## M.Sc. (Hons.) Botany (Session 2019-2020)
(Under the frame work of Honours School System)

### Semester I

<table>
<thead>
<tr>
<th>Core Courses</th>
<th>Theory</th>
<th>Practical</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Plant Physiology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2 Principles of Ecology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3 Bryology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>4 Pteridology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>5 Plant Resource Utilization</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

### Semester II

<table>
<thead>
<tr>
<th>Core Courses</th>
<th>Theory</th>
<th>Practical</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Phycology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2 Plant Biotechnology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3 Mycology and Plant Pathology</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>4 Genomics</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>5 Cytogenetics and Plant Breeding</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

### M.Sc. (Hons. School) III Semester Botany

**THEORY (500 marks)**
- **Paper I**: Mycology
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper II**: Plant Physiology
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper III**: Plant Biochemistry
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper-IV**: Molecular Biology
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper-V**: Ecosystem Ecology and Forestry
  - 75 (60A+15CA) + 25 (20A+5CA)

### M.Sc. (Hons. School) IV Semester Botany

**THEORY (500 marks)**
- **Paper I**: Plant Pathology
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper II**: Biostatistics & Research methodology
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper III**: Plant Biotechnology & Genetic Engineering
  - 75 (60A+15CA) + 25 (20A+5CA)
- **Paper-IV**: Comprehensive Test & Field Botany
  - 50+50
- **Paper-V**: Project & Seminar
  - 50+50
Semester I
Course Code: BOT-Core-1001

Plant Physiology

THEORY

Total Lectures: 60  Credits: 4

Course Objectives: This course aims to educate student on concepts of Membranes function, basic plant signaling mechanisms, carbon fixation and oxidation mechanism, Impacts of stresses and defense strategies, plant hormones and secondary metabolites.

Instructions to the paper setter: The question paper will have four units. The examiner will set a total of nine questions from each unit and one compulsory question of short answer type covering the entire syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:

1. Students will be taught about Membranes, carbon fixation pathways, oxidation pathways.
2. The students will be learning about the various signal transduction mechanisms in plants. The concept of second messengers, calcium signaling, kinases/phosphatases in plant signaling would be delineated to enhance their grasping power for understanding of different signaling pathways operative in plants. Two component signaling concept would be introduced and extended to plant hormone signaling, and its potential biotechnological applications should be clear to students after these classes.
3. During the course students will gain knowledge about various mechanisms related to defence against abiotic stresses. Further the course will deal with various phytohormones and their role in physiology of growth and development, Secondary metabolites and their role in biotic defense. This course will introduce students to physiological advances in sensory photobiology.
4. Students will gain the knowledge on reproductive strategies in higher plants along with physiology of flowering, molecular and hormonal basis of flowering mechanism.

Contents:

Unit-I

2. Signal Transduction: Overview, second messengers, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanisms and their regulation, e.g. simple and hybrid type of two-component sensor-regulator system in bacteria and plants (examples of chemotaxis, osmosensing, ethylene and cytokinin signaling).

Unit -II

4. Respiration: Mitochondria as biological oxidators, Oxidation pathways for glucose and fats, Electron transport mechanisms, including alternate pathways.
Unit -III
5. **Stress Physiology**: Responses of plants to Drought, salinity, Heat, Cold, heavy metals; tolerance mechanisms, Stress sensing and signaling pathways, Genes in stress tolerance, Phyto-remediation mechanisms.

Unit -IV
7. **Plant hormones and other growth regulators**: Pathways of biosynthesis, functions involving defense against abiotic and biotic stresses, Signaling mechanisms
8. **Secondary metabolites and chemical defence**: Natural products (secondary metabolites), their range and ecophysiological functions. Overview of terpenoidal, alkaloidal, and phenolic metabolites and their biosynthesis. Biochemical mechanisms of plants’ chemical war against other plants and animals.

Practicals
1. Demonstration of membrane functions
2. Separation and identification of photosynthetic pigments using various methods
3. Determination of chlorophyll, carotenoids, anthocyanins from normal and stressed plants
4. Bioassays or experiments related to plant hormones
5. Experiments related to abiotic stresses
6. Experiments related to testing of various secondary metabolites

Essential Readings:

Suggested Readings:
Course Code: BOT-Core-1002

Principles of Ecology

THEORY

Course Objectives: The aim of this course is to familiarize the students with the basic concepts, principles and processes of ecology at different hierarchical levels such as species, population, community and ecosystem level. The study will also focus on the current and applied aspects of ecology such as conservation, sustainable development and environment management.

Instructions to the paper setter: The question paper will have four units. The examiner will set a total of nine questions from each units and one compulsory question of short answer type covering the entire syllabus. The students will attempt one question form each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes: The students will gain knowledge about basic and functional aspects of various ecological processes such as how ecosystems function; characteristics and dynamics of species, populations and communities; how species interact; how biomes are distributed and factors affecting them, theory of island biogeography and learn about various applied issues on ecology.

UNIT -I
1. Basic concepts of Ecology: Ecological hierarchy, nature and scope, habitat and niche concept, niche width and overlap, resource partitioning, character displacement, laws of limiting factors, tolerance, edges and ecotones, physical environment.
2. Behavioral ecology: Genetic variations and their measurement, minimum viable population, effective population size, demographic and environmental stochasticity, extinction and speciation.

UNIT -II
1. Population ecology: Life tables and fecundity schedules, reproductive model, logistic growth, stochastic and deterministic models, characteristics of populations, population growth curves, population regulation, life history strategies (r and K selection), metapopulation- demes and dispersal, interdemic extinctions, age structured populations.
2. Community ecology: Nature of communities, community structure and attributes, levels of species diversity and its measurements, community similarity, Community and ecosystem stability, ecological succession (Models and patterns of succession, attributes at early and later seral stages, mechanism).

UNIT -III
1. Ecosystems: Structure and function, energy flow models, productivity and its measurement, ecological efficiency, decomposition and nutrient cycling, biogeochemical cycles, structure and function of some Indian ecosystems.
2. **Species interactions**: Competition, evolution and coexistence, herbivory, carnivory (predation and parasitism), allelopathy, mutualism, commensalism and proto-cooperation.

UNIT -IV
1. **Biomes**: Major terrestrial biomes and aquatic areas (distribution, climatic conditions, major growth forms and human activities), theory of island biogeography (species area effect, species turnover on islands, effect of distance and size on island immigration), biogeographical zones of India.
2. **Applied ecology**: Sustainability, environmental degradation, ecological and carbon footprints and conservation,

**Practicals**
1. To determine various sampling techniques to study plant communities.
2. To determine various ecological indices in the open grassland areas.
3. To determine degree of association between two species by Chi-Square method.
4. To determine indices of similarity between vegetation of two communities.
5. To calculate and understand alpha, beta and gamma diversity.
6. To identify and enlist various ecosystem services.
7. An assignment on response of plants to environmental pollution.

**Suggested Readings**
Course Code: BOT-Core-1003

Bryology

THEORY

Total Lectures: 60 Credits: 4

Course Objectives: To expose the students to the key fundamentals and queries in the recent advances in bryophytes with an objective to mould them to be excellent teachers/scientists in the subject of Bryology. To enable the students to solve various short-answer questions which they are likely to face at various competitive examinations like NET, GATE, All India Civil Service Examinations etc.

Instructions to the paper setter: The question paper will have four units. The examiner will set a total of nine questions from each units and one compulsory question of short answer type covering the entire syllabus. The students will attempt one question form each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:
1. The students will be learning the strategies for the evolution of land habit of bryophytes.
2. The strategies for conduction of water and photosynthates?
3. The reproductive mechanisms during the course of evolution of bryophytes.

Contents:

UNIT-I

1. Comparative morphology and anatomy of gametophytes and sporophytes of major orders of Anthocerophyta, Marchantiophyta and Bryophyta.
2. Vegetative and reproductive innovations.

UNIT-II

4. Evolution of thallose condition in bryophytes.
5. Ontogeny of Antheridia and Archegonia in major taxonomic groups of bryophytes : Exogenous and Endogenous sex organs, development by an apical cell.

UNIT-III

9. Drought tolerance, Desiccation and Rehydration; Mechanism of Damage.

UNIT-IV

bryophytes; strategies to conserve bryodiversity at National and Global levels.
13. Role of bryophytes in Ecosystem Dynamics and in carbon budget.

Practicals

1. Morphology and Internal Organization of the following:
   Representatives of Polytrichales: Polytrichum, Atrichum; Sphagnales: Sphagnum; Fissidentales: 
   Fissidens; Pottiales: Barbula, Eubryales: Mnium; Entodontales: Entodon; Thuidiales: Thuidium; 
   Jungermanniales: Porella, Frullania; Metzgeriales: Pellia; Marchantiales: Targionia, 
   Plagiochasma, Athalamia, Cenocephalum, Rebullia, Wiesnerella, Dumortiera; Anthocerotales: 
   Anthoceros, Phaeoceros, Notothylas.
2. To compare the structure and behaviour of endohydric and ectohydric mosses.
3. To study regeneration potential of dried moss leaves and stem fragments.

Essential Readings:

- Goffinet, B. and Shaw, A.J.(Edited). *Bryophyte Biology (2nd Edn.)*, Cambridge University 
- Vanderpoorten, A. and Goffinet, B. *Introduction to Bryophytes*. Cambridge University Press, 

Suggested Readings:

- Chopra, R. S. *Taxonomy of Indian Mosses*, CSIR, New Delhi, 1975.
- Kashyap, S.R. *Liverworts of Western Himalayas and Punjab Plains*, Researchco Publications, 
  New Delhi, 1932.
- Kumar, S.S. *An Approach towards Phylogenetic Classification of Mosses*, Jour. Hattori 
Course Code: BOT-Core-1004

Pteridology

THEORY

Total Lectures: 60          Credits: 4

Course Objectives: To familiarize students with the diversity of Pteridophytes (both ferns and fern allies), their evolutionary history and origin, economic importance, classification, detailed study on the representative ferns of major families with reference to their morphology, anatomy and reproduction. Practicals and exposure of students to fern flora in the surrounding areas and botanical garden further add to their knowledge.

Instructions for the Paper-setter

Question paper will have **FOUR** units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:

UNIT-I

1. Origin and evolution of Pteridophytes
2. Economic importance of Pteridophytes
3. Diversity and distribution of Pteridophytes in India.

UNIT-II

5. General characteristics of some living fern families. A brief account of genera of major fern families especially Marattiaceae (Marattia), Ophioglossaceae (Ophioglossum), Osmundaceae (Osmunda), Dryopteridaceae (Dryopteris), Pteridaceae (Adiantum), Marsileaceae (Marsilea), Salviniaeaceae (Salvinia), Azollaceae (Azolla), Aspleniaceae (Asplenium) and Polypodiaceae (Platycerium).
6. Telome theory and evolution of stelar system in Pteridophytes.

UNIT-III

7. Types, structure and germination pattern of spores in Pteridophytes.
8. Structure, types and development of fern prothalli
9. Antheridium-inducing substances in ferns

UNIT-IV

10. Apogamy and apospory in pteridophytes (types and inductions), heterospory and its significance.
11. Role of ferns in phytoremediation, ferns as hyperaccumulators of arsenic, mechanism of uptake, transfer and tolerance.
12. Chromosome numbers and polyploidy in Pteridophytes.
Practicals
1. Study of the morphology, anatomy and reproductive structures of the representatives of the fern families mentioned in the theory part.
2. Taxonomical characters of ferns for generic identification and characterization of families.

Essential Readings

Suggested Readings
- Mehra, P.N. and Gupta, A. *Gametophytes of Himalayan Ferns*, Publisher: Mehra, P.N., Bot Department, P.U., Chandigarh, 1986.
Course Code: BOT-Core-1005
Plant Resource Utilization and Conservation

THEORY

Total Lectures: 60 Credits: 4

Course Objectives: To acquaint the students about the origin and uses of pseudocereals, millets, pulses, oil crops, psychoactive drugs and medicinal plants, unexploited plants and their resource utilization. Students will also be introduced to major work of Vivalov and De Candolle in origin of cultivated plants and green revolution and its consequences.

Instructions for the paper setter: Question paper will have FOUR units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:
1. Students are apprised about lesser important food crops especially those which are unexploited and are of great importance to mankind.
2. Medicinal plants, psychoactive drugs and aromatic plants and their importance is made known along with their identification.
3. Important avenue, pollution and esthetically beautiful plants of the city and adjoining areas are shown to the students.
4. Students are also acquainted to important debatable topics such as origin of species and green revolution.

Contents:
Unit -I

1. General Account, centre of origin and uses of (a) Minor cereals – Millets, barley, oat (b) Oil crops – Mustard, groundnut, coconut and linseed (c) Legumes – chickpea, red gram, soyabean, lentil, pea, fodder legume.
2. Psychoactive drugs and Narcotics: Source, classification, botany, active principle and commercial significance.

Unit-II

3. Medicinal Plants: History and classification of drugs; source, part used, active principle and uses of important drugs of B.P. & I.P.
4. Aromatic Plants: Source, classification, botany and uses.

Unit-III

5. Innovations for meeting world food demands.
6. Plants used as avenue trees for shade, pollution control and aesthetics.
7. Insecticides: Source and uses of plant based insecticides i.e. Rotenone, Pyrethrum etc.

Unit-IV

8. World centres of primary diversity of domesticated plants: The Indo-Burmese centre; plant introductions and secondary centres.
Practicals

The Practical Course is divided into two units; (1) Laboratory Work; and (2) Field Survey and Scientific Visits.

Laboratory Work:

1. **Food Crops**: Millets, red gram, chickpea (Bengal gram), pseudocereals sweet potato, mustard, linseed, morphology, anatomy, microchemical tests for stored food materials.
2. **Forage/fodder Crops**: Study of any five important crops of the locality (for example fodder sorghum, bajra, berseem, guar, bean, gram, *Ficus* sp.).
3. **Vegetables Oils**: Mustard, groundnut, soyabean, coconut, sunflower, castor, morphology, microscopic structure of the oil-yielding tissues, tests for oil and iodine number.
4. Aromatic plants, psychoactive plants and avenue trees, shrubs for shade, pollution and aesthetic beauty.

Field Survey:

1. Prepare a list of 10 most important sources of firewood and timber in your locality. Give their local names, scientific names and families to which they belong. Mention their properties.
2. The students should be taken to a recognized botanical garden or a museum (such as those at the Forest Research Institute, Dehra Dun; National Botanical Research Institute, Lucknow) and to a CSIR Laboratory doing research on plants and their utilization and an ICAR Research Institute or a field station dealing with crops.

Essential Readings


Suggested Readings

Semester II
Course Code: BOT-Core-2001
Phycology
THEORY

Total Lectures: 60 Credits: 4

Course Objectives: To acquaint the students about the comparative account of morphology, biology and importance of algal and cyanobacterial organisms. They will be learning through field visits how to collect these organisms from water bodies or terrestrial habitats as also about their current areas of concern and importance.

Instructions for the paper setter: Question paper will have **FOUR** units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:
1. Students would be, at the end of course would be able enough to undertake project work about most of the aspects covered concerning algal and cyanobacterial taxonomy, ecology and areas of economic importance of these organisms.
2. Students will also be competent to know the picture about the immense diversity and cultural conditions of these microbial organisms.
3. They would be able to appreciate these tiny photoautotrophic organisms.

Contents:
UNIT-I
1. Criteria for algal classification (pigments, reserve food, flagella, chloroplast endoplasmic reticular membrane etc.); Comparative account of important systems of classification (Fritsch and Lee); Salient features of major divisions (Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta; Phaeophyta, Dinophyta, Cryptophyta and Rhodophyta).

UNIT-II
2. Diversity in algal habitats (terrestrial, freshwater and marine).
3. Thallus organization in algae including evolutionary trends.

UNIT-III
5. Current concepts and relationships of prochlorophycean algae.

UNIT-IV
6. Rhythms and bioluminiscence in dinoflagellates.
7. Economic Importance of algae (algal biofertilizers, algal blooms, algae as food and feed, uses in industries etc.).
Practicals
1. Collections and culture (media preparation, sterilization, inoculation and incubation).
2. Range of thallus and sex organs in major algal groups.
3. Heterocysts and their frequency in some cyanophycean genera.

Essential Readings:
- Kumar, H.D., *Introductory Phycology*, East West Press, New Delhi, 1999

Suggested Readings:
Course Code: BOT-Core-2002

Plant Biotechnology

THEORY

Total Lectures: 60  
Credits: 4

Course Objectives: Objective of this course is to acquaint the students about Plant Tissue Culture and Biotechnology, Somatic embryogenesis, Somaclonal variations, Haploid Production, Somatic Hybridization, Secondary metabolite Production, Germplasm Storage, and Genetic Engineering. To enable the students to solve various short answer questions during competitive examinations like NET, GATE, All India Civil Service Examinations etc.

Instructions to the paper setter: The question paper will have four units. The examiner will set a total of nine questions, comprising 2 questions from each unit and one compulsory question of short answer type covering the entire syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:
The students will be learning
1. Scope and applications of Biotechnology and Biotechnological utilization of regeneration potential.
2. Secondary metabolite production, utility of somatic embryogenesis, and artificial seeds in micropropagation and germplasm storage
3. Applications of somaclonal variations and biotechnological utilization of haploid production
4. Applications of, somatic hybridization and genetic engineering

Contents:
UNIT-I

3. Plant regeneration: Definition, pre-conditions, role of plant material, effect of culture media and culture conditions, and biotechnological utilization of regeneration potential.

UNIT-II

5. Somatic Embryogenesis; factors affecting somatic embryogenesis and its utility.

UNIT-III

7. Somaclonal variations and their applications.
8. Haploid Production: Definition, androgenesis, Gynogenesis, culture techniques and induction factors, biotechnological utilization of haploid production.

UNIT-IV

10. Genetic Engineering: Transgenic Plants, recombinant DNA technology, cloning vehicles, gene engineering through cutting and joining DNA molecules, restriction endonucleases, ligases, applications of genetic engineering.
Practicals
1. Laboratory organization and techniques for tissue culture.
2. Different nutrient Media; their preparation and sterilization.
3. Selection of different explants, surface sterilization and inoculations to initiate cultures.
4. To study different regeneration pathways in explants, under controlled conditions.
5. To study effect of different growth regulators in in vitro cultures.
6. Anther and pollen culture techniques to establish haploid cultures.
7. Technique of single cell cultures and suspension culture.
8. Technique of production of haploids.

Essential Readings

Suggested Readings
Course Code: BOT-Core-2003

Mycology and Plant Pathology

THEORY

Total Lectures: 60

Credits: 4

Course Objectives: The aim of the course is to make the students competent to identify the fungi and different diseases of plants of economic importance.

Instructions to the paper setter: The question paper will have four units. The examiner will set a total of nine questions from each unit and one compulsory question of short answer type covering the entire syllabus. The students will attempt one question form each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:

1. To make the students conversant with the morphological and anatomical details of the fungi.
2. To make the students familiar with principles of systematics of fungi.
3. To make the student familiar with the identification of plant diseases on the basis of symptoms and to teach basics of physiological plant pathology.

Contents:

UNIT-I

1. Kingdom Fungi: Introduction to Fungi and their significance to humans.
2. Characteristics of fungi and fungal systematics.
3. Recent trends in classification of fungi.
4. Phylum Chytridiomycota and Zygomyctota.
5. Phylum Ascomycota: Introduction to Ascomycetes

UNIT-II

A general account, structure and reproduction of the following:
10. Phylum Basidiomycota: Agaricales and Gasteromycetes
11. Phylum Basidiomycota: Aphyllophorales (Polypores, Chantarelles, Tooth fungi, Coral fungi and Corticiods)
15. Phylum Hyphochytriomycota: General characteristics and classification.
16. Phylum Labyrinthulomycota: Net slime moulds
17. Phylum Plasmodiophoromycota: Endoparasitic slime moulds.
18. Phylum Dictyosteliomycota: Dictyostelid cellular slime moulds
UNIT-III
21. **Introduction, History of Plant Pathology.**
22. **Pathogenesis:** Introduction, prepenetration, penetration and development inside host tissue.
23. **Enzymes and Toxins in Plant Diseases:** Enzymes in plant diseases, composition of cell wall materials and middle lamella, enzymes for waxes and cutins, Hemicellulases, macerating enzymes, cellulolytic, lignolytic and proteolytic enzymes. Toxins and their classification.
24. **Host Parasite Interaction:** Alteration in plant physiological functions.
25. **Defence mechanism:** Morphological, biochemical and genetical defence of the host.
26. **Genetics of Plant Pathogen Interaction:** Resistance and susceptibility, vertical and horizontal resistance, mutation, heterokaryosis, transformation, transduction and physiological specialization.

UNIT-IV
27. **Dispersal of Plant Pathogens:** Direct and indirect transmission.
28. **Plant Disease Epidemiology and Disease Forecasting:** Introduction, epiphytotic growth and analysis, computer simulation of epidemics, methods used in plant-disease forecasting.
29. **Disease Control:** Cultural and chemical control, breeding for disease resistance.
30. **Symptoms, life-cycles and control measures of the following diseases of plants:** White rust, Downy mildews, Powdery mildews, Rusts, Smuts, Ergot, Groundnut leaf spot, Red rot of Sugarcane, Wilt diseases, Paddy blast, Citrus canke and, Bacterial blight of paddy.

**Practicals (Units I and II)**

Morphological study of the following genera:

- *Peronospora*
- *Chaetomium*
- *Drechslera*
- *Puccinia*
- *Albugo*
- *Morchella*
- *Phoma*
- *Ustilago*
- *Mucor*
- *Melampsora*
- *Penicillium*
- *Aspergillus*
- *Yeast*
- *Phallus*
- *Polyporus*
- *Colletotrichum*

**Practicals (Units III and IV)**

1. V. S. of White Rust of Crucifer.
2. T. S. of Linseed Rust.
3. Rust on Wheat and Barberry.
5. Downy mildew of Grapes.
7. Red rot of Sugarcane.
8. Tikka disease of Groundnut.
9. Late blight of Potato.
10. Early blight of Potato.
11. Diseases caused by fungi imperfecti.
13. Wart disease of Potato.
15. Citrus canker.

**Essential Readings (Units I and II)**

Suggested Readings


Essential Readings (Units III and IV)


Suggested Readings:

Course Code: BOT-Core-2004

GENOMICS

THEORY

Total Lectures: 60

Credits: 4

Course Objectives: This course aims to introduce the students to the exciting area of “omics”. It is structured in such a manner that the theory, practical and presentations/seminars would provide a complete over-view of the methods of genome analysis and their significance in understanding biological systems.

Instructions to the paper setter: The question paper will have four units. The examiner will set a total of nine questions from each units and one compulsory question of short answer type covering the entire syllabus. The students will attempt one question form each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:
Students will acquire understanding of:

1. Basic principles of DNA sequencing and evolution of DNA sequencing from classical Sanger to Next Generation Sequencing. Relevance of genomic variations and their utility.
3. Utility of generating mutants with respect to forward and reverse genetics and how these mutants can be used for studying genome wide changes in gene expression.
4. Comparative genomics and its utility in deciphering genome organization of a sequenced genome.
5. Control of gene expression at transcriptional and post transcriptional levels by genome imprinting and formation of heterochromatin by small RNAs.
6. Modern tools for genome engineering.

Contents:

Unit-I
Basic principles of DNA sequencing and evolution of DNA sequencing from classical Sanger to Next Generation Sequencing. Genome sequencing strategies and programs, new technologies for high throughput genome and transcriptome sequencing. Methods for sequence alignment.

Unit-II

Unit-III
Concept of forward and reverse genetics as applied to designing genome wide screens for deciphering gene function. Gene tagging, gene and promoter trapping, knockout and knock-down mutants. Introduction to comparative genomics of model plants and related crop species.
Unit-IV
Introduction to RNAi and gene silencing. Genome imprinting, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing. Introduction of genome engineering and a comparative study of genome engineering methods.

Practicals
1. Gene, genome and transcriptome sequence download and mining from various databases.
2. Assembly and annotation of standard sequences.
3. Sequences alignment and analysis using various available methods.
4. In-Silico gene characterization and promoter mining and analysis.
5. Designing of RNAi targets and RNA fold and interaction analysis.
6. Analysis of given sequences for CRISPR-Cas, ZFN and TALENs targets.
7. Designing of ZFN, TALENs and CRISPR-Cas targets for given sequences.

Essential Readings:

Suggested Readings:
Course Code: BOT-Core-2005

Cytogenetics and Plant Breeding

THEORY

Total Lectures: 60
Credits: 4

Course Objectives: Course objective is to study about genomes, functioning of genes and chromosomes and their characterisation and various methods of plant breeding.

Instructions for the Paper-setter:
Question paper will have **FOUR** units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Course Learning Outcomes:
1. Genome organization in prokaryotes and eukaryotes; fine structure of gene.
2. Role of various enzymes involved in cell cycle.
4. Objectives, methods and applications of plant breeding.

Contents:
UNIT-I

1. **Genomes**: Organization in prokaryotes and eukaryotes, law of DNA constancy and C value paradox. Organization of plastid and mitochondrial genomes.
2. **Chromatin and chromosomal organization**: Chromosome structure and DNA packaging, euchromatin and heterochromatin, karyotype analysis and banding patterns. Special chromosome types: polytene, lampbrush, B and sex chromosomes.
3. **Fine structure of gene** Coding and noncoding sequences, unique and repetitive DNA; pseudogenes, gene families.

UNIT-II

4. **Cell cycle**: Phases, cell cycle checkpoints, genetic regulation of the cell cycle.
5. **DNA enzymes**: Enzymes involved in replication, polymerase, topoisomerase, methylase, nucleases and restriction endonucleases; replication origin and replication fork, fidelity of replication.
6. **DNA damage and repair**: Causes of DNA damage; Photoreactivation, excision, mismatch, post replication and error prone repair systems.

UNIT-III

7. **Genetic recombination**: Crossing over and chiasma formation; molecular basis of genetic recombination.
8. **Sex determination**: Mechanism of sex determination, sex chromatin and dosage compensation, Sex linked inheritance and common genetic disorders.
9. **Gene mapping methods**: Genetic and physical maps of chromosome, mapping with molecular markers and somatic cell hybrids.

UNIT-IV

10. **Principles of plant breeding**: Principles and objectives, methods of breeding self and cross pollinated crops; heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding.
11. **Male sterility**: Concept, classification, causes, genetic control, inheritance pattern and breeding utility.
Practicals

1. Preparation and study of prefixatives, fixatives and stains.
2. Staining and study of polytene chromosomes.
3. Characteristics and behavior of B chromosomes.
4. Preparation and study of karyotype.
5. Mitosis and meiosis in higher plants.
6. Study of aberrant meiosis in *Rhoeo*, *Tradescantia* and *Chrysanthemum*.
7. Calculation of mitotic index and chiasma frequency.

Essential Reading


Suggested Reading


*****
M.Sc. (Hons. School) III Semester

Paper –I : Mycology

Objective: To acquaint the students about the morphology, biology, systematics and importance of fungal organisms.

Teaching Methodology: It will involve class room lectures, power point presentations, charts, models, practicals and field visits etc.

Instructions for the paper setter

Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I
1. Kingdom Fungi: Introduction to Fungi and their significance to humans.
2. Characteristics of fungi and fungal systematics.
3. Recent trends in classification of fungi.

UNIT-II
A general account, structure and reproduction of the following:
4. Phylum Chytridiomycota and Zygomycota.
5. Phylum Ascomycota: Introduction to Ascomycetes

UNIT-III
A general account, structure and reproduction of the following:
10. Phylum Basidiomycota: Agaricales and Gasteromycetes
11. Phylum Basidiomycota: Aphyllophorales (Polypores, Chantarelles, Tooth fungi, Coral fungi and Corticioidis)

UNIT-IV
A general account, structure and reproduction of the following:
15. Phylum Hyphocytriomycota: General characteristics and classification.
16. Phylum Labyrinthulomycota: Net slime moulds
17. Phylum Plasmodiophoromycota: Endoparasitic slime moulds.
18. Phylum Dictyosteliomycota: Dictyostelid cellular slime moulds

Practicals
Morphological study of the following genera:

Peronospora  
Albigo  
Chaetomium  
Morchella  
Drechslera  
Phoma  
Puccinia  
Ustilago
Mucor  Melanospora  Penicillium
Yeast   Phallus   Aspergillus
Polyporus  Colletotrichum

Essential Reading


Further Reading


Semester-III

Paper –II : Plant Physiology Theory : 75 (60 A+15CA)
Practical: 25 (20 A+ 5CA)

Objective: The course would deal with advances in plant physiology especially involving molecular concepts. Beginning with overview of the cell and its organelles, the course would cover the advances in membranes (structure and function), photosynthesis, respiration, nitrogen metabolism, plant hormones, reproductive physiology and conclude with responses of the plants to abiotic stresses. The course has been designed keeping in view the UGC-NET syllabus.

Teaching Methodology: The teaching methodology would provide comprehensive information on board along with demonstration through models, slides and practicals.

Instructions for the paper setter

Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I

1. Membranes: Recent concepts of structure and composition of membrane with various classes of pumps and their significance.
2. Plant Respiration: Detailed mechanism; Glycolysis and TCA cycle, Mitochondria as biological oxidators; Chemiosmotic regeneration of ATP; CN⁻ resistant respiration and metabolic inhibitors regulating the respiration.
UNIT-II

3. **Photosynthesis**: Energy pathway in photosynthesis; Chloroplast as an energy transducing organelle, Composition and characterization of photosystem-I and -II; Electron flow through cyclic, non-cyclic and pseudo-cyclic photophosphorylations, Pathways of \( \text{CO}_2 \) fixation; \( \text{C}_3, \text{C}_4 \) and CAM) and regulation of photorespiration; RUBISCO as an example of model enzyme for semi-autonomy at the molecular level.

4. **Nitrogen fixation by free and symbiotic organisms**: An overview - mechanism of biological nitrogen fixation; Nodule formation and Nod factors; Interrelationship between photosynthesis and nitrogen metabolism; Mechanism of nitrate uptake and reduction, ammonium assimilation; Sulfur and phosphorus uptake; transport and assimilation.

UNIT-III

5. **Plant Hormones**: A critical discussion on hormones, their molecular mechanism of action and role in modulating metabolism, tropisms and reproduction at tissue cell and at genetic level.

6. **Reproductive Physiology**: Phytochrome/Hormones in reproduction.

UNIT-IV

7. **Stress physiology**: Introduction to various abiotic stresses, effects at physiological, biochemical and molecular levels.

8. **Secondary Metabolites**: Terpenes, Phenols, Nitrogenous substance; roles.

Practicals

1. Determination of water potential by various methods.
3. Spectroscopic determination of chlorophyll a, chlorophyll b, and total chlorophyll, carotenoids and anthocyanins under varied environmental conditions.
4. Determination of chlorophyll a and chlorophyll b ratio in \( \text{C}_3 \) and \( \text{C}_4 \) plants.
5. Seed germination as affected by environmental factors.
7. Preparation of biovisual aids with respect to plant metabolic or molecular process(es).

Essential Reading


Further Reading

Objective: To acquaint the students about the basic concepts of plant biochemistry including composition, structure and functions of bio-molecules.

Teaching Methodology: The teaching methodology would involve elaborate description of the various topics on board along with demonstration through models and practicals.

Instructions for the paper setter

Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I


2. Lipids: Classification, Structure and functions; Biosynthesis of Fatty Acids.

UNIT-II

3. Amino acids and Proteins: Structure types, properties and Metabolism of Amino acids; Primary, Secondary, Tertiary and Quaternary structure of proteins; stability of protein structure; Classification of proteins based on composition, solubility function; Reverse turns and Ramachandran plot.


UNIT-III

5. Enzymes: Nomenclature and Classification; Enzyme Kinetics; Mode and Mechanism of Enzyme Action, Enzyme Regulation, Activators, Inhibitors and Isoenzymes: Allosteric enzymes.

6. Vitamins: Structure, and functions of Thiamine, Riboflavin, Nicotinic Acid, Pantothenic Acid, Pyridoxine, Biotin, Folic Acid, Vitamin B12, Ascorbic Acid, Vitamin A, D, E and K.

UNIT-IV

7. Compounds of Energy Transfer and Redox Reactions: Compounds of Energy Transfer: Adenosine Triphosphate, Uridine Triphosphate. Cytidine Triphosphate, Guanosine Triphosphate

Practical

1. Detection of reducing, non reducing and total sugars.
2. Quantitative estimation of total carbohydrates by anthrone reagent.
3. Qualitative tests of protein like Biuret test, Ninhydrin test.
4. Quantitative estimation of amino acid and phenols by using Spectrophotometer.

Essential Reading


**Suggested Readings**


**Semester-III**

**Paper-IV: Molecular Biology**

**Theory**: 75 (60 A+15CA)

**Practical**: 25 (20 A+ 5CA)

**Objective**: Objective of this course is to expose students to current knowledge of plant molecular biology and the experimental basis of that knowledge.

**Teaching Methodology**: Traditional and power point presentations.

**Instructions for the paper setter**

Question paper will have *four* units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

**UNIT – I**

1. **Analysis of macromolecules**: Isolation and purification of RNA, DNA and proteins and their analysis by gel electrophoresis.
2. **RNA synthesis and processing**: Structure and functions of different types of RNA, formation of initiation complexes; Transcription factors, activators and repressors, RNA polymerases. RNA processing (capping, splicing polyadenylation); RNA editing and RNA transport.

**UNIT – II**

3. **Control of gene expression**: Regulation of gene expression in, prokaryotes and eukaryotes; role of chromatin in regulating gene expression and gene silencing.
4. **Gene expression analysis**: DNA microarrays for gene expression analysis, types, target preparation; Probe synthesis and hybridization, data analysis.

**UNIT- III**

1. **Gene libraries**: Construction of genomic and cDNA libraries in plasmid, phage, cosmids, BAC and YAC vectors.
2. **DNA sequencing**: Principle, dideoxy chain termination and chemical methods. Strategies for genome sequencing; automated sequencing.
3. **Polymerase chain reaction**: Principle and procedure; types, applications of PCR in basic and applied research.

**UNIT – IV**

8. **Blotting techniques**: Concept of nucleic acid hybridization; Southern, Northern and Western blotting.

9. **Molecular markers**: Types and characteristic features, RFLP, RAPD, AFLP and SNP techniques. Applications of molecular markers in germplasm assessment and conservation.

**Practicals**

1. Extraction and estimation of DNA from plant material.
2. Extraction and estimation of RNA from plant material.
3. Genomic DNA isolation.
4. DNA analysis by gel electrophoresis.
5. Protein isolation and their separation by polyacrylamide gel electrophoresis.
6. To prepare a restriction digest by using different restriction enzymes.
7. DNA amplification by polymerase chain reaction.

**Essential Reading**


**Further Reading**


**Semester-III**

**Paper –V : Ecosystem Ecology and Forestry**

**Theory**: 75 (60 A+15CA)

**Practical**: 25 (20 A+ 5CA)

**Objective**: This syllabus is designed with the view to sensitize and familiarize the students of M.Sc with the basic concepts of ecology and forestry. The major goals for designing this course include: to make students learn various ecological theories, their applications and implementation and to provide them a platform for further studies and competitive exams.

**Teaching Methodology**: Teaching is done in any way (following both traditional and modern methods) so as to sensitize and inspire students on the subject.

**Instructions for the paper setter**

Question paper will have **four** units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.
UNIT- I

1. **Basic concepts of Ecology**: Physical conditions of Environment, resources. Concept of habitat and niche: Types of niche (Fundamental and Realized), Resource partitioning and character displacement.
2. **Ecosystem**: Structure and function, energy flow and mineral cycling (CNP), primary production and decomposition, structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
3. **Ecological succession**: Types, mechanisms, changes involved in succession, concept of climax.

UNIT- II

4. **Population ecology**: Characteristics of populations, population growth curves, population regulation, life history strategies ($r$ and $K$ selection), Metapopulations- demes and dispersal, interdemic extinctions, age structured populations
5. **Community ecology** Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones.
6. **Species interactions**: Various types of positive and negative interactions - Competition, herbivory, carnivory, pollination, Mutualism, symbiosis, proto-cooperation.

UNIT- III

7. **Conservation at the population and species level**: Problems of small populations, effective population size, minimum viable population, loss of genetic variability, demographic variations, approaches to establishing new populations,
8. **Conservation biology**: Approaches to conservation, Ex-situ conservation strategies (Zoos, botanical gardens, aquaria, seed/germplasm banks).
9. **Establishment protected areas**: Establishment and classification of protected areas, existing protected areas, creating new protected areas.

UNIT- IV

10. **Designing and management of protected areas**: Issues of reserve design, protected area networks, landscape ecology and park design. Various management tools, identifying and managing various threats to protected areas. Indian case studies on conservation (Project Tiger, Biosphere reserves).
11. **Forest Types**: Climate of India, different climatic regions of India. Central characters and distribution of the different forest types of India.
12. **Forest Ecosystem Services**: What are ecosystem services, Classification of various forest ecosystem services and their management.

Practicals /Assignments

1. To determine various sampling techniques to study plant communities
2. To determine various ecological indices in the open grassland areas
3. To determine degree of association between two species by Chi-square method
4. To determine index of similarity between vegetation of two communities
5. To calculate and understand alpha, beta and gamma diversity
6. To study the ecological attributes some important invasive exotic plants found in Chandigarh
7. To demonstrate and write a small project on allelopathy (a type of plant-plant interaction)
8. To measure tree height and diameter at the breast height of important tree species in the Panjab University Campus
9. To identify and enlist various ecosystem services
10. An assignment on the Trees, herbs and shrubs of Panjab University campus

Essential Reading


Further Reading


M.Sc. (Hons. School) IV Semester

Paper –I : Plant Pathology Theory : 75 (60A+15CA) Practical: 25 (20A+ 5CA)

Objective: To acquaint the students about the history of plant pathology and detailed study about various diseases and their defense mechanisms.

Teaching Methodology: It will involve class room lectures, power point presentations, charts, models, practicals and field visits etc.

Instructions for the paper setter

Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I

1. Introduction, History of Plant Pathology.
2. Pathogenesis: Introduction, prepenetration, penetration and development inside host tissue.

UNIT-II

5. Defence mechanism.
UNIT-III

7. **Dispersal of Plant Pathogens**: Direct and indirect transmission.
8. **Plant Disease Epidemiology and Disease Forecasting**: Introduction, epiphytotic growth and analysis, computer simulation of epidemics, methods used in plant-disease forecasting.
9. **Disease Control**: Cultural and chemical control, breeding for disease resistance.

UNIT-IV

10. **Symptoms, life-cycles and control measures of the following diseases of plants**: White rust, Downy mildews, Powdery mildews, Rusts, Smuts, Ergot, Groundnut leaf spot, Red rot of Sugarcane, Wilt diseases, Paddy blast, Citrus canker, Bacterial blight of paddy, leaf spot of disease.

Practicals

1. V. S. of White Rust of Crucifer.
2. T. S. of Linseed Rust.
3. Rust on Wheat and Barberry.
5. Downy mildew of Grapes.
7. Red rot of Sugarcane.
8. Tikka disease of Groundnut.
9. Late blight of Potato.
10. Early blight of Potato.
11. Diseases caused by fungi imperfecti.
12. Study of Viral diseases.
15. Wart disease of Potato.
17. Citrus canker.
18. Tundu disease of Wheat.

Essential Reading


Further Reading

Objective: This course is designed to make students learn and understand the applications of various statistical methods in plant sciences and the research methodology as to how to design experiments, write research papers and familiarize them with Science citation index, impact factor etc. and importance of ethics in research. This course content of this paper is prepared on the patterns of relevant topics of the life sciences paper of UGC-CSIR with the aim of imparting comprehensive knowledge to the students.

Teaching Methodology: Teaching is done in any way (following both traditional and modern methods) so as to sensitize and inspire students on the subject.

Instructions for the paper setter

Question paper will have four units. Examiner will set a total of nine questions comprising Four questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt at least one question from each unit apart from the compulsory question. All questions may carry equal marks, unless specified.

SECTION (A): Biostatistics

UNIT-I

1. Introduction, objectives and applications of statistical methods in plant sciences; Collection, compilation and presentation of data;
2. Central tendency: mean (arithmetic, geometric and harmonic) median and mode. Standard deviation and standard error;
3. Probability distributions (Normal, Binomial and Poisson), Tests of hypothesis and statistical significance;
4. Test for comparing means of one or two samples.

UNIT-II

5. Analysis of variance (one way) multiple comparisons – Duncan’s Multiple range test, Dunnett’s test, Tukey test;
7. Tests of association, goodness of fit using chi-square test

SECTION (B): Research Methodology

UNIT-III

1. Basic principles and significance of research design;
2. Experimental set-up;
3. Randomized Block Designs (RBD), completely randomized designs,
4. Research articles research papers, popular research articles and reviews,

UNIT-IV

5. How to write a research paper, reference styles, process of reviewing;
6. Important journals in plant sciences,
7. An introduction to science citation index and impact factor of a journal;
8. Copyright act, academic frauds, plagiarism.

Practicals
Data collection, calculation of mean, median and mode, standard deviation and error, \( t \)-value, \( F \)-value and \( r \) value, One way analysis of variance and introduction to post hoc tests with the help of statistical softwares, Calculation of chi square value. Listing of important journals of botany, introduction to online submission of research papers and calculation of impact factor of a journal.

**Essential Reading**

Further Reading


Semester-IV

Paper - III : Plant Biotechnology and Genetic Engineering

Objective: Objective of this course is to expose students to current knowledge of plant molecular biology, genetic engineering and their experimental basis.

Teaching Methodology: It will involve class room lectures, power point presentations, charts, models, practicals and field visits etc.

Instructions for the paper setter

Question paper will have four units. Examiner will set a total of nine questions comprising two questions from each unit, and one compulsory question of short answer type covering the whole syllabus. Students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I

3. Plant regeneration: Definition, pre-conditions, role of plant material, effect of culture media and culture conditions, and biotechnological utilization of regeneration potential.

UNIT-II

5. Somatic Embryogenesis; factors affecting somatic embryogenesis and its utility.

UNIT-III

7. Somaclonal variations and their applications.
8. Haploid Production: Definition, androgenesis, Gynogenesis, culture techniques and induction factors, biotechnological utilization of haploid production.

UNIT-IV

10. Genetic Engineering: Transgenic Plants, recombinant DNA technology, cloning vehicles, gene engineering through cutting and joining DNA molecules, restriction endonucleases, ligases, applications of genetic engineering.

Practicals

1. Laboratory organization and techniques for tissue culture.
2. Different nutrient Media; their preparation and sterilization.
3. Selection of different explants, surface sterilization and inoculations to initiate cultures.
4. To study different regeneration pathways in explants, under controlled conditions.
5. To study effect of different growth regulators in \textit{in vitro} cultures.
6. Anther and pollen culture techniques to establish haploid cultures.
7. Technique of single cell cultures and suspension culture.
8. Technique of production of haploids.

\textbf{Essential Reading}


\textbf{Further Reading}


\textbf{Semester-IV}

\textbf{Paper-IV: Comprehensive Test & Field Botany} \hspace{1cm} (Marks: 50+50)

\textbf{Objective}: The basic objective of this course is to acquaint the students with natural flora and fauna in various regions through field trips.

\textbf{Teaching Methodology}: It will involve organizing botanical excursions and visits to various herbaria and botanical gardens of the country.

The students will have to go for field study trip to the place of the choice of the course incharge/Academic Committee and prepare a field report. The team of accompanying teachers will evaluate the level of academic interest, team-spirit, cooperativeness, discipline and other non-scholastic attributes, apart from the Field Report submitted by the students. The Teacher-in-charge of the Course / Academic Committee will also arrange a comprehensive test based on the Field Botany.

\textbf{Semester-IV}

\textbf{Paper-V: (A) Project Work & (B) Seminar} \hspace{1cm} Marks : (A) 50 & (B) 50)

\textbf{Objective}: The paper will involve seminar presentations by the students on topics pertaining to their course study and submission of project report based on field trips.

\textbf{Teaching Methodology}: It will involve power point presentations followed viva-voce examinations.
- The topic of Project work shall be of the choice of the students in consultation with the Academic Committee.
- Topics of current interest and related to the theory papers shall be selected by the student and approved by the Academic Committee.
- Each student has to present her/his seminar on the assigned topic.
- The schedule of the seminar shall be decided and finalized by the Chairman.
- Attendance in the seminar is compulsory.
- There is no internal assessment as such.
- Credit to be given for attendance and participation in discussion by the board of examiners.
- End written examination will be conducted from within the topics of the seminar.