POST GRADUATE SYLLABUS

(Prepared from ICAR PG Syllabus of Horticulture)

Degree to be awarded

M. SC. (HORT.) IN FLORICULTURE, MEDICINAL AND AROMATIC PLANTS

Department of Floriculture, Medicinal and Aromatic Plants

FACULTY OF HORTICULTURE

UTTAR BANGA KRISHI VISWAVIDYALAYA

PUNDIBARI, COOCH BEHAR

PROPOSED POST- GRADUATE CURRICULA & SYLLABI

MASTER DEGREE PROGRAMME
[M. SC. (HORT.) IN FLORICULTURE, MEDICINAL AND AROMATIC PLANTS]

CODE	COURSE TITLE	CREDITS
FIRST SEMESTER		
FAM-501	PRODUCTION TECHNOLOGY OF CUT FLOWERS	2+1
FAM - 502	BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS	2+1
FAM- 503	PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS	2+1
SECOND SEMESTER		
FAM-551	PRODUCTION TECHNOLOGY OF LOOSE FLOWERS	2+1
FAM-552	LANDSCAPING AND ORNAMENTAL GARDENING	2+1
FAM - 553	BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1
THIRD SEMESTER		
FAM-601	PROTECTED FLORICULTURE	2+1
FAM-602	VALUE ADDITION IN FLOWERS	2+1
FAM- 603	PROCESSING OF MEDICINAL AND AROMATIC CROPS	2+1
FAM-604	TURFING AND TURF MANAGEMENT	2+1
FOURTH SEMESTER		
FAM-651	CAD FOR OUTDOOR AND INDOORSCAPING	2+1
FAM - 652	UNDEREXPLOITED MEDICINAL AND AROMATIC PLANTS	1+1
FAM- 691	MASTER'S SEMINAR	1+0
FAM- 699	MASTER'S RESEARCH	20

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme; Optional for Ph.D. scholars)

CODE	COURSE TITLE	CREDITS
PGS - 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS - 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS - 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS - 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1

CODE	COURSE TITLE	CREDITS
PGS - 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS - 506 (e-Course)	DISASTER MANAGEMENT	1+0

DOCTORAL DEGREE PROGRAMME

CODE	COURSE TITLE	CREDITS
FIRST SEMESTER		
FAM-701	ADVANCES IN FLOWER PRODUCTION TECHNOLOGY	2+1
FAM-702	ADVANCES IN MEDICINAL AND AROMATIC CROP PRODUCTION TECHNOLOGY	2+1
FAM-703	ADVANCES IN PROTECTED AND PRECISION FLORICULTURE	2+1
SECOND SEMESTER		
FAM-751	ADVANCES IN BREEDING OF FLOWER CROPS	2+1
FAM -752	ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1
FAM-753	POST HARVEST PROCESSING AND EXTRACTION IN MEDICINAL AND AROMATIC CROPS	2+1
FAM-754	ADVANCES IN LANDSCAPE ARCHITECTURE	1+2
FAM-755	ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS	2+1
THIRD SEMESTER ONWARDS		
FAM - 791	DOCTORAL SEMINAR- I	1+0
FAM - 792	DOCTORAL SEMINAR II	1+0
FAM - 799	DOCTORAL RESEARCH	45

MINIMUM CREDIT REQUIREMENTS

Subject	Master's programme	Doctoral programme
Major	20	15
Minor	09	08
Supporting	05	05
Seminar	01	02
Research	20	45
Total credits	**55**	**75**
Compulsory non-credit courses	06 (compulsory)	Maximum 06 (optional)

FLORICULTURE, MEDICINAL AND AROMATIC PLANTS
COURSE CONTENTS

FAM – 501 : PRODUCTION TECHNOLOGY OF CUT FLOWERS (2+1)

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House. 52
Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FAM - 502 : BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS (2+1)

Objective
To impart comprehensive knowledge about the principles and practices of breeding of flower crops and ornamental plants.

Theory
UNIT I
Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence-Patents and Plant Variety Protection in India.
UNIT II
Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life.
UNIT III
Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.
UNIT IV
Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium.
UNIT V
Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.

Practical
Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

Suggested Readings
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.
Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.
Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.
Singh BD. 1990. *Plant Breeding*. Kalyani.

FAM – 503 : PRODUCTION TECHNOLOGY FOR MEDICINAL AND AROMATIC CROPS (2+1)

Objective

To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory

UNIT I

Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO's in production, GAP in medicinal crop production.

UNIT II

Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, *Dioscorea* sp., *Aloe vera*, *Phyllanthus amarus*, *Andrographis paniculata.*

UNIT III

Production technology for Medicinal solanum, Isabgol, Poppy, Safed musli, *Stevia rebaudiana, Mucuna pruriens, Ocimum sp.*

UNIT IV

Post harvest handling – Drying, Processing, Grading, Packing and Storage, processing and value addition; GMP and Quality standards in herbal products.

UNIT V

Influence of biotic and abiotic factors on the production of secondary metabolites, Regulations for herbal raw materials, Phytochemical extraction techniques.

UNIT VI

Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VII

Production technology for palmarosa, lemongrass, citronella, **v**ettiver, geranium, artemisia, mentha, ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.

UNIT VIII

Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations.

UNIT IX

Institutional support and international promotion of essential oil and perfumery products.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important Aromatic crops, Visit to distillation and value addition units – Visit to CIMAP.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Aromatic Plants*. RRL,CSIR, Jammu

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*.RRL,CSIR, Jammu
Farooqi AA & Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.
Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.
Hota D. 2007. *Bio Active Medicinal Plants*. Gene Tech Books.
Jain SK. 2000. *Medicinal Plants*. National Book Trust.
Khan IA & Khanum A. *Role of Bio Technology in Medicinal and Aromatic Plants.*Vol.IX. Vkaaz Publ.
Kurian A & Asha Sankar M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.
Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.
Prajapati SS, Paero H, Sharma AK & Kumar T. 2006. *A Hand book of Medicinal Plants*. AgroBios
Ramawat KG & Merillon JM. 2003. *BioTechnology-Secondary Metabolites*. Oxford & IBH.
Skaria P Baby, Samuel Mathew, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. *Aomatic Plants*. New India Publ. Agency.

FAM- 551 : PRODUCTION TECHNOLOGY OF LOOSE FLOWERS (2+1)

Objective
To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory
UNIT I
Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques
UNIT II
Soil and climate requirements, field preparation, systems of planting, precision farming techniques.
UNIT III
Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM.
UNIT IV
Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.
UNIT V
Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, trasportation and marketing, export potential, institutional support, Agri Export Zones.
Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

Practical

Botanical description of species and varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture andLandscaping.* Naya Prokash.
Chadha KL & Chaudhury B.1992. *Ornamental Horticulture in India*. ICAR.
Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.
Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.*Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India.* Allied Publ.
Sheela VL. 2007. *Flowers in Trade*. New India Publ. Agency.
Valsalakumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. *Flowering Trees*. New India Publ. Agency.

FAM – 552 : LANDSCAPING AND ORNAMENTAL GARDENING (2+1)

Objective

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

UNIT I

Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II

Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

UNIT III

Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.

UNIT IV

Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

UNIT V

Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

Practical

Selection of ornamental plants**,** practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of

special types of gardens, bur lapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.
Woodrow MG.1999. *Gardening in India.* Biotech Books.

FAM – 553 : BREEDING OF MEDICINAL AND AROMATIC CROPS (2+1)

Objective

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

UNIT I

Plant bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops; Scope for improvement of Medicinal and Aromatic Crops through selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches.

UNIT II

Breeding for yield and quality improvement in medicinal plants, Breeding for high herbage yield, essential oil and quality components, secondary metabolites in medicinal and aromatic crops; Genetics of active principles and assay techniques useful in evaluation of breeder's material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

UNIT III

Achievements and prospects in breeding of medicinal crops, *viz*. *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, Stevia, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, *Dioscorea* sp.

UNIT IV

Prospects in breeding of medicinal crops, *viz. Chlorophytum* sp, *Rauvolfia serpentina*, *Aloe vera*, *Ocimum* sp, *Phyllanthus amarus, Solanum* sp.

UNIT V

Prospects in breeding of aromatic crops viz., Geranium, vettiver, Lemon grass, Palmarosa, citronella, Rosemary, Patchouli, Eucalyptus, Artemisia and Mint.

Practical

Description of Botanical features, Cataloguing of cultivars, varieties and species in medicinal and aromatic crops, Floral Biology, Selfing and crossing, Evaluation of hybrid progenies,

Induction of economic mutants, High alkaloid and high essential oil mutants, evolution of mutants through physical and chemical mutagens, Introduction of polyploidy, Screening of plants for biotic and abiotic stress and environmental pollution, *in-vitro* breeding in medicinal and aromatic crops.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*.RRL,CSIR, Jammu
Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. XI. Malhotra Publ. House.
Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops.* Natural Remedies Pvt. Ltd.
Jain SK. 2000. *Medicinal Plants*. National Book Trust.
Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ
Kurian A & Asha Sankar, M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.
Prajapati ND, Paero Hit SS, Sharma AK, Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios (India).
Skaria P Babu. 2007. *Aromatic Plants*. New India Publ. Agency.
Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*.CSIR.

FAM – 601 : PROTECTED FLORICULTURE (2 + 1)

Objective

Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.

Theory

UNIT I

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO_2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, postharvest handling, packing methods, project preparation, visit to commercial greenhouses.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.
Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Nelson PV. 1978. *Green House Operation and Management*. Reston Publ. Co.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FAM – 602 : VALUE ADDITION IN FLOWERS (2+1)

Objective

To develop understanding of the scope and ways of value addition in flowers.

Theory

UNIT I

Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management.

UNIT II

Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.

UNIT III

Dry flowers– Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage.

UNIT IV

Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

Practical

Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers; Techniques in flower arrangement; Techniques in floral decoration; Identification of plants for dry flower making; Practices in dry flower making; Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.; Visit to dry flower units, concrete and essential oil extraction units.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Chadha KL.1995. *Advances in Horticulture*. Vol.XII. Malhotra Publ. House.
Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007.*HightechFloriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FAM – 603 : PROCESSING OF MEDICINAL AND AROMATIC PLANTS (2+1)

Objective

To facilitate deeper understanding on principles and practices of post harvest technology of medicinal and aromatic crops.

Theory

UNIT I

Processing of medicinal plants– dioscorea, gloriosa, stevia, coleus, ashwagandha, tulsi, isabgol, safed musli, senna, aloe, catharanthus, etc.

UNIT II

Different methods of drying and storage. Microbial contamination of stored product. Influence of temperature and time combination on active principles.

UNIT III

Extraction and analysis of active principles using TLC / HPLC / GC. Distillation, solvent extraction from aromatic plants– davana, mint, rosemary, rose, citronella, lavender, jasmine, etc.

UNIT IV

Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

Practical

Study of processing of different spices and plantation crops. Study of processing of medicinal plants, their drying and storage. Extraction of active ingredients from different spices and herbs using TLC, HPLC, GC/CG-MS technology. Distillation, solvent extraction from aromatic plants – davana, mint, rosemary, citronella, lavender, jasmine, etc. Identification of different odoriferous factors in essential oil with GLC/GCMS. Physico-chemical and sensory evaluation of oils and oleoresin. Value added products from spices and plantation crops.

Suggested Readings

Chadha KL et al. (Eds.). 1993-95. *Advances in Horticulture*. Vol. IX.*Plantation Crops and Spices*. Malhotra Publishing House, NewDelhi.
Fellows PJ. 1988. *Food Processing Technology*. Ellis Horwood International. Switzerland.

Fennema OR. 1985. *Food Chemistry*. Marcel Dekker.
Kumar N, Abdul Khader ML, Rangaswamy P & Ikrulappan I. 1994. *Spices, Plantation Crops, Medicinal and Aromatic Plants*. Rajalakshmi Publ.
Mandal RC. 1996. *Coconut Production and Processing Technology*. Agro. Bot.
Mandal RC. 1997. *Cashew: Production and Processing Technology*. Agro. Bot.
Masada Y.1986. *Analysis of Essential Oil by Gas Chromatograph and Mass Spectrometry*. John Wiley & Sons.
Paine FA. 1987. *Modern Processing, Packaging and Distributions Systems for Food*. AVI Publ.
Peter KV. (Ed.). 2001. *Handbook of Herbs and Spices*. Vols.I-III. Wood Head Publishing Co., UK & CRC, USA.
Sudheer KP & Indira V. 2008. *Post-Harvest Technology of Horticultural Crops*. Horticulture Science Series. New India Publ. Agency.
Thampan PK. 1981. *Handbook of Coconut Palm*. Oxford & IBH.

FAM – 604 : TURFING AND TURF MANAGEMENT (2+1)

Objective
To develop understanding of the principles and management of turfing.

Theory
UNIT I
Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.
UNIT II
Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement- Adaptation; Turfing for roof gardens.
UNIT III
Preparatory operations; Growing media used for turf grasses – Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.
UNIT IV
Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing -- mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.
UNIT V
Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

Practical
Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices – mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic stress management; Project preparation for turf establishment, visit to IT parks, model

cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics.

Suggested Readings

Nick-Christians 2004. *Fundamentals of Turfgrass Management*.www.amazon.com

FAM – 651 : CAD FOR OUTDOOR AND INDOORSCAPING (2+1)

Objective

To impart basic knowledge about the operation of Computer Aided Designing (CAD) in landscape garden designing.

Theory

UNIT I

Exposure to CAD (Computer Aided Designing) – Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing.

UNIT II

2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects.

UNIT III

Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout.

UNIT IV

3D drawing methods, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD.

UNIT V

ARCHICAD organization tools, Dimensioning and detailing of designs, Attribute settings of components, Visualization tools for landscape preview, Data management, plotting and accessories for designing, Inserting picture using photoshop, Making sample drawing for outdoor and indoor gardens.

Practical

Practices in point picking methods, Using tool bars and icons, Using modifying tools and modifying comments, Isometric drawings, Using productivity tools, Drawing designs by AUTOCAD for home garden, institutional garden and special types of garden, Using tools and info-box for 3D drawing, Creation of garden components with ARCHICAD, Organization, dimensioning, detailing and visualization tools with ARCHICAD, Using Photoshop package for 3D picture insertion, Drawing designs with ARCHICAD for home garden, interior garden designing, IT parks, Corporates, Theme parks and Ecotourism spots.

Suggested Readings

Christine Wein-Ping Yu 1987. *Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture*. amazon.com

FAM – 652 : UNDEREXPLOITED MEDICINAL AND AROMATIC CROPS (1+1)

Objective
To facilitate understanding on the importance, conservation and cultivation of medicinal and aromatic crops.

Theory
UNIT I
Introduction, importance, present status and future prospects, origin, distribution, species, varieties, economic parts and their uses in different diseases, Biodiversity and conservation, RET (Rare, Endangered and Threatened) and MPCAs (Medicinal Plants Conservation Areas).
UNIT II
Underutilized species – importance, traditional usage, ISM, TCM, Functional foods.
UNIT III
Production technology of underutilized medicinal crops– *Morinda citrifolia, Caesalpinia sappan, Caralluma, Terminalia chebula, Strychnos nuxvomica, Solanum trilobatum,* Physalis, *Aegle marmelos, Alpinia* sp., *Anthocephalus kadamba, Costus.*
UNIT IV
Production technology of underutilized aromatic crops– *Curcuma aromatica, C. caesia, Coleus aromaticus, Ocimum kilimanjaricum, Bursera.*
UNIT V
National and international conservation network, IPR issues, Promotion of under utilized species, Processing and value addition, Marketing.

Practical
Case studies.

Suggested Readings
Atal CK & Kapur BM. 1982. Cultivation and Utilization of Aromatic Plants. RRL,CSIR, Jammu
Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*.RRL,CSIR, Jammu
Chadha KL Gupta. R. 1995. *Advance in Horticulture.* Vol. XI. *Medicinal & Aromatic Plants.* Malhotra Publ. House.
CSIR. 1971. *The Wealth of India.* Vols. A-Z. CSIR.
Farooqui AA, Khan MM & Sreeramu BS. 1997. *Cultivation of Medicinal and Aromatic Crops in India.* Naya Prokash.
Guenther E. 1975. *The Essential Oils.* Robert K. Krieger Publ. Co.
Jain SK. 1979. *Medicinal Plants.* National Book Trust.
Kurian A & Asha Sankar M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.
Peter KV. (Ed.). 2007-08. *Underexploited and Underutilized Horticultural Crops*. Vols.I-IV. New India Publ. Agency.
Sivarajan VV & Balachandran I. 1994. *Ayurvedic Drugs and their Plant Sources.* Oxford & IBH.

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

Course Contents

PGS – 501 : LIBRARY AND INFORMATION SERVICES (0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

PGS – 502 : TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing **-** Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.
Communication Skills **-** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
Richard WS. 1969. *Technical Writing*. Barnes & Noble.
Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India
Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS – 503 : INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN (e-Course) AGRICULTURE (1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI
Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS – 504 : BASIC CONCEPTS IN LABORATORY TECHNIQUES (0+1)

Objective
To acquaint the students about the basics of commonly used techniques in laboratory.
Practical
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings
Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*.Chemical Publ. Co.

PGS – 505 : AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL (e-Course) DEVELOPMENT PROGRAMMES (1+0)

Objective
To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory
UNIT I
History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.
UNIT II
Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
UNIT III
Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-

Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
Singh K.. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

PGS – 506 : DISASTER MANAGEMENT (1+0)
(e-Course)

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.\

FAM – 701 : ADVANCES IN FLOWER PRODUCTION TECHNOLOGY (2+1)

Objective
To keep abreast with latest developments and trends in production technology of flower crops

Theory
UNIT I
Commercial flower production; Scope and importance; Global Scenario in cut flower production and trade, varietal wealth and diversity; Soil and Environment; Special characteristics and requirements; cut flower, loose flowers, dry flowers and floral oil trade.
UNIT II
Propagation and multiplication; IPR issues related to propagation of materials; Greenhouse management; Soil/media decontamination techniques; Microirrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and flowering; regulation for quality flowers.
UNIT III
Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation; Harvest indices; Harvesting techniques; Post-harvest handling; Precooling, pulsing, packing, marketing; Export potential; Agri Export Zones.
UNIT IV
Crop specific practices – rose, anthurium, orchids, carnation, gladioli, gerbera, liliums, heliconia, bird of paradise, *Jasminum* sp., marigold, tuberose, crossandra.
UNIT V
Floral oil industry, floral concrete production, extraction methods, recent advances.

Practical
Varietal wealth in flower crops; Greenhouse management; Soil decontamination techniques; Microirrigation; Nutrition and fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Assessing harvest indices; Post-harvest handling; Tissue analysis; Preparation of floral decoratives; Extraction of floral concrete and oils; case studies; visit to commercial cut flower units.

Suggested Readings
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Chadha KL & Choudhury B. 1992. *Ornamental Horticulture in India*. ICAR.
George S & Peter KV. 2008. *Plants in a Garden.* New India Publ. Agency.
Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Reddy S, Janakiram B, Balaji T, Kulkarni. S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, NewDelhi.

FAM – 702 : ADVANCES IN MEDICINAL AND AROMATIC CROP PRODUCTION TECHNOLOGY (2+1)

Objective
To keep abreast with latest developments and trends in production technology of medicinal and aromatic crops.

Theory

UNIT I

Genetic biodiversity of medicinal plants, Conservation networks, Global initiatives on medicinal plants conservation and development, World history on usage of medicinal plants, Preference to natural products, Advanced research in biomedicines, Nutraceuticals and natural drugs, American, European and Asian legislations on plant drugs, Intellectual Property Rights, Patents.

UNIT II

Indian traditional wisdom and Heritage- Indian herbal wealth, Documentations, Databases, Scientific validation, Production Problems of Medicinal and Aromatic plants, Export and import status. WTO scenario - Principles and guidelines for GAP, GCP and GMP in medicinal crops.

UNIT III

Climate, Soil and substrate culture, Improved varieties, Organic production, Nutrition and irrigation requirements, inter culture, mulching, Weed control, Maturity indices and Harvesting, Post-harvest handling, Drying, Processing, Grading, Packing and Storage, Quality standards in medicinal plants, Biotechnological approaches for advances in phytochemical extraction technologies, Separation of Bio-molecules, Distillation methods, Essential oil extraction and value addition in aromatic plants, Phytochemicals and drug development.

UNIT IV

Medicinal crops : *Coleus forskohlii*, Glory liliy, Senna, Periwinkle, *Stevia rebaudiana*, Aswagandha, Sarpagandha, *Aloe vera*, *Dioscorea* sp, *Phyllanthus amarus, Andrographis paniculata*, Medicinal solanum, Isabgol, *Poppy, Digitalis* sp, *Commiphora* sp, *Ipecac, Henbane, Ocimum* sp., *Centella, Bacopa, Saraca indica* and *Bael.*

UNIT V

Aromatic crops: Palmarosa, Lemongrass, citronella, vetiver, Geranium, Artemisia, Mentha, Ocimum, Eucalyptus, Rosemary, Thyme, patchouli.

Practical

Identification and documentation- propagation in medicinal crops, Maturity standards, Harvesting and Drying techniques, Processing and grading, Analysis of bio-molecules, Extraction of secondary metabolites, identification and characterization of - secondary metabolites, Essential oils, Visit to commercial medicinal plants field, Visit to GMP phytochemical extraction and value addition unit.

Suggested Readings

Dharamvir H. 2007. *Bioactive Medicinal Plants*. Gene Tech Books.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.

Farooqi.AA & Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops.* Orient Longman Publ.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Khan IA & Khanum A. 2001 *Role of Biotechnology in Medicinal and Aromatic Plants*. Vol. IX. Vikaaz Publ.

Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.

Prajapati ND, Paero Hit SS, Sharma AK & Kumar T. 2006. *A Hand Book of Medicinal Plants*. Agro Bios.

Ramawat KG & Merillon JM. 2003. *BioTechnology – SecondaryMetabolites*. Oxford & IBH.

FAM - 703 : ADVANCES IN PROTECTED AND PRECISION FLORICULTURE (2+1)

Objective
Appraisal on the advances in protected and precision farming of flower crops.

Theory
UNIT I
Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance.
UNIT II
Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques.
UNIT III
Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, liliums, cut foliage; Harvest indices – harvesting, PH handling, marketing, export.
UNIT IV
Precision floriculture, Principles and concepts, Enabling technologies of precision farming, GPS, GIS, Remote sensing, sensors.
UNIT V
Variability management in precision farming, mapping, variable rate technology, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Practical
Growing structures, basic considerations in establishment and operation of greenhouses, Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques, Crop regulation, special horticultural practices under protected cultivation, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Suggested Readings
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Reddy S, Janakiram B, Balaji T, Kulkarni S, & Misra RL. 2007. *HightechFloriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FAM – 751 : ADVANCES IN BREEDING OF FLOWER CROPS (2+1)

Objective
To update knowledge on the recent research trends in the field of breeding of flower crops with special emphasis on crops grown in India.

Theory
UNIT I
Origin and evolution of varieties, distribution, Genetic resources, genetic divergence, Plant introduction, selection and domestication, Inheritance of important characters, Genetic

mechanisms associated with flower colour and flower size, doubleness, fragrance and post-harvest life, Plant Variety Protection Act.

UNIT II

Specific objectives of breeding in flower crops, Methods of breeding suitedto seed and vegetatively propagated flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility-Incompatibility problems, *In Vtro* breeding.

UNIT III

Breeding for resistance to pests, diseases, nematodes and other biotic and abiotic stresses in flower crops.

UNIT IV

Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, gerbera, gladioli, orchids and anthurium.

UNIT V

Specific breeding problems and achievements made in aster, petunia, liliums, heliconia, bird of paradise, hibiscus and bougainvillea.

Practical

Description of crops and cultivars; Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies; Induction of mutants; Physical and chemical mutagens; Induction of polyploidy; Screening of plants for biotic and abiotic stresses and environmental pollution; *in-vitro* breeding in flower crops.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Choudhary RC.1993. *Introduction to Plant Breeding.* Oxford & IBH.
Singh BD.1990. *Plant Breeding*. Kalyani.

FAM- 752 : ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS (2+1)

Objective

To update knowledge on the recent research trends in the field of breeding of medicinal and aromatic crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT I

Origin and evolution of varieties, distribution- Genetic resources, genetic divergence, Plant introduction, selection and domestication - Inheritance of important characters, Genetic mechanisms associated with alkaloids and secondary metabolites.

UNIT II

Methods of breeding suited to seed and vegetative propagated crops. Polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops.

UNIT III

Specific breeding objectives in medicinal and aromatic crops, Genetic biodiversity, Breeding problems and improvements in Senna, Periwinkle, Aswagandha, Isabgol, Sarpagandha, Poppy, Glory lily, *Coleus*, *Mucuna and Ocimum*, Centella, Bacopa, Dioscorea, Solanum, Andrographis, *Aloe vera*, Phyllanthus, Eucalyptus, Bael, Cinchona.

UNIT IV

Specific breeding objectives in medicinal and aromatic crops, Genetic bio diversity, Breeding problems and improvements in Henbane aromatic grasses, Geranium, Patchouli, Artemisia, Rosemary, Thyme, Sage, Marjoram, Fever few.

UNIT V

Biotechnological approaches for crop improvement of medicinal and aromatic crops.

Practical

Description of crops and cultivars, Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies, Induction of economic, colour mutants, Increased alkaloid content in medicinal crops, high essential oil content in aromatic plants, Physical and chemical mutagens, Induction of polyploidy, Screening of plants for biotic and abiotic stresses and environmental pollution, *in-vitro* breeding in flower crops, medicinal and aromatic crops.

Suggested Readings

Atal C & Kapoor V. 1992. *Cultivation and Utilization of Medicinal and Aromatic Crops*. CSIR.
Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol.XI. Malhotra Publ. House.
Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.
Handa SS & Kaul MK. 1982. *Cultivation and Utilization of Medicinal Plants*. NISC, CSIR.
Jain SK. 2000. *Medicinal Plants*. National Book Trust.
Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ.
Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.
Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*. CSIR.

FAM – 753 : POST-HARVEST PROCESSING AND EXTRACTION IN MEDICINAL AND AROMATIC PLANTS (2+1)

Objective

To teach advances in post harvest processing and extraction of economically important medicinal and aromatic crops.

Theory

UNIT I

Post-harvest handling of plant material, preparation of plant material for packaging and extraction. Methods of extraction of secondary metabolites from medicinal crops like sarpagandha, steroid-bearing solanums, ashwagandha, henbane, periwinkle, senna, costus, coleus, etc.

UNIT II

Procedures and equipments used for extraction of active principles. Principles and practices of different types of chromatographs - paper, thinlayer, column, gas and high performance liquid

chromatography and mass spectroscopy. Preservation of plant extracts and their trade mechanisms.

UNIT III

Harvesting, drying, handling and preparation of different aromatic crops - jasmine, tuberose, oil-bearing rose, scented geranium, patchouli, davana, mints, basils, etc., for essential oil extraction.

UNIT IV

Principles and practices of different types of extraction - distillation, solvent extraction, supercritical fluid extraction, etc. Fine flavour and perfume extraction. Qualitative determination of essential oils. *In vitro* production of biomass and organic extraction of oils. Quality analysis and characterization through chromatographs.

UNIT V

Commercial uses of essential oils, aromatherapy, etc. Commercial utilization of spent material. Storage of essential oils.

Practical

Identification of different economic parts of medicinal and aromatic crops. Preparation of plant material for extraction. Study of different extraction methods. Study of solvents used in extraction of concrete and absolutes. Extraction of crude drugs and essential oils from different medicinal and aromatic crops respectively. Handling of different chromatographs. Quality analysis of essential oils - both physical and chemical, determination of phenol values, acid values, alcohol values, etc. Sensory evaluation of essential oils. Storage studies in essential oils. Visit to commercial extraction and product development units.

Suggested Readings

Bhattacharjee SK. *Amenity Horticulture, Biotechnology and Post-harvestTechnology*. Vol. V. International Book Periodicals Supply Services.

Chadha KL (Ed.). 1993-95. *Advances in Horticulture*. Vols. I-XIII. Malhotra Publ. House.

Kumar N, Abdul Khader ML, Rangaswamy P & Ikrulappan I. 1994. *Spices, Plantation Crops, Medicinal and Aromatic Plants.* Rajalakshmi Publ.

Leo ML Nollet. 1995. *Food Analysis by HPLC*. Marcel Dekker.

Masada Y.1986. *Analysis of Essential Oil by Gas Chromatograph and Mass Spectrometry*. John Wiley & Sons.

Sadasivam S & Manickam A. 1996. *Biochemical Methods*. 2nd Ed. New Age International Pvt. Ltd., Bangalore and TNAU; Scientific Publishers (India), Jodhpur.

Teranishi R, Hornstein I, Issenberg P &. Wick EL. 1971. *Flavour Research: Principles and Techniques*. Marcel Dekker.

WHO. 1998. *Quality Control Methods for Medicinal Plants Materials*.WHO.

FAM – 754 : ADVANCES IN LANDSCAPE ARCHITECTURE (1+2)

Objective

To update knowledge on the recent trends in the field of landscape architecture and developing practical skills.

Theory

UNIT I

Commercial landscape gardening- History, Plant identification and ecology, Materials of garden design, Design making by different garden styles and types.

UNIT II

Expenses to model landscaping units of all category, Creativity and communication skills for landscape architect, Way of designing a commercial landscape project.

UNIT III

Assessing site and plants adaptability for different locations, Landscape engineering (Topographical) survey and designing concept), special techniques in garden landscaping (Burlaping, waterscaping, hardscaping, lawn making, topiary styles specializing, bioaesthetic planning).

UNIT IV

Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing.

UNIT V

Contemporary landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Case study with the successful landscapist, Budget / Project cost estimating, Execution strategies, Assessing a successful design in site.

Practical

Commercial landscaping, Plant identification, Materials of garden design, Design making by different garden styles and types. Way of designing a commercial landscape project, visit to model ornamental nursery. Assessing site and plants adaptability for different locations, Landscape engineering (Topographical survey and designing concept), special techniques in garden landscaping (Burlaping, waterscaping, hardscaping, lawn making, topiary styles specializing, bioaesthetic planning). Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing. Contemporary landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Case study with the successful landscapist, Budget/Project cost estimating, Execution.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das, P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

FAM – 755 : ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS (2+1)

Objective

Appraisal on the advances in biochemistry of flowers and application of biotechnology in flower crops.

Theory

UNIT I

Biochemistry of flowers: Principle involved in the formation of pigments – chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins. Chemistry and importance of secondary metabolites in rose, jasmine, marigold, tuberose, carnation, orchids, liliums and bougainvillea. Biochemistry and utilization commercial products (select items).

UNIT II

Recent trends- Extraction of biocolours and their value addition, uses in food and textile industries. Biochemistry of post harvest management of cut flowers.

UNIT III

Biotechnology – tools techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cytodifferentiation, organogenesis, somatic embryogenesis.

UNIT IV

In vitro lines for biotic and abiotic stress – Meristem culture for disease elimination, production of haploids through anther and pollen culture – embryo and ovule culture, micrografting, wide hybridization and embryo rescue techniques, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, *in vitro* pollination and fertilization, hardening media, techniques and establishment of tissue culture plants in the primary and secondary nursery.

UNIT V

Somoclonal variation and its applications – variability induction through *in vitro* mutation, development of cell suspension cultures, types and techniques, *in vitro* production of secondary metabolites, role of bioreactors in production of secondary metabolites, quantification and quality analysis of secondary metabolites using HPLC, *in vitro* conservation and cryo-preservation techniques.

UNIT VI

Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, *Agrobacterium* mediated, transgenic plants in flower crops, medicinal and aromatic crops, isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE & PAGE techniques; identification of molecular markers.

UNIT VII

Construction of c- DNA library, DNA fingerprinting technique in economic flower crop varieties, molecular approaches to control ethylene response, improving shelf life, improving resistance for environmental stress, approaches to improve flower development, pigment production, secondary metabolite production, post harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.

Practical

Extraction of flower pigments – xanthophylls, carotenoids and anthocyanins. Plant nutrient stock- growth regulators- media preparation and sterilization- *In vitro* seed germination- callus culture and organ culture- Cell suspension culture – cell plating and regeneration- clonal propagation through Meristem culture, induction of multiple shoots- Anther- Pollen- Ovule and Embryo culture- Synthetic seed production, *in vitro* mutation induction, *in vitro* rooting – hardening at primary and secondary nurseries, Project preparation for establishment of low, medium and high cost tissue culture laboratories, DNA isolation from economic flower crop

varieties – Quantification and amplification, DNA and Protein profiling – molecular markers for economic flower crops, restriction enzymes, vectors for cloning and particle bombardment, DNA fingerprinting of flower crop varieties .

Suggested Readings

Chopra VL & Nasim. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications.* Oxford & IBH.
Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ.
Dey PM & Harborne JB. 1997. *Plant Biochemistry*. 2nd Ed. AcademicPress.
Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.
Goodwin TW & Mercer EI. 2003. *Introduction to Plant Biochemistry*. CBS.
Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.
Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Methods in Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press).
Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. (Eds.).2007. Recent Trends in Horticultural Biotechnology. Vols. I,II. New India Publishing Agency.
Panopoulas NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.
Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S.2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.
Sharma R. 2000. *Plant Tissue Culture*. Campus Books International.
Singh BD. 2001. *Biotechnology*. Kalyani.
Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro*. Symp. Soc. Exp. Biol.11: 118-131.
Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.
Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. www.amazon.com

FLORICULTURE, MEDICINAL AND AROMATIC PLANTS

List of Journals & Magazines

- Acta Horticulture
- Floriculture Today
- Haryana Journal of Horticulture Science
- Horticulture Reviews
- HortScience
- Indian Horticulture
- Indian Journal of Arid Horticulture
- Indian Journal of Horticulture
- Journal of American Society of Horticultural Sciences
- Journal of Applied Horticulture
- Journal of Horticultural Sciences
- Journal of Horticultural Sciences & Biotechnology
- Journal of Japanese Society for Horticulture Science
- Journal of Korean Society for Horticulture Science
- Journal of Landscape architecture
- Journal of Ornamental Horticulture
- Journal of Spices and Aromatic Crops
- Scientia Horticulture
- South Indian Horticulture

Suggested Broad Topics for Master's and Doctoral Research

- Micro-propagation of major flower, medicinal and aromatic crops
- Application of genetic engineering in flower, medicinal and aromatic crops
- Use of molecular markers in flower, medicinal and aromatic crops
- Flower, medicinal and aromatic crops improvement
- Crop selection for biotic and abiotic stresses
- Improved cultivation practice development in flowers, medicinal and aromatic crops
- Diagnostic and recommended integrated system in floriculture, medicinal and aromatic crops
- Nutritional and water requirements of flower, medicinal and aromatic crops
- Organic production of flower, medicinal and aromatic crops
- Precision farming in floriculture, medicinal and aromatic crops
- Protected cultivation of flower crops
- Post-harvest management of flower, medicinal and aromatic crops
- Root distribution studies in medicinal and aromatic crops
- Value addition in flower, medicinal and aromatic crops etc.