DEPARTMENT OF HORTICULTURE
B.SC. (INTEGRATED) SYLLABUS

Code	Title	Credits
	SEMESTER I	
HOR-UG-101	Elementary Statistics & Computer Application	2+1
HOR-UG-102	Fundamentals of Soil Science	1+1
HOR-UG-103	Introduction to Major Field Crops	1+1
HOR-UG-104	Elementary Plant Biochemistry & Elementary Biotechnology	2+1
HOR-UG-105	Introductory Crop Physiology	1+1
HOR-UG-106	Fundamentals of Horticulture	2+1
HOR-UG-107	Introductory Economics	2+0
HOR-UG-108	Fundamentals of Plant Protection	2+1
HOR-UG-109	English/ Regional Language	1+0
	TOTAL	**14 + 7 (21)**
	SEMESTER II	
HOR-UG-201	Tropical and Subtropical Fruits	2+1
HOR-UG-202	Tropical and Subtropical Vegetables	2+1
HOR-UG-203	Elementary Agro-meteorology	1+1
HOR-UG-204	Water Management in Horticultural Crops	1+1
HOR-UG-205	Plant Propagation an Nursery Management	1+1
HOR-UG-206	Growth and Development of Horticultural Crops	2+1
HOR-UG-207	Introductory Microbiology	1+1
HOR-UG-208	Principles of Genetics and Plant Breeding	2+1
	TOTAL	**12+ 9 (21)**
	SEMESTER III	
HOR-UG-301	Ornamental Horticulture	2+1
HOR-UG-302	Temperate Vegetables and tuber crops	2+1
HOR-UG-303	Fundamental of Extension Education & Rural Sociology	2+1
HOR-UG-304	Genetic Resources Management & Intellectual Property Rights	2+1
HOR-UG-305	Temperate Fruits	2+1
HOR-UG-306	Commercial Floriculture	2+1
HOR-UG-307	Environmental Science	2+1
HOR-UG-308	North East Study Tour (Winter Vacation)	0+1
	TOTAL	**14+8 (22)**
	SEMESTER IV	
HOR-UG-401	Spices and Condiments	2+1
HOR-UG-402	Post Harvest Management of Horticultural Crops	2+1
HOR-UG-403	Plantation Crops	2+1
HOR-UG-404	Breeding of Fruits, Plantation &Medicinal Plants	2+1
HOR-UG-405	Integrated Insect- Pest Management of Fruits, Plantation & Medicinal plants	2+1
HOR-UG-406	Integrated Disease Management of Fruits, Plantation & Medicinal plants	2+1

HOR-UG-407	Integrated Nutrient Management and Soil and Plant Tissue analysis	2+1
	TOTAL	**14+7 (21)**
	SEMESTER V	
HOR-UG-501	Arid and Minor Fruits	1+1
HOR-UG-502	Production and Post Harvest Management of Medicinal and Aromatic Crops	2+1
HOR-UG-503	Integrated Insect- Pest Management of Vegetables, Flowers & Spices	2+1
HOR-UG-504	Integrated Disease Management of Vegetables, Flowers & Spices	2+1
HOR-UG-505	Breeding of Vegetables, Flowers & Spices	2+1
HOR-UG-506	Farm Mechanization in Horticultural Crops	2+1
HOR-UG-507	Principles of Landscaping	1+1
HOR-UG-508	Weed Management in Horticultural Crops	1+1
	TOTAL	**13+8 (21)**
	SEMESTER VI	
HOR-UG-601	Protected Cultivation of Horticultural Crops	2+1
HOR-UG-602	Apiculture, Sericulture and Mushroom Production	1+2
HOR-UG-603	Processing and Value Addition of Horticultural Crops	1+2
HOR-UG-604	Seed Production of Vegetable and Flowers	2+1
HOR-UG-605	Horti-Business Management	2+1
HOR-UG-606	Organic Farming	1+1
HOR-UG-607	Introductory Agroforestry & Agri-Horti Tourism	2+1
HOR-UG-608	Orchard Management	1+1
	TOTAL	**12+10 (22)**
	SEMESTER VII	
HOR-UG-701	Experiential Learning (Professional Package & Industrial/Institutional Attachment)	5+10
HOR-UG-702	All India Study Tour (Winter Vacation)	0+1
	TOTAL	**5+11 (16)**
	SEMESTER VIII	
HOR-UG-801	Experiential Learning (Professional Package & Rural Horticultural work Expierence)	5+10
HOR-UG-802	Physical Education/ NSS/NCC	0+1
	TOTAL	**5+11 (16)**
	GRAND TOTAL CREDITS	**89+71= 160**

Semester I

HOR-UG-101: Elementary Statistics and Computer Application

Unit I: 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.

Unit II: Dispersion
Range, standard deviation, variance, coefficient of variation for raw and grouped data.

Unit III: 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 IV: 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.

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

Unit VI: Computer application
Introduction to computers and personal computers, basic concepts, operating system, DOS and Windows, introduction to programming languages and programming techniques, MS Office, introduction to Multi-Media and its application. VISUAL BASIC-concepts, basics and programming techniques, introduction to statistical packages.

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

HOR-UG-102: Fundamentals of Soil Science

Unit I: Concept of soil

Composition of earth's crust, soil as a natural body – major components. Soil Forming Factors Eluviations and illuviation formation of various soils.

Unit II: Physical properties of soil

Physical parameters; texture – definition, methods of textural analysis, stock' s law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), PD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure.

Unit III: Soil air, soil temperature and soil colour

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 colour – definition, its significance, colour variable, value hue and chroma. Munsell colour chart, factors influencing, parent material, soil moisture, organic matter.

Unit IV: Soil water

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 .

Unit V: Soil consistency and soil colloids

Soil consistency, plasticity, Atterberg' s constants. Soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil organic matter decomposition, pH and nutrient availability, soil buffering capacity.

Unit VI: Remote sensing, soil formation and land capability classification

Aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties.

Practical:

Basic laboratory techniques, handling of glasswares, estimation of soil - moisture, EC, ESP, pH and bulk density. Textural analysis of soil by Robinson's pipette method, cation exchange capacity. Ennumeration of soil microbes, Soil profile.

HOR-UG-103: Introduction to Major Field Crops

Unit I: Basic concepts of Crop-raising

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping

Unit II: Cultivation of major field crops

Cultural practices for raising major cereals, millets, pulses, oilseeds and fodder crops, green manuring, crop rotation.

Practical
Identification of crop plants, seeds and weeds. Preparation of cropping scheme- mono cropping, inter cropping, mixed cropping, relay cropping, alley cropping etc. Application of herbicides in field crops cultivation practices on rice, maize, mustard, grams, kodo, nursery raising in rice.

HOR-UG-104: Elementary Plant Biochemistry & Elementary Biotechnology

Unit I: Carbohydrates
Occurrence classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis.

Unit II: Proteins
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.

Unit III: Lipids
Classification, important fatty acids and triglycerides, essential fattyacids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance.

Unit IV: Enzymes and vitamins
Enzymes: Classification and mechanism of action; factors affecting enzyme action, co-factors and coenzymes. Vitamins and minerals as co-enzymes/ co-factors.

Unit V: Plant pigments
Plant pigment structure and function of chlorophyll, anthocyanins, xanthophylls and carotenoids, sterols, basic structure.

Unit VI: Biosynthesis and metabolism
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 VII: Biotechnology
History of plant biotechnology. Fundamental principles, micro-propagation and scope for commercialization. Application of micro-grafting in horticultural crops, meristem culture, anther culture, pollen culture, embryo culture, callus culture, cell culture, somoclonal variation, protoplast isolation, culture, fusion and applications. Cryopreservation.

Unit VIII: Genetic engineering

Genetic engineering and transgenics. Future scope and present trends, Importance of biotechnology in horticulture, biosafety issues.

Practicals
Laboratory safety measures and first aid. Preparation of standard solutions and reagents. Carbohydrates – qualitative reaction, estimation of starch, reducing and non-reducing sugars; estimation of proteins by Lowery's method. Estimation of free fatty acids; determination of iodine number of vegetable oils. Vitamins – estimation of ascorbic acid. Paper and thin layer chromatography. Sterilization techniques, extraction and quantification of DNA, basic techniques in TC.

HOR-UG-105: Introductory Crop Physiology

Unit I: 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.

Unit II: Guttation and Transpiration
Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration.

Unit III: Drought and other stresses
Drought, Different types of abiotic stresses; water,hea, cold, acid, salt, heavy metal, ozone stress and tolerance; mechanism of tolerance.

Unit IV: Plant Nutrition
Essentiality of nutrients - criteria and classification, mechanism of absorption and its role in plant metabolism.

Unit V: Photosynthesis and respiration
Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO_2 fixation – C_3, C_4 and CA metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis.

Unit VI: Plant Hormones
Phytohormones, physiological role in controlling plant processes.

Practicals
Measurement of water potential, osmosis & root pressure. Structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull. Importance of light and chlorophyll in photosynthesis in horticultural crops, estimation of phenols, studying plant movements, root initiation in cuttings. Estimation of plant pigments-chlorophyll, carotenoids, xanthophylls etc.

HOR-UG-106: Fundamental of Horticulture

Unit I: Horticultural crops: classification, status, exports and agro-climatic zones
Classification of horticultural crops, economic importance and and their culture and nutritive value, area and production, fruit and vegetable zones of India and of different states, exports and imports.

Unit II: Nursery and orchard management
Nursery management practices, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens , principles and planning and layout, management of orchards, planting systems and planting densities.

Unit III: Production technology
Production practices for fruit, vegetable and floriculture crops, nursery techniques and their management. Principles and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management, weed management, fertility management, cropping systems, intercropping, multi-tier cropping, mulching, bearing habits in fruits, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working and frame working.

Practicals
Features of orchard, planning and layout of orchard, tools and implements, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, digging of pits, 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 and vegetables, assessment of bearing habits, maturity standards and harvesting, grading, packaging and storage.

HOR-UG-107: Introductory Economics

Unit I: Nature and scope of Economics
Definition and concepts, divisions of economics, economic systems, approaches to the study of economics.

Unit II: Consumption
Theory of consumer behaviour, laws of consumption, classification of goods.

Unit III: 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.

Unit IV: Theory of demand
Demand schedule and curve, market demand. Price, income and cross elasticity, Engil's law of family expenditure – consumer's surplus.

Unit V: Theory of firm

Factors of production – land and its characteristics, labour and division of labour, theories of population.

Unit VI: Capital and its characteristics
Classification and capital formation. Enterprises – forms of business organization – merits and demerits.

Unit VII: Laws or return
Law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities.

Unit VIII: Market equilibrium, distribution
Theories of rent, wage, interest and profit. Price determination and forecasting under various market structures.

HOR-UG-108: Fundamentals of Plant Protection

Unit I: Introduction to phytopathology
Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminologies.

Unit II: Parasitic and non-parasitic plant diseases
Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and pheneno gamic parasitic plants, their characteristics and classification. Non-parasitic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens.

Unit III: Plant disease and its management
Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management.

Unit IV: Introductory entomology
Introduction to phylum arthropoda. Importance of class Insecta. Insect dominance. Definition, division and scope of entomology.

Unit V: Insect morphology and anatomy
Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetalia. Anatomy of digestive, excretory, nervous and reproductive systems. Postembryonic development, Metamorphosis. Types of larvae and pupa. Classification of insects upto orders and families of economic importance and their distinguished characters.

Unit VI: Introduction to non insect
Nemoteds, birds, bats, rodents, molluscs, mites etc,

Practical

Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their applications. Insect collection and preservation. Identification of important insects. General body organization of insects. Study on morphology of grasshopper. Preparation of permanent mounts of mouth parts, antennae, legs and wings. Dissection of grasshopper and caterpillar for study of internal morphology. Observations on metamorphosis of larvae and pupae. Study on insect traps

HOR-UG-109: English/ Regional Language

Unit I: Grammar
Grammatical Focus- Grammatical & Structural aspects covering Parts of Speech, Tense, Voice, Clause, Preposition, Degrees of Comparison, Synonyms & Antonyms, etc; Identifying & Analysing Grammatical Errors including errors in Spelling & Punctuation.

Unit II: Reading and writing
Reading - Vocabulary Building; Comprehension; Interpretation; Summarising. Writing- Letter Writing – Formal, Informal; Accepting & Declining Invitations; Precise Writing, Effective Writing- Business Correspondences (Letter, Fax, e-mail) for- Making Enquiries, Placing Orders, Asking & Giving Information, Registering Complaints, Handling Complaints; Drafting notices; Drafting Advertisements; Job Applications.

Unit III: Speaking, pronunciation and listening
Speaking- Interactive Communication like Introducing Self, Greetings, Conversations, etc; Business Etiquettes; Impromptu Speech; Debate; Role Play; Presentations. Pronunciation- appropriate stress, intonation, clarity. Listening- Understanding – Spoken English, Formal English; Exercises.

Semester II

HOR-UG-201: Tropical and Subtropical Fruits

Unit I: Classification
Horticultural classification of fruits including genome classification. Horticultural zones of India, Charecteristics of Troipcal and sub tropical fruits

Unit II: Production technology of tropical and subtropical fruits
Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops.

Mango, Banana, Grapes, Citrus, Papaya, Sapota, Guava, Pineapple, Jackfruit, Avocado, Mangosteen, Litchi, Carambola, Durian and Passion fruit.

Unit III: Production problems and its management
Bearing in Mango, guava and Citrus, causes and control measures of special production problems, alternate and irregular bearing. Seediness and kokkan disease in banana, citrus decline and pineapple flowering.

Unit IV: Crop specific special production techniques
Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, pineapple flowering, economics of production.

Practicals
Description and identification of varieties based on flower and fruit morphology in T&ST Fruits. 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, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits.

HOR-UG-202: Tropical and Subtropical Vegetables

Unit I: Introduction
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; planting for directly sown/transplanted vegetable crops. Spacing, planting systems water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest and yield. Economics of cultivation of tropical and sub-tropical vegetable crops; post-harvest handling and storage of

Unit II: Tomato, Brinjal, Chillies
Unit III: Okra
Unit IV: Amaranthus
Unit V: Cluster Beans, Cowpea, Lab-Lab, Snap Bean,
Unit VI: Cucurbits,
Unit VII: Moringa, Curry Leaf, Portulaca and Basella.
Unit VIII: Off season production technique

Practicals
Identification and description of tropical and sub-tropical vegetable crops and their seeds; 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, seed extraction cost of cultivation for tropical and sub-tropical vegetable crops. Pot raising of vegetables.

HOR-UG-203: Elementary Agro-meteorology

Unit I: Atmosphere
Structure of atmosphere; weather elements, solar radiations, temperature, atmospheric pressure, wind, humidity, evaporation, rainfall, clouds, hydrologic cycle, monsoon and season.

Unit II: Abnormalities in weather
floods, droughts, cyclones, other abnormalities; weather forecasting organizations, essentials of weather forecasting, forecasting information, types of weather forecasting, methods of forecasting; weather modifications- artificial rain making, reduction in wind velocity and its losses, protection against frost damage, heat trapping.

Unit III: Influence of climate on crops
Agro-climatic zones of India, solar radiations-photosynthetic effect, photoperiodic effect, other effects, utilization of solar energy; cardinal temperatures, cool season crops, warm season crops, influence of temperature on growth, growing degree days, photo thermal units, extreme temperature chilling requirements rainfall climatology, relative humidity-water relation, leaf growth, photosynthesis and pollination.

Practicals
Measurement of maximum and minimum air temperatures, soil temperatures, rain fall, open pan evaporation and evapo-transpiration. Determination of vapour pressure relative humidity, atmospheric pressure, wind speed and wind direction. Processing, tabulation and presentation of weather data.

HOR-UG-204: Water Management in Horticultural Crops

Unit I: Water resources
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- Deficit & excess

Unit II: Soil water relation
Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern.

Unit III: 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.

Unit IV: Irrigation scheduling

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.

Unit V: Irrigation management
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 under ground pipeline system and drainage.

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

HOR-UG-205: Plant Propagation and Nursery Management

Unit I: Basics of Propagation
Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy (scarification & stratification) internal and external factors, nursery techniques, apomixes – mono-embrony, polyembrony, chimera & bud sport.

Unit II: Propagation Structures
Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, nursery (tools and implements),

Unit III: Propagation methods: Physiology and techniques
Use of growth regulators in seed and vegetative propagation, methods and techniques of cutting, layering, grafting and budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility scion-stock relationship and their influences . Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers etc. Micrografting, hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery. Off season nursery production of vegetables.

Practicals
Media for propagation of plants in nursery beds, pot and mist chamber. 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 etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labeling and packing of

fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and bud wood certification. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Top grafting, bridge grafting and nursery management. Nutrient and plant protection applications during nursery.

HOR-UG-206: Growth and Development of Horticultural Crops

Unit I: Growth and development
Growth and development -definitions, components, photosynthetic productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, growth analysis in horticultural crops.

Unit II: Plant Growth regulators
Plant bioregulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening.

Unit III: Seed development and dormancy
Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops.

Unit IV: Training and Pruning
Pruning and training physiological basis of training and pruning source and sink relationship, translocation of assimilates.

Unit V: Flowering and its physiology
Factors affecting flowering, physiology of flowering, light -photoperiodism-long day, short day and day neutral plants, vernalisation and chilling temperature and its application in horticulture.

Unit VI: Fruit growth and development
Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climacteric and non climacteric fruits.

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

HOR-UG-207: Introductory Microbiology

Unit I: Introduction to 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.

Unit II: Microscopy and Specimen Preparation
The bright field microscope, fixation, dyes and simple staining, differential staining.

Unit III: Prokaryotic organism
Difference between prokaryotic and eucaryotic cells. Procaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelial growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacterophages. General principle of bacterial genetics, DNA as genetic material. Antibiosis, symbiosis, intramicrobial and extra-microbial association.

Practicals
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, colony isolation and turbidometric estimation of microbial growth.

HOR-UG-208: Principles of Genetics and Plant Breeding

Unit I: Introduction to genetics
Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, mitosis, meiosis and its significance. Gametogenesis and syngamy in plants.

Unit II: 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.

Unit III: Pollination and reproduction
Sexual reproduction (cross and self pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure).

Unit IV: Introduction to plant breeding
Plant breeding as a dynamic science, genetic basis of Plant Breeding – classical, quantitative and molecular, Plant Breeding in India – limitations, major achievements, future requirements.

Unit V: Breeding strategies and techniques
Genetic components of polygenic variation and breeding strategies and methods as a basis of crop breeding. Hybridization and selection – goals of hybridization, selection of plants; population developed by hybridization – simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis – concepts, estimation and its genetic basis. Mutation and polyploidy breeding

Practicals
Study of fixatives and stains. Squash and smear techniques. Demonstrations of permanent slides and cell division, illustration in plant cells, pollen fertility and viability, gametes, Solving problems of monohybrid, dihybrid, and test cross ratios using chi-square test.
Breeding objectives and techniques in major field crop plants. Floral biology – its measurement, emasculation, crossing and selfing techniques in major crops. Handling of breeding material and maintenance of experimental records in self and cross pollinated crops. Use of chemical mutagens.

Semester III

HOR-UG-301: Ornamental Horticulture

Unit I: Introduction to Gardening
History, scope of gardening, aesthetic values. types of gardens, Gardens in India,. Landscaping, historical background.

Unit II: Floriculture industry
Importance, area and production, industrial importance in India.

Unit III: Principles of gardening
Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden, etc. Landscaping, basic principles and basic components.

Unit IV: Garden types, features and components
Special types of gardens, their walk-paths, bridges, constructed features. Greenhouse. Special types of gardens, trees, their design, values in landscaping, propagation, planting shrubs and herbaceous perennials. Importance, design values, propagation, potting, climbers and creepers, palms, ferns, grasses and cacti succulents.

Unit V: Floral arrangement and bonsai
Importance, production details and cultural operations, constraints, post-harvest practices. Culture of bonsai, art of making bonsai.

Unit VI: Bio-aesthetic planning
Bio-aesthetic planning, definition, need, round country planning, urban planning and planting avenues, schools, villages, beautifying railway stations, dam sites, planting material for play grounds. Vertical gardens, roof gardens. Parks and public gardens.

Practicals
Identification and description of annuals, herbaceous, perennials, climbers, creepers, foliage flowering shrubs, trees, palms, ferns, ornamental grasses; cacti succulents. Planning and designing gardens, layout of location of components of garden study, functional uses of plants in the landscape. Panning design of house garden, roadside planting, avenues for new colonies, traffic

islands, preparation of land for lawn and planting. garden, and Japanese gardens, recreational and children' s corner. Layout of terrarium, bottle garden, dish garden. Flower arrangement, bonsai practicing and training. Visit to nearby gardens.

HOR-UG-302: Temperate Vegetables and tuber crops

Unit I: Introduction
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, seed production, post-harvest technology and marketing of crops

Unit II: Cole crops
Cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, Chinese cabbage.

Unit III: Leafy vegetables
Lettuce, palak, spinach.

Unit IV: Bulb crops
Garlic, onion, leek

Unit V: Root crops
Radish, carrot, turnip, beet root.Squashroot

Unit VI: Peas, beans and perennials
Peas, broad beans, rhubarb, asparagus, globe artichoke.

Unit 7: Tuber crops
Potato, Taro, Cassava, Yams, Colocasia, Sweet potato

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

HOR-UG-303: Fundamentals of Extension Education & Rural Sociology

Unit I: Extension education
History, definition, nature, scope, objectives, principles and approaches.

Unit II: Horticulture extension
Horticulture extension: process, principles and selected programmes of leading national and international forest institutes. People' s participation in forestry programmes. Motivation of women community, children, youth and voluntary organizations for horticulture extension work.

Unit III: Rural Development
Objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND),front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR.

Unit IV: Communication
Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Programming planning process – meaning, scope, principles and steps. Agrarian journalism

Unit V: Evaluation
Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA).

Unit VI: Management and administration
Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. Definition of Jounalism.

Unit VII: Basics of rural sociology
Concepts, methods, tools, characteristics of rural society and people, rural-urban continuum and differences,

Unit VIII: Rural social structure and stratification
Rural social structure: interaction, processes, institutions, groups; Rural social stratification: status, roles, class, castes, etc.

Unit IX: Panchayat Raj and Land reforms
Panchayat Raj, and Block Development, specific programmes for rural area upliftment/ employment, Land reforms, Council for advancement of Peoples Action and Rural Technology.

Practicals
Preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like OHP & 35 mm slide projector transparencies. Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning. Visits to study structure and mode of functioning of voluntary organizations (NGO)/Mahila Mandal, Village Panchayat, State Deptt. of Agriculture/All India Radio (AIR). Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of horticulture extension programmes. Preparation of Village horticultural productions plan. Visit to Kisan Call Centre and Plant Health Clinic.

HOR-UG-304: Genetic Resource Management & Intellectual property Rights

Unit I: Genetic resources
Role of genetic resources, centers of origin and diversity of crop plants, law of homologous series, plant introduction and exchange of genetic resources.

Unit II: Introduction, domestication and germplasm conservation
Principles and concepts of plant quarantine, plant introduction in horticultural crops, germplasm collection and gene bank, gene sanctuary for conservation, gene erosion, germplasm exploration, germplasm conservation, in vitro conservation, cryopreservation, DNA finger printing.

Unit III: Sources of crop resistance and quality characters
Wild relatives and sources of resistance to biotic, abiotic stress and quality characters for fruit vegetable, flower and plantation crops, spices, medicinal and aromatic plants.

Unit IV: Intellectual property rights
International Institutes and organization for germplasm – Trade Related Intellectual Property Rights (TRIPS) and Intellectual Property Rights (IPR) for Indian cultivars.

Unit V: Copy right and trade mark
Copy right, Trade marks, geographical indicators

Unit VI: Industrial design
Industrial design, layout design

Unit VII: Trade secrets and patents
Trade secrets, Patents (Plant, Utility and Design)

Unit VIII: Protection of Plant variety and farmers Right
Protection of Plant variety and farmers Right, DUS Testing, Plant Breeders Right

Practicals
Morphological evaluation of germplasm, collection and identification of wild relatives for fruit crops, vegetable crops, flower crops, spices, plantation crops, medicinal and aromatic plants, preparation of herbariums. Photo album/digital photo album preparation of important horticultural plants. Use of descriptors, monographs in hort crops. Visit to the nearest germplasm centre, herbal garden, biodiversity park and botanical gardens.

HOR-UG-305: Temperate Fruits

Unit I: Production technology of 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 pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, plum, apricot, cherry, persimmon, strawberry, kiwi, Queens land nut (Macadamia nut), almond, walnut, pecan nut, hazel nut, chest nut and raspberry.

Unit II: Production problems and its management

Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures.

Practicals

Description and identification of varieties of temp crops, Nursery management practices, , 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.

HOR-UG-306: Commercial Floriculture

Unit I: Production technology of flowers

Scope and importance of commercial floriculture in India, production techniques of ornamental plants like Rose, Marigold, Chrysanthemum, Anthurium, Jasmine, Dahlia, Bird of Paradise, China Aster, Orchid,

Bulbous crops, Astroemeria, Amaryllis, Begonia, Hyacinth, Zantedischia, Ornythogallum, Tulip

Unit II: Cut foliage and pot plants

Unit III: Post harvest technology of cut flowers

Post harvest technology of cut flowers in respect of commercial flower crops

Unit IV: Oil extraction and dry flowers

Essential oil/concrete extraction, dehydration techniques of flowers.

Practicals

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

HOR-UG-307: Environmental Science

Unit I: Introduction

Definitions, Scope and Importance of Environment

Unit II: Ecology and ecosystems

Definition of ecology. Concept of 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 :- Mountain ecosystems (Forest ecosystem, Grassland ecosystem), Aquatic ecosystems (ponds, streams, lakes, rivers and other wetlands)

Unit III: Natural resources

Renewable and non-renewable resources: Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber and Minor Forest Produce, overgrazing, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources . Agro-Horticultural resources, changes caused by agriculture, effects of modem agriculture, fertilizer pesticide problems, water logging, organic farming. Energy resources: energy needs, renewable and non renewable energy sources, use of alternate energy sources. Land resources.

Unit IV: Biodiversity and its Conservation

Introduction - Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Medicinal, Aromatic and Wild edible plants, with especial reference to Sikkim. Agrobiodiversity. 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 V: Human Population and Environment

Population growth, variation among nations. Population explosion -Family Welfare Programme. Environment and Human health. Human Rights. HIV/AIDS. Women and Child Welfare.

Unit VI: Social Issues and the Environment

Social problems related to energy. Water conservation, rain water harvesting, concept of watershed. Resettlement and rehabilitation of people; its problems and concerns. Public awareness and Environmental ethics (Issues and possible solutions). Consumerism and waste products. Tourism and eco-tourism. Environmental laws and policies: Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act .Biodiversity Act. Wildlife Protection Act. Forest Conservation Act, etc.

Unit VII: Environmental Pollution

Definition, Cause, Effects and Control Measures of: Air pollution , Water pollution: Water quality criteria- potable water and sewage (domestic and industrial effluent) treatment, fundamentals, primary, secondary and tertiary treatment. Soil pollution , Noise pollution, Thermal pollution, Radioactive pollution . Role of an individual in prevention of pollution.

Unit VIII: Environmental Management

Concept of Sustainable development, Hazard and Disaster management, Solid waste Management - Causes, effects and control measures of rural, urban and industrial wastes, biomedical wastes. Watershed management. Land degradation. Wasteland reclamation and management. Environmental impact assessment (EIA): Concept of EIA, various methods of EIA and their relative advantages, EIA as a management tool. Environmental economics.

Unit IX: Climate change

Definition of climate, Causes of climate change: anthropogenic and natural, Global warming,

Impact of climate change, Acid rain, ozone depletion and related issues of climate change, Carbon trading and clean energy concept- carbon foot prints, carbon sequestration, carbon credit and audit, Global perspective of climate change- conferences.

Project Work
Students should be given project work, covering any of the topics covered in the syllabus; however, the emphasis should be given on Sikkim aspects. Mechanism to involve other locally based research institutions need to be strengthened.

HOR-UG-308: North East Study Tour (Winter vacation)

Visit to research institutes & production clusters, industries, botanical garden of horticultural importance located within NE region

Semester IV

HOR-UG-401: Spices and Condiments

Unit I: Production technology
History, scope and importance, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micropropagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping, training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation of Cardamom, pepper, ginger, turmeric, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme, rosemary and Garcinia (Kokum)

Unit II: Institutes and organization dealing with spices
Role of Spice Board and Pepper Export Promotion Council, institutions and research centers in R&D.

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

HOR-UG-402: Post Harvest Management of Horticultural Crops

Unit I: Important of Post Harvest Technology
Importance of post-harvest technology in horticultural crops. Principles and methods

Unit II: Post-harvest physiology

Structure of fruits, vegetables and cut flowers related to physiological changes after harvest.

Unit III: Post harvest handling and Pre-harvest factors affecting quality
Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, 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. Pre-harvest treatment and precooling, pre-storage treatments.

Unit IV: Post-harvest treatments and quality parameters
Post-harvest treatments of horticultural crops. Quality parameters and specification.

Unit V: Storage, packaging and transport
Methods of storage for local market and export. 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.

Practicals
Practice in judging the maturity index of various horticultural produce and organoleptic test, 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 and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseased in spices. Visit to markets, packaging houses and cold storage units. Vase life increase in cut flowers.

HOR-UG-403: Plantation Crops

Unit I: History and status of plantation crops
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.

Unit II: Production technology of Plantation crops
Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, cropping system, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics and by product utilization of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea and rubber.

Practicals
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. 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. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

HOR-UG-404: Breeding of Fruits, Plantation & Medicinal Plants

Unit I: Introduction to breeding
History, importance of breeding in horticultural crops production, distribution, domestication and adaptation and centres of origin, plant bio-diversity and its conservation,

Unit II: Modes of reproduction
Modes of reproduction, pollination systems and genetics of important of commercially important fruits, medicinal and aromatic plants and plantation crops

Unit III: Breeding strategies and achievements
Principles of breeding in self-and cross pollinated crops, pure line selection, mass selection, heterosis breeding, hybridization, pedigree method, mass pedigree method, bulk method, modified bulk method, single seed descent method and back cross method. Self incompatibility and male sterility, its classification and application in crop improvement. Variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement –manipulations

Unit IV: Biotechnology for crop improvement and resistance breeding
Application of biotechnology in crop improvement. Breeding for disease resistance.

Practicals
Exercises on floral biology, pollen viability; emasculation and pollination procedures for some model crops; use of mutagens to induce mutations and polyploidy. *Invitro* breeding methods. Embryo rescue.

HOR-UG-405: Integrated Insect-Pest Management of Fruits, Plantation & Medicinal Plants

Unit I: Introduction to insect pest management
Economic classification of insects; ecology and insect-pest management with reference to horticultural crops; pest surveillance. Distribution, host range, bio-ecology, damage, integrated management of important insect pests affecting important horticultural crops.

Unit II: Storage pest and its management
Storage insects – distribution, host range, bioecology, damage, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products.

Unit III: Toxicology

Toxicology – insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their tolerance limits.

Practicals
Study of symptoms, damage, collection, identification, preservation, assessment of damage/population of important insect-pests affecting fruits, plantation, medicinal and aromatic crops in field and during storage. Management practices for important pests.

HOR-UG-406: Integrated Disease Management of Fruits, Plantation & Medicinal Plants

Unit I: Disease management of horticultural crops
Etiology, symptoms, mode of spread epidemiology and integrated management of the diseases of important Fruits, Plantation and Medicial crops.

Unit II: Post Harvest Disease management
Important post-harvest diseases of Fruits, Plantation and Medicial crops and their management.

Practicals
Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of horticultural crops. Bio control, management including post Harvest management.

HOR-UG-407: Integrated Nutrient Management and Soil and Plant Tissue Analysis

Unit I: Plant nutrient elements
Essential plant nutrient elements- functions, deficiency systems, transformations and availability.

Unit II: Micro-organism and plant nutrition
Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition.

Unit III: Fertility evaluation and INM:
Soil fertility evaluation methods, critical limits of plant nutrient elements, deficiency symptoms, visual diagnosis and hunger signs.

Unit IV: Manure and fertilizers
Manures, fertilizers: micronutrients composition and application methodology, luxury consumption, nutrient interactions,.

Unit V: Different INM practices in Horticultural crops
Components of INMand their integration in horticultural crops

Unit VI: Sampling methods
Methods of soil and plant sampling and processing for analysis.

Unit VII: Soil structural analysis and mineral quantification
Quantification of minerals and their abundance. Soil structure and aggregate analysis.

Unit VII: Soil moisture
Theories and concepts of soil moisture estimation – gravimetric, tensiometric, gypsum block, neutron probe and pressure methods. Characterization of hydraulic mobility – diffusion and mass flow.

Unit IX: Leaf tissue analysis
Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values.

Unit X: Analytical instruments and its principles
Principles of working of pH meter, electrical conductivity meter, spectrophotometer, flame photometer and atomic absorption spectrophotometer.

Unit XI: Quality of irrigation water
Irrigation water quality, determination of quality parameters, empirical equation management of irrigation water.

Practicals
Collection and preparation of soil and plant samples for analysis. Determination of water holding capacity and hydraulic conductivity of soil. Estimation of moisture content in soils and plants. Estimation of available macro and micronutrient elements in plants. Irrigation water quality analysis. 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. Hoagland solution, Soil less culture, identification of different fertilizers, numerical calculations on fertilizers, nutrient deficiency identification, amendment measures.

Semester V
HOR-UG-501: Arid and Minor Fruits

Unit I: Arid zones of India
Plant adaptations for arid conditions.

Unit II: Production, nutritive value 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. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops.
Ber, Aonla, Annona, Jamun, Wood Apple, Bael, Pomegranate, Carissa, Date Palm, Phalsa, Fig, West Indian Cherry, Tamarind and indigenous fruits of Sikkim.

Practical

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, post harvest management,calculation of cost economics and packaging studies.

HOR-UG-502: Production and Post Harvest Management of Medicinal and Aromatic crops

Unit I: Introduction to medicinal and aromatic crops
History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India.

Unit II: Outline of production technology
Importance, origin, species and varieties, 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 for the following crops

Unit III: Medicinal crops
Medicinal Plants: Betelvine, periwinkle, Rauvolfia, Dioscorea, Isabgol, *Ammi majus*, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. *Aloe vera*.

Unit IV: Aromatic plants
Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, Mentha, musk, Ocimum and other species relevant to the local conditions.

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

HOR-UG-503: Integrated Insect-Pest Management of Vegetables, Flowers & Spices

Unit I: Insect pest management
Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, damage, integrated management of important insect-pests affecting vegetable, ornamental and spice crops (selected crops).

Unit II: Storage pest and its management
Storage insects – distribution, host range, bioecology, damage, integrated management of important insect pests attacking stored vegetable, flower and spice crops and their processed products.

Unit III: Toxicology
Toxicology – insecticide residue problems in vegetable, flower and spice crops and their tolerance limits.

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

HOR-UG-504: Integrated Disease Management of Vegetables, Flowers & Spices

Unit I: Disease management of Vegetables, Flowers & Spice crops
Etiology, symptoms, mode of spread epidemiology and integrated management of the diseases and management of important Vegetables, Flowers & Spices crops (selected crops).

Unit II: Post Harvest Disease management
Important post-harvest diseases of Vegetables, Flowers & Spices crops and their management.

Practical
Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of vegetable, flower and spice crops.

HOR-UG-505: Breeding of Vegetables, Flowers and Spices

Unit I: Introduction to breeding of Vegetables, Flowers & Spices crops
History, importance of breeding in Vegetables, Flowers & Spices crops production, distribution, domestication and adaptation and centres of origin, plant bio-diversity and its conservation,

Unit II: Modes of reproduction in Vegetables, Flowers & Spices crops
Modes of reproduction, pollination systems and genetics of important of commercially important Vegetables, Flowers & Spices crops.

Unit III: Breeding strategies and achievements
Variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – polidy manipulations. Breeding techniques employed in Vegetables, Flowers & Spices. Principles of breeding in self-and cross pollinated crops, pure line selection, mass selection, heterosis breeding, hybridization, pedigree method, mass pedigree method, bulk method, modified bulk method, single seed descent method and back cross method. Self incompatibility and male sterility, its classification and application in crop improvement.

Unit IV: Biotechnology for crop improvement and resistance breeding
Application of biotechnology in crop improvement. Breeding for disease resistance. MAS, QTL

Practical
Exercises on floral biology, pollen viability and germination; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy.

HOR-UG-506: Farm Mechanization in Horticultural Crops

Unit I: Farm mechanization
Farm mechanization: benefits and constraints, role of power and energy in mechanization, different sources of power and energy. Ergonomics in design of farm tools, safety aspects of agricultural machinery.

Unit II: Implements for land preparation and sowing etc.
Horticultural land preparation implements: Tillage, methods of ploughing, field capacity and working out problems. Primary tillage implements: function of indigenous ploughs, mould board ploughs, disc and rotary ploughs, chisel plough, hole-diggers, and augers. Secondary tillage implements: function of tillers, harrows, levelers, ridgers, bund formers, channel formers, and trencher. Nursery raising machinery: planters, under cutters, compost and soil shredders, rotary sieves - functions of components. Sowing machines: seed drills, planters, and plant replacer.

Unit III: Implements for interculture and mowing etc.
Intercultural equipments: sweep, junior hoe, weeders, power rotary weeder - types and their uses. Mowing machines: types and uses. Harvesting tools, turf aerators, rakes, edge trimmers, turf cutters, chain saws, hedge cutters, pruner. Plant protection equipment: types and uses of sprayers, dusters, orchard sprayers.

Unit IV: Harvesting equipment
Equipment for root crops and fruits harvesting – turmeric digger, onion digger, potato digger, cassava digger, fruit crop harvesting – manual fruit plucker, and tree shakers. Cost analysis of Farm Machinery and equipment. Selection of systems of equipment for horticultural crops.

Unit V: Cost and maintenance of farm equipments
Cost analysis of Farm Machinery and equipment. Selection of systems of equipment for horticultural crops. Repair and maintenance of farm equipment.

Practical
IC engines – showing the components of dismantled engines. Identification of functional components of tractors and power tillers. Tractor and power tiller operation. Primary & secondary tillage implements: hitching, adjustments, and operations. Plant protection equipment: calculation of dilution ratio, calibration and operation. Weeding & harvesting equipment: adjustment and operations of weeders, mowers, fruit harvester, plucker, tapioca puller, ladders & hoists, multi-utility elevated platform. Local implements.

HOR-UG-507: Principles of Landscaping

Unit I: Principles of landscaping
Basic principles and components of landscaping. Principles of landscape design, Principles of gardening, land scaping, garden components, adornments, lawn making, methods of designing rockery, water garden etc.

Unit II: Garden types, features and components
Special types of gardens, their designs, their walk paths, bridges, trees, constructed features, values in landscaping. Planting climbers and creepers, annuals, flowering plants, palms, ferns, grasses and cacti succulents. Different types of gardens, vertical gardens, roof gardens, park and public gardens.

Unit III: Landscape gardening in public place
Landscaping in place of public importance like town, railway station/bus terminus, educational institutes, industrial sites, place of historical importance and worship, home gardens, roadside avenue plantation, colonies, river banks, planting materials for play grounds, CAD.

Practical
Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, Application of CAD

HOR-UG-508: Weed Management in Horticultural Crops

Unit I: Introduction
Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop - weed competition and allelopathy. Seasonal weeds.

Unit II: Weed control
Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management.

Unit III: Herbicides
Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control. Advantages and limitation of herbicide usage in India.

Practical
Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information;

Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices.

Semester VI

HOR-UG-601: Protected Cultivation of Horticultural Crops

Unit I: Basic principles

Importance, scope and basic principles of protected cultivation of horticultural crops.

Unit II: Protected structures and components

Greenhouse designs, use of portable tunnel. types of protected structures, greenhouses, polyhouses, shade houses, rain shelters etc., designing and erection of protected structures. Low cost/Medium cost/High cost structures, economics of cultivation; location specific designs; structural components;

Unit III: Environmental control and management

Environment control, management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooling , light regulation.

Unit IV: Protected cultivation techniques

Containers and substrates, media decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM, Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); staking and netting. Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards, Green house cultivation of important horticultural crops- Tomato, Cucumber, Capsicum, Bell Pepper, Gerbera, Rose, Carnation and Strawberry,Orchid.

Practical

Study of various protected structures, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, harvesting methods, post harvest handling, packing methods, project preparation, visit to commercial Green houses. Spray of PP chemicals.

HOR-UG-602: Apiculture, Sericulture and Mushroom Cultivation

Unit I: Importance and history of apiculture

Different species of bees, morphology, anatomy, colony organization and life cycle, bee-keeping equipment, social behaviour, reproduction, queen rearing, bee pasturage, seasonal management, economics of beekeeping.

Unit 2: Bees
Bee enemies, diseases of bees, role of bees in increasing the productivity of horticultural crops in India economy, bee products and their uses. Recent trends in apiculture. Acquaintance with honey bee species, morphology, structural adaptation, biology-castes-bee-keeping equipment, bee forage plants.

Unit III: Collection and preservation of bee flora
Enemies and diseases of bees. Handling of bee colonies and manipulation for honey production.

Unit IV: Introduction to sericulture
Identification of silk moth, basic life cycle of silk moth, enemies of silk moth

Unit V: Manual and industrial level silk production
Equipments required for silk production and scientific procedure

Practical
Handling of bee colonies (on and off season); extraction of honey from the honey comb; visit to apiculture centre.
Identification of silk moth, study of basic life cycle, visit to commercial silk rearing centre, cultivation of silk rearing plant species. Introduction to mushrooms fungi – nutritional value, edible and poisonous types, edible mushrooms, Pleurotus, Volvariella and Agaricus, medicinal value of mushrooms, genetic improvement of mushroom, preparation of culture, mother spawn production, multiplication of spawn, cultivation techniques, harvesting, packing and storage; problems in cultivation – diseases, pest and nematodes – weed moulds and their management strategies. Economics of cultivation, post harvest technologies. Equipment and sterilization techniques for culture media, isolation of mother culture, and span preparation and maintenance of mushroom beds of oyster mushroom, Volvariella and Agaricus. Processing and preservations of mushrooms, economics of spawn and mushroom production and mushroom recipes

HOR-UG-603: Processing and Value addition of Horticultural Crops

Unit I: Importance and scope of fruit and vegetable preservation industry in India
Food pipe line, losses in post-harvest operations, unit operations in food processing.

Unit II: Principles and guidelines for the location of processing units

Unit III: 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.

Unit IV: Processing and value addition of plantation crops

Products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits.

Unit V: Food laws
Product development from flowers and ornamental crops.

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

HOR-UG-604: Seed Production of Vegetable and Flowers

Unit I: Introduction
Seed -definition –importance – quality characteristics –history of seed industry -classes of seed - difference between Orthodox and recalcitrant seeds- generation system - multiplication ratio -seed replacement rate – varietal deterioration -causes –maintenance.

Unit II: Principles of seed production
Methods and tools of seed production in variety and hybrid –seed crop management - land requirement-isolation – pre-sowing seed treatment –dormancy -spacing –nutrient-irrigation - contaminants -roguing – plant protection – physiological maturation –pre-harvest sanitation spray - harvest and postharvest techniques-extraction –methods -drying –processing -seed treatment -pre-storage – packing –storage – mid-storage treatment.

Unit III: Seed quality control and seed certification
Seed certification –phases –procedures -general and specific standards –field inspection –field counts –contaminants -post harvest inspection –seed standards -bagging –tagging –blending of seed lots –grow out test.

Unit IV: Seed testing
Seed testing -importance –seed lot –seed sample -sampling methods –purity analysis –moisture estimation –germination tests – viability test –seed vigour tests -seed health test .

Unit V: Seed legislation
Seed Act and Rules –Central Seed Committee -Central Seed Certification Board, State Seed Certification Agency -Central and State Seed Testing Laboratories -Seed Inspector -duties and responsibilities –offences and penalties -Seed Control Order 1983 –New policy on seed development / New Seed Policy 1988–National Seed Policy 2002 -Seed Bill 2004.

Unit VI: Introduction to horticultural crops seed production
Variety and hybrid seed production -factors influencing seed production. -seed production planning,

Unit VII: Seed production in tropical vegetables
Seed production in tomato, brinjal and chilli (solanaceae) -bhendi –malvaceae) and cowpea, lablab and (fabaceae) – bitter gourd, ribbed gourd and bottle gourd (cucurbitaceae) -onion (alliaceae), amaranthus (amaranthaceae)and yam (amaryllidaceae)

Unit VIII: Seed production in temperate vegetables
Seed production in cabbage, cauliflower (cruciferae) –carrot (umbelliferae) and beetroot (chenopodiaceae) - peas and french beans (fabaceae) - potato (solanaceae)

Unit IX: Seed production in flowers
Seed production - flower crops – marigold, chrysanthemum and annuals

Practical
Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production in self and cross pollinated crops. Seed processing machines. Visit to seed production units.

HOR-UG-605: Horti-Business Management

Unit I: Farm management
Definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships,

Unit II: 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.

Unit III: 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.

Unit IV: Direction
Guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices.

Unit V: 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.

Unit VI: Materials management
Types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization.

Unit VII: 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.

Practical
Visit to the office of agricultural produces trading house, commercial farming units, processing units, markets.Project preparation, interaction with market personnel

HOR-UG-606: Organic Farming

Unit I: Introduction
Introduction, concept, relevance in present context; Organic production requirements;

Unit II: Biological intensive nutrient management
Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues,

Unit III: Biofertilizers
Biofertilizers; Soil improvement and amendments;

Unit IV: Organic disease, pest and weed management
Use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management;

Unit V: Organic certification
Certification, Quality considerations, labeling and accreditation processors, marketing, exports.

Practical
Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post harvest management.
Visit to an organic certified village and interaction with the members of small farm holder group regarding quality standard, inspection, certification, labeling and accreditation for farm produce. Bio fertilizer, Bio control agents, Botanicals

HOR-UG-607: Introductory Agroforestry & Agri-Horti-Tourism

Unit I: Agroforestry
Definition, objectives and potential. Distinction between agroforestry and social forestry. Status of Indian forests and role in India farming systems.

Unit II: Agroforestry system, sub-system and practice
Agri-silviculture, silvipastoral, horti-silviculture, hortisilvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations.

Unit III: Planning for agroforestry
Constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry.

Unit IV: Agroforestry projects
National, overseas, MPTS – their management practices, economics of cultivation – nursery and planting (*Acacia catechu, Dalbergia sissoo,, Tectona, Populus, Morus, Grewia, Eucalyptus, Quercus* spp. and bamboo, tamarind, neem etc.)

Unit V: Introduction to rural and green tourism
Community-based tourism, home stay villages, types of attributes and their corresponding levels, Peri urban cultivation

Unit VI: Research related to tourism
Seasonality, experiences, and events; mass tourism, type of accommodations, log cabins and CONDO to motels; farm inns, experiences, events and meals, the cost factors

Unit VII: History of Green Tourism
Promotion policies and its potential success, Horti tourism in Sikkim.

Practical
Identification and seeds and seedlings of multipurpose tree species. Nursery practices for poplar, *Grewia optiva, Morus alba, Acacia catechu, Dalbergia sissoo,* robinia, leucaena, *Alnus*, Teak etc. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry plantations – 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.

HOR-UG-608: Orchard Management

Unit I: Introduction
Orchard management, importance, objectives, merits and demerits

Unit II: Floor Management
Clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches.

Unit III: Cropping system
Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, Crop model and crop regulation in relation to cropping systems.

Unit IV: Irrigation, nutrition pest management

Systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Integrated nutrient and pest management. Utilization of resources constraints in existing systems.

Practical

Layout of different systems of orchard 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.

SEMESTER VII

HOR-UG-701: EXPERIENTIAL LEARNING (Rural Horticulture Work experience (RHWE) & Industrial/Institutional attachment)

To inculcate professional attitude one full semester the students will be attached with village/industry/institutes connected with horticulture activities.

Orientation	– 3 weeks
RHWE	- 7 weeks
Industrial attachment	- 3 weeks
Institutional attachment	- 3 weeks
Report writing & Evaluation	- 2 weeks

HOR-UG-702: All India Study Tour (winter vacation)

Visit to to the research institutes of various agro climatic regions and horticulture zones of India. Report writing & viva voce.

SEMESTER VIII

HOR-UG-801: EXPERIENTIAL LEARNING (Professional Package)

To inculcate entrepreneurship skill and confidence among the students studying horticulture as a major subject, it was felt that the graduates coming out must have adequate hands on experience on different aspects of horticulture for which provision for one semester of professional pachage with a total course credit of 15 has been made in the eighth semester. The following four areas have been identified and detailed as a model with different activities for learning and evaluation. The students would be required to prepare a work plan in the area selected with end-to-end approach *i.e* from purchasing the input to producing a product and marketing. It should have components of project development, monitoring and accounting. Students at the end of completion of project will submit report for evaluation. An advisor/faculty member will guide the students and supervise their work and a committee appointed by the Dean of the Faculty/Academic Executive will evaluate the

project. The evaluation will entail skills developed/learnt, proficiency in project execution, project report preparation followed by viva-voce.

Final year B.Sc (Hort.) students have to select any one area from the following to undergo specialized training.

I. Nursery Production and Orchard Management

1. Project proposal preparation
2. Nursery registration, methodology and processing of certification
3. Establishment and management of plant propagating structures
4. Plant tissue culture practices
5. Establishment of progeny blocks, identification of mother plants and maintenance of bud wood bank
6. Procurement of inputs (pots, polythene, FYM etc.)
7. Techniques and environment management for large scale production
8. Packaging and selling of plant material
9. Working out economics
10. Project report preparation
11. Viva -voce

II. Floriculture

1. Project proposal preparation
2. Soil and water analysis, preparation of land and layout
3. Visit to flower growing areas and export house
4. Specialized lectures by the experts
5. Production and management of commercial flowers
6. Harvesting and post harvest handling of produces
7. Marketing of produces
8. Cost analysis
9. Institutional management
10. Attachment with private landscape agencies
11. Planning and designing, site analysis, selection and use of plant material for landscaping
12. Formal and informal garden, features, styles, principles and elements of landscaping
13. Preparation of landscape plans of home gardens, farm complexes, public parks, institutions, highways, dams and avenues
14. Making of lawns, use of software in landscape
15. Making of bouquets, button hole, wreath, *veni* and *gajras*, car and marriage palaces
16. Dry flower technology (identification of suitable species, drying, packaging and forwarding techniques)
17. Project report preparation
18. Viva-voce

III. Protected Cultivation of High Value Horticultural Crops

1. Project proposal preparation
2. Specialized lectures by the commercial flower experts
3. Study of designs of green house structures for cultivation of crops
4. Land preparation and soil treatment

5. Visit to commercial poly houses
6. Planting and production:
- ❖ Cultural management including soil/media management in poly house
- ❖ Fertigation and irrigation management
- ❖ Integrated Pest Management
- ❖ Harvesting and Post harvest management, certification and distribution; cost of production

7. Visit to export houses
8. Market intelligence/survey
9. Marketing of produce
10. Cost analysis
11. Institutional management
12. Project report preparation
13. viva-voce

IV. Post Harvest Technology and value Addition

1. Project proposal preparation
2. Design and layout of pilot plant, cold store, grading-packing line cool-chain
3. Pre-harvest practices to extend shelf life
4. Quality standards of fruits and vegetable for processing
5. Procurement of raw material, inventory control
6. Post harvest handling; grading; packaging; cool chain transportation and storage of fresh produce
7. Processing (juice/pulp extraction, concentration, product preparation; dehydration, waste management; input quality control)
8. Packaging (bottling, corking, sealing, labeling, aseptic packaging, storage)
9. Quality laboratory exercises, quality assurance, analytical tools, hygiene, machinery maintenance, HACCP, International standards, FPO License, PFA standards, Codex law
10. Sales promotion, certification, distribution and marketing, banking, finance and institutional managements
11. Work experience in food processing unit.
12. Project report preparation
13. Viva-voce

HOR-UG-802: Physical Education/NCC/NSS

NSS: Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, non-formal education of rural youths, eradication of of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition.

NCC: Introduction to NCC, defence services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order match, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill, weapon training-rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and firecontrol orders, battle craft, field signals,

description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self defence, general principles, precaution and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defence, leadership and NCC song.

Physical Education: Introduction to physical education. Posture, exercise for goodposture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules are regulations of important games, skill development in any of the games-football, hockey, volleyball, badminton, throw ball, tennikoit. Participation in of the indoor games- shuttle badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events- broad jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running. Safety education, movement education, effective way of doing day-to-day activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience.

Grand Total **89+71= 160**