

Course Curriculum



B.Sc. (Hons.) Horticulture



Sri Sri University
Sri Sri Vihar, Ward 3, Bidyadharpur-Arilo, Cuttack 754 006, Odisha

The course curricula of B.Sc. (Hons.) Horticulture is as per the recommendations of 5th Dean's Committee Report, Indian Council of Agriculture Research (ICAR), New Delhi. The course curriculum is distributed in 8 semesters during 4 year's period.

Program outcome: Promotes student centric mentoring and imparting technical knowledge with major focus on Horticulture agriculture and allied science. Besides, students are also exposed to yogic sciences, human values and ethics, spiritualism and experiential learning and internship in industries. Students after completion of the program should be able to i) Comprehend the interdisciplinary science of Horticulture, Agriculture, Plantation science and allied scientific knowledge required to increase the income of horticultural activities; ii) Comprehensively gain the knowledge on status and importance of horticulture in India and optimization of income generating enterprises of horticulture; iii) Contribute to knowledge dissemination of hi-tech horticulture in India; and iv) Create platform for profitable enterprises to market horticultural produce and post-harvest technologies and value addition.

Graduates have several career option to serve at various capacity viz., Horticulture officer, Farm or Plantation Manager, Horticultural Research Scientist, Horticulture Development Officers, Agriculture Technician, Practicing progressive agriculturists, Business Development Executive, Marketing Executive, professional in colleges and universities, Technical advisor in NGOs, Agricultural innovators and entrepreneurs.

I	Fruit Science	
HFH 101	Fundamentals of Horticulture	3 (2+1)
HPN 102	Plant Propagation and Nursery Management	2 (1+1)
HSF 102	Tropical and Subtropical Fruits	3 (2+1)
HOM 305	Orchard and Estate Management	2 (1+1)
HPC 204	Plantation Crops	3 (2+1)
HTF 203	Temperate Fruit crops	2 (1+1)
HWM 203	Weed Management in Horticultural Crops	2 (1+1)
HPB 102	Principles of Plant Breeding	3 (2+1)
HGC 101	Principles of Genetics and Cytogenetics	3 (2+1)
HBC 204	Breeding of Fruit and Plantation Crops	3 (2+1)
HIDH 204	Dryland Horticulture	2 (1+1)
	Total	28 (17+ 11)
II	Vegetable Science	
HSV 102	Tropical and Subtropical Vegetable crops	3 (2+1)
HSC 204	Spices and Condiments	3 (2+1)
HBC 305	Breeding of Vegetable Tuber and Spice Crops	3 (2+1)
HSV 306	Seed Production of Vegetable Tuber and Spice Crops	3 (2+1)
HVC 203	Temperate Vegetable crops	2 (1+1)
HPT 305	Potato and Tuber Crops	2 (1+1)
HPP 204	Precision Farming and Protected Cultivation	3 (2+1)

	Total	19 (12+7)
III	Postharvest Technology	
HPM 306	Postharvest Management of Horticultural Crops	3 (2+1)
HPH 306	Processing of Horticultural Crops	3 (1+2)
HFT 203	Fundamentals of Food Technology	2 (1+1)
	Total	8 (4+4)
IV	Floriculture & Landscape Architecture	
HOH 204	Ornamental Horticulture	2 (1+1)
HBF 306	Breeding and Seed Production of Flower and Ornamental Crops	3 (2+1)
HLA 101	Principles of Landscape Architecture	2 (1+1)
HCF 203	Commercial Floriculture	3 (2+1)
HMA 305	Medicinal and Aromatic Crops	3 (2+1)
	Total	13 (8+5)
V	Plant Protection	
HPP 203	Fundamentals of Plant Pathology	3 (2+1)
HDC 203	Diseases of Fruit, Plantation and Medicinal and Aromatic Crops	3 (2+1)
HDV 305	Diseases of Vegetable, Ornamental and Spice Crops	3 (2+1)
HEN 203	Fundamentals of Entomology	3 (2+1)
HNM 203	Nematode Pests of Horticultural Crops and their Management	2 (1+1)
HFP 204	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	3 (2+1)
HAS 306	Apiculture, Sericulture and Lac Culture	2 (1+1)
HPV 306	Insect Pests of Vegetable, Ornamental and Spice Crops	3 (2+1)
	Total	22 (14+8)
VI	Natural Resource Management	
HSS 101	Fundamentals of Soil Science	2 (1+1)
SFM 102	Soil Fertility and Nutrient Management	2 (1+1)
HEM 102	Environmental Studies and Disaster Management	3 (2+1)
HAS 204	Soil, Water and Plant Analysis	2 (1+1)
HPM 204	Farm Power and Machinery	2 (1+1)
HWM 102	Water Management in Horticultural Crops	2 (1+1)
HOP 305	Organic Farming	3 (2+1)
HMC 305	Agro-meteorology and Climate Change	2 (1+1)
HAF 305	Introductory Agro-forestry	2 (1+1)
HFC 305	Introduction to Major Field Crops	2 (1+1)
	Total	22 (12+10)
VII	Basic Sciences	
HCA 101	Elementary Statistics and Computer Application	3 (2+1)
HPB 101	Elementary Plant Biochemistry	2 (1+1)
HPB 103	Elementary Plant Biotechnology	2 (1+1)

HCP 101	Introductory Crop Physiology	2 (1+1)
HGD 102	Growth and Development of Horticultural Crops	2 (1+1)
HIP 101	Introductory Microbiology	2 (1+1)
	Total	13 (7+6)
VIII	Social Sciences	
HEM 101	Economics and Marketing	3 (2+1)
HBM 306	Horti-Business Management	2 (2+0)
HEE 306	Fundamentals of Extension Education	2 (1+1)
HED 306	Entrepreneurship Development and Business Management	2 (1+1)
HPD 101	Communication Skills and Personality Development	2 (1+1)
HCT 102	Information and Communication Technology	2 (1+1)
HPE 101	Physical and Health Education (NC)*	1 (0+1)
	NSS/NCC(NC)*	1 (0+1)
	Total	15 (8+7)
	Grand Total	140 (82+58)

Sl. No.	Activity	Credits
1	Experiential learning (Professional Package)	0+20
2	RHWE& Placement in Industries	0+20
	Total	0+40
S. No.	RHWE Program schedule	Duration
1	Orientation Program	2 weeks
2	Village stay at RSK/Hobli level	12 weeks
3	All India Study Tour	3 weeks
4	Placement Program	4 weeks
5	Report writing & Final Examination	3 weeks
	Total	24 Weeks

Student Ready: Experiential Learning program

Professional Packages of Hands on Training/Experimental Learning Modules: Final year B.Sc. (Hort.) students can select two modules under student ready- Experiential Learning program depending on the facilities available facilities.

Course Code	Course Title	Credits Practical
HCH 408	Commercial Horticulture	10
HPC 408	Protective Cultivation of High Value Horticulture Crops	10
HPF 409	Processing of Fruits and Vegetables for Value Addition	10
HFL 410	Floriculture and Landscape Architecture	10
HBF 411	Bio-inputs: Bio-fertilizers and Bio-pesticides	10

HMT 412	Mass Multiplication of Plant And Molecules through Tissue Culture	10
HMC 413	Mushroom culture	10
HBK 414	Bee keeping	10
Total		20

Batch of student can select 2-modules under Student Ready- Experiential Learning Program depending on the facilities available at the college.

Rural Horticultural Work Experience Program (0+20)

- i) Student Ready: Placement in Industries (0+10)
- ii) Student Ready: Placement in Villages (0+10)

Courses offered in each Semester

Semester – I		
Course Code	Title of the Course	Credit Hours
HCA 101	Elementary Statistics and Computer Application	3 (2+1)
HSS 101	Fundamental of Soil Science	2 (1+1)
HEM 101	Economics and Marketing	3 (2+1)
HPB 101	Elementary Plant Biochemistry	2 (1+1)
HCP 101	Introductory Crop Physiology	2 (1+1)
HFH 101	Fundamentals of Horticulture	3 (2+1)
HLA 101	Principles of Landscape Architecture	2 (1+1)
HGC 101	Principles of Genetics and Cytogenetics	3 (2+1)
HIP 101	Introductory Microbiology	2 (1+1)
HPD 101	Communication Skills and Personality Development	2 (1+1)
HPE 101	Physical Education and Yogic Practices	1 (0+1)
Total		25 (14+11)

Semester – II		
Course Code	Title of the Course	Credit Hours
HSF 102	Tropical and Subtropical Fruits	3 (2+1)
HSV 102	Tropical and Subtropical Vegetables Crops	3 (2+1)
HPB 102	Principles of Plant Breeding	3 (2+1)
HSF 102	Soil Fertility and Nutrient Management	2 (1+1)
HWM 102	Water Management in Horticultural Crops	2 (1+1)
HPN 102	Plant Propagation and Nursery Management	2 (1+1)
HEM 102	Environmental Studies and Disaster Management	3 (2+1)
HGD 102	Growth and Development of Horticultural Crops	2 (1+1)
HPE 102	Physical and Health Education	1 (0+1) (NC)*
HCT 102	Information and communication technology*	2 (1+1) (NC)*
Total		23 (13+10)

Semester – III		
Course Code	Title of the Course	Credit Hours
HPP 203	Fundamentals of Plant Pathology	3 (2+1)
HEN 203	Fundamentals of Entomology	3 (2+1)
HVC 203	Temperate Vegetable Crops	2 (1+1)
HNM 203	Nematode pests of horticultural crops and their Management	2 (1+1)
HDC 203	Diseases of fruit, Plantation, Medicinal and Aromatic Crops	3 (2+1)
HFT 203	Fundamentals of Food Technology	2 (1+1)

HTF 203	Temperate Fruit Crops	2 (1+1)
HWM 203	Weed Management in Horticultural Crops	2 (1+1)
HCF 203	Commercial Floriculture	3 (2+1)
HPB 203	Elementary Plant Biotechnology	2 (1+1)
HST 203	Statistical Methods	2 (1+1)
	Total	24 (14+10)

Semester – IV

Course Code	Title of the Course	Credit Hours
HAS 204	Soil, Water and Plant Analysis	2 (1+1)
HSC 204	Spices and Condiments	3 (2+1)
HOH 204	Ornamental Horticulture	2 (1+1)
HPC 204	Plantation Crops	3 (2+1)
HBC 204	Breeding of Fruit and Plantation Crops	3 (2+1)
HPM 204	Farm Power and Machinery	2 (1+1)
HFP 204	Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops	3 (2+1)
HPP 204	Precision Farming and Protected Cultivation	3 (2+1)
HDH 204	Dry land Horticulture	2 (1+1)
	Total	23 (14+9)

Semester – V

Course Code	Title of the Course	Credit Hours
HOP 305	Organic Farming	3 (2+1)
HFC 305	Introduction to Major Field Crops	2 (1+1)
HMA 305	Medicinal and Aromatic crops	3 (2+1)
HAF 305	Introductory Agroforestry	2 (1+1)
HBC 305	Breeding of Vegetable, Tuber and Spice Crops	3 (2+1)
HDV 305	Diseases of Vegetables, Ornamentals and Spice Crops	3 (2+1)
HOM 305	Orchard and Estate Management	2(1+1)
HMC 305	Agro-meteorology and Climate Change	2 (1+1)
HPT 305	Potato and tuber crops	2 (1+1)
BSE 306	Biosafety and Bio-ethics	1 (1+0)
	Total	23 (13+9)

Semester – VI

Course Code	Title of the Course	Credit Hours
HAS 306	Apiculture, Sericulture and Lac culture	2 (1+1)
HPV 306	Insect Pests of Vegetable, Ornamental and Spice Crops	3 (2+1)
PM 306	Postharvest Management of Horticultural Crops	3 (2+1)

HSV 306	Seed production of Vegetable, Tuber and Spice Crops	3 (2+1)
HBF 306	Breeding and Seed Production of Flower and Ornamental Plants	3 (2+1)
HPH 306	Processing of Horticultural Crops	3 (1+2)
HBM 306	Horti-Business Management	2 (2+0)
HED 306	Entrepreneurship Development and Business Management	2 (1+1)
HEE 306	Fundamentals of Extension Education	2 (1+1)
	Total	23 (14+9)

Semester – VII

Rural Horticultural Work Experience (RHWE)

Course code	Title of the Course	Credit Hours
HRW 407	Student Ready: Placement in Industries	0+10
HRW 408	Student Ready: Placement in Villages	0+10
	Total	20 (0+20)

Semester – VIII

Experimental Learning program (ELP)

Course Code	Title of the Course	Credits
HCH 408	Commercial Horticulture	10 (0+10)
HPC 408	Protective Cultivation of High Value Horticulture Crops	10 (0+10)
HPF 409	Processing of Fruits and Vegetables for Value Addition	10 (0+10)
HFL410	Floriculture and Landscape Architecture	10 (0+10)
HBF 411	Bio-inputs: Bio-fertilizers and Bio-pesticides.	10 (0+10)
HMT 412	Mass Multiplication of Plant And Molecules through Tissue Culture	10 (0+10)
HMC 413	Mushroom culture	10 (0+10)
HBK 414	Bee keeping	10 (0+10)
	Total	20 (0+20)

The student undergoing ELP may be allowed to register for a maximum two courses in which they have failed but completed requisite percentage of attendance.

SYLLABUS

FRUIT SCIENCE

HFH 101 Fundamentals of Horticulture 3 (2+1)

Objective: Provide insights on basic theory, concepts, production statistics and practices involved in management practices of horticultural crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the importance and scope of horticulture in day to day life as well as in agro based industry.
- Get idea about planning of any orchard based on resource availability.
- Explain the several practices involved in cultivation and management of various horticultural crops.
- Identify various horticultural crops like fruits, vegetable, flower seeds, plant types in their natural existence.
- Categorize crops grown in different agro-climatic conditions with their classification according to various physiological and morphological features.
- Accumulate skills to practice training, pruning, top working techniques involved in management of different horticultural crops.
- Ability to develop marketing skills of horticultural crops.

Theory

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops. Principles objectives, types and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops–manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming, market chain management.

Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

Suggested Reading:

- Prasad and Kumar, 2014. *Principles of Horticulture* 2nd Edn. Agrobios (India).
- Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1st Edn. IBDC Publishers.
- Gardner/Bardford/Hooker. J.R., 1957. *Fundamentals of Fruit Production*. Mac Graw Hill Book Co., New York.
- Edmond,J.B, Sen,T.L, Andrews,F.S and Halfacre R.G., 1963. *Fundamentals of Horticulture*. Tata Mc Graw Hill Publishing Co., New Delhi.
- Kumar, N., 1990. *Introduction to Horticulture*. Rajyalakshmi publications, Nagarcoil, Tamilnadu

Jitendra Singh, 2002. *Basic Horticulture*. Kalyani Publishers, Hyderabad.
Denisen E.L.,1957. *Principles of Horticulture*. Macmillan Publishing Co., New York.
Chadha,K.L.(ICAR),2002,2001. *Hand book of Horticulture*. ICAR, New Delhi
K.V.Peter, 2009. *Basics Horticulture*. New India Publishing Agency
Kausal Kumar Misra and Rajesh Kumar, 2014. *Fundamentals of Horticulture*. Biotech Books.
D.K. Salunkhe and S.S. Kadam, 2013. *A handbook of Fruit Science and Technology*. CRC Press.
S. Prasad and U. Kumar, 2010. *A handbook of Fruit Production*. Agrobios (India).
Jitendra Singh, 2011. *Basic Horticulture*. Kalyani Publications, New Delhi.

HPN 102 Plant Propagation and Nursery Management 2 (1+1)

Objective: Familiarization with principles and practices of propagation and nursery management for various horticultural crops.

Course outcome: Upon completion of the course students will be able to;

- Learn about different methods of propagation commercially adopted for horticultural crops.
- Explain about requirement for plant propagation with the structures needed for plant propagation.
- Understand various physiological and morphological behavior of plant propagation.
- Practice various techniques followed in grafting, budding, layering, cutting and seed germination of horticultural crops.

Theory

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification stratification) internal and external factors, nursery techniques nursery management, apomixes – mono-embryony, polyembryony, chimera& bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), use of growth regulators in seed, types and stages of seed germination with examples and vegetative propagation, methods and techniques of division-stolons, pseudobulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery, Cost of establishment of propagation structures.

Practical

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery.

Suggested Reading:

Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. *Plant Propagation- Principles and Practices (7th Edition)*. PHI Learning Private Limited, New Delhi-110001

T.K.Bose, S.K.Mitra, M.K.Sadhu, P. Das and D. Sanyal. *Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3rd Revised edition)*. Naya Udyog, 206, Bidhan Sarani, Kolkata 700006.

Guy W. Adriance and Feed R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).

S. Rajan and B.L. Markose (series editor Prof. K.V. Peter). *Propagation of Horticultural Crops- Horticulture Science Series vol.6*. New India Publishing Agency, Pitam Pura, New Delhi-110088.

Hartman, H.T and Kester, D.E. 1976. *Plant Propagation Principles and practices*. Prentice hall of India Pvt. Ltd., Bombay.

Sadhu, M.K.1996. *Plant Propagation*. New age International Publishers, New Delhi.

Mukherjee, S. K. and Majumdar,P.K. 1973. Propagation of fruit crops. ICAR, New Delhi.

Ganner, R. J. and Choudhri,S.A.1972. *Propagation of Tropical fruit trees*. Oxford and IBN publishing Co., New Delhi.

Sarma, R.R.2002. *Propagation of Horticultural Crops*. Kalyani Publishers, (Principles and practices) New Delhi.

Symmonds,1996. *Banana*. II edition Longman, London.

Chundawat, B. S. 1990.*Arid fruit culture*. Oxford and IBH, New Delhi.

Chadha, K. L. (ICAR)2002,2001. *Hand book of Horticulture*. ICAR, New Delhi.

HSF 102 Tropical and Sub-Tropical Fruits 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of tropical and subtropical fruit crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different tropical and subtropical fruit crops.
- Identify different seeds of tropical and subtropical fruit crops with their plant types in their natural existence.
- Classify different tropical and subtropical fruit crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different tropical and subtropical fruit crops.

Theory

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Practical

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in

banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

Suggested Reading:

- H.P.Singh and M.M.Mustafa, 2009. *Banana*-new innovations. Westville Publishing House, New Delhi.
- M.S.Ladaniya, 2013. *Citrus Fruits*. Elsevier, India post ltd.
- Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical-Vol-I*. Naya Udyog-Kolkata
- Rajput, CBS and Srihari babu, R., 1985. *Citriculture*. Kalyani Publishers, New Delhi.
- Chundawat, B.S., 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.
- Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
- Symmonds, 1996. *Banana*. II Edn. Longman, London.
- Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency. by W S Dhillon,
2013. *Fruit Production in India*. Narendra Publishing House, by New Delhi
- T.K.Chattopadhyay, 1997. *Text book on pomology*. Kalyani Publishers, New Delhi.
- R.E.Litz, 2009. *The Mango* 2nd Edn. Cabi Publishing, Willingford, U.K.
- K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.
- S.P. Singh, 2004. *Commercial fruits*. Kalyani Publishers, New Delhi.
- F.S. Davies and L.G.Albrigo, 2001. *Citrus*, Cab International.

HTF 203 Temperate Fruit Crops 2(1+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of temperate fruit crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different temperate fruit crops.
- Identify different seeds of temperate fruit crops with their plant types in their natural existence.
- Classify different temperate fruit crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different temperate fruit crops.

Theory

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinizers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

Suggested Reading:

- Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008
- Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
- Kaushal Kumar Misra.2014. *Text book of Advanced Pomology. Biotech Books*.4762-63, Ansari Road, Darya Ganj, New delhi-11002.
- Das B.C and Das S. N. *Cultivation of Minor Fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
- Pal J.S.2010. *Fruit Growing* .2010. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
- Mitra S.K, Rathore D.S and Bose T. K. 1992. *Temperate Fruit Crops. Horticulture and Allied Publishers*, Calcutta.
- Chattopadhyay, T.K. 2000. *A Text Book on Pomology (Temperate Fruits)* Vol. IV Kalyani Publishers, Hyderabad
- Chadha, T.R, 2001. *Text Book of Temperate Fruits*. Indian Council of Agricultural Research, New Delhi.
- David Jackson & N E Laone, 1999 *Subtropical and Temperate Fruit Production*. CABI, Publications.
- W S Dhillon. 2013. *Fruit Production in India*. Narendra Publishing House. New Delhi

HOM 305 Orchard and Estate Management 2 (1+1)

Objective: Provide insights on basic theory, concepts and practices involved in orchard and estate management.

Course outcome: Upon completion of the course students will be able to;

- Practice about different activities conducted for production and management of orchard crops.
- Familiarize with advance system of production practices for quality improvement.

Theory

Orchard & estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of Horticultural crops.

Practical

Layout of different systems of orchard and estate, soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

Suggested Reading:

- Kumar, 1990. *Introduction to Horticulture crops*. Rajyalakshmi Publications, Nagercoil, Tamilnadu.
- Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping systems in the Tropics*. New age International (P) Ltd., Publishers, New Delhi.
- Shanmugavelu, K.G.1989. *Production Technology of Fruit Crops*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- W. S. Dhillon and Bhatt. 2011. *Fruit Tree Physiology*. Narendra Publishing House, New Delhi.
- B . C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya Publishing House, New Delhi.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural Crops*. New India Publishing Agency, New Delhi.
B . C. Mazumdar. 2004. *Orchard Irrigation and Soil Management Practices* Daya Publishing Agency, New Delhi. Daya Publishing Agency, New Delhi.

HPC 204 Plantation Crops 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of plantation crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different plantation crops
- Identify different seeds of plantation crops with their plant types in their natural existence.
- Classify different plantation crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different plantation crops.

Theory

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

Practical

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

Suggested Reading:

Kumar, N. J. B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.
Thampan, P.K. 1981. *Hand Book of Coconut Palm*. Oxford IBH, New Delhi.
Nair 1979. *Cashew*. CPCRI, Kerala Wood, GAR, 1975. *Cacao*. Longmen, London
Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.
Thompson, P.K. 1980. *Coconut*. Oxford & IBH Publishing Co. Ltd., New Delhi.

HWM 203 Weed Management in Horticultural Crops 2 (1+1)

Objective: To provide insights on agronomic practices involved in management of weeds in horticultural crops.

Course outcome: Upon completion of the course students will be able to;

- Able to identify and classify the weeds.
- Able to identify suitable herbicides and bio-herbicides to control the weeds.
- Identify agronomic practices to control the weeds.

Theory

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Suggested reading:

- Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Gupta, O.P. 1984. *Scientific Weed Management*. Today and Tomorrow Printers and Publishers, New Delhi.
- Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur.
- Naidu, V.S.G.R., *Handbook of Weed Identification*. Directorate of Weed Research, Jabalpur.
- Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. *Weed management of Horticultural Crops*. Agrobios (India), Jodhpur.
- Ramamoorthy, K. and Subbian, P., *Predominant Weed flora in hill –ecosystems*. Agrobios (India), Jodhpur.
- Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co., New Delhi.
- Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. *All About Weed Control*. Kalyani Publishers, Ludhiana.
- Tadulingam, C. and Venkatnarayana, D. 1955. *A Handbook of Some South Indian Weeds*. Government Press, Madras.
- Thakur, C. 1977. *Weed Science*. Metropolitan Book Co. Pvt. Ltd., New Delhi.

HGC 101 Principles of Genetics and Cytogenetics 3 (2+1)

Objective: To provide the concept of fundamental biology principles occurring inside the cell and its influence on character expression.

Outcome: Students will be able to explain inheritance and expression of characters.

- Learn how variation occurs within living organisms.
- Able to acquaint with genetic terminology and its application.
- Explain genetic principles behind the development of variety

Theory

Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, mitosis, meiosis and its significance. Gametogenesis and syngamy in plants. Mendelian genetics—Mendel’s principles of heredity, deviation

from Mendelian inheritance, pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Modification of monohybrid and dihybrid ratios. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. Chemical basis of heredity, structure of DNA and its replication. Evidence to prove DNA and RNA – as genetic material. Mutations and their classification. Chromosomal aberrations, changes in chromosome structure and number.

Practical

Study of fixatives and stains. Squash and smear techniques. Demonstrations of permanent slides and cell division, illustration in plant cells, pollen fertility and viability, determination of gametes, solving problems of monohybrid, dihybrid, and test cross ratios using chi-square test, gene interactions, estimation of linkages using three-point test cross from F₂ data and construction of linkage maps. Genetic variation in pea.

Suggested Reading:

- Gardner E J, Simmons M J & Snustard D P. *Principles of Genetics (VIII Edn)*. John Wiley & Sons, New York.
- Strickberger. *Genetics*. Macmillan Publishing Company, New York.
- William D. Stansfield. *Theory and Problems of Genetics (3rd Ed)*. Schaum's Outline series - McGraw-Hill Inc.
- Benjamin Lewin. *Genes (II edn)*. John Wiley & Sons, New York.
- Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.
- Swanson & Webster. *The Cell (V edn)*. Prentice Hall of India Pvt. Ltd, New Delhi
- Norman, V. Rothwell. *Understanding Genetics (IV Ed)*. Oxford University Press, Oxford.
- Sinnut, Dunn & Dobzhansky. *Principles of Genetics XIX reprint*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Griffiths, Miller, Suzuki Lewontin & Gelbart. *An introduction to Genetic Analysis (V Ed)*. W.H. Freeman & Company, New York
- Robert Schief. *Genetics & Molecular Biology (1986)*. The Benjamin/cummings publishing Co, Inc, California.
- Swanson, Merz & Young. *Cytogenetics (II ed)*. Prentice Hall of India Pvt. Ltd. New Delhi.
- Joseph Jahier & INRA working group. *Techniques of Plant Cytogenetics (1986)*. Oxford & IBH Publishing Co Pvt. Ltd., New Delhi
- Loewy & Siekevitz. *Cell Structure & Function (II Ed)*. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
- Stent & Calendar. *Molecular Genetics* (II Ed.). CBS Publishers, New Delhi
- Singh B D. *Fundamentals of Genetics*. Kalyani Publishers, New Delhi
- Srivastava & Tyagi. *Selected Problems in Genetics (Vol.1-3)*. Anmol Publications Pvt. Ltd., New Delhi
- Khanna VK. *Genetics—Numerical Problems*. Kalyani Publishers, New Delhi.
- Farook & Khan. *Genetics & Cytogenetics* (I Ed.). Premier Publishing House, Hyderabad
- Shukla. *Cell Biology (2001)*. Dominant publishers, New Delhi
- George Acquaah *Principles of Plant Genetics and Breeding*. Blackwell
- B.D. Singh. *Fundamental of Genetics*. Kalyani. India
- Gupta, P.K. 1985. *Cytology, genetics and cytogenetics*. Rastogi Publication, India.

HPB 102 Principles of Plant Breeding 3 (2+1)

Objective: Provide insights on basic theory, genetic principles and methods applied for development of variety.

Outcome:

- Able to acquainted with floral biology of crop.
- Able to explain about basic principles of variety development.
- Able to know different methods applied in different crop for development of variety.

Theory

Plant breeding as a dynamic science, genetic basis of Plant Breeding – classical, quantitative and molecular, Plant Breeding in India – limitations, major achievements, goal setting for future. Sexual reproduction (cross and self-pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding and marker assisted selection Hybridization and selection – goals of hybridization, selection of plants; population developed by hybridization – simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis – concepts, estimation and its genetic basis. Calculation of heterosis, heterobeltosis, GCA, SCA, inbreeding depression, heritability and genetic advance. Emasculation, pollination techniques in important horticultural crops. Breeding for resistance of biotic and abiotic stresses. Polyploidy breeding. Mutation breeding.

Practical

Breeding objectives and techniques in important horticultural crops. Floral biology – its measurement, emasculation, crossing and selfing techniques in major crops. Determination of mode of reproduction in crop plants, handling of breeding material, segregating generations (pedigree, bulk and back cross methods), Field layout, and maintenance of experimental records in self and cross pollinated crops. Demonstration of hybrid variation and production techniques. Hardy Weinberg Law and calculation, male sterility and incompatibility studies in horticultural crops calculation of inbreeding depression, heterosis, heterobeltioses, GCA, SCA, GA, heritability.

Suggested Reading:

- R.W. Allard. Principles of plant breeding. John Wiley & Sons, New York.
V.L. Chopra. Plant breeding: Theory and Practice. Oxford & IBH Publishing CO. Pvt. Ltd., New Delhi.
Phundan Singh. Essentials of plant breeding. Kalyani Publishers
J.R. Sharma. Principles and practices of plant breeding. Tata McGraw Publishing Company Ltd., New Delhi
B.D. Singh. Plant breeding: principles and methods. Kalyani Publishers, Ludhiana.
R.C. Chaudhary. Plant Breeding
Hays and Garber. Breeding crop plants. Mc Graw Hill Publications, New York
G K Kallo. Breeding of vegetables. Panima publishers, New Delhi
W.R. Fehr. Principles of cultivar development: theory and technique (Vol. 1). Macmillan Publishing Company, New York.
D.S. Falconer. Introduction to quantitative genetics. Longman Scientific & Technical, Longman Group, UK, Ltd., England.
R.K. Singh and B.D. Chaudhary. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, Ludhiana.
K. Mather and J.L. Jinks. Introduction to Biometrical genetics. Chapman and Hall, London
B D Singh. Fundamental of Plant breeding. Kalyani. India.
Pundan Singh. Essentials of plant breeding, Kalyani. India
G. S. Chahal and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding. Narosa Publishing House, New Delhi.
Poehlman, J.M. and Borthakar, D. 1995. Breeding Asian Field Crops. Oxford & IBH Publishing Co., New Delhi

HBC 204 Breeding of Fruit and Plantation Crops 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in Breeding of Fruit and Plantation Crops.

Course outcome: Upon completion of the course students will be able to;

- Know about history and importance of fruit and plantation crop breeding.
- Practice different breeding method and techniques involved in each method for improvement of various fruit and plantation crops.

Theory

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistachonut, Apple, Pear, Plum, Peach, Apricot and Strawberry.

Suggested Reading:

Nijar 1985. Fruit breeding in India, Oxford & IBH Publishing Co. New Delhi
Anil Kumar Shukla 2004. Fruit breeding approaches & Achievements. International Book Distributing Co. New Delhi.
Kumar, N. 1997. Breeding of Horticultural Crops, Principles and Practices. New India Publishing Agency, New Delhi.
Singh, B.D. 1983. Plant Breeding Principles and methods. Kalyani Publishers, New Delhi.

HDH 204 Dryland Horticulture 2 (1+1)

Objective: To keep abreast with latest developments and trends in production technology of various horticultural crops in dryland area.

Course outcome: Upon completion of the course students will be able to;

- Define importance and limitation of dry land horticulture
- Explain different practices followed in dry and arid areas for successful cultivation of horticultural crops.

Theory

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc.

Techniques and management of dry land horticulture. watershed development, soil and water conservation methods-terraces, contour bunds, etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits, etc., *in-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, anti transpirants, growth regulators, etc. water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc.

Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical

Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.

Suggested reading:

Chundawat, B.S. 1990. *Arid Fruit Culture*. Oxford and IBH, New Delhi.
P.L. Taroj, B.B. Vashishtha, D.G.Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.
T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency.

VEGETABLE SCIENCE**HSV 102 Tropical and Sub-Tropical Vegetable Crops 3 (2+1)**

Objective: Objective: Provide insights on basic theory, concepts and practices involved in production practices of different tropical and subtropical vegetable crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different tropical and subtropical vegetable crops.
- Identify different seeds of tropical and subtropical vegetable crops with their plant types in their natural existence.
- Classify different tropical and subtropical vegetable crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different tropical and subtropical vegetable crops.

Theory

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and sub-tropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

Suggested Reading:

S. Thamburaj, 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi
B.R.Choudhary, 2009. *A Text book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
T.K.Bose, 2002. *Vegetable Crops*. Nayaprakash. Kolkata
P.Hazra, 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
T.R.Gopal Krishnan, 2007 *Vegetable Crops*. New India Publishing Agency. New Delhi.
K.V.Kamath, 2007. *Vegetable Crop Production*. Oxford Book Company. Jaipur

- M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. *Indian Vegetables*. Anmol Publications. Pvt.Ltd . New Delhi.
- K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004
- M.K.Rana, 2008. *Olericulture in India*. Kalyani Publishers. Ludhiana
- P.Hazra, 2006. *Vegetable science*. Kalyani Publishers. Ludhiana
- Pratibha Sharma, 2007. *Vegetable : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
- Uma Shankar,2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
- Nath Prem, 1994. *Vegetables for the Tropical Regions*. ICAR New Delhi
- K. L. Chadha, 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G., 1989. *Production Technology of Vegetable Crops*. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
- Choudhury, B. (ICAR). 1990. *Vegetables*. 8th edition, National Book Trust, New Delhi.
- Singh, D.K., 2007. *Modern Vegetable varieties and production*. IBN publishers, Technology International Book Distributing Co, Lucknow.
- Premnath, Sundari Velayudhan and Singh, D.P., 1987. *Vegetables for the tropical region*. ICAR, New Delhi.

HSC 204

Spices and Condiments 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of spices and condiments.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different spices and condiments.
- Identify different seeds of spices and condiments with their plant types in their natural existence.
- Classify different spices and condiments according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different spices and condiments.

Theory

History, scope and importance, Present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micropropagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper. Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, pepper, betel vine ginger, turmeric, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

Practical

Identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Visit to commercial plantations.

Suggested Reading:

Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. *Production technology of spices and plantation crops*. Agrosis, Jodhpur

Shanmugavelu, K.G. and Madhava Rao, 1977. *Spices and Plantation Crops*. Madras Popular Book Depot.
 Kumar, N. J.B. M. Md. Abdul khaddar, Ranga Swamy, P. and Irulappan, I., 1997. *Introduction to Spices, Plantation Crops, and aromatic crops*. Oxford & IBH, New Delhi.
 Pruthi, J.S., 1980. *Spices and Condiments*. Academic Press, New York.
 Pruthi, J.S., 1993. *Major Spices of India- Crop Management Postharvest Technology*. ICAR, New Delhi
 Pruthi, J.S., 2001. *Minor Spices and Condiments-Crop Management Post Harvest Technology*. ICAR, New Delhi.
 Purselglove, Brown, E.G. Green, G.Z. Robbins, S.R.J. London, Longman, 1981. *Spices* Vol.I & II.

HBC 305 Breeding of Vegetable, Tuber and Spice Crops 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in Breeding of Vegetable, Tuber and Spice Crops.

Course outcome: Upon completion of the course students will be able to;

- Know about history and importance of Vegetable, Tuber and Spice Crops breeding.
- Practice different breeding method and techniques involved in each method for improvement of various vegetable, tuber and spice crops.

Theory

Breeding objectives and important concepts of breeding self-pollinated, cross pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops Tomato, Brinjal, Bhendi, Capsicum, Chilli, Cucurbits, Cabbage, Cauliflower, Tuber crops, Potato, Carrot, Radish, Spice crops (Ginger, Turmeric). Breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adoptability and stability.

Practical

Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Suggested Reading:

Hari Hara Ram, 2013. *Vegetable Breeding: Principle and Practices*. Kalyani Publishers. Ludhiana.
 Vishnu Swaroop, 2014. *Vegetable Science & Technology in India*. Kalyani Publishers. Ludhiana.
 Kallo.G, 1998. *Vegetable Breeding (Vol.I to IV)*. CRC Press. Florida. 1988.
 H.P. Singh, 2009. *Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.
M.S. Dhaliwal. 2012. *Techniques of Developing Hybrids in Vegetable Crops*. Agrobios. Jodhpur.
 P.K.Singh, 2005. *Hybrid Vegetable Development*. CRC Press. Florida.
 M.S.Dhaliwal, 2009. *Vegetable Seed Production & Hybrid Technology*. Kalyani Publishers. Ludhiana.
 Fageria, M.S., 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers, Ludhiana.

HSV 306 Seed Production of Vegetable, Tuber and Spice Crops 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in seed production of Vegetable, Tuber and Spice Crops

Course outcome: Upon completion of the course students will be able to;

- Know about history and importance seed production for Vegetable, Tuber and Spice Crops.
- Practice different method and techniques involved in seed production of various Vegetable, Tuber and Spice

Theory

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

Suggested Reading:

- G.N. Kulkarni, 2002. Principles of Seed Technology. Kalyani Publishers, Ludhiana.
L.O. Copeland, 1999. Principles of Seed Science and Technology. Springer Publications.
N.P. Nema, 1988. Principles of seed certification and Testing. Allied Publications.
P. Hazra and M.G. Som, 2009. Vegetable seed production and Hybrid Technology. Kalyani Publishers, Ludhiana.
Agarwal, P. K. 2010. Techniques in Seed Science and Technology. South Asian Publishers. New Delhi.
Agrawal R. L. 1999. Seed Technology. Oxford and IBH Publicity Company, New Delhi.
Arya, Prem Singh. 2003. Vegetable seed Production Principles. Kalyani Publishers. Ludhiana.
Fageria, M. S. 2011. Vegetable Crops- Breeding and Seed Production. Kalyani Publishers. Ludhiana.
Geetharani, P. 2007. Seed Technology in Horticultural Crops. NPH Publications. Jodhpur.
Singh, S.P. 2001. Seed Production in Commercial Vegetables. Agrotech Publishing Academy, Udaipur.
Vanangamudi, K. 2010. Vegetable Hybrid Seed Production and Management. Agrobios. Jodhpur.
Singh, Prabhakar. 2015. Seed Production Technology of vegetable. Daya Publishing House. New Delhi.
Raymond A.T., 2000. Vegetable Seed Production. Oxford University Press, USA
Prem Singh Arya, 2003. Vegetable breeding, production and seed production. Kalyani publishers, New Delhi.
Rattan lal Agarwal, 1995. Seed technology. Oxford & IBH, New Delhi
Singh, S.P. 2001. 1st edition, *Seed production of commercial vegetables*. Agrotech Publishing, Udaipur
Vanangamudi, K. 2006. Natarajan, P. Srimathi, N. Natarajan, T. Saravanan, M. Bhaskaran, A. Bharathi, P. Nateshan, K. Malarkodi. *Advances in Seed Science*. Agrobios (India), Jodhpur.
Nemgal Singh, P.K. Singh, Y.K. Singh and Virendra kumar, 2006. *Vegetable Seed Production Technology*. International book distributing co., Lucknow.
Khare, D. and Bhole, M.S. 2000. *Seed Technology*. Scientific Publishers (India) Jodhpur.

HVC 203 Temperate Vegetable Crops 2 (1+1)

Objective: Objective: Provide insights on basic theory, concepts and practices involved in production practices of different temperate vegetable crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different temperate vegetable crops.
- Identify different seeds of temperate vegetable crops with their plant types in their natural existence.
- Classify different temperate vegetable crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different temperate vegetable crops.

Theory

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, Vegetable kale.

Practical

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

Suggested Reading:

- S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
- B.R.Choudhary 2009. *A Text book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- T.K.Bose. 2002. *Vegetable Crops*. Nayaprakash. Kolkata
- P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
- K.V.Kamath. 2007. *Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. *Indian Vegetables*. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2004. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
- M.K.Rana, 2008. *Olericulture in India*. Kalyani Publishers. Ludhiana
- P.Hazra. 2006. *Vegetable science*. Kalyani Publishers .Ludhiana
- Pratibha Sharma, 2007. *Vegetables : Disease Diagnosis and Biomangement*. Avishkar Publishers. Jaipur
- Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
- Nath Prem. 1994. *Vegetables for the Tropical Regions*. ICAR New Delhi
- K.L.Chadha. 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G. 1989. *Production technology of vegetable crops*. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. *Vegetable Crops*. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
- Prem Singh Arya, 1999. *Vegetable Seed Production Principles*. Kalyani Publishers, New Delhi.
- Choudhery, B., 1990. *Vegetables*. 8th edition. National Book Trust, New Delhi.

HPT 305 Potato and Tuber Crops 2 (1+1)

Objective: Objective: Provide insights on basic theory, concepts and practices involved in production practices of potato and tuber crops.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of potato and tuber crops.
- Identify different seeds of potato and tuber crop with their plant types in their natural existence.
- Categorize different tuber crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of potato and tuber crops.

Theory

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing. Crops to be covered – potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Seed collection, working out cost of cultivation, project preparation of commercial cultivation.

Suggested Reading:

- S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
- B.R.Choudhary 2009. *A Text book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- T.K.Bose. 2002. *Vegetable Crops*. Nayaprakash. Kolkata
- P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
- K.V.Kamath. 2007. *Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. *Indian Vegetables*. Anmol Publications. Pvt.Ltd . New Delhi.
- K S Yawalkar, 2004. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
- M.K.Rana, 2008. *Olericulture in India*. Kalyani Publishers. Ludhiana
- P.Hazra. 2006. *Vegetable science*. Kalyani Publishers. Ludhiana
- Pratibha Sharma, 2007. *Vegetables: Disease Diagnosis and Biomangement*. Avishkar Publishers. Jaipur
- Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
- Nath Prem. 1994. *Vegetables for the Tropical Regions*. ICAR New Delhi
- K.L.Chadha. 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G. 1989. *Production technology of vegetable crops*. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. *Vegetable Crops*. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
- Prem Singh Arya, 1999. *Vegetable Seed Production Principles*. Kalyani Publishers, New Delhi.
- Choudhery, B., 1990. *Vegetables*. 8th edition. National Book Trust, New Delhi.
- Vincent Lebot, 2008. *Tropical roots and tuber crops*. CAVI.
- J.E. Bradshaw, 2010. *Root and tuber crops*. Springer Publications.

Objective: Appraisal on the advances in protected and precision farming of various horticultural crops.

Course outcome: Upon completion of the course students will be able to;

- Explain about various protected structure, construction mechanism of green house.
- Practice different system used for operation of protected structure.
- Know about precision horticulture and its importance in future horticulture.
- Explain the principles and practices of protected cultivation of various horticultural crops.

Theory

Precision farming – laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, mapping of soils and plant attributes, site specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

Practical

Study of different types of greenhouses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization; Visit to commercial greenhouses; Economics of protected cultivation.

Suggested Reading:

- Balraj Singh. 2006. *Protected cultivation of vegetable crops*. Kalyani Publishers, Ludhiana.
- Brahma Singh, 2014. *Advances in Protected Cultivation*. New India Publishing Agency. New Delhi.
- Reddy P. Parvatha, 2003. *Protected Cultivation*. Springer Publications. USA.
- Reddy**, P. Parvatha. 2011. *Sustainable crop protection under Protected Cultivation*. Springer Publications. USA.
- Jitendra Singh, 2015. *Precision Farming in Horticulture*. New India Publishing Agency. New Delhi.
- Prasad S. 2005. *Greenhouse Management for Horticultural Crops*. Agrobios. Jodhpur.
- Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat. 2013. *Precision forming in Horticulture*. New India Publishing Agency, New Delhi.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural crops*. New India Publishing Agency, New Delhi.
- Aldrich RA & Bartok JW. 1994. NRAES, Riley, Robb Hall. *Green House Engineering*. Cornell University, Ithaca, New York.
- Pant V Nelson. 1991. *Green House Operation and Management*. Bali Publications

POST HARVEST TECHNOLOGY

HPM 306 Postharvest Management of Horticultural Crops 3 (2+1)

Objective: Provides knowledge on causes of post-harvest losses in horticultural crops and how different post-harvest management practices helps to increase shelf life with preparation of different processed product.

Course outcome: Upon completion of the course students will be able to;

- Know about maturity indices, harvesting stages of different horticultural crops.
- Explain different factors responsible for deterioration of horticultural produce.
- Know about different post-harvest treatments of horticultural crops to reduce post-harvest losses.
- Explain different storage, packaging and transportation methods.
- Prepare different post-harvest product from fruit and vegetable and know about their standards and specification.

Theory

Importance of Postharvest Technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants. Pre-harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process. Postharvest treatments of horticultural crops. Quality parameters and specifications. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Methods of storage for local market and export. Pre-harvest treatment and pre-cooling, pre-storage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging. Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.

Practical

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops, spices and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packing houses and cold storage units.

Suggested Reading:

- Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
- Wiils, McGlasson and Graham, J. 2007. Post-Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International
- Stanley, J. K. 1998. Post-Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
- Neetu Sharma and Mashkoo Alam, M. 1998. Post-Harvest Diseases of Horticultural Perishables. International Book Distributing Co., Lucknow.
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi.
- Hulme, A.C. 1970. Food Science & Technology - A Series of Monograph. The Biochemistry of Fruits and their Products. Vol.-1. Academic Press London & New York.
- Mitra, S. K. 1997. Post-Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International.
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Thomposon, A. K. 1996. Post harvest Technology of Fruits and Vegetables. Blackwell Science.
- Battacharjee, S. K. and De, L. C. 2005. Post Harvest Technology of Flowers and Ornamentals Plants. Ponteer Publisher, Jaipur, India.
- Pruthi, J. S. 2001. Minor Spices and Condiments – Crop Managements and Post Harvest Technology. ICAR, New Delhi.
- Shanmugavelu, K. G., Kumar, N. and Peter K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios (India).
- Saraswathy, S. *et. al.* 2008. Post harvest Management of Horticultural Crops. Agribios (India).81-7754-322-9.

Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4th ed.). US Davis, PHT Research and information Center.

Jacob John, P. 2008. A Handbook on Post Harvest management of Fruits and vegetables. Daya Publishing House, Delhi-1081-7035-532-X.

Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4 ed). US Davis, PHT Research and information Center.

<http://www.postharvest.com.au>

http://www.fao.org/infoods/index_en.stm

www.postharvest.ucdavis.edu

HPH 306 Processing of Horticultural Crops 3 (1+2)

Objective: Focuses on importance of processing in horticultural crops, principles and different methods of preservation and processing.

Course outcome: Upon completion of the course students will be able to;

- Know how to establish processing units.
- Explain in detail about importance and scope of fruit and vegetable preservation industry in India.
- Emphasize principles and methods of preservation to check post-harvest losses and to make it available round the year with different taste.
- Know about different food laws and govt. policies on import and export of processed fruits.
- Prepare different post-harvest product from fruit and vegetable and know about their quality standards and specification.

Theory

Importance and scope of fruit and vegetable preservation industry in India, food pipe line, losses in post-harvest operations, unit operations in food processing. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Equipment's used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

Suggested Reading:

Verma, L. R. and Joshi, V. K. 2000. Postharvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.

Dauthy, M. E. 1995. Fruits and Vegetables Processing- FAO Bulletin 119. International Book Distributing Co., Lucknow.

Srivastava, R. P. & Sanjeev Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.

Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press

Neetu Sharma and Mashkoo Alam, M. 1998. Postharvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow

Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi

Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood

Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.

Vijay, K. 2001. Text Book of Food Sciences and Technology. ICAR, New Delhi.

Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi

FAO - Training Manual No.17/2. 2007. Prevention of postharvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.

Morris, T. N. 2006. Principles of Fruit Preservation. Biotech Books, Delhi.

<http://www.postharvest.com.au>

http://www.fao.org/infoods/index_en.stm

Srivastava, R. P. and Sanjeev K. 1998. Fruit and vegetable preservation principles practice. International Book Distributing Co., Lucknow.

Girdharilal, Siddappa, G. S. and Tandon, G. L. 1998. Preservation off fruits and vegetables. ICAR, New Delhi.

Dauthy and Mircea, E. 1995. Fruit and vegetables processing. International Book Distribution Co, Lucknow.

Kaysand Stanely, J. 1998. Postharvest physiology of perishable plant products. CBS Publishers, Distributors, New Delhi

Bhatti, S 1995. Vame, Fruit and vegetable processing. CBS Publishers, Distributors, New Delhi.

HFT 203 Fundamentals of Food Technology 2 (1+1)

Objective: Provides an idea on importance of food to combat malnutrition by maintaining balanced diet for good health.

Course outcome: Upon completion of the course students will be able to;

- Explain on food, it's properties and preparation techniques.
- Identify well and malnourished population.
- Know the importance of minerals, vitamins and effects of deficiency.
- Know how to maintain balanced diet.

Theory

Food and its function, physico-chemical properties of foods, food preparation techniques, nutrition, relation of nutrition of good health. Characteristics of well and malnourished population. Energy, definition, determination of energy requirements, food energy, total energy needs of the body. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

Practical

Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy, value proteins and fats of foods. Planning diet for various age groups.

Suggested Reading:

Dr. Swaminathan, M.1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.

Dr. Swaminathan, M. 1985. Essential of Food and Nutrition Vol. II. BAPPCO, Bangalore.

Manoranjan, K. and Sangita, S. 1996. Food Preservation and Processing. Kalyani Publishers

Srilakshmi. 2010. Food Science. New age International.

Srilakshmi. 2005. Dietetics. New age International.

Shankunthala, M. 1972. Foods-Facts, Principles & Procedure. The Eastern Press, Bengaluru

Passmore, R. and Eastwood, M. A. 1986. Human Nutrition & Dietetics. ELBS.

Anita, T. 1996. Food and Nutrition. Oxford.

Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science and technology and Quality Management. Kalyani Publishers 81-272-2521-5.

Monoranjan, K. and Sangita, S. 2008. Food Preservation and Processing. Kalyani Publishers

George, I. S. and Dennis, D. L. 1994. Chemistry for the Health Science. MacMillan.

Masferton and Hurley. 1989. Chemistry Principles and Reactions. Saunders Golden Sunburst.

Bettelheim and March. 1984. Introduction to General, Organic & Biochemistry. Harcourt Brace college Puplishers 0030202175 Sounders college Puplishing.

Gopalan, G., Ramasastri, B.V. and Balasubramnian, S. C. 1989. Nutritive value of the Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.

<http://www.fao.org/infoods/>

Swaminathan, M. 1988. Hand book of Food Science & Experimental Foods. Bappco publishers, Bangalore

Manay, S.N, Shadaksharaswamy, M.1998. Food-facts & Principles New Age International Publishers, New Delhi

Srilakshmi, B. 1995. Food Science. New Age International Publishers, New Delhi.

FLORICULTURE & LANDSCAPE ARCHITECTURE

HOH 204 Ornamental Horticulture 2 (1+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of Ornamental crops, with different style and features of landscape designing.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different ornamental crops.
- Identify different ornamental crops seed with their plant types in their natural existence.
- Classify different ornamental crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different ornamental crops.

Theory

History, definitions, scope of ornamental horticulture, aesthetic values, Floriculture industry, Importance, area and production, industrial importance of ornamental plants and flowers. Importance, classification, design values and general cultivation aspects for ornamental plants *viz.* Annuals, biennales herbaceous perennials, grasses and bulbous ornamentals. shrubs, climbers, trees, indoor plants, palms and cycads, ferns and sellagenellas, cacti and succulents, Importance, design and establishment of garden features/components *viz.* hedge, edge, borders, flower beds, bridges, paths, drives, fences, garden walls, gates, carpet bed, arbour, Patio, decking, retaining walls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools, waterfalls, fountains, bog garden, avenue planting and children garden. Lawn types, establishment and maintenance. Importance of Garden adornments *viz.* floral clock, bird bath, statutes, sculptures, lanterns, water basins, garden benches etc. Importance of flower arrangement, Ikebana, techniques, types, suitable flowers and cut foliage, uses of vertical garden, bottle garden, terrariums, art of making bonsai, culture of bonsai and maintenance.

Practical

Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns and sellagenellas, Palms and cycads and Cacti and succulents. Planning and designing and establishment of garden features viz. lawn, hedge and edge, rockery, water garden, carpet bedding, shade garden, roof garden, Study and creation of terrariums, vertical garden, study and practice of different types of flower arrangements, preparation of floral bouquets, preparation of floral rangoli, veni etc., Study of Bonsai techniques, Bonsai practicing and training. Visit to nurseries and floriculture units.

Suggested Reading:

- Bose, Chowdhury and Sharma.1991. Tropical Garden Plants in colour. Horticulture and allied publishers, 3D Madhab Chatterjee street Kolkata.
- K.V. Peter. 2009.Ornamental plants. New India publishing agency, Pitampura, New Delhi.
- Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries Pvt. Ltd.
- Bimaldas Chowdhury and Balai Lal Jana.2014. Flowering Garden trees. Pointer publishers, Jaipur. India.
- Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
- Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
- Bose, T.K. Mukherjee, D. 2004. Gardening in India. Oxford & IBH Publishers.
- Chadha, K.L. and Chaudhary, B. 1986. Ornamental Horticulture in India. Publication and Information division. ICAR, New Delhi.

HBF 306 Breeding and Seed Production of Flower and Ornamental Crops 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in Breeding and seed production of flower and ornamental Crops.

Course outcome: Upon completion of the course students will be able to;

- Know about history and importance of flower and ornamental crop breeding.
- Practice different breeding method and techniques involved in each method for improvement of various flower and ornamental crop
- Know the practices about seed production of flower and ornamental crop.

Theory

History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops viz., Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia Heliconia, Lilium, Gaillardia, Petunia, *Hibiscus*, Bouganvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, crossandra, marigold, geranium, antirrhinum, china aster, orchids, anthurium, carnation, hibiscus etc. Breeding for disease resistance. Development of promising cultivars of important ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

Practical

Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods.

Suggested Reading:

- B.P. Pal. *The Rose in India*. 1966. Directorate of Knowledge management in Agriculture, Indian council of Agriculture Research-New Delhi.
- T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers*. Partha Sankar Basu, Nayadyog, 206, Bidhan Sarani, Kolkata-700006.
- S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
- D.J. Callaway and M.B. Callaway. 2000. *Breeding Ornamental Plants*. Timber Press
- J. Harding, F.Singh and J.N. Mol. 1991. *Genetics and Breeding of Ornamental Species*. Springer Publishers
- A. Vainstein. 2002. *Breeding for Ornamental: Classical and Molecular Approaches*. Springer Publishers
- Singh,B.D. 1983. *Breeding Principles and Methods*. Kalyani Publishers, New Delhi.
- R.L. Agarwal. 1996. *Seed Technology*. Oxford & IBH Publishers, New Delhi
- P.K. Agarwal. 1994. *Principles of Seed Technology*. ICAR Publication, New Delhi

HLA 101 Principles of Landscape Architecture 2 (1 +1)

Objective: To develop understanding of the principles and management landscaping.

Course outcome: Upon completion of the course students will be able to;

- Know about different styles and form of garden with their basic features.
- Use of Auto CAD and Arch CAD in designing gardens
- Acquainted with skills to plan garden for different public and private area.

Theory

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD and Arch CAD in designing gardens. Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc. Elements of landscape gardens viz. tangible and intangible elements. Bio-aesthetic planning, definition, objectives, Planning and designing of home gardens, colonies, country planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydroelectric stations, river banks, play grounds, Gardens for places of religious importance viz. temples, churches, mosques, tombs etc, Importance, features and establishment of English garden , Japanese gardens , Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens, Xeriscaping, definition, principles and practice.

Practical

Study of garden equipment's. Study of Graphic language, Use of drawing equipment's, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, designing gardens using Auto-cad/ archi-cad, designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, temples, churches, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

Suggested Reading:

A.K. Tiwari and R. Kumar. 2012. *Fundamentals of ornamental horticulture and landscape gardening*. New India.
 H.S.Grewal and Parminder Singh. 2014. *Landscape designing and ornamental plants*
 R.K. Roy. *Fundamentals of Garden designing*.2013. New India publishing agency, Pitampura, New Delhi.
 Rajesh Srivastava. 2014. *Fundamentals of Garden designing*. Agrotech press, Jaipur, New Delhi
 L.C. De. *Nursery and landscaping*.2013. Pointer publishers, Jaipur India.
 Bose, T.K. Malti, R.G. Dhua, R.S. & Das, P. 2004 Nayaprakash, Calcutta
 Arora, J.S. 2006. Kalyani publishers, Ludhiana. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana.
 Randhawa, G.S. and Amitabha Mukhopadhyay 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.

HCF 203 Commercial Floriculture 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of Ornamental crops,

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different ornamental crops,
- Identify different ornamental crops seed with their plant types in their natural existence.
- Classify different ornamental crops according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different ornamental crops.
- Skills to plan for various structure used in commercial flower industry with package of practices and post harvest management.

Theory

Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, crossandra, anthurium, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export market, production techniques of flowers and foliage filler materials growing of flowers under protected environments such as glass house, plastic house etc., postharvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers, production techniques for bulbous.

Practical

Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

Suggested Reading:

A.K.Singh.2006.*Flower crops, cultivation and management*. New India publishing agency, Pitampura, New Delhi.
 T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003. *Commercial flowers*.
 S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
 Dewasish Choudhary and Amal Mehta. 2010. *Flower crops cultivation and management*. Oxford book company Jaipur, India.
 Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd:
 Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
 Prof. Bhattacharjee, S.K. Advanced Commercial Floriculture. Aavishkar Publishers Distributors, Jaipur

Prof. V.L. Sheela, 2008. Flower for trade. New India Publishing Agency, Pitampura, New Delhi

HMA 305 Medicinal and Aromatic Crops 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in production practices of Medicinal and aromatic plants.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in cultivation and management of different medicinal and aromatic plants.
- Identify different medicinal and aromatic plants seed with their plant types in their natural existence.
- Classify different medicinal and aromatic plants according to their agro-climatic requirement, physiological and morphological features.
- Practice techniques involved in management of different medicinal and aromatic plants.

Theory

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils. Medicinal Plants: Withania, periwinkle, Rauwolfia, Dioscorea, Isabgol, opium poppy Ammi majus, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum and other species relevant to the local conditions. Marketing.

Practical

Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Suggested Reading:

Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.

Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants. United Press Limited.

Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.

Kumar, N. J.B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants. Oxford & IBH, New Delhi.

Jain, S.K. 1968. Medicinal Plants. National Book Trust New Delhi. Oxford & IBH, New Delhi

Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala sons and co-private Ltd, Bombay.

PLANT PROTECTION

HPP 203 Fundamentals of Plant Pathology 3 (2+1)

Objective: Provide insights on basic theory, concepts and practices involved in crop protection against plant diseases.

Course outcome: Upon completion of the course students will be able to;

- Explain the several practices involved in crop protection from diseases.
- Explain the different infection, reproduction, survival mechanism and spread of different pathogens.
- Categorize different biotic and abiotic causes of diseases and different diseases caused due to them.
- Practice techniques involved in integrated disease management.

Theory

Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management. Fungicides classification based on chemical nature, commonly used fungicides, bactericides and nematocides.

Practical

Familiarity with general plant pathological laboratory and field equipment's. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their applications.

Suggested Readings:

- N.G. Ravichandra, 2013. Fundamentals of Plant Pathology. PHI Hall of India, New Delhi
R.S. Mehrotra, Ashok Agarwal. *Fundamental of Plant Pathology*-
Sambamurthy A *textbook of Plant Pathology*
R.S.Singh *Introduction to principles of plant pathology*
Alexopoulos, C. J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.
Mandahar, C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi.
Mehrotra, R.S. and Aneja, K.R. 1990. An Introduction to Mycology. New Age International (P) Ltd., New Delhi.
Singh, R.S. 1982. Plant Pathogens - The Fungi. Oxford and IBH Publishing Co., New Delhi.
Singh, R.S. 1989. Plant Pathogens - The Prokaryotes. Oxford and IBH Publishing Co., New Delhi.
Dhingra and Sinclair 1993. Basic Plant Pathology Methods. CBS, Publishers & Distributors, New Delhi.
Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.

HDC 203 Diseases of Fruit, Plantation, Medicinal and Aromatic Crops 3 (2+1)

Objective: Provide insights on basic theory, symptoms and practices involved diseases of fruits, plantation, medicinal and aromatic crops.

Course outcome: Upon completion of the course students will be able to;

- Differentiate different diseases of fruits, plantation, medicinal and aromatic crops.
- Explain the different symptoms, pathogens, disease cycle and management of different diseases of fruits, plantation, medicinal and aromatic crops.
- Identify post-harvest diseases of fruit and plantation crops and their management

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, croton, datura, dioscorea, mint, opium, *Solanum kbasianum* and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

Suggested Reading:

- L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers
- Srikant Kulkarni, Yashoda R. Hedge, *Diseases of Plantation crops and their management*-Agrotech publication Academy.
- S.L. Godara, BBS Kapoor, B.S. Rathore *Disease management of spice crops*-, Madhu Publications.
- Alfred Steferud *Diseases of Plantation Crops*-, Biotech books.
- R.S.Singh, *Plant diseases* –Oxford and IBH Publishing Co. Pvt. Ltd.
- L.Darwin Christdhar Henry and H. Lewin Devasahayam. *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook, New India publishing. Agency.
- Anna L *A colour atlas of Post-Harvest Diseases and Disorders of fruits and vegetables* -. Snowdon, CRC Press.
- Pathak, V.N. 1980.*Diseases of Fruit Crops*.Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
- Ranga Swamy, G. 1988.*Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi.
- Singh, R.S. 1996.*Plant Diseases*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
- Saha, L.R. 2002.*Hand Book of Plant Diseases*. Kalyani Publishers, New Delhi.
- Arjunan, Karthikeyan, Dinakaran, Raghuchander, 1999.*Diseases of Horticultural Crops*. Dept. of Plant Pathology, TNAU, Coimbatore
- Chadha, K.L. 2002.*Hand Book of Horticulture*. ICAR, New Delhi.
- Anna L.Snowdon *A colour atlas of Post-Harvest Diseases and Disorders of fruits and vegetables*. CRC Press, New Delhi.
- L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*., Indus Publishers, New Delhi.
- Yashoda R. Hedge. *Diseases of Plantation crops and their management*, Srikant Kulkarni, Agrotech publication Academy.
- S.L. Godara, BBS Kapoor, B.S. Rathore. *Disease management of spice crops*., Madhu Publications.
- Ranga Swamy, G. 1988.*Diseases of crop plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi
- R.S.Singh, *Plant diseases*. Oxford and IBH Publishing Co. Pvt. Ltd.
- L. Darwin Christdhar Henry and H. Lewin Devasahayam, *An Illustrated Handbook*. New India publishing. Agency

HDV 305 Diseases of Vegetables, Ornamental and Spice Crops 3 (2+1)

Objective: Provide insights on basic theory, symptoms and practices involved diseases of vegetables, ornamentals and spice crops.

Course outcome: Upon completion of the course students will be able to;

- Differentiate different diseases of vegetables, ornamentals and spice crops.
- Explain the different symptoms, pathogens, disease cycle and management of different diseases of vegetables, ornamentals and spice crops.
- Identify post-harvest diseases of vegetables and ornamentals and their management.

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerbera, anthurium, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

Practical

Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops in field as well as in protected cultivation.

Suggested Reading:

Srikant Kulkarni, Yashoda R. Hedge. *Diseases of Plantation crops and their management*-, Agrotech publication Academy
S.L. Godara, BBS Kapoor, B.S. Rathore. *Disease management of spice crops*-, Madhu Publications
L.Darwin Christdhar Henry and H.Lewin Devasahayam *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook –, New India publishing Agency
Singh, R.S. 1994. *Diseases of Vegetable Crops*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
Singh, R.S 1996. *Plant Diseases*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
Sohi, H.S. 1992. *Diseases of Ornamental plants in India*. ICAR, New Delhi
Ranga Swamy, G. 1988. *Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi.
Saha, L.R. 2002. *Hand Book of Plant Diseases*. Kalyani Publishers
Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. *Diseases of Horticultural Crops*. Dept. of Plant Pathology, Tamilnadu Agricultural University Coimbatore.

HNM 203 Nematode Pests of Horticultural Crops and their Management 2 (1+1)

Objective: Provide insights on basic theory, symptoms and practices involved diseases caused due to nematodes.

Course outcome: Upon completion of the course students will be able to;

- Identify different plant pathogenic nematodes.
- Identify different symptoms and diseases caused by nematodes.
- Accumulated the knowledge on integrated nematode management.

Theory

History and development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, sub-tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex. Integrated nematode management.

Practical

Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Suggested Reading:

- Upadhyay, K.D and Dwivedi, K. 1997. A text book of plant nematology. Amman Publishing House Aman publishing house, Meerut
- Vasanth Raju David, B. 2001. Elements of economic entomology. Popular book Depot, Chennai.
- Gopal Swaroop and Das Gupta 1986.ICAR, New Delhi. Plant Parasitic Nematodes of India Problems and Progress.
- Nair, M.R.G.K. 1975. Insects and Mites of Crops in India. ICAR, New Delhi
- Metcalf, R.L and Luckman, W.H. 1982. Introduction to Insect pest management Wiley Inter Science Publishing, New York.
- Butani, D.K. 1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi
- E.I.Jonathan, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, Agricultural Nematology. TNAU, Coimbatore.

HEN 203 Fundamentals of Entomology 3 (2+1)

Objective: To provide basic knowledge on insect's morphology and taxonomy.

Course outcome: Upon completion of the course students will be able to;

- Know the morphology and physiology of a typical inset body.
- Know the morphological features and families of plant mites.
- Acquainted with history of entomology in India.
- Gained insight on insect taxonomy and classification of insects as economically beneficial and pests.

Theory

Introduction to phylum arthropoda. Importance of class Insecta. Insect dominance. History of entomology in India, Importance of entomology in different fields. Definition, division and scope of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genitalia. Structure, function of cuticle & moulting and body segmentation, Anatomy of digestive, Circulatory, Sensory, respiratory, glandular, excretory, nervous and reproductive systems. Types of reproduction. Postembryonic development-eclosion. Matamorphosis. Types of egg larvae and pupa. Classification of insects upto orders, sub-order and families of economic importance and their distinguished characters. Plant mites – morphological features, important families with examples.

Practical

Insect collection and preservation. Identification of important insects. General body organization of insects. Study on morphology of grasshopper or cockroach. Preparation of permanent mounts of mouth parts, antennae, legs and wings. Dissection of grasshopper and caterpillar for study of internal morphology. Observations on metamorphosis of larvae and pupae. Dissection of cockroaches.

Suggested Reading:

- Awasthi, V.B. 1997. *Introduction to general and applied entomology*. Scientific Publishers, Jodhpur, 379 p.
- Borror, D.J., C.A. Triple Horn and N.F. Johnson. 1987. *An introduction to the study of insects (VI Edition)*. Harcourt Brace College Publishers, New York, 875p.
- Chapman, R.F. 1981. *The Insects: Structure and function*. Edward Arnold (Publishers) Ltd, London, 919p.
- Gullan, P.J. and Cranston, P.S. 2001. *The insects- An outline of entomology*, II edition, Chapman & Hall, Madras, 491p.
- Mani, M.S. 1968. *General entomology*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 912p.

Nayar, K.K., T.N. Ananthkrishnan and B.V. David. 1976. *General and applied entomology*, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.

Richards, O.W. and R.G. Davies. 1977. *Imm's general text book of entomology*, Vol.1&2, Chapman and Hall Publication, London, 1345p.

Romoser, W.S. 1988. *The Science of Entomology*, McMillan, New York, 449p.

Saxena, S.C. 1992. *Biology of insects*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 366p.

Srivastava, P.D. and R.P. Singh. 1997. *An introduction to entomology*, Concept Publishing Company, New Delhi, 269p.

Tembhare, D.B. 1997. *Modern Entomology*. Himalaya Publishing House, Mumbai, 623p.

Pedigo, L.P. 1999. *Entomology and pest management*. III Edition. Prentice Hall, New Jersey, USA, 691p.

H. Lewin and Devasahayam. Practical manual of entomology insect and non-insect pests.

Pant, N.C. and Ghai, S. 1981 Insect physiology and anatomy, ICAR, New Delhi

Snodgrass, R.E. 2001. Principles of Insect Morphology. CBS Publishers and Distributors, New Delhi

James, L, Nation. CRC Press, Insect Physiology and Biochemistry. Washington

HFP 204 Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops 3 (2+1)

Objective: To gain knowledge about the insect pests of Fruit, Plantation, Medicinal and Aromatic Crops.

Course outcome: Upon completion of the course students will be able to;

- Know about important insect and non-insect pests of Fruit, Plantation, Medicinal and Aromatic Crops along with their host range, bio-ecology, injury and integrated management.
- Know integrated pest management tactics for above crops.

Theory

General – economic classification of insects; Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, belladonna, pyrethrum, costus, crotalaria, datura, dioscorea, mint, opium, Solanum khasianum and. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs).

Practical

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.

Suggested Reading:

Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.

Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.

Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.

Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.

David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.

David.V. Alford. Pest of fruit crops. A.M. Ranjith. Identification and management of Horticultural pest.

Rachna and Benna kumari. Pest management and residual analysis in horticultural crop

K. P. Srivastav and Y. S. Ahawat. Pest management in citrus

Ramnivas Sharma. Identification and management of horticulture pest.
Fryer. Insect pest of fruit crops
A. S. Atwal. Agricultural pests of South Asia and their management
Mark Vernon Slingerland and C. R. Crosby. Manual of fruit insects
Metcalf, R. Land Luckman, W.H. 1982. Introduction to Insect pest management. Wiley Inter Science, Publishing, New York
Butani, D.K. 1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi

HAS 306 Apiculture, Sericulture and Lac Culture 2 (1+1)

Objective: To gain knowledge about rearing and management of beneficial insects (honey bees, silkworms and lac insects).

Course outcome: Upon completion of the course students will be able to;

- Know the rearing of honeybees and developing an apiary.
- Know about lac culture and sericulture.
- Gain an entrepreneurial idea regarding apiculture, lac culture and sericulture.

Theory

Introduction to beneficial insects. Importance and History of apiculture. Species of honey bees, Rock bee, Little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons, Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues. Importance, History and development in India, silkworm's kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs. Silkworm rearing young age/chawki rearing and old age rearing of silkworms. Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture-Mulberry varieties, package of practices, Pests and diseases and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.

Practical

Honey bee colony, different bee hives and apiculture equipment. Summer and Winter management of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipment's for silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

Suggested Reading:

- Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.
- Sunita, N.D, Guled , M.B, Mulla S.R and Jagginavar,2003, Beekeeping, UAS Dharwad
- Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
- Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).
- Paul DeBach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991)
- YA Shinde and BR Patel. Sericulture in India
- Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd
- M.L. Narasaiah. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.
- Ganga,G. and Sulochana Chetty, J. 1997. An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
- Krishnaswamy, S. (Ed). 1978. Sericulture Manual - Silkworm Rearing. FAO Agrl. Services bulletin, Rome.
- Singh, S. 1975. Bee keeping in India. ICAR, New Delhi.
- Glover, P.M. 1937. Lac cultivation in India. Indian Lac Research Institute, Ranchi.
- Jolly, M.S. 1987. Appropriate sericulture techniques. International centre for training and Research in Tropical Sericulture, Mysore,209.
- K.P. Srivastava. A Text Book on Applied Entomology Vol. I&II., Kalyani Publishers, Ludhiyana
- B.R. David and V.V. Ramamurthy. Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai

HPV 306 Insect Pests of Vegetable, Ornamental and Spice Crops 3 (2+1)

Objective: To gain knowledge about the insect pests of Vegetable, Ornamental and Spice Crops.

Course outcome: Upon completion of the course students will be able to;

- Know about important insect and non-insect pests of Vegetable, Ornamental and Spice Crops along with their host range, bio-ecology, injury and integrated management.
- Know integrated pest management tactics for above crops.

Theory

Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect-pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host range, bio-ecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical

Study of symptoms, damage, collection, identification, preservation, assessment of damage/ population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

Suggested reading:

- Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur
- Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
- Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.
- Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.

David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.
 P. Srivastava, Dharmo K. Butani Pest management in vegetables – Part1. Researcho Book Centre, 1998
 K.P. Srivastava, Dharmo K. Butani Pest management in vegetables – Part-2. Researcho Book Centre, 1998
 Rachna and Benna kumari. Pest management and residual analysis in horticultural crop
 Ramnivas sharma. Identification and management of horticulture pest.
 T. V. Sathe. Pests of ornamental plants.
 A. S. Atwal. Agricultural pests of south Asia and their management
 Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi.
 Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi
 Metcalf, R. Land Luckman, W.H.1982. Introduction to Insect pest management. Wiley Inter Science

NATURAL RESOURCE MANAGEMENT

HSS 101 Fundamentals of Soil Science 2 (1+1)

Objective: To acquaint with soil forming process, its properties- physical, chemical and biological, as a plant growth medium.

Course outcome: Upon completion of the course students will be able to;

- Explain the soil forming process to relate to the soil forming factors in various climatic conditions.
- List the physical properties and chemical properties that affect both plant growth and biological activity
- Explain soil as medium of plant, soil quality and soil health in relation to plant growth.

Theory

Composition of earth's crust, soil as a natural body – major components. Eluviations and alleviations formation of various soils. Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), AD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value hue and chroma. Munsell colour chart, factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal, soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Rock & Minerals classification, Pedogenic process. Objectives of soil science research institute in India (NBSS&LUP, ISSS, LTFE & NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Soil Biology benefits and harmful effects. Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation.

Practical

Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Quantification of minerals and their abundance.

Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Estimation of soil moisture using gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of pore space of soil. Determination of field capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by field method.

Suggested Reading:

- Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.
- Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
- Dilip Kumar Das, 2015. *Introductory Soil Science*. Kalyani Publishers, Ludhiana.
- Biswas, T.D. and Mukharjee, S.K., 2015. *Text Book of Soil science*. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
- Brady, N.C., 1995. *The Nature and properties of Soils*. Macmillan Publishing Co, New York.
- Ghildyal, B.P. and Tripathi, R.P., 1987. *Soil Physics*. Acad. Press. New York.
- Kolay, A.K., 1983. *Basic concepts of Soil Science*. Wiley Eastern Ltd., New Delhi
- Brady, N. C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition), Pearson Education, New Delhi.
- Foth, H.D., 1991. *Fundamentals of Soil Science* (8th Edition), John Wiley & Sons, New Delhi.
- Das, D.K., 2011. *Introductory Soil Science* (3rd Edition), Kalyani publisher, Ludhiana (India).
- Khan, T. O. 2013 *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland
- Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
- Gupta, P.K. 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
- Jaiswal, P.C. 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson, M. L. 2012. *Soil Chemical Analysis: Advanced Course*, Scientific Publisher

HSF 102 Soil Fertility and Nutrient Management 2 (1+1)

Objective: To provide detailed information on essentiality and available forms of nutrients in soils, types of fertilizers of different chemical properties and their essential nutrient content and forms.

Course outcome: Upon completion of the course students will be able to;

- Explain the criteria of essentiality and available forms of nutrients in soils.
- List types of fertilizers and classify them in terms of nutrient source.
- Gained insights on factors affecting their transformation in soils and availability
- Gained knowledge on methods soil analysis for nutrient contents and fertilizer recommendations.
- Accumulated knowledge on fertilizer application methods and nutrient use efficiency.

Theory

Introduction to soil fertility and productivity- factors affecting. Essential plant nutrient elements- functions, deficiency systems, transformations and availability. Acid, calcareous and salt affected soils – characteristics and management. Soil organic matter, Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition, soil buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Plant nutrient toxicity symptoms and remedies measures. Soil test crop response and targeted yield concept. Biofertilizer. Nutrient use efficiency and management. Secondary and micronutrient fertilizer. Fertilizer control order. Manures and fertilizers classification and

manufacturing process. Properties and fate of major and micronutrient in soils. Fertilizer use efficiency and management. Effect of potential toxic elements in soil productivity.

Practical

Analysis of soil for organic matter, available N, P, K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils. Estimation of organic carbon content in soil. Determination of Boron and chlorine content in soil. Determination of Calcium, Magnesium and Sulphur in soil. Sampling of organic manure and fertilizer for chemical analysis. Physical properties of organic manure and fertilizers. Total nitrogen in urea and farmyard manure. Estimation of ammonical nitrogen and nitrate nitrogen in ammonical fertilizer. Estimation of water soluble P₂O₅, Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate. Visiting of fertilizer testing laboratory.

Suggested Reading:

- Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers*. Agri. Horticultural Publishing House, Nagpur.
- Tandon HLS, 1994. *Fertilizers Guide*. Fertilizers Development Consultation Organization, New Delhi.
- Seetharaman S, Biswas B C, Yadav D S and Matheswaru S. Usage 1996. *Hand Book on Fertilizers*. Oxford and IBH Publishing Company, New Delhi.
- The fertilizer Association of India, Shaheed Jit singh marg, New Delhi, 1985. Fertilizer control order
- Ranjan Kumar Basak , 2000. *Fertilizers A Text book*. Kalyani publishers, New Delhi.
- British Crop Production Council, U.K., 1995. *The Pesticide Manual, A – World Compendium*.
- Sree Ramulu US, 1991. *Chemistry of Insecticides*. Oxford and IBH Publishing and Fungicides Company, New Delhi.
- Nene Y L and Thapliyal P N, 1991. *Fungicides in plant disease control*. Oxford and IBH Publishing company, New Delhi.
- Havlin *et al.* 2014. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (8th Edition), PHI Learning Pvt. Ltd., Delhi.
- Binkley, D. and R. Fisher, 2012. *Ecology and Management of Forest Soils* (4th Edition), John Wiley & Sons Singapore Pvt. Ltd., Singapore
- Reddy M. V., 2001. *Management of Tropical Plantation Forests and Their Soil Litter System-Litter, Biota and Soil Nutrient Dynamics*, Science Publishers, U. S.
- Khan, T. O., 2013. *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland
- Brady, N. C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition.), Pearson Education, New Delhi
- Das, D.K., 2011. *Introductory Soil Science* (3rd Edition), Kalyani Publisher, Ludhiana (India). Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. Indian Society of Soil Science, IARI, New Delhi.
- Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
- Gupta, P.K., 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
- Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson, M. L., 2012. *Soil Chemical Analysis: Advanced Course*, Scientific Publisher
- J. Benton Jones, Jr., 2012. *Plant Nutrition and Soil Fertility Manual* (2nd Edition), CRC Press, USA.
- Mengel, *et al.*, 2001. *Principles of Plant Nutrition* (5th Edition), Springer
- Kanwar, J.S.(Ed),1976. *Soil Fertility: Theory and Practice*, ICAR, New Delhi
- Bear, F.E.,1964. *Chemistry of the Soil*. Oxford and IBH Publishing Co., New Delhi
- Richards, L.A., 1968. *Diagnosis and Improvement of Saline and Alkaline soils*. Oxford& IBH Publishing Co. New Delhi (USDAH and Book No.60)
- Chopra, S.C and Kanwar, J.S.,1976. *Analytical Agricultural Chemistry*. Kalyani Publishers, Ludhiana.
- Tisdale, S.L.Nelson, W.L.and Beaton, J.D.,1993. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York
- Yawalkar, K.S.Agarwal, J.P.and Bokde, S.,1977. *Manures and Fertilizers*. Agri-Horticultural Publishing House, Nagpur

Seetharamaan, S.Biswas, B.C.Maheswari, S.and Ya dav, D.S., 1986. *Hand Bookon FertilizersTechnology*. The Fertilizers Association of India, New Delhi

HEM 102 Environmental Studies and Disaster Management 3 (2+1)

Objective: To sensitize students about the basics of biology in special reference to botany.

Course outcome: Upon completion of the course students will be able to;

Objective: To get an insight into various environmental components including ecosystem, ecological succession and disaster management.

Course outcome: Upon completion of the course students will be able to;

- Accumulated the knowledge about various types of energy sources (renewable and non-renewable).
- Know various components of an ecosystem.
- Know various types of pollution sources and their management.
- Gained awareness on various kinds of disasters and their management.

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems, Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: - a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:-Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of - Air, Water, Soil, Marine, Noise and Thermal pollution and Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air, Water, Wildlife and Forest Conservation Acts, Issues involved in enforcement of environmental legislation and Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Program. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Field work:

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. 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. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management-Effect to migrate natural disaster 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.

Practical

Visit to local areas - river/forest/ grassland/catchment etc. to document components of ecosystem. Study of common plants, insects, birds and animals. Visit to industries to study pollution abatement techniques and case studies - solid waste management, Human population and the Environment.

Suggested Reading:

- A. Nandini, N. Suneetha and Sucharitha Tandon. *Environmental Studies*.
Aswathanarayana, U. 1999. *Soil resources and the environment*. Oxford and IBH publishing Co., New Delhi.
D. D. Misra. *Fundamental Concepts in Environmental Studies*.
Diwan, P. and P. Diwan. 1998. *Environmental Management Law and Administration*. Variety Books International, New Delhi.
Krishnamurthy. *An Advanced Textbook on Biodiversity*.
S. Deshwal A. Deshwal. *A Basic Course in Environmental Science*.
Erach Bharucha 2005. Textbook of environmental studies for under graduate courses. UGC, University press, Hyderabad.
Manohara Chary and Jayaram Reddy 2004. Principles of Environmental studies BB publishers, Hyderabad.
William, P. Cunning Ham and Mary Ann. Inquiry and applications
Cunningham 2005. Principles of Environmental science. Tata MCG raw-hill publishing company limited, New Delhi.
Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India). Jodhpur.
Spencer R. Weart. The discovery of global warming.
Daniel B. Botkin, Edward A. Keller. Environmental Science.
Richard T. Wright and Bernard J. Nebel Environmental science: toward a sustainable agriculture.
Linfield C. Brown. Pollution prevention and control.

HAS 204 Soil, Water and Plant Analysis 2 (1+1)

Objective: To provide insights on the importance of soil, water and plant analysis to understand the nutrient sufficiency and deficiency of crops

Course outcome: Upon completion of the course students will be able to;

- Gained knowledge on method and procedure of soil, water and plant collection for chemical analysis.
- Gained insights on analysis of soil samples for various parameters and nutrients contents.
- Ability to interpret the data and recommendations.

Theory

Methods of soil and plant sampling and processing for analysis. Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox

potential. Use of radio tracer techniques in soil fertility evaluation. Soil micro-organisms and their importance. Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values Quality of irrigation water. Radio tracer technology application in plant nutrient studies. Rapid tissue tests for soil and plant. Management of poor quality irrigation water in crop management. Soil and Water pollution.

Practical

Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Estimation of available macro and micronutrient elements in soils and their contents in plants. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of Calcium and Magnesium in soil and irrigation water. Determination of N, P, K, Ca, Mg, Sand micronutrients in plant samples. Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

Suggested Reading:

- H.L.S. Tandon. 2013, *Methods of analysis of soil, plant, water and fertilizers*. FDCO, New Delhi.
- Yawalkar, K.S. Agarwal, J.P. and Bokde, S., 1977. *Manures and Fertilizers*. Agri-Horticultural Publishing House, Nagpur.
- Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
- Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson M. L., 1967. *Soil Chemical Analysis*, Oxford and IBH Publishing Co., New Delhi.
- Richards L A, 1968. *Diagnosis and Improvement of Saline and Alkaline Soils*. Oxford and IBH publishing Co. New Delhi (USDA Hand Book No. 60)
- Chopra S.C. and Kanwar, J. S 1976. *Analytical Agricultural Chemistry*, Kalyani Publishers, Ludhiana.
- C. S. Piper. 2014, *Soil and plant analysis*, Scientific publishers India.
- Mushtaq A. Wan., 2014, *Soil, plant and water analysis manual*. Agrotech publishing company, Udaipur.
- P. K. Gupta., 2013, *Soil, plant, water and fertilizer analysis*. Agrobios, India.
- M. V. Durai., 2014, *Hand book of Soil, plant, water, fertilizers and manure analysis*. New India Publishing Agency.

HPM 204 Farm Power and Machinery 2 (1+1)

Objective: Discussed detailed knowledge on various farm machineries and their functioning principles.

Course outcome: Upon completion of the course students will be able to;

- List types of farm machineries and their working principles.
- Accumulated skills to repair and trouble-shooting of machineries
- Identify suitable tillage equipment's to be used with power operated machines.
- Analytical ability on cost analysis of power usage in land preparation.

Theory

Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples. IC Engines: Basic principles of operation of compression, ignition and spark ignition engines, two stroke and four stroke engines, cooling and lubrication system, power transmission system, broad understanding of performance and efficiency, tractors, power tillers and their types and uses. Electric motors: types, construction and performance comparison. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of indigenous ploughs, improved indigenous ploughs, mould board ploughs, disc and rotary ploughs. Secondary tillage implements: construction and function of tillers, harrows, levelers, ridgers and bund formers. Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter. Grafting, pruning and training tools and equipment. Inter-

culture equipment: sweep, Junior hoe, weeders, long handle weeders. Crop harvesting equipment's: potato diggers, fruit pluckers, tapioca puller and hoists.

Practical

Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment, calculation of dilution ratio and operation.

Suggested Reading:

- T. P. Ojha and A.M. Michael. 2005. *Principles of Agricultural Engineering* (Volume - 1), Jain Brothers
Manoj Kumar Ghoshal and Dharendra Kumar Das. 2008. *Farm Power*, Kalyani Publishers
Surendra Singh. 2007. *Farm Machinery Principles and Applications*. ICAR Publications
Roth/Field. 1992. *Introduction to Agricultural Engineering - Problem Solving Approaches*, 2nd. Edition. CBS publishers & distributors Pvt. Ltd.
Surendra Singh & Verma. 2009. *Farm Machinery Maintenance & Management*. ICAR Publication.
M.M. Pandey & Others. 2012 *Handbook of Agricultural Engineering*. ICAR publication
Jagadishwar Sahay.1992. *Elements of Agricultural Engineering*. Agro Book Agency, Patna.
Michal AM and Ojha TP.1993. *Voll. Principles of Agricultural Engineering*. Jain Brothers, New Delhi.
Kepner RARoy Bainerand Barger BL.1978. *Principles of Farm Machinery*. CBS Publisher and Distributors, Delhi.
JainS C. 2003. *Farm Machinery-An approach*. Standard Publishers and Distributors, New Delhi
Nakra, C.P.1986. *Farm Machinery and Equipment*. Dhanpat Raiand Sons, New Delhi
Klenin, N.I.Popov, I.F.and Sakun,V.A.1985. *Agricultural Machines*. Amerind publishing Co. Pvt. Ltd., New Delhi.

HWM 102 Water Management in Horticultural Crops 2 (1+1)

Objective: To provide insight the theory, concepts and method employed in water management in various horticultural crops.

Course outcome: Upon completion of the course students will be able to;

- Ability to explain the principle involved in the water management methods.
- Able to identify various types of technologies available for irrigation.
- Able to understand the water use efficiency and calculate irrigation water requirement of crops.

Theory

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages– critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

Practical

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different, methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices.

Suggested Reading:

Rao, Y.P. and Bhaskar, S.R. 2008. *Irrigation Technology. Theory and practice*. Agrotech publishing Academy, Udaipur
Dilip Kumar Mujmdar. 2004. *Irrigation Water Management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.,
S.V. Patil & Rajakumar, G. R., 2016. *Water Management in Agriculture and Horticultural Crops*. Satish serial publishing House, Delhi.
Carr M. K. V. and Elias Fereres. 2012. *Advances in Irrigation Agronomy*. Cambridge University Press.
Michael, A.M. 2015. *Irrigation Theory and Practices*. Vikas publishing house Pvt., Ltd.

HOP 305 Organic Farming 3 (2+1)

Objective: To learn about principles and practices of organic farming.

Course outcome: Upon completion of the course students will be able to;

- Know about fundamentals of nutrient use, insect, pest, disease and weed management under organic mode of production.
- Gained insights on organic certification process and standards of organic products set by various agencies.
- List agencies related with organic production practices in India.
- Gained insights on socio-economic status of farmers and environmental quality due to adoption of organic production practices.

Theory

Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports.

Practical

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, postharvest management.

Suggested Reading:

A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
S.P. Palaniappan and K. Annadurai. 2010. *Organic farming – Theory and Practice*. Scientific Publishers. Jodhpur.
U.Thapa and P. Tripathy. 2006. *Organic farming in India- Problems and Prospects*. Agrotech publishing agency, Udaipur.
G.K.Veeresh. 2006. *Organic farming*. Foundation Books. New Delhi.
Purshit, S.S. 2006. *Trends in Organic Farming in India*. Agros Bios (INDIA), Jodhpur.

Thampan, P. K. 1995. *Organic Agriculture*. Peckay tree Crops Development Foundation, Cochin, Kerala.
Sathe, T.V.2004. *Vermiculture and Organic Farming*. Days Publishing House, New Delhi.

HMC 305 Agro-meteorology and Climate Change 2 (1+1)

Objective: Provides basic knowledge about atmospheric phenomenon and their relation with crop production.

Course outcome: Upon completion of the course students will be able to;

- Understand about various atmospheric weather variables and their measurement.
- Explain how weather variables effect crop production.
- Gained insights on climate change and their impact on agriculture.
- Explain the importance of weather forecasting in crop production.

Theory

Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought, weather disasters and their management atmospheric pollution and role of meteorology. Basics of weather forecasting. Climate change-causes. Global warming-causes and remote sensing. Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases. Atmospheric chemistry. Plants sense and respond to changes in CO₂ concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C₃ and C₄ species. plant development affected by growth in elevated CO₂. Physiology of rising CO₂ on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO₂. Change in secondary metabolites and pest disease reaction of plants. The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

Practical

Site selection for Agromet observatory; Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine duration and solar radiation; Measurement of wind direction and speed and relative humidity; Study of weather forecasting and synoptic charts. Visit to Meteorological observatory, visit to IMD meteorological Observatory-Lay out plan of standard meteorological observatory. Recording of air and soil temperature. Measurement of radiation and components, Measurement of rainfall-different types of raingauges, Measurement of wind speed and direction and atmospheric humidity, Recording of evaporation. Synoptic charts and weather reports, symbols, *etc.*

Suggested Reading:

A. K. Srivastava and P. K. Tyagi, 2011. *Practical Agricultural Meteorology*. New Delhi Publishing Agency, New Delhi.
D.Lenka, 2006. *Climate, Weather and Crops in India*. Kalyani Publishers, New Delhi.
G. S. L. H. V. Prasad Rao, 2008. *Agricultural Meteorology*. Prentice Hall of India Pvt. Ltd., New Delhi.

H.S.Mavi and Graeme J. Tupper, 2005. *Agrometeorology – Principles and applications of climate studies in agriculture*. International Book Publishing Co., Lucknow.

H.S.Mavi, 1994. *Introduction to Agrometeorology*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

H.V.Nanjappa and B.K.Ramachandrappa, 2007. *Manual on Practical Agricultural Meteorology*. Agrobios India. Jodhpur.

S.R.Reddy, 1999. *Principles of Agronomy*. Kalyani Publishers, New Delhi.

T.Yellamanda Reddy and G.H.Sankara Reddi, 2010. *Principles of Agronomy*. Kalyani Publishers, New Delhi.

Pattersen, S.1958. *Introduction to Meteorology*. Mc. Graw Hill Book Co. Inc., New York

Taylor, J.T.1967. *Agricultural Climatology*. Pergman Press Ltd., Headington Hill Hall, Oxford, England

Trewarthe, T.G.1968. *An Introduction to Climate*. McGrawHill Book Co. Inc., New York.

Mavi, H.S.1985. *Introduction to Agrometeorology*. Oxford & IBH Publishing Co., New Delhi.

HAF 305 Introductory Agro-forestry 2 (1+1)

Objective: To acquire some basic knowledge on agro-frestry, silviculture and their management.

Course outcome: Upon completion of the course students will be able to;

- Able to know about basic components of agro-forestry systems.
- Technical knowledge on nursery techniques and tending operations.
- Identify plant species suitable for agroforestry systems and the benefits.

Theory

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Status of Indian forests and role in India farming systems. Agroforestry system, sub-system and practice: agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry. Agroforestry projects – national, overseas, MPTS– their management practices, economics of cultivation – nursery and planting (*Acacia catechu*, *Dalbergiasissoo*, *Tectona*, *Populus*, *Morus*, *Grewia*, *Eucalyptus*, *Quercus* spp. and bamboo, tamarind, neem etc.).

Practical

Identification and seeds and seedlings of multipurpose tree species. Nursery practices for poplar, *Grewiaoptiva*, *Morus alba*, *Acacia catechu*, *Dalbergiasissoo*, *robinia*, *leucaena* etc. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages. Economics and marketing of products raised in agro-forestry systems.

Suggested Readings:

A. K. Patra, 2013. *Agroforestry – Principles and Practices*. New India publishing agency.

A. P. Dwivedi, 1992. *Agroforestry – Principles and Practices*. Oxford and IBH Publishing company.

Dadhwal et al., 2014. *Practical Manual on Agroforestry*. Jaya publishing house, Delhi.

L.K. Jha, 2015. *Advances in Agroforestry*. APH Publishing corporation, New Delhi.

Linford, Jenny, 2007. *A Concise Guide to Trees*. Parragon books service limited, Parragon.

Negi, S.S., 2007. *Agroforestry Hand book*. International book distributor, New Delhi.

P.S. Pathak and Ram Newaj, 2010. *Agroforestry – Potentials and Opportunities*. Agrobios, Jodhpur

Pankaj Panwar & Sunil Puri, 2007. *Agroforestry: Systems & Practices*. New India publishing agency, New Delhi.
 Ramesh Umrani and C.K. Jain, 2010. *Agroforestry – Systems & Practices*. ABD Publishers, New Delhi.
 Ramachandran Nair, P.K. 1993. *An Introduction to Agroforestry*. First reprint in India–2008. Springer International Edition
 Tejawani, K.G. 1994. *Agro forestry in India*. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi
 Luna, R.K. 1989. *Plantation forestry in India*. International Book Distributors, Dehradun.
 Leda Satish. 2006. *Biodiesel and Jatropha Plantations*. AGROBIOS, Jodhpur.
 Chaturvedi, A.N. and Khanna, L.S. 1982. *Forest Menstruation*. Reprinted in 2006. International Book Distributors, Dehradun
 Negi, S.S.2006. *Forest Tree Seed*. Prashant Gahlotat Valley printers and publishers, Dehradun.
 Chundawat and S K Gautam.1996. *A text book of Agroforestry*. Oxford and IBH Publishing company Pvt. Ltd.

HFC 305 Introduction to Major Field Crops 2 (1+1)

Objective: To provide detailed classification of field crops and their management

Course outcome: Upon completion of the course students will be able to;

- Identify field crops and categorize them on the basis of their utility.
- Gained basic knowledge on cropping systems and selection crop types in intensive cropping pattern.
- Ability to identify weeds and herbicide based management.
- Preparation of cropping scheme for agricultural land area.

Theory

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals, pulses, oil seeds and fodder crops, green manuring, crop rotation.

Practical

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

Suggested Reading:

B. Gurarajan, R.Balasubramanian and V.Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
 Chidida Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
 Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
 Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICAR Publication.
 S.R.Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
 S.S.Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
 UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.
 Chidida Singh 1983. Modern Techniques of raising Field crops. Oxford & IBH, Publishing Co., New Delhi
 Rajendra Prasad 2002. Text Book of Field crops Production, ICAR, New Delhi.
 Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
 Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi.

HCA 101 Elementary Statistics and Computer Application 3 (2+1)

Objective: To understand the types of data, basic methods used in data analysis and computer based software's used in data collection, management and interpretation of data.

Course outcome: Upon completion of the course students will be able to;

- Explain the data and data classification.
- Organize data in excel sheet for analysis and interpretation using various statistical methods.
- Perform sampling, data collection and analysis to apply test of significance.
- Develop field scale testing of design and collect the primary empirical data.
- Able to use of computer based statistical software to analyze a set of data.

Theory

Introduction to statistics, limitations of statistics. Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles, for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poison and normal distributions, sampling, basic concepts, sampling vs. complete enumeration parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of Significance: Basic concepts, tests for equality of means, and independent and paired t-tests, chi-square test for application of attributes and test for goodness of fit of Mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient. Experimental designs: Basic concepts, completely randomized design, randomized block design, latin square designs, factorial experiments, basic concepts, analysis of factorial experiments up to 3 factors – split plot design, strip plot design, long term experiments, plot size, guard rows. Computer application: Introduction to computers and personal computers, basic concepts, operating system, DOS and Windows, MS Word- Features of word processing, creating document and tables and printing of document, MS Excel-Concept of electronic spreadsheet, creating, editing and saving of spreadsheet, inbuilt statistical functions and formula bar, MS Power point-preparation, presentation of slides and slide show. Introduction to programming languages, BASIC language, concepts, basic and programming techniques, MS Office, Win Word, Excel, Power point, introduction to multi-media and its application. Visual basic-concepts, basic and programming techniques, introduction to internet.

Practical

Construction of frequency distribution table and its graphical representation, histogram, frequency polygon, frequency curve, bar chart, simple, multiple, component and percentage bar charts, pie chart, mean, mode for row and grouped data, percentiles, quadrille, and median for row and grouped data, coefficient of variation, 't' test for independent, will equal and unequal variants, paired 't' test, chi-square test for contingency tables and theoretical ratios, correlation and linear regression. Studies on computer components – Basic language, visual basic, programming techniques, MS Office, Excel, power point.

Suggested Reading:

Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan chand and sons. New Delhi
Nageswara Rao, G. 2007. *Statistics for Agricultural Sciences*. B.S. Publications, Hyderabad.
Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad.

Gupta, V., 2002. *Comde x Computer Kit*. Dream Tech Press, New Delhi.
Parmar, A. Mathur, N. Deepthi P. U. and Prasanna, V. B., 2000. *Working with WINDOWS A Hands on Tutorial*. Tata Mc Graw Hill Publishing Co., New Delhi.
Bandari, V. B., 2012. *Fundamentals of Information Technology*. Pearson Education, New Delhi.
Fundamentals of Computers. 2011. Pearson Education-ITL ESL, New Delhi

HPB 101 Elementary Plant Biochemistry 2 (1+1)

Objectives: Provide insights on basic theory, principles, certain biochemical process and technology used for development of transgenic variety.

Objectives:

- Acquainted with chemistry of biological phenomenon.
- Knowledge on various biochemical process involved in the synthesis of biological products.
- Use techniques involved in extraction and determination of enzymes and biomolecules of importance.

Theory

Carbohydrates: Occurrence, classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation. Lipids: Classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance. Plant pigments – structure and function of chlorophyll and carotenoids, sterols, basic structure, role of brassino sterols in plants. Proteins: Classification, function and solubility, amino acids – classification and structure, essential amino acids, properties of amino acids, colour reactions, amphoteric nature and isomerism; structure of proteins – primary, secondary tertiary and quaternary properties and reaction of proteins. Enzymes: Classification and mechanism of action; factors affecting enzyme action, co-factors and coenzymes. Vitamins and minerals as co-enzymes/ co-factors. Carbohydrate metabolism – glycolysis and TCA-cycle; metabolism of lipids, fatty acid oxidation, biosynthesis of fatty acids, electron transport chain, bioenergetics of glucose and fatty acids, structure and function of nucleic acid replication, transcription and translation.

Practical

Preparation of standard solutions and reagents; Carbohydrates: Qualitative reactions; Estimation of starch; Estimation of reducing and non-reducing sugars from fruits; Amino acids: Reactions of amino acids; Proteins: Estimation of proteins by Lowry's method; Fatty acids: Estimation of free fatty acids; Determination of iodine number of vegetable oils; Vitamins: Estimation of Ascorbic acid; Techniques: Paper chromatography, Thin layer chromatography; Electrophoresis of pigments extracted from flowers, Extraction of oil from oil seeds; Enzymes: Enzyme assay, Enzyme Immobilization.

Suggested Reading:

Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry*. Freeman Publishers
Narayanan L M. Biochemistry. Saras Publications
Bose. Developments in Physiology Biochemistry & Molecular Biology of Plants Vol.-1. New India Publications.
Voet, D and Voet J. G. 2004. Biochemistry 4th Edn. Wiley & sons Publishers. USA.
Sadashiv, S and Manickam, A. 1996. Biochemical methods for Agricultural sciences. New age International publishers, New Delhi.
Voet, D. and Voet, J.G. 2004. (3rd edit). Biochemistry. John Wiley & sons Incl. USA.
Rameshwar, A. 2006. (3rd edit). Practical Biochemistry. Kalyani Publishers, New Delhi.

Buchanan, B. B., Gruissem, W. and Jones, R. L. 2002. Biochemistry and molecular biology of plants. 2nd edition. Blackwell publications, UK.

HPB 103 Elementary Plant Biotechnology 2 (1+1)

Objectives: Provide insights on basic theory, principles, tools used in biotechnology.

Objectives:

- Acquainted with genetic make-up of life-form.
- Know the r-DNA technology for development of transgenic variety.
- Acquire knowledge about how the principles of totipotency useful for
- Use techniques to develop complete plant through tissue culture.

Theory

Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of In-vitro cultures, Micropropagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples, Nano toxicology and safety.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis techniques. Green synthesis of nano particles and their size characterization.

Suggested Reading:

Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co., Meerut.
Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, Inc. USA
Gautam V K, 2005. *Agricultural Biotechnology*. Sublime Publications
Thomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. *Molecular markers and Plant Biotechnology*, New Publishers, New Delhi.

Purohit, S.S., 2004. *A Laboratory Manual of Plant Biotechnology* 2nd Edn. Agribios, India.
 Singh, B.D. 2012. *Plant Biotechnology*. Kalyani publishers, Ludhiana
 Bilgrami, K.S. and Pandey, A.K.1992. *Introduction to Biotechnology*. CBS Pub. New Delhi □ y Gupta, P.K. 1994.
Elements of Biotechnology. Rastogi Pub. Meerut.
 Chahal, G.S. and Gosal, S.S.2003. *Principles and Procedures of Plant Approaches Breeding Biotechnological and Conventional*. Narosa Publishing House, New Delhi

HCP 101 Introductory Crop Physiology 2 (1+1)

Objective: Provide insights on basic theory, and processes involved in different physiological and metabolic activities of plant.

Course outcome: Upon completion of the course students will be able to;

- Explain different process involved in different physiological process found in plants responsible for its growth
- Explain various metabolisms and physiological process of C3 and C4 plants.

Theory

Water Relations in Plants: Role of water in plant metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Biological Nitrogen Fixation Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO₂ fixation – C3, C4 and CA metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, Secondary metabolites and plant defense.

Practical

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

Suggested Reading:

Salisbury. 2007. *Plant Physiology*. CBS. New Delhi.
 Taiz, L. 2010. *Plant Physiology*. SINAUR. USA.
 Zeiger. 2003. *Plant Physiology*. PANIMA. New Delhi.
 Edward E. Durna. 2014. *Principles Of Horticultural Physiology*. CABI, UK.
 Delvin, R.M . 1986. *Plant Physiology*. CBS. Delhi.
 Richard, N. Arteca. 2004. *Plant Growth Substances*. CBS. New Delhi.
 Jacobs, W. P. 1979. *Plant Hormones And Plant Development*. Cambridge Univ. London.
 Basra, A. S. 2004. *Plant Growth Regulators in Agriculture & Horticulture*. HAWARTH press. New York.
 Lincoln Taiz and Eduards Zeiger (5th Edition). *Plant physiology*
 Noggle G.R and Fritz T.G. *Introductory Plant Physiology*
 Pandey and Sinha. *Plant Physiology*
 Salisbury and Ross. *Plant Physiology*

Carl fedtke. Biochemistry and Physiology of Herbicide Action
Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. Abiotic stress adaptation in plants:
Physiological, Molecular and Genomic foundation
Horst Marschner, Mineral Nutrition of Higher plants

HGD 102 Growth and Development of Horticultural Crops 2 (1+1)

Objective: Provide insights on basic theory, and processes involved in different physiological and metabolic activities of horticultural crops.

Course outcome: Upon completion of the course students will be able to;

- Explain different process involved in different physiological process and parameters found in plants responsible for its growth
- Explain the principles and practices of different plant growth regulators used in various management of horticultural crops.
- Gained insights on physiology of fruit growth and development and post-harvest physiology of fruit

Theory

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

Suggested Reading:

Salisbury. 2007. *Plant Physiology*. CBS. New Delhi.
Taiz, L. 2010. *Plant Physiology*. SINAUR. USA.
Zeiger. 2003. *Plant Physiology*. PANIMA. New Delhi.
Edward E. Durna. 2014. *Principles of Horticultural Physiology*. CABI, UK.
Delvin, R.M . 1986. *Plant Physiology*. CBS. Delhi.
Richard, N. Arteca. 2004. *Plant Growth Substances*. CBS. New Delhi.

Jacobs, W. P. 1979. *Plant Hormones And Plant Development*. Cambridge Univ. London.
Basra, A. S. 2004. *Plant Growth Regulators In Agriculture & Horticulture*. HAWARTH press.
New York.
Lincoln Taiz and Eduards Zeiger (5th Edition). *Plant physiology*. Sinauer Associates, Inc.
Noggle G.R and Fritz T.G.1944. *Introductory Plant Physiology*.
Pandey and Sinha. *Plant Physiology*.
JKA Bleasdale, *Plant Physiology in relation to Horticulture*
Amarjit Basra, *Plant Growth Regulators in Agriculture and Horticulture: Their role & Commercial Uses*
C.Rajendran, K.Ramamoorthy and S. Juliet Hepziba, *Nutritional and Physiological Disorders in Crop Plants*

HIP 101 Introductory Microbiology 2 (1+1)

Objective: Provide insights on basic theory on microorganisms: Beneficial and harmful to crop plants.

Course outcome: Upon completion of the course students will be able to;

- Delineate the history of microbiology leading to discovery of microorganisms.
- Gained knowledge on various artificial methods of culturing the microorganisms and different sterilization methods.
- List and identify various plant growth promoting microorganisms.
- Gained knowledge on mushrooms and their cultivation.

Theory

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelia growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association. Sterilization methods – Physical and chemical, Isolation of pure cultures and preservation of cultures, Plant growth promoting microorganisms and mushrooms – Economical importance, Industrially important microorganisms in large scale production and common microbial fermentations. Mushrooms- edible and poisonous types, nutritive values, Culturing and production techniques.

Practical

Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plats, turbid metric estimation of microbial growth, mushroom culture- Spawn production, Culture and production techniques, harvesting, packing and storage.

Suggested Reading:

M T Madigan, and J M Martinko, 2014. *Brock Biology of Microorganisms* 14th Edn. Pearson.
M J Pelczar, 1998. *Microbiology* 5th Edn. Tata Mc. Grow Hill Education Pvt. Ltd.
Stainer, R, 1987. *General Microbiology*. Palgrave Macmillan.
Edward Alchano, 2002. *Introduction to Microbiology*. Jones and Bartlett hearing.
R P Singh, 2007. *General Microbiology*. Kalyani Publishers.
J Heritage, E G V Evans, R A Killington, 2008. *Introductory Microbiology*. Cambridge University Press P. date.

Pelczar, Jr. M.J.E.C.S. Chan and Krieg, N.R. 1996. *Microbiology*. Mc Graw Hill Publishers, New York.
 Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. *Microbiology*. Mc Graw Hill Publishers, New York.
 Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. *Biology of Microorganisms*. Prentice Hall of India Pvt. Ltd., New Delhi.
 Jamaluddin, M. Malvidya, N. and Sharma, A. 2006. *General Microbiology*. Scientific Publishers, Washington.
 Sullia, S.B, and Shantaram 1998. *General Microbiology*. Oxford and IBH.

SOCIAL SCIENCES

HEM 101 Economics and Marketing 3 (2+1)

Objective: Provide insights on the basic economic theories applied in marketing of agricultural produce.

Course outcome: Upon completion of the course students will be able to;

- Acquired ideas on the basic characteristics of Indian economy, its potential on natural resources, understanding agriculture as the foundation of economic growth and development.
- Explain the strategies involved in marketing and various types of investment analysis.
- Compute and assess real situation of economy and income pattern.
- Understand the relationship between investment and savings.
- Demonstrate role of government to correct market failures and possible advantages of public financing.
- Understand conditions of financial markets and its impact in the economy

Theory

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engil’s law of family expenditure – consumer’s surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization – merits and demerits. Laws or return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures. Marketing- definition – Marketing Process – Need for marketing – Role of marketing — Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

Suggested Reading

H L Ahuja. S. Chand and Company Limited. *Advanced Economic Theory*. Micro Economic Analysis.
 Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.

Dewett, K.K. and Chand, A.1979. *Modern Economic Theory*. S.Chand and Co., New Delhi

Dewett, K.K. and Varma, J.D. 1986. *Elementary Economics*. S.Chand and Co., New Delhi.

Gupta RD & Lekhi RK. 1982. *Elementary Economic Theory*. Kalyani Publishers.

Kotler Philip and Armstrong. *Principles of Marketing*. Prentice-Hall.

Jhingan, M.L. 2012. *Macro Economic Theory*. Vrinda publishers, New Delhi .

Kotler Philip and Armstrong. *Principles of Marketing*. Prentice-Hall.

SS Acharya and N L Agarwal. 2005. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd

Sampat Mukherjee. 2002. *Modern Economic Theory*. New Age International.

Subba Reddy, S., Raghu ram, P., Neelakanta Sastry T.V., Bhavani Devi. I., 2010, *Agricultural Economics*, Oxford & IBH Publishing Co. Private Limited, New Delhi

William J. Stanton. 1984. *Fundamentals of Marketing*. Tata McGraw-Hill Publication, New Delhi.

C.N. Sontakki. *Marketing Management*. Kalyani Publishers, New Delhi.

John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. *International Business*, 15th Ed., Pearson Education

Aswathappa. *International Business*. Tata McGraw-Hill Education, New Delhi

Fransis Cherunilam. *International Business: Text and Cases*, 5th Ed. PHI Learning, New Delhi.

Prasanna Chandra. *Projects*. Tata McGraw-Hill Pu blication, New Delhi

John M. Nicholas. *Project Management for Business and Technology – Principles and Practices*. Pearson Prentice Hall

Harold Kerzner. *Project Management – A System Approach to Planning, Scheduling, and Controlling*. CBS Publishers & Distributors.

Prasanna Chandra. *Projects – Planning, Analysis, Selection, Financing, Implementation, and Review*. Tata McGraw-Hill Publishing Company Ltd.

P. Gopalakrishnan and V.E. Rama Moorthy. *Textbook of Project Management*. Macmillan.

HBM 306 Horti-Business Management 2 (2+0)

Objective: Provide details of horticultural business, cost involved in production and management, marketing of the products, management of farms, personnel's as well as financial management.

Course outcome: Upon completion of the course students will be able to;

- Develop ideas of the basic characteristics of horticultural farms, its potential on natural resources, understanding the cost and return for economic growth and development.
- Understand factor of marketing, and operational management of farms.
- Compute and assess real situation of business organization, direction, coordination and operational management pattern.
- Formulate horticulture based project and evaluate it.
- Plan, organize and run a horticulture based industry with well-balanced economic assessment.

Theory

Farm management - definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concepts, curves and functions – factors, product, relationship – factors relationship, product relationship, optimum conditions, principles of opportunity cost-equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing

the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing program, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation evaluation measures.

Suggested Reading

- Heady Earl O and Herald R. Jenson, 1954, *Farm Management Economics*. Prentice Hall, New Delhi
- S.S. Johl, J.R. Kapur, 2006, *Fundamentals of Farm Business Management*. Kalyani Publishers, New Delhi
- Karan Singh and Kahlon A S. *Economics of Farm Management in India*. Theory and Practice. New Delhi. Allied
- L.M. Prasad. 2001. *Principles and Practices of Management*, 9th Ed. S. Chand & Sons, New Delhi.
- Koontz Harold. *Principles of Management*. Tata McGraw-Hill Education Private Limited, New Delhi.
- P.C. Thomas. *Managerial Economics*, 9th Ed. Kalyani Publishers.
- K.K. Dewett and M.H. Navalur. *Modern Economic Theory*. S. Chand & Sons, New Delhi.
- P. Subba Rao. *Human Resource Management*. Himalaya Publications.
- S.P. Jain. *Financial Accounting*. Kalyani Publications, Shapiro *Macroeconomic analysis*. Galgotia Publications Delhi
- Barry P J, Hopkins J A and Baker C B. *Financial Management in Agriculture*, 6th ed. Danville, IL Interstate Publishers.
- Gittiner, J P., *Economic analysis of agricultural projects*. The John Hopkins University Press Baltimore, USA, 1982
- Benjamin Mc Donald P 1985. *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK
- Pandey U K 1990. *An Introduction to Agricultural Finance*. Kalyani Publishers New Delhi.

HEE 306 Fundamentals of Extension Education 2 (1+1)

Objective: Intended to orient students with the concepts of extension education and its importance in Agriculture development, expose the students with various rural development program and transfer of technology and innovations.

Course outcome: Upon completion of the course students will be able to know;

- Explain the concept of extension practices in agriculture.
- Able to organize community development program.
- Explain extension system of SAUs and ICAR.
- Explain the meaning of market-led-extension.
- Identify the utility of cyber extension and farming situation based extension.
- Explain the qualities of rural leadership and develop PRA survey questionnaire.

Theory

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Horticulture extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in Horticulture programmes. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Adoption and diffusion process, Teaching and learning-concepts and principles, Teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. ICT in Extension education, ICT use in rural India.

Practical

Visits to study structure, functions, linkages and extension program of ICFRE institutes/ voluntary organizations/Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension program. Preparation of Village Agricultural productions plan.

Suggested Reading:

- Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
- Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
- Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship and Communication Skills*, Kalyani Publications.
- Rathore, O. S. et al., 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
- Supre, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K. Jain for CBS Publishers & Distributors, New Delhi.
- M. Hilaris. *Indian Agriculture and Information: Soundari*, New century Publications, 2011 and communication technology (ICT)

HED 306 Entrepreneurship Development and Business Management 2 (1+1)

Objective: The first part of the course is intended to provide overall picture of planning and development of enterprises for extending sustainable livelihoods for rural people. The second part of the course is structured to help the students to gain knowledge and skills in different concepts and techniques of communication and management in extension organizations.

Course outcome: Upon completion of the course students will be able to know about;

- Explain the concepts of Entrepreneurship, Entrepreneur and Enterprises.
- Identify opportunities of Agri-enterprises.
- Gained managerial and business communication skills.

Theory

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Supply chain management and total quality management. Overview of horticultural inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business. Communication Skills: meaning and

process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills developing organizational and managerial skills, problem solving skills. field diary and lab record; indexing, footnote and bibliographic procedures.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; Conducting market survey to the demand for product, preparing advertisements for popularization of product, news writing, preparing project proposals, individual, group presentation, features of oral presentation, presentation, evaluation of presentation and evaluation of sheet, dyadic communication-face to face conversation, telephone conversation, rate of speech and clarity of voice, speaking and listening politeness, telephone etiquettes, organizing general and group meeting, salient features of participation in seminars and conferences, conducting and participating in mock interviews.

Suggested Reading:

Benjamin MC Donald P. 1985, *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK.

Chole, R. R. *et al.*, 2012, *Entrepreneurship Development and Communication skills*, Scientific publishers, Jodhpur.

Gittiner, J P., 1982, *Economic Analysis of Agricultural Projects*, The John Hopkins University Press Baltimore, USA.

Hopkins J A and Baker C B Danville, *Financial Management in Agriculture*, 6th ed Barry P J, IL Interstate Publishers.

Kotler Philip and Armstrong, *Principles of Marketing*. Prentice-Hall.

Pandey U. K., *An Introduction to Agricultural Finance*.

Sagar Mondal and G. L. Ray, *Text Book on Rural Development, Entrepreneurship and Communication Skills*, Kalyani Publications.

Somani, L. L., *Extension Education and Communication*, Agrotech, Publishing Academy, Udaipur.

Dr.A.K. Singh,2009. *Entrepreneurship Development and Management*. Lakshmi Publications Ltd.,

S. Anil Kumar, S.C Poornima, M.K. Abraham and K. Jayashree, 2008; *Entrepreneurship Development*. New Age International Publishers

HPD 101 Communication Skills and Personality Development 2 (1+1)

Objective: In this course students will learn about the concept, meaning and process of communication and various methods. Students will also learn various communication skills and about personality development

Course outcome: Upon completion of the course students will be able to learn about;

- Gained various communication methods and communication skills
- Acquired the skills to write technical articles
- Gained insights on various personality traits
- Gained skills to organize different seminars and conferences

Theory

Structural Grammar: Introduction of Word Classes; Structure of Verb in English; Uses of Tenses; Study of Voice; Study of Conjunctions and Prepositions; Sentence Patterns in English. Spoken English: Conversations of different situations in everyday life; the concept of stress; stress shift in words and sentences; silent letters in words and pronunciation of words with silent letters, the basic intonation patterns. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Structural Grammar: Exercises in word classes, identification and study of verbs in sentences, application of tenses and voice, exercises in conjunctions and prepositions, other structural grammar exercises, report writing, letter writing (different types of letters). Spoken English: Conversations of everyday life, the concept of stress; stress shift. Silent letters in words, basic intonation patterns, preparing and address.

Suggested Reading:

- Balasubramanian T. 1989. *A Text book of Phonetics for Indian Students*. Orient Longman, New Delhi.
- Balasubramanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.
- Naterop, Jean, B. and Rod Revell. 1997. *Telephoning in English*. Cambridge University Press, Cambridge.
- Mohan Krishna and Meera Banerjee. 1990. *Developing Communication Skills*. Macmillan India Ltd. New Delhi.
- Krishnaswamy, N and Sriraman, T. 1995. *Current English for Colleges*. Macmillan India Ltd. Madras.
- Narayanaswamy V R. 1979. *Strengthen your writing*. Orient Longman, New Delhi.
- Sharma R C and Krishna Mohan. 1978. *Business Correspondence*. Tata Mc Graw Hill publishing Company, New Delhi.
- Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.
- Covey Stephen R. 1989. *The Seven Habits of Highly Successful People*. Free Press.
- Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.
- Verma, KC. 2013. *The Art of Communication*. Kalpaz.
- Dr. T. Bharati, Dr. M. Hariprasad and Pro. V. Prakasam, Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi.
- Wren and Martin, S. Key to High School English Grammar and Composition- Chand and Company Ltd., New Delhi
- Wren and Martin, S. High School English Grammar and Composition- Chand and Company Ltd., New Delhi
- Raymond Murphy, English Grammar in Use. Cambridge University Press
- The Official Guide to the TOEFL Test-IV Edition, Educational Testing Services. Mc Graw Hill, New Delhi.

HCT 102 Information and Communication Technology 2 (1+1)

Objective: To provide usage of various computer based software packages, word processing and creation of documents and storage.

Course outcome: Upon completion of the course students will be able to;

- Able use computer and various packages.
- Able to use Word, Excel, PowerPoint packages.
- Able to create document, word processing, data management, creation of graphs etc.

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of AV aids; video conferencing. Communication process, Berlo's model, feedback and barriers to communication.

Practical

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipment's. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual program.

Suggested Readings:

Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt. Ltd.
Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI.
Harshawardhan P. Bal. 2003. Education. *Perl Programming for Bioinformatics*. Tata McGraw-Hill
Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology*. Kalyani Publishers.

HST 203 Statistical Methods 2 (1+1)

Objective: To understand the types of data, basic methods used in data analysis and computer based software's used in data collection, management and interpretation of data.

Course outcome: Upon completion of the course students will be able to;

- Explain the data and data classification.
- Organize data in excel sheet for analysis and interpretation using various statistical methods.
- Perform sampling, data collection and analysis to apply test of significance.
- Develop field scale testing design and collect the primary empirical data.
- Use of computer based statistical software to analyze a set of data.

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2×2 Contingency Table. Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data).

Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2×2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling.

Suggested Reading:

Nageswara Rao, G 2007. Statistics for Agricultural Sciences. B S Publications, Hyderabad
Rangaswamy, R 1995. A Text Book of Agricultural Statistics. New Age International (P) Limited, Hyderabad.
Chandel SRS, Hand Book of Agricultural Statistics. Achal Prakashan Mandir publications, New Delhi.
Agrawal, B. L. Programmed Statistics. 2nd Edition, New Age International Publishers, Hyderabad.

BSE 306 Biosafety and Bio-ethics 1 (1+0)

Objective: Provide insights on various aspects of biosafety regulations and bio-ethical concerns arising from the commercialization of products and process developed utilizing biotechnological tools.

Course outcome: Upon completion of the course students will be able to;

- Explain the difference between bio-safety and bioethics.
- Develop a method to safely handle hazardous biological materials in the laboratory.
- Understand the rules and regulation and governing bodies involved in biosafety and bio-ethics.
- Gained a detailed knowledge on biosafety issue related GM crops in agriculture.
- Gained knowledge on the national biosafety rules and regulatory framework, policies.

Theory

Introduction to bio-safety, Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc. Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of super weeds/super viruses, etc.

Biosafety: Definition, Biosecurity: Definition, Bio weapons, Definition of Biohazard, Application to Use Biohazardous Materials, Laboratory Safety protocols, Classification of pathogens by risk group, Containment, Safe handling of biological spills, Sterilization and disinfection in the laboratories

Challenges in Animal Biosecurity, Poultry Biosecurity Issues, An awareness of trade issues and their relevance to agricultural biosecurity, An understanding of the foundation principles and basic practices of pest exclusion, eradication, and management tactics for invasive species, An appreciation of early detection and correct identification of new and emerging pest problems, An awareness of news and developments reported in the popular and scientific media, An awareness of the importance of insect vectors to animal and human health, An awareness of the importance of exotic animal disease threats to agriculture.

National Biosafety rules, Applications of National Biosafety rules, Establishment of National Biosafety rules, Functions of National Biosafety committee, Functions of technical advisory committee, Functions of institutional Biosafety committee, Prohibition and license requirement, Confidential information, Risk assessment and risk management, Decision making and communication of decision, Grant of license, Application of re-examination, Special requirement for import and export of living modified organisms, Agriculture pathogen biosafety, Integrated pest management.

Introduction to Ethical analysis of genetic modification, Genetic modification and risk factors, Possible misuse of genetic modification, Nanobiotechnology, Cybernetics, Applications of genetic modification and their ethical issues, Ethical issues

related to genetically modified food, Risk factors of GM food, Genetic modifications of animals and their uses, Genetic modifications of animals and their ethical issues. Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Benefits of transgenics to human health, society and the environment.

Personal protective equipment and clothing, plans for emergency preparedness and response, Introduction to the transport of infectious materials, Biosafety and recombinant DNA technology, Hazardous Chemicals, Safety checklist, first aid, Overview of Biosecurity risk assessment methodology, Evaluate the pathogens and toxins, Occupational Health

The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc. Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

Shomini Parashar, Deepa Goel 2013. IPR, Biosafety and Bioethics
Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.
<http://patentoffice.nic.in>
www.wipo.org
www.dbtindia.nic.in
www.dbtbiosafety.nic.in

HPE 102 Physical and Health Education 1 (0+1)

Objective: To introduce the students to yogic asanas and health improving physical exercises.

Course outcome: Upon completion of the course students will be able to;

- Realize the importance the physical exercises and yogic asanas.
- Practice various yogic asanas
- Spread awareness on the utilities of yoga.

Practical

Physical Education: Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules are regulations of important games, skill development in any one of the games – football, hockey, cricket, volleyball, ball badminton, throw ball, tennikoit. Participation in one of the indoor games– shuttle badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events – broad jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-today activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience. Importance of Asanas and Surya namaskar. Free hand exercises and Yoga. Recreation: definition, agencies promoting recreation, camping and recreation. Note: Warming up and conditioning exercises are compulsory before the commencement of each class.

Suggested Reading:

O.P. Aneja. Encyclopaedia of Physical education, sports and exercise science (4 volumes).
Anil Sharma. Encyclopaedia of Health and Physical Education (7 Volumes).
N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).

Pintu Modak, O P Sharma, Deepak Jain. Encyclopaedia of Sports and Games with latest rules and regulations (8 volumes).
Edwin F Bryant. Yoga sutrap of Patanjali.

HRW 407 STUDENT READY-PROGRAMME (ELP+RHWE) 40 (0+40)

Objective: To provide hands on practical experience while working on specific project.

Course outcome: Upon completion of the course students will be able to;

- Able to develop a technical project on various activities in the area of horticulture, agriculture, services etc.
- Able to collaborate with various departments and functionaries like extension and processing industries.
- Able to develop a business project and financial management.

Practical

Students will practically gain hands on expertise for a semester in any two options out of commercial horticulture, protective cultivation of high value horticulture crops, processing of fruits and vegetables for value addition, floriculture and landscape gardening, production of bioinputs-biofertilizers and biopesticides, mass multiplication of plants and bio-molecules through tissue culture, mushroom culture and bee keeping. In one semester students will be working with horticulture farmers/horticulture based industries in collaboration with developmental departments, extension functionaries, input suppliers, marketing and procurement functionaries, processing industries.

1) EXPERIENTIAL LEARNING PROGRAMME (ELP) 20 (0+20)

Module-I. Commercial Horticulture: Nursery production of fruit crops: Raising of rootstocks, grafting and budding of rootstocks, management of grafted plants, plant certification, packaging and marketing, quality control. Nursery production of ornamentals: Production of plantlets, production of potted plants, management and maintenance, sale and marketing. Protected cultivation of vegetables and flowers: Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing.

Module-II. Protective cultivation of high value horticulture crops: Visit to commercial polyhouses, Project preparation and planning. Specialized lectures by commercial export house. Study of designs of green- house structures for cultivation of crops. Land preparation and soil treatment. Planting and production: Visit to export houses; Market intelligence; Marketing of produce; cost analysis; Visit to export houses; Market intelligence; Marketing of produce; cost analysis; institutional management. Report writing and viva-voce.

Module-III. Processing of fruits and vegetables for value addition: Planning and execution of a market survey, preparation of processing schedule, preparation of project module based on market information, calculation of capital costs, source of finance, assessment of working capital requirements and other financial aspects, identification of sources for procurement of raw material, production and quality analysis of fruits and vegetables products at commercial scale, packaging, labelling, pricing and marketing of product.

Module-IV. Floriculture and landscape gardening: Preparation of project report, soil and water analysis, preparation of land and layout. Production and Management of commercial flowers. Harvesting and postharvest handling of produce. Marketing of produce, Cost Analysis, Institutional Management, visit to Flower growing areas and Export House, Attachment with private landscape agencies. Planning and designing, site analysis, selection and use of plant material for landscaping. Formal and informal garden, features, styles, principles and elements of landscaping. Preparation of landscape plans of home gardens, farm complexes, public parks, institutions, high ways, dams and avenues. Making of lawns, use of software in landscape. Making of bouquets, button hole, wreath, veni and gazaras, car

and marriage palaces. Dry flower Technology (identification of suitable species, drying, packaging and forwarding techniques).

Module-V. Bio-inputs: Bio-fertilizers and bio-pesticides: Isolation and pure culture establishment of fertilizers and bio-pesticides. Culture methods and substrates. Scale of methods for bio-fertilizers and bio-pesticides. Substrate preparation and mixing techniques. Quality analysis of bio-fertilizers and bio-pesticides. Testing the final product in small scale level. Storage, marketing and cost analysis of bio-fertilizers and pesticides.

Module-VI. Mass multiplication of plants and molecules through tissue culture: Preparation of stock solutions of tissue culture media. Preparation of solid media and liquid media. Initiation of in vitro culture and multiplication (preparation of explant, inoculation and culturing) (crop to selected). Sub-culturing, Hardening and establishment, Initiation of callus cultures – suspension cultures, Induction of selected biomolecules in callus, Harvesting and extraction of biomolecule, Marketing and cost analysis.

Module-VII. Mushroom culture: Construction cultivation room/structure and Disinfection. Compost preparation & pasteurization. Procurement of mother culture and spawn preparation. Procurement of casing soil and preparation for production. Mushroom seeding, Casing with soil and maintenance, Harvesting, processing, Grading, packing, marketing and Cost economics of mushroom culture.

Module-VIII. Bee keeping: Procurement and arrangement of bee keeping equipment's. Location and collection of potent nectar yielding bee flora seeds from wild. Raising/ enriching the high nectar yielding bee flora in the campus. Location and hiving the natural bee colony from the wild. Establishing the apiary with suitable/favorable necessities. Maintenance and multiplication of hived colonies. Management of natural enemies and diseases of bees. Maintenance of bee colonies during dearth and honey flow seasons. Harvesting and Processing of honey and bee wax. Marketing and cost analysis.

HRW 408 RURAL HORTICULTURAL WORK EXPERIENCE PROGRAMME 20 (0+20)

Objective: To provide practical experience on farming practices by working with farmer and living in villages and industries.

Course outcome: Upon completion of the course students will be able to;

- Able to categorize the components of the village, social fabric and farmer's lifestyle.
- Able to develop farming practices, land preparation, selection of crop, organization of logistics and become a practicing farmer.
- Able to build linkages with industries and development of viable small-scale agri-based business projects.
- Able to analyze various types of industries involved in agri-produce processing.

1. Placement in Industries (0+10)

2. Placement in Village (0+10)

