

**Karmaveer Bhaurao Patil University, Satara
Yashavantrao Chavan Institute of Science,
Satara**

**B. Sc. II (Botany)
As Per NEP-2020**

With effect from Academic Year 2023-2024

Syllabus for Bachelor of Science (B. Sc.) Part – II Botany

PREAMBLE:

The B. Sc. Botany course under autonomy will be effective from the academic year 2024-2025. It has been prepared to keep in view the unique requirements of B. Sc. Botany students as per NEP-2020. The contents have been drawn up to accommodate the widening horizons of the discipline of biological sciences. The emphasis is to provide students with the latest information along with due weightage to the concepts of classical botany so that they can understand and appreciate the current interdisciplinary approaches in the study of plant sciences and their role in societal development. The course content also lists new practical exercises so the students get a hands-on experience with the latest techniques that are currently in use. The course will also inspire students to pursue higher studies in botany, for becoming an entrepreneur, and enable students to get employed in plant-based industries.

GENERAL OBJECTIVES OF THE COURSE:

- i. To impart the knowledge of plant science is the basic objective of this course.
- ii. To develop a scientific attitude among the students and to make the students open-minded, critical, and curious.
- iii. To develop skills in practical work, experiments, and laboratory materials.
- iv. To understand scientific terms, concepts, facts, phenomenon, and their relationships.
- v. To make the students aware of natural resources and the environment.
- vi. To enable the students to acquire knowledge of plants and related subjects to understand nature and the environment for the benefit of human beings.
- vii. To develop the ability for the application of acquired knowledge to improve agriculture and related fields to make themselves self-reliant.

PROGRAMME OUTCOMES :

After completing B. Sc. Programme the students will.....

1. Graduate with proficiency in the subject.
2. Develop scientific attitude and become open minded, critical and curious so that they enter research field with a positive approach.
3. Develop skill in practical work, experiments and laboratory materials.
4. Become eligible to continue higher studies in their subject in India as well as abroad.
5. Become eligible to appear for the examinations for jobs in government organizations.
6. Become eligible to appear for jobs with minimum eligibility as science graduate.
7. Be able to establish their own entrepreneurial ventures.
8. Acquire increased ability of critical thinking, development of scientific attitude, handling of problems

and generating solution, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value system

PROGRAM SPECIFIC OBJECTIVES:

- 1.The students are expected to understand the fundamentals, principles, concepts and recent developments in the botany.
2. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in botany.
3. It is expected to inspire and boost interest of the students in botany.
4. To develop the power of appreciations, the achievements in science and role in nature and society.
5. To enhance student sense of enthusiasm for science and to involve them in an intellectually stimulating experience of Course in a supportive environment.

PROGRAMME SPECIFIC OUTCOMES:

After completing B. Sc. (Botany) Programme the students will.....

- 1.Explain, describe, discuss and ask questions related to the different aspects of plant sciences.
- 2.Perform and design experiments related to plant sciences
- 3.Critically analyze the interactions between the living and non- living entities around them.
- 4.Apply the knowledge of plant sciences in finding sustainable solutions for the society as well as industry.
- 5.Apply the knowledge of plant sciences in becoming self- reliant either through entering into a job, establishing a model agricultural set up or initiating a plant based entrepreneurial venture
- 6.Design and undertake projects related to plant sciences
- 7.Attain skills needed in the plant based industries through internship.
- 8.Improve the research based skills by entering into a research internship as well as in house project.
- 9.Present their research findings in research conglomerations like conferences and in research journals in the form of publications.
- 10.Critically analyze their role as an environment sustainability goals oriented citizen

1. TITLE: Botany

2. YEAR OF IMPLEMENTATION: 2024 - 25

3. DURATION: 01 year

4.PATTERN: Semester examination.

5. MEDIUM OF INSTRUCTION: English

6. COURSE STRUCTURE:

Course Structure as per NEP-2020

Level	Sem	Subject - 1 Major		Subject - 2 Minor		VSC	SEC	AEC	VEC	CC	Total
		T	P	T	P						
		5	III	4 (2 Theory Paper)	4 (2 Practical Papers)						
5	IV	4 (2 Theory Paper)	4 (2 Practical Papers)	2	2	2	2	4	---	2	22

7.TITLE OF COURSE

1.THIRD SEMESTER

Sr. No.	Course Title	Theory				Practical		
		Course No. & Course Code	Title of Course	No. of lectures per week	Credits	Course No.& Course Code	No. of lectures Per week	Credits
1.	Botany (Major)	Course - I (BBT 231)	Plant Anatomy	5	4	Practical Course – I (BBP 233)	4	2
		Course - II (BBT 232)	Plant Biochemistry			Practical Course – I (BBP 234)	4	2
2.	Botany (Minor)	Course - I (BBT 235)	Plant Propagation Techniques	5	2	Practical Course – I (BBP 236)	4	2
3	Vocational Skill Course (VSC)	Course - I (BBPVSC 1)	Advanced Botanical Skills Part-I (Microtechniques, Slide preparation & Staining Techniques)	--	--	Practical Course - I	4	2
4	Skill Enhancement Course (SEC)	Course - I (BBPSEC 2)	Plant Photography- from laboratory to field	--	--	Practical Course – I (BBPSEC 2)	4	2
5	Value Education Course (VEC)	Course – I (BBTVEC 2)	Environmental studies in Botany	3	2	--	--	--
6	Ability Enhancement Courses (AEC)	BBTAEC 1	English for Communication I	--	2	--	--	--
		BBTAEC 2	English for Communication II	--	2	--	--	--

2.FOURTH SEMESTER

Sr. No.	Subject Title	Theory				Practical		
		Course No. & Course Code	Title of Course	No. of lectures per week	Credits	Course No. & Course Code	No. of lectures Per week	Credits
1.	Botany (Major)	Course - III (BBT 241)	Plant Embryology	5	4	Practical Course – II (BBP 243)	4	2
		Course - IV (BBT 242)	Plant Ecology & Environment			Practical Course – II (BBP 244)	4	2
2.	Botany (Minor)	Course - III (BBT 245)	Green House Technology	5	2	Practical Course – II (BBP 246)	4	2
3.	Vocational Skill Course (VSC)	Course - III (BBPVSC 2)	Advanced Botanical Skills Part-II (Plant Collection, Identification & Preservation)	--	--	Practical Course – II (BBPVSC 2)	4	2
4.	Skill Enhancement Course (SEC):	Course – I (BBPSEC 3)	Scientific writing	--	--	Practical Course – II (BBPSEC 3)	4	2
5	Cocurricular Course (CC)	BBTCC 2			2	--	--	--

Bachelor of Science (B. Sc.) Part - II: Botany (Major)

Semester-III

Course-I (BBT 231): Plant Anatomy

Course objectives: Students should be able to ...

1. aware about the basic concepts of anatomy.
2. imbibe anatomical framework of angiosperms.
3. understand the about the different types of tissue systems in plants.
4. know the concept of primary and secondary growth in plants

Credit=2	Plant Anatomy	No. of hours per unit=30Hrs
Unit-I	Organization of higher plant body	07
	1.1 Development of plant body 1.2 The plant organs; internal organization of the plant body (stem and leaf)	
Unit-II	Meristematic and Permanent Tissue	08
	Meristem: 2.1 Introduction, Characteristics and Classification of meristems based on position 2.2 Theories of structural development a) Apical cell theory b) Histogen theory; c) Tunica Corpus theory Permanent tissue: 2.3 Simple tissue- Parenchyma (Chlorenchyma, Arenchyma) Collenchyma and Sclerenchyma 2.4 Complex tissue: Xylem and Phloem; types of Vascular bundles	
Unit- III	Tissue systems	07
	3.1 Epidermal tissue system: Structure and Function; Uniseriate and multiple; epidermal outgrowths-unicellular, multicellular, glandular and non-glandular; stomata- structure, types and function. 3.2 Secretory tissue system: Glandular and lactiferous. 3.3 Mechanical tissue system: distribution of mechanical tissue in leaf, stem and root of dicot and monocot.	
Unit-IV	Primary and secondary structure of plant body	

4.1 Primary structure of root, stem and leaf of Monocotyledon and Dicotyledon.

4.2 Normal secondary growth in Dicotyledon root and stem

4.3 Structure and function of periderm (bark and lenticels)
Anomalous secondary growth; definition and causes, Anomalous secondary growth in *Bignonia* (Dicot) and *Dracaena* (Monocot) stem.

08

Course outcomes: Student will be able to...

1. analyze the composition of different parts of plant.
2. imbibe the meristematic tissue of plants.
3. identify different types of tissue systems in plants.
4. known different stages of growth in plants.
5. imbibe the primary and secondary structure of the plant body.
6. differentiate and understand plant tissue systems.

References:

1. Bowes B. G, Mauseth, J. D (2008) Plant structure: a colour guide. . 2 edn. London: Manson Publishing.
2. Cutler D. F, Botha T. (2008) Plant anatomy., Stevenson DW.: An applied approach. Oxford: Blackwell Publishing.
3. Evert RF. Esau's (2006) Plant anatomy, Meristems, cells, and tissues of the plant body: their structure, function, and development. 3rd edn. Hoboken, NJ: John Wiley & Sons, Inc.
4. Beck CB. (2005) An introduction to plant structure and development. 1st edn. Cambridge: Cambridge University Press.
5. Dickison W. C., (2000), Integrative plant anatomy. New York: Harcourt Academic Press.
6. Fahn A., (1974) Plant Anatomy, (2nd Edn.), Pergamon Press, Oxford.
7. Esau K, (1977), Anatomy of Seed Plants, (2nd Edn.), John Wiley and Sons, New York.
8. Chandurkar P. J., (1971), Plant Anatomy, , Oxford and IBH publication Co. New Delhi .
9. Pandey B. P, S. Chand. Plant Anatomy, & Company, Ltd., New Delhi.

Bachelor of Science (B. Sc.) Part - II: Botany (Major)

Semester-III

Course-II (BBT 232): Plant Biochemistry

Course objectives: The students should be able to...

1. understand the structure and behavior of biomolecules
2. study and understand the structure and properties of substance.
3. know biological role of biomolecules.
4. understand the basic knowledge of different aspects of enzymology.

Credit=02 Unit	Course -II: Plant Biochemistry	No. of hours per unit=30Hrs
Unit-I	Carbohydrates	07
	1.1 Introduction 1.2 Classification of Carbohydrates 1.3 Structure and properties of monosaccharides (glucose and fructose), oligosaccharides (sucrose and maltose) and polysaccharides (starch and cellulose); 1.4 Biological role of carbohydrates	
Unit-II	Protein	08
	2.1 Introduction 2.2 classification of Amino acids 2.3 Structure, properties and biological role of amino acids 2.4 Proteins - classification, structure (primary, secondary, tertiary and quaternary), properties and biological role of proteins	
Unit-III	Lipids	07
	3.1 Introduction 3.2 Classification of Lipids 3.3 Structure & properties of Lipids 3.4 Biological role of fatty acids and lipids	
Unit-IV	Enzymes	08
	4.1. Nomenclature and classification, 4.2. Mode of action, 4.3. Enzyme kinetics, Michaelis Menten equation, 4.4. competitive, non- competitive, and uncompetitive inhibitors.	

Course objectives: The students will be able to...

1. Classify a monosaccharide as an aldose or a ketose, and indicate the number of carbon atoms.
2. Evaluate the role of enzymes in plant physiology.
3. apply the knowledge and principles of plant biochemistry to analyze and understand the biochemical processes and metabolic pathways involved in crop growth, development, and metabolism.

References:

1. J.L.Jain, Sunjay Jain, Nitin Jain ., (2016), Fundamentals of Biochemistry-; S. Chand & Company Ltd.
2. Nelson, D.L. and Cox, M.M., (2013), Lehninger: Principles of Biochemistry, 6th ed., W.H. Freeman and Company (New York).
3. Berg, J.M., Tymoczko, J.L. and Stryer L., (2012), Biochemistry 7th ed., W.H. Freeman and Company (New York).
4. Devlin, T.M., (2011), Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New York).
5. P. S. Verma, V. K. Agarwal., (2005), Cell Biology, Genetics, Molecular Biology, Evolution and Ecology- S. Chand & Company Ltd.
6. Donald Voet, Judith G. Voet, Charlotte W. Pratt., (2016), Fundamental of Biochemistry, Wiley Publication.

Bachelor of Science (B. Sc.) Part - II: Botany (Practical Course-I)

Semester-III

Practical Course – I (BBP 233)

Course objectives: The students should be able to...

1. Know about anatomical features of plants.
2. Understand morphological features of angiosperm
3. Utilize the practical knowledge about various physiological processes.
4. Participate students in experiential learning with these practicals

Credit=02	Practical Course-I (BBP 233) (Practicals based on Course-I)	No. of hours per unit=30Hrs.
	<ol style="list-style-type: none">1. Study of shoot apex by permanent slides.2. Study of root apex by permanent slides.3. Study of simple tissues.4. Study of complex tissues.5. Study of epidermal tissue system.6. Study of mechanical tissue system.7. Study of secretory tissue system.8. Double stained permanent micro preparation of any suitable material.9. Study of primary structure of dicot stem.10. Study of primary structure of monocot stem.11-12. Studies of normal secondary growth in dicot stem (<i>Annona</i> / <i>Moringa</i>/ <i>Sunflower</i>) by temporary double stained preparation.13. Study of anomalous/abnormal secondary growth in <i>Bignonia</i> (Dicot stem).14. Study of anomalous/abnormal secondary growth in <i>Dracaena</i> (Monocot stem).15. Study of Periderm and Lenticel	

Course outcomes: The students will be able to...

1. identify meristematic tissue of plants.
2. compare different types of tissue systems in plants.
3. distinguish different stages of growth in plants.
4. examine primary and secondary structure of the plant body.
5. analyze the composition of different parts of plant.

References:

1. Adriance S. Foster, (2023) Practical Plant Anatomy, Maxwell Press, India
2. Richard Crang , Sheila Lyons-Sobaski , Robert Wise.,(2018) Plant Anatomy, Springer.
3. Sunita Gupta , N.K. Gupta & M.K. Sangha., (2016), Practicals in Plant Physiology and Biochemistry Manju Bala , Scientific Publishers.
4. Pandey B P, (2011), Modern Practical Botany, Vol. I, S. Chand and Company Ltd., New Delhi.
5. Wallis C. J.,(1966), Practical Botany for Advanced Level and Intermediate Students, (5th Edn.), William Heinemann Medical Books Ltd.
6. Bendre A., (2010), Practical Botany, Rastogi Publications, Meerut.

Bachelor of Science (B. Sc.) Part - II: Botany (Practical Course-II)

Semester-III

Practical Course – II (BBP 234)

Course objectives: The students should be able to...

1. gives an idea for the maintenance of a laboratory and the practices that should be accomplished in a laboratory.
2. understand the practical knowledge about various physiological processes.
3. participate students in experiential learning with these practicals

Credit=02	Practical Course-II(BBP 234) (Practicals based on Course- II)	No. of hours per unit=30Hrs.
	<ol style="list-style-type: none">1. Calculation and preparation of different normal and molar solutions.2. Preparation of buffers; determination of pH.3. Estimation of soluble protein by Lowry's method.4. Estimation of amino acids by Ninhydrin method.5. Chemical tests to demonstrate the presence of starch in plant material.6. Chemical tests to demonstrate the presence of sugar in plant material7. Chemical tests to demonstrate the presence of fat in plant material8. Chemical tests to demonstrate the presence of protein in plant material9. Separation of amino acids by paper chromatography10. Estimation of proteins by Biuret method11. Effect of temperature on the activity of Catalase enzyme12. Effect of pH on the activity of dehydrogenase enzyme13. Effect of substrate variation on the activity of amylase14. Identification of structure of protein15. Identification of structure of lipid16. Identification of structure of carbohydrate	

Course Outcomes: The students will be able to...

1. become familiar with qualitative and quantitative tests and data analysis for important biomolecules, as well as the professional operation of various equipment and reagents related to basic plant biochemical profiling.
2. equip themselves with the basic biochemistry techniques that can later applied for their laboratory research and also for many other industrial research.
3. acquainted the techniques of chromatography used in the field of life science.
5. explains how to prepare solutions and reagents for various methods of qualitative tests for proteins, carbohydrates and lipids.

References:

1. Gour Lokesh, Radheshyam Sharma and R. Shiv Rama Krishnan., (2020), Fundamental of Plant Biochemistry and Biotechnology-A Practical Book, AkiNik Publications.
2. Sunita Gupta , N.K. Gupta & M.K. Sangha., (2016), Practicals in Plant Physiology and Biochemistry Manju Bala , Scientific Publishers.
3. Pandey B P, (2011), Modern Practical Botany, Vol. I, S. Chand and Company Ltd., New Delhi.
4. Sadasivam and Manickam, (1996), Biochemical Methods, New Age International Publishers, New Delhi.
5. Wallis C. J.,(1966), Practical Botany for Advanced Level and Intermediate Students, (5th Edn.), William Heinemann Medical Books Ltd.

Bachelor of Science (B. Sc.) Part - II: Botany (Minor)

Semester-III

Course-I (BBT 235): Plant Propagation Techniques

Course objectives: Students should be able to...

1. understand the biology of plant propagation.
2. know different methods of asexual propagation.
3. discuss propagation by specialized structures.
4. observe different aspects of plant tissue culture.

Credit=02 Unit	Course-I (BBT 235) Plant Propagation Techniques	No. of hours
Unit-I	Plant Propagation	07
	1.1 Introduction. 1.2 Biology of propagation: Asexual and sexual methods of propagations; its advantages and disadvantages. 1.3 Apomixis and Polyembryony. 1.4 Propagation facilities: Mist chamber, humidifiers, greenhouses, glasshouses, poly-houses, phytotrons nursery - tools and implements. 1.5 Propagation by division and separations: Bulbs, pseudobulbs, corms, tubers and rhizomes; runners, stolon, suckers and offsets.	
Unit-II	Vegetative propagation	08
	2.1 Cuttings: Definition, types, Plant propagation by herbaceous, soft wood, semi hard wood, hard wood cuttings. 2.2 Physiological and biochemical basis of rooting; factors influencing rooting of cuttings; Use of plant growth regulators in rooting of cuttings. 2.3 Layering: Definition, Plant propagation by layering: tip layering, simple layering, trench layering, mound (stool) layering and compound (serpentine layering), air layering. 2.4 Grafting: Definition, scion-stock relationship; Propagation by whip, cleft, side, and bark grafting. 2.5 Budding: Definition; techniques of 'T', inverted 'T', patch and chip budding.	
	Plant Tissue culture	
	3.1 Introduction and history of plant tissue culture.	

Unit-III	3.2 Totipotency, differentiation, dedifferentiation, redifferentiation. 3.3 Culture media, phytohormones, and environmental conditions. 3.4 Applications of plant tissue culture. Micropropagation, embryo culture, Haploid Production, callus culture, cell culture, somatic embryogenesis. 3.5 Synthetic seeds.	07
Unit-IV	Hydroponics, aeroponics, and aquaponics	08
	4.1 Basics of different soil-less growing systems: hydroponics, aeroponics, aquaponics. 4.2 Commercial aspects and advancements. 4.3 Media used for Hydroponics: Clay, Rock wool, cocopeat, Perlite, Pumice, Vermiculite, Sand, Gravel, Hydroton, Polystyrene packing peanuts, wood fibre. 4.4 Techniques in hydroponics: Static solution culture, Continuous-Flow solution culture, Deep water culture, Aeroponics.	

Course outcomes: Students will be able to...

1. recognise different types plant propagation techniques.
2. identify sexual and asexual methods of plant propagation.
3. perform plant propagation using plant tissue culture.
4. distinguish between hydroponics, aeroponics, and aquaponics.

References:

1. Razdan, M.K., (2019) Introduction to Plant Tissue Culture (Third Edition); Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Gupta, P.K., (2019) Elements of Biotechnology (4th Reprint, Second Edition); Rastogi Publications, Meerut.
3. Bentone Jones Jr., J., (2014) Complete Guide for Growing Plant Hydroponically. CRC Press, Boca Raton.
4. Singh, B.D., (2010) Biotechnology. Kalyani Publishers, New Delhi.
5. Dubey, R.C., (2005) A Text book of Biotechnology S. Chand & Co, New Delhi.
6. Dej, S.C., (2003) Complete Home Gardening. Agrobias, Jodhpur, India.
7. Dawson, C. (2002) Practical research methods. UBS Publishers, New Delhi.
8. Kumar, N., (1997) Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
9. Khan, M.R., (1995) Horticulture and Gardening. Nirali Prakashan, Pune. India.

Bachelor of Science (B. Sc.) Part - II: Botany (Minor)

Semester-III

Practical Course -I (BBP 236)

Course objectives: The students should be able to...

1. introduce the different plant propagation methods.
2. explain the basic material, tools, and techniques required to establish a plant nursery.
3. demonstrate various practices followed in plant nurseries.
4. comprehend knowledge and skills required for plant nurseries.

Credit=02	Practical Course -I (BBP 236)	No. of hours per unit=30Hrs.
	<p>1-2. Study of vegetative modes of propagation (bulbs, bulbils, corms, rhizomes, tubers, runners, suckers, stolons, epiphyllous buds)</p> <p>3. Study of apomixis and polyembryony with the help of suitable material (For e.g. remnant seeds in grapes/ banana, polyembryony in <i>Citrus</i>).</p> <p>4. Visit to polyhouse/ greenhouse/ phytotron/ nursery facilities.</p> <p>5. Study of plant propagation by herbaceous/ soft wood/semi hard wood/hard wood cuttings.</p> <p>6. Study of plant propagation by layering technique.</p> <p>7. Study of plant propagation by grafting technique</p> <p>8. Study of plant propagation by budding technique</p> <p>9-10.. Preparation and sterilization of MS medium.</p> <p>11. Preparation of culture tubes, culture bottles and liquid cultures for plant tissue culture.</p> <p>12. Preparation and inoculation of explants in culture medium.</p> <p>13. Visit to commercial plant tissue culture laboratory.</p> <p>14. Study of preparation of synthetic seeds.</p> <p>15-16. Study of plant propagation using hydroponics.</p>	

Course outcomes: The students will be able to...

1. develop plant seedlings by vegetative propagules.
2. demonstrate micropropagation technique.
3. set up hydroponics system for plant propagation.
4. analyse the commercial aspects of plant propagation.

References:

1. Razdan, M.K., (2019) Introduction to Plant Tissue Culture (Third Edition); Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Bentone Jones Jr., J., (2014) Complete Guide for Growing Plant Hydroponically. CRC Press, Boca Raton.
3. Ray, P.K., (2012). Plant Nursery Management: How to Start and Operate a Plant Nursery. Scientific Publishers, Jodhpur.
4. Mason, J. (2004), Nursery management Landlinks Press, Australia.
5. Dawson, C. (2002) Practical research methods. UBS Publishers, New Delhi.
6. Kumar, N. (1997). Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
7. Mishra, K., Mishra, N. K., (1994). Plant Propagation, Chand, S. John Wiley & Sons, New Jersey.

Bachelor of Science (B. Sc.) Part - II: Botany (Vocational Skill Course)

Semester-III

Vocational Skill Course (BBPVSC 1)

Advanced Botanical Skills Part-I

(Microtechniques, Slide preparation & Staining Techniques)

Course objectives: Students should be able to...

1. impart basic knowledge about microtechniques.
2. understand the techniques of slide preparation.
3. know the various staining techniques and their uses in plant sciences.
4. understand the practical applications of microtechniques in plant sciences.

Credit=02	Practicals (BBPVSC 1) (Microtechniques, Slide preparation & Staining Techniques)	No. of hours allotted: 30hours
	<ol style="list-style-type: none">1. Study of various fixation techniques in plant sciences.2. Study of various staining techniques in plant sciences.3. Study of various clearing and mounting medium used in plant sciences.4-6. Study of various instrument which are used in Microtechniques (Microphotography, Scanning Electron Microscopy, Microtome, Centrifuge)7. Study of mitosis in <i>Allium cepa</i> roots.8. Study of meiosis in <i>Allium cepa</i> flower buds.9. Isolation of DNA from suitable plant specimen10-11. Study of different types of Microscopy (Light microscopy, fluorescence microscopy and light microscopy).12. Study of methods of slide preparation (whole mount, smear, squash and section).13. Study of preparation of permanent slides.14. Isolation of protoplast from given plant specimen.15. Study of Methods of microscopic measurement and data processing.16. Study of maceration techniques in plants.17. Study of different pre-treating agents used for chromosome separation.	

Course outcomes: The student will be able to...

1. use the various techniques of microscopy.
2. got basic knowledge of staining techniques.
3. apply microtechnique in various fields.
4. know the practical knowledge of micotechniques.

References:

1. Archana Sharma, (2020), Chromosome Techniques: A Manual.
2. S Ruzin, (1999), Plant Microtechnique and Microscopy.
3. ECT Yeung, C Stasolla, MJ Sumner, BQ Huang, (2015), Plant Microtechniques and Protocols.
4. Donald Alexander Johansen, (1940), Plant Microtechnique.
5. GP Berlyn, JP Miksche, (1976), Botanical microtechnique and cytochemistry. Iowa State University Press, Ames .
6. Johansen DA (1940) Plant microtechnique. McGraw-Hill Book, New York.
7. Sass JE (1958) Botanical microtechnique. Iowa State University Press, Ames.
8. Fowke, L.C., Rennie, P.J. (1995). Botanical Microtechnique for Plant Cultures. In: Gamborg, O.L., Phillips, G.C. (eds) Plant Cell, Tissue and Organ Culture. Springer Lab Manual. Springer, Berlin, Heidelberg.

Bachelor of Science (B. Sc.) Part - II: Botany (Skill Enhancement Course)

Semester-III**Skill Enhancement Course (SEC) (BBPSEC 2)****Plant Photography-from laboratory to field**

Course objectives: Students should be able to...

1. understand the basics of photography and its importance.
2. identify equipments needed for photography.
3. know copyright issues related to photography.
4. understand photography skills along with scientific perception.

Credit=02	Skill Enhancement Course (SEC) (BBPSEC 2) Plant Photography-from laboratory to field	No. of hours allotted: 30 hours
	1-2. Study of photography and its types 3. Study of Indoor and Outdoor Photo Shoots 4. Study of types of camera and accessories 5-6. Study of shooting quality images 7. Study of Light and shadow as requirements in photography 8. Study of Colour and Black & White Photography 9-10. Study of any suitable photoshop software 11-12. Study of Digital Photography 13-14. Study of Processing of digital photographs 15. Study of Macro photography 16-17. Study of Micro photography 18-19. Study of Labelling of Photographs 20. Ethics in photography and nature photography	

Course outcomes: Students will be able to..

1. recognise different equipments needed for photography.
2. take photographs of plants in the laboratory as well as in field with scientific viewpoint.
3. conduct photography sessions of plants with professional finesse.
4. comprehend and implement copyright regulations while taking photographs of plants.

References:

1. Gerlach J. and Gerlach B., (2013) Digital Wildlife Photography, Focal Press, Taylor and Francis Group.
2. Arbabi S., (2011) The Complete Guide to Nature Photography. Amphoto Books, Crown Publishing Group, New York.
3. Shaw J., (2000) Nature Photography Field Guide. Amphoto Books, Crown Publishing Group, New York.
4. Harnischmacher C., (2016). Complete guide to Macro and Close-up Photography. Rocky Nook.
5. Broll B., (2010) Microcosmos: Discovering the World through Microscopic Images from 20 X to Over 20 Million X Magnification. Firefly books.
6. Saikia N., (2015) Art and Indian Copyright Law- A statutory Reading.

Bachelor of Science (B. Sc.) Part - II: Botany (Value Education Course)

**Semester-III
Value Education Course (VEC) (BBTVEC 2)
Environmental Studies in Botany**

Course objectives: The students should be able to...

1. understand the environmental issues.
2. relate that laws made to safeguard the environment.
3. know importance of sustainable development.
4. correlate knowledge of sustainable development with plant sciences.

Credit=02 Unit	Value Education Course (VEC) (BBTVEC 2) Environmental Studies in Botany	No. of hours per unit=30Hrs
Unit-I	Environmental issues	10
	1.1 Pollution (Air, Water and Land), 1.2 Fresh-water overuse, 1.3 Natural disasters, 1.4 Fuel and Energy shortage due to overuse, 1.5 Increase in wasteland, 1.6 Biodiversity loss, 1.7 Global warming and climate change (Causes and intensity of the problem), 1.8 Role of Botany in creation of environmental issues	
Unit-II	Environmental laws and ethics	07
	2.1 Environmental Protection Act 2.2 Wildlife Protection Act 2.3 Forest Conservation Act 2.4 Prevention and Control of Pollution Act (Air, water and Land), 2.5 From unsustainable to sustainable development, 2.6 Responsibilities of an Environmentally aware citizen.	
Unit-III	Sustainable Development Goals	07
	Global sustainable goals with emphasis on environment related Sustainable Development goals	
Unit-IV	Role of Plant Sciences in meeting the sustainable development goals.	06
	Examples and case studies	

Course outcomes: The students will be able to...

1. explain the causes of environmental issues
2. discuss concepts related to environmental laws and ethics.
3. discuss the sustainable development goals.
4. compare and analyze the importance of plant sciences in meeting the sustainable development goals.

References:

- 1.S. K. Agarwal, (2008), Fundamentals of Ecology (New Delhi: APH Publishing Corporation.
- 2.Agarwal, K.C., (2001). Environmental Biology, Nidi Pub. Ltd., Bikaner.
3. P. D. Sharma, (2007) Ecology and Environment (Meerut: Rastogi Publications.
4. E. P. Odum, and G. W. Barrett, (2005), Fundamentals of Ecology (California: Thomson Brooks/ Cole Publishing.
- 5.Brunner R.C., (1989), Hazardous Waste Incineration, McGraw Hill Inc.

Bachelor of Science (B. Sc.) Part - II: Botany (Ability Enhancement Courses)

Semester-III English For Communication I (BBTAEC 1)

Course objectives: The students should be able to...

1. understand basics of communication.
2. study the non-verbal communication.
3. learn the reading strategies for fast reading.
4. know the comprehension skills.

Credit=02 Unit	English For Communication I (BBTAEC 1)	No. of hours per unit=30Hrs
Unit-I	Introduction to Communication	10
	1.1 Definition	
	1.2 Process of communication	
	1.3 Elements	
	1.4 Types of communication	
	1.5 Barriers of communication	
	1.6 Good communication gateways: 7c's of communication	
Unit-II	Non-verbal communication	07
	3.1 Overview of non -verbal communication	
	3.2 Facial expressions and gestures	
	3.3 Eye contact	
	3.4 Body language	
	3.5 Voice and paralinguistic cues	
	3.6 Non -verbal communication in context	
Unit-III	Reading Skills	07
	2.1 Definition	
	2.2 Scheming and scanning techniques,	
	2.3 Effective strategies for reading	
	2.4 Reading material: 2.4.1 Tree by Kalpana Chitnis 2.4.2 Facebook is making us miserable by Daniel Gulati	
	Comprehension Skills	

Unit-IV	4.1 Definition 4.2 Types 4.3 Strategies 4.4 Summarising 4.5 Paragraphs for Comprehension	06
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Course outcomes: The students will be able to...

After completion of the course the students will be able to:

- 1.apply techniques to improve communication.
- 2.use the reading strategies for fast reading.
- 3.identify the note making and note taking skills.
- 4.enhance the comprehension skills.

Reference:

- 1.Aggarwal Shalini, Essential Communication Skills, Ane Books Pvt. Ltd. New Delhi, first edition 2009
- 2.Dutt P. Kiramani, Rajeevan Geetha, Basic Communication Skills, Cambridge University Press India Pvt. Ltd. New Delhi, 2007 First, reprint 2010
- 3.Kumar Sanjay, Pushp Lata, Communication Skills, Oxford University Press, New Delhi , 2018 First Edition
- 4.Inthira S.R. and Saraswath V. Enrich Your English, OUP, New Delhi 1997.
- 5.Lester Mark,Tata MC Grew, Handbook of English Grammar and Usage, Hill Publishing Company: New Delhi ,2018
- 6.Pearson, Business English, Language, Literature and Creativity, Orient Blackswan, 2013.
- 7.Thomson and Marlinet, A Practical English Grammar, OUP ,New Delhi 1960
- 8.Turton, N.D. and Heaton J.B., Longman Dictionary of Common Errors, ,Longman, 1998.
9. Wood John East, Oxford Practice Grammar. O.U.P-1999- Second Edition

Bachelor of Science (B. Sc.) Part - II: Botany (Ability Enhancement Courses)

Semester-III English For Communication II (BBTAEC 2)

Course objectives: The students should be able to...

- 1.learn the language skills
- 2.understand expansion of an idea
- 3.study the various methods of professional communication
- 4.explore the strategies for effective conversation

Credit=02 Unit	English For Communication II (BBTAEC 2)	No. of hours per unit=30Hrs
Unit-I	Language Skills	07
	1.1 Word building	
	1.2 Grammar 1.3 Language and style	
Unit-II	Expansion of an Idea	07
	2.1 Definition,	
	2.2 Sentence building	
	2.3 Paragraph writing 2.4 Expansion of an idea	
Unit-III	Reading Skills	08
	3.1 Definition	
	3.2 Writing process	
	3.3 ABC Model of writing	
	3.4 Writing style and tone	
3.5 Writing formats- Essay, business writing, Writing for digital media		
Unit-IV	Conversation Skills	08
	4.1 Art of conversation	
	4.2 Manners and Etiquettes	
	4.3 Telephonic communication 4.4 Professional conversation	

Course outcomes:

Students will be able to....

1. Identify the language skills
- 2..expand an idea
- 3..use the various methods for effective professional communication
- 4.analyse the strategies for effective conversation

References:

- 1.Sanjay Kumar and Pushp Latha. Communication Skills New Delhi: OUP, 2012.
- 2.Farhathullah, T.M. English for Business Communication , Bangalore: Prism Publishers, 2009
- 3.Bikram K Das Functional Grammar and Spoken and Written Communication in English. Kolkata: Orient Blackswan, 2011.
- 4.Kiranmai Dutt, P et al. A Course in Communication Skills. New Delhi: CUP India , 2011.

5. Krishnaswamy, N. Modern English – A Book of Grammar, Vocabulary and Usage New Delhi: Macmillan India Pvt. Ltd, 2000.

Bachelor of Science (B. Sc.) Part - II: Botany (Major)

Semester-IV

Course-III (BBT 241): Plant Embryology

Course objectives: The students should be able to...

1. know the basic knowledge of flower structure in angiosperms.
2. imbibe basic knowledge about processes of pollination.
3. understand the basic knowledge about the process of fertilization.
4. study the basic knowledge of embryo development.

Credit=02 Unit	Course-III (BBT 241): Plant Embryology	No. of hours per unit
Unit-I	Structural Organization of Flower	07
	1.1 Structure of typical flower. 1.2 Structure of typical androecium. 1.3 Types of anthers, adhesion, cohesion, adalphy, epipetalous, epiphyllous. 1.4 Structure of bisporangiate anther, tetrasporangiate anther and pollen grain. 1.5 structure of gynoecium; parts of carpel, syncarpus, apocarpus, types of style. 1.6 structure of ovule, types of ovules. 1.7 Concept of flower as a modified Shoot.	
Unit-II	Pollination and Fertilization	08
	2.1 Definition, types and mechanism in Anemophily (<i>Zea mays</i>), Entomophily (<i>Calotropis</i>) and Hydrophily (<i>Vallisneria</i>). 2.2 Pollen germination and male gametophyte; megasporogenesis. 2.3 Structure of embryo sac: Monosporic (<i>Polygonum</i>) and Bisporic (<i>Allium</i>); fertilization: Entry of pollen tube (Chalazogamy, mesogamy, porogamy). 2.4 Double fertilization and triple fusion. Significance of double fertilization.	
Unit-III	Embryo and Endosperm Development	07

	<p>3.1 Structure and development of embryo in Monocotyledons and Dicotyledons.</p> <p>3.2 Development of endosperm, Types of endosperms- Nuclear, Helobial and Cellular.</p>	
Unit-IV	Polyembryony, Apomixis and Parthenocarpy	08
	4.1 Polyembryony: Introduction, Types - True polyembryony (Cleavage and Adventive), false polyembryony, Causes of polyembryony, Significance of polyembryony.	
	4.2 Apomixis – Introduction causes of Apomixis, Types – Gametophytic & Sporophytic, Significance of Apomixis with respect to parthenocarpy.	
	4.3 Apomixis and its Application in Crop Improvement.	
	4.4 Industrial applications of polyembryony.	

Course outcomes: Students will be able to...

1. Explain the structural organization of typical angiosperm flower, functions pollination and different processes of pollination.
2. know concept to microsporogenesis and megasporogenesis and fertilization in angiosperms.
4. process of embryo developments and the variations found in the process. Types of endosperms and its uses.
5. imbibe the different concepts in embryology such as polyembryony, apomixis and parthenocarpy and their applications.

References:

1. Bhojwani S. S. and Bhatnagar S. P. (2015), An Embryology of Angiosperms, (6thEdn.), Vikas Publishing House Pvt. Ltd., Noida.
2. Raghvan, V., Springer-Verlag. (2000)., Developmental Biology of Flowering Plants, New York.
3. Raven, P.H., Evert, R.F. and Eichhorn, S.E (1999)., Biology of Plants, (5th Edn.) W.H., Freeman and Co., Worth Publishers, New York.
4. Maheshwari P. (1950), An Introduction to Embryology of Angiosperms, Tata McGraw Hill Publishing Co. New Delhi.
5. Steeves T. A. and Sussex IM (1989)., Patterns in Plant Development, (2nd Edn.), Cambridge University Press, Cambridge.
6. Datta S. C., (1989) Systematic Botany, New Age International Publishers, New Delhi.
7. Nair PKK, (1985). Essentials of Palynology, Today & Tomorrow's Printers and Publishers, New Delhi.

Bachelor of Science (B. Sc.) Part - II: Botany (Major)

Semester-IV

Course-IV (BBT 242): Plant Ecology & Environment

Course objective: The students should be able to...

1. understand basic concepts of ecology & the factor affecting ecosystem.
2. provide knowledge of bio-geochemical cycles and its importance.
3. develop knowledge of major ecosystem of the world.
4. aware about the concepts of ecology & advanced environmental science.
5. understand the inter-relationships between the living and non- living world.
6. aware about phytogeographical zones of India, biodiversity and sustainable development.
7. understand the concept of bioremediation and its applications.

Credit=02 Unit	Course-IV (BBT 242) Plant Ecology & Environment	No. of hours per unit
Unit-I	Ecological Factors and Adaptations	07
	1.1. Introduction, Definition and Scope of Ecology. 1.2. Ecological Factors: Edaphic factors: Soil- Origin and formation, Composition, soil profile. 1.3. Climatic factors: Light and Temperature as ecological factors. 1.4. Ecological Adaptations: Ecological adaptations in Hydrophytes, Xerophytes, Epiphytes and parasites.	
Unit-II	Plant Communities and Succession	08
	2.1. Plant Communities: introduction, general characters, forms and structure, Raunkier's life forms. 2.2. Plant Succession: characters, process and types – Hydrosere, Xerosere.	
Unit-III	Ecosystem and phytogeography	07
	3.1. Ecosystem: Introduction, Definition, Composition and Food Chain. 3.2 Ecological pyramids - Number, Biomass and Energy with suitable example. 3.4. Biogeochemical cycles - Introduction, Phosphorus and Nitrogen cycle. 3.5. Phytogeographical regions in India as per Chatterji and Mani.	
Unit-IV	Phytoremediation	08
	4.1. Concept and scope; Types of remediation (bioaccumulation, rhizofiltration, rhizoextraction). 4.2 Phytoremediation of dyes, chemicals and heavy metals.	

Course outcomes: Students will be able to...

1. discuss interactions between species and the environment that determine community composition and structure.

2. apply ecological principles to current conservation issues.
3. critically analyze papers from the ecological literature.
4. learn the abiotic and biotic factors that influence ecosystem structure
5. understand the important biogeochemical cycles
6. learn about various community concepts
7. gain and insight in to the diverse ecosystem, related food web and ecological pyramids.
8. explains the basic terms and issues in the field of ecology and environmental protection.
9. describes the relations and interactions between biotic and abiotic components of the environment.
10. presents the causes and consequences of a biological imbalance in the ecosystems.
11. indicates the need for biological monitoring of the environment and the possibility of using bio-indicators in the assessment of the environment.

References:

1. R. S. Ambasht., (2017), A Textbook of Plant Ecology, CBS Publishers and Distributors.
2. S. K. Agarwal, (2008), Fundamentals of Ecology (New Delhi: APH Publishing Corporation.
3. P. D. Sharma, (2007) Ecology and Environment (Meerut: Rastogi Publications.
4. E. P. Odum, and G. W. Barrett, (2005) , Fundamentals of Ecology (California: Thomson Brooks/ Cole Publishing.
5. C. J. Krens, (1985) Ecology: The experimental analysis of distribution and abundance, Third Edition (New York: Harper and Row Publishers.
6. Helmut Lieth and R. H. Whittaker, (1975), Patterns of primary production in the biosphere (Berlin, Heidelberg, New York: Springer Verlag.
7. E. J. Kormondy, (1996). , Concepts of Ecology (New Jersey: Prentice Hall Publishing Company.
8. K. C. Misra, (1991) , Manual of Plant Ecology (New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Bachelor of Science (B. Sc.) Part - II: Botany (Major)

Semester-IV

Practical Course-II (BBP 243) :Practicals based on Course-III

Course objectives: The students should be able to...

1. understand the practical knowledge to students about identification of plants around them.
2. know the practical knowledge about morphological and anatomical variations in plants.
3. employ various techniques in different experimental aspects of plant physiology.
4. understand the in experiential learning with these practical's
6. participate students in experiential learning with these practicals.

Credit=02	Practical Course-II (BBP 243) (Practicals based on Course- III)	No. of hours per unit=30
	<ol style="list-style-type: none">1. Study of typical flower and its parts (floral whorls with their functions)2. Study of young / mature anther by permanent slides and slide preparations.3. Study of germination of pollen grains.4. Detection of pollen viability by staining technique.5. study of mechanisms of pollination in angiosperms.6. Study of types of anthers7-8. Study of types of Gynoecium in angiosperms.9. Study of types of ovules (by permanent slide or photograph).10. Study of dicotyledon embryo (by permanent slide or photograph).11. Study of monocotyledon embryo (by permanent slide or photograph).12. Dissection of embryo / endosperm from any suitable developing seeds13. Study of parthenocarpic fruits.14. Identification of types embryo sac15. Identification of types of endosperms	

Course outcome: Students will be able to...

1. Know the typical flower of angiosperms.
2. explain pollen biology. types of gynoecium and ovules, development of embryo and endosperm.
3. imbibe the process and significance of parthenocarpy. concept of transpiration, The effect of plant growth regulators on plants growth,

References

1. Pandey B. P. (2011), Modern Practical Botany, Vol. I, S. Chand and Company Ltd., New Delhi.
2. Pandey B. P (2011), Modern Practical Botany, Vol. II, S. Chand and Company Ltd., New Delhi.

3. Bendre. A. (2010) , Practical Botany, Rastogi Publications, Meerut.
4. Singh G, S. Chand, (2000), Angiosperm systematics: Theory and Practice, and Company Ltd., New Delhi.
5. B. P. Pandey, (1999) , Modern Practical Botany, Vol. I and II (New Delhi: S Chand and Company Ltd.
6. Wallis C. J . (1966) Practical Botany for Advanced Level and Intermediate Students, (5thEd.), William Heinemann Medical Books Ltd.
- 7 Lawrence GHM, (1951), Taxonomy of Vascular Plants, Oxford and IBH Publ.Co. Pvt. Ltd. New Delhi.

Bachelor of Science (B. Sc.) Part - II: Botany (Major)

Semester-IV

Practical Course-II (BBP 244) : Practicals based on Course- IV

Course objectives: The students should be able to...

1. understand the practical knowledge to students about identification of plants around them.
2. know the practical knowledge about morphological and anatomical variations in plants.
3. employ various techniques in different experimental aspects of plant physiology.
4. understand the in experiential learning with these practical's
5. give practical knowledge to students about ecological factors and ecological adaptation in plants.
6. participate students in experiential learning with these practicals.

Credit=02	Practical Course-II (BBP 244) (Practicals based on Course- IV)	No. of hours per unit= 30Hrs.
	1-2. Study of Meteorological Instruments 3. Study of pH of different soils. 4. Study of Water Holding Capacity of different soils 5. Study of morphological and anatomical adaptations in Hydrophytes - <i>Hydrilla, Eichhornia</i> . 6. Study of morphological and anatomical adaptations in Xerophytes - <i>Aloe, Nerium</i> . 7-8. Study of morphological and anatomical adaptations in Epiphytes (Orchid) and Parasites, (<i>Cuscuta</i>). 9. Study of Ecological pyramids based on the field data / given data. 10. Study of phytogeographical regions of India using standard maps. 11. Study of plants used in phytoremediation. 12. Identification of types of types plant succession 13-14. Study of types of food chain 15. Study of soil texture	

Course outcome: Students will be able to...

1. able to learn the different physiological processes and different techniques used in plant physiology.
2. prepare map of phytogeographical regions of India.

3. handling of meteorological instruments and edaphic factors.
4. about ecological principles, phytogeographical regions and adaptations in different groups of plants.
5. use of plants in remediation.
- 6.

References

1. Pandey B. P. (2011), Modern Practical Botany, Vol. I, S. Chand and Company Ltd., New Delhi.
2. Pandey B. P (2011), Modern Practical Botany, Vol. II, S. Chand and Company Ltd., New Delhi.
3. Bendre. A. (2010) , Practical Botany, Rastogi Publications, Meerut.
4. Singh G, S. Chand, (2000), Angiosperm systematics: Theory and Practice, and Company Ltd., New Delhi.
5. B. P. Pandey, (1999) , Modern Practical Botany, Vol. I and II (New Delhi: S Chand and Company Ltd.
6. Wallis C. J . (1966) Practical Botany for Advanced Level and Intermediate Students, (5thEd.), William Heinemann Medical Books Ltd.
- 7 Lawrence GHM, (1951), Taxonomy of Vascular Plants, Oxford and IBH Publ.Co. Pvt. Ltd. New Delhi

Bachelor of Science (B. Sc.) Part - II: Botany (Minor)

Semester-IV

Course -III (BBT 245): Green House Technology

Course Objectives: The students should be able to...

1. understand the fundamentals of green house.
2. maintain established green house.
3. identify the need of crop plants in green house.
4. cultivate various crop plants in green house.

Credit=02 Unit	Green House Technology (BBT 245)	No. of hours per unit
Unit-I	Fundamentals of Green House	08
	1.1 Introduction to Green House, scope and importance 1.2 Types of protected structures – Low-cost structures – Green house – Poly house – Polytunnels – Net house 1.3 Erection of Greenhouse Structures; Covering with nets and shades (Types of glazing material and its characteristics)	
Unit-II	Maintenance of green house	07
	2.1 Maintenance of erected structures 2.2 Maintenance of operational elements of the greenhouse for periodic checking, tightening, greasing etc	
Unit-III	Factors responsible for crop growth in protected cultivation	08
	3.1 Role soil factors: Soil temperature, pH and Electrical conductivity (EC) maintenance – 3.2 Micro and Macro nutrient content – Organic carbon content - Cation exchange capacity (Sodium and Ammonium Acetate, Centrifuge Method) 3.3 Environmental factors in protected cultivation: Light intensity and air temperature 3.4 Relative humidity (RH) and CO ₂ concentration, Air movement mechanism	
	Protected Cultivation Techniques for crop plants	

Unit-IV	4.1 Tomato: Protected cultivation techniques – Introduction, Varieties, Soil, Climate, Field preparation, Season and planting	07
	4.2 Cabbage: Protected cultivation techniques – Introduction, Varieties, Soil, Climate, Field preparation, Season and planting	
	4.3 Gerbera: Protected cultivation techniques – Introduction, Varieties, Soil, Climate, Field preparation, Season and planting	

Course outcomes: The students will be able to....

1. know basic needs to establish green house.
2. maintain the green house.
3. apply the fertilizers as per the need in green house.
4. cultivate different crop plants in green house.
5. train the protected cultivation practices.

References:

1. Singh. D. K & Peter. K. V, (2013), Protected cultivation of horticultural crops, Publishing Agency New India.
2. Balraj Singh, (2005) Protected Cultivation of Vegetable Crops ,kalyani Publishers.
3. Prasad S and Kumar U. (2003) Greenhouse management of horticultural crops. 2nd Edition. Agrobios.
4. Shanmugavelu, K.G.(1985), Production Technology of Vegetable Crops. Oxford and IBM Publishing Co. Pvt. Ltd., New Delhi.
5. Bose, T.K. and Som, T. K. (1986) Vegetable Crops in India. Naya Prakash, Kolkata.
6. Bose, T.K. and Yadav, L.P. (1992) Commercial Flowers. Naya Prakash, Kolkata.
7. Randhawa, G.S. and Mukhopadhyaya, A. (1994), Floriculture in India. Allied Publishers Pvt.Ltd. New Delhi.
8. Shanmugavelu, K.G. (1985). Production Technology of Vegetable Crops. Oxford and IBM Publishing Co. Pvt. Ltd., New Delhi.
9. Prasad S and Kumar U (2003). Commercial Floriculture. Agrobios.
10. Prasad S and Kumar U (2003), Greenhouse management of horticultural crops. 2nd Edition. Agrobios.
11. Principles of drip irrigation system, Dr. M.S. Mane, B.L.Ayare, Dr.S.S.Magar., Jain Bros., New Delhi
12. Principles of sprinkler irrigation, Dr. M.S. Mane, Dr.B.L.Ayare. Jain Bros., New D

Bachelor of Science (B. Sc.) Part - II: Botany (Minor)

Semester-IV

Practical Course – II (BBP 246)

Course Objectives: The students should be able to.....

1. understand the need of greenhouse to cultivate specific crop plants.
2. use different equipment's used in green house.
3. study the intercultural operations of tomato under protected condition
4. enhance the knowledge on intercultural operations of capsicum under protected condition
5. learn the intercultural operations of lettuce under protected condition

Credits =02	Practical Course – II (BBP 246)	No. of hours per unit= 30 hrs (4 Hrs /Practical)
	<ol style="list-style-type: none">1. Study of preparation of compost.2. Study of media preparation and fumigation.3. Study of Preparation of layout of greenhouse.4. Study of different type/ structure of green houses.5. Study of environmental factor influencing green house material.6. Study of different equipments used in green house.7-8. Identification of different nutrient deficiency symptoms in crop plants.9-10. Study of preparation and application of different nutrient Fertilizers used in greenhouse.11-12. Study of preparation and application of different pesticides used in greenhouse.13. Study of types of protected structures / components of green house and covering materials.14. Study of types of glazing material and its characteristics.15. Study of Protected cultivation techniques for any suitable plants.16. Visit to commercial green house and poly house unit.	

Course outcome: The students will be able to...

1. prepare compost for cultivation of crop plants in green house.
2. formulate different fertilizers and pesticides used in green house.
3. learn the protected cultivation practices.
4. train the protected cultivation practices in plant.
5. educate the protected cultivation practices of plant.

References:

1. Balraj Singh, (2005) Protected Cultivation of Vegetable Crops ,kalyani Publishers.
2. Prasad S and Kumar U. (2003) Greenhouse management of horticultural crops. 2nd Edition. Agrobios.
3. Shanmugavelu, K.G. (1985), Production Technology of Vegetable Crops. Oxford and IBM Publishing Co. Pvt. Ltd., New Delhi.
4. Balraj Singh, (2005) Protected Cultivation of Vegetable Crops ,kalyani Publishers.
5. Singh.D.K & Peter.K.V, Protected cultivation of horticultural crops, Publisig Agency New India,
6. Parvatha Reddy. P, Sustainable Crop Protection Under Protected Cultivation
7. .Singh.D.K, (2007) Modern vegetable varieties & Production Technology ,, IBDC Publisher

Bachelor of Science (B. Sc.) Part - II: Botany (Vocational Skill Course)

Semester-IV
Vocational Skill Course (BBPVSC 2)
Advanced Botanical Skills Part-II
(Plant Collection, Identification & Preservation)

Course objectives: Students should be able to...

1. impart basic knowledge about plant collection.
2. understand the techniques of preservation.
3. know the various collection methods.
4. understand the practical applications of plant identification.

Credits=2	Vocational Skill Course (BBPVSC 2) (Plant Collection, Identification & Preservation)	No. of hours allotted: 30 hours
	<ol style="list-style-type: none">1. Study of various equipments used in collection of plant material.2. Study of Dry collection method of plant.3. Study of wet collection methods of plant.4. Study of various preservatives used in plant sciences.5. Study of different preservation techniques.6. Study of collection of microscopic plants.7. Study of use of flora for identification of plant.8. Study of preparation of herbarium specimen.9. Study of herbarium preparation of specialized plants.10. Study of poisoning methods of herbarium.11. Identification of genus and species of locally available wild flora.12. Study of wet preservation methods.13. Study of different types of field guides (Flora, Monograph, Manual, Icones etc.).14. Study of taxonomic keys.15. Study of Identification of microscopic plants.16. Study of collection, preservation and collection of algae.	

	<p>17. Study of collection, identification and preservation of Wild Mushroom.</p> <p>18. Field trips within and around the Institute campus, compilation of field notes and preparation of herbarium sheets of such plants.</p>	
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Course outcomes: The student will be able to...

1. recognize the various techniques of microscopy.
2. Know basic knowledge of staining techniques.
3. apply microtechnique in various fields.
4. know the practical knowledge of micotechniques .

References:

1. Bonnie Smith & C.C. Chinnappa, (2015). Plant Collection, Identification, and Herbarium Procedures,
2. ECT Yeung, C Stasolla, MJ Sumner, BQ Huang, (2015), Plant Microtechniques and Protocols,
3. Bharati Bhattacharya, (2009), Systematic Botany , Alpha Science International
4. R. N. Sutaria, (1998), Textbook of Systematic Botany ,Publ. Ramniklal P. Kothari.
5. Jones SB Jr, Luchsinger SE (1986) Plant systematics, 2nd edn. McGraw-Hill, New York
6. Savile DBO (1962) Collection and care of botanical specimens. Publ. 1113. Queen's, Ottawa
7. Bowles JM, Guide to plant collection & identification. Queen's University, Kingston
8. Surender Singh Yadav, Herbarium: Historical Account, Significance, Preparation Techniques and Management Issues, Plant Archivesm

Bachelor of Science (B. Sc.) Part - II: Botany (Skill Enhancement Course)

Semester-IV Skill Enhancement Course (BBPSEC 3) Scientific writing

Course objectives: Students should be able to...

1. understand the basics of scientific writing and its importance.
2. know ethical issues in research.
3. understand Intellectual Property Rights (IPR).
4. understand writing and presentation skills in scientific perspectives.

Credits=2	Skill Enhancement Course (BBPSEC 3) (Plant Collection, Identification & Preservation)	No. of hours allotted: 30 hours
	1-2. Introduction to scientific writing and its types 3. Study of research ethics and plagiarism 4. Study of scientific communications in daily newspaper/ Research blogs 5-6. Study of referencing and its citations 7. Study of poster presentation skills 8. Study of oral presentation skills 9-10. Study of research paper writing skills 11-12. Study of review article writing skills 13-14. Study of book/book chapter writing skills 15. Study of graphical abstract 16-17. Study of research proposal writing for research degree 18-19. Study of research proposal writing for funding agency 20. IPR	

Course outcomes: Students will be able to...

1. recognize different types of scientific writing.
2. write research proposal for research degree or funding agencies.
3. do literature survey using library and online databases.
4. distinguish between different types of IPR.

References:

1. Kothari, C.R., (2004) Research Methodology: Methods and Techniques. New Age International (P)Ltd., Publishers, New Delhi.

2. Ganguli, P., (2001) Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
3. Miller, A.R., Davis, M.H., (2000) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
4. Stapleton, P., Yondewei, A., Mukanyange, J., Houten, H. (1995). Scientific Writing for Agricultural Research Scientists – A Training Reference Manual. West Africa Rice Development Association, Hong Kong.

Bachelor of Science (B. Sc.) Part - II: Botany (Cocurricular Course)

Semester-IV Cocurricular Course (CC) COMMUNITY COMMUNICATION (BBSTCC-2)

Course objectives: Students should be able to...

1. Know the basic concepts of NSS.
2. Realize the importance of NSS in Life.
3. Inculcate the awareness and preparation of basic of social important goals.
4. Improve personality.

Unit	Name of the units	No. of hours per unit/ Credits-2
Unit – I	Introduction to Basic concept of NSS	08
	1.1.Basic of NSS, The motto, Symbol, Badge, NSS song, aims and objective of NSS, 1.2.Classification of NSS programme. 1.3 Organisational structure, roles and responsibilities of various NSS functionaries.	
Unit – II	NSS Programmes and activities 2.1 NSS Regular activities in adopted villages, Slums and with Voluntary Organisations. 2.2. Contributions of Special Camping Programm, Planning and preparation of special camping programme. 2.3 Guidelines for the success of Camp.Importance of successful camping programme. Organization,	07
Unit – III	Community gardening through NSS Key benefits of community gardening, startup, Local resources, Common tree plantation, Save tree save nature, Public parks and its maintenance through people. Immunity boosting plant development. Nursery development through public help. Budding, grafting. Layering etc. Medicinal plant development Waste water management for gardening through community.	07
Unit – IV	Sustainable agriculture through group farming. 4.1 Fruit plant nursery development. Vegetable crop nursery development through community. 4.2 Farm manuring, Vermicomposting project development through Community. 4.3 Save water, save nation through community. Conservation of native plant. Importance and conservation of native plant.	08

Course Outcomes: Student will be able to...

1. Apply NSS knowledge and Objectives.
2. Develop their interest in NSS and social service
3. Participated in social activity
4. Realize the rural development by GO and NGO'

References

1. Avhan Chancellor's Brigade – NSS Wing, Training camp on Disaster Preparedness Guidelines, March 2012
2. University of Mumbai National Service Scheme Manual 2009.
3. National Service Scheme Manual (Revised) 2006, Government of India, Ministry of Youth Affairs and Sports, NewDelhi
4. Rashtriya Seva Yojana Sankalpana – Prof. Dr. Sankay Chakane, Dr. Pramod Pabrekar, Diamond Publication, Pune

