VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI – 583 105

Department of Studies in Botany

SYLLABUS

Master of Science

(I-IV Semester)

With effect from
2021-22

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Botany

Programme: Master of Science (M.Sc.) in Botany

Duration: 2 Years (4 Semesters)

Programme Overview:

M.Sc. Botany curriculum is designed to mold students for better understanding of subject domain knowledge and technical skills about plants in a holistic manner. It aims to empower the students in all basic to advanced areas of plant sciences with a unique combination of the basic to frontier areas of plant science and elective papers with significant interdisciplinary components. Students have exposure to cutting-edge technologies that are currently used in the Plant molecular research also made aware about the social and environmental issues, significance of plants and their relevance to national economy through well-structured teaching-learning process.

Programme Outcomes (POs):

At the end of the programme the students will be able to:

1. Able to identify various life forms of plants, design and execute experiments related to basic to advanced areas plant science on evolution, developmental biology, ecology, physiology, anatomy, reproduction, genetics, molecular biology, tissue culture, genetic engineering, DNA barcoding, proteomics, genomics biochemistry, ecology, plant interactions with microbes and insects, forensic science, aquatic botany, economic botany, transgenic technology, etc.
2. Students are also familiarized with the use of Bioinformatics tools and databases and in the application of statistics to biological data.
3. Students also completing the course is capable to perform short research projects using tools and techniques in plant develop scientific temperament and research attitude/
4. Enlist the solutions from medicinal plants for health problems, disorders and disease of human beings and estimate the phytochemical content of plants which meet the specified needs to appropriate consideration for the public health.

5. Understand the techniques for drug evaluation (chemical, physical and biological), phytochemical investigations, standardization and quality control of herbal drugs. Also know the technique of medicinal plants gardening – cultivation practices, marketing and utilization of selected medicinal plants.

6. This program also converses research-oriented learning, it enhances skills in handling scientific instruments, planning and executing biological research. Helps to qualify competitive exams (). It also promotes creative and novel ideas in biological concepts, also provides entrepreneurship skill development

7. Students will be qualified KSET, IFS, ICAR.NET, ICMR.NET, GATE, CSIR etc. It promotes job opportunities in both Government and private sectors.

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) for

DEPARTMENT OF STUDIES IN BOTANY

M.Sc. I-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FIRST	DSC1	21 BOT1C1L	Plant diversity & Human Welfare	30	70	100	4	-	-	4	3
	DSC2	21 BOT 1C2L	Systematics of Angiosperms	30	70	100	4	-	-	4	3
	DSC3	21 BOT 1C3L	Plant pathology & protection	30	70	100	4	-	-	4	3
	DSC4	21 BOT 1C4L	Ecology &Ecoinformatics	30	70	100	4	-	-	4	3
	SEC1	21BOT1S1P	Modern Methods of plant Analysis	20	30	50	-	-	4	2	2
	DSCL	21 BOT 1C1P	Plant diversity & Human Welfare	20	30	50	-	-	4	2	4
	DSCL	21 BOT 1C2P	Systematics of Angiosperms	20	30	50	-	-	4	2	4
	DSCL	21 BOT 1C3P	Plant pathology & protection	20	30	50	-		4	2	4
Total Marks for I Semester						**600**				**24**	

M.Sc. II-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
SECOND	DSC5	21 BOT 2C5L	Plant anatomy &histochemistry	30	70	100	4	-	-	4	3
	DSC6	21 BOT 2C6L	Plant Cytogenetics	30	70	100	4	-	-	4	3
	DSC7	21 BOT 2C7L	Plant Reproductive biology	30	70	100	4	-	-	4	3
	DSC8	21 BOT 2C8L	Herbal drug development	30	70	100	4	-	-	4	3
	SEC2	21BOT2S2P	Bioinformatics	20	30	50	-	-	4	2	2
	DSCL	21 BOT 2C4P	Plant anatomy &histochemistry	20	30	50	-	-	4	2	4
	DSCL	21 BOT 2C5P	Plant Cytogenetics	20	30	50	-	-	4	2	4
	DSCL	21 BOT 2C6P/ 21 BOT 2C2T	Reproductive biology of Angiosperms	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

M.Sc. III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
THIRD	DSC9	21 BOT 3C9L	Plant physiology	30	70	100	4	-	-	4	3
	DSC10	21BOT3C10L	Molecular Biology & Genetic Engineering	30	70	100	4	-	-	4	3
	DSE1	21BOT3E1AL	A. Botanical Garden & Landscaping	30	70	100	4	-	-	4	3
		21BOT3E1BL	B. Advanced Plant Molecular Genetics								
		21BOT3E1CL	C. Plant Metabolism &Biochemistry								
	DSE2	21BOT3E2AL	A. Medicinal & Aromatic plants	30	70	100	4	-	-	4	3
		21BOT3E2BL	B. Seed Technology								
		21BOT3E2CL	C. ForestBotany								
	GEC1	21BOT3G1AL	A. Forensic Botany	20	30	50	2	-	-	2	2
		21BOT3G1BL	B. Biofertilizers & Biopesticides								
		21BOT3G1CL	C. Aquatic Botany								
	SEC3	21BOT3S3LP	Research Methodology	20	30	50	1	-	2	2	2
	DSCP	21BOT3C7P	Plant physiology	20	30	50	-	-	4	2	4
	DSCP	21BOT3C8P	Molecular Biology & Genetic Engineering	20	30	50	-	-	4	2	4
Total Marks for III Semester						**600**				**24**	

M.Sc. IV-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	21BOT4C11L	Plant breeding, molecular farming and Biosafety	30	70	100	4	-	-	4	3
	DSC12	21BOT4C12L	Plant Biotechnology	30	70	100	4	-	-	4	3
	DSE3	21BOT4E3AL	A. Plant DNA barcoding	30	70	100	4	-	-	4	3
		21BOT4E3BL	B. Plant microbe interactions								
		21BOT4E3CL	C. Global climate change								
	DSE4	21BOT4E4AL	A. Conservation Biology &Phytogeography	30	70	100	4	-	-	4	3
		21BOT4E4BL	B. Palaeobotany& Palynology								
		21BOT4E4CL	C. Plant Translational Research& IPR								
	GEC2	21BOT4G2AL	A. Clinically useful herbal drugs	20	30	50	2	-	-	2	2
		21BOT4G2BL	B. Plant Foods for human nutrition and medicine								
		21BOT4G2CL	C. Floriculture								
	DSCP	21BOT4C9P	Plant breeding & Plant Biotechnology	20	30	50	-	-	4	2	4
	Project	21BOT4C1R	Research Project	30	70	100		-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester)- Total Marks: 2400 **Total credits: 96**

DSC – Department Specific Core, DSE – Discipline Specific Elective, SEC – Skill Enhancement Course, GEC – Generic Elective Course, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.

M.Sc. Botany First Semester

Course: Plant diversity and human welfare	Course code: 21 BOT1C1L
Teaching hours/ week (L-T-P): 4-0.0	No of credits – 04
Internal Assessment: 30 marks	Semester end Examination: 70 marks

Course objectives:

1. To understand the world of microbes and important types: Virus, Fungi and Bacteria.
2. To study the algal diversity, distribution, pigmentation, life cycles and Economic importance of algae.
3. Study of lower plants Bryophytes- Diversity; External and internal morphology; and Phylogeny.
4. The Study of Pteridophytes- Diversity; External and internal morphology and Phylogeny
5. Study of stelar evolution, evolution of sporangium and Heterospory and seed habit in Pteridophytes.
6. The study of naked seed plants Gymnosperms- Diversity and distribution; External and internal morphology; Phylogeny; reproduction and economic Botany.

Unit-1 Introduction to plant diversity: Plant diversity and its scope. Understanding and documenting plant diversity; Origin and evolution of land plants: non-vascular, vascular and seed plants; Education and awareness about Plant Diversity and its conservation. 11 hrs

Unit-2 Viruses, Mycoplasma and Bacteria: Introduction, classification, ultrastructure, Life cycle and economic importance of virus, bacteria and mycoplasma. Viral diseases- TMV, YBMV, papaya ring spot virus (PRSV). Viroids and Prions. Mycoplasma diseases- Sandal spike, little leaf of vinca rosea, grassy shoot of sugarcane. Bacterial diseases- citrus canker, black arm of cotton 11 hrs

Unit-3 Algae, Fungi and Lichens: Introduction, classification, thallus organization, reproduction, lifecycle and economic importance of Algae, Fungi and Lichens. Type studies in Algae – *Nostoc*, *Chlorella*, S*pirulina*, Diatoms, Batrachospermum, Sargassum. Type studies in Fungi – *Rhizopus*, Xylaria, *Puccinia*, *Alternaria*, *Cercospora*. Type studies in Lichens- *Rhizocarpon*, *Xanthoparmelia*, *Cladonia*. 11 hrs

Unit-4 Bryophytes and Pteridophytes: Origin, distribution, general account and classification of Bryophytes and Pteridophytes. Structure, reproduction and life cycle in Marchantiales, Jungermanales, Anthocerotales, Sphagnales and Polytrichales. Stelar evolution, seed habit and heterospory of Pteridophytes. Psilopsida - comparative account of Psilophytales and Psilotales. Lycopsida – vegetative habits and reproductive features with reference to Lepidodendrales, Lycopodiales and Isotales. Economic and ecological importance of Bryophytes and Pteridophytes. 11 hrs

Unit-5 Gymnosperms: Introduction, classification, morphology, anatomy and reproduction in Cycadales - *Cycas* and *Zamia*. Ginkgoales –*Ginkgo biloba*. Coniferales – *Pinus* and *Araucaria*. Gnetale - *Gnetum* and *Ephedra*. Economic Importance of Gymnosperms. 11 hrs

Reference books:

1. Kumar HD (1999). Introductory Phycology. Affliliated East-West. Press Pvt. Ltd, Delhi, 2nd edition.
2. Tortora GJ, Funke BR, Case CL (2010). Microbiology: An Introduction, Pearson Banjamin Cummings, USA. 10th edition.
3. Sethi IK and Walia SK (2011) Text book of Fungi & their Allies, MacMillan Publishers Pvt. Ltd., Delhi

4. Alexopoulos CJ, Mims CW, Blackwell M (1996) Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven P.H., Johnson GB, Losos JB, Singer SR (2005). Biology. Tata McGraw Hill Delhi, India.
6. Vashishta PC, Sinha AK, Kumar A., 2010. Pteridophyta, S.Chand. Delhi, India
7. Bhatnagar SP and Moitra A (1996). Gymnoperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar NS (19910 An introduction to Embryophyta. Vol-1. Bryophyta. Central Book Depot. Allahabad.

Course outcomes (COs):

At the end of the course students will be able to:

CO1: Identify the major groups of organisms with an emphasis on plants also able to classify them with in a phylogenetic framework.

CO2: This course also offers to compare and contrast the characteristics of plants, non-vascular and vascular plants that differentiate them from each other and from other forms of life.

CO3: Able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth.

CO4: Able to give specific examples of the physiological adaptations, development, reproduction and mode of life cycle followed by different forms of plants.

CO5: Understand the relationships between environment and life on earth by tracing energy and nutrient flow through the environment.

CO6: Able to relate the physical features of the environment to the structure of populations, communities and ecosystems.

M.Sc. Botany First Semester

Course: Systematics of Angiosperms	Course Code:21 BOT 1C2L
Teaching Hours/Week (L-T-P): 4 - 0 – 0	No. of Credits: 04
Internal Assessment: 30 Marks	Semester End Examination: 70 Marks

Course objectives:

1. Acquire knowledge of plant identification using dichotomous keys and classify plant diversity
2. Understanding of plant morphology terminologies and identifying morphological peculiarities of plant and plant families.
3. Major features and evolutionary origins of vascular plants
4. Understand the core systems of classification of angiosperms, nomenclature and interdisciplinary approaches and development of various classification systems
5. Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance.
6. Evaluate the medicinal importance of selected angiosperms

Unit-1 General Characters of Angiosperms; Meristems; Mature Tissues: Simple Tissues, Complex Tissues; Epidermal Tissue System: Root, Stem and Leaf – comparative studies, Specialized Stem, Leaf and Root, Abscission. Flower; Transition and Formation of floral organs; Morphological Nature of Flower; Vascular Anatomy of the Flower; Fruits: Simple and Compound Fruits, False Fruits, Development; Fruit Abscission; Apomixis; Seed; Diversity in Seed Form. Pollination; Attractants for Pollinators; Specific Pollinators and Behaviour; Flowers – Pollinator Coevolution; Deception of Flower visitors 11 hrs

Unit-2 Taxonomy: Scope, History and Principles of Taxonomy; Carolus Linnaeus and his contributions to plant Taxonomy; A brief account of the concept of family, genus and species; concept of primitive flower and evolutionary tendencies. Phylogenetic systems of classification (APG-III) (Cronquist, Takthajan and Thorne), system of classification. ICBN - Principles, priority, valid publication and effective publication, citation. ICNCP, Classification of cultivated plant species, documentation and registration of cultivated plants. Study & classification of RET species of Karnataka and India 11 hrs

Unit-3 Herbaria and their importance. Preparation and maintenance of herbarium specimens. Brief account on the herbaria of world and India. Botanical gardens of world and India. Importance of Botanical gardens. Establishment of Botanical garden. Botanical Survey of India. 11 hrs

Unit-4 Taxonomic study and economic importance of tree species of each family Ranunculaceae, Magnoliaceae, Leguminoceae, Caryophyllaceae, Meliaceae, Rhiophoraceae, Orchidaeae, Aristalochacae, Asclepiadaceae, Dioscoriaceae, Bignoniaceae, Solanaceae, Lauraceae, Loranthaceae, Euphorbiaceae, Asteraceae, Arecaceae, Typhaceae and Poaceae. 11 hrs

Unit-5 Flora writing: Preparation of dichotomous key, Identification plants by using key. Role of Taxonomy with relation to Anatomy, embryology, cytology, molecular biology, genetics, histology. An introduction to chemotaxonomy, Numerical taxonomy, Molecular taxonomy and phylogenetics. 11 hrs

Reference books:

1. Airy-show, H.K. 1983. Eighth edition. A dictionary of flowering plants and ferns, Cambridge Uni. Press.
2. Cronquist, A. 1968. The Evolution and classification of flowering plants, Thomas Nelson and Sons Ltd., London.
3. Jain S K and Rao RR. 1973. *A Handbook on field herbarium Methods. T*oday and Tomorrow's Printers and Publishers, c1977.
4. Bennet, S.S.R. 1979. An introduction to plant nomenclature, InternationalBook Distributors, Dehradun.
5. Cronquist, A. 1968. The evolution and classification of flowering plants, Thomas Nelson and Sons Ltd.London.
6. N.P. Singh. *Flora of Eastern Karnataka* .Vol I and Vol. II. Mittal Publications, Delhi.
7. O.P. Sharma. *Plant Taxonomy.* Second edition. McGraw Hill Education Pvt. LTd., Chennai.
8. Davis, P.H. (2011). Principles of Angiosperm Taxonomy. Scientific Publishers, Jodhpur
9. Stace, C.A. (1989). Plant Taxonomy and Biosystematics. Edward Arnold Press, UK
10. Singh, V. (2010). Taxonomy. Rastogi Publication, Meerut. 4. Verma, B.K. (2011). Introduction to Taxonomy of Angiosperms. PHI Learning Private Limited, New Delhi. 5.
11. Subramanyam, N.S.(1996). Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd. New Delhi.
12. Esau, K. (2006). Anatomy of Seed Plants. Wiley
13. Roy, P. (2010). Plant Anatomy. New Central book Agency, New Delhi.
14. Pandey, B.P. (2001). Plant Anatomy. S.Chand& Company Ltd. New Delhi.
15. Dwivedi, J.N. & Singh, R.B. (1986). Anatomy of Angiosperms. Central book Depot, Allahabad.
16. Bhojwani, S.S., Bhatnagar, S.P. &Dantu, P.K. (2014). The Embryology of Angiosperm. Vikas Publishing House Pvt. Ltd., New Delhi.
17. Jeffery, C. 1982. Sec. Edn. An introduction to plant taxonomy, Cambridge Uni.Press.
18. Jhori, B.M. and Bhatnagar, S. P. 1994. Taxonomy of Angiosperms. NarosaPublishers, NewDelhi.
19. Jones, S. B. and Luchsinger, A. E. 1979. Plant Systematics McGrew Hill Book Co. N.Y.

Course outcomes (COs):

At the end of the course students will be able to:

CO1: Describe each organ of flowering plants.
CO2: Understand diversity of leaves, flowers, roots, fruits seeds of flowering plants.
CO3: Understand concepts of pollination and behavior of pollinators.
CO4: To classify plants proposed system of classifications.
CO5: Prepare herbarium and techniques of maintaining herbarium.
CO6: Technically describe families of flowering plants.
CO7: Develop concept of Phylogenetic systems of classification
CO8: Identify and classify RET species

M.Sc. Botany First Semester

Course: Plant pathology and protection	Course Code:21 BOT 1C3L
Teaching Hours/Week (L-T-P): 4- 0 - 0	No. of Credits: 04
Internal Assessment: 30 Marks	Semester End Examination: 70 Marks

Course objectives:

1. Learn the concepts and types disease in plants.
2. Identify major principles of plant pathology and factors causes diseases.
3. Recognize the etiological agents/ microbes responsible for plant disease and disease cycle and life cycle of various important diseases.
4. Study and Employ methods to diagnose and manage a wide range of plant diseases.
5. Describe aspects of integrated pest management.
6. Explain the impact of plant disease on humans.

Unit-1	Concept of plant disease: History and development of plant pathology, Disease concept in plants, disease classification, Effect of the pathogen. Plant pathology in practice- Plant Clinic and Plant Doctor Concept. Effect of the pathogen on the physiology of host plant (photosynthesis, translocation, transpiration, respiration, permeability, transcription, and translation).	11 hrs
Unit-2	Epidemiology of plant diseases: Traditional and modern concepts of disease triangle. Role of the host, pathogen, and environment in disease development. Aerobiology in relation to Epidemiology. Methods of monitoring splash borne and airborne inoculum.	11 hrs
Unit-3	Disease assessment: Methods of assessment of disease incidence and disease severity and estimation of yield loss. Study of plant diseases of major crops Ballari region caused by fungi, bacteria, and viruses (with reference to symptoms, etiology, and control).	11hrs
Unit-4	Management of plant diseases: Regulatory methods- plant quarantine, regulation, inspection, and certification. Physical methods- heat and cold treatment. Cultural methods- crop rotation, flooding, solarization, trap crops. Chemical methods - prophylactics and systemic chemicals. Biological methods- use of antagonistic microorganisms. VAM fungi and control of soil-borne diseases. Cross protection.	11hrs
Unit-5	Study of diseases of crop plants: Potato spindle tuber disease, Tobacco Mosaic Disease, sandal spike disease, the bacterial blight of paddy, citrus canker, late blight of potato, downy mildew of maize, grain and head smut of sorghum, tikka disease of groundnut. Non-parasitic diseases of plants. Seed-borne diseases.	11 hrs

Reference books:

1. Agrios,G.N.PlantPathology, FourthEdition1997,AcademicPress,USA.
2. Burdon:DiseasesandPlantpopulationbiology.CambridgeUniversityPress,Cambridge.
3. S.Nagarajan:PlantDiseaseEpidemiology.OxfordandIBHPublishingCo.NewDelhi(1983).
4. M.S.WolfeandC.E.Caten(Eds.)PopulationofPlantPathogenBlackwellScientificPublication.Oxford (1987)
5. Ilanchet(Ed.).Innovative Approaches to plant disease Control. Wiley Inter Science
6. Publication, IhonWileyand Sons, NewYork (1987)
7. S.A.Tarr.PrinciplesofplantPathology.MacMillanPublishers. Ltd. London.
8. P. H. Gregery. Microbiology of Atmosphere (2 Ed.) Leonard Hill Books 24 marketSquare, Aylesbury, Bucks(1961)
9. C.T.Ingold.Fungalspores,theirliberationanddispersaloxfordUniversityPress, London(1971)
10. R.T.V.Fox.PrincipleofdiagnostictechniquesinplantpathologyCABInternational,Wallingford,UK. (1993).

11. K.R.Aneja.Experiments in microbiology,PlantPathology and Tissueculture, WiswaPrakash an, NewDelhi, (1993)
12. V. N. Pathak. Laboratory Manual of Plant Pathology (2Ed.) Oxford and IBH Publishers,NewDelhi(1984)
13. Rangaswamy,G.DiseasesofCropPlantsinIndia,PrenticeHall,NewDelhi,1979.
14. R.S.Singh,IntroductiontoPrinciplesofPlantpathology, OxfordandIBH NewDelhi.
15. Wheeler,B.E.J.AnIntroductiontoPlantdiseases,JohnWiley&SonsLtd.UK.1972

Course Outcomes (COs):

At the end of the course students will be able to:

CO1: understand the principles of host-pathogen interactions and how diseases occur in plants. The defence mechanisms of plants against plant pathogens and how other micro-organisms and humans have been able to manipulate the host-pathogen interaction to reduce and manage diseases.

CO2: Know the national and international relevance as it is dealing with the protection of food from pests and diseases for sustained food security.

CO3: Understand the science of the development of plant pathology in India and the World and the role of plant clinics and plant doctors in alleviating crop losses.

CO4: Explain the various pathological events during the progression of an infectious disease
CO5: Apply the principle of epidemiological sciences in studying the underlying mechanisms of spread of disease and controls required thereof to combat the spread of pathogens.

M.Sc. Botany First Semester

Course: Ecology and ecoinformatics	Course Code:21 BOT 1C4L
Teaching Hours/Week (L-T-P): 4- 0 - 0	No. of Credits: 04
Internal Assessment: 30 Marks	Semester End Examination: 70 Marks

Course objectives:

1. Learn about the different ecosystems and describe the habitats within ecosystem
2. Observe and identify organisms with similar needs that compete for resources
3. Describe the climate changes which cause organisms to thrive, become ill or perish
4. to systematically learn the ecosystem and ecosystem functioning
5. Describe how organisms modify environment to meet their needs

Unit-1	Ecosystem organization: Ecosystem structure and functions, primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies); litter fall and decomposition; mineral cycles in terrestrial and aquatic ecosystems Ecosystem management: Concepts; sustainable development; sustainability indicators.	11 hrs
Unit-2	Community ecology: Concepts of community and continuum; community attributes; species diversity (α, β and γ); community coefficients; concept of ecological niche. Community development: Models and mechanisms of ecological succession; changes in ecosystem properties during succession; Concept of climax.	11 hrs
Unit-3	Earth and its Atmosphere. Air pollution: Types and sources, Effects of SO2, NO2, O3, HF, photochemical smog and particulates on plants. Water Pollution: Types and sources; Effects on water quality, plants. Thermal pollution. Soil pollution: Types and sources, Effects of pesticides and heavy metals on ecosystems, mechanisms of metal toxicity, metallophytes. Radioactive pollution: Sources and hazards. Soil erosion and conservation.	11 hrs
Unit-4	Global Environmental Change. Global Environmental change issues. Stratospheric ozone layer: Evolution of ozone layer; Causes of depletion and consequences; Effects of enhanced UV-B on plants, microbes, animals, human health and materials; Biological action spectra; Global efforts for mitigation ozone layer depletion. Climate change: Greenhouse effects; Drivers of climate change; Greenhouse gases and their sources; Implications on climate, oceans, agriculture, natural vegetation, wildlife and humans; Effects of increased CO2 on plants; International efforts on climate change issues.	11 hrs
Unit-5	Remote Sensing and GIS: Definition and Components, Development, Platforms and Types. ; Indian Remote Sensing Satelites and Sensors. GIS Data Structures: Types (spatial and Non-spatial), Raster and Vector Data Structure.	11 hrs

Reference books:

1. Ambasht, R.S. and Ambasht, N.K.1999. A Text book of plantEcology.
2. Brij Gopal and N. Bhardwaj Elements ofEcology. Vikas publishing House. New Delhi.
3. Clements, F.E. (1916) Plant Succession: Analysis of the Development of Vegetation. Carnegie Institution of Washington Publication Sciences, 242, 1-512.E.P.Odum and G.W. Barrett. 2005. Fundamentals of Ecology. Cengage Learning India Pvt. Ltd.
4. H. R. Byers. 2006. General Meteorology. McGraw-Hill. 4. K. S. Valdiya. 1987. Environmental Geology. Tata McGraw-Hill.
5. Hanson, H.C. and E.D. Churchill, The Plantcommunity.
6. J. M. Wallace and P. V. Hobbs. 2006. Atmospheric Science – An introductory survey.Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
7. J.S. Singh, S.P. Singh and S.R. Gupta. 2008. Ecology, Environment & Resource Conservation. Anamaya Publications.
8. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
9. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
10. Kormondy, E.J. 1989. Concepts ofEcology.

11. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
12. Microbiology of the atmosphere, by P.h.Gregory.
13. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
14. Odum, E.P. 1971. Fundamentals ofEcology.
15. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
16. Robert Leo. Smith 1980. Elements of Ecology and fieldBiology.
17. Sarkar, A. (2015) Practical geography: A systematic approach. Orient Black Swan Private Ltd., New Delhi 10. Chauniyal, D.D. (2010) SudurSamvedanevamBhogolikSuchanaPranali, Sharda Pustak Bhawan, Allahabad
18. Sharma, P.D. 1999. Ecology andEnvironment.
19. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
20. T. R. Oke. 2006. Boundary layer climates. Methuen & Co. Ltd. 2. S. Pal Arya. 2001. Introduction to Micrometeorology. Academic Press.
21. Wolf P. R. and Dewitt B. A., 2000: Elements of Photogrammetry: With Applications in GIS, McGrawHill.

Course outcomes (COs):

At the end of the course students will be able to:

CO1: Understand various structure and functions of ecosystem

CO2: Realize Importance minerals, in sustainable development of ecosystem.

CO3:Acquire a broad base of knowledge of ecology and environmental systems, including the Earth's atmosphere, hydrosphere, lithosphere, and biosphere.

CO4: The students will be able to assess and conduct environmental impacts and uses of remote sensing and GIS on various ecosystems and this program helps to study the management and control of air, soil and water pollution.

CO5: This programme on a broader sense will enable the students to opt for a career in the academia, central and state pollution control boards, MoEFCC, industries, laboratories, and can opt for Ph.DProgrammes.

M.Sc. Botany First Semester

Course: Modern methods of plant analysis	Course Code:21BOT1S1P
Teaching Hours/Week (L-T-P): 1- 0 - 2	No. of Credits: 02
Internal Assessment: 20 Marks	Semester End Examination: 30 Marks

Course objectives:

1. Learn broad knowledge in modern analytical instrumentation with deep knowledge in its core concepts and its applications
2. Understand the principle, instrumentation of different types of light microscopy and electron microscopy and their applications in various fields of research
3. Acquire knowledge about the basics and latest developments in the instrumentation techniques of centrifugation, electrophoresis, spectroscopy, chromatography and their applications in various research fields
4. Learn about basic radioactivity principles, measurement and its biological applications

Unit-1 — 8 hrs

Microscopy:
Principle and applications of dissecting, compound microscope, phase-contrast microscope, confocal microscope, scanning electron microscope (SEM) and transmission electron microscope (TEM), atomic force microscope (AFM), scanning tunnelling microscope (STM), camera lucida
pH meter and centrifugation:
pH meter: principles and applications. Centrifugation: principles, types of centrifuges, types of rotors, ultracentrifugation, application, sonication, freeze drying.
Chromatography:
Chromatography techniques: principle and applications – paper, thin layer, column, gas, ion-exchange, high performance liquid chromatography

Unit-2 — 8 hrs

Electrophoretic, blotting and PCR techniques:
Principle and applications of SDS-PAGE (protein separations), agarose gel electrophoresis (DNA and RNA separations),

Polymerase chain reaction, quantitative real-time PCR, colony PCR, RT-PCR, western blotting, southern blotting and northern blotting techniques,

Genome editing/ Crisper-cas9, radio-immune assay (RIA), ELISA, micro-array and sequencing technique
Spectroscopy:
Introduction, principle of Beer-Lamberts Law, Colorimetry and Spectrophotometry. Ultra-violet and visible spectroscopy (UV-Vis), Mass-spectroscopy, NMR spectroscopy, Flow cytometry and their applications

Unit-3 — 11 hrs

Experiments

1. pH meter: instrumentation and working principle
2. Preparation of buffers with acidic pH to alkaline pH
3. Centrifugation: Instrumentation and working principle
4. Separation of genomic DNA using agarose gel electrophoresis
5. Separation of plasmid DNA by alkaline lysis method using agarose gel electrophoresis
6. Separation of RNA by Trizol method using agarose gel electrophoresis
7. Determination of absorption spectrum of chlorophyll pigment in the visible light range (350 to 700 nm) using spectrophotometry
8. Estimate the total phenols present in the given plant extract using spectrophotometer
9. HPLC analysis of purified phytocompounds

Reference books:

1. Birren R.E. et al., 2006. Genome analysis-A laboratory manual Vol-I: Analyzing DNA Panima Publishing House (reprinted) New Delhi/ Bangalore.
2. Bold RW and Primerose SB. Principles of gene manipulation- An introduction to genetic engineering. Black Well Scientific Publications. London, Edinburg, Boscon
3. Introduction to plant Biotechnology, Oxford and IBH Publishing Co. Pvt Ltd. New Delhi.
4. Datta A. 2009. Experimental Biology-A Laboratory Manual. Narosa Publishing House. New Delhi.
5. Gurumani N. 2005. Research methodology for Biological Sciences M.J.P.
6. Marimuthu R. 2011. Microscopy and microtechniques
7. Pratibha Devi. 2000. Principles and methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios (India).
8. Rick Wood D and Hames B.D., 1990. Gel electrophoresis of Nucleic acid – A practical approach, III edition IRL presses Oxford. New York
9. Shukla YM., Dhruve JJ., Patel NJ., Bhatnagar R., Talati JG and Kathiria KB., 2009. Plant secondary metabolites, New India Publishing House, New Delhi.
10. Veena Kumari., 2006. Bioinstrumentation. M.J.P. Publication.
11. Gregery PH., 1961. Microbiology of Atmosphere (2 Ed). Leonard Hill Books 24 market square, Aylesbury, Bucks.
12. Ingold CT., 1971. Fungal spores, their liberation and dispersal oxford University Press, London.
13. Fox RTV. 1993. Principle of diagnostic techniques in plant pathology CAB International, Wallingford UK.
14. Aneja KR. 1993. Experiments in microbiology. Plant pathology and Tissue culture, WiswaPrakashan, New Delhi
15. Pathak VN. 1984. Laboratory Manual of Plant pathology (2 Ed) Oxford and IBH Publishers, New Delhi.

Course outcomes (COs):

At the end of the course students will be able to:

CO1:Knows the general safety routines for laboratory work in molecular biology
CO2:Understand the basic principles of different bioanalytical techniques, electrophoresis, PCR, western blotting spectroscopy, chromatography techniques
CO3:Demonstrate separation of proteins from the different tissue extracts by PAGE
CO4:Separate amino acids by paper and thin layer chromatography
CO5:Practice isolation of biomolecules from biological samples
CO6:Separate plant pigments and secondary metabolites from the different plant tissue / organ extracts by column chromatography
CO7:Perform DNA amplification using PCR

M.Sc. Botany First Semester

Course:Plant diversity and human welfare	Course Code:21 BOT 1C1P
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 20 Marks	Semester End Examination: 30 Marks

Course Objectives:

1. This course is intended to learn about plants and their impact on humans.
2. Which include plant as food, medicine and many other basic needs of humans.
3. How plants are distributed and influence the human population as natural resource.
4. How we are all depend on plant diversity and humans are deteriorating it.
5. Conservation of these precious diversity and maintain sustainable utilization of plants.
6. Explore and learn using plants and plant products to cater human need without harming world plant community.

List of Experiments

1. Laboratory safety guidelines and design, Tools and equipment's for studying microorganisms.
2. Preparation of stains and fixatives
3. Staining of Bacteria: Gram's staining
4. Demonstration of Bacterial motility
5. Determination of microbial counts using haemocytometer
6. Collection and study of algae, identification using monographs
7. Isolation of fungi from soil using serial dilution technique
8. Study of morphological and reproductive structures of fungi
9. Collection, preservation and identification of Bryophytes (minimum 2 genera from each group)
10. Thallus structure, anatomy and reproductive features of *Riccia, Anthoceros, Funaria* and *Polytrichum*
11. Habit, anatomy and reproductive features of *Psilotum, Lycopodium, Isoetes, Equisetum, Ophioglossum*and *Osmunda*
12. Habit, anatomy and reproductive features of *Pteris, Ceretopteris, Hymenophyllum, Marselia, Salvinia* and *Azolla*.
13. Habit, anatomy and reproductive features of *Zamia, Ginkgo, Araucaria, Podocarpus, Agathis, Ephedra* and*Gnetum*
14. Types of fossils and fossiliferous rocks
15. Study of available fossil specimens and slides of Pteridophytes and Gymnosperms
16. Submission of herbarium
17. Paleobotany- Study of Lepidodendrales, Calamitales, Sphenophyllales and Coenopteridales (Fossil Pteriodophytes).
18. Gymnosperms: Study of morphology, anatomy and reproductive morphology of *Cyacs, Pinus, Auracaria, Podocarpus, Agathis, Cupressus*, and *Thuja*; *Ephedra, Gnetum, Ginkgo*. Economic importance of Gymnosperms

Note: Submission of 5 herbarium

References Books:

1. Krishnamurthy K. V. 2007. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford & IHB Publishing Co. Pvt. Ltd. New Delhi.
2. Christian Leveque and Jean-Claude Mounolou, 2003. Biodiversity. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
3. Jeffries Michael J. 2006. Biodiversity and conservation, 2nd edn. Taylor and Francis Group, New York.
4. Holt, J.G., Krige, N.R., Sneath., P.H.A. Stuley, J.T. and Williams, S.T. 2010. Bergey`s Manual of Determinative Bacteriology, 9th edn. Williams and Wilkins, USA.
5. Smith, G.M. 1951. Manual of Phycology. Pub. Co. Waltham., Mass.

6. Schenck, N.C. and Perez, Y.1990. Manual for the identification of VA mycorrhizal fungi. InternationalCulture Collection of VA Mycorrhizal Fungi. Synergistic Publications, Gainesville, Florida, USA.
7. Jain, S.K. 1995. Manual of Ethno-botany, Scientific Publishers, Jodhpur.
8. Sambrock, J., Fritch, E.F., and Maniatis, T. 1989. Molecular cloning- a laboratory manual.
9. Croiat, 1952. Manual of Phytogeography.

Course outcomes (COs):

At the end of the course students will be able to:

CO1:Review the characteristics of organisms belonging to the Kingdom Plantae
CO2:Review the alternation of haploid and diploid cells and structures in plants
CO3:Develop understanding of the concept and scope of plant biodiversity
CO4:Identify the causes and implications of loss of biodiversity
CO5:Apply skills to manage plant biodiversity
CO6:Conceptualize the role of plants in human welfare with special reference to India.

M.Sc. Botany First Semester

Course: Systematics of Angiosperms	Course code: 21 BOT 1C2P
Teaching Hours/Week (L-T-P): 0- 0 - 4	No of credits – 02
Internal Assessment: 20 marks	Semester end Examination: 30 marks

Course objectives:

1. Understand the systems of classification of angiosperms, nomenclature and interdisciplinary approaches
2. Provide lab-based training in writing short species description and illustration
3. Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance
4. Evaluate the medicinal importance of selected angiosperms
5. Develop skills for identification of plants using dichotomous keys
6. Collect, preserve and identify herbarium specimens in a phylogenetic context
7. Pursue higher studies to get employability opportunities.

List of Experiments

1. Description of plants using technical terms
2. Identification of plants to family level
3. Identification of plants to species level using flora
4. Preparation of Dichotomous Key for identification
5. Listing of endangered species
6. Study of locally available economically important plant products
7. Map indicating origin of crop plants
8. Preparation of herbarium of locally available plants
9. Extraction of essential oils using Clevenger's apparatus
10. Estimation of carbohydrates cereals and proteins in pulses

Note: Submission of 5 herbarium / photographs of plant specimens during practical examination.

Reference Books:

1. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.A. and Donoghue, M.J. 2002. Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
2. Gurucharan Singh. 2004. Plant Systematics: Theory and Practice, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Jeffrey, C. 1982. An introduction to Plant Taxonomy. II Edn., Cambridge Uni. Press.
4. Mondal, A.K. 2009. Advanced Plant Taxonomy. New Central Book Agency Pvt. Ltd., Kolkata, WB.
5. Pullaiah, T. 1998. Taxonomy of Angiosperms. Regency Publications, New Delhi.
6. Johri, B.M. and Bhatacharjee, S.P. 1994. Taxonomy of Angiosperms. Narosa Publishers, New Delhi.
7. Lawrence, G.H.M. 191. Taxonomy of Vascular Plants. MacMillan, London.
8. Chase, M.W. and Reveal, J.L. 2009. A phylogenetic classification of the land plants to accompany APG III. Botanical Journal of Linnaean Society, 161: 122-127.
9. Nei, M. and Kumar, S. 2000. Molecular Evolution and Phylogenetics. Oxford Univ. Press, New York

Course outcomes (COs):

At the end of the course students will be able to:

CO1:Understand the plant morphological terminologies and morphological diversity of plants.
CO2:Learn the system and scheme of classification of angiosperms, nomenclature and identification of plants

CO3: Gain proficiency in the use of taxonomic keys and identification manuals for identifying any unknown plants to species level.
CO4:Provide lab-based training in writing short species descriptions and illustration with floral diagram.
CO5:Recognize members of the major angiosperm families by identifying their diagnostic features and study their ecological distribution and their economic importance.
CO6:Learn the techniques of herbarium preparation and maintenance

M.Sc. Botany First Semester

Course: Plant pathology and protection	Course code: 21 BOT 1C3P
Teaching Hours/Week (L-T-P): 0- 0 – 4	No of credits – 02
Internal Assessment: 20 marks	Semester end Examination: 30 marks

Course objectives:

1. Introduce students to basic principles and concepts of plant pathology
2. Introduce and illustrate the major groups of organisms that cause plant diseases
3. Identify the etiological agents of disease
4. Employ methods to diagnose and manage a wide range of plant diseases
5. Explain the impact of plant disease on human affairs

List of Experiments

1. Study of locally available diseases
2. Preparation of herbarium of disease specimens
3. Study of Koch's postulations
4. Assessment affected leaf area by Stover's method
5. Field visits to assess disease incidence and severity
6. Estimation percent of spore germination
7. Experiment to show fungicidal inhibition of spore germination
8. Study of Fungal bio-control agents.
9. Isolation of fungi from disease plants/ parts
10. Estimation of total phenols in diseased and healthy plant tissues.
11. Isolation of bacterial, fungal, and nematode plant pathogens of crop plants.
12. Myco-flora analysis by Standard Blotter Method SBM/agar plating method.
13. Study of mineral deficiency diseases of Tomato and French bean.
14. Study of Tobacco mosaic, bacterial blight, downy mildew of maize, powdery mildew of cucurbits, grain smut of sorghum, leaf rust of coffee, root knot of mulberry, bunchy top of banana, grassy shoot of sugar cane, little leaf of brinjal, potato spindle tuber disease (PSTVd)

Reference Books:

1) Agrios, G. N. 2005. Plant Pathology 5th edn. Academic Press, San Diego.
2) Dickinson, M. 2003. Molecular Plant Pathology, Garland Publishing Inc, CT.
3) Ingram,D.S. and Robertson, N.F. 1999. Plant Diseases, Collins Publishers, London.
4) Johnston, A and Both, C. 1983. Plant Pathologists Pocket-book. 2nd edn. Commonwealth Mycological Institute, Oxford and IBH Pub. Co. Calcutta.
5) Lane, C.R., Beales P.A. and Hughes, K.J.D. 2012. Fungal Plant Pathogens, CABI Publishing, Wallingford. 17.

Course outcomes (COs):

At the end of the course students will be able to:

CO1:Understand the science of development of Plant Pathology in India and the World and the role of Plant Clinics and Plant Doctors for alleviating crop losses.
CO2:Know the mechanism of disease development and genetics of host pathogen interactions.
CO3:Study the plant diseases caused by different ethological agents, symptoms, epidemiology and their management.
CO4:Understand the disease management practices such as regulatory, cultural, physical, biological, chemical and biotechnological approaches including IDM.
CO5:Know the national and international relevance as it is dealing with protection of food from pests and diseases for sustained food security.