SYLLABUS FOR DOCTORAL DEGREE ENTRANCE EXAMINATION
(AGRICULTURE; HORTICULTURE & AGRICULTURAL
ENGINEERING) -2016

FACULTY OF AGRICULTURE:

1. AGRICULTURAL CHEMISTRY AND SOIL SCIENCE


2. AGRICULTURAL BIOCHEMISTRY


3. AGRICULTURAL CHEMICALS

Surface chemistry, pH, Buffer solutions; Redox reactions, Chemical kinetics, Stereochemistry and chirality, diastereoisomerism, tautomerism, atropisomerism, asymmetric synthesis, nomenclature of organic molecules, displacement, elimination, addition, rearrangement, SN1 and SN2 reactions, reaction involving free radicals, and carbene intermediates, Organic reagents and catalysts in organic synthesis,. Beckmann, Claisen condensation, Hofmann-Löffler-Freytag reaction, Petri-Buchi reaction, Curlius, Michael, Kolbes, Arndt-Eistert and Wittig reaction. Reformatsky reaction., Barton reaction, Umpolung reaction, Norrish Type I & II reactions. Basic principles and application of chromatography; column, paper, thin layer, and ion exchange chromatography; gas liquid chromatography (GLC); high performance liquid chromatography (HPLC); UV, FT-IR; NMR and mass spectroscopy; GC-MS and LC-MS techniques and their applications. Extraction of natural products; Classification, structure, chemistry, properties and function of carbohydrates, proteins, amino acids, enzymes, nucleic acids, vitamins, lipids, and polymers. Chemistry of terpenoids, alkaloids, phenolics, plant pigments, steroidal and triterpenic saponins and sapogenins; juvenile and molting hormones; Plant derived nutraceuticals; Chemistry of natural antioxidants and food colorants and their application in human and crop health. Biosynthetic pathways of natural products. Natural pyrethrroids, nicotine, rotenone, neem and karanj based botanical pesticides; microbial macrolides (avermectins and milbemycins), agricultural antibiotics, semiochemicals; insect pheromones-types and uses, insect hormones, insect growth regulators; Plant hormones, phytoallaxins, essential oils and their pest control properties; advantages and limitations of natural pesticides; juvenile hormones, juvenile hormone mimics and anti-JH; chemosterilants, insect antifeedants, insect attractants and repellents; microbial pesticides; Application of plant biotechnology in crop protection, herbicide tolerant and insect resistant transgenic plants. History, scope and principles of chemical insect control; Insecticides and their classification Chemistry of major groups of insecticides (organo-chlorine, organo-phosphorus, organo-carbamates, synthetic pyrethroids, neonicotinoids), fungicides (inorganics, dithiocarbamates, OP’s, phenols, quinines, carboxamides, azoles, methoxyacrylates), rodenticides, Insect growth regulators; Chitin synthesis inhibitors, insecticide synergists, fumigants. Mode of action of different groups of insecticides, fungicides and nematicides. Physical, chemical and toxicological properties of different groups of herbicides (pheoxyacids, carbamates, amides, tiazines, phenyl ureas, dinitroanilines, bipyridiliums, sulfonlyl ureas), Herbicide safeners, Plant growth regulators – auxins, gibberellins, cytokinins, ethylene, abscisic acid; Brassinolides; Mode of action of different groups of herbicides. Basic concepts of pesticide formulation - classification, solid and liquid formulations; preparation, properties, uses; controlled release formulations; Formulants - carriers/ diluents, surfactants, encapsulants, binders, anti-oxidants, stabilizers; Application - devices and quality of deposits; Types of spray appliances, seed treatment and dressing; nanotechnology in crop protection, Tools to develop and measure nanoparticles. Pesticide residues- concepts and toxicological significance; pesticide
dynamics in agro ecosystem, biotic and abiotic transformations affecting fate of pesticides. Experimental design, sampling, principles of extraction and clean-up from different substrates; Application of ELISA and radiotracer techniques in pesticide residue analysis; new cleanup techniques, QUECHERS, ASE (Accelerated solvent extraction); Multi-residue methods; Bound and conjugated residues; Method validation - linearity, LOD and LOQ, microbial and photochemical degradation, adsorption/ desorption, leaching in soil. Production, consumption and trade statistics of pesticides and fertilizers; banned and restricted pesticides, registration and quality control of insecticides; Laws, Acts and Rules governing registration and regulations of agrochemical production and use; key provisions of the Insecticides Act (1968), Environmental Protection Act (1986). Pesticide Management Bill, EPA, Food Safety and Standards Act, WHO, FAO, CODEX and national/international guidelines; Quality Control, Sanitary / phyto-sanitary issues in relation to food safety, good laboratory practices, Accreditation certificate, Pesticide stewardship. Soil, plant and microbial biodiversity, Characteristics and classification of natural resources; Major soil groups of India their characteristics, management strategies for natural resources; integrated pest and pesticide management; Essential plant nutrients (major, secondary and micro), organic manures (farm yard, compost, sewage sludge, green manure, biogas slurries, etc); production and manufacture and uses of various nitrogenous, phosphatic, potassic and complex fertilizers and fertilizer mixtures, liquid fertilizers, biofertilizers, integrated plant nutrient systems; benefits, disadvantages and environmental toxicity. Nitrification inhibitors to enhance nitrogen use efficiency, Hydrogels and their application in agriculture, soil conditioners and amendments, toxicity issues. Problems of pesticide hazards and environmental pollution; Adverse effects of pesticides on micro-flora, fauna and on other non-target organisms; Effect of pesticide on soil health, persistent organic pollutants, and their effect on ecosystem. Adverse effect of industrial effluent on the soil and aquatic environment; disposal of obsolete and outdated pesticides; physical, chemical and microbial decontamination and detoxification of pesticides. Agrochemicals and homeland security, misuse of agrochemicals (pesticides and fertilizers), hazard mitigation plans or strategies, analytical and bioassay techniques to assess off-farm migration of agrochemicals into natural waters, ozone depletion causing agrochemicals. Methods of statistical analysis as applied to agricultural data – standard deviation, standard error, accuracy and precision, analysis of variance (ANOVA), correlation and regression; Hest, chi-square (X2), F test., Probit analysis.

4. AGRICULTURAL ECONOMICS

Role of agriculture in economic development; growth and development, characteristics of developing and developed economies; theories of development; role of economic, technological, social, cultural, political and environmental factors; interdependence between agricultural and industrial development; growth models - Harrod-Domar, neo-classical, Von Neumann; development strategies in India; five-year plans and agriculture. Agricultural growth analysis - determinants of agricultural growth and their measurements; planning models, features of planning in capitalist, socialist, neo-socialist and mixed economies; types of planning - micro level, regional, sectoral, agro-eco regional development; role of non-government organisations (NGOs) and self help groups (SHGs) in agricultural development; characterizing agricultural growth, changes in cropping pattern, decomposition analysis and sources of output growth; analysis of instability; capital formation, crop livestock insurance, infrastructure; transfer of technology - constraints to technology adoption, yield gap analysis and research planning; agricultural information system. Agricultural policy analysis and reforms - energy, water, fertilizer, land, seed, labour, technology, rural infrastructure, marketing, pricing, trade etc. Concepts of food security, production oriented policies, food price policies, food subsidies, food
safety net and food quality. Measurement of poverty, poverty alleviation programmes. Characteristics and classification of natural resources; sustainability issues in natural resources; role of economics in natural resource accounting, planning, management and policy formulation; social welfare function; allocation of renewable and non-renewable resources (forests, water, land, etc.) under various market structures: management strategies for major natural resources; Government programmes for conservation and development of natural resources. Basic principles of farm management - marginal returns, opportunity cost, cost substitution, equimarginal returns, enterprises combination, time comparison and comparative advantage; cost concepts and analysis; farm efficiency measures; farm financial analysis; farm planning and budgeting; book keeping and accountancy; process of decision making under different knowledge situations; measurement and management of risk and uncertainty in agriculture (including livestock, horticulture, fisheries, forestry, etc.), diversification and insurance in agriculture and allied sectors. Forms and applications of production functions - linear, quadratic, square root, spillman, cubic, semi-log, Cobb-Douglas, constant elasticity of substitution (CES), variable elasticity of substitution (VES), etc; dualities between production, cost and profit functions; derivation of supply and factor demand functions from production and profit functions; optimization of resource allocation; product-product relationships; resource-enterprise organization; resource-use efficiency and returns to scale; frontier production function; total factor productivity; rainbow (green, white, yellow, blue, etc.) revolution. Importance of agricultural finance; rural credit structure-demand, supply, sources and forms; estimation of credit requirement; cost of credit/capital; credit appraisal- 3 Rs and 3 Cs of credit; reforms in agricultural credit policy; innovations in agricultural financing - microfinance, kisan credit cards; role of institutions in agri-finance - public and private sector banks; cooperatives, micro-finance institutions (MFIs), SHGs; international financial institutions; principles of agricultural financial management; successes and failures of co-operative sector in India; Role of co-operatives under emerging economic scenario; agricultural project analysis; Internal Rate of Return (IRR), Benefit Cost (B-C) ratio analysis. Marketing in a developing economy; structure, conduct and performance analysis; marketable and marketed surplus; marketing functions; processing, transportation, storage and warehousing; forward trading, futures market; and commodity boards; channels in marketing, price spread and efficiency; problems in marketing agricultural produce; government interventions including regulated markets, procurement, buffer stock operations, co-operative marketing etc.; demand and supply models-formulation, estimation and projections; marketed surplus models: marketing of agricultural inputs; market integration; price stabilization measures and policies. The agribusiness system; management processes, planning, controlling, organizing, motivating and leading; decision making; managerial skills; level of managers; organizational context of decisions; decision making models; management by objectives; organizational culture; management of organizational conflicts; managing change; leadership styles; group dynamics; motivation. Human resource planning, job analysis and design; recruitment, selection, induction and placement; human resource training and development; management development; performance appraisal and job evaluation; wage and salary administration; promotion, transfer, separation, absenteeism and turnover, employee welfare and safety; morale; personnel supervision; styles; participative management; labour management relations; negotiation and negotiating skills; conflict management. Fundamentals of accounting and book-keeping; objectives and functions of financial management; analysis of financial statements- balance sheet, income statement, cash flow statement; capital structure theories; sources of long term finance and cost of capital; concepts of components of working capital, managing working capital - cash management, dividend decision; capital budgeting, appraisal criteria; agribusiness financing system in India-money and capital markets, national, regional and global financial institutions; rural insurance; risk management; micro-credit. Indian marketing environment; rural marketing; agricultural marketing system, wholesaling and retailing, consumer behaviour; the buying process; marketing mix; marketing strategy; planning
marketing mix; market segmentation; land targeting; marketing organization, marketing information system, market research, marketing extension; rural retailing; international marketing and finance. Operations management of an agro-industrial unit including operations system and processes; productivity of operations; work force productivity; facilities management; operations planning and control; material and supply chain management; quality management. Strategic management – meaning, concept and scope; framework for strategic management; industrial (external) and organizational (internal) environmental factors influencing strategy; scanning the external and internal environment; strategy formulation; SWOT analysis; strategy implementation; strategy and structure, strategic analysis, strategy and technology, strategy and leadership, total quality management, the customer resource, development of strategy, creating competitive advantage strategy, evaluation of strategy. Entrepreneurship and small business concepts; process of business opportunity identification; project feasibility study; detailed business plan preparation; managing small enterprises; planning for growth; sickness in small enterprises; government policies for promotion of small and tiny enterprises; rehabilitation of sick enterprises; entrepreneurship.

5. AGRICULTURAL EXTENSION


6. AGRICULTURAL METEOROLOGY & PHYSICS

Laws of radiation: Planck's law, Stephan-Boatman law, Wein's displacement law; Kirchoff’s law, Beer's law and Lambert's, Cosine law, Solar constant, length of day;

Atmospheric and astronomical factors affecting depiction of solar radiation; Ozone hole; Direct and diffuse radiation; Heat transfer, convection, conduction and radiation; Concepts of latent and sensible heat; Radiant flux and flux density; Atmospheric motion balanced forces; Gas laws, pressure gradient, isobars, hydraulic equation and its application; Carioles force, geotropic, gradient and cyclostrophic winds; Pressure systems; Cyclones and anticyclonic motions: trough, ridge and col; Thermal wind; Contour charts, Concepts of specific heat at constant volume and pressure; First and second laws of thermodynamics, vapor pressure, specific humidity, relative humidity, mixing ratio, absolute humidity and dew point temperature; Vapour pressure deficit; Psychometric equation, entropy, T-phi gram; Vertical stability of atmosphere, virtual temperature and potential temperature; Moist and dry adiabatic processes; Clouds their description and classification; Condensation process-artificial rain making; Bergeron-Findegson theory; Dew, frost, fog, mist, haze thunderstorm and hail; Air masses and fronts; Extra tropical cyclones; Land and sea breeze; Mountain and valley winds; Tropical cyclones and their structures; Weather variables and their measurements; Units for measurements of momentum, force work, power, surface tension, pressure, temperature; Thermal - conductivity and diffusivity, resistance, radiation light intensity and water vapour. Elements of weather and climate; Seasonal distribution of radiation, rainfall, temperature sunshine, wind pressure over India; Climatic classification - Koppen and Thornthwaite; Climatology principles of weather phenomena occurring in four main seasons of India; Mechanism of Indian monsoons; Climatic variability, recent trends, factor affecting rainfall distribution, cyclones and cyclonic tracks over the Indian region; North western disturbances and monsoon breaks; Drought climatology, rainfall and its variability, atmospheric and agricultural droughts intensity, duration, beginning and end of drought and wet spells; Moisture availability indices; Heat and cold waves; Contingents, maritime and monsoon climates, El-Niño, La Nino and their impact on Indian rainfall systems. Meaning and scope; Effect of thermal environment on growth and yield of crops; Cardinal temperatures; Thermoperiodism, photoperiodism; Vont Hoff’s law, phenology of crops; Heat unit concept, thermal time and thermal use-efficiency and their applications; Length of growing period determination. contingency planning far different weather aberrations; Meteorological factors associated with incidence and development of crop pests and disease, potato blight, apple scan, groundnut red hairy caterpillar, locust etc.; Effect of climate on humans and animals, warm and cold season indices for comfort zones, role of weather in animal disease
and protection against weather hazards. Concept of micro, meso and macro meteorology; micrometeorological processes near bare ground and crop surfaces; shearing stress, molecular and eddy diffusion, forced and free convection; boundary layer, frictional velocity, roughness length and zero plane displacement; Micrometeorology of crops, rice and wheat; day and night radiation, humidity, temperature, wind and CO2 profiles in crop canopies; Richardson number, Reynolds analogy, exchange coefficients, fluxes of momentum, water vapors, CO2 and heat; inversion and its effect on smoke plume distribution; Windbreaks and shelterbelts, different methods on modification of field microclimate; frost protection, spectral properties of vegetation; light interception by crop canopies as influenced by leaf area index, leaf arrangement and leaf transmissibility, extinction coefficient and radiation use-efficiency; microclimatic conditions of field crops, forest and orchards etc.; Hydrological cycle and concept of water balance, concepts of evaporation, evapotranspiration, potential and actual evapotranspiration, consumptive use, different approaches of ET determination empirical methods, energy balance and Bowen's ratio methods, water balance single and multilayered soil methods, aerodynamic, eddy correlation and combination approaches, field lysimetric approaches and canopy temperature based methods; Advantages and limitations of different methods; Water use and water use-efficiency, dry matter production and crop yield functions; Irrigation scheduling based on ET; advective energy determination and its effect on water use by crops; Physiological variation in relation to crop growth and development. Concepts of mechanistic and deterministic models; General features of dynamical and statistical modeling techniques; Crop weather models and their use in crop yield assessments; Crop weather analysis models, empirical, statistical models, and crop growth simulation models for yield assessment; Use of SPA and CERES models, concepts for crop growth and yield; Advantages and limitations of modeling, climatic change, greenhouse effect, CO2 increase, global warming and their impact on agriculture. Crop weather calendars: Short, medium and long range weather forecasting; monsoon onset and rainfall forecasts; Weather forecasting and agro-advisories; Use of satellite cloud imageries in weather forecasting; Synoptic charts and synoptic approach to weather forecasting, use of medium, long range and vegetative indices based agro meteorology forecasts for monitoring crop prospects and crop yield forecasts; Meteorological satellites for weather forecasts; Forecast of Indian monsoon rainfall; Early warning systems for agriculture operation forecasts.

7. AGRICULTURAL STATISTICS


Balanced incomplete block designs and their analysis with and without recovery of inter block information. Partially balanced incomplete block designs with two associate classes, lattice designs. Youden square design. Multiple comparison procedures. Fractional replication of symmetrical factorials, confounding in asymmetrical factorial experiments. Response surface designs, second order rotatable designs. Combined analysis of groups of experiments. Sampling in field experiments. Experiments on cultivators’ fields.


Computer Organization and Architecture- number system, input/output unit, memory, arithmetic logic unit and control unit.

Computer algorithms. Programming in C-Building blocks, control structures, arrays, pointers, dynamic memory allocation, file management. Data Structures linked list, stack, queue, tree, graph, sorting and searching algorithms. Data Base Management System definition and features,
data models, relational database. Object oriented programming encapsulation, inheritance, polymorphism with C++/JAVA.

Networking need, basic concepts, types of networks. Connecting computers local area networks, wide area networks. Value added network services E-mail, on-line services, Internet, etc. Hyper Text Markup Language (HTML), Building static and dynamic web pages. Numerical analysis interpolation, numerical integration, solution of ordinary differential equations, solution of linear and non-linear system of equations. Modeling and simulation random number generation and testing, discrete simulation models, simulation of stochastic events and processes, design of simulation experiments, analysis of data generated by simulation experiments, validation of simulation models. Linear Programming formulation and graphical solution, simplex method, duality, transportation and assignment problems.

8. AGRONOMY

Principles of crop ecology; Ecosystem concept and determinants of productivity of ecosystem; Physiological limits of crop yield and variability in relation to ecological optima; Crop adaptation; Climate shift and its ecological implication; Greenhouse effect; Agro-ecological and agro climatic regions of India; Geographical distribution of cereals, legumes, oilseeds, vegetables, fodders and forages, commercial crops, condiments and spices, medicinal and aromatic plants; Adverse climatic factors and crop productivity; Photosynthesis, respiration, net assimilation, solar energy conversion efficiency and relative water content, light intensity, water and CO2 in relation to photosynthetic rates and efficiency; Physiological stress in crops; Remote sensing: Spectral indices and their application in agriculture, crop water stress indices and crop stress detection. Scope and principles of weed management; Weeds’ classification, biology, ecology and allelopathy; Crop weed competition, weed threshold; Herbicides classification, formulations, mode of action, selectivity and resistance; Persistence of herbicides in soils and plants; Application methods and equipment; Biological weed control, bio-herbicides: Integrated weed management; Special weeds, parasitic and aquatic weeds and their management in cropped and non cropped lands; weed control schedules in field crops, vegetables and plantation crops; Role of GM crops in weed management. History of soil fertility and fertilizer use; Concept of essentiality of plant nutrients, their critical concentrations in plants, nutrient interactions, diagnostic techniques with special emphasis on emerging deficiencies of secondary and micronutrients; Soil fertility and productivity and their indicators; Fertilizer materials including liquid fertilizers, their composition, mineralization, availability and reaction products in soils; Water solubility of phosphate fertilizers; Slow release fertilizers, nitrification inhibitors and their use for crop production; Principles and methods of fertilizer application; Integrated nutrient management and bio-fertilizers; Agronomic and physiological efficiency and recovery of applied plant nutrients; Criteria for determining fertilizer schedules for cropping systems direct, residual and cumulative effects; Fertilizer related environmental problems including ground water pollution; Site-specific nutrient management; Contamination of heavy metals in peri-urban soils and their remediation. Concept of dryland farming; dryland farming vs rainfed farming; History, development, significance and constraints of dryland agriculture in India; Climatic classification and delineation of dryland tracts; Characterization of agro-climatic environments of drylands; Rainfall analysis and length of growing season; Types of drought, drought syndrome, effect on plant growth, drought resistance, drought avoidance, drought management; Crop Planning including contingency, crop diversification, varieties, cropping systems, conservation cropping and mid-season corrections for aberrant weather conditions; Techniques of moisture conservation in-situ to reduce evapotranspiration, runoff and to increase infiltration; Rain water harvesting and recycling concept, techniques and practices; Timelines and precision key factors for timely sowing, precision in seeding, weed control; Fertilizer placement, top dressing and
foliar application, aqua-fertigation; Concept and importance of watershed management in dryland areas. Problem soils and their distribution in India, acid, saline, waterlogged and mined soils; Response of crop to acidity, salinity, sodicity, excess water and nutrient imbalances; Reclamation of problem soils, role of amendments and drainage; Crop production techniques in problem soils - crops, varieties, cropping system and agronomic practices; Effects of water table fluctuation on crop growth; Degraded lands and their rehabilitation. Crop production techniques for cereals, millets, legumes, oilseeds, fiber crops, sugarcane, tobacco, fodder and pasture crops including origin, history, distribution, adaptation, climate, soil, season, modern varieties, fertilizer requirements, intercultural operations, water requirement, weed control, quality components, industrial use, economics and post harvest technology. Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Tests of significance-t, F and chi-square (X2); Data transformation and missing plot techniques; Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs; Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis. Concept of sustainability; Sustainability parameters and indicators; Conservation agriculture; Alternate land use systems; Types, extent and causes of wasteland; Shifting cultivation; Agro forestry systems; Agricultural and agro-industrial residues and its recycling, safe disposal; Allelopathy and biomass production. Soil and water as vital resources for agricultural production; Occurrence of groundwater, groundwater aquifers, exploration of groundwater; Hydrological cycle; Soil-plant water relationship; Fate of rain water received at the soil surface, runoff and infiltration reciprocity, factors affecting infiltration, means to enhance infiltrability of soil, mechanical and biological means to reduce runoff and soil loss; Water harvesting for crop life saving irrigations; watershed management; Soil and water conservation; Contingent crop plans and other strategies for aberrant weather conditions; Cropping patterns, alternate land use and crop diversification in rainfed areas; Analysis of hydrologic data and their use. Soil water relations, water retention by soil, soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water; Soil irrigability, classifications, factors affecting profile water storage; Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head; Movement of soil water saturated and unsaturated water flow; Field water budget, water gains and water losses from soil, deep percolation beyond root zone, capillary rise; Evapotranspiration (ET), scope for economizing water, measures for reducing direct evaporation from soil and crop canopies; Soil physical properties in relation to plant growth and development; Erodability of soils and their prevention. Plant water relations: Concept of plant water potential, cell water relations, plant water potential and its components; Significance of osmotic adjustment, leaf diffusive resistance, canopy temperature, canopy temperature depression (CTD); Water movement through soil - plant atmosphere systems, uptake and transport of water by roots; Development of crop water deficit, crop adaptation to water deficit, morpho physiological effect of water deficit; Drought tolerance, mechanisms of drought tolerance, potential drought tolerance traits and their measurements, management and breeding strategies to improve crop productivity under different patterns of drought situations of limited water supplies; Effect of excess water on plant growth and production; Types of droughts, drought indices. Management of irrigation water; History of irrigation in India; Major irrigation projects in India; Water resources development; Crop water requirements; Concepts of irrigation scheduling, Different approaches of irrigation scheduling; Soil water depletion plant indices and climatic parameters; Concept of critical stages of crop growth in relation to water supplies; Crop modeling, crop coefficients, water production functions; Methods of irrigation viz. surface methods, overhead methods, drip irrigation and air conditioning irrigation, merits and demerits of various methods, design and evaluation of irrigation methods; Measurement of irrigation water, application and distribution efficiencies; Management of water resources (rain, canal and
ground water) for agricultural production; Agronomic considerations in tile-design and operation of irrigation projects, characteristics of irrigation and family systems affecting irrigation management; Irrigation legislation; Water quality, conjunctive use of water, irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal command areas; Socio-economic aspects of on-farm water management; Irrigation water distribution, Irrigation efficiencies; Design of irrigation canals, design of irrigation structures; Interaction between irrigation and fertilizers. Problem soils and their distribution in India; Salt-affected, acidic, water logged soils; Ground water resources, water quality criteria and use of brackish waters in agriculture; Excess salt and salt tolerant crops; Hydrological imbalances and their corrective measures; Concept of critical water table depths for crop growth; Contribution of shallow water table to crop water requirements; Management strategies for flood prone areas crop and crop calendar for flood affected areas; Drainage for improving water logged soils for crop production; Crop production and alternate use of problematic soils and poor quality water for agricultural and fish production; Amelioration of salt affected soils.

9. ANIMAL SCIENCE


Centres, Lab to Land Programme, Operational Research Project, National Agricultural Research Project, Agricultural Technology Management Agency, National Agricultural Innovative Project. Understanding the functioning of livestock development institutions - DRDA, NABARD, Insurance Companies, NGOs. Integrated livestock farming system: Scope and
limitation of integrated farming systems - Sustainability of integrated Livestock Farming Systems and their economic importance. Integration of fish, arable farming and different livestock enterprises vis-à-vis gobar gas plant, FYM, solar and wind energy utilization, cattle, buffalo sheep, goat, pig, poultry, rabbit, silk worm, bee keeping etc. New approach for changing farming systems in present energy crises. Project formulation and evaluation of various livestock enterprises.

10. AGRICULTURAL ENTOMOLOGY

and insect products in medicines. Usefulness of insects in scientific investigations, insects as food. Frequency distribution, mean, mode and median. Standard, normal, binomial and Poisson’s distribution. Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi-square, Duncan’s multiple range tests. Design of experiments: Principles of Randomized block design, completely randomized block design, Latin square design, Split-plot designs. Probit analysis. Use of software packages like SPSS, SAS, etc. for the above tests and designs of experiments for analysis.

11. GENETICS & PLANT BREEDING


12. PLANT PATHOLOGY


13. PLANT PHYSIOLOGY


14. SEED SCIENCE & TECHNOLOGY

Floral biology, mode of reproduction, sporogenesis, pollination, fertilization, embryogenesis, fruit and seed development. Apomixis, parthenocarpy, polyembryony and somatic embryos and synthetic seeds. Seed structure of monocot and dicot. Seed maturation and longevity in orthodox and recalcitrant seed. Chemical composition of seed. Seed dormancy - types, causes and mechanisms of induction and release, factors affecting, methods to overcome dormancy and its significance in agriculture. Seed germination - requirements, imbibition pattern, physiological and biochemical changes, and role of hormones. Introduction to crop breeding methods. Variety testing, release and notification. Genetic purity concept and factors responsible for deterioration of varieties. Maintenance breeding. General system of seed multiplication. Seed production agencies. Identification of seed production areas and factors affecting it. Compact area approach in seed production. Seed production planning, equipment, input and manpower requirement. Factors affecting pollination and seed set viz., temperature, humidity, wind velocity, insect pollinators, and supplementary pollination. Male sterility, self-incompatibility and their role in hybrid seed production. Principles and methods of seed production of varieties and hybrids of cereals like wheat, paddy, sorghum, pearl millet and maize; pulses like chickpea, pigeon pea, green gram, black gram, soybean and cowpea; oilseeds like groundnut, brassica, sesame, sunflower and castor; fibre crops like cotton and jute; vegetables crops like tomato, brinjal, okra, chilli, important cole and cucurbitaceous crops; important forage legumes and grasses and seed crop management, time of harvesting and threshing/extraction methods. Seed production technology of plantation crops like coffee, tea, rubber, cocoa, cardamom and pepper. Disease free clonal propagation of crops like potato, sugarcane sweet potato, tapioca, colocasia, betel vine, fruit crops like mango, citrus, banana, guava, sapota, pineapple, grape, apple, pear, plum, peach, apricot and seed production and clonal propagation of annual and perennial flowers like

15. SOIL & WATER CONSERVATION


Concept and definition of watershed, classification of watershed, shape and nature, importance of watershed management and its role in conservation of natural resources – soil, water and vegetation. Concept of water harvesting and runoff recycling, preparation of watershed management plan, selection of pond size and design of a pond, sedimentation problem in watershed, seepage control, watershed management for runoff and sediment control – economical aspects of watershed management.


characteristics in soil, soil moisture characteristics, soil moisture constants. Soil moisture diffusion. Open channel hydrology, manning’s Co-efficient, wetted perimeter etc. Flow of water – V-notch, orifice, Parshall flume etc. Water stage recording. Concepts of open and close aquifers.


Monsoon- types and behavior in India, rainfall – characteristics and distribution, onset and withdrawal of effective rains, dry spells and wet spells, critical dry spells, water loss from the soil, measurement and factors, hydrological cycle, Importance and issues relating water status. Rainwater harvesting- methods, classes, benefits, approach, water saving technologies, rainwater harvesting and draught mitigation, crop productivity and water security.


Irrigation and drainage relations, sources of excess water and salts in soil. Development of drainage problems in different crops and soils, agricultural drainage – waterlogging, surface drainage and subsurface drainage, impact of waterlogging and drainage, drainage requirement of crops, drainage coefficient. Biodrainage - drainage alternatives.

Soil as a natural body, soil evolution, soil morphology and methods of its study. Soil development, soil formation – factors and process, pedons and polypedons, soil taxonomy – epipedons, diagnostic subsurface horizons, soil moisture and temperature regimes, USDA classification systems : order, sub-order, great group, sub-group, family, series, types, phase, benchmark soils.

Concept of soil moisture conservation, use and methods, rainfall and temperature distribution in India and rainfed farming areas. Soil water relation in rainfed farming – infiltration and available moisture storage. Soil moisture conservation measures – tillage, mulches – their different kinds, effectiveness and economics, draught resistance in crop, mechanism for draught situation, shoot and root growth characteristics. Water harvesting and life
saving irrigation. Moisture use efficiency and economics of conservation technique in low rainfall areas.

Basic concept of remote sensing, satellite remote sensing, satellite orbits, stages of remote sensing, band used in remote sensing, major components of remote sensing technology, various platforms and sensors, active and passive remote sensing. Characteristics of electromagnetic radiation and its interaction with matter; sensors in visible, infrared and microwave regions. Characteristics of Different satellites like IRS, INSAT, LANDSAT etc. Microwave remote sensing. Introduction to GIS and GPS. Software and hardware requirements in GIS. Application of remote sensing data in agriculture with special emphasis on soil and water conservation.

FACULTY OF HORTICULTURE: (Course outline)

1. VEGETABLE CROPS

Importance, area, production and productivity, nutritional value and importance of vegetable and tuber crop; origin, distribution: classification of vegetables, types of vegetable growing, regions of cultivation and export and import of these commodities.
Definition of growth and development, dormancy and rest period, physiology of flowering, chemical induction of flowering, sex expression and alteration, fruit set and development, fruit drop, parthenocarpy, seedlessness; role of auxins, gibberellins, cytokinins, ethylene and other growth regulators including retardants in vegetable and tuber crop production.
Use of poly houses in vegetable production; drip and sprinkler irrigation, fertigation, shading; off-season production of high value vegetable crops; weed, insect nematode and disease control including IPM and organic farming
Soil and climate; seed rate, important varieties, nutritional requirements, deficiency disorders and corrective measures, irrigation spacing of important vegetables like, cole crops, cucurbits, bulb, root and tuber crops, solanaceous vegetables, leguminous vegetables, leafy vegetables, okra, etc.
Seed morphology, development, environmental factors responsible for belting and flowering, pollination systems, isolation, roguing and certification; seed production , storage and viability in important crops like tomato, chilli, brinjal, okra, onion, cucurbits, cole crops, and seed spices like fenugreek, coriander, cumin, fennel, etc; hybrid seed production.
Nursery establishment, preparation of soil mixtures, soil sterilization, containers, watering and plant protection practices; Use of vegetative propagation for vegetable and tuber crops.
Principles, problems and prospects of improvement of vegetable and tuber crops; introduction, selection including clonal selection and hybridization, mutation breeding, polyploidy and heterosis breeding for specific purposes like productivity, resistance to biotic and abiotic stresses and processing; recent advances in breeding including biotechnological approaches. Breeding objectives and advances made in important vegetables crops.

2. SPICES AND PLANTATION CROPS

Growth and development of spices and plantation crops; nursery management of spices and plantation crops; growth substances for production of spices and plantation crops; Nursery establishment, preparation of soil mixtures, soil sterilization, containers, watering and
plant protection practices; use of vegetative propagation, selection of shoots in pepper and nutmeg, selection of rhizomes in cardamom, turmeric and ginger.

Modern production technology of plantation crops covering soils and climate; propagation, varieties; planting and planting density; training and pruning; nutrition and irrigation; weed, disease and pest control including IPM of important plantation crops like, coconut, arecanut, oilpalm, cashew, cocoa, tea, coffee, rubber, bête vine.

Soil and climatic seed rate, important varieties, spacing, irrigation, nutritional requirement, deficiency disorders and corrective measures; pest and disease including IPM and organic farming of spice crops like, black pepper, chilli, ginger, turmeric, cardamom, coriander, cumin, black cumin, fennel, fenugreek, curry leaf, clove, nutmeg, cinnamon.

Principles, problems and prospects of breeding of plantation crops; floral biology; methods of improvement e.g. introduction, clonal selection, hybridization, mutation breeding, polyploidy and heterosis breeding; breeding objectives, problems and advances made in plantation crops e.g. coconut, arecanut, oilpalm cashew, tea, coffee, etc.

Principles problems and prospects of spice crops improvement; floral biology; introduction, selection including clonal selection and hybridization; mutation breeding, polyploidy and heterosis breeding for specific purposes like productivity, resistance to biotic and abiotic stresses and processing; recent advances in breeding including biotechnological approaches; breeding objectives and advances made in ginger, turmeric, coriander, fenugreek, black pepper, cardamom etc.

Seed morphology, development, environmental factors responsible for belting and flowering; pollination systems, isolation, roguing and certification; seed production; storage and viability in important seed spices like fenugreek, coriander, cumin, fennel, etc.

3. POST HARVEST TECHNOLOGY OF HORTICULTURAL CROPS

Post harvest physiology and biochemistry of fruits and vegetable; nutritive value and quality control; principles and causes of spoilage of horticultural products; principles and methods of processing; fruits and vegetable processing; packaging science; dehydration and fermentation technology.

Importance of post harvest handling in fruit, vegetable, spice and plantation crops; Maturity indices for harvesting and ripening; pre- cooling, various types of storage and storage temperatures; grading, packing and transportation; Storage disorders and use of chemicals, skin coatings and growth regulators for control of spoilage during storage and transit.

Factors affecting bud development, flower development and senescence physiology and biochemical change during flower senescence, effect of pre-harvest factors on harvest quality of cut flower, stages of harvest of commercial flowers, decline in vase life, floral preservatives, pulsing and holding solution, grading packing, storage and transportation of cut flower.

Harvesting with reference of maturity indices, grading, packing including consumer packaging, transport, Different methods of storage, storage temperatures disorders. Pre and post harvest treatments to control disorders; value-added products of fruits, vegetables, tuber crops, spices and plantation crops.

4. FRUITS AND ORCHARD MANAGEMENT

Area, production and productivity of fruits crops in India; nutritional value and importance in national economy of fruit crops; origin, distribution and classification of fruits crops into
temperate, tropical, sub-tropical, arid zone crops; classification of edible parts; regions of cultivation; export potential of different fruits; management of biodiversity and climate change.

Planning, layout and management of nurseries, soil mixtures, containers, soil sterilization, raising of seedlings, transplanting, packing and transport of nursery plants; importance of rootstocks, inter-stocks, apomixis and polyembryony; recent propagation techniques, method and time of propagation of different fruit crops; stionic incompatibility; role of chemicals in seed germination, root induction and seedling growth; propagation structures like mist chambers, hot beds and cold frames; advances in micro-propagation, shoot tip grafting.

Definition of growth and development; dormancy, rest period chilling requirements and heat units; physiology of flowering and chemical induction of flowering; fruit bud differentiation and fruit set, development, fruit drop and its control; parthenocarpy and seedlessness; role of auxins, gibberellins, cytokiins, ethylene, inhibitors and other growth retardants in fruit production.

Modern production technology of fruit covering soil and climate; propagation varieties; planting and population density; training and pruning; nutrition and irrigation; weed, disease and pest control including IPM and other orchard management practices of important fruit crops e.g. mango, citrus, banana, pineapple, papaya, guava, sapota, grape, litchi, pomegranate, ber, aonla, jackfruit, longan, olive, strawberry, apple, pear, stone fruits, etc.

Causes and recent advances in the control of alternate bearing, malformation, spongy tissue in mango; granulation and decline in citrus; bunchy top in banana; fruit drop and fruit cracking in citrus, mango, litchi and pomegranate; guava wilt: internal breakdown and bitter pit in apple, barrenness in grapes; management of biotic and abiotic stress

Principles, problems and prospects of fruit breeding; method of improvement e.g. introduction, clonal selection, hybridization, mutation breeding, polyploidy and heterosis breeding; breeding objectives, problems in improvement and advances made in important crops like mango, citrus, banana, grape, papaya, guava, apple, aonla and pomegranate, etc; advance in root stock breeding in apple, peach, pear, cherry, grape, citrus.

5. FLORICULTURE AND LANDSCAPING

Importance, area, production and productivity; Importance of flower in national economy; Origin, distribution and classification of flowers e.g. cut, loose, dry flowers, pot plants; and classification of ornamental plants e.g. annuals, biennials, edges, hedges, shrubs, climbers, trees bulbous plant, foliage plants, succulents, cactus and water loving plants; regions of cultivation, import and export.

Selection of site; layout, rooting media and its sterilization; recent propagation techniques; stock and scion relationship, method and time of propagation; raising of seedlings, Transplanting pruning, grading, packing and marketing; role of chemicals in seed germination, root induction and seedling growth; use of propagation of structures. e.g. hot bed, cold frame, mist propagation chamber, plastic tunnels and green houses.

Soil and climate; varieties; population density (seed rate) and planting, nutrition, irrigation, training, pruning and staking, weed, disease and pest control of important flower e.g. rose, carnation, chrysanthemum, gladiolus, marigold, tuberose, gerbera, aster, orchids, iris, anthurium, lilies, tulip, lotus and begonia.

Definition of growth and development; dormancy and rest period, physiology of flowering and biochemical changes during flower senescence, effect of pre-harvest factors on post harvest
quality of cut flowers, stages of harvest of commercial flowers, decline in vase life, floral preservatives, pulsing and holding solutions, grading packing, storage and transportation of cut flowers.

History of gardening in India; styles of gardening, their principles and practices with special reference to Mughal, Japanese, and English gardens; visual aspects of plants arrangement view; garden parts (features) their materials, and methods of garden development. Classification and utilization of ornamental trees, shrubs, climbers, annuals, edges, hedges, bulbous, succulents and cactus, foliage and water loving plants; preparation and management of shrubbery, herbaceous borders, lawn and bonsai; landscape gardening; planning of road side, home gardens, children, amusement and zoological parks; flower arrangement.

Principles of seed production, development, environmental factors for seed set, pollination system, isolation, rouging and certification, Hybrid seed production, seed harvesting, cleaning, storing, packing and marketing.

Principles, problems and prospects of ornamental plant breeding; methods of improvement i.e. introduction, clonal selection, hybridization for specific purposes, mutation breeding, polyploidy and heterosis breeding; breeding objectives and advances made in important crops like rose, gladiolus, carnation, chrysanthemum, marigold, aster, orchids, lilies, tulip, lotus, begonia and bougainvillea.

**FACULTY OF AGRICULTURAL ENGINEERING**

**1. FARM MACHINERY AND POWER**

Status of farm mechanization in India; power availability on farms; hand tools used for different kinds of farm operations and materials for construction. Functional requirement, principle of working, constructional features and operation of animal and power operated equipment for land development, tillage, sowing, planting, transplanting, fertilizer application, intercultivation, plant protection, harvesting, threshing, mowing, chaff cutting and baling; special equipment for crops such as sugarcane, cotton, groundnut, potato and plantation crops like coconut, areca nut, cashew nut etc. Design and selection of machinery elements viz. gears, pulleys, chains and sprockets, belts, bearings, couplings and springs and fasteners. Farm machine system characteristics and evaluation, dynamic balancing and stability of farm machines, force analysis on agricultural tools and implements, pull, draft, unit draft and power of farm equipment, design of soil working tools for sowing and planting; design of fertilizer applicators, intercultivation equipment, harvesters and threshers; pneumatic and hydraulic controls. Calibration of seed drills, planters, plant protection equipment; methods of testing and performance evaluation of tillage equipment, seed drills and planters, fertilizer applicators, sprayers and dusters, harvesting and threshing equipment, grain and straw combines, and special equipment such as sugarcane, cotton, rice and potato planter; calculations of field capacity, efficiency and rates of seed fertilizer and chemical applicators; calculation of capacity, efficiency and losses in threshers, harvesters and chaff cutters. Farm machinery selection and management for different soils, crops and operations; cost analysis of animal and tractor operated implements and tractors; matching power-implement system, estimation of energy and power requirements, reliability of farm machinery. Engineering thermodynamics, power cycles, fuels; various systems of IC engines; operations, adjustment and trouble shooting of different systems; calculations of power, torque, speed, firing arrangement and intervals, heat load and power transmission from piston to the flywheel; tractor power transmission, differential, final drives; power outlets such as P.T.O. and drawbar; recent trends in
tractor design; emissions and control of pollutants; mechanical and power steering; tractor chassis mechanics, hitching systems, hydraulic controls for tractors, automatic position and draft control; tractor performance tests, operation and maintenance tractors and power tillers. Anthropometry in equipment design, physiological cost and effect of work on physiological responses, fatigue and comfort; ergonomics in design of farm tools; safety aspects of agricultural machinery; effect of noise and vibration on work performance; chemical hazards and control measures; operator’s protective gadgets; design of tractor controls viz., hand and foot controls, visual range and limitations, seat design etc. Dynamic properties of soil and their measurements; stress-strain relationships; theories of soil failure, mechanics of tillage tools; design parameters and performance of tillage tools. Introduction to traction devices, tyre function and size, their selection, mechanics of traction devices, traction theories, slippage and sinkage of wheels, evaluation and prediction of traction performance; soil compaction - causes and methods for alleviating the effect on soil and crop responses. Conventional and renewable energy sources in agriculture; solar radiation and its measurement; characteristics of solar spectrum; solar energy collection, storage and applications; solar photovoltaic conversion and SPV powered systems. Types of wind mills and their applications; thermo-chemical conversion of biomass, direct combustion, Pyrolysis and gasification, chemical conversion processes, carbonization, briquetting, pelletization and densification of biomass; bioconversion into alcohols, methyl and ethyl esters, organic acids, solvents of amino acids; types of biogas plants, biogas properties, uses and distribution, alternate fuels for IC engines. Energy requirement in agricultural production systems, energy ratio and specific energy value, inflow and outflow of energy in unit agricultural operation, energy audit, accounting and analysis. Specification of materials, surface roughness, production drawing, computer aided drawing heat treatment, workshop practices applied in prototype production, common tools and press operations, metal cutting and machining, jigs, fixtures and gauges, casting and die-casting processes; basic joining processes, welding processes, weldments testing and metallurgy. Mechanical measurements, sensors and transducers, application of electrical strain gauges, signal transmission and processing, dynamic measurements; measurement of temperature, pressure, strain, force, torque, power vibrations etc.; determination of calorific value, fluid flow rates etc; signal conditioning and monitoring, data acquisition and storage.

2. SOIL & WATER ENGINEERING


3. POST HARVEST & FOOD ENGINEERING

Uniqueness of bio-materials and physical characteristics viz. shape, size, volume, density, porosity, surface areas, friction, rolling resistance, angle of repose. Properties of bulk particulate solids viz. specific surface area, mean diameter, flow rate. Aerodynamics drag coefficient and terminal velocity. Pressure drop through packed beds. Thermal properties such as specific heat, thermal conductivity, thermal diffusivity. Dielectric properties viz. dielectric and microwave radiation, dielectric constant, energy absorption, heating. Optical properties and transmittance and reflectance. Rheological properties and stress-strain-time relationship, rheological models, visco-elasticity, Hertz’s theory of contact stresses. Food Quality and BIS specifications for quality of food materials, milling quality analysis, cooking and baking qualities. Organoleptic and sensory evaluation of product quality. Determination of protein, oil content, carbohydrates, color, hardness, texture, nutritive value, bio-availability and microbial loads, non-destructive quality evaluation techniques. Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation, UV VIS NIR spectroscopy, X-ray, CT, NMR, machine vision. Maturity, ripening stages and indices of fruits and vegetables.

Basic laws of thermodynamics, thermodynamic properties and processes, energy equations, heat, work, heat engine, heat pump, refrigeration and steam tables. EMC, sorption and desorption isotherms, water activity and psychrometry. Modes of heat transfer, heat exchanger. Mass transfer and mass-heat-momentum transfer analogies. Fluid statics, fluid dynamics, continuity equation and Bernoulli’s theorem. Dimensional analysis and simulation. Simulation models and mathematical modeling. Finite difference analysis, Finite element analysis. Grading, cleaning, washing, sorting, shelling, dehusking, decortication, milling, polishing, pearling, drying (evaporative, osmotic and freeze drying), pasteurization and sterilization of liquid foods, kinetics of microbial death, size reduction, cryogenic grinding, granulation, crystallization, filtration, membrane processing, microfiltration, ultra-filtration, nano-filtration, reverse osmosis, evaporation, distillation, mixing, clarification, coagulation, mechanical separation, sedimentation, pressing, expelling, leaching, extraction, palleting, extrusion and industrial fermentation and processing. Pre-milling/ conditioning treatments. Process technology and machinery for cereals, pulses, oil seeds, fruits, vegetables, flowers, spices, condiments, plantation crops, animal products, sea-foods, fiber crops, animal feed, natural resins and gums. Bioprocess engineering, enzyme reaction kinetics, Industrial fermentation and processing, downstream processing, bio-separation. Minimal processing of fruits and vegetables, high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano encapsulation of food ingredients, Food nanotechnology Seed processing and technology, Agricultural byproducts/residue utilization, Waste disposal of food processing plants, different methods and equipment. Design of grain cleaners, graders, dryers, parboiling plants, size reduction machines, bioreactors, fermenters, centrifuges, cyclones, heat-exchanger, evaporators, filters, extrusion cookers. Computer aided design and analysis of machines and machine components. Materials, manufacturing processes, design of elements and selection of standard parts (pulley, chains, sprockets, bearings, belts, fasteners, hydraulic components, pipes, hoses)

Bulk conveying equipments viz. belt conveyors, screw/auger conveyors, bucket elevators and drag/chain conveyors. Estimation of energy requirement, damage to products during mechanical handling. Operation and maintenance of conveying equipment. Packaging material characteristics and selection. Packaging techniques and equipment for liquid, powder and