PUNYASHLOK AHILYADEVI HOLKAR
SOLAPUR UNIVERSITY, SOLAPUR

NAAC Accredited-2022
'B^{++}' Grade (CGPA 2.96)

Name of the Faculty: Science & Technology

Syllabus As per New Education Policy 2020

Subject: BOTANY

Name of the Course: M.Sc. I (Sem I & II)

(Syllabus to be implemented from w.e.f. June 2023)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
M. Sc. I Choice Based Credit System (CBCS)
Course Structure (NEP 2020)
M.Sc. I w.e.f. 2023-24

Sr. No	Paper Code	Course/Title	Nature	Credit	Marks	
Semester I						
1.	**DSC (1)** Theory	**Major mandatory course I** Biology & diversity of Algae, Bryophytes, Pteridophytes and fungi	Theory	4	20	80
2	**DSC (2)** Theory	**Major mandatory course II** Taxonomy of Angiosperms	Theory	4	20	80
3	**DSC (1)** Practical	**Major mandatory course I**	Practical	2	10	40
4	**DSC (2)** Practical	**Major mandatory course II**	Practical	2	10	40
5	**DSE (1)** Theory	**Major elective course I** (Select One) 1) Plant Growth and development 2) Herbal & Drug Technology 3) Plant Biotechnology	Theory	4	20	80
6	**DSE (1)** Practical	**Major elective course I**	Practical	2	10	40
7	**RM**	Research Methodology	Theory	4	20	80
		Total credits with marks		**22**	**110**	**440**
Semester II						
1	**DSC (3)** Theory	**Major mandatory course I** Biology and Diversity of Gymnosperm and Paleobotany	Theory	4	20	80
2	**DSC (4)** Theory	**Major mandatory course II** Advances in Pathology	Theory	4	20	80
3	**DSC (3)** Practical	**Major mandatory course I**	Practical	2	10	40
4	**DSC (4)** Practical	**Major mandatory course II**	Practical	2	10	40
5	**DSE (2)** Theory	**Major elective course I** (Select One) 1) Crop Physiology 2) Angiosperm Systematics 3) Plant Tissue Culture	Theory	4	20	80
6	**DSE (2)** Practical	**Major elective course I**	Practical	2	10	40
7	**OJT/FP**	OJT/In-house Project/ Internship/ Apprenticeship		4	20	80
		Total credits with marks		22	110	440

Revised Syllabus for the Master of Science in Botany, Punyashlok Ahilyadevi Holkar Solapur University, Solapur

(National Education Policy 2020)

Applicable from academic year 2023 – 2024 (June 2023) for M.Sc. Part I and Part II (Botany)

as per Resolution No. …… dated ..... of Board of Studies in Botany and Resolution No.

……dated ……. of Academic Council of Punyashlok Ahilyadevi Holkar Solapur University, Solapur.

1. Title: M. Sc. Botany, Punyashlok Ahilyadevi Holkar Solapur University, Solapur Revised Syllabus as per NEP 2020

2. Faculty: Faculty of Science and Technology.

3. Year of implementation: For M. Sc. I (Semester I and Semester II): From June 2023 and for M. Sc. II (Semester III and Semester IV): From June 2024.

4. Preamble: Education is fundamental for achieving full human potential, developing an equitable and just society and promoting national development. Providing universal access to quality education is the key to India's continued ascent and leadership on the global stage in terms of economic growth, social justice and equality, scientific advancement, national integration and cultural preservation. Universal high-quality education is the best way forward for developing and maximizing our country's rich talents and resources for the good of the individual, the society, the country and the world. India will have the highest population of young people in the world over the next decade and our ability to provide high-quality educational opportunities to them will determine the future of our country. Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution–a democratic, just socially-conscious, cultured and human nation upholding liberty, equality, fraternity and justice for all. Higher education significantly contributes towards sustainable livelihood and economic development of the nation. As India moves towards becoming a knowledge economy and society, more and more young Indians are likely to aspire for higher education. India has tremendous biodiversity, genetic as well as of species and ecosystems which is a biological capital of our country. It contains over 7 percent of the world's biodiversity on 2.5 per cent of the Earth's surface. This diversity can be attributed to the vast variety of landforms and climates resulting in habitats ranging from tropical to temperate, and from alpine to desert. The number of plant species in India is estimated to be over 45,523 representing about 11.8 per cent of the world's flora. It is estimated that 32% of Indian plants are endemic to the country and found nowhere else in the world. Among the plant species the flowering plants have a much higher degree of endemism, a third of these are not found elsewhere in the world. There are 17,527 species, 296 subspecies, 2215 varieties, 33 subvarieties and 70 forma, altogether 20,141 taxa of angiosperms under 2991 genera and 251 families in India, representing approximately 7% of the described species in the world. About 5725 species of flowering plants are broadly considered as endemics and represent 33.5% of the flora, of

which, 3471 species are found in the Himalayas, 2051 in the Peninsular India and 239 in Andaman & Nicobar Islands. Gymnosperms are woody perennials, either shrubs or trees. There are 58 taxa growing in wild under 15 genera and 8 families in India. Though they are lesser in number, provide timber, wood, resins, tars and turpentine. Estimated number of pteridophytes (fern and fem-allies) are about 1200 taxa under 204 genera are distributed in different biogeographic regions of India. The Eastern Himalaya and the Northeast India with about 845 taxa in 179 genera, representing approximately 67% of the pteridophytes known from the country, followed by southern India, including Eastern and Western Ghats, with 345 taxa in 117 genera and Northern India, including Western Himalaya, with 340 taxa in 101 genera. Bryophytes less known group of plants, comprising about 2800 species, is the second largest group of green plants in India, next only to the angiosperms. About 16 genera and 678 species are endemic to India. Liverworts are represented by ca. 850 species under 140 genera and 52 families. Lichens are a symbiotic association of fungi and algae and constitute a dominant component of epiphytic and saxicolous vegetation. At present about 2021 species of lichens in 248 genera are known to occur in India. Fungi range from microscopic organisms to huge solid bodies. Approximately 14,500 species in 2300 genera are found in India of which ca. 3500 species are endemic. Algae represented by over 6500 species in ca. 666 genera, they are found growing in a variety of habitats ranging from fresh water, marine, terrestrial and to soil. Of which 1924 species are endemic to the country. The major portion of Indian algal flora accounting for ca. 390 genera and 4500 species followed by terrestrial algae (125 genera and 615 spp.); soil algae (80 genera and 1500 spp.); marine algae (169 genera and 680 spp.).

5. General objectives of the course:

Major Mandatory I: Biology & Diversity of Algae, Bryophyte, Pteridophyte & fungi

This syllabus will provide detailed ideas about lower cryptogamic plants.

- To get idea about Algae, Fungi, Bryophytes & Pteridophytes
- To get knowledge about characters of cryptogamic plant
- To get knowledge about internal structure, methods of identification, classification
- To get knowledge about Current trends of research in lower plants with their economic importance.

Major Mandatory II: Taxonomy of Angiosperms

This syllabus provides detailed knowledge about Plant taxonomy
To get knowledge about morphological characters of plant
To get knowledge about methods of identification of the plants
To get knowledge about importance of plant taxonomy & its importance in research

Major elective 1: Plant Growth & Development

This syllabus gives an idea about physiological parameters of plant growth & development.

- To get knowledge about physiological changes in plants
- To get knowledge about applications of fertilizers, organic fertilizers its applications & utilization
- To get knowledge about post-harvest storage methods for fruits & vegetables
- To get knowledge about different organizations working on different parameters for plant growth & development

Major elective 2: Herbal Technology

This subject gives knowledge to the students of basic understanding of herbal drug industry, the quality of raw material, guidelines for quality of herbal drugs, herbal cosmetics, natural sweeteners, nutraceutical etc. The subject also emphasizes on Good Manufacturing Practices (GMP), patenting and regulatory issues of herbal drugs

Upon completion of this course the student should be able to:

- Understand raw material as source of herbal drugs from cultivation to herbal drug product
- Know the WHO and ICH guidelines for evaluation of herbal drugs
- Know the herbal cosmetics, natural sweeteners, nutraceuticals
- Appreciate patenting of herbal drugs, GMP.

Major elective 3: Plant Biotechnology

- Understand different hybridization techniques and basics of embryogenesis.
- They will be able to learn about different gene delivery techniques.
- Identify different biotechnological techniques used in plant research and breeding.
- Critically assess the scientific validity and reliability of research studies in plant biotechnology.

Research Methodology:

Recall and identify key concepts and terminology related to research methodology.

- Analyze the strengths and weaknesses of different research methodologies in relation to specific research contexts or objectives.
- Apply the principles of a specific research methodology to design a research study or experiment.
- Critically evaluate the reliability and validity of data collection and analysis methods used in a study.
- Design and propose modifications or adaptations to existing research methodologies to address specific research challenges or gaps.

Major Mandatory I: **Gymnosperms & Paleobotany**

- To study about gymnosperm classification, characters
- To get knowledge about importance of gymnosperms
- To get knowledge about fossils & their characters

Major Mandatory II: Advances in Plant Pathology

This syllabus gives an idea about plant Pathology

- To get knowledge about disease incidence, mechanism, mode of action
- To get knowledge about host pathogen relationship
- To get idea about different types of plant diseases & their causal organisms

- To get knowledge about control measures

Major Elective 1: Crop Physiology

This syllabus gives an idea about crop physiology

- To get knowledge about photoperiodism & vernalization techniques
- To get knowledge about plant growth regulators & their effects on plant physiology
- To get knowledge about plant retardance & their effects on plant physiology
- To get knowledge about different physiological processes in plants.

Major Elective 2: Angiosperm Systematics

In establishing the Phylogenetic relationship that exists naturally many groups of plants

- Using nomenclature principles and rules all plants are named.
- It has a great value in Forestry because all forest trees have been named and classified.
- It has wide importance in Agriculture, Horticulture, etc
- To study ecology, the knowledge of taxonomy / systematic botany became essential, plant ecologist must be aware of the names of plants and their relationship to habitat and environment.

Major Elective 3: Plant Tissue Culture

- Recall the basic principles and history of plant tissue culture.
- Identify the components of plant tissue culture media and their functions.
- Explain the significance of aseptic techniques in plant tissue culture.
- Demonstrate proficiency in using aseptic techniques for culturing plant tissues.
- Assess the commercial applications and benefits of plant tissue culture in various industries.

a. **Programme outcomes**:

i. Rational thinking: To check assumptions for their accuracy and validity.
ii. Biodiversity awareness: To understand the local and global issues of environment and its sustainable development.
iii. Continuous learning: To develop ability to engage independently on the context of human society and technological changes.
iv. Solving problems related to food scarcity.

b. Course outcomes:

a. Working knowledge of the basic concepts of Botany i. e. cellular, molecular, physiological, evolutionary biology of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
b. Identification and classification of algae, fungi, bryophytes, pteridophytes, gymnosperms, angiosperms; evolution of reproductive structures, phylogeny and interrelationship of the selected genera.
c. Identification and understanding of basic concepts, plant diseases and several processes related to physiology, cell and molecular biology and biochemistry & physiology of plants under stress conditions.
d. Knowledge of plant pathology, identification of disease, their causal organisms, symptomology and defense mechanism of the plants against selected diseases.

e. Acquisition of skills required for the production of disease-free plants, development of hybrids, development of plants with novel traits. Intellectual property rights, their importance, ecological risks and ethical concerns.
f. Commercial storage products, knowledge and value-added structural components and information about active components.
g. Knowledge about plant classification, identification & economic value.
h. Understand raw material as source of herbal drugs from cultivation to herbal drug product.
i. Know the WHO and ICH guidelines for evaluation of herbal drugs.
j. Know the herbal cosmetics, natural sweeteners, nutraceuticals.
k. Appreciate patenting of herbal drugs, GMP.
l. Recall the basic principles and history of plant tissue culture.
m. Identify the components of plant tissue culture media and their functions.
n. Explain the significance of aseptic techniques in plant tissue culture.
o. Demonstrate proficiency in using aseptic techniques for culturing plant tissues.
p. Assess the commercial applications and benefits of plant tissue culture in various industries.

The entire course of M. Sc. (Botany) will be of four Semesters spread over two years.

- **Pattern of Examination**: The examinations will be conducted semester wise for both theory as well as practical courses.
- **Fee structure:** As Per PAH Solapur University, Solapur.
- **Eligibility criteria for Admission:** B. Sc. in Botany/B.Sc. Agriculture
- A student shall be held eligible for admission to the M. Sc. Course in Botany who has passed the B. Sc. examination with Botany as a principal subject from PAH Solapur University Solapur and also has passed the entrance examination conducted by the University.
- A student from other university shall be eligible who qualifies entrance examination of PAH Solapur University, Solapur and scores minimum 55% (B+) marks in the subject at the B. Sc. with Botany as a principal subject or with Botany at B. Sc. II level.
- While preparing merit list, only the marks of entrance examination will be considered.
- Medium of instruction: English

Other Features:

i) Intake capacity/ Number of students at M. Sc. I will be 20 per year.

ii) The student may take exit after successful completion of M. Sc. I (Semester I & II) and acquire a certificate of 'PG Diploma in Botany'. Such student may join M. Sc. part II within next five years after exit.

General guidelines:

1) There shall be at least a short tour (up to 3 days) and a long tour (not exceeding 10 days) per year for all M. Sc. I and M. Sc. II students. The long tour may be arranged to a region out of the state covering various Botanical Regions/ Research Institutes/ Centers and Universities. Tours are the part of curriculum and are obligatory to each student, failing which they will not be considered eligible to appear for the practical

examination. Under unavoidable circumstances, if the student fails to attend the tour, he/ she has to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.

2) If there are female students in a batch of sixteen, one additional lady teacher is permissible for excursion. T.A. and D.A. for teachers and non-teaching staff participating in the excursions should be paid as per the rules.
3) Following documents will have to be produced by each student at the time of practical examination (at the end of each Semester):

a. Submission of a laboratory journal of practical records.

b. Submission of a tour report (in his/ her own handwriting) duly signed by the concerned teacher is mandatory.

Important instructions:

a. On Job Training /Field Project: Every student shall go for on job training or field project in semester II. The same work will be evaluated in the department at the end of semester.

b. Research Project: Every student will have to work for research project in semester III and IV. The same work will be evaluated in the department at the end of semester III as well as semester IV. Project report shall be submitted in hard bound form and there will be presentation at the time of evaluation.

M.Sc. (Botany) Part- I SEMESTER – I

Major Mandatory I (Theory 4 credits, Practical 2 credits)

DSC (1): Biology & diversity of Algae, Bryophytes, Pteridophytes and fungi (L-60)

Unit – I	**Phycology:** Algae in diversified habitats (terrestrial, fresh water, marine), thallus organization, cell ultrastructure, reproduction (vegetative, asexual and sexual), modern trends in classification of algae – criteria – pigments, reserve food, flagella etc. and System Salient features, inter-relationship and phylogeny of the following classes – Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae Isolation, culture, cultivation and preservation of algae. Use of algae as a biofuel, Biomass production, phytoplankton. Recent trends in Phycology.	**12 L**
Unit – II	**Bryology:** Diversity in Bryophytes with respect to thallus structure, reproduction, life cycle, modern classification. Salient features, phylogeny and inter-relationship of the following orders– Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Buxbaumiales, funariales and Polytrichales. Economic importance of Bryophytes.	**12L**
Unit – III	**Pteridology:** Salient features, phylogeny and inter-relationship of the following classes – Psilopsida, Lycopsida, Sphenopsida Pteropsida. Diversity in Pteridophytes with respect to morphology, anatomy, reproduction in *Psilotum, Mesipteris, Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Angiopteris, Gleichenia, Pteris, Salvinia, Azolla,* Telome concept and stelar evolution. Current trends of Research in Pteridophytes.	**12L**
Unit- IV	**Fungi:** General characters and recent trends in classification, Cell ultrastructure and Cell wall composition, nutrition (saprobic, biotrophic, symbiotic), reproduction (vegetative, asexual and sexual), fructification and Spore forming structures, heterothallism, heterokaryosis parasexuality, life cycle patterns, growth, reproduction and phylogeny	**12L**
Unit -V:	Phylogeny with respects to following major classes up to the level of order (As per Ainsworth`s 1973 system) A) Myxomycota: Mastigomycotina B) Eumycota: 1) Zygomycotina 2) Ascomycotina 3) Basidiomycotina 4) Deuteromycotina. Life cycle patterns, growth, reproduction of: Stemonitales, Plasmodiophoromycetales, Chytridiales, Perenosporales, Mucorales, Taphrinales Eurotiales Melioles, Xylariales, Claricepitales, Pezizales, Dothideales, Uridinales, Ustilaginales, Polyporales Agaricales Lycoperlales Nidullariales, Hypomycetales Tubercularіales, Sphaeropsidales, Melanconiales	**12L**

Practicals
DSC (1): Biology & diversity of Algae, Bryophytes, Pteridophytes and fungi

1-3. Study of algal types as per theory per Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae with the help of specimens and slides (at least available specimens)

4-6. Morphological, anatomical and reproductive studies of the following members by using specimens and slides: *Marchantia, Targionia, Cythodium, Fossombronia, Notothyllus, Pogonatum, Polytrichum* and *Sphagnum*. (Available specimens)

7-9. Study of Pteridophytes mentioned against each class as per theory paper (specimens / Slides) Submission of (at least 10) dry and wet specimens/ slides / photographs from each group.

10-12. Study of types of fungi according to order in your syllabus

Reference Books:

Text book of Algae by Kumar H. D. and H. N. Singh (1971)
Text book of Algae by Sharma O.P. (1986)
Text book of Botany - Algae by Pandey B.P. (1994)
Botany for degree students - Algae by Vashishta B.R. (1995)
College Botany Vol. II by Gangulee H. C. and A.K. Kar (1992)
Taxonomy and Biology of blue green algae by Desikachary T.V. (1972)
The structure & reproduction of algae by Fritsch F. E. (1965)
The algae by Chapman V.J. & Chapman D.J. (1973)
Algae form and function by Venkataraman et . al. (1974)

Journals

1) Phykos
2) Phycologia
3) Seaweed Research
4) Mahasagar
5) Indian Journal of Marine Biology.

Bryophytes:

1) Bryophyta by Parihar N. S. (1991)
2) Watson E.V. [1964] The structure and life of Bryophytes.
3) BryophytesAtma Ram and Sons , Delhi by Puri . P. (1980)
4) Inter relationship of Bryophytes by Cavers F. [1964]
5) Liverworts of Western Himalayas & The Punjab plains Part I and II.by Kashyap S.R. [1929]
6) Bryology in India by RamU-dar [1976]

Pteridophytes:

1) Biology and Morphology of Pteridophytes by Parihar N. S. (1996)
2) Bierhorst D.W. [1971] Morphology of vascular plants.
3) Jermy A.G. [1973] The Phylogeny and Classification of ferns.
4) Rashid A. [1978] An Introduction to Pteridophytes.
5) Sporne K. R. [1966] Morphology of Pteridophytes

Fungi

1) Introductory Mycology John Wiley and Sons Inc. by Alexopoulos C.J. , Mims C.W. and Blackwel . M. (1996)
2) Introduction to Bacteria McGraw Hill book Co. , New York by Clifton .A.(1958)
3) Introductory Phycology Affiliated East – West Press Ltd., New Delhi by Kumar H.D.(1988)
4) Introduction to Plant Viruses Chand and Co. Ltd., Delhi by Mandahar .C.L.(1978)
5) An Introduction to Mycology New Age Intermediate Press by Mehrotra R.S. and Aneja R.S. (1998)
6) Diseases of crop plants in India Prentice Hall of India Pvt.Ltd. New Delhi by Rangaswamy G. and Mahadevan A.
7) Biology of Lichens by Hale M., Tos . E. Jr. (1967)
8) The Fungi Vol . – I , II , III , IV A , IV B by Ainsworth G. E. and A.S. Sussman
9) Introduction to Fungi Cambridge University Press , Cambridg by Webster . J. (1985)
10) Textbook of fungi by Sharma O.P. (1989)
11) Morphology and Taxonomy of fungi by Bessey . E.A.
12) College Botany Vol. I by Gangulee H.S. and A.K. Kar (1992)
13) The Myxomycetes of India by Thind. K. S. (1977)
14) Taxonomy of fungi imperfecti Hypomycetes by Kendrick W.B. (1979)
15) Hypomycetes by Subramanian C.V. (1971)
16) Illustrated Genera of Rust Fungi by Cummins G.B. (1959)
17) The Rust fungi of Cereales , Grasses and Bamboo by
18) 17Cummins G.B. (1971 18) The Rusts of Leguminaceae & 18Compositae by Cummins G.B. (1984)
19) Ustilaginales of India by Mundkur B.B. & M.J. Tirumalachar (1952)
20) Aquatic Phycomycetes by Sparrow F.K. (1960)
21) Aquatic fungi of India by Dayal (1995)
22) New concepts of kingdoms of Organisms [Science 163: 150-160] by Whittaker R.H. (1969)
23) A Text book of Botany: Fungi S. Chand & Co. Ltd. Ramnagar , New Delhi , pp- 416 by Pandey B.P. (1994)
24) Biology of the Fungi (first ed.) Satyajeet Prakashan, Pune, pp.67 by Vaidhya J.G. (1995)
25) The Fungi Hafner Publ. Co. Ltd. N.Y. by Gaumann G.A. (1952)
26) The Fungi Oxford & IBH by Mehrotra B.S. (1976)
27) The Fungi [Vol. I & Vol. II] John Wiley and Sons , Inc, New York by Wolf F.A. and Wolf F. T.
28) Modern topics in Fungi. Ed.D. S. Mukadam. Saraswati press, Aurangabad,
29) Microbiology and plant pathology by P.D. Sharma, Rastogi

Major Mandatory II (Theory 4 credits, Practical 2 credits)

DSC (2): Taxonomy of Angiosperms (L-60)

Unit – I	**Taxonomy**: Introduction, aims, principles and importance of taxonomy in charting, documentation, Bioprospecting, CBD implementation, conservation and sustainable use of plants. Taxonomic Tools: Herbarium, Botanical Gardens and their role in teaching, research and conservation; important herbaria and botanical gardens of the world and India, Important Websites for taxonomic literature. alpha Taxonomy, omega taxonomy, chemotaxonomy, numerical taxonomy and serotaxonomy.	**12L**
Unit – II	**General evolutionary trends and Species Concept:** **General evolutionary trends:** Habitat and habit, vegetative and reproductive structures of flowering plants. **Species concept:** Classical, modern, typological, non-dimensional, multidimensional.	**12L**
Unit – III	**Nomenclature:** ICN, principles, rules, recommendations, articles, typification, principle of priority, effective and valid publications, citation of authority, transference, rejection of names, synonyms and homonyms. Systems of classifications- Principles, outlines, merits and demerits of Bessey's and Cronquist's systems, Angiosperm Phylogeny group, APG IV (2016)	**12L**
Unit – IV	**Biodiversity:** Characterization, generation, maintenance, loss, magnitude and distribution, economic value, conservation strategies, floristic diversity of India, hotspots, endemic and genetic diversity of plants, floristic works in Maharashtra	**12L**
Unit – V	Salient features, morphological diversity and economic importance of plant families **Dicotyledonae**: Annonaceae, Fabaceae, Meliaceae, Myrtaceae, Polygonaceae Bignoniaceae, Verbenaceae, Lamiaceae, Sapotaceae Casuarinaceae, Amaranthaceae, Euphorbiaceae, Urticaceae **Monocotyledonae**: Arecaceae, Amaryllidaceae, Commelinaceae, Orchidaceae, Liliaceae, Poaceae	**12L**

Practicals
DSC (2): Taxonomy of Angiosperms

1. Preparation of bracketed / indented dichotomous keys for identification of taxa.

2. Preparation of botanical description of a plant species.

3-11. Study of families as per theory syllabus (available plant families and Bentham and Hooker's system to be followed)

12. Knowledge of identification of common local flowering plants with the help of flora.

Submission- Herbarium sheets preferably of weeds (at least 10)

Excursion report

Reference Books:

Ahmedullar, M. and M.P. Nayar 1987. Endemic plants of the Indian region, Vol. I
Benson, L.1957. Plant classification
Benson, l.1962. Plant Taxonomy
Cronquist, A. 1968 Evolution and Classification of flowering plants.
Cronquist, A. 1981. An integrated system of classification of flowering plants.
Davis, P.H. and V.M. Heywood 1963. principles of Angiosperm taxonomy.
Dahlgren, P.M.T. 1980. A revised system of classification of the Angiosperms Bot. J. Linn.soc. 80;91-124.
Dahlgren, R.M.T.: 1981 Angiosperm classification and phylogeny-A rectifying comment, bot.J.1961.
Hajra, P.K.et.al. 1996. flora of India. Introductory volume (part-I)
Kubitzki, K. 1977.Plant systematics and evolution.
Lawrence, G.H.M. 1951.Taxonomy of vascular plants.
Naik, V.N.1984. Taxonomy of Angiosperms.
Nayar, M.P.1996. Hot spot of endemic plants of India, Nepal and Bhutan.
Quicke, Donald I.J.1993 Principles and Techniques of contemporary taxonomy.
Rao.R.R. 1994. Biodiversity of India (FloristicAspects).
Rendle, A.B. 1925. The classification of flowring plants.
Stace, C.A. 1980. plant taxonomy and biosystematics.
Takhtajan, A.L.1969 Flowering plants: origin and dispersal.
The new global Taxonomy initiatives BOTANY 2000-ASIA Newsletter 5(4) 1996.
Systematics agenda 2000 charting the bosphere: a global initiative to discover, describe, and classify the world's species. Technical report. Published by SA200, New York Botanical Gardens.

Major elective course I
(Theory:4 credits + Practical: 2 credits)
Plant Growth and development (60 L)

Unit 1:	**Growth and Photomorphogenesis** Phytochrome & cryptochrome- discovery, properties, role and mechanism of action.	**10L**
Unit 2:	**Senescence**: Senescence of leaves and petals, Mechanism, biochemical changes and Programmed cell death.	**10L**
Unit 3:	**Physiology of seed development & seed germination** A brief outline of physiology of seed development & seed germination. Post harvest physiology- ripening of fruits and its regulation, metabolism of stored seeds and leafy vegetables	**10L**
Unit 4:	**Plant growth regulators**: Plant growth regulators-signaling mechanism of auxin, cytokinin, gibberellin, ABA, ethylene. a brief idea about discovery and possible mechanism of action of triacontanol, Brassinosteroids, salicylic acid, jasmonates, polyamines & morphactins. A brief idea about role of growth retardants- CCC, Paclobutrazol, Maleic hydrazide and TIBA	**15L**
Unit 5:	**Secondary messengers and signaling in plants cells** A brief idea about role of mutants in physiological studies with references to *Arabidopsis thaliana*	**15L**

Practical

DSE (1): Plant Growth and development

1. Comparative growth study of etiolated and light grown seedlings and analysis of Photosynthetic pigments
2. Study of change in nitrate reductase activity during leaf senescence.
3 & 4. Hormonal and chemical regulation of leaf and Petal senescence. (Kinetin / ethephon / SA / KCl / $CaCl_2$)
5. Pigment changes during ripening of fruits.
6. Study of enzyme acid phosphatase during ripening of fruits.
7. Study of changes in respiration rate during ripening of fruits
8. Effect of different chemical compounds on pollen germination.
9. Effect of various PGRS on seedling growth.
10. Effect of growth retardants on plants.
11. Study of changes in starch & sugars during fruit ripening of Banana / Guava.
12. Study of changes in acidity and TSS (total soluble solids) during grape ripening.

References

- Bidwell R.C.S. 1979. Plant physiology.
- Boner J. and Varner J. E. 1976. Plant Biochemistry.
- Edwards G. Walker D.W. 1983. C3-c4 mechanism and cellular environmental regulation ofphotosynthesis. Govindjee 1982. Photosynthesis vol I & II. Hopkins W.C. 1995. Introduction to plant physiology.
- Krishnmoorthy H.N. 1992. Physiology of plant growth and development.
- Marschner, H.W. 1986. Mineral nutrition of higher plants.
- Miller P. 1973. Phytohemistry vol I, II & III. Moore T.C. 1974. Research experiences in plant physiology, a laboratory manual.
- Mukherjee, S.P. and Ghosh A.N. 1996. Plant physiology
- Noggle G.R. & G.J. Fritz. 1990. Introductory plant physiology II Ed.
- Randhir Singh & Sawhney S.K. 1988. Advances in frontier areas of Plant Biochemistry.
- Sadasivan and Manikkam 1996. Plant biochemical methods.
- Salisbury F.B. & Ross C.W. 1992. Plant physiology IV Ed.
- Sinha S.K. Sane P.V. Bhargava S.C. And Agraval P.K 1990. Preceding Of International congressof plant physiology vol I& II.
- Smith H. 1975. Phytochrome and Photomorphogenesis.
- Steward F.C. 1976. Growth and Organization in Plants.
- Stumpf P.K. & Conn.E. 1980. The Biochemistry of Plants: A Comprehensive Treaties.
- Taiz L. And Zieger, F. 1998. Plant Physiology.
- Wilkins M.B. 1976. Physiology of Plant Growth and Development. Annual Reviews of Plant Physiology and Molecular Biology. Indian Journal of Plant Physiology. Journal of Experimental Botany

Major Elective course
(Theory:4 credits + Practical: 2 credits)
DSE (1): Herbal & Drug Technology (60L)

Unit I	**Herbs as raw materials** Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation Source of Herbs Selection, identification and authentication of herbal materials, Processing of herbal raw material **Biodynamic Agriculture** Good agricultural practices in cultivation of medicinal plants including Organic farming. Pest and Pest management in medicinal plants: Biopesticides/Bioinsecticides. **Indian Systems of Medicine** 1. Basic principles involved in Ayurveda, Siddha, Unani and Homeopathy 2. Preparation and standardization of Ayurvedic formulations viz Aristas and Asawas, Gutika, Churna and Bhasma.	**(12L)**
Unit II	**Nutraceuticals** General aspects, Market, growth, scope and types of products available in the market. Health benefits and role of Nutraceuticals in ailments like Diabetes, Cardiovascular System (CVS) diseases, Cancer, Irritable bowel syndrome (IBS) and various Gastrointestinal disorders. **Study of following as health food:** Alfa-alfa, Chicory, Ginger, Fenugreek, Garlic, Honey, Amla, Ashwagandha, Spirulina **Herbal-Drug and Herb-Food Interactions:** General introduction to interaction and classification. Study of following drugs and their possible side effects and interactions: Hypercium, kava-kava, Ginkgo biloba, Ginseng, Pepper & Ephedra.	**(12L)**
Unit III	**Herbal Cosmetics** Sources and description of raw materials of herbal origin used via fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products. **Herbal excipients:** Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors & perfumes. **Herbal formulations:** Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes	**(12L)**

Unit IV	**General Introduction to Herbal Industry** Herbal drugs industry: Present scope and future prospects. A brief account of plant-based industries and institutions involved in work on medicinal and aromatic plants in India. Schedule T – Good Manufacturing Practice of Indian systems of medicine Components of GMP (Schedule -T) and its objectives Infrastructural requirements, working space, stor- age area, machinery and equipments, standard operating procedures, health and hygiene, documentation and records	**(12L)**
Unit V	**Patenting and Regulatory requirements of natural products:** Evaluation of Drugs WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs. Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem. Regulatory Issues – Regulations in India (ASU DTAB, ASU DCC), Regulation of manufacture of ASU drugs – Schedule Z of Drugs & Cosmetics Act for ASU drugs.	**(12L)**

Practicals:

1. Preliminary Phytochemical Screening of Aqueous Extract of Neem.
2. Determination of The Alcohol Content of Asava and Arista
3. Evaluation of Excipients of Natural Origin of Honey, Acacia and Starch
4. Preparation and Evaluation of Turmeric Cream
5. Preparation and Standardization of Herbal Lotion
6. Preparation and Standardization of Methi-Shikakai Shampoo
7. Preparation and Evaluation of Orange Syrup.
8. Preparation and Evaluation of Tablet and Churna Mixture
9. Monograph Analysis of Castor oil wt/ml of castor oil Acid value of castor oil saponification value of castor oil Refractive index of castor oil
10. Determination of Aldehyde content
11. Determination of phenol content
12. Determination of Total Alkaloids

References:

Glossary of Indian medicinal plants, R. N. Chopra, S. L. Nayar and I. C. Chopra, 1956. C.S.I.R, New Delhi.

The indigenous drugsof India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book-Distributors.

Herbal plants and Drugs Agnes Arber,1999. Mangal DeepPublications.

Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994.OxfordIBH-publishingCo.

Ayurveda and Aromatherapy. Miller,Lightand Miller, Bryan, 1998.Banarsidass, Delhi.

Principles of Ayurveda, Anne Green, 2000. Thomsons, London.

Pharmacognosy, Dr.C. K. Kokate et al.1999.Nirali Prakashan

Major elective course I
(Theory:4 credits + Practical: 2 credits)
DSE (1): Plant Biotechnology 60L

UNIT-I	**Plant Biotechnology, Plant Genomics and Genetic Engineering** Definition, scope, and historical development of plant biotechnology. Overview of the plant biotechnology industry. Ethical considerations and public perception of plant biotechnology. Basics of plant molecular genetics. Techniques for gene isolation and characterization. Ti & Ri Plasmid and their uses, viral vectors & their applications. Methods of gene transfer into plants.	**15L**
UNIT-II	**Micropropagation** Organogenesis, Somatic Embryogenesis, Synthetic seeds. Shoot tip culture/Axillary bud culture. Rapid clonal propagation. Embryo Culture & Embryo Rescue. Acclimatization of Plants. Soma clonal Variations/In vitro mutagenesis Selected successful examples of Plants of Diverse Origin using Tissue Culture technology Rescue of endangered Plants.	**15L**
UNIT-III	**Plant Tissue Culture and Transformation** Principles and applications of plant tissue culture Callus induction and regeneration techniques Protoplast Isolation, Culture, Fusion, Selection of Hybrid Cells and Regeneration of Hybrid Plants, Symmetric and Asymmetric hybrids. Anther, Pollen and Ovary culture for production of Haploid Plants and Homozygous lines. Genetic transformation methods in plants Cryopreservation, Slow growth & DNA Banking for germplasm Conservation.	**15L**
UNIT-IV	**Tools and Applications of plant biotechnology** Polymerase chain reaction (PCR) and its applications DNA sequencing and gene expression analysis Functional genomics and transcriptomics Commercial micro propagation. Metabolic engineering & Industrial products, Plant secondary metabolites, Industrial enzymes, Biodegradable plastics, Therapeutic proteins: lysosomal enzymes, Antibodies and edible vaccines.	**15L**

Practical

DSE (1): Plant Biotechnology

1. Aseptic technique for plant tissue culture
2. Preparation of culture media and sterilization techniques.
3. Callus induction and regeneration experiments using explants
4. Anther and ovule culture.
5. Embryo culture, Protoplast isolation and fusion technique.
6. Micropropagation of plants through shoot proliferation
7. In vitro rooting and acclimatization.
8. Protein extraction from plant tissues.
9. Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) for protein separation.
10. Study of Gene Expression Analysis through PCR.
11. RNA/DNA extraction from plant tissues.
12. Designing and executing controlled experiments in plant biotechnology.

Submission

Project report based upon this paper.

Reference Books:

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers,USA.
2. Textbook of plant biotechnology, Chawala P.K.2002, Oxford & IBH, New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture: Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002. Plant Tissue Culture: Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary metabolism, lower Academic Publisher.
7. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
8. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14Blackwell Publ)
9. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the21st century (Academic press).
10. Bhojwani SS. & Razdan MK (1996). - Plant Tissue Culture: Theory & Practice (Elsevier)

Mandatory (Theory: 4 credits)
RM: Research Methodology (60L)

Unit-I:	**Introduction to Research** Importance and Meaning of Research, Objectives, Characteristics, Types of Research, Steps in Research; Identification, Selection and Formulation of Research Problem, Research Design, Formulation of Hypothesis.	**(15L)**
Unit-II:	**Sampling Techniques & Parametric Tests** Sampling theory, Types of Sampling, Steps in Sampling, Sample Size, Advantages and limitations. Collection of Data: Primary Data, Data Collection Methods, Secondary Data, Relevance, Limitations and Cautions, Testing of significance Mean, Proportion, Standard Deviation, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Coefficient. Chi-square tests, ANOVA.	**(15L)**
Unit-III:	**Thesis and Manuscript writing:** Preparation of Manuscript; Author instructions, Modes of paper communication, criteria for publication. Computer and internet application in Research (Search engines). Presentation of a scientific Paper, Preparation of Oral Presentation and Poster Presentation. Concept of plagiarism, citation index, h-index, i10-index, ISSN and ISBN.	**(15L)**
Unit-IV:	**Introduction to IPR and Patents:** Intellectual property, Protection of Intellectual property, Forms of protection- patent, copyright, trademark, geographical indications, trade secrets. Criteria and procedure of patenting, patenting biological material. Patent procedure in India, Types of patenting, Patenting of biological materials with examples and case studies.	**(15L)**

References:

- Gibaldi, Joseph (6th edn. 2003), MLA Handbook for Writers of Research Papers, New York: MLA Association. Adam Sirjohn (2004), Research Methodology: Methods & Techniques, Delhi: New Age International Ltd Bateson, F. W. (1972), The Scholar Critic: An Introduction to Literary Research, London: Routledge
- Brown, James Dean (2006), Understanding Research in Second Language Learning, New York: Cambridge University Press
- Kothari,C.R. (1985), Research Methodology: Methods & Techniques, Delhi : New Age International Ltd
- Seliger (2001), Second Language Research Methods, Oxford University b. Additional Reading
- Caivary, R. & Nayak V. K. (2005), Research Methodology,
- S. Chand Chindhade, S. and A. Thorat (2009), An Introduction to Research, Mumbai: CUP
- Deshpande, H. V. Research Literature and Language: Philosophy, Areas and Methodology. Kolhapur: Sukhada Saorabh Prakashan, 2007
- Lenburg, Jeff (2007), Guide to Research, Viva Books
- Rajannan, B. (1968), Fundamentals of Research, ASRC Hyderabad c. References
- Abdul Rahim, F. (2005), Thesis Writing: A Manual for Researchers (New Delhi: New Age International)
- Eliot, Simon and W. R. Owens (4th edn. 1998), A Handbook to Literary Research, London: Routledge & Open University
- Gupta, R. K. (1971), American Literature Fundamentals of Research, ASRC Hyderabad
- Harner, James L. (2002), Literary Research Guide: An Annotated Listing of Reference Sources in English Literary Studies, New York: MLA of America
- Hunt, Andy (2005), Your Research Project, New Delhi: Foundation Books
- Litosseliti,Lia (2000), Using Focus Groups in Research, British Library Cataloguing
- Miller, R. H. (1995), Handbook of Literary Research, Methuen
- Mishra, D. S. (1989), A Grammar of Literary Research, New Delhi: Harman Publishing House
- Oakman, Robert L. (1984), Computer Methods for Literary Research, Athens: University of Georgia Press 23. Rahim, F. Abdul (1996), Thesis Writing-A Manual for Researchers, New Delhi: New Age International Ltd

SEMESTER II

Major mandatory course I (Theory: 4 credits+ Practical: 2 credits)

DSC (3): Biology and diversity of Gymnosperms and Paleobotany 60L

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Unit- I	**Introduction to Gymnosperm:** Diversity of Gymnosperms with respect to morphology, anatomy, reproduction, phylogeny and modern trends in classification	**12L**
Unit –II	**Introduction to Paleobotany:** Salient features, phylogeny, affinities and inter- relationships of the following orders – Cycadales, Coniferales, Ginkgales, Taxales, Ephedrals and Welwitschiales, Economic importance of Gymnosperms	**12L**
Unit III	**Fossils**: Process of fossilization, types of fossils, techniques used in fossil studies.	**12L**
Unit IV	**Studies on morphology and evolutionary trends in plants:** Psilophytales, Filicales, Pteridospermales, Benettitales, Cycadales, Cordaitales, Coniferales and Angiosperms. Indian fossil flora.	**12L**
Unit – V	**Studies of morphology and anatomy of following fossils genera** **Psilophytales-** Rhynia, Astroxylon, Psilophyton **Lepidodendrales-** Lepidodendron, Stigmaria, Lepidocapon. **Calamitales-** Arthropitys, calamostachys, Annularia. **Coenopteridales-** Staraurrpteris, Botryopteris, Etapteris. **Filicales-** Rodeites, Gleichemites **Pteridosperales-** Lygenopteris, Medullosa, Pachytesta **Coniferales-** Elatocladus, Brachyphyllum **Cycadales-** Ptilophyllum Dictyozamites **Angiosperms-** Palmoxylon, Enigmocarpon, Sahnianthus	**12L**

Practicals (2 credits):

DSC (3): Biology and diversity of Gymnosperms and Paleobotany

1-5. Habit, morphology of vegetative parts, external morphology of reproductive parts and anatomy of available [specimens/slides] types for Following---

- Cycadales- *Zamia*
- Coniferales- *Auraucaria, Podocapus, Cupressus.*
- Ginkgoales- *Ginkgo*
- Taxales - *Taxus*
- Ephedrales - *Ephedra*.

6-12. Practicals on Palaeobotany –

Types of fossils- Impression, compression, petrifaction, coal ball

Study of following fossil genera-

- **Psilophytales-** *Rhynia, Astroxylon, Psilophyton*
- **Lepidodendrales-** *Lepidodendron, Stigmaria, Lepidocapon.*
- **Calamitales-** *Arthropitys, calamostachys, Annularia.*
- **Coenopteridales-** *Staraurrpteris, Botryopteris, Etapteris.*
- **Filicales-** *Rodeites, Gleichemites*
- **Pteridosperales-** *Lygenopteris, Medullosa, Pachytesta*
- **Cycadales-** *Ptilophyllum Dictyozamites*
- **Angiosperms-** *Palmoxylon, Enigmocarpon, Sahnianthus*
- **Coniferales-** Elatocladus, Brachyphyllum

  Submission of at least 5 slides from gymnosperms

Reference Books:

1. Bierhorst D.W. [1971] Morphology of Vascular plants Macmillan and co. New York
2. Chamberlein C.J. [1966] Gymnosperms. Structures and evolution.
3. Coulter & Chamberlein J.M. [1978] Morphology of Gymnosperms Central Book Depot. Allahabad.
4. Foster A. S. & Gifford E. M. [1959] Comparative Morphology of Vascular Plants Vakil, Feffer & Simons Ltd.
5. Ramanujan c. G. K. [1979] Indian Gymnosperms in Time and space. Today & Tommorows Publisher.
6. Sporne K. R. [1967] Morphology of Gymnosperms-Hutchinson vaiv. Lib. London
7. Vashistha, p.C. Gymnosperms [1976]

Paleobotany

1. Arnold C.A. [1972] An Introduction to Paleobotany
2. Andrevs H.N. Studies in Paleobotany [1961]
3. Darroh, W.C. [1960] Principles of Paleobotany
4. Surange K.R. Indian Fossil Pteridophytes
5. Shukla A. C. and Mishra S.D. [1975] Essentials of Paleobotany

Major mandatory course I (Theory: 4 credits+ Practical: 2 credits)
DSC (4): Advances in Plant Pathology (60L)

Unit – I	**Introduction plant diseases:** Concept and classification of plant diseases, plant pathogens-concept and classification. Importance of plant diseases. Methods of diagnosis of plant diseases. Mechanism of infection – Pre penetration, penetration, post penetration and colonization	**12L**
Unit – II	**MLO:** Classification, morphology and characteristics of MLO, Identification Techniques of MLOs.	**12L**
Unit – III	**Defense mechanism and Epidemiology:** Defense mechanism against pathogen- structural, physiological, genetical and chemical, systematic acquired resistance Role of environmental factors on disease development, Epidemiology- slow and rapid epiphytotics, Disease forecasting, assessment of disease incidence and crop loss.	**12L**
Unit – IV	**Principles of plant disease control:** Prophylaxis - Exclusion, Eradication, Protection, Immunization-Chemical control, genetic resistance. Plant diseases and disorders- a brief idea of following important diseases.	**12L**
Unit – V	**Diseases: (Pathogen, Symptoms and disease management)** 1. Viral diseases: TMV, BMV 2. Phytoplasma diseases: little leaf of brinjal, Grassy Shoot disease of sugarcane 3. Bacterial diseases- Canker, Blight, Leafspot. 4. Fungal diseases- club root, white rust, Downy mildew, powdery mildew Rusts, smuts Ergot, Leaf spot, fruit rot, study of seed borne pathogens. 5. Algal diseases- Red rust. Phanerogamic diseases- Total and partial stem and root parasites 6. Nematodes- Root knot of vegetables.	**12L**

Practical (2 credits)

DSC (4): Advances in Plant Pathology

1. Study of Fungal diseases (as per theory)
2. Study of bacterial diseases (as per theory)
3. Study of viral diseases (as per theory)
4. Study of Phytoplasma diseases (as per theory)
5. Study of diseases caused by Nematodes
6. Study of phanerogamic total and partial stem and root parasites
7. Estimation of chlorophylls, from healthy and infected plant parts.
8. Estimation of sugars from healthy and infected plant parts.
9. Estimation of polyphenols from healthy and infected plant parts.
10. Study of some fungicides, biopesticides (Demonstration)
11. Isolation of Soil fungi
12. Demonstration of antibiotics using a bacterial culture and known antibiotics

Reference Books:

1. Mehrotra. R.S. (1980)- plant pathology. Agrios, G.N. (1978)-plant pathology.
2. Ny vail, R. F. (1979) – Field Crop Diseases Hondbook. Stingh, R.S. (1963) – Plant diseases
3. Padoley, S.K. and P.B. Mistry – A manaual of plant pathology.
4. Gangopadhyay,S. (1984)- Clinical plant pathology. Rangaswami, G.(1979) Diseases of crop plants in India.
5. Mahadevan A.and R.Sridhar (1982)- Methods in physiological plant pathology. Aneja, K. R. (1993) – Experiments in Microbiology plant Pathalogy and Tissue culture. Gangulee, H.C.&A.K. kar (1992) – College Botany Vol. II.
6. Cooke, A.A. (1981) – Diseases of Tropical and subtropidal field, Fiber and Oil Plants. Paul Khurana, S.M. (1998) – Pathalogical problems of Economic Crop plants and their management.
7. Kuljit,J.(1969)- The Biology of parasitic flowering plants. Univ. of California Press, U.S.A. Plank, J.E. Van der (1963)- Plant diseases, Epidemics and Control.
8. Plank, J.E. Van der (1968)- Diseases Resistance in Plants. A.P. London and New York. Chaube and Pundhir (2005)- Crop diseases and their management
9. Microbiology and plant pathology by P.D. Sharma. Rastogi publication Shivaji Road, Meerut.

Major elective course II
(Theory:4 credits + Practical: 2 credits)
DSE (2): Crop Physiology 60L

Unit I	**Crop growth:** Crop growth analysis and its applications, crop productivity, harvest Index, water use efficiency and N- use efficiency, plant growth regulators in agriculture and anti transpirants Reproductive development- Photoperiodism and vernalization Fertilizers- Types, application through soil, foliar application, organic farming and its importance.	**15L**
Unit II	**Crop weed interactions:** Common weedicides and their mode of action. Source sink relationship Phloem transport, vegetative and reproductive phase and factors affecting source sink relationship, Agronomy	**10L**
UNIT III	**A brief idea of physiological basis of yield** in sugar cane, Jowar, cotton, groundnut & wheat	**10L**
UNIT IV	**Physiology of crops with reference to following aspects-** i) Mineral nutrition of groundnut. ii) Nitrogen fixation in chickpea. Fruit physiology of Ber, Pomegranate, Mango, lemon and grape. [any 2] Post harvest technology of grapes/ Ber/ and pomegranate w.r.t. market strategy	**15L**
Unit V	**A brief idea of crop physiological 5 stations in India** ICRISAT, IARIT, CIMAP Luck now, central soil salinity research lab Karnal, CAZRI Jodhpur, BARC, UAS, Bangalore.	**10L**

Practical
DSE (2): Crop Physiology

1. Growth analysis of any two crop plants (RGR, NAR, LAR, LAI etc).
2. Study of the effect of anti transpirants on stomatal behavior.
3. Study of the effect of source manipulation on sink capacity in any crop plant.
4. Estimation of acid invertase during ripening of sugarcane stalk.
5. Study of allelopathic effect of weed extract on germination of crop seeds.
6. Estimation of total lipids in oilseeds.
7. Study of effect of weedicide on some aspects of weed metabolism.
8. Study of Crop varieties
9. Visit to ware houses to study proper storage conditions for grains, seed and fruits.
10. Study of root nodules in leguminous crops.
11. Study of fertilizers (Chemical and Biofertlizers)
12. Effect of biofertilizers on growth and development of plant.

Reference Books:

Cherry J.H. 1989. Environmental Stress in Plants. Biochemical & Physiological Mechanisms.2 Fageria N.K. 1992. Maximizing Crop Yield.

Gupta U.S. 1975. Physiological Aspects of Dry land Farming.4 Kozlowski T.T. 1984. Flooding and Plant Growth.

Rice E.L. 1982. Allelopathy (Physiological Ecology)

Sharma S.K. & Gupta I.S. 1986. Physiological Aspects of Dryland Farming.

Turner N.C. & Kramer P.J. 1980. Adaptations of Plants to Water and High Temperature Stress.8 Yawalkar & Agrawal, Manures and Fertilizers.

Evans L.T. 1972. Crop Physiology.

Levitt J. 1980. Responses of Plants to Environmental Stresses. Vol. 1 And 2.12 Indian Journal of Plant

Physiology. New Delhi.

13 Agros Annual Review of Plant Physiology. Jodhpur.14 Environmental Plant Physiology.

15 Journal of Experimental Botany. 16 Environmental Plant Physiology.

Major elective course II
(Theory:4 credits + Practical: 2 credits)
DSE (2): Angiosperm Systematics (60L)

Unit I	**Plants, Taxonomy and Systematics** Two kingdom system, empires of three kingdom system, five kingdom system, the plant kingdom, basic components of systematics, advancement levels in systematics.	**10L**
Unit II	**Biosystematics and Evolutionary Concepts:** **Biosystematics**: Steps in biosystematics, Biosystematics categories, Importance of Biosystematics studies, **Evolutionary concepts:** Origin of intra-population variation, population and environment General biological Principle, Transference of Function, Adaptive radiations	**10L**
Unit III	**Tools of Taxonomy and Floristics** **Tools of Taxonomy:** Floras, monographs, revisions, websites, Computer, GPS, GIS, Herbarium, flora, Botanical Garden. **Floristics**: Need and significance. History of botanical exploration in India and recent works with special emphasis on Maharashtra.	**10L**
Unit IV	**Identification and Classification of Plants** **Identification**: Collection, specimen preparation, herbarium methods, Identification methods **Classification**: based on morphology, sexual system, natural system, phylogenetic system. Phenetic and cladistic method of classification.	**10L**
Unit V	**Taxonomic evidences** Based on morphology, anatomy, embryology, palynology, cytology, metabolites and molecular level	**10L**
Unit VI	Studies on the following as per Bentham and Hooker's system of classification. Dicot: Malvales, Celastrales, Rosales, Rubilaes, Ebenales, Lamiales Series: curvembrae Monocot: Microspermae and Glumaceae	**10L**

Practicals
DSE (2): Angiosperm Systematics

1-9. Citation, Taxonomical description illustration and economic importance of family (as per theory syllabus). Note: Select available material belongs to order mentioned in theory.

10. Preparation of key for genus and species

11& 12. Studies on variation between genus of same family

13&14. Studies on variation between species of same genus

15. Studies on taxonomic evidences in angiospermic plants (any two)

References

1. Briggs, David. 2009. Plant microevolution and Conservation in Human-influenced Ecosystems. Cambridge University Press.
2. Cooke, T. 1903-1908. The Flora of Presidency of Bombay, Vol. I-III.
3. Cronquist, A. 1981.An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
4. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press,U.S.A. Hickey, M. and King, C. 2000. The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK.
5. Hutchinson, J. 1959. Families of Flowering plants. Clarendon Press, Oxford.
6. Jain S.K. and Rao R.R. 1976.Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.
7. Jones, S. B. and Luchinger A.E. 1986. Plant Systematics 2ndedn, McGraw Hill Book Co.
8. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. 2008. Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers. Sunderland,Massachusetts, USA.

i.Kubitzki, K. 1977. Flowering Plants Evolution and Classification of Higher Categories. Plant Systematics Evolution Supplement I.

9. Kuijt J. 1969. The biology of parasitic flowering plants.California University Press.
10. Lawrence, G. H. M. 1951. Taxonomy of Vascular Plants.Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi. Mabberly, T. J.2009. The Plant Book 2ndedn Cambridge University Press,Cambridge.
11. Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998.A Handbook of Taxonomic Training. DST, NewDelhi.
12. Gurcharan Singh (2010). Plant Systematics, Science Publishers, USA.

Major elective course II
(Theory:4 credits + Practical: 2 credits)
Plant Tissue Culture (60L)

Unit I	**Plant tissue culture** Objectives and goals of plant tissue culture, laboratory design and development, Operation and management. Tissue nutrition-Basic principles of in vitro culture, factors influencing morphogenesis and Physiological significance of tissue nutrition Media preparation: Media preparation and handling: Sterilization methods, equipment and apparatus, procedures of media preparation and stock solutions.	**15L**
Unit II	**Plant regeneration and plant propagation** Types of Cultures: Explant culture, Callus formation and culture, Callus desiccation. Organogenesis, Meristem culture- Axillary Bud culture, protocols and schedules of observation. Callus culture- Somatic Embryogeny Cell suspension culture, Cell line and bioreactors	**15L**
Unit III	**Organ culture** Anther culture, ovary culture, Isolation of haploids &its significance. Embryo culture, embryo rescue. Hardening of tissue cultured plants Synthetic seed- Concept, method and applications.	**15L**
Unit IV	**Cell and Protoplast Culture** Cell suspension culture: Types and Application. Cell line isolation, Cell immobilization and synseed production Somaclonal variation: Nomenclature; schemes for obtaining somaclonal variations- without invitro selection and with invitro selection; factors influencing somaclonal variation; Applications and Limitations; Gametoclonal variations. Protoplast isolation, culture and somatic hybridization, Cryopreservation: Introduction, principle, procedure, importance and future prospects	**15L**

Practical
DSE (2): Plant Tissue Culture

1. Designing of plant tissue culture laboratory.
2. Preparation of culture media.
3. Sterilization techniques.
4. Callus culture, organogenesis, Meristem culture.
5. Anther culture,
6. Somatic embryogenesis.
7. Cell suspension culture.
8. Techniques of hardening.
9. Encapsulation of embryos.
10. Synthetic seed preparation.
11. Visit to commercial greenhouse/ Tissue culture laboratory.
12. Project Report Submission

References:

- Dodds J. H. & Roberts L.W. (1985): Experiments in Plant Tissue Culture.
- Camborg O.L. And Philips G.C. (1996): Plant, Tissue and Organ Culture FundamentalMethods.
- Dixon, R.A. (1985): Plant Cell Culture. A Practical Approach.
- Narayanaswamy S. (1997): Plant Cell and Tissue Culture.
- Evans et. al. (1983): Hand Book of Plant Cell Culture Vol. I, II, III.
- VASIL T.K. (1984): Cell Culture and Somatic Cell Genetics of Plant Vol. I. Laboratory Procedures and Their Applications
- Bhojwani S.S. And Razdan N.K.(1983): Plant Tissue Culture, Theory And Practice:Elsevier Public Street H.E. (1974): Tissue Culture.
- Reinert J. And Bajaj Y.P.S. (1976): Plant Cell, Tissue and Organ Culture Thorpe T.A. (1981): Plant Tissue Culture.
- Nelson P.V. (1973) Greenhouse, Operation and Management. Prasad Kumar- Greenhouse Management for Horticultural Crops.