



गोंय विद्यापीठ

ताळगांव पठार

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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2023/102/7

Date: 16.06.2023

CIRCULAR

The University has decided to implement the UGC Curriculum and Credit Framework for the Undergraduate Programme (CCFUP) of **Bachelor of Science in Botany/Bachelor of Science in Botany (Honours)** under the National Education Policy (NEP) 2020 from the Academic Year 2023-2024 onwards.

The approved Syllabus of Semesters I and II of the **Bachelor of Science in Botany/Bachelor of Science in Botany (Honours)** Programme is attached.

Principals of Affiliated Colleges offering the **Bachelor of Science in Botany/Bachelor of Science in Botany (Honours)** Programme are requested to take note of the above and bring the contents of this Circular to the notice of all concerned.

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,

1. The Principals of Affiliated Colleges offering the Bachelor of Science in Botany /Bachelor of Science in Botany (Honours) Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa.
2. The Dean, School of Biological Sciences and Biotechnology, Goa University.
3. The Vice-Deans, School of Biological Sciences and Biotechnology, Goa University.
4. The Chairperson, BOS in Botany.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website

Goa University
Programme Structure for Semester I to VIII Bachelor of Science in Botany

Semester	Major -Core	Minor	MC	AEC	SEC	I	D	VAC	Total Credits	Exit
I	BOT-100 Fundamentals of Botany (3T+1P)	BOT-111 Plants in Everyday Life (4)	BOT-131 Kitchen Gardening (3)		BOT-141 Nursery and Gardening (1T+2P)					
II			BOT-132 Ecosystem Diversity (3)		BOT-142 Fruits and Vegetable Processing (1T+2P)					BOT-161 Floriculture (1+3)
III	BOT-201 Diversity of Microbes and Nonflowering plants (3+1) BOT-202 Cell Biology and Biomolecules (3+1)	BOT-211 Algal Resources and Its Utilization (3+1)	BOT-231 Plant Propagation Methods (3)		BOT-241 Herbal Technology (1T+2P)					

IV	<p>BOT-203 Diversity of Flowering plants (3+1)</p> <p>BOT-204 Plant Anatomy and Embryology (3+1)</p> <p>BOT-205 Plant ecology and phytogeography (3+1)</p> <p>BOT-206 Biofertilizers (1+1)</p>	<p>BOT-221 Mushroom Cultivation (4) [VET]</p>							20	<p>BOT-261 Organic farming (1+3)</p>
V	<p>BOT-300 Plant taxonomy and phylogeny (3+1)</p> <p>BOT-301 Cytogenetics & Plant breeding (3+1)</p> <p>BOT-302 Plant physiology (3+1)</p> <p>BOT-303 Plant tissue culture (1+1)</p>	<p>BOT-321 Applied Botany and Entrepreneurship (4) [VET]</p>				<p>BOT-361 Internship-2</p>			20	
VI	<p>BOT-304 Plant biochemistry (3+1)</p>	<p>BOT-322 Environmental</p>							20	

	<p>BOT-305 Microbiology and plant pathology (3+1)</p> <p>BOT-306 Molecular biology & Genetic engineering (3+1)</p> <p>BOT-307 Minor Project (4)</p>	<p>Pollution and Management (4) [VET]</p>								
VII	<p>BOT-400 Agricultural techniques & disease management (3+1)</p> <p>BOT-401 Instrumentation Techniques (4)</p> <p>BOT-402 Research methodology (4)</p> <p>BOT-403 Biostatistics & Mathematical Biology (3+1)</p>	<p>BOT-411 Seed Technology (3+1)</p>							20	

VIII	BOT-404 Clinical Botany (3+1) BOT-405 Bioinformatics and Computational Biology (3+1) BOT-406 Algal and Fungal Technology (3+1) BOT-407 Phytochemistry and Pharmacognosy (3+1)	BOT-412 Plants Towards Sustainable Future (3+1)				#BOT-462 Project - (12)			20	
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Major [Disciplinary/Interdisciplinary Major (Core)]; Minor (Disciplinary/Interdisciplinary Minors); MC (Multidisciplinary Courses); VET (Vocational Education and Training); AEC (Ability Enhancement Courses); I/D (Internship/Apprenticeship/Dissertation); VAC (Value Added Courses).

#Honors with research programme students shall opt any 4 credits course from BOT-405 to BOT-408.

Name of the Programme: B. Sc (Botany)

Course Code: BOT-100

Title of the Course: Fundamentals of Botany

Number of Credits: 3T+1P

Effective from AY: 2023-24

Prerequisites for the course:	Should have basic knowledge of Biology.	
Course Objective(s):	This course aims to increase the understanding about the diversity, identification, classification, evolutionary history, relationship of plants with man and other sciences, fundamentals of different branches in Botany, studying the plants with regards to their morphological features, physical, chemical and biological functioning of plants and various plant processes with emphasis on basic instruments and techniques used in the Botanical studies. Laboratory exercises are designed to give hands on experience in handling all specimens and to understand the processes and functioning of plants.	
Content:	Module 1: Introduction to plant kingdom Fundamental notions of plants: Relation of plants to man, relation of Botany to other sciences, brief description of various branches in Botany (Systematic botany- Classification, Taxonomy and nomenclature; Morphology – external, internal; Embryology, Physiology, Ecology, Phytogeography, Economic Botany, Cytology and Cytogenetics, Ethnobotany, Biotechnology, Molecular Biology, Biochemistry). Evolutionary history of plants: Evolution of plants on geological time scale; Paleobotany: Fossil formation process, types of fossils –Impression, Compression, Petrification and coal balls. Broad classification of plant kingdom: Introduction to seven kingdom classification of life, Characteristic features of the plant kingdom. Classification of Plant kingdom up to divisions (G.M. Smith’s classification).	15 hours
	Module 2: Plant morphology Types of roots (Tap, fibrous and adventitious), stem (aerial and underground), leaf (parts of the leaf; phyllotaxy – Alternate, spiral, opposite, whorled; shapes of leaves; leaf types - compound, simple; leaf margins, leaf apex, leaf venation - parallel and reticulate, vernation), inflorescence types – cymose and racemose, flower (parts, symmetries, functions of different parts of the flower, aestivation types), fruit (Simple, Aggregate, Multiple). Seed and its structure, embryo; seed types; germination in Ricinus and Cucurbita; Seed dispersal mechanisms. Tissues in plants: Meristems – types, positions, functions; simple tissues– Parenchyma, Collenchyma, Sclerenchyma – their positions, functions; Vascular tissues - types, positions, functions	15 hours
	Module 3: Plant growth and Plant movements; Instrumentation	15 hours

	Plant movements: tropic responses (phototropism, geotropism, chemotropism, hydrotropism and thigmotropism); leaf movements (nyctinasty and seismonasty). Photosynthesis, Respiration, Transpiration, Osmosis, Imbibition and Diffusion, (definition, brief process and significance). Principle, working and applications of: microscopy (Dissection and light microscope), micrometry, distillation unit, spectrophotometer, centrifuge, laminar air flow unit, orbital shaker, pH meter, Autoclave.	
	Practicals (15P = 15 × 2 hours)	
	1. Study of different types of fossils as mentioned in theory.	2 hours
	2. To study different types of stem and root	2 hours
	3. To study different characters of leaves with respect to: a. phyllotaxy – Alternate, spiral, opposite, whorled; shapes of leaves, leaf types - compound, simple. b. leaf margins, leaf apex, leaf venation - parallel and reticulate, vernation	2 hours
	4. To study various parts of the flower, types of inflorescences and fruits.	2 hours
	5. To study type of seeds and germination in seeds of <i>Ricinus</i> and <i>Cucurbita</i> .	2 hours
	6. To study types of tissues as mentioned in theory with the help of permanent slides.	2 hours
	7. Demonstration of tropic responses in plants - phototropism, geotropism, chemotropism, hydrotropism and thigmotropism.	2 hours
	8. To demonstrate leaf movements as mentioned in theory.	2 hours
	9. Photosynthesis and Respiration: a. To demonstrate that oxygen is evolved during photosynthesis using inverted funnel method b. Demonstration of respiration in germinating seeds by phenol red method	2 hours
	10. Demonstration of process of Osmosis and Imbibition in plants.	2 hours
	11. Demonstration of process of Diffusion and Transpiration in plants.	2 hours
	12. Study of basic instruments used in botanical studies: a. Dissection microscope, light microscope, distillation unit, spectrophotometer, Autoclave (1P) b. Laminar air flow unit, centrifuge, orbital shaker, micrometres (stage and ocular), pH meter (1P)	4 hours
	13. Field visit to observe the plant diversity (Algae, bryophytes, pteridophytes, gymnosperms, angiosperms)	4 hours
Pedagogy:	Lectures/ Use of Multimedia / Assignments/ Hands-on experiments/ Demonstrations/ Field visit.	

<p>References/ Readings:</p>	<p>Arnold CA (2018). An introduction to Paleobotany. Surjeet Publications, Delhi.</p> <p>Bhojwani, SS, Bhatnagar, SP, Dantu, PK (2015). The embryology of Angiosperms. 6th Edition. Vikas Publishing House Pvt. Ltd., New Delhi.</p> <p>Davis, PH and Heywood, VH (1963). Principles of Angiosperm Taxonomy. Oliver & Boyd, London.</p> <p>Gangulee, SC, Das, KS, Dutta, CD. and Kar, AK (1968). College Botany Vol. I, II and III. Central Education Enterprises.</p> <p>Gifford, EM and Foster, AS (1988). Morphology and Evolution of Vascular Plants, W.H. Freeman & Company, New York.</p> <p>Gurumani, N (2006). Research methodology for biological sciences. MJP Publishers, Chennai.</p> <p>Hopkins, WG and Huner, NP (2009). Introduction to Plant Physiology. 4th edition. John Wiley & Sons, U.S.A.</p> <p>Jain, VK (2017). Fundamentals of Plant Physiology. 19th edition. S. Chand Company Ltd. New Delhi.</p> <p>Lawrence, GHM (1951). Taxonomy of Vascular Plants. MacMillan, New York.</p> <p>Pandey, BP (2014). Plant Anatomy. S. Chand & Company Pvt. Ltd., New Delhi.</p> <p>Sambamurty AVSS (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International publication, New Delhi.</p> <p>Sharma VK (1991). Techniques in microscopy and cell biology. Tata McGraw-Hill, New Delhi.</p> <p>Singh, G. (2012). Plant Systematics. Theory and Practice. 3rd edition. Oxford & IBH Pvt. Ltd., New Delhi.</p> <p>Singh, V, Pandey, PC and Jain, DK (2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.</p> <p>Steward, WM (2010). Paleobotany and the Evolution of Plants. Cambridge University Press, Cambridge.</p>	
<p>Course Outcomes:</p>	<ol style="list-style-type: none"> 1. Outline the classification of life and identify the characteristics features of plant kingdom. 2. Summarize the evolutionary history of plants. 3. Outline the different branches in botany and their relation to other sciences. 4. Analyse the morphological features of plants. 5. Examine the stages of plant growth, plant cells, processes and its responses. 	

Name of the Programme: B. Sc (Botany)

Course Code: BOT-111

Title of the Course: Plants in Everyday Life

Number of Credits: 4

Effective from AY: 2023-24

Prerequisites for the course:	Nil	
Course Objective(s):	This course is designed to give an overview of how plants are indispensable to humans. It gives a broad exposure to the various aspects of plant resource & its utilization.	
Content:	<p>Module 1: Plant services to humans in everyday life</p> <p>Introduction to science of Botany, plant resources in everyday life.</p> <p>Role of plants: Air purifier (photosynthesis); plants used in rituals/festivals; Pollution removal (phytoremediation and its types), pollution indicator (lichens), and nutrient source (litter manure, organic manure).</p> <p>Familiarizing the students to identify plants based on morphology of plant parts. Identify common wild plants using live plants/herbarium/photographs etc.</p>	<p>2 hours</p> <p>4 hours</p> <p>4 hours</p>
	<p>Common wild plants and their utilization: Identification and utilization of following plants: Hirda (<i>Terminalia chebula</i>), Behda (<i>Terminalia bellirica</i>), Matti (<i>Terminalia elliptica</i>), Kinal (<i>Terminalia paniculata</i>), Savar (<i>Ceiba pentandra</i>), Kate-savar (<i>Bombax ceiba</i>), Bhillo mad (<i>Caryota urens</i>), Arjun/Pandruk (<i>Sterculia foetida</i>), Kumyo (<i>Careya arborea</i>), Asale (<i>Microcos paniculata</i>), Charan (<i>Buchanania cochinchinensis</i>), Chunna (<i>Ziziphus rugosa</i>) and Kanna (<i>Carissa carandas</i>).</p> <p>Grandma's herbal pouch: Following plants to be studied with respect to botanical source, part of the plant used, and medicinal uses: Tulsi (<i>Ocimum sanctum</i>), Adulsa (<i>Adhatoda vasica</i>), Ale (<i>Zingiber officinale</i>), Halad (<i>Curcuma longa</i>), Kate kuvar (<i>Aloe vera</i>), Kirayte (<i>Andrographis paniculata</i>), Ganjan (<i>Cymbopogon citratus</i>), Ottalao (<i>Coleus aromaticus</i>), Vaikhand (<i>Acorus calamus</i>), Punarnava (<i>Boerhaavia diffusa</i>), Paripat (<i>Oldenlandia corymbosa</i>) and Gulvel (<i>Tinospora cordifolia</i>).</p>	<p>2 hours</p> <p>3 hours</p>
	<p>Module 2: Plant resources and utilization-I (including brief description of plants and/or plant parts used).</p> <p>a. Cereals: Rice, Wheat, Maize</p> <p>b. Milletts: Ragi, Jowar and Bajra</p> <p>c. Legumes: Bengal gram, Green gram, Red gram, Black gram and Cowpea.</p> <p>d. Cash crops: Cashew, Sugarcane and Cocoa.</p> <p>e. Plantation crops: Coconut, Banana, Mango and Jackfruit.</p> <p>f. Edible oils: Groundnut, Coconut, Soyabean and Palm Oil.</p> <p>g. Starch and tuber crops: Potato, Sweet potato and Yam</p>	<p>2 hours</p> <p>2 hours</p> <p>2 hours</p> <p>2 hours</p> <p>3 hours</p> <p>2 hours</p> <p>1 hour</p>

	h. Vegetable crops: Red amaranth, Radish, Lady's finger, Teren, Kudduki, Ankur and Taikhilo.	1 hour
	Module 3: Plant resources and utilization-II (including brief description of plant and/or plant parts used). a. Spices: Chillies, Nutmeg, Clove, Black pepper, Cardamom, Star anise (Chakriful) and Dagad phul (<i>Parmotrema perlatum</i>). b. Beverages: Tea and Coffee (including processing). c. Eco-friendly use of plant parts: Banana fresh leaves, Arecanut spathe, Kumyo leaves (<i>Carea arborea</i>), Jackfruit leaves and Bamboo culm. d. Oils: Eucalyptus, Rose and Orange peel (including methods of extraction) e. Fibres: Coir, Cotton, Jute, Banana and Sisal Including method of separation of spathe, drying and storing of fibre of banana and; Collection, drying, processing and extraction of fibre from <i>Agave</i> leaf (demonstration/video) f. Timber: Teak (Sailo), Rose wood (Shisham), Matti and Bamboo. g. Rubber: <i>Hevea brasiliensis</i> (including demonstration of rubber extraction process)	2 hours 2 hours 2 hours 2 hours 4 hours 2 hours 1 hour
	Module 4: Utilization of plants in value added products Herbal based hair dyes: Role of ingredients used in formulation; preparation of herbal dyes; application of hair dye; evaluation and uses of hair dye (Henna, Bhringaraj, Hibiscus, Amla). Including demonstration on preparation of herbal hair dye and evaluation/testing on hair wig. Herbal cosmetics and aromatics: Introduction and scope, Extraction Methods-Maceration, infusion, decoction, distillation and tinctures, Types of herbal preparations. <hr/> Plants used in cleansers (Neem, Cucumber, Rose), scrubs (Marigold, Neem), wash (Rose –face wash, hibiscus & amla- hair wash & oil), packs (Neem, Tulsi, Sandalwood, Turmeric) and creams (Rose, Jasmin, Marigold). Extraction of essential oil from lemon grass / orange peel or citrus fruit peel. Preparation of Henna powder from Henna leaves and Aloe gel from <i>Aloe vera</i> . Preparation of plant based holi colours. Paper making from plants: Paper industry and paper manufacturing; Raw materials, Processing and kinds of paper, paper Industry in India. Method of making of handmade paper with demonstration/video. Demonstration on preparation of herbal formulation/herbal tea. Field visit in the campus to identify the plants of economic importance and report preparation.	3 hours 3 hours 2 hours 1 hour 3 hours 1 hour 1 hour
Pedagogy:	Lectures/ Tutorials/Assignments/Presentation / Demonstration/Field visit/Team based learning.	

<p>References/ Readings:</p>	<p>Billings S and Collingwood S (2013). The Big book of home remedies. Lulu.com publisher.</p> <p>Buckley, C (2020). Plant Magic: Herbalism in Real Life. Roost Books Publishers, New York.</p> <p>Chrispeels, MJ and Sadava, DE (1994). Plants, Genes and Agriculture. Jones & Bartlett Publishers.</p> <p>Fuller, KW and Gallon, JA (1985). Plant Products and New Technology. Clarendon Press, Oxford, New York.</p> <p>Hill, AF (1952). Economic Botany: A Textbook of Useful Plants and Plant Products. McGraw Hill Publishing Company Ltd., New Delhi.</p> <p>Kochhar, SL (2012). Economic Botany in the Tropics. MacMillan India Ltd., New Delhi.</p> <p>Purohit, SS and Vyas, SP (2008). Medicinal Plant Cultivation: A Scientific Approach. Agrobios, India.</p> <p>Rao, RS (1985-1986). Flora of Goa, Diu, Daman & Nagar-Haveli. 2 Volumes. Botanical Survey of India.</p> <p>Shailesh, R (2019). Everyday Ayurveda: The complete book of Ayurvedic home remedies. Notion Press, India.</p> <p>Sambamurthy AVSS and Subramanyam NS (1989). A Textbook of Economic Botany. Wiley Eastern Ltd., New Delhi.</p> <p>Sen, S (2009). Economic Botany. NCBA Publishers, New Delhi.</p> <p>Sharma, OP (1996). Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi.</p> <p>Simpson BB and Conner-Ogorzaly M (1986). Economic Botany - Plants in Our World. McGraw Hill, New York.</p> <p>Singh V, Pande PC and Jain DK (2009). A Text Book of Economic Botany. Rastogi Publications, Uttar Pradesh.</p> <p>Trivedi, PC (2006). Medicinal Plants: Ethnobotanical Approach. Agrobios, India.</p> <p>Upadhyay, R (2023). Botany for B.Sc. students, Economic Botany, Ethnomedicine and phytochemistry/Commercial Botany and phytochemical Analysis. S. Chand and Company Ltd. Publishers, India.</p> <p>Wickens, GE (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.</p>	
<p>Course Outcomes:</p>	<ol style="list-style-type: none"> 1. Recall various economically and medicinally important plant species used in day-to-day life. 2. Explain the uses of economically important plants and illustrate the processing of various plant parts. 3. Analyze the utilization of various plant resources in day-to-day life. 4. Apply theoretical knowledge in utilization, and report generation of economical and medicinal plants. Create awareness on conservation of medicinal plants and use of natural plant products as alternatives to synthetic products. 	

Name of the Programme: B. Sc (Botany)

Course Code: BOT-131

Title of the Course: Kitchen Gardening

Number of Credits: 3

Effective from AY: 2023-24

Prerequisites for the course:	Nil
Course Objective(s):	This course aims to create understanding about the importance of a kitchen garden, routine operations in a Kitchen Garden, Organic manures, Soil preparation, Nursery Management for vegetable crops, plants for kitchen garden and pest management.
Content:	Module 1: Introduction to Kitchen Garden, Nursery Management for vegetable crops and Routine operations. Concept and importance; planning and layout of kitchen garden; indoor/urban kitchen gardening (terrace, grow bags, hanging pots, vertical garden). Seed selection, bed preparation for nursery plants, seedling trays, seed sowing, after care of nursery plants. Irrigation, mulching, transplantation, pinching, pruning, cropping patterns (intercropping and crop rotation), spacing of crops; Tools and kitchen garden implements; Plant supports (stakes, wall trellis, split bamboo, moss pole, fan trellis, etc.); Compost pit; Weed management; Manuring; harvesting; Seeds and tuber collection, traditional and modern methods of seed storage.
	Module 2: Soil preparation, organic manures, Pest and disease management. Soil mixtures; vegetable plots (flat beds, raised beds, ridges and furrows, basin). Organic manures (panchagavya, beej amrit solution, compost, fish manures, bone meal, farm yard manure, vermicompost, wood ash, oil - cakes, green manure). Plant protection measures; Biocontrol agents, bio-pesticides, pheromones, trap crops, bird perches; Common Garden pests and control measures – sucking insects (mealy bugs, aphids, white flies, mites), biting and chewing insects (caterpillars, beetles, grasshoppers, larve), borers, ants, slugs and snails, rodents; Common diseases of vegetable plants, symptoms and control measures (damping off, Powdery mildew, Root knot, Vein clearing, Wilt). Visit to a local vegetable cultivation field and field report.
	Module 3: Plants for kitchen garden and monthly kitchen garden activities. Identification and uses - Drumstick, curry leaves, bilimbi, lemon, tamarind, kokum, coconut, breadfruit, papaya, banana, pineapple, guava, mango, pepper, Herbs (ginger, turmeric, mint, coriander, lemon grass, Indian spinach (<i>Basella</i>)).

	<p>Annual vegetables - Classification on the basis of (a) Planting season (b) Plant part used as vegetable.</p> <p>General cultivation practices followed for: Cole crops (Cabbage, cauliflower, knol – khol, lettuce), Root vegetables (Raddish, carrot, turnip, beet, sweet potato, elephant foot (suran), Kate kandga, <i>Colocasia</i>), Solanaceous crops (Tomato, brinjal, chilli, bell pepper), Cucurbitaceous crops (Bottle gourd, bitter gourd, snake gourd, ridge gourd, ash gourd, little gourd, pumpkin, musk melon, water melon, cucumber), Leafy vegetables (Spinach, <i>Amaranthus</i>, Fenugreek, dill), Beans (French beans, cluster beans, virvil), Bulbs (Onion, garlic), Okra, Corn, Micro greens.</p> <p>Importance of a kitchen gardening planner; vegetable growing operations for every month as per the seasons (time of sowing, successional sowing, transplanting, etc.). Preparation of a yearly diary of kitchen gardening activities.</p>	
Pedagogy:	Lectures, Tutorials, Assignments, Demonstrations, live specimens, Herbarium specimens, Videos, Field visit and report writing.	
References/ Readings:	<p>Agrawal, P.K. (1993). Hand Book of Seed Technology. Department of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.</p> <p>Alphonso, N. (2004). Home Gardening. Agriculture Officers' Association, Panaji – Goa.</p> <p>Bailey, L.H. (2009). Manual of Gardening. Srishti Book Distributors, New Delhi.</p> <p>Biles, R.E. (2003). The Complete Book of Gardening. Biotech Books, Delhi.</p> <p>Bose, T.K. and Mukherjee, D. (1972). Gardening in India. Oxford & IBH Publishing Co., New Delhi.</p> <p>Karant, A. (2013). Seed Technology. Black Prints India INC., New Delhi.</p> <p>Rao, K.M. (2005). Textbook of Horticulture. 2nd edition. Macmillan India Limited, New Delhi.</p> <p>Rao, P.S. (2016). Vegetable Crops Production. Sonali Publications, New Delhi.</p> <p>Sheela, V.L. (2011). Horticulture. MJP Publications, Chennai.</p> <p>Sud, R.K. and Kumar, S. (2004). Herbs: Culinary, Medicinal, Aromatic. Pawan Kumar Scientific Publishers, Jodhpur.</p> <p>Sutton, M. (1997). The Culture of Vegetables and Flowers from Seeds and Roots. Ambey Publications, New Delhi.</p> <p>Trivedi, P.P. (1987). Home Gardening. Indian Council of Agricultural Research, New Delhi.</p> <p>Zingare, A.K. (2013). A Manual of Gardening. Satyam Publishers & Distributors, Jaipur.</p>	
Course Outcomes:	<p>The students will be able to:</p> <ol style="list-style-type: none"> 1. Plan and design a kitchen garden 2. Understand the techniques of Nursery Management for vegetable crops. 	

	<ol style="list-style-type: none">3. Gain knowledge of organic fertilizers, composting.4. Have the basic knowledge of growing different types of vegetables.5. Identify the plants for a kitchen garden and know their uses.6. Plan yearly activities for a kitchen garden., Identify and manage crop pests in kitchen garden.	
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Name of the Programme: B. Sc (Botany)

Course Code: BOT-141

Title of the Course: Nursery and Gardening

Number of Credits: 3 (1 Theory + 2 Practical)

Effective from AY: 2023-24

Prerequisites for the course:	Should have basic knowledge of Biology.	
Course Objective(s):	This course aims to increase the understanding about the different types of gardens, their features and routine operations in nursery management and gardening. The practical component of this course aims to impart skill in designing a plant nursery, different types gardens, cultivation practices to be followed in operating a plant nursery and garden.	
Content:	Module 1: Plant nursery, gardens and their management Definition, objectives and scope of a plant nursery and garden. Plant nursery layout, infrastructure, planning and seasonal activities; marketing challenges. Different types of gardens and their design: indoor garden (gardening in window boxes, tubs, troughs, trays and hanging baskets; vertical garden; terrarium; bonsai) and outdoor garden (landscape, avenue plantation, park, rock garden, water garden, terrace garden and kitchen garden). Features of a garden (fence, hedge, edge, steps, drives and paths; arches, pergolas, lawns, carpet bed, flower bed, shrubbery, border, topiary, plant supports, garden adornments). Preparation of soil, methods of breaking seed dormancy, planting (direct seeding and transplanting), hardening, irrigation, manuring, staking, pinching, pruning and defoliation; management of pests and diseases.	15 hours
	Practicals (30P = 30 × 2 hours) 1. Preparation of a layout sketch of a nursery. 2. Preparation of layout sketches of any 2 types of gardens. 3. Familiarization with various tools, implements and plant supports. 4. Identification and description of any 2 plants used for avenues, hedges, flower beds, lawns, ornamental shrubs, rock garden, water garden and indoor garden. 5. Raising of any 2 seedlings in seed trays, preparation of potting mix, transplanting of seedlings in pots and bags; care and maintenance of plants till flowering/maturity. 6. Treatment of seeds of coriander or other suitable seeds to break dormancy and to find germination percentage of treated seeds. 7. Propagation of plants by cutting, layering, budding, grafting, runners, suckers, corms, bulbs, bulbils and tubers. 8. Preparation of a coir stick/coir basket. 9. Preparation of a garden in window boxes, troughs and trays	2 hours 4 hours 2 hours 4 hours 6 hours 2 hours 6 hours 2 hours 4 hours

	<p>(any 2).</p> <p>10. Preparation of a terrarium. 2 hours</p> <p>11. Preparation/creation of a vertical garden and its after care. 4 hours</p> <p>12. Preparation of potting medium and cultivation of different types of potted plants (foliage, succulent, anthurium and orchid). 4 hours</p> <p>13. Demonstration of cultivation of house plants and after care of upright and climbing plants. 4 hours</p> <p>14. Cultivation of any 3 vegetables in the College Botanical Garden (red amaranth, cluster beans, cucurbits, chillies, lady's finger, ginger and tomato). 6 hours</p> <p>15. Preparation of compost. 4 hours</p> <p>16. Field visit to a plant nursery or landscape garden. 4 hours</p>	
Pedagogy:	Lectures, practical, field visits, participatory learning, seminars, assignments etc.	
References/ Readings:	<p>Acquaah, G (2019). Horticulture: Principles and Practices (4th edition). India: Pearson India Education Services Pvt. Ltd.</p> <p>Agrawal, PK (1993). Hand Book of Seed Technology. Department of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.</p> <p>Alphonso, N (2004). Home Gardening. Agriculture Officers' Association, Panaji – Goa.</p> <p>Bose, TK and Mukherjee, D (1972). Gardening in India. Oxford & IBH Publishing Co., New Delhi.</p> <p>Courtier, J and Clarke, G (1997). Indoor plants: The Essential Guide to Choosing and Caring for Houseplants. Reader's Digest, New York.</p> <p>Edmond, JB, Musser, AM and Andrews, FS (1957). Fundamentals of Horticulture. McGraw Hill Book Co., New Delhi.</p> <p>Janick, J (1979). Horticultural Science (3rd edition). W.H. Freeman & Co., San Francisco, USA.</p> <p>Kumar, N (1997). Introduction to Horticulture. Rajalakshmi Publications, Nagercoil.</p> <p>Randhawa, GS and Mukhopadhyay, A (1986). Floriculture in India. Allied Publishers Limited, New Delhi.</p> <p>Rao, KM (2005). Textbook of Horticulture (2nd edition). MacMillan India Limited, New Delhi.</p> <p>Rao, PS (2016). Vegetable Crops Production. Sonali Publications, New Delhi.</p> <p>Sandhu, MK (1989). Plant Propagation. Wiley Eastern Ltd., Bangalore.</p> <p>Stevenson, V (1984). Plants and Flowers in the Home. Treasure Press, London.</p> <p>Trivedi, PP (1987). Home Gardening. Indian Council of Agricultural Research, New Delhi.</p> <p>Zingare, AK (2013). A Manual of Gardening. Satyam Publishers & Distributors, Jaipur.</p>	

Course Outcomes:	On completion of this course students will be able to: <ol style="list-style-type: none">1. Explain the objective and scope of a plant nursery and garden.2. Describe the different types of gardens and their features.3. Analyze the different routine operations in nursery management and gardening.4. Develop skills in designing a plant nursery and different types of gardens, routine operations in gardening and nursery management, cultivation practices for entrepreneurial opportunities.	
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Name of the Programme: B. Sc (Botany)

Course Code: BOT-132

Title of the Course: Ecosystem Diversity

Number of Credits: 3

Effective from AY: 2023-24

Prerequisites for the course:	Nil	
Course Objective(s):	The paper is designed to enable the students to understand about different ecosystems, their structural and functional components, explore complexities of the natural environment and our relationship with it, also understand about uses of biological resources to mankind, threats and conservation measures, develop scientific, interpretive and creative thinking skills.	
Content:	Module 1: Ecosystem structure and diversity in terrestrial ecosystems: Abiotic and biotic components; Functioning of ecosystem: energy flow and nutrient cycles, food chains, food webs, Trophic levels: autotrophs, heterotrophs, saprotrophs; Biogeochemical cycles (C, N, P). Ecological succession on the terrestrial ecosystem; Structure and functions of terrestrial ecosystems; Uses of terrestrial resources to mankind; Threats to terrestrial ecosystems and the methods of conservation; Causes of endangerment and extinction.	15 hours
	Module 2: Diversity in aquatic ecosystems (Freshwater - lentic and lotic, marine, estuarine and wetland): Structure, functions, uses of freshwater resources to mankind; Threats to freshwater ecosystems and methods of conservation; Structure, tidal dynamics, uses of marine and estuarine resources to mankind; Threats to marine and estuarine water ecosystems and methods of conservation; Biomedical and industrial use of marine bio resources; reasons for coastal, open and deep sea bio resources depletion. Classification, functions and values; Physical, chemical and anthropogenic factors influencing wetland habitats; Biodiversity of wetland habitat; Ramsar sites- meaning and importance, examples in India and world.	15 hours
	Module 3: Ecosystems of west coast with special reference to Goa; biodiversity hotspots of India; threats to biodiversity and its conservation Western Ghats and its impact on monsoons in Goa; Forest types of Goa; Wetlands of Goa: paddy fields, mud flats, streams and lakes (Ramsar sites in Goa); Mangroves and <i>Myristica</i> swamps; Coastal sand dunes; Lateritic plateau ecosystems; Anthropogenic impact on natural ecosystems of Goa. India as a mega-diversity nation; Biodiversity hotspots: The Himalayas, the Western Ghats, the Indo-Burma region and the Sunderland (Nicobar group of Islands); Endangered and endemic species of India: Scheduled species and their distribution; Conservation efforts of Indian flora	15 hours

	with special reference to <i>in-situ</i> and <i>ex-situ</i> methods. Biodiversity at global, regional and local levels. Threats to ecosystem diversity: overexploitation, fragmentation, habitat loss, poaching of wildlife, man-wildlife conflicts, natural calamities, bio-invasion, pollution, global climate change; Effect of degeneration of biodiversity on future of evolution. Social awareness and social movements concerning conservation issues; Ecosystem restoration; equitable use of resources for sustainable lifestyles; Role of an individual and organizational efforts in conservation of natural resources, integrating development and conservation.	
Pedagogy:	Lectures/Assignments/Videos/ Field visits	
References/ Readings:	<p>Dash, MC (2001). Fundamentals of Ecology. Tata McGraw-Hill Publishing Education Pvt Ltd., India.</p> <p>Kormondy, EJ (1996). Concepts of Ecology. 4th edition. PHI Learning Pvt. Ltd., Delhi, India.</p> <p>McCleery, RA., Moorman, C and Peterson, MN (Eds.). (2014). Urban Wildlife Conservation - Theory and Practice. Springer publication, New York.</p> <p>Miller, GT and Spoolman, S (2015). Environmental Science. Cengage Learning Pvt. Ltd., New Delhi.</p> <p>Mitra, A and Chaudhuri, TR (2020). Basics of Environmental Science. New Central Book Agency, West Bengal.</p> <p>Nandini, N (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru.</p> <p>Odum, EP (2005). Fundamentals of Ecology. 5th edition. Cengage Learning India Pvt. Ltd., New Delhi.</p> <p>Rao, RS (1985-1986). Flora of Goa, Diu, Daman & Nagar-Haveli. 2 Volumes. Botanical Survey of India.</p> <p>Rawat, M., Dookia, S and Sivaperuman, C (2015). Aquatic Ecosystem: Biodiversity, Ecology and Conservation. Springer publication, New Delhi.</p> <p>Sharma, PD (2010). Ecology and Environment, 8th edition. Rastogi Publication, Meerut, India.</p> <p>Shukla, RS and Chandel PS (2014). A Textbook of Plant Ecology Including Ethnobotany and Soil Science. 12th edition. S. Chand and Company Limited, New Delhi.</p> <p>Singh, JS, Singh, SP and Gupta, S (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi, India.</p> <p>Smith, TM and Smith, RL (2007). Elements of Ecology. Pearson Education, India.</p> <p>Underkoffler, SC and Adams, HR. (Eds.). (2021). Wildlife Biodiversity Conservation - Multidisciplinary and Forensic Approaches, Springer Nature, Switzerland AG.</p> <p>Wilkinson, DM (2007). Fundamental Processes in Ecology: An Earth System Approach. Oxford University Press., U.S.A.</p>	

Course Outcomes:	<ol style="list-style-type: none">1. Students will gain entry level competence in understanding the ecological dynamics and their influence on humans and anthropogenic endeavours.2. Students will gain theoretical understanding of ecosystem diversity.3. Develop an understanding of the natural resources.4. Understand status of wildlife, the pressures faced by wildlife areas and cultivate an insight into the conservation practices.5. Be able to use the acquired knowledge in decision making and hence add to quality of life.	
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Name of the Programme: B. Sc (Botany)

Course Code: BOT-142

Title of the Course: Fruits and Vegetable Processing

Number of Credits: 3 (1 Theory + 2 Practical)

Effective from AY: 2023-24

Prerequisites for the course:	Should have basic knowledge of Biology.	
Course Objective(s):	This course is designed to give an overview of different types of fruits and vegetables, their composition and methods used in processing and preservation. The practical component of this course deals with imparting skills in preparation of various processed products.	
Content:	Module 1: Fruits and Vegetables: Methods of processing and processed products Fruits - Definition, types of fruits (fleshy and dry) with examples. Vegetables - Definition, types of vegetables (leafy, stem, root, flower and fruit) with examples. Composition of fruits and vegetables. Maturation and ripening of fruits. Spoilage of fruits and vegetables. Pigmentation in fruits and vegetables. Principles of processing and preservation. Harvesting and pre-processing. Methods of processing: Drying, pickling, fermentation, freezing and dehydration, canning. Scope and importance of processing and preservation.	15 hours
	Preparation of the following products: a. Frozen vegetables - Carrots (<i>Daucus carota</i>), Cauliflower (<i>Brassica oleracea</i> var. <i>botrytis</i>) and peas (<i>Pisum sativum</i>). b. Dehydrated products - Potato (<i>Solanum tuberosum</i>) chips and garlic (<i>Allium sativum</i>) powder. c. Preparation of pickles from fruits and vegetables - Bilimbli (<i>Averrhoa bilimbi</i>), karanda (<i>Carissa carandas</i>), bitter gourd (<i>Momordica charantia</i>) and brinjal (<i>Solanum melongena</i>). d. Canning of fruits - Preparation of sugar syrup and canning of jackfruit (<i>Artocarpus heterophyllus</i>) and pineapple (<i>Ananas comosus</i>). e. Canning of vegetables - Preparation of brine and canning of green mango (<i>Mangifera indica</i>). f. Fermentation - Vinegar and wine. g. Juices & squashes - Amla (<i>Phyllanthus emblica</i>) juice, kokum (<i>Garcinia indica</i>) juice, pineapple (<i>Ananas comosus</i>) squash. h. Jams and Marmalades - Guava (<i>Psidium guajava</i>) jam, orange (<i>Citrus sinensis</i>) marmalade. i. Sauces and Ketchups - Tomato (<i>Solanum lycopersicum</i>), chilli (<i>Capsicum annum</i>) sauce and ketchup.	
	Practicals (30P = 30 × 2 hours) 1. Study of fruits (Amla, banana, guava, jackfruit, mango, papaya, pineapple, cashew and kokum) and vegetables (Cucumber,	4 hours

	<p>tomato, ash gourd, little gourd, ladyfinger, radish and brinjal), their composition and use in value-added products.</p> <p>2. Techniques of sterilization and packing. 2 hours</p> <p>3. Determination of pH and ascorbic acid content of any <i>Citrus</i> fruit. 2 hours</p> <p>4. Microscopic observation of yeast (<i>Saccharomyces cerevisiae</i>). 2 hours</p> <p>5. Preparation of any one type of pickle. 2 hours</p> <p>6. Preparation of kokum syrup/lemon/ginger cordial. 2 hours</p> <p>7. Preparation of fruit juice and squash. 4 hours</p> <p>8. Preparation of tomato puree and tomato ketchup. 4 hours</p> <p>9. Preparation of jam and marmalade from suitable fruits. 6 hours</p> <p>10. Preparation of tutti fruity from raw papaya. 4 hours</p> <p>11. Preparation of raisins. 2 hours</p>	
	<p>12. Preparation of chutney from fruit and vegetable. 4 hours</p> <p>13. Preservation of green peas and carrots by freezing. 2 hours</p> <p>14. Preparation of vinegar from toddy or any suitable fruit and assessment of pH. 4 hours</p> <p>15. Preparation of papad from jackfruit/breadfruit. 2 hours</p> <p>16. Preparation of amla and ginger candy. 2 hours</p> <p>17. Preparation of wine from any suitable fruit. 6 hours</p> <p>18. Determination of alcohol content of wine by hydrometer method/specific gravity method. 2 hours</p> <p>19. Field visit to a distillation unit or a food processing unit. 4 hours</p>	
Pedagogy:	Lectures, Practicals, Assignment, Presentations, Field visit.	
References/ Readings:	<p>Ashraf, SM (2008). Handbook of Fruit and Vegetable products. Agrobios, India.</p> <p>Cruess, WV (2004). Commercial Fruit and Vegetable Products. Agrobios, India.</p> <p>Dubey, RC (1993). A Textbook of Biotechnology. S. Chand & Company Pvt. Ltd., New Delhi.</p> <p>Frazier, WC and Westhoff, DC (2008). Food Microbiology. Tata Mc. Graw Hill Education Private Limited, New Delhi.</p> <p>Lal G, Siddappa, GS & Tandon, GL (2019). Preservation of fruits & Vegetables. ICAR, New Delhi.</p> <p>Manay, SN and Shadaksharaswamy, M (2008). Foods: Facts and Principles. New Age International, Bengaluru.</p> <p>Narang, RK (2010). Fruit and Vegetable Preservation Techniques. APH Publishing Corporation, Delhi.</p> <p>Potter, NN and Hotchkiss, HJ (1996). Food Science. CBS Publishers & Distributors, New Delhi.</p> <p>Rahman, MS (2020). Handbook of food preservation (3rd Edition). CRC-press, United States.</p> <p>Ranganna, S (1986). Handbook of analysis and quality control for fruits and vegetable products (2nd Edition). Tata Mc Graw-Hill Publishing Company Limited, New York.</p>	

	<p>Saldanha, E (2010). Successful Goan home wines. Rajhauns Vitaran, Goa.</p> <p>Srilakshmi, B (2007). Food Science. New Age International (P) Limited, New Delhi.</p> <p>Srivastava, RP and Kumar, S (2017). Fruit and Vegetable Preservation- Principles and Practices (3rd edition). CBS publishers and distributors Pvt Ltd., India.</p> <p>Thompson, AK (2003). Fruit and Vegetables - Harvesting, Handling and Storage (2nd Edition). Blackwell Publishing Ltd., US.</p> <p>Verma, LR and Joshi, VK (2000). Post harvest technology of Fruits and vegetables- handling, processing, fermentation, and waste management. Vol I & II, Indus Publishing, New Delhi.</p> <p>Wolff, IA (1982). CRC Handbook of Processing and Utilization in Agriculture. CRC series in Agriculture, Vol II, part-I, CRC press, California.</p>	
<p>Course Outcomes:</p>	<p>On completion of this course students will be able to:</p> <ol style="list-style-type: none"> 1. Recall the types of fruits and vegetables used for processing. 2. Explain the principles of fruits and vegetable processing. 3. Analyse the different methods used in processing of fruits and vegetables. 4. Apply the skills in preparation of various processed products for entrepreneurial opportunity. 	

Exit Course

Name of the Programme: B.Sc Botany

Course Code: BOT-161

Title of the Course: Floriculture

Number of Credits: 4 (1 Theory + 3 Practical)

Effective from AY: 2023-24

Prerequisites for the course:	Should have basic knowledge of Biology.	
Course Objective(s):	The course is designed to provide knowledge of nursery bed preparation, use of various methods of plant propagation, garden implements, cultivation, care, harvesting, designing floral arrangement and marketing of flowers.	
Content:	Module 1: Floriculture: Scope, routine garden operations, propagation and commercial aspects. Scope of floriculture; Global trends and importance. Future of floriculture as an industry in Goa and Government initiatives (SCHEMES). Different garden tools and their operations. Routine Garden Operations - Preparation of nursery beds, sowing of seeds, soil sterilization, planting and transplanting; Pricking, pinching, defoliation and mulching. Role of plant growth regulators (Auxins, Gibberellins, Cytokinins, ABA and Florigen), Fertilizers and Manures. Types of Grafting, Layering, Cutting and Budding of ornamental plants. Different styles and types of flower arrangements, Preparation of floral bouquets, floral rangoli, Garlands, Crown, Wreaths, Baskets and Dry Flower arrangements.	15 hours
	Practicals (45 P) 1. Ornamental Garden planting plan/design 2. Garden implements and their operations; plant supports. 3. Identification and description of plants based on types and shapes: a. Flowers (any 5); Cut greens (any 5); Cacti (any 2); Water plants (any 2); Lawns (any 2) b. Decorative plants according to their shapes (Upright – <i>Sansivieria</i> , bushy - <i>Dieffenbachia</i> , trailing - <i>Chlorophytum</i> , climbing - <i>Monstera</i> , standard - <i>Ficus benjamina</i> , architectural- <i>Chamaerops</i> /palms, ball - Cacti, rosette - <i>Haworthia</i> , <i>Echeveria</i>)	2 hours 4 hours 10 hours
	4. Soil preparation and sterilization. 5. Preparation of different types of nursery beds (Flat beds, raised beds, ridges and furrows, basin etc.) and pots. 6. Methods of vegetative propagation: Grafting, layering, cuttings, offsets, budding. 7. Handling and propagation of bulbs, bulbils, tubers, suckers, runners, and corms. 8. Cultivation of plants based on substrates and maintenance of the same till flowering/maturity. Coconut husk/Coco peats: Orchids and Anthuriums. Soil: Cultivation of flowering / foliage / water / cacti / succulent plants (1 of each category).	2 hours 4 hours 6 hours 4 hours 15 hours

	<p>9. Aesthetic grouping of plants in open and container gardens</p> <p>10. Garden operations: Mulching, pricking, topping, trimming and training, feeding and repotting.</p> <p>11. Harvesting, packing of cut flowers - packaging material (polythene, butter paper, brown paper, newspaper, and corrugated cardboard), storage conditions (room temperature, refrigeration, water).</p> <p>12. Prolonging shelf life of cut flowers (any two)</p> <p>13. Identification of plant disease and pest. (Insects, Fungal, Bacterial, Viral and Mycoplasmic)</p> <p>14. Methods of drying plant materials (air-drying, desiccants, sand, microwave/oven etc.)</p> <p>15. Styles of flower arrangements: Garlands (any 2); bouquets (any 2) Crown (any 1); wreath (any 1); baskets (any1); flower swag (any 1), Ikebana (any 1), Dry flower arrangement (any 1)</p> <p>16. Field visit to an orchidarium / flowering plant polyhouse / nursery / landscaped public place.</p>	<p>4 hours</p> <p>5 hours</p> <p>6 hours</p> <p>2 hours</p> <p>6 hours</p> <p>4 hours</p> <p>10 hours</p> <p>6 hours</p>
Pedagogy:	Lectures, Practicals, Assignment, Presentations, Field visit.	
References/ Readings:	<p>Database Floriculture and Seeds (apeda.gov.in).</p> <p>Gorer, R (1978). The Growth of Gardens. Faber and Faber. London.</p> <p>Gupta, J and Dubey RK (2018) Factors Affecting Post-Harvest Life of Flower Crops International Journal of Current Microbiology and Applied Sciences (7) 548-557.</p> <p>Hall, DA. (2002). Fertilizers and Manures. Biotech Books Delhi.</p> <p>Hartman, HT and Kester, DF. (1976). Plant propagation: Principles and practices. Prentice & Hall of India. New Delhi.</p> <p>Knee, M. (2000). Selection of biocides for use in floral preservatives. Postharvest Biology and Technology (18): 227-34.</p> <p>Publications of Directorate of Agriculture, Govt. of Goa and ICAR, Old Goa.</p> <p>Randhawa, G.S. and Mukhopadhyay. A. (1986). Floriculture in India. Allied Publishers, India.</p> <p>Singh, K, Singh, R, Kumar, R and Chawla, N. (2010). Effect of harvesting stages and BAP on post storage keeping quality of cut stems of Chrysanthemum (<i>Dendranthema grandiflora</i>). Journal of Ornamental Horticulture (13): 233-236.</p> <p>Swarup, V. (1997). Ornamental Horticulture. MacMillan India Ltd., UK</p>	
Course Outcomes:	<p>1. Understand the concept of floriculture and cultivation of commercial ornamental plants.</p> <p>2. Develop basic skills in techniques and different styles flower arrangement.</p> <p>3. Learn routine nursery management practices, garden operations & postharvest technology for ornamental plants.</p> <p>4. Understand the concept of plant growth and plant care.</p> <p>5. Develop insight to various government schemes in floriculture industry establish start-ups in floriculture business.</p>	