HORTICULTURE

UG- Honos. Syllabus

S. No	Course Code	Title of the Course	Credit Hour
		SEMESTER I	
1	HOR- UG- 101	Plant Biochemistry, Biotechnology, Physiology, Microbiology	4
2	HOR- UG- 102	Elementary Field Crop Production	4
3	HOR –UG- 103	Fundamentals of Horticulture and Plant Propagation	4
4	HOR –UG- 104	Plant Biochemistry, Biotechnology, Physiology, Microbiology- **Practical**	4
5	HOR -UG -105	Elementary Field Crop Production- **Practical**	4
6	HOR –UG- 106	Fundamentals of Horticulture and Plant Propagation- **Practical**	4
			Total: 24
		SEMESTER II	
1	HOR –UG- 201	Elementary statistics and computer application	4
2	HOR- UG- 202	Production technology and Breeding of Fruit Crops	4
3	HOR –UG- 203	Principles of Genetics and Plant Breeding	4
4	HOR -UG- 204	Fundamental of Plant pathology and Entomology	4
5	HOR –UG- 205	Fruits and Plantation Crops-**Practical**	4
6	HOR -UG- 206	Genetics and Plant Breeding of Fruit and Plantation Crops- **Practical**	4
			Total: 24
		SEMESTER III	
1	HOR- UG- 301	Fundamentals of Extension education, communication skills and personality development	4
2	HOR- UG -302	Fundamentals of soil science, soil fertility, nutrient management and analysis	4
3	HOR- UG- 303	Temperate vegetables, spices and condiments	4
4	HOR –UG- 304	Production technology of medicinal, aromatic and plantation crops	4
5	HOR -UG- 305	Extension education and information and communication technology- **Practical**	4
6	HOR -UG-306	Soil science, soil fertility, weed and nutrient management –**Practical**	4
			Total: 24
		SEMESTER IV	
1	HOR –UG- 401	Commercial Floriculture- Production, Breeding and Seed production	4
2	HOR –UG- 402	Insect Pests and Diseases of Horticulture crops	4
3	HOR- UG- 403	Fundamentals of Economics, Horti-Business management and Entrepreneurship development	4
4	HOR- UG- 404	Commercial Floriculture- Production, Breeding and Seed production- **Practical**	4
5	HOR -UG -405	Pests and Disease management in Horticulture crops – **Practical**	4
6	HOR- UG- 406	Communicative English	4
			Total: 24
		SEMESTER V	
1	HOR- UG- 501	Environmental Science	4

2	HOR- UG -502	Introductory Agroforestry, Organic farming and Climate change	4
3	HOR -UG -503	Production technology of tropical, subtropical and tuber vegetable crops	4
4	HOR- UG -504	Agro forestry and organic farming - **Practical**	4
5	HOR- UG -505	Production technology of vegetable crops and spices- **Practical**	4
6	HOR- UG 506	Ornamental horticulture and landscape architecture – **Practical**	4
			Total: 24
		SEMESTER VI	
1	HOR -UG -601	Intellectual property rights	4
2	HOR- UG -602	Breeding and seed production of vegetable, tuber crops and spices	4
3	HOR –UG- 603	Fundamentals of food technology, post harvest management and processing of horticultural crops	4
4	HOR -UG -604	Precision Farming and Protected Cultivation	4
5	HOR –UG- 605	Breeding and seed production of vegetable, tuber crops and spices –**Practical**	4
6	HOR -UG -606	Fundamentals of food technology, post harvest management and processing of horticultural crops – **Practical**	4
			Total: 24

VII Semester			
1	HOR –UG- 701	**RHWE-** Orientation and Report Writing	4
2	HOR- UG- 702	**RHWE**- Village Attachment (8 weeks)	8
3	HOR -UG-703	All India Study Tour- 2 weeks	4
4	HOR- UG- 704	Industrial Attachment - 2 weeks	4
		Total	Credits: 20
VIII Semester* (Any Two Module)			
1	HOR -UG- 801	Bee keeping	10
2	HOR -UG- 802	Protected Cultivation of High Value Horticulture crops	10
3	HOR -UG- 803	Processing of Fruits and Vegetables for Value Addition	10
4	HOR -UG- 804	Floriculture and Landscape Architecture	10
5	HOR- UG- 805	Bio-inputs: Bio-fertilizers and Bio-pesticides.	10
6	HOR- UG- 806	Mass Multiplication of Plant And Molecules through Tissue Culture	10
7	HOR -UG- 807	Commercial Horticulture	10
9	HOR- UG- 808	Mushroom culture	10
10	HOR -UG- 809	NSS	Non -credit
		Total	**20**
		TOTAL CREDIT	**184**

Semester I

HOR UG 101: Plant Biochemistry, Biotechnology, Physiology, Microbiology

Unit -I: Elementary Plant Biochemistry

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 brassinosterols 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.

Unit -II: Biotechnology

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.

Unit -III: Plant Physiology

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, CO_2 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.Growth and development-definitions, components, photosynthetic productivity, leaf area index; different stages of growth, growth curves, growth analysis in horticultural crops. Factors affecting flowering, physiology of flowering, light–photoperiodism vernalisation and chilling temperature and its application in horticulture. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climacteric and non climacteric fruits.

Unit -IV: Fundamentals of Microbiology

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.

Reading List:

1. Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry*. Freeman Publishers **.**
2. Voet, D and Voet J. G. 2004. Biochemistry 4th Edn. Wiley & sons Publishers. USA.
3. Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
4. Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co.,Meerut.
5. Salisbulry. 2007. *Plant Physiology*. CBS. New Delhi.
6. Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.
7. R P Singh, 2007. *General Microbiology*. Kalyani Publishers.

HOR UG 102: Elementary Field Crop Production

Unit -I: Introduction to major Field Crops

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.

Unit -II: Water management

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.

Unit -III: Agro-metereology

Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere. Definition of weather, climate, aspects involved in weather and climate. Study of the following factors with respect of their relation with crops growth and development - atmospheric temperature, soil temperature, solar radiation, wind, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds. Drought, weather disasters and their management. Atmospheric pollution and role of meteorology. Agromet Observatories. Basics of weather forecasting and application in agriculture.

Unit -IV: Farm Power Machinery

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 equipments: potato diggers, fruit pluckers, tapioca puller and hoists.

Readings-

1. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Rao, Y.P. and Bhaskar, S.R. 2008. *Irrigation technology.Theory and practice*. Agrotech publishing Academy, Udaipur.
3. Dilip Kumar Mujmdar. 2004. *Irrigation water management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.
4. D.Lenka, 2006. *Climate, Weather and Crops in India*. Kalyani Publishers, New Delhi.
5. G. S. L. H. V. Prasad Rao, 2008. *Agricultural Meteorology*. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Surendra Singh. 2007.*Farm Machinery Principles and Applications*. ICAR Publications
7. Surendra Singh & Verma. 2009. *Farm Machinery Maintenance & Management*. ICAR Publication.

HOR UG 103: Fundamentals of Horticulture and Plant Propagation

Unit -I: Fundamental of Horticulture

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and its states, 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 and irrigation, weed management and fertility management, 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.

Unit -II: Plant Propagation

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, use of growth regulators in seed, apomixes – mono-embrony, polyembrony, chimera& bud sport. types and stages of seed germination with examples. Vegetative propagation by specialized plant parts (corm, runners, suckers, 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. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation hardening of plants in nurseries.

Unit -III: Nursery Management

Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), Nursery registration act. Insect/pest/disease control in nursery, Cost of establishment of propagation structures.Techniques of nursery management.

Unit IV: Orchard Management

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.

Readings-

1. Prasad and Kumar, 2014. *Principles of Horticulture* 2nd Edn. Agrobios (India).
2. Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1st Edn. IBDC Publishers.
3. Sadhu,M.K.1996. *Plant Propagation*. New age International Publishers, New Delhi.
4. 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.
5. 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.
6. B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya Publishing House, New Delhi.
7. T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural Crops*. New India Publishing Agency, New Delhi.

HOR UG 104:Plant Biochemistry, Biotechnology, Physiology and Microbiology- Practical

Unit -I: Elementary Plant Biochemistry

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.

Unit -II: Biotechnology

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.

Unit -III: Plant Physiology

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpiration pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.Growth analysis of seedling & leaf, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, preparations of hormonal solution and induction of rooting in cuttings.

Unit -IV: Fundamental of Microbiology

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.

Readings-

1. Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry*. Freeman Publishers **.**
2. Voet, D and Voet J. G. 2004. Biochemistry 4th Edn. Wiley & sons Publishers. USA.
3. Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
4. Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co.,Meerut.
5. Salisbulry. 2007. *Plant Physiology*. CBS. New Delhi.
6. Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.
7. R P Singh, 2007. *General Microbiology*. Kalyani Publishers.

HOR UG: 105 Elementary Field Crops Production- Practical

Unit -I: Introduction to major Field Crops

Identification of crop plants, seeds and weeds. Preparation of herbarium. Preparation of cropping scheme. Application of herbicides in field crops. Field visit to major field crops field.

Unit -II: Water management

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land levelling 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.

Unit -III: Agro-meteorology

Site selection for Agro met 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, Measurement of relative humidity; Study of weather forecasting and synoptic charts. Visit to Meteorological observatory, recordingofair and soil temperature. Measurement of radiation and components, Measurement of rainfall, recordingofevaporation. Synoptic charts and weather reports, symbols, *etc*.

Unit -IV: Farm Power Machinery

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.

Readings-

1. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Rao, Y.P. and Bhaskar, S.R. 2008. *Irrigation technology.Theory and practice*. Agrotech publishing Academy, Udaipur.
3. Dilip Kumar Mujmdar. 2004. *Irrigation water management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.
4. D.Lenka, 2006. *Climate, Weather and Crops in India*. Kalyani Publishers, New Delhi.
5. G. S. L. H. V. Prasad Rao, 2008. *Agricultural Meteorology*. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Surendra Singh. 2007. *Farm Machinery Principles and Applications*. ICAR Publications
7. Surendra Singh & Verma. 2009. *Farm Machinery Maintenance & Management*. ICAR Publication.

HOR UG 106: Fundamental of Horticulture and Plant Propagation-Practical

Unit -I: Fundamental of Horticulture

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.

Unit -II: Propagation

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.

Unit -III: Nursery Management

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.

Unit -IV: Orchard Management

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.

Readings-

1. Prasad and Kumar, 2014. *Principles of Horticulture* 2nd Edn. Agrobios (India).
2. Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1st Edn. IBDC Publishers.
3. Sadhu,M.K.1996. *Plant Propagation*. New age International Publishers, New Delhi.
4. 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.
5. 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.
6. B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya Publishing House, New Delhi.
7. T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural Crops*. New India Publishing Agency, New Delhi.

SEMESTER II

HOR UG 201: Elementary statistics and computer application

UNIT I: Introduction to statistics, representation of data and sampling

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.

UNIT II: Test of significance, correlation and regression

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 Mendelian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient.

UNIT III: Practical aspects of statistics

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 raw and grouped data, percentiles, quadrille and median for raw and grouped data, coefficient of variation, 't' test for independent, equal and unequal variants, paired 't' test, chi-square test for contingency tables and theoretical ratios, correlation and linear regression.

UNIT IV: **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, introduction to multi-media and its application. Visual basic-concepts, basic and programming techniques, introduction to internet.

Readings-

1. Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan chand and sons. New Delhi.
2. Nageswara Rao,G. 2007. *Statistics for Agricultural Sciences*. BS Publications, Hyderabad.
3. Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad.
4. Gupta, V., 2002. *Comdex Computer Kit*. Dream Tech Press, NewDelhi.
5. Parmar, A. Mathur, N. Deepti P.U. and Prasanna, V. B.,2000. *Working with WINDOWS A HandsonTutorials*. Tata McGraw Hill Publishing Co., NewDelhi.
6. Bandari, V. B., 2012. *Fundamentals of Information Technology*. Pearson Education, New Delhi.
7. Fundamentals of Computers. 2011. Pearson Education-ITL ESL, New Delhi.

HOR UG 202: Production technology and Breeding of Fruit Crops

UNIT I: Tropical and Sub Tropical Fruits

Horticultural classification of fruits. Production area 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. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops.

Mango, banana, grapes, citrus, papaya, sapota, guava, litchi, pineapple, jackfruit, avocado, mangosteen, carambola, durian, rambutan, loquat, passion fruit, arid and minor fruits i.e. aonla, annona, ber, fig, jamun, pomegranate, bael, phalsa, tamarind, indigenous fruits of Sikkim.

UNIT II: Production Problems in Fruit Crops

Causes and control measures of special production problems, alternate bearing in mango and citrus decline and 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, economics of production. causes and control measures of guava wilt, Flowering in pineapple, Production problem in temperate fruit like re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders. Production problems and physiological disorders in arid and minor fruits.

UNIT III: Temperate Fruits

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 pollenizers, 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 (Macadamia nut), almond, walnut, pecan nut, hazel nut and chest nut and raspberry, indigenous fruits of Sikkim.

UNIT IV Breeding of Fruit Crops

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 (Mango, banana, citrus, papaya, grapes, apple, pear, peach, plum, aonla, pomegranate, ber, annona, fig)

Readings-

1. Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical*-Vol-I. Naya Udyog -Kolkata
2. Chadha,K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
3. Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.
4. Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292,Rajinder Nagar,Ludhiana-141008
5. Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
6. Anil Kumar Shukla 2004. *Fruit breeding approaches & Achievements*. International Book Distributing Co. New Delhi.
7. Kumar, N. 1997. *Breeding of Horticultural Crops, Principles and Practices*. New India Publishing Agency, New Delhi.

HOR UG 203: Principles of Genetics and Plant Breeding

UNIT I: Principle of Genetics

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.

UNIT II: Principles of Cytogenetics

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.

UNIT III: Introductory Plant Breeding

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.

UNIT IV: Heterosis and Breeding for specific objectives

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.

Readings-

1. Gardner E J, Simmons M J &Snustard D P. *Principles of Genetics (VIII Edn)*. John Wiley & Sons, New York.
2. Strickberger. *Genetics*. Macmillan Publishing Company, New York.
3. Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.
4. R.W. Allard. *Principles of plant breeding*. John Wiley & Sons, New York**.**
5. V.L. Chopra. *Plant breeding: Theory and Practice.* Oxford & IBH Publishing CO. Pvt. Ltd., New Delhi.
6. Phundan Singh. *Essentials of plant breeding*. Kalyani Publishers
7. B.D. Singh. *Plant breeding : principles and methods*. Kalyani Publishers, Ludhiana.

HOR UG 204: Fundamental of Plant pathology and Entomology

UNIT I: Introduction to Plant Pathology

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.

UNIT II: Introductory entomology

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 morphology-types of mouth parts, antennae, legs, wings and genetalia. Structure, function of cuticle and moulting and body segmentation, anatomy of digestive, circulatory, respiratory, excretory, nervous and reproductive systems. Study of beneficial insects i.e. apiculture, sericulture, lac culture and role of insects in agricultural production system

UNIT III: Reproduction and Classification of Insects

Types of reproduction. Postembryonic development. Metamorphosis. Types of egg larvae and pupa. Classification of insectsupto orders, sub-order and families of economic importance and their distinguished characters. Plant mites – morphological features, important families with examples. Introduction to non insect pests i.e. nematodes, birds, bats, rodents, molluscs, their morphology,

UNIT IV: Management of diseases and pests

Principles and methods of plant disease management. Integrated plant disease management. Fungicides classification based on chemical nature, commonly used fungicides, bactericides and nematicides. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their application. Insect collection and preservation. General body organization of insects, preparation of permanent mounts of mouth parts, antennae, legs and wings, observations of larvae and pupae, study on insect traps. Management of non insect pests.

Readings-

1. N.G. Ravichandra, 2013.Fundamentals of Plant Pathology. PHI Hall of India, New Delhi
2. Mehrotra, R.S. and Aneja, K.R. 1990. An Introduction to Mycology. New Age International (P) Ltd., New Delhi.
3. Singh, R.S. 1982. Plant Pathogens - The Fungi. Oxford and IBH Publishing Co., New Delhi.
4. Awasthi, V.B. 1997. *Introduction to general and applied entomology*. Scientific Publishers, Jodhpur, 379 p.
5. 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.
6. Chapman, R.F. 1981. The Insects: Structure and function. Edward Arnold (Publishers) Ltd, London, 919p.
7. Mani, M.S. 1968. *General entomology*. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 912p.

HOR UG 205: Fruits and Plantation Crops - Practical

Unit 1: Tropical and Sub tropical Fruits

Description and identification of varieties based on flower and fruit morphology in temperate and subtropical fruit 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.

Unit II: Temperate Fruit

Nursery management practices, description and identification of varieties of temperate fruit 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.

Unit III: Arid and minor fruits

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. 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. Nursery preparation, growth regulator application, anti transpirants application, pruning in ber, multi stem training and bahar treatment in pomegranate, postharvest management, calculation of cost economics and packaging studies. Visit to commercial orchards.

Unit IV: Plantation Crops

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. Visit to commercial orchards.

Reading-

1. Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical*-Vol-I. Naya Udyog -Kolkata
2. Chadha,K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
3. Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.
4. Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292,Rajinder Nagar,Ludhiana-141008
5. Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
6. P.L. Taroj, B.B. Vashishtha, D.G.Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.
7. 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.
8. Thampan, P.K. 1981.*Hand Book of Coconut Palm*. Oxford IBH, New Delhi.

HOR UG 206: Genetics and Plant Breeding of Fruit and Plantation Crops- Practical

UNIT I: Basic experiment in Genetics

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 F_2 data and construction of linkage maps. Genetic variation in pea.

UNIT II:Breeding Techniques

Breeding objectives and techniques in important fruits and plantation crops i.e. mango, banana, citrus, grapes, guava, apple, pear, aonla, ber, coconut, arecanut, tea, oil palm. 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.

UNIT III: Heterosis and combining ability

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, GCA, SCA

UNIT IV: Breeding of Fruits and Plantation Crops

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 crops i.e. mango, banana, citrus, grapes, guava, apple, pear, aonla, ber, coconut, arecanut, tea, oil palm.

Readings-

1. Strickberger. *Genetics*. Macmillan Publishing Company, New York.
2. Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.
3. R.W. Allard. *Principles of plant breeding*. John Wiley & Sons, New York**.**
4. V.L. Chopra. *Plant breeding: Theory and Practice.* Oxford & IBH Publishing CO. Pvt. Ltd., New Delhi.
5. B.D. Singh. *Plant breeding: principles and methods*. Kalyani Publishers, Ludhiana.
6. Nijar 1985.*Fruit breeding in India*,Oxford & IBH Publishing Co. New Delhi
7. Anil Kumar Shukla 2004. *Fruit breeding approaches & Achievements*. International Book Distributing Co. New Delhi.
8. Kumar, N. 1997. *Breeding of Horticultural Crops, Principles and Practices*. New
9. India Publishing Agency, New Delhi.

Semester III

HOR UG 301: Fundamentals of Extension education, communication skills and personality development

Unit I: Extension education

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),KrishiVigyanKendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR, Extension Reform Programme (ATMA).

Unit II: Communication

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.

Unit III: Personality development I

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.

Unit IV: Personality development II

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.

Readings-

1. Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
2. Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
3. Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
4. Balasubramanian T. 1989. *A Text book of Phonetics for Indian Students*. Orient Longman, New Delhi.

5. Balasubrmanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.
6. Naterop, Jean, B. and Rod Revell. 1997. *Telephoning in English*. Cambridge University Press, Cambridge.
7. Mohan Krishna and Meera Banerjee. 1990. *Developing Communication Skills*. Macmillan India Ltd. New Delhi.

HOR UG 302: Fundamentals of soil science, soil fertility, nutrient management and analysis

Unit I: Fundamentals of soil science

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. Munsellcolour 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.

Unit II:Fundamentals of soil science

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, Pedogenicprocess. 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.

Unit III: Soil fertility

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.

Unit IV: Nutrient analysis

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.

Readings-

1. Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.
2. Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.
3. Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
4. Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.
5. Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers.* Agri. Horticultural Publishing House, Nagpur.
6. The fertilizer Association of India, Shaheed Jit singh marg, New Delhi, 1985. Fertilizer control order
7. Ranjan Kumar Basak , 2000. *Fertilizers A Text book.* Kalyani publishers, New Delhi.

HOR UG 303: Temperate vegetables, spices and condiments

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 temperate vegetable crops. History, scope and importance, Present status, area and production, uses, export potential and role of 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.

Unit I: Cole crops and leafy vegetables

Cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, lettuce, palak, chinese cabbage and spinach

Unit II: Bulb, root, peas, beans and other minor vegetables

Onion, garlic, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, vegetable kale.

Unit III: Tree spices

Crops: Cardamom, pepper, betel vine, clove, nutmeg, cinnamon, all spice and curry leaf.

Unit IV: Annual and seed spices

Ginger, turmeric, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary

Readings-

1. S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
2. B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
3. T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata
4. P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
5. Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. *Production technology of spices and plantation crops*. . Agrosis, Jodhpur
6. 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.
7. Pruthi, J.S., 1980. *Spices and Condiments*. Academic Press, New York.

HOR UG 304: Production technology of medicinal, aromatic and plantation crops

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.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 and role of growth regulators in plantation crops. Soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of plantation crops.

Unit I: Medicinal plants

Withania, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy *Ammi majus*, Belladonna, Cinchona and Pyrethrum.

Unit II: Aromatic Plants

Citronella grass, khus grass, flag, lavender, geranium, patchouli, bursera, menthe, musk and occimum.

Unit III: Plantation crops I

Coconut, arecanut, oil palm, palmyrah palm and cocoa.

Unit IV: Plantation crops II

Cashew nut, coffee, tea, Date palm and rubber.

Readings-

1. Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.
2. 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.
3. Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, New Delhi.
4. 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.
5. Nair 1979. *Cashew*. CPCRI, Kerala
6. Wood, GAR, 1975. *Cacao*. Longmen, London
7. Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.

HOR UG 305: Extension education and information and communication technology–Practical

Unit I: Extension work I

Visits to study structure, functions, linkages and extension programmes 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.

Unit II: Extension work II

Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension programmes. Preparation of Village Agricultural productions plan.

Unit III Basic ICT

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.

Unit IV (Audio-video aids)

Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Readings-

1. Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.

2. Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
3. Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
4. Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology*. Kalyani Publishers.
5. Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.
6. Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt Ltd.

HOR UG 302: Soil science, soil fertility, weed and nutrient management–Practical

Unit I: Soil physical and chemical properties

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 filed capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus.

Unit II: Soil analysis

Aggregate size distribution analysis of soil. Air capacity of soil by field method. 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 P_2O_5, Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate.

Unit III: Soil and irrigation water nutrient analysis

Visiting of fertilizer testing laboratory. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. 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.

Unit IV: Weed management

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.

Readings-

1. Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.

2. Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.
3. Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
4. Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.
5. Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers.* Agri. Horticultural Publishing House, Nagpur.
6. Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
7. Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur.

Semester IV

HOR UG 401: Commercial Floriculture- Production, Breeding and Seed production

Unit I: Introduction

Scope and importance of commercial floriculture in India. Current status, Government initiatives and constraint of the commercial floriculture in India. Value addition of ornamental and flower crops- Dehydration technique for drying of flowers, fragrance and flavour industry, Bio-colour. Marketing and Export.

Unit II: Production of Commercial Flower Crops - I

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, postharvest technology with respect of following crops viz., Rose, Carnation, Gerbera, Gladiolus, Alstroemeria, Bird of Paradise, Lilium, Orchids, Anthurium, other important bulbous cut flowers, Annual flowers,

Unit III: Production of Commercial Flower Crops - II

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, postharvest technology with respect of following crops viz., Jasmine, Chrysanthemum, Tuberose, Crossandra, Marigold, China aster, Bromeliads, Fillers and Cut greens.

Unit IV: Breeding and Seed Production for Cut Flower

Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding, production of F1 hybrids and utilization of male sterility, production of open pollinated seed, harvesting processing and storage of seeds, seed certification for following crops: Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, Lilium, Petunia, *Hibiscus*, Bouganvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy,Crossandra, Marigold, Antirrhinium, China aster, Orchids, Anthurium, Carnation.

Readings-

1. A.K.Singh.2006.*Flower crops, cultivation and management*. New India publishing agency, Pitampura, New Delhi.
2. T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003.*Commercial flowers.* Partha Sankar Basu, Nayaudyog,206, Bidhan Sarani, Kolkata-700006
3. S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
4. Dewasish Choudhary and Amal Mehta. 2010. *Flower crops cultivation and management*. Oxford book company Jaipur, India.
5. D.J. Callaway and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press

6. J. Harding, F.Singh and J.N. Mol. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers
7. R.L. Agarwal. 1996. Seed Technology. Oxford &IBH Publishers, New Delhi

HOR UG 402: Insect,Pests and Diseases of Horticulture crops

Unit I: Diseases, Insect and Pest of Fruit and Plantation Crops

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits and plantation, *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.

Integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits and plantation crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, and plantation crops and their processed products.

Unit II: Diseases and Insect-Pest of Medicinal and Aromatic Crops

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of medicinal and aromatic crops betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management. Economic importance of insects in medicinal and aromatic crops -ecology and pest management with reference to these crops. Pest surveillance in important medicinal and aromatic crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting ornamental, medicinal and aromatic crops. Important storage insect-pests of medicinal and aromatic crop their host range, bio-ecology, injury and integrated management.

Unit III:Diseases, Insect and Pest of Vegetable and Spice Crops

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, 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. Important post-harvest diseases of vegetables and spice crops and their management.

Economic importance of insects in vegetable, and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, and spice crops. Important storage insect-pests of vegetable, and spice crops, their host range, bio-ecology, injury and integrated management.

Unit IV:Diseases, Insect and Pest of Ornamental Crops

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: jasmine, rose, crossandra, tuberose, gerbera, anthurium, orchids, lilium, carnation, geranium. Important post-harvest diseases of ornamental crops and their management.

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

Readings-

1. L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers
2. Pathak, V.N. 1980.*Diseases of Fruit Crops*. Oxford IBH Publishing
3. Singh, R.S. 1994. *Diseases of Vegetable Crops*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi

4. Sohi, H.S. 1992. *Diseases of Ornamental plants in India*. ICAR, New Delhi
5. Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.
6. Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
7. Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.

HOR UG 403: Fundamentals of Economics, Horti-Business management and Entrepreneurship development

Unit I: Economics and Marketing

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.

Unit II: Marketing

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.

Unit III:Horti-Business Management

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 programmes, marketing mix and four P's. Financial management – financial statements and rations, capital budgeting. Project management – project preparation evaluation measures.

Unit IV: Entrepreneurship Development and Business Management

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 horti 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.

Readings-

1. H L Ahuja. S. Chand and Company Limited. *Advanced Economic Theory*. Micro Economic Analysis.
2. Gupta RD & Lekhi RK. 1982. Elementary Economic Theory. Kalyani Publishers.
3. Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.
4. S.S. Johl, J.R. Kapur ,2006, *Fundamentals of Farm Business Management*. Kalyani Publishers, New Delhi
5. Karan Singh and Kahlon A S. *Economics of Farm Management in India*. Theory and Practice. New Delhi. Allied
6. L.M. Prasad. 2001. *Principles and Practices of Management*, 9th Ed. S. Chand & Sons, New Delhi.
7. Chole, R. R. *et al.*, 2012, *Entrepreneurship Development and Communication skills*, Scientific publishers, Jodhpur.

HOR UG 404: Commercial Floriculture- Production, Breeding and Seed production – Practical

Unit I: Production Commercial Flowers- I

Identification of Garden tools, Identification of commercially important cut flower crops, fillers and cut greens. Propagation by cutting, layering, budding and grafting. Propagation of bulbous crop. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Training and pruning of roses. Practice of pinching, disbudding, de-shooting etc. Identification of important disorders of cut flowers.

Unit II: Production Commercial Flowers- II

Use of PGR for forcing. Study of effect of temperature and light on flower forcing. Harvesting index and harvesting methods for cut flowers. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Practice of Drying methods, and preservation of flowers. Flower arrangement practices. Preparation of artifact.

Unit III: Breeding of Cut Flower

Floral biology and pollination mechanism in self and cross pollinated, bulbous ornamental crops. Techniques of inducing polyploidy and mutation. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Unit IV: Seed Production

Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods. Study of seed structure, colour size, shape and texture of different flower crops.

Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis.

Readings-

1. A.K.Singh.2006.*Flower crops, cultivation and management*. New India publishing agency, Pitampura, New Delhi.
2. T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003.*Commercial flowers*. Partha Sankar Basu, Nayaudyog,206, Bidhan Sarani, Kolkata-700006
3. S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
4. Dewasish Choudhary and Amal Mehta. 2010. *Flower crops cultivation and management*. Oxford book company Jaipur, India.
5. D.J. Callaway and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press
6. J. Harding, F.Singh and J.N. Mol. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers
7. R.L. Agarwal. 1996. Seed Technology. Oxford &IBH Publishers, New Delhi

HOR UG 405: Pests and Disease management in Horticulture crops - Practical

Unit I: Diseases of Fruit, Plantation, Medicinal and Aromatic Crops

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.

Unit II:Diseases of Vegetable, Ornamental and Spice Crops

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

Unit III:Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops

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.

Unit IV:Insect Pests of Vegetable, Ornamental and Spice Crops

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.

Readings-

1. L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers
2. Pathak, V.N. 1980.*Diseases of Fruit Crops*. Oxford IBH Publishing
3. Singh, R.S. 1994. *Diseases of Vegetable Crops*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
4. Sohi, H.S. 1992. *Diseases of Ornamental plants in India*. ICAR, New Delhi
5. Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.
6. Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
7. Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.

HOR UG 406: Communicative English

To be adopted from university's Syllabus

Semester V

HOR UG 501: Environmental Science

Unit I: Natural resources

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.

Unit II: Ecosystem and biodiversity

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.

Unit III: Environment conservation

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 Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Unit IV: Disaster management

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.

Readings-

1. Nandini, N. Suneetha and Sucharitha Tandon. *Environmental Studies*.

2. Aswathanarayana, U. 1999. *Soil resources and the environment*. Oxford and IBH publishing Co., New Delhi. P. 173-195.
3. Diwan, P. and P. Diwan. 1998. *Environmental Management Law and Administration*. Variety Books International, New Delhi.
4. Erach Bharucha 2005.Textbook of environmental studies for under graduate courses.UGC, University press, Hyderabad.
5. Manohara Chary and Jayaram Reddy 2004. Principles of Environmental studies. BB publishers, Hyderabad.
6. 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.
7. Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India). Jodhpur.

HOR UG 502: Introductory Agroforestry, Organic farming and Climate change

Unit I: Introductory Agroforestry

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.).

Unit II: Organic farming

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.

Unit III: Climate change

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.

Unit IV: Mitigation for climate change

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.

Readings-

1. K. Patra, 2013. *Agroforestry – Principles and Practices*. New India publishing agency.
2. P. Dwivedi, 1992. *Agroforestry – Principles and Practices*. Oxfird and IBH Publishing company.
3. Dadhwal et al., 2014. *Practical Manual on Agroforestry*. Jaya publishing house, Delhi.
4. L.K. Jha, 2015. *Advances in Agroforestry*. APH Publishing corporation, New Delhi.

5. A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
6. Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
7. Tailor,J.T.1967. *Agricultural Climatology*. Pergman Press Ltd., Headington Hill Hall, Oxford, England

HOR UG 503: Production technology of tropical, subtropical and tuber vegetable crops

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 in vegetable crops. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical, sub-tropical vegetable and tuber crops.

Unit I:Solanaceous vegetables and okra

Tomato, brinjal, chillies, capsicum and okra.

Unit II: Cucurbits

Cucumber, water melon, musk melon, bottle gourd, bitter gourd, ridge gourd, sponge gourd, snake gourd, spine gourd, little gourd, chayote, pumpkin and squashes.

Unit III: Leafy vegetables, beans and other minor vegetables

Amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Unit IV: Tuber crops

Potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Readings-

1. M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
2. Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd. New Delhi.
3. K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004
4. M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
5. K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi
6. Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
7. Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.

HOR UG 504: Agro forestry and organic farming - Practical

Unit I: Nursery management of tree species

Identification and seeds and seedlings of multipurpose tree species. Nursery practices for poplar, Grewiaoptiva, Morusalba, Acacia catechu, *Dalbergiasissoo*, robinia, leucaena etc.

Unit II: Visit to agro forestry belts

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.

UNIT III: Organic Farming- I

Raising of vegetable crops organically through nutrient, diseases and pest management; Demonstration of different Methods of Composting, Vermicomposting; Azolla Production, Methods of Biofertilizer application, Identification of Major biofertilizer species and estimation of microbial load, Visit to Integrated organic farm and analysis of the different components of farming system.

Unit IV: Organic Farming- II

Preparation of Botanicals and Plant extracts, Preparation of different formulation like Jeevamrit, Pachagavya etc. Application of Biodynamic formulation. In vitro testing of essential oils and botanicals againt pathogens. Field visit to organic farm, Interaction with certifying agencies and service provider for internal control system.

Readings-

1. K. Patra, 2013. *Agroforestry – Principles and Practices*. New India publishing agency.
2. P. Dwivedi, 1992. *Agroforestry – Principles and Practices*. Oxfird and IBH Publishing company.
3. Dadhwal et al., 2014. *Practical Manual on Agroforestry*. Jaya publishing house, Delhi.
4. L.K. Jha, 2015. *Advances in Agroforestry*. APH Publishing corporation, New Delhi.
5. A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
6. Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
7. Tailor, J.T.1967. *Agricultural Climatology*. Pergman Press Ltd., Headington Hill Hall, Oxford, England

HOR UG 505: Production technology of vegetable crops and spices–Practical

Unit I: Temperate vegetables

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 of temperate vegetable crops and field visits to commercial farms.

Unit II: Tropical and subtropical vegetables

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.

Unit III: Tuber crops

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.

Unit IV: Spices and condiments

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 in spices. Visit to commercial plantations.

Reading-

1. M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana.
2. Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd. New Delhi.
3. K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004
4. M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
5. 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.
6. Pruthi, J.S., 1980. *Spices and Condiments*.

Academic Press, New York.
7. Pruthi, J.S., 1993. *Major Spices of India- Crop Management Postharvest Technology*. ICAR, New Delhi.

HOR UG 506: Ornamental horticulture and landscape architecture – Practical

Unit I: Identification and designing of garden features
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.

Unit II: Flower arrangement
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.

Unit III: Garden designing
Study of garden equipments. Study of Graphic language, Use of drawing equipments, 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.

Unit IV: Designing gardens for public places and institutions
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.

Readings-

1. Bose, Chowdhury and Sharma.1991.Tropical Garden Plants in colour Horticulture and allied publishers, 3D Madhab Chatterjee street, Kolkata.
2. Bimaldas Chowdhury and Balai Lal Jana.2014.Flowering Garden trees. Pointer publishers, Jaipur. India.
3. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
4. Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
5. H.S.Grewal and Parminder Singh. 2014. *Landscape designing and ornamental plants*
6. Rajesh Srivastava. 2014. *Fundamentals of Garden designing*. Agrotech press, Jaipur, New Delhi.
7. L.C. De. *Nursery and landscaping*.2013. Pointer publishers, Jaipur India.

Semester VI

HOR UG 601: Intellectual property rights

Unit I: Historical perspectives to IPR
Historical perspectives and need for the introduction of IntellectualProperty Right regime; TRIPs and various provisions in TRIPS Agreement;Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPR.

Unit II: Indian Legislations for Intellectual Properties

Indian Legislations for the protection of various types ofIntellectual Properties; Fundamentals of patents, copyrights, geographicalindications, designs and layout, trade secrets and traditional knowledge,trademarks, protection of plant varieties and farmers' rights.

Unit III: Biodiversity protection

Biodiversityprotection; Protectable subject matters, protection in biotechnology,protection of other biological materials, ownership and period of protection;National Biodiversity protection initiatives; Convention on Biological Diversity.

Unit IV: International treaties

International Treaty on Plant Genetic Resources for Food andAgriculture; Licensing of technologies, Material transfer agreements, ResearchCollaboration, Agreement, License Agreement.

Readings-

1. Erbisch FH & Maredia K.1998. Intellectual Property Rights in AgriculturalBiotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing KnowledgeEconomy. McGraw-Hill.
3. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and OtherDeveloping Countries: A Compendium on Law and Policies. Daya Publ.House.
4. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
5. Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout
6. Design Act, 2000; PPV and FR Act 2001, and Rules 2003; NationalBiological Diversity Act, 2003.

HOR UG 602: Breeding and seed production of vegetable, tuber crops and spices

Unit I: Principles of vegetables, tuber crops and spice breeding

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.

Unit II: Breeding techniques in vegetables, tuber crops and spices

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.

Unit III: Fundamentals of seed production

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. Seed legislation.

Unit IV: Seed production technology of vegetables, tuber crops and spices 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.

Readings-

1. Hari Hara Ram, 2013.*Vegetable Breeding: Principle and Practices*. Kalyani Publishers. Ludhiana.
2. Vishnu Swaroop, 2014. *Vegetable Science &Technology in India*. Kalyani Publishers. Ludhiana.
3. Kallo.G, 1998. *Vegetable Breeding (Vol.I to IV)*. CRC Press. Florida. 1988.
4. H.P. Singh, 2009. *Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.
5. P. Hazra and M.G. Som, 2009. *Vegetable seed production and Hybrid Technology*. Kalyani Publishers, Ludhiana.

6. Arya, Prem Singh. 2003. *Vegetable seed Production Principles*. Kalyani Publishers. Ludhiana.
7. Fageria, M. S. 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers. Ludhiana.

HOR UG 603: Fundamentals of food technology, post harvest management and processing of horticultural crops

Unit I: Food technology

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.

Unit II: Post harvest handling

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.

Unit III: Storage and packaging

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. 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.

Unit IV: Preservation and processing

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.

Readings-

1. Dr. Swaminathan, M.1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
2. 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.
3. Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
4. Wiils, McGlasson and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International
5. Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
6. Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.
7. Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi.

HOR UG 604: Precision farming and protected cultivation
Unit I: Precision Farming

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.

Unit II: Introduction to Protected cultivation

Definition of protected cultivation. Different structure in protected cultivation. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Green house equipment, materials of construction for traditional and low cost green houses. Tunnels, Shed house, Mulches etc.

Unit III: Environment control system

Design criteria of greenhouse for cooling and heating purposes. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Carbon dioxide regulation, Light control, Humidity control.

Unit IV: Cost and crop choices

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.

Readings-

1. Balraj Singh. 2006. *Protected cultivation of vegetable crops*. Kalyani Publishers, Ludhiana.
2. **Reddy**, P. Parvatha. 2011. *Sustainable crop protection under Protected Cultivation*. Springer Publications. USA.
3. Jitendra Singh, 2015.*Precision Farming in Horticulture*. New India Publishing Agency. New Delhi.
4. Prasad S. 2005. *Greenhouse Management for Horticultural Crops*. Agrobios. Jodhpur.
5. Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat.2013. *Precision forming in H orticulture*. New India Publishing Agency, New Delhi.
6. Aldrich RA & Bartok JW. 1994. NRAES,Riley, Robb Hall. *Green House Engineering*. Cornell University, Ithaca, New York.
7. Pant V Nelson. 1991.*Green House Operation and Management*. Bali Publ

HOR UG 605: Breeding and seed production of vegetable, tuber crops and spices - Practical

Unit I: Floral biology study
Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices*viz*., Tomato, Brinjal, Okra, Capsicum, Chilli, Cucurbits, Cabbage, Cauliflower, Tuber crops, Potato, Carrot, Radish, Spice crops (Cardamom, Ginger, Turmeric).

Unit II: Quantitative study
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.
Unit III: Seed technology

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. Seed processing machines. Visit to seed production units.

Unit IV: Seed Production

Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables.

Readings-

1. Hari Hara Ram, 2013.*Vegetable Breeding: Principle and Practices*. Kalyani Publishers. Ludhiana.
2. Vishnu Swaroop, 2014. *Vegetable Science &Technology in India*. Kalyani Publishers. Ludhiana.
3. Kallo.G, 1998. *Vegetable Breeding (Vol.I to IV)*. CRC Press. Florida. 1988.
4. H.P. Singh, 2009. *Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.
5. P. Hazra and M.G. Som, 2009. *Vegetable seed production and Hybrid Technology*. Kalyani Publishers, Ludhiana.
6. Arya, Prem Singh. 2003. *Vegetable seed Production Principles*. Kalyani Publishers. Ludhiana.
7. Fageria, M. S. 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers. Ludhiana.

HOR UG 606: Fundamentals of food technology, post harvest management and processing of horticultural crops - Practical

Unit I: Food technology

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.

Unit II: Post harvest handling

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.

Unit III: Storage of horticultural crops

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. Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables.

Unit IV: Preservation and processing

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.

Reading-

1. Dr. Swaminathan, M.1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
2. 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.
3. Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
4. Wiils, McGlasson and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International
5. Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
6. Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.

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

SEMESTER VII
Rural Horticulture Work Experience

HOR UG 701: RHWE- Orientation and Report Writing	4
HOR UG 702 : RHWE- Village Attachment (8 weeks)	8
HOR UG 703: All India Study Tour- 2 weeks	4
HOR UG 704: Industrial Attachment - 2 weeks	4

SEMESTER VIII
Experiential Learning Programme

HOR UG- 801Module-I Bee keeping: Procurement and arrangement of bee keeping equipments. 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/favourable necessaries. 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.

HOR UG -802Module-II. Protected cultivation of high value horticulture crops:
Visit to commercial polyhouses, Project preparation and planning. Specialised 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.

HOR- UG- 803Module-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.

HOR- UG- 804Module-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).

HOR- UG- 805Module-V. Bio-inputs: Bio-fertilizers and bio-pesticides:
Isolation and pure culture establishment of fertilisers 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.

HOR- UG- 806Module-VI. Mass multiplication of plants and molecules through tissue culture:
Preparation of sock 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.

HOR UG 807 Module-VII. 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.

HOR- UG- 808 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.