

M.Sc. PROGRAMME IN BOTANY



(Effective from Session 2026-27)
(Batch: 2026-2028)



SAMBALPUR UNIVERSITY
JYOTI-VIHAR, BURLA, SAMBALPUR, ODISHA-768019

A BREIF INTRODUCTION OF THE PROGRAMME

Program Outcome: M.Sc. in Botany

M.Sc. in Botany is a two years regular course, offered by P.G. department of Botany. Sambalpur University. The present syllabus covers different components of theoretical and practical, as well as project work, field study and seminar presentations, which will help the students to get in depth knowledge on advanced Botany. During and the completion of this course, students are expected to have an overall knowledge on Microbiology, different lower (Cryptogams) and higher plants (Phanerogams) diversity, their anatomy, physiology, biochemistry, biostatistics, reproductive biology, genetics, evolutionary history and Paleobotany etc. The students can learn about the erigis and history of different cultivated plants, their economic importance, utilization and conservation of natural resources different renewable and nonrenewable energy sources. The course curriculum is designed to introduce the students about sensory biology and stress physiology along with the hands on training on the theory and practical aspects of different instruments along with microbial and plant tissue culture. The course also encompasses an enriched knowledge on Ecology, environmental pollutions and different Environment laws. After completion of this course, students are expected to have practical knowledge on how to handle and operate basic instruments for their experimental purposes. They might have basic idea on experimental designing, project handling and writing their project reports, which may be beneficial for them in future and improve their capability to write notes and research articles for different scientific journals. The degree of M.Sc. Botany may open their path into academia/research career at national and international level as a scientist, as a teaching faculty or as a scholar or into different administrative positions.

Course Outcome

After successful completion of this course, students will be able to understand, the cell structures in relation to function of cells, the fundamental unit of life along with molecules present in cells, the concepts in prokaryotic eukaryotic, and viral genetics, the central dogma of molecular biology (replication, transcription, and translation), the types of mutation, gene regulation and transposable element, the diversity of lower cryptogams (Algae, Fungi Bacteria, and viruses), the collection and study of algae, fungi, bacteria from different natural sources, the identification up to generic level. After completion of the course the students will be familiar with various physiological aspects involved in the plant development, the role of enzymes in it and mechanism of photosynthesis respiration, nitrogen and lipid metabolism. Identification of genus and species of locally available wild plants preparation of botanical keys at generic level by locating key characters, knowledge of at least 10 medicinal plan species, the study of at least 20 locally available families of flowering plants and knowledge of secondary metabolite and its use in taxonomy, development of plant reproductive parts i.e. male, female gametophytes and fruit Sterilization techniques for media as well as for explants and their culture, anther culture, pollen culture.



**SEMESTER-WISE COURSE STRUCTURE FOR THE TWO YEAR P.G PROGRAMME IN
UNIVERSITY P.G DEPARTMENT AND COLLEGES UNDER
SAMBALPUR UNIVERSITY**

TO BE EFFECTIVE FROM 2025-2026

For MSc Botany (Science Dept.)			
	From the Department		
Semester	Credit		Credit
First	20	Environmental Studies and Disaster management	2
Second	20	Inter Dept. Course (IDC) or open elective	3
Third	20	Entrepreneurship Development	2
Fourth (including project of 4credit)	20		
TOTAL	80	MOOCs one paper (in Indoor III rd Sem)	3
Total credit for 2years course =90 Credits			
Further more following non-credit course will be taken by the students			
1. Yuva Sanskar		2. N.C.C/N.S.S/Sports/Performing Arts/Yoga (Of which one has to be opted)	

M.Sc. BOTANY

(Effective from the Session 2025-2026)

OUTLINE OF THE COURSE

SL NO	PAPER	COURSE TITLE	CREDITS (CH)	MARKS		
				End term	Midterm	Total
SEMESTER I						
1	BOT-411	Microbial Diversity	4	80	20	100
2	BOT -412	Diversity of Cryptogams and Gymnosperm	4	80	20	100
3	BOT -413	Biochemistry	4	80	20	100
4	BOT -414	Analytical Techniques	4	80	20	100
5	BOT -415	Practical-I	2			100
	BOT -416	Practical-II	2			100
	BOT -417	Environmental Science Disaster Management	2	60	40	100
		Total credit hours/marks for First semester	22	380	120	700
SEMESTER II						
1	BOT -421	Systematics of Angiosperm	4	80	20	100
2	BOT -422	Plant Physiology and Metabolism	4	80	20	100
3	BOT -423	Cell and Molecular Biology	4	80	20	100
4	BOT -424	Ecology and Biostatistics	4	80	20	100
5	BOT -425	Practical-I	2			100
	BOT-426	Practical-II	2			100
	BOT-427 IDC	Mushroom Cultivation	3	60	40	100
		Total credit hours/marks for Second semester	23	380	120	700
SEMESTER III						
1	BOT -511	Plant Embryology and Anatomy	4	80	20	100
2	BOT -512	Genetics, Plant Breeding and Evolution	4	80	20	100
3	BOT -513	Plant Pathology	4	80	20	100
4	BOT -514	Natural Resource, Conservation and Utilization	4	80	20	100
5	BOT -515	Practical-I	2			100
	BOT-516	Practical-II	2			100
	BOT-517	ED- Entrepreneurship Development	2	60	40	100
		Total credit hours/marks for Third semester	22	380	120	700
SEMESTER IV						
1	BOT -521	Advance Plant Biotechnology	4	80	20	100
2	BOT -522	Stress Biology	4	80	20	100
3	BOT -523	Environment Law	4	80	20(Interim)	100
4	BOT -524	Project, Seminar Presentation, Field Study, Scientific visit	4	100		100
5	BOT-525	Practical-I	2			100
	BOT-526	Practical-II	2			100
	BOT-527	MOOCs/ Alternative To MOOCs	3			100
		Total credit hours/marks for Fourth semester	23	640	60	700
		Grand Total	90	1780	420	2200

SEMESTER I

PAPER: BOT411

MICROBIAL DIVERSITY

100 marks (80+20)

4 CH

Unit-I:

Bacteria and Archaea: Classification, cell structure, nutrition, growth, reproduction, Economic importance. Bacterial genetics: plasmid and episome, conjugation, transduction and transformation. Cyanobacteria: Classification, cell structure, nutrition, reproduction, cellular differentiation, heterocyst and its function. Economic importance of cyanobacteria,

Unit-II:

Virus: General properties, structure, purification, cultivation, principle of viral taxonomy, classification, one step growth experiment and lifecycle, Animal virus and their reproduction, Plant virus and their transmission. Economic importance of viruses, Virioids and Prions, Bacteriophage

Unit-III:

Algae: Distribution (terrestrial, freshwater, marine); thallus organization; cell structure; criteria for classification of algae; pigments, reserve food, flagella, reproduction (vegetative, asexual, sexual). Salient features of Chlorophyta, Euglenophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Economic importance of algae. Algal blooms and toxins, algae as biofertilizer, food, feed, and uses in industry.

Unit- IV:

Fungi: General characters of fungi; substrate relationship in fungi; cell ultra-structure, unicellular and multicellular organization; nutrition (saprobic, biotrophic, symbiotic) reproduction (vegetative, asexual, sexual); heterothallism; heterokaryosis; parasexuality; recent trends in classification. Phylogeny of fungi. General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. Fungi in industry, medicine and food, Fungi as biocontrol agent, Mycorrhizae, Lichen.

Select text books for reading:

- Prescott, L. M., Harley, J. P. and Klen, D. A. (1999). Microbiology, 7th Ed., McGraw-Hill, New York.
- Pelczar, Jr., M. J., Chan E.C.S. and Krieg, N. R. (2005). Microbiology, 5th Ed, Tata McGraw-Hill. New Delhi.
- Alexopoulos, C. J., Mims, C. W. and Blackwel, M. (1996). Introductory Mycology, John Wiley, New York.
- Kumar, H. D. (1988). Introductory Phycology. East-West Press, New Delhi.
- Maloy, S. R., Cronan, J. E. Jr. and Freifelder, D. (2008). Microbial Genetics, 2nd Ed. Norosa, New Delhi.
- Mehrotra, R. S. and Aneja, R. S. (1998). An Introduction to Mycology, New Age International, New Delhi.

DIVERSITY OF CRYPTOGRAMS AND GYMNOSEPM

100 marks (80+20)

4 CH

Unit-I:

BRYOPHYTA: Morphology, origin, structure, reproduction and life history. Distribution, classification, Comparative study of Marchantiales, Jungermaniales, Anthoceratales, Sphagiales, Funariales and Polytrichales. Ecological importance, phylogeny of Bryophytes.

Unit- II:

PTERIDOPHYTA: Morphology, origin, anatomy and reproduction; classification; evolution of stele; heterospory and origin of seed habit. General account of morphology and reproduction of Psilopsida, Lycopside: Sphenopsida and Pteropsida.

Unit-III:

GYMNOSEPM: General characteristic feature of Gymnosperms, Classification of Gymnosperms and their distribution in India. General account of Cycadales, Coniferales, Ephedrales, and Gnetales.

Unit- IV:

PALEOBOTANY: Geological time scale, origin and geological evidences; evolutionary time scale (eras, periods and epoch). Types of fossils, processes of fossilization, role of fossils in evolution. Brief account of fossil Pteridophytes and Gymnosperms. Cycadcoidales, Pentoxylales, Medullosales and Glossopteriodales.

Select text books for reading:

1. Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
2. Parihar, N. S. (1991). Bryophyta. Central Book Depot, Allahabad.
- 3Parihar, N. S. (1991). Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- Chamberlin, C. J. (1935). Gymnosperms: Structure and Evolution. Dover Publications, New York Arnold Scott

PAPER: BOT413
BIOCHEMISTRY

100 marks (80+20)

4 CH

Unit-I:

Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

Unit- II:

Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

Unit-III:

Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

Unit- IV:

Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

SUGGESTED READINGS:

1. Lehninger Principles of Biochemistry
2. Harper's Illustrated Biochemistry
3. Biochemistry by U.Satyanar

ANALYTICAL TECHNIQUES

100 marks (80+20)

4 CH

Unit-I:

Microscopic techniques: Visualization of cells and sub cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Unit- II:

Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

Unit-III:

Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

Unit- IV:

Chromatography: Principle, Paper Chromatography, Ion exchange chromatography, Thin layer chromatography, gas chromatography, Electrophoresis technique, Autoradiography. Centrifugation: general principles, types of centrifuges, differential and density gradient centrifugation.

SUGGESTED READING (PAPER-104)

1. Instrumental Analysis for Science & Technology. W. Ferren, Agro Botanical Publication.
2. Biophysical Chemistry-Upadhyay & Nath.
3. Useful techniques for plant scientists by Dhopte.
4. Methods of soil physics by S.K. Jalota, R. Khera& B.S. Ghuman.
5. An Introduction to plant Taxonomy- C. Jeffrey
6. An Introduction of Systematic Botany & Ecology- J.N. Mishra
7. Ecology & Environment-P.D. Sharma, Rastogi Pub.
8. Plant Ecology- W.D. Bellings.
9. Fundamentals of Ecology - Wever& Clements.
10. Fundamental of Ecology-E.P. Odum.

PAPER: BOT415

PRACTICAL

100 marks

4CH

DETAILED SYLLABUS SEMESTER-1

(PRACTICAL-IV)

HOURS: 06

Marks: 100

(PRACTICAL RELATED TO THEORY PAPERS)

1. Collection, Identification and Preservation of common infected plants of the locality
2. Symptomology study of diseased specimens.
3. Collection of algae from various habitat of locality, either separation, preparation temporary and permanent mounts and identification.
4. Microbiological Method: Measurement of length, breadth and diameter of algal/fungal cells and spores using ocular and stage micrometer.
5. Preparation and sterilization of media for the culture of Bacteria and Fungi.
6. Gram staining of Bacteria.
7. Identification of fungal cultures- Rhizopus, Mucor, Aspergillus, Pencillium, Fusarium.
8. Temporary and permanent preparation of slides of important genera belonging to all important classes of fungi.
9. Study of morphology, anatomy and reproductive structures of representative members of Bryophytes, Pteridophytes and Gymnosperm.
10. Study of Mitosis and Meiosis by squashing technique. Drawing the chromosomes and different stages of Mitosis and Meiosis by using camera Lucida.
11. Biometry
12. Viva-Voce
13. Practical record duly certified by the concerned teacher.

SEMESTER II

PAPER: BOT 421

SYSTEMATICS OF ANGIOSPERM

100 marks (80+20)

4 CH

Unit I: Taxonomic Structure:

Taxonomic hierarchy; Concept of species, genus and family, Plant Nomenclature: Salient features of International Code of Nomenclature (ICN) for Algae, Fungi and Plants: priority, effective and valid publications and author citation. Type concept, Taxonomic Tools: Field and Herbarium techniques; Floras and Botanic Gardens, Computer and Taxonomy.

Unit II: Systems of Angiosperm classification

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series), Hutchinson; Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit III Range of floral structures and comparative study of important orders.

Dicots: Ranales, Umbelliferae, Rosales, Asterales. Monocots: Glumiflorae, Scitamineae, Microspermae. Brief account of flora of Odisha.

Unit IV: Numerical taxonomy and Taxonomic evidences

Angiospermic cladistic, Variations, OTUs, Phenograms, Cladograms, Terms and concepts (Primitive and advanced, Homology and Analogy, Parallelism and convergence, monophyly, paraphyly, polyphyly and cladodes). Evidences: Anatomy, Palynology, Cytology, Phytochemistry, Evolution of Angiosperm (Phylogenetic tree).

SUGGESTED READINGS:

1. Principles of Angiosperms Taxonomy by Davis, P. H. and Heywood, V. H., Robert E. Kreiger, New York.
2. Current Concepts in Plant Taxonomy by Heywood, V. H. and Moore, D. M., Academic press, London.
3. Principles and Methods Plant Biosystematics by Solbrig, O. T., MacMillan, London.
4. Plant taxonomy and Biosystematics by Stace, C. A., Edward Arnold, London.
5. Diversity and Classification of Flowering Plants by Takhtajan, A. L. Columbia University Press, NY.
6. Contemporary Plant Systematics by Woodland, D. W. Prentice-Hall, New Jersey, USA

PLANT PHYSIOLOGY AND METABOLISM

100 marks (80+20)

4 CH

Unit-I:

Water relation: Properties of water, Types of solutions, Water potential– uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

Unit- II:

Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO₂ fixation-C₃, C₄ and CAM pathways. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

Unit-III:

Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.

Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

ATP Synthesis- Mechanism of ATP synthesis, substrate level phosphorylation and oxidative phosphorylation, Chemiosmotic Mechanism (ETC), ATP synthesis, Boyers conformational change model, role of uncouplers.

Unit- IV:

Phytohormones- Discovery, chemical nature, transport and physiological role of Auxin, Gibberelins, Cytokinins, ABA, Ethylene, Brassinosteroids, Jasmonic Acids.

Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

SUGGESTED READINGS:

1. Plant Physiology by Taiz and Zieger
2. Plant Physiology by Frank B. Salisbury, Cleon W. Ross

CELL AND MOLECULAR BIOLOGY

100 marks (80+20)

4 CH

Unit-I:

Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).

Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

Unit- II:

Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons). Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)

Unit-III:

DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

Unit- IV:

Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins).

Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

SUGGESTED READING (PAPER-103)

1. Lewin. B.2000, Genes VII, Oxford Univ Press, New York.
2. Alberts B. Bray D, Lewis J. Raff M. Roberts K. Watson J.D. 1999 Molecular Biology of the cell.
3. Wolfe S.L., 1993, Molecular and Cellular Biology, Wadsworth Pub. Co. California, USA. Cucharaw BB Gruissem 4. W. Jones R.L. 2000 Biochemistry and Molecular Biology of Plant, American Society of Plant Physiologists.
4. Kleinsmith L...J. and Kish VM 1995, Principles of cell and Molecular Biology, harp and Collins College Pub. New York, USA
5. Lodish H. Berk A. Zipursky S.L. Matsudaira P. Baltimore D. and Darnell J.2000,
6. Molecular Biology, W.H. Freeman & Co.
7. Alberts B. Bray D. Lewis J. Raff M. Roberts K. & Watson J.D. 1989 Molecular Biology of Cell,

Garland Pub. Inc. New York.

8. Khush G.S. 1973 Cytogenetics of Aneuploids, Academic Press New York.
9. Karp G. 1999, Cells and Molecular Biology, Concepts and experiments, John Wiley & Sons Inc. USA.
10. Lewin B. 2000 Genes VII, Oxford University Press New York, USA.
11. Russell P.J. 1998 Genetics, The Benjamin Cummings Pub. Co. USA.
12. Snustad DP and Simmons M.J. 2000 Principles of Genetics, John Wiley and Sons Inc. USA.

ECOLOGY AND BIOSTATISTICS

100 marks (80+20)

4 CH

Unit-I:

The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, inter demic extinctions, age structured populations.

Unit- II:

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (Carbon, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

Unit-III:

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation

Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit- IV:

Biostatistics: Statistics, data, population, samples, variables, parameters, Representation of Data: Tabular, Graphical; Measures of frequency and central tendency: Arithmetic mean, mode, median, Measures of dispersion: Range, mean deviation, variance, standard deviation; Chi-square test for goodness of fit. Test of significance: comparison of large, small and paired samples (t-Test) and Correlation.

SUGGESTED READINGS:

1 Fundamentals of Ecology E.P. Odum

2 Ecology by M.C. Dash

3 Ecology by Sadabha

4 Biostatistics by Mishra and Mishra

1. Description and Identification of Angiosperms family, genus and species level flora.
2. Herbarium techniques.
3. Microscopic study of ovules.
4. Determination of rate of photosynthesis
5. Preparation of Buffers.
6. Quantitative estimation of protein (Lowry methods/Bradford Method), Sugar (Anthrone Method), Lipids (Bligh and Dyer Method).
7. Quantitative estimation of Amino acids (Ninhydrin methods)
8. Estimation of Pigments (Chlorophylls and carotenoids) from plant and algal materials.
9. Isolation of plant DNA and quantification of extracted DNA by spectrophotometric methods.
10. Soil Nitrogen estimation.
11. Soil Carbon estimation.
12. Measurement of Central tendency
13. Measurement of Dispersion
14. Student t-Test
15. Chi-Square Test

SEMESTER III

PAPER: BOT 511

PLANT EMBRYOLOGY AND ANATOMY

100 marks (80+20)

4 CH

Unit-I:

Male and female gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development and gene expression; male sterility, sperm dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. Female gametophyte: Ovule development, megasporogenesis; organization of the embryo sac, structure of the embryo sac cell.

Unit- II:

Pollination, Pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanisms and vectors, breeding system; commercial considerations, structure of the pistil, pollen stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), double fertilization, in vitro fertilization.

Unit-III:

Seed development and fruit ripening: Endosperm development during early, maturation and desiccation stages, embryogenesis, ultra-structure; cell lineages during late embryo development; storage proteins of endosperm and embryo; polyembryony, apomixis; embryo culture, dynamics of fruit growth and ripening; Latent life-dormancy; Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.

Unit- IV:

Plant Anatomy: Tissue and tissue system; Meristematic tissue, distribution of mechanical tissues, apical meristem, Anomalous secondary growth (adaptive and non-adaptive), Root-shoot transition, shoot-root development. leaf development and phyllotaxy, transition to flowering.

SUGGESTED READINGS:

1. Bewley, J. D. and Black, M. (1994). Seed: physiology of Development and Germination.
2. Plenum, New York.
3. Bhojwani, S. S. and Bhatnagar, S. P. (2008). The Embryology of Angiosperms. Vikas Publishing House, New Delhi,
4. Raghavan, V. (1997). Molecular Embryology of Flowering Plant. Cambridge University Press, Cambridge. Raghavan, V. (1999). Developmental Biology of Flowering Plants. Springer-Verlag, New York

GENETICS, PLANT BREEDING AND EVOLUTION

100 marks (80+20)

4 CH

Unit-I:

Genetics: Mendelism and deviation of Mendelian ratios, epistasis, linkage and crossing over. sex-linked inheritance, three-point test cross and chromosome mapping, Extra chromosomal inheritance.

Cytogenetics: Structural Chromosomal aberrations duplication, deficiency, inversion and translocations heterozygotes; Numerical chromosome aberrations aneuploids: trisomics and monosomics; euploids: autopolyploids, allopolyploids, role polyploidy in speciation with reference to Triticum and Brassica,

Unit- II:

Origin and history of crop plants: Plant domestication morphological, agronomic and genetic features accompanying domestication of plants, Genetic erosion. Biological diversity and genetic variation: Kinds and patterns of variation, variation and variability, genetics, utilization and analysis of genetic variation; qualitative and quantitative traits and their genetics, polygenic inheritance, inbreeding depression, heterosis, recent development in quantitative genetics.

Unit-III:

Genetic system and breeding methods: Reproduction and breeding systems in plants. Recombination, genetic control and manipulation of breeding systems including male sterility and apomixis. Selection and breeding strategies for self-pollinated, crosspollinated, breeding for crop quality, biotic and abiotic stresses, gene pyramiding for multi-trait incorporation.

Unit- IV:

Emergence of evolutionary thoughts Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis. B. Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. C. Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants

SUGGESTED READINGS:

Lewin, B. (2004). Gene VIII. Person-Prentice Hall, London.

Pierce, B. A. (2006). Genetics: A Conceptual Approach. W. H. Freeman, New York.

Gardner, Simmons & Snustad: Principles of Genetics, John Wiley & Sons Inc.

Plant breeding by B.D. Singh

Plant physiology by Salisbury and Ross

Plant physiology by Teiz and Zeiger.

Unit-I:

Plant pathology

Physiological, Biochemical, Genetic aspects of symbionts Host- Pathogen relationships; Disease cycle and environmental relation; General symptoms; Geographical distribution of diseases; etiology; symptomology; prevention and control of plant diseases and role of quarantine. Bacterial diseases - Citrus canker and angular leaf spot disease of Cotton. Viral diseases-Tobacco Mosaic viruses, vein clearing. Fungal diseases - Early blight of potato, Black stem rust of wheat, white rust of crucifers.

Unit- II:

Phytopathology: Plant disease symptoms, modes of infection and dissemination; altered metabolism of plants under biotic and abiotic stresses; host-parasite relationship, molecular mechanism of pathogenesis, recognition phenomenon, penetration and invasion. Primary disease determinant; enzymes and toxins in relation to plant diseases; mechanism of resistance; phytoalexins, PR proteins, antiviral proteins, SAR, HR and active oxygen radicals.

Unit-III:

Historical introduction to Mycology, definition of different terms, basic concepts. Importance of Mycology in Agriculture, relation of fungi to human affairs, history of mycology. Morphology of reproductive structures and conidiogenous cells, Spore types, Saccardo's spore grid, groups and its taxonomic bearing, Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi. The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi.

Unit- IV:

History of plant viruses, composition and structure of viruses. Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship. Virus nomenclature and classification, Structure of plant virus, genome organization, replication and movement of viruses. Isolation and purification, estimation of virus titre and purity, electron microscopy, protein and nucleic acid based diagnostics. Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

PAPER: BOT 514

NATURAL RESOURCE, CONSERVATION AND UTILIZATION

100 marks (80+20)

4 CH

Unit-I:

Natural resources and management: Conservation of natural resources, Non-renewable energy resources, Alternative sources of energy, new concepts for alternative energy. Renewable energy resources: soil resources, Soil conservation and management. Water resources and conservation: rain water harvesting, water shed management. Forest as a renewable resource, deforestation, afforestation, conservation, social forestry, wild-life conservation.

Unit- II:

World Centres of Primary Diversity of Domesticated Plants: Basic concepts, origin of agriculture and plant introduction. Origin, evolution, botany, cultivation and uses of (i) Food crops, (ii) fibre crops, (iii) medicinal and aromatic plants, and (iv) vegetable and oil-yielding crops with special reference to local plants. Plants, plant parts and plant products used in traditional medicines, Important timber-yielding plants, Important poisonous plants of India. Unit III:

Unit-III:

In situ conservation: International efforts and Indian initiatives; protected areas in India Sanctuaries, national parks, biosphere reserves, wetlands and mangroves for conservation of wild biodiversity. Ex situ conservation: Principles and practices; botanical gardens, field gene banks, seed banks,

Unit IV:

Cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR). Principles of conservation; extinction; environmental status of plants based on IUCN (Now World Conservation Union). Salient features of Biodiversity Act and rules.

Select text books for reading:

Conway, G. and Barbier, E. (1994). Plants, Genes and Agriculture. Jones and Bartlett, Boston, USA.

Heywood, V. H. and Wyse Jackson, P. S. (1991). Tropical Botanical Gardens, Their role in Conservation and Development. Academic press, San Diego, USA.

Kothari, A. (1997). Understanding Biodiversity: Life sustainability and Equity. Orient Longman, New York. Negi, S. S. (1993). Biodiversity and its Conservation in India, Indus Publishing Company, New Delhi.

Simmonds, N. W. (1979), Evolution of Crop Plants. Longman, New York.

PAPER: BOT515

PRACTICAL

100 marks

4CH

1. Microscopic observation of various microsporangiums (T.S &L.S), microspore tetrad, Pollen structure.
2. Pollen counting and viability, staining of pollen tube.
3. Microscopic study of ovules (T.S &L.S), ovaries (T.S &L.S)
4. Microscopic observation of tissue system (preparation of slides)
5. Study of biodiversity and important flora of odisha through field trip.
6. Study and observation disease plant specimen.
7. Chromosome mapping (through two and three point test cross)
8. Squashing technique (mitosis and meiosis through onion root tips)
9. Study of Carbon footprinting, Ecological modeling.
10. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.

SEMESTER IV

PAPER: BOT 521

ADVANCE PLANT BIOTECHNOLOGY

100 marks (80+20)

4 CH

Unit-I:

Tissue culture techniques: Totipotency, Media preparation, types of media(liquid and solid), Hybrid Production And Germplasm Conservation Selection of heterokaryotic fusion products, analysis of hybrids, somatic hybrids and cybrids crop improvement, artificial seeds, cryopreservation, , Vector-mediated Gene Transfer to plants Molecular basis of gall and hairy root diseases, features of Ti plasmids, vectors based on PT & PR binary and co-integrate vectors, optimized protocols for Agrobacterium-mediated m transformation, transgenic Plant viruses as vectors. physical methods (particle bombardment microprojectile/biolistics, electroporation, microinjection), chemical methods (PEG-mediated).

Unit- II:

Processing of The Recombinant Proteins Purification and refolding characterization, stabilization. Analysis of proteins: SDS-PAGE, 2-D Gel electrophoresis, methods used for generation of homoplasmic transplastomic plants, vectors for chloroplast transformation, strategies for optimizing foreign gene expression in chloroplast, transplastemics without antibiotic resistant me, applications of chloroplast transformation Metabolic engineering: Molecular farming of carbohydrates, lipids and proteins

Unit-III:

Antisense RNA Technology Regulatory RNA (micro RNA), Antisense RNA, construction of antisense vectors, analysis of antisense clones, applications of antisense technology. Gene silencing causes (DNA methylation, homology-dependent suppression by antisense gene), strategies for avoiding gene silencing, methods of inducing gene silencing and its application. Diagnostics in agricultures and molecular breeding: ELISA. Opine assay, enzyme activity assay (GUS, NPT), transient and stable expression, transgene stability and silencing, production of marker free transgenic plants: co-transformation, site specific recombination, intra-chromosomal recombination. Biosafety regulation.

Unit- IV:

Detection of Transgene and Products, commercialization, Gene tagging: Transposable genetic elements in bacteria, IS elements, composite transposon, Class I & II transposable elements in eukaryotes, isolation of genes by transposon gene tagging and T-DNA tagging DNA Sequencing: Sanger's technique, Maxam & Gilbert technique and automated sequencing. Advantages of transgenics.

Unit-I:

Defining stress Acclimation and adaptation. Brief introduction to diverse stressors in plant, animals and human Environmental factors Abiotic stress (Water; Salinity, High light, Temperature); Biotics stress (Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates) in plants and animals. Lifestyle and environment induced functional (hormonal, cardiovascular and hepato-renal) changes. Posturerelated stress- system design, system optimisation.

Unit- II:

Stress sensing mechanisms Role of nitric oxide. Calcium modulation, Phospholipid signaling, growth factors, salicylic acid signalling, arachidonate. Developmental and physiological mechanisms that protect plants, animals and human against environmental stress Morphological, biochemical and genetic adaptation in plants in osmotic stress; Xenobiotics and biotransformation.

Redox imbalance, Reactive oxygen species, Production and scavenging mechanisms

Unit III:-Stress Physiology

Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.

Superoxide activity in seedlings in the absence and presence of salt stress, Quantitative estimation of peroxidase and superoxide dismutase activity, catalase, glutathione reductase. Estimation of superoxide anions, Salt stress assay in plants, Assessment of different nutritional and physiological stress parameters in individuals involved in different workplace stressors.

Mechanism of biotic and abiotic stress tolerance, IR and SAR, water deficit and drought resistance, salinity stress, metal stress, freezing and heat stress, oxidative stress.

Unit IV: Signal Transduction

Hormones and their receptors, cell surface receptors, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases. specific signaling mechanisms (two component sensory regulatory system in bacteria and plants. sucrose-sensing mechanism).

ENVIRONMENT LAW

BNS 522 C Environmental Law and Society

4CH

Objectives: The environment is degrading because of the human intervention on its different spheres. This demands implementation and refinement of national and internal laws and rules on environment and policy frameworks. The course aims to provide the students with an understanding on i) environmental policies ii) important acts and rules for prevention and control of pollution, iii) rules and notifications on waste management, and iv) Laws related to forest, wildlife and forest dwellers. The student will be exposed to different provisions under these policies, acts and laws.

Outcome: On completion of the course, the candidate will be able to understand a) different national and international policies b) different acts and rules on prevention and control of pollution and protection of environment and c) forest and wildlife acts. Develop skill to participate and contribute to the areas where legal compliance on pollution and protection of environment is required.

Unit-I: Human impact on the Earth: Hunting and Gathering Society, Agriculture Society, Industrial Society, Sustainable -Earth Society: Concept of throw-away and sustainable -Earth Society, our future society; a prediction. Environmental movement and peoples participation with special references to Gandhamardan, and Narmada Bachao

Andolan. Women and Environmental protection. Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States. National river conservation plan – Namami Gange and Yamuna Action Plan

Unit-II: Air, Water, Forest and Wildlife related Laws in India: Constitutional provisions in India (Article 48A and 51A). Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982. Constitution of Central and State Pollution Control Boards, Power, Function and responsibility of Central and State Boards (Objectives, Area of jurisdiction, responsibility of an industry, power and function of state and central Government, Cognizance of offence, Penalties and Punishment). Environmental (Protection) Act, 1986 and Rules 1986. *Forest conservation Act, 1980:* Objective and Jurisdiction, Responsibility of Industry. Wildlife Protection Act 1972 Authorities under the Act. Wild life Advisory Boards and their functions, Detection and prevention of offences. Cognizance of offences, The wildlife (protection) Amendment Act. 1991. Biological Diversity Act, 2002. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Unit III: Acts and Rules for Environment Protection: The Environment Protection Act 1986 - Necessity and Scope of the Act. Powers of the Central Government, Parallel Provisions with the water and the Air act. Important rules & notification under the Environment Protection Act 1986. The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

Unit-IV: Economics and Environment and Environmental Ethics: Economic growth, Gross National product and the quality of life: Sustainable-earth economy, Economics and Pollution control, Discount factor, Cost-benefit and cost effectiveness analysis, Environmental Ethics: Ethics and moral, Throw-away society ethics, Sustainable-Earth Society ethics, Ethical guidelines. Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

1. Hand Book of Environment, Forest and Wild life laws in India, WPSI /Natraj
2. Environmental Science, Santra, Central
3. Environmental Law in India, Gurdip Singh, Quality Law Books
4. CPCB: Pollution Control Acts, Rules and Notifications issued there under, Pollution Control Law series: PCLS/02/2010, GSR 475(E), Gazette no. 202 dated 05.05.92. Central Pollution Control Board (CPCB), Ministry of Environment and Forests. Government of India. Parivesh Bhawan, East Arjun Nagar, New Delhi. India. 1992.
5. CPCB: Pollution Control Acts, Rules and Notifications issued there under, Pollution Control Law series: PCLS/02/2010, GSR 422 (E), Gazette no. dated 19.05.93. Central Pollution Control Board (CPCB), Ministry of Environment and Forests. Government of India. Parivesh Bhawan, East Arjun Nagar, New Delhi. India. 1993.
6. Agrawal, K. C. (2000). Environmental Laws: Indian Perspectives. Nidhi Publisher, Bikaner.

PROJECT, SEMINAR PRESENTATION, FIELD STUDY, SCIENTIFIC VISIT
100 marks (80+20) 4 CH

Objectives: The objectives of this course are to develop research aptitude, scientific temper and critical analysis among students.

Learning Outcome: Students are expected to gain the basic skill in project handling and writing of their project report, which will be helpful for them to be an independent scientist.

Plan and Execution: Project work of IVth semester will be assigned to the students at the beginning of IIIrd semester and will be completed in the IVth semester. The students will plan and carry out projects with self-involvement through understanding and learning of different research tool and techniques. During their research tenure the students learn the skill of writing theses, articles and project for their future benefits.

Project Report/Dissertation: At the end of the project, theses have been written giving full details about their project. Project report should include introduction, background of the problem, Review of literature, objectives, methodology, results, discussion and references.

Evaluation of the project report and viva voce will be open defense type through power point presentation and evaluated by both external and internal examiners.

PG 4th Sem Practical

Paper - 525

- 1) To Measure the Water potential of potato tuber with different salt stress condition.
- 2) Study of Starch-Sugar Mobilisation on Heat stress.
- 3) Demonstration of Gel Electrophoresis.
- 4) Demonstration of ELISA Technique.
- 5) Preparation of MG Medium for tissue culture.
- 6) Isolation of Plasmid DNA.
- 7) Prepare a report on Environmental pollution Act.
- 8) Prepare a report on different ^{National} Environmental policy.
- 9) Prepare a report on National River Conservation Directorate.
- 10) Write a Report on Global Environmental Summit.

PAPER: BOT-IDC
(Inter Department Course/Open elective)

3CH

MUSHROOM CULTIVATION

Unit-I: Unit-I Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus. Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.

Unit-II Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

Unit-III Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fiber content - Vitamins.

Unit-IV Food Preparation: Types of foods prepared from mushroom. Research Centers - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Text Books:

1. B. C. Suman and V. P. Sharma. (2007). Mushroom Cultivation in India. Daya Publishing House, New Delhi.

Reference Books:

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Distribution of Mark/work:

SEMESTERWISE WORK AND DISTRIBUTION OF MARKS IN % FOR PROJECT				
IIIrd SEMESTER (20%) EVALUATION OF INTERIM REPORT OF THE PROJECT WORK				
Background of the problem (5%) (5marks)	Review of Literature (5%) (5mark)	Objectives (5%) (5marks)	Methodology (5%) (5marks)	Total (20%) 20marks
IVth SEMESTER (80%) EVALUATION OF FINAL REPORT OF THE PROJECT WORK				
Project work (50%) – 50marks		Viva (30%) = 30marks		Total (80%) – 80marks
GRAND TOTAL		4CH		100 MARKS

M.Sc.–BOTANY

DISTRIBUTION OF MARKS IN PERCENTAGE FOR THEORY PAPERS

(Reference: Letter No 6220/Acdl dated 01.10.2022 of Sambalpur University)

End Term	Midterm	Total
80% -80marks	20% -20 marks	100%-100marks

MIDTERM EXAMINATION

In each theory paper following distribution of marks for mid semester exam will be followed.

Class test (5%)	Class test (5%)	Assignment (5%)	Case study (5%)	Total (20%)
5marks	5 marks	5marks	5marks	20marks

ENDTERM EXAMINATION

(Four unit course)

Time: 3h

Full Mark: 80

Q1. Twenty questions of 1 mark each (MCQ/fill in the blanks/True-False, Definition etc)

1x20=20

2. For Unit-I, Unit –II, Unit-III and Unit-IV

15x4=60E

Each question will be of 15 marks and it should have an alternative in each unit

(Suggested pattern of distribution of 15 marks are 15; 8+7; 7.5+7.5; 5+10; 2+3+10; 5+5+5)

M.Sc.– BOTANY

SAMPLEQUESTIONPAPER

PRACTICAL

Time:6h

Fullmark–100

Answer all
questions

Q1. Minor experiment (Any
One)

20marks

a.---

b.---

c.---

d.---

e.

Any other experiment suggested by the examiner

Q2. Major experiment (Any One)

30marks

a.---

b.---

c.---

d.---

e.

Any other experiment suggested by
the examiner

Q3. Spotting

(Any **08** in consultation with external
examiner)

(Museum specimen/slides/models/visual aid/instrument

3.5x8=28marks

Q4. Practical Record. 05 marks

Q5. Seminar presentation and Report 10

Marks Seminar Presentation in class seminar -
05 marks Seminar Report Preparation –05
marks

Q6. Viva voce 07marks

**QUESTION PATTERN AND DISTRIBUTION OF MARKS IN THEORY PAPER OFFERED
BY OTHER DEPARTMENTS**

(Reference: Letter No 6220/Acd Idated 01.10.2022 of Sambalpur University)

Theory Paper offered by other Department	
End Term	Mid Term
60%	40%

MID TERM EXAMINATION

Class test	Class test	Assignment	Case study	Total
10%	10%	10%	10%	40%

END TERM EXAMINATION

For end term examination of total marks 60 (Four unit course)

Q1. Twelve questions of 1 mark each (MCQ/fill in the blanks/True-False, Definition etc)

$$1 \times 12 = 12$$

2. For Unit-I, Unit –II, Unit-III and Unit-IV

$$12 \times 4 = 48$$

Each question will be of 12 marks and it should have alternative in each unit. The distribution of marks will be decided by the paper setter.

(Suggested pattern of distribution of 12 marks are 12; 8+4; 6+6; 2+3+7; 4+4+4 etc.)

MOOCs COURSE(3CH)

(In II nd or III rd SEMESTER)

The students will take one MOOCs course according to his /her preference in consultation with HOD and submit the documents in support of undertaking the MOOCs course to the Department. The students will prefer the course related to subject concerned. The duration of course will be **12-16** week. The students are required to submit their course certificate after completion of course in the Department. For MOOCs course the pass percentage is as per the programme guidelines.

NONCREDIT COURSE

1. Yuva Sanskar- **Ist Semester** – HOD of the concerned Department will take care of the course
2. N.C.C/N.S.S/Sports/Performing Arts/Yoga (of which one has to be opted) – **II nd or III rd Semester**

The course in charge will float the course at the beginning of the semester

PASS PERCENTAGE

1. For each paper pass percentage is 30% (G P 4).
2. For clearing the semester Grade Point Average (GPA) should be 4.5 (40%).
3. For IDC, Environmental studies and Disaster Management and Entrepreneurship Development Programme the pass percentage is 30% (G P 4).
4. For MOOCs course the pass percentage is as per the Programme guideline.