity, threatened species, roles of IUC (IUCN), red data book. Conservation strategies -Principles of conservation, major approaches to management; *In-situ* and *Ex-situ* conservation, biosphere reserves, wild life sanctuaries and Nationalparks in India with special reference to Kerala, Project Tiger. **Agriculture and conservation of resources -** Novel agricultural technologies, nitrification inhibitors, wind mills for irrigation, solar energy for drawing ground water, biogas for cooking and slurry leftto be used as fertilizers. **Urbanization and Conservation –** Conservation of Physical resources. (soil, water and air), Planning for environmentally compatible human settlements, sustainable development, strategies for sustainable industrial development.	10	4	4,5	3,6
4	**Conservation and energy –** Causes of energy crisis, Conventional and Non-conventional energy sources, Development of non-polluting energy systems - Solar energy, Wind energy, energy recovery from solid wastes, Plant as a source of renewable energy. **Afforestation -** social forestry, agroforestry. **Legislations and action plans-** Wild life preservation act (1972), Indian forest conservation act (1980), United Nations Environmental Programme, Environment protection Act. International Biological	10	4	4,5	3,7

	programme (IBP), Man and Biosphere (MAB), World environment day.				
5	**Phytogeography** Definition, static and dynamic phytogeography, principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution. Climate and its interaction with living organisms - different climatic types, plant distribution and adaptation to the environment. Deserts (dry and cold) Tundra, Grassland, Savannah, Temperate forests, Tropical rain forests, Mangrove, vegetation and botanical zones of India.	10	5	2,3	3,9
	Total Credits	**3**			

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

1. APHA Standard methods for the examination of water and waste water, APHA.
2. Barbour MD et. al. (1980) Terrestrial plant ecology. The Benjamin-Cammings Pub. Com
3. Benton AH and Werner WE (1976) Field biology and Ecology, Tata McGraw Hill.
4. Dash MC (1993) Fundamentals of Ecology, Tata McGraw Hill.

5. Eldon DE, Bradley SF (1995) Environmental Science, W C Brown publications.
6. Furley PA et. al. (1983) Geography of the biosphere: An introduction to the nature, distribution and evolution of the world life zones. Butterworths
7. IUCN (2007) The 2000 IUCN red list of threatened species, IUCN, England.
8. Jain SK, Sastry ARK (1984) The Indian plant red data book. BSI, Calcutta.
9. Kormondy EJ (Ed) (1999), Concept of ecology, Prentice Hall.
10. Michael P (1984) Ecological methods of field and laboratory investigations, Tata McGraw Hill

Further Reading:

Stilling P (2011) Ecology – a Global insights and Invesigation, McGraw Hill.
Molles MC (2012) Ecology – Concepts and applications, 6th Edition, McGraw Hill.
Cain ML (2011) Ecology, 2nd Edition, Sinauer Associates.
Vodopich D (2009) Ecology – Lab Manual, McGraw Hill.
Odum EP 3rd Edition (1991) Fundamentals of ecology, Saunders and Com.
Jennifer LM (2010) The Atlas of Global Conservation, University of California Press.
Oliver SO and Daniel DC (1995) Natural Resource Conservation for a Sustainable Future, Prentice Hall.
Blanco-Canquiand Humberto**L**R (2008) Principles of Soil Conservation and Management, Springer.
Elaine RI et al (2010) Soil Biology Primer, USDA.
. Jeffrey S et al (2004) Water Auditing and Water Conservation, IWA Publ.
. Amy Vickers (2001) Water Use and conservation, Amazon Press.
. Christopher AS (2006) Alternative Energy, Political, Economical and Social Feasibility, Rowman & Littlefield, Lanham, Maryland.
. Tim F (2005) The Weather Makers: The History and Future Impact of Climate Change.
. Rajagopalan R (2015) Environmental studies-from crisis to cure, Third Edition, Oxford University Press.

MAHATMA GANDHI UNIVERSITY

PLM21E23: - Remote Sensing of biomass and biodiversity resources

School Name	**National Institute of Plant Science Technology (NIPST)**					
Programme	**Msc Botany and Plant Science Technology**					
Course Name	**Remote Sensing of biomass and biodiversity resources**					
Type of Course	Elective					
Course Code	**PLM21E23**					
Course Summary & Justification	This course provides knowledge on various biodiversity systems in nature, their interactions and functioning. Remote sensing studies show students to how are data on environment as a whole is collected on a large scale, how to classify them etc.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of ecology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To introduce students into the vast features of a new developing area	I	1
2	help students understand about the data collection from atmosphere	U	2
3	encourage students into pursuing a different career options	Ap	4

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Concepts and types of remote sensing –** evolution of remote sensing technology – stages of remote sensing – spatial data acquisition – interdisciplinary nature and relationship to other disciplines –application of remote sensing –applications over conventional methods of surveying and inventorying	10	1	1	1,2,3
2	**sic principles** – electromagnetic spectrum - characteristics of electromagnetic radiations – types of remote sensing with respect different wavelength regions – definition of radiometry – blackbody radiation – special characteristics of solar radiations – EMR interactions with earth materials – spectral signature concepts – spectral reflectance and emittance – specular reflection and non-specular reflectance – Albedo of materials – EMR interaction with vegetation, water and rocks – factors affecting spectral reflectance of materials.	17	1,2	1,2	4,3
3.	**Sensors, Platforms** and Georeferencing – aerial photographs and photogrammetry -types of sensors – passive and active sensors – imaging systems – photographic sensors – sensor resolution – thermal sensors – atmospheric sensors – platforms – principles of satellite missions – IRS, Landsat and the like – **Fundamentals of satellite image interpretation** –pre-processing of multispectral imagery – image enhancement and interpretation – digital image classification - types of imaging elements of interpretation – techniques of visual interpretation – generation of thematic maps – advance remote sensing technology –thermal imaging system – advance LASER terraiin mapping – satellite data acquisition, storage and retrieval – data formats – compression – satellite system – image display system - planimetric information from aerial photographs – overlapping of vertical photographs – geometry, scale orientation and measurements	18	2,3	2,4	5,6
4	**Applications of Remote Sensing** - Lidar Remote Sensing for Biomass Assessment - Forest Structure Retrieval from Multi-Baseline SARs - Ocean Color Remote Sensing of Phytoplankton Functional Types - Mapping Aboveground and Foliage Biomass – remote sensing of biodiversity	15	2	2	7,8
	Total Credits of the Course	4			

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. **Campbell James B (2011) Introduction to Remote Sensing, 5th edition**. **New York. The Guilford Press**
2. Congalton R and K Green (2009) **Assessing the Accuracy of Remotely Sensed Data**. 2nd edition. CRC Press
3. Maune DF ed. (2007) Digital Elevation Model Technologies and Applications: The DEM Users Manual, 2nd edition. Bethesda, MD. American Society for Photogrammetry and Remote Sensing

Further Reading:

1. McGlone JC ed. (2004) Manual of Photogrammetry, 5th edition. Bethesda, Md.: American Society for Photogrammetry and Remote Sensing
2. Wolf P and B Dewitt (2000) **Elements of Photogrammetry**, 3rd edition. Boston. McGraw-Hill.
3. **Photogrammetric Engineering and Remote Sensing ,** American Society for Photogrammetry and Remote Sensing
4. Jensen JR (2007) **Remote Sensing of the Environment - an Earth Resource Perspective** 2nd ed. Upper Saddle River, NJ, Prentice Hall

MAHATMA GANDHI UNIVERSITY

PLM21E24: - Horticulture

SchoolName	**National Institute of Plant Science Technology (NIPST)**					
Programme	**M.Sc. Botany and Plant Science Technology**					
Course Name	**Horticulture**					
Type of Course	Elective					
Course Code	**PLM21E24**					
Course Summary & Justification	This course is a branch of plant agriculture which deals with garden crops, fruits, vegetables, and ornamental plants. It deals with the development, sustainable production, marketing, and use of high-value intensively cultivated food and ornamental plants.					
Semester	Fourth					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic knowledge in biology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	ents will have working knowledge on plant species, it's characteristics and ecological impact	U/A	1
2	Students will have career options in retail management, crop inspection etc	A	2,3
3	Students will be able to self-employ	S	3,4
4	Students will be able to propose research ideas	S/C	4

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Introduction to Horticultural science:** Definition, importance and objectives of Horticulture, branches of Horticulture, Pomology, Olericulture, Landscape Gardening, Nurseries and development Allied branches; **Nursery management and ornamental gardening:** Tools and machinery used in Nursery management and ornamental gardening - different types of nursery and gardens and their essential requirements; Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Automated greenhouses, microcontrollers. Different types of propagation, seed propagations, hybrids, apomixis, polyembryony, chimeras; Factors influencing seed germination of horticultural crops, seed dormancy, hormonal regulation of germination and seedling growth. Asexual method of propagations: Cutting methods, layering methods, budding methods, grafting methods. Lawn plants - purpose of preparation of lawn, method of preparation of lawn and management of lawn and lawn plants	15	1	1	1,2
2	**Nursery Management of Fruit and Cash Crops:** Biodiversity of local fruit crops: Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit and custard apple – nursery management of these and other rare tropical fruit crops; Nursery management of Rubber, Cardamomum, Coconut and Tea	15	1,2,3	1,2,3	3,4
3.	**Post harvest technology for horticultural Crops:** Maturity indices, harvesting practices of flowers and fruits for specific market requirements – flower and fruit packaging for transport/export - influence of pre-harvest practices, enzymatic and textural changes, respiration, and transpiration. Physiology and biochemistry of fruit ripening, ethylene management, factors leading to post-harvest loss, pre-cooling - Treatments of fruits and flowers prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products; Methods of storage, packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies. Dried and dehydrated products	15	1,2,3	1,2,3	5,6

4	**Horticulture technology:** Biotechnological interventions, achievements and future thrust in the economically important garden plants and fruit crops. Green house technology and hardening of plants. Space gardens technology. Seed harvesting technology- Integrated and modern approaches in water and nutrient management in horticultural crops- Layout and construction of irrigation systems, care and their attention. Total quality management (TQM).	15	1,3,5	1,3,4	9,10
	Total Credits of the Course	4			
	Books for Reference				
Compulsory Reading: Bose TK, Mitra SK & Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops, Naya Prokash. Chadha KL and Pareek OP Edited (1996) Advances in Horticulture, Vols. IIIV, Malhotra Publishing House. Durbin R et al (1999) Biological Sequence Analysis: Probabilistic Model of Proteins and Nucleic Acids, Cambridge Univ. Press. Frankel OH and Hawkes JG (1975) Crop Genetic Resources for Today and Tomorrow, Cambridge University Press Haid NF and Salunkhe SK (1997) Post Harvest Physiology and Handling of Fruits and Vegetables, Grenada Publ.					
Further Reading: 1. Hartmann HT and Kester DE (1989) Plant Propagation – Principles and Practices, Prentice Hall of India. 2. Keshavachandran R et al (2007) Recent Trends in Biotechnology of Horticultural Crops, Vols. I- II, New India Publ. Agency 3. Pant V Nelson (1991) Green House Operation and Management, Bali Publ. 4. Peter KV and Abraham Z (2007) Biodiversity in Horticultural Crops, Vol. I, Daya Publ. House. 5. Peter KV (2008) Biodiversity of Horticultural Crops, Vol. II, Daya Publ. House. 6. Rajan S and Baby LM (2007) Propagation of Horticultural Crops, New India Publ. Agency 7. Sudheer KP and Indira V (2007) Post Harvest Technology of Horticultural Crops, New India Publ. Agenc					

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **B. Semester End examination – 60 marks**

MAHATMA GANDHI UNIVERSITY

PLM21E25: - Entrepreneurship and Business in Biology

SchoolName	**National Institute of Plant Science Technology (NIPST)**					
Programme	**MSc Botany and Plant Science Technology**					
Course Name	**Entrepreneurship and Business in Biology**					
Type of Course	Elective					
Course Code	**PLM21E25**					
Course Summary & Justification	This course enables students to introduce them into business. This course aims students to develop knowledge on how to start a business, how one can be an innovator or an entrepreneur, and what are the processes of entrepreneurship.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic knowledge of an undergraduate					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will be able to get understanding on the various steps in making a business venture.	U/An	1
2	Students will be able to convert their ideas into products with profit	A	2
3	Students will be able to develop ideas to earn profits	S	5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Entrepreneurship**: Entrepreneur - Classification of entrepreneurs - Entrepreneurial attributes and characteristics - Entrepreneurial challenges – Entrepreneurship Vs. Management. Roles and functions of entrepreneurship - Small business as seedbed of entrepreneurship - Entrepreneur competencies - Entrepreneur motivation- Performance and rewards; Role of Entrepreneurship Development Institute of India; National Institute of Entrepreneurship and Small Business.	8	1	1	1,2,3
2	**Opportunity scouting and idea generation**: Role of creativity and innovation and business research - Sources of business ideas- Entrepreneur opportunities in contemporary business environment - The process of setting up a small business in bio-based areas - Concept of project and classification of project – Identification and project formulation - Project report - Project appraisal.	15	1,2	1,2	4,5
3.	**Management – its roles and functions in a small business:** Designing of business plan, location, layout- Management principles and functions - Managing business growth - Pros and cons of alternative growth options: Internal expansion, Acquisitions and mergers, Integration and diversification - Good business management- Leadership and human relations- Leadership Vs. Management - Importance of team goals and accountability, Delegation of authority- Understanding effective communication - Effective communication in the workplace - Essential listening skills.	15	1,2	1,2	6,7
4	**Principles of double-entry book-keeping**: Journal entries- Cash-book and pass book- Bank reconciliation statement - Ledger accounts - Trial balance - Trading and profit and loss account - Balance-sheet - Single-entry system of record keeping - Sources of risk/venture capital, fixed capital, working capital and a basic awareness of financial services such as leasing and factoring.	15	1	1	8,9
5	**Issues in small business management and marketing.** Recruiting employees, the interview process, from resume vetting to the job offer, effective interviewing skills, creating performance/evaluation systems- Providing feedback - Employee termination issues - The concept and application of product lifecycle, advertising and publicity, sales and distribution management. The idea of consortium marketing,	7	2,3	2,5	10

	competitive bidding/tender marketing, negotiating with principal customers - The contemporary perspectives on infrastructure development, product and procurement reservation, marketing assistance, subsidies and other fiscal and monetary incentives. National state level and grass-root level financial and non-financial institutions in support of small business development.			
	Total Credits of the Course	4		

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks **B. Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Brandt S C (1977): The 10 Commandments for Building a Growth Company, Third Edition, Macmillan Business Books, Delhi.
2. Bhide AV (2000): The Origin and Evolution of New Business, Oxford University Press, New York.
3. Dollinger M J (2006): Entrepreneurship Strategies and Resources', 3rd edition, Pearson Education, New Delhi.
4. Desai V (2004): Management of Small Scale Enterprises, Himalaya Publishing House, New Delhi.
5. Taneja G (2010): Entrepreneur Development New Venture Creation, 2nd ed. Galgotia Publishing Company.

Further Reading:

1. Holt D H (1955): Entrepreneurship: Strategies and Resources, Illinois, Irwin.
2. Panda S C (2008): Entrepreneurship Development, New Delhi, Anmol Publications.
3. Patel V G (1995): The Seven Business Crises and How to Beat Them, Tata-Mcgraw, New Delhi.
4. SIDBI Report on Small Scale Industries Sector [latest edition]
5. Verma J C and Gurpal Singh (2002): Small Business and Industry-A Handbook for Entrepreneurs, Sage, New Delhi.
6. Desai V: Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, Mumbai.
7. Louis A Allen: Management and Organization, McGrawHill, New York.
8. Antony R N: Management Accounting, Taraprewalla, Mumbai.

MAHATMA GANDHI UNIVERSITY

PLM21C26: Laboratory course 5

SchoolName	**National Institute of Plant Science Technology (NIPST)**					
Programme	**MSc. Botany and Plant Science Technology**					
Course Name	**Laboratory course 5**					
Type of Course	Core					
Course Code	**PLM21C26**					
Course Summary & Justification	This course enables students to gain knowledge about how to test the various physiological aspects of water and soil.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	50		60
Pre-requisites	Theoretical knowledge in ecology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will be able to test the various physiological aspects of water and soil	A/U	1,2,3
2	ents will be able to give awareness on ecological conservation methods	S	4,5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Hrs	CO No.	PSO	PO
1	**Analysis of water quality** (a) Dissolved CO2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate, nitrate and total alkalinity.	20	1	1,2,3	1,2,3

2	**Physico-chemical analysis of soil** (a) Total water-soluble mineral ions (b) estimation of soil organic carbon (Walkey and Black method).	20	1	1,2 ,3	4, 5, 6
3.	**Analysis of vegetation -** Quadrate /line transects to find frequency and interpret the vegetation in terms of Raunkiaer's frequency formula.	20	1	1,2 ,3	7, 8
4.	Visit to an ecologically significant location (Polluted site/National parks/ mangroves/estuaries) to make them aware of conservation efforts, common environmental problems, their consequences and possible solutions.		2	4,5	9,10
	Total Credits of the Course	3	60		

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks **B. Semester End Practical examination – 60 marks**

REFERENCES

Compulsory Reading:

. APHA Standard methods for the examination of water and waste water, APHA.
. Michael P (1984) Ecological methods of field and laboratory investigations, Tata McGraw Hill.
. Vodopich D (2009) Ecology – Lab Manual, McGraw Hill.

Further Reading: