SYLLABUS FOR JUNIOR RESEARCH ASSISTANT

INDEX

1. AGRI BUSINESS MANAGEMENT

Agronomy: Definition, scope, basic elements of crop production and factors affecting crop production, classification of field crops, package of practices like area, production, productivity, economic importance, soil and climatic requirement, nutrient requirment, irrigation, water and weed management, seeds and sowing, plant protection measures, harvesting and yield for crops viz., sorghum, paddy, wheat, maize, pearl millet, redgram, green gram, black gram, cowpea, pea, groundnut, soybean, sesamum, sugarcane, gram, red gram, sunflower, safflower, rapeseed, mustard, linseed, castor, potato, tomato, cotton, jute etc. cropping systems. Agricultural Meteorology: Importance in agriculture, weather and climate, weather elements and factors affecting them, Atmosphere – composition and structure, solar radiation – nature, properties, depletion, factors affecting solar radiation, solar constant and energy balance. Atmospheric temperature, factors affecting temperature, importance, horizontal and vertical distribution in temperature, global warming. Soil temperature – importance, variation with heat. Wind types, classification, and importance in agriculture, forces acting to produce wind, cyclones, anticyclones and general circulation system of earth. Atmospheric humidity – saturated and actual vapour pressure, specific and relative humidity, diurnal variation of humidity, condensation – forms like dew, fog, frost, mist, snow, rain and hail. Cloud – types, formation and classification. Precipitation – process, forms, types of rain – thunder and hail storms. Types of monsoon, agricultural seasons. Drought – classification, strategy to mitigate drought. Evaporation – importance, microclimate, weather forecasting – Basics, types and importance, Remote sensing and introduction to crop modelling.

Farming System: Definition, scope, classification, components of farming system. Crops and cropping system, animal components like dairy, poultry, sheep, goat , piggery fish, duck, rabbit, trees for fuel, timber, fodder, fruits, and sericulture, apiculture, mushroom. Interactions between components, complementary and competitive factors governing choice and size of enterprises and resource allocation in farming system. Integrated farming system models for irrigated and rainfed situation. Cropping System: Interaction- competitive alellopathy legume effect, effect of preceding crop and associated crops. Indices for evaluation of cropping systems. Agronomic requirements in management of cropping system. Cropping scheme, calendar of operations, preparation of cropping scheme for wet garden and dry lands. Sustainable agriculture: Introduction, definition, goal and current concepts, sustainable yield index and sustainable value index. Organic farming: Definition, principles and components. Recycling of organic waste, management practices to prevent environmental deterioration, concept of sustainable agriculture. Resource management under constraint situations. Agronomic measures for management of scarce and costly inputs, delay and insufficiency of water supply, layout cost, scarcity and peak season demand, poor quality of irrigation water, soil problems, nutrient deficiency, problematic weeds, cost reduction in crop production, low cost technology and non-monetary inputs. Reclamation and development of wastelands and problematic soils, sewage farming and water farming. Rainfed farming techniques for soil and water conservation, management practices for rainfed crops, drought management, crop diversification, contingency planning for abnormal weather situation, alternate land use systems

Water resource development and utilization in India, Importance of irrigation, Soil water plant relationship, measurement of soil moisture, irrigation water, infiltration. Water requirement of important crops, Consumptive use and evapotranspiration, different irrigation efficiencies. Irrigation methods: border, check basin, furrow, sprinkler and drip

irrigation. Sprinkler irrigation: types, components, design and layout and care and maintenance. Drip irrigation: Types, components, design and layout and care and maintenance. Fertigation and filtration aspects of micro-irrigation. Introduction to other pressurized irrigation system, rain gun, porous pipe etc.

Classification of fruit crops on horticultural basis. Importance, present status and future scope for fruit growing in Maharashtra and India. Area and production, export, import scenario of fruit crops and plantation crops in Maharashtra and India. Nutritive value of fruits, importance of selection of site, fencing, planting systems, high density planting, wind breaks and shelter belts in fruit production. Planning and establishment of orchard. Propagation methods and use of rootstocks, methods of training and pruning. Special horticultural practices like bahar treatment, ringing, girdling, bending, notching, etc. Nutrient management, water management, weed control, mulching, intercropping, use of growth regulators in fruit production, physiological disorders in fruit crops. Package of practices for cultivation of major fruit crops like, mango, banana, citrus, grape, papaya, sapota, guava, pomegranate, minor fruit crops like pine apple, ber, fig, anola, jamun, tamarind, jackfruit, kokum, karonda, annona, strawberry, cashewnut, coconut, arecanut, coffee, betelvine, etc. Industrial value of plantation crops (Give brief cultivation information in tabular form for minor crops).

Vegetable: Definition, scope and importance of vegetable crops, area, production, distribution, exports and imports of vegetables from Maharashtra and India. Nutritive value, classification of vegetables, type of vegetable farming – kitchen garden, market garden, truck garden, vegetable production for processing, vegetable seed production, role of growth regulators in vegetable production. Cultivation of major vegetables like tomato, potato, chilli, brinjal, onion, garlic, peas, beans, cabbage, cauliflower, carrot, radish, watermelon, cucumber, muskmelon, bitter gourd, bottle gourd, ridge gourd, red pumpkin, sponge gourd, snake gourd and minor vegetables like methi, coriander, palak, amaranthus, lettuce, drumstick, tondali. Floriculture: Importance and scope of floriculture industry in Maharashtra and India. Horticulture gardening. Principles of garden design (Formal and Informal garden and Land scaping), garden features, land scaping of homes, educational institutes, hotels, resorts, city parks and industries, road side planting. Production technology of rose, chrysanthemum, aster, carnation, jasmine, marigold, gladiolus, tuberose, gaillardia, orchids, anthurium, gerbera and dahlia. (Give brief cultivation information in tabular form for minor vegetable and flower crops).

Importance and present status of post harvest technology in horticultural crops in India and Maharashtra. Maturity, harvesting and handling in relation to extended shelf-life and storage quality of fruits, vegetables and flowers. Maturity and harvesting indices of fruits, vegetables and flowers. Factors responsible for maturity, ripening and deterioration of horticultural produce. Methods used for harvesting and post-harvest treatment for delaying ripening. Respiration and transpiration rate during packaging and storage. Methods of pre-cooling, grading, packaging, storage and transport of fruits, vegetables and flowers. Importance and scope of fruits and vegetable preservation. Selection of site for fruit and vegetable preservation unit. Principles and methods of preservation. Preparation of jams, jellies, marmalades, squashes, juices, syrups, preserves, crystallized fruits, chutney, pickle and ketchups. Spoilage of processed products. Post harvest management of cut flowers. Control of post harvest diseases of important fruits and vegetables.

Concepts of Plant Biotechnology: History of plant tissue culture and plant genetic engineering, Scope and importance in crop improvement, Totipotency and Morphogenesis,

Techniques of in- vitro cultures, Nutritional requirements of in- vitro cultures, Micropropagation, anther culture, pollen culture, ovule culture, embryo culture, test tube fertilization, endosperm culture, factors affecting in-vitro culture techniques, applications and achievements, Somaclonal variations, types, reasons: Somatic embryogenesis and synthetic seed production technology, somatic hybridisation and its applications in crop improvement. Genetic engineering, restriction enzymes, vectors for gene transfer– Gene cloning – Direct and indirect method of gene transfer. Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes, Mapping QTL and future prospects. Marker Assisted Selection (MAS), and its application in crop improvement.

Scope and importance of environmental studies. Natural resources: Renewable and nonrenewable resources. Forest, water, food, energy and land resources. Ecosystems: Definition, concept, structure and functions. Producers, consumers and decomposers of an ecosystem. Energy flow in the ecosystem. Types of ecosystems. Bio-diversity: Definition, classification, threats to biodiversity and its conservation. Environmental pollution: Causes, effects and control of air, water, soil, thermal, noise and marine pollution. Causes, effects and management of soil nuclear hazards and industrial wastes. Disaster management: floods, earthquakes, cyclones and land slides. Social issues and the environment, unsustainable to sustainable development. The Environment Protection Acts. Role of information technology in environment and human health.

Soil as a medium for plant growth, soil fertility and productivity, methods of soil evaluation. Essential plant nutrients, macro and micronutrients and its role. Mechanism of nutrient uptake. Problematic soils: Saline, saline-sodic, sodic, acid soils and calcareous soils and their reclamation. Organic manures: FYM, compost, vermi compost, green manuring and its preparation, concentration, organic manure, biogas slurry, sewage and slugs, agro-industrial and urban wastes. Role of organic manures in soil fertility, organic and natural farming. Fertilizers- NPK fertilizers, classification, properties, reaction in soils. Mixed, complex and compound fertilizers. Fertigation, slow release fertilizers, bio-fertilizers. Fertilizer management: Use efficiency, handling and storage. Integrated nutrient management: Concepts, components, sources and utility, INM in relation to fertilizer use efficiency. Ecofriendly farming for sustainable agriculture. Soil pollution by agricultural chemicals and sewage water.

Scope of livestock in Indian economy. Livestock census and trend of livestock production. Terminology used in livestock care, poultry care and management of livestock and poultry i.e. calf, heifer, milking animal, dry animal, pregnant animal, draft animal and breeding bull, stress management. Housing of different livestock and poultry. Routine farm management. Preparation of animal for different purposes. Various breeds of cattle , sheep, goat, buffalo and poultry. Nutrient requirement of livestock and poultry. Maintenance of records on livestock dairy and poultry farms. Animal health cover, structure of udder and letting down of milk, clean and hygienic milk production. Reproductive systems of male and female, estrus cycle, pregnancy and parturition. Systems of breeding, artificial insemination.

Present status of dairy, poultry, meat, wool and hide industries in WTO regime. Milk composition of different species. Production, packing, marketing of milk, meat and their products. Import, export of animal and poultry products. Utilization of animal dung, poultry manure for F.Y.M. and vermi compost, gobar gas production and its valuation, price regulation in animal products. Factors influencing price. Trends in marketing and utilization of animal products. Importance of hides and bones, quality standards and storage. Market standards and regulation of animal products.

Introduction, location, size and management of farmstead, septic tank, soak pit, its location, capacity, construction and maintenance, farm fencing and their types. Animal shelter and their types, poultry housing and their types, building materials, farm silos and their types. History, development and scope of green house technology, green house planning, layout and its construction. Effect of temperature, pH and CO2 with reference to micro-climate on green house crops. Role of light, ventilation, cooling, utility of green house for different crop production, covering material, irrigation, fertigation and humidification inside green house. Pests and disease control in green house. Post harvest technology.

Importance of Post harvest technology. Problems occurring in harvesting, threshing, transport, drying, milling and marketing. Moisture content and its measurement. Drying and its importance: Methods of drying grains. Thin layer and deep bed drying (excluding mathematical expression). Equilibrium moisture content (excluding mathematical expression). Grain dryers. Food grain storage structures. Bulk storage structures. Unit operations in seed processing. Equipments for cleaning, sorting, grading and separation. Technology of parboiling of paddy. Principles of parboiling, advantages, disadvantages of parboiling, oil expression and extraction. Screw and hydraulic methods. Material handling equipments (excluding design), Principles of refrigeration, and cold storage.

Importance of pest control, status of chemical/ bio-pesticides in India. Chemical pesticides and hazards, definition of IPM, principles of of IPM and components. Parasites and predators, IPM strategies for paddy, pigeon pea, chickpea, cotton, sugarcane, grape, pomegranate, mango, citrus, okra, brinjal, tomato, potato, cabbage, cauliflower etc. Food safety standards and pesticide residue management, APEDA and its role in agricultural export.

Introduction, History of Plant Pathology: History and development of Plant Pathology in different eras, contribution made by different scientists in IDM, and significant plant diseases. Definitions and objectives of Plant Pathology: Concepts of disease, Important plant pathogenic organisms: Different groups like fungi, bacteria, fastidious bacteria, viruses and phytoplasma with examples of diseases caused by them, Disease: economic importance and losses caused by plant diseases, basic procedures in the diagnosis of plant diseases. Definition of IDM, concept, advantage and importance, principle approaches to IDM: Direct action against the pathogen, genetic modification of the host to resist disease and modification of the environment. Exclusion: Legislation (Quarantines, Regulation measures), eradication, protection. Epiphytotic diseases, epidemic and diseases forecasting in IDM. Present status of fungicides / bio-agents in India, their use and restriction in plant disease control. Integrated control in a perennial crops, and annual crops. Development of IDM strategy for important crops viz., cotton, groundnut, sunflower, sorghum, bajra, rice, wheat, sugarcane, grape, banana, pomegranate, mango, citrus, fig, guava, tomato, potato, chilli, okra, brinjal, cabbage and cauliflower. Post-harvest diseases of important crops and their management.

Bio-fertilizers: Introduction, importance and definition. Types of bio-fertilizers. Growth characteristics of microbial agents used in preparation of biofertilizers. Methods of preserving cultures of microorganisms used in production of biofertilizers. Types of micro-organisms: Phosphate solublising micro-organisms. Nitrogen fixation by Microorganisms (Azotobacter, Azospoirilium, Rhizobium, Acetobacter, Blue green algae and Azolla), VAM (Vesicular Arbuscular Mycorrhiza), Application of bio-fertilizers. Efficiency of bio- fertilizers, Role of bio-fertilizer in nutrient availability and soil fertility. Beneficial role of microorganism. Harmful microorganism in plant growth. Economics of bio-fertilizer production. Mushroom: Introduction, importance and types of mushrooms. Study of morphology and nutritive and

medicinal values of mushrooms. Edible and poisonous mushrooms. Requirements for mushroom cultivation: different tools, equipments, substrates and chemicals required for commercial cultivation of mushroom.

Entrepreneur : Evolution of the concept of Entrepreneur, characteristics of an Entrepreneur, Types of Entrepreneur. Differentiate in the concept of entrepreneur and manager. Entrepreneurship: Concept, Growth of Entrepreneurship in India, Role of Entrepreneurship in Economic development. Factors affecting Entrepreneurial Growth: Economic factors, Non-Economic factors, Government actions. Promotion of a venture: Opportunities analysis, external environmental analysis, economic, social and technological, competitive factors, legal requirements for promotion of a venture. Entrepreneurial Behaviour: Innovation and Entrepreneur, Entrepreneurial Behaviour and psycho-theories, social responsibility. Entrepreneurial motivation: Definitions, motivation Theories, motivating factors, Achievement motivation. Entrepreneurial mobility: Factors influencing mobility, occupational mobility, locational mobility. Small Enterprises: Meaning, definition, characteristics, Relationship between small and large units. Role of small Enterprises in economic development, opportunities for an entrepreneurial career. Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises. Management: meaning, characteristics, scope, functions, management process, Difference between management and Administration. Working capital management: Meaning, significance, factors determining requirement of working capital, sources and management of working capital. Human Resource Management: Meaning, selection, Training and development, Remuneration and Benefits, job requirements. Personality: Meaning, definition, popular and scientific view of personality.Factor influencing personality: Constitutional determinants, Group membership, role, situation. Socialization: through role and status, social roles and personality. Role Behaviour: Ascribed and Achieved Status, role personality and true personality. Formation of personality: Physical, heredity, culture and unique experiences.

Communication: Meaning, Concepts and definitions, Process of Communication, Importance and Types of Communication. Barriers to effective communication, improving Communication Effectiveness, Models and Theories of Communication, Organizational Communication, feedback– problems in communication, Interpersonal Communication, Effective business communication, Presentation skills, Business writing skills, speed reading, listening skills, Nonverbal Communication and Body Language, drafting the Message, Defining the Audience Delivery Skills, Visual Aids, Designing Effective Visual Aids, Using Visual Aids Effectively, Principles and Techniques of making Presentations with impact, Using Technology wisely. Market-led Extension: Meaning, definition and importance of market –led-extension. Areas of extension education in marketing, Marketing Network for Agricultural Products, Production of Agricultural products distributed in different pockets of the country, Food availability and its consumption in India, Transportation, Storage – Types, Costs, Returns etc Rules, regulation and their impact on implementation of marketing network, Linking of entire marketing networking system for agricultural products.

Psychology: Concept, Meaning, definitions, scope and importance. Perception: Meaning, definitions, determinants of perceptions, general principles, errors in perceptions. Attitude: Meaning and characteristics, formation of stereotypes and prejudices, factors in attitude change. Consumer buying: The decision making process. Consumer information processing, consumer learning process. Consumer preferences: Post-purchase processes, situational influence. Social classes and buying behaviour. Emotion: Concept, meaning, definition, motivation and emotion, type of emotion, theories of emotion, expressive

components of emotions. Learning: Definition, principles, indicators theories of learning and experimental learning, factor affecting learning. Consumer spending: Consumer spending and savings, consumer behaviour and the marketing manager, product positioning, marketing mix development.

Information Technology: meaning, role and importance in Agri business and Agriculture marketing, Importance of Common Service Centres (CSC), Common issues of CSCs, Expert decision support system in Agriculture, Information Technology for Agriculture marketing, On line market information, online market status in India, e-commerce in Agriculture, Advantages of e-commerce over traditional marketing, electronic auction, websites on Agriculture marketing and export, role of private companies in online marketing –e-Chaupal, HLL Shakti etc Futures Trading in Agricultural Commodities, database Management.

Organization and its analysis: Nature of organization, scope and significance of Organizational Behaviour, relevance of Organizational Behaviour in today's business environment. Personality and Motivation: Objectives, Introduction, Meaning, Personality determinants, Personality traits, Theories of Personality-Levinson's theory of adult life stages, Hall's Career Stage Model, Chris Argyris' immaturity to Maturity Continuum, Edgar Schein's Socialization process. Motivation: Types, Characteristics, Theories of motivation Early theories and Contemporary theories. Motivation at different levels. How to motivate subordinates. Team Building: Introduction, Systematic Approach, Information stage, Reviewing in order to improve, Analyzing skills, Feedback of observations, Supportive development building on ideas, Contributions in a group, Degrees of Agreement, Aspirations. Leadership Development: Understanding leadership, Theories of leadership-Trait theory, contingency theory, Situational leadership theory, Organizational theory, Power theory, Ethical Assessment theory, Transactional or Transformational leadership. Negotiation Skills: Negotiation, simple Negotiation Model, Guidelines on negotiation, Positional bargaining, Positions and Interests.

Introduction, history, concepts of hardware, software, machine language, high level language, DOS commands, working with different Windows Operating Systems Utilities: Note pad, Word pad, Paint Brush, Control Panel, Windows explorer, etc Working with MS WORD: Creating, saving, importing, exporting and inserting files, Formatting pages, paragraphs and sections, indents, creating lists and numbering headings, styles, fonts and font sizes. Editing texts, position and viewing texts, using tabs and tables, Tabs and dot leaders, finding and replacing texts, Inserting page breaks, page numbers, bookmarks, symbols and date, header, footer, footnotes, annotations, endnotes, working with text boxes and frames, working with columns, pictures, charts and graphs, forms, tools, working with objects – word arts, equations and worksheets, automating with macros, printing and working with master documents. Working with MS EXCEL: Creating worksheets and workbooks, opening and saving workbooks and exiting excel, formatting numbers and texts, protecting cells, producing charts, printing operations, linking workbooks, macros, database, using tables, using files with other programs, creating graphs, performing statistical analysis of data. Working with MS ACCESS: Understanding databases, creating table, creating queries, forms, finding information in a database, creating reports, adding graphs to reports, creating mailing labels, automating work with macros. Working with MS Power Point: Working with built in wizards, working with texts and lists, colors and transitions, adding headers and footers, drawing tools, animation and sound, importing objects from other applications, automating presentations, hyperlinks to external resources, printing presentation, modifying and integrating presentation, distributing

presentation with power point viewer. Internet and E-mail: Internet applications, access, e-mail, internet services, web pages search tools, web utilities, Internets and Extranets. Working with different statistical analysis software.

Definition of statistics, meaning, scope, statistics and industry, its applications, uses and misuses of statistics in business. Frequency distribution, raw data, the array frequency distribution, determining classes and class interval, cumulative frequency distribution. Graphic presentation of data. Measures of central tendency, AM, Median, Mode, GM, HM for grouped and ungrouped data. Characteristics of mean, mode and median, weighted mean, their uses and applications. Dispersion, Range, Mean Deviation, Variance, Standard Deviation, Properties of SD, relative measures of dispersion for grouped and ungrouped data, Skewness, Kurtosis and moments. Probability and probability distribution. Definition of probability, mathematical probability. Empirical probability and axiomatic approach. Events, sample space, probability of independent and dependent events. Generalization and extensions of the law of probability formula. Discrete probability distribution. Binomial and Poisson distribution and its parameters. Normal distribution, its properties and procedure of fitting the normal curve. Tests of hypothesis-two-sided test, one sided test, confidence limit. Critical region, power of a statistical test. Study of student's 't' distribution. One sample, two sample 't' test. 'F'-test, c2 test, uses and applications. Study of simple correlation and regression. Scatter diagram. The least-square criteria for fitting simple regression. Tests of hypothesis for slope and correlation coefficient. The standard errors of estimates. Multiple and partial correlation, multiple regression up to three variables. The normal equation with least squares estimates. The matrix theory approach in solving the normal equations and testing the significance of partial regression coefficients. Coefficient of multiple determination and its significance. Time series and index number analysis.

Agricultural Economics: Meaning, definition, Basic concepts: Goods, Services, Utility, Value, Price, Wealth, Welfare, Wants: Meaning, characteristics, classification of wants, importance. Scope and importance of agriculture in National economy. Land: Meaning, importance, land use classification, land ownership and distribution of land, management of land . Agricultural Labour: Meaning, definition, types of labour, categorisation of labour wages, Minimum Wages Act, efficiency of labour. Agricultural Capital: Meaning, importance, capital formation in Indian agriculture and present trends. Farm Mechanization: Types, scope for farm mechanization, effects of mechanization. Agricultural technology and its effects on Indian agriculture, green revolution, white revolution etc. Growth in agricultural output in India. Natural Resource Economics: Natural Resources - meaning and importance of natural resources. Renewable and non-renewable natural resources - Meaning and importance. Forest Development Programme in India, surface water and ground water-their potential and utilization in Maharashtra. Importance and types of fishery, fishery development policies in India.

Place of agriculture in National economy and comparison with other countries. Special characteristics of agriculture in Indian economy. Pattern of agriculture holdings, fragmentation, sub-division and consolidation of land holdings. Agricultural productivity: Trends, causes and consequences of low productivity in India. Input utilization, fertilizers, pesticides etc. Green revolution: New strategy in development of Indian agriculture, High Yielding Varieties (HYV) programme, irrigation development and farm mechanization. Five Year Plans and place of agriculture in National planning, problems of food security. Demographic profile of Indian population. Review of development programmes: Programmes for weaker sections including Tribal, Integrated Rural Development, nature and dimensions.

Farm Management: Meaning and definition, objectives and scope. Basic economic Principles of Farm Management, types and systems of farming, cost and returns, farm planning and budgeting, risk and uncertainty, Farm Records: Objectives, types and importance, farm inventory and depreciation, farm efficiency measures. Production Economics: Meaning, definition, nature and scope of agricultural production economics, basic concepts terms and objectives. Basic relationships: Factor-Product relationship, Factor- Factor relationship and Product-Product relationship, cost concepts used in farm management studies.

Money: Meaning, importance, evolution, qualities of good money, coins and coinage, kinds of money, functions of money, demand for and supply of money, monetary standards, bimetalism, monometalism and paper standard. Banking: Types of banks, role in economic development, functions and achievements of commercial banks. Central bank – banking principles and functions of central bank, measures of credit control, monetary policy. Nationalization of banks and its impacts, role of credit institutions in development of agriculture. International Trade: Meaning, definition, scope, pre-export behaviour-factors to be considered, methods of entering foreign markets, importance of International markets, economic reasons for export. International marketing: Practices and problems, policies and economic forces and political considerations. GATT: Basic principles and emergence of WTO. Trade codes, application of WTO. Import-Export Policies: Present Agril. Export Policy of the Govt. under liberalized economic environment. IPR, TRIPS, TRIM, AoA etc.

Co-operation: Meaning, definition, principles of co-operation and its application in agriculture. Importance and role of co-operation in agriculture and rural development. Cooperation compared with capitalism, socialism, communism, and co-operative movement in India. Co- operative marketing and processing Institutions: Institutional, non – institutional and multi-agency approach, Forms of co-operatives. Co-operative education and training. State Co-operative Union and NCDC, Co-operative administration and HRM, Cooperative Management: Nature and functions, professional management of co-operatives, role of leadership in co-operative management.

Agricultural policies: Meaning, types and importance, evolution of agricultural policy, Famine Commission Report, Royal Commission on Agriculture: Recommendations, Drought Prone Area Programme (DPAP), Land Reform Policy, National Insurance Policy, Nature and objectives of land reforms, Tenancy reforms, Crash Scheme for Rural Development, Major agricultural input policies including seed, fertilizer, pesticides, credit and irrigation. National Rural Employment Programme, Abolition of Bonded Labour, Jawahar Rojgar Yojana, Employment Assurance Programme and other recent Agricultural Development Programmes. New Agricultural Export Policies for different commodities. National Forest Policy: National Forest Policy of 1952, Forest Policy of 1988, Forest Development Programme, Social Forestry, Animal Husbandry, Dairy Improvement in cattle breeding, Government policy regarding Animal Husbandry and Poultry Development.

Nature and scope of input-output relationship, production concept, factor-product relationship, forms of production functions and their characteristics, production surfaces, isoquants, isoclines and their economic applications. Quantitative estimation of parameters of input-output relationship, and their interpretation, principle of choice and resource allocation, price and product relationship, resource substitution, cost minimization, resource combination and enterprise combination, returns to scale and farm size.

Science: Definition, meaning, goals, functions, types of sciences. Scientific Method: Features, induction and deduction, steps involved in scientific investigation. Research: Definition, classification, importance of research in agricultural economics, research methods in agricultural economics, steps in agricultural economics. Research Problem: Definition, nature, selection, components, formulation of hypothesis characteristics and functions of hypothesis. Sampling: Meaning, need for sample, sampling methods with their merits and demerits. Data: Source, types, methods of data collection, observation, interview, questionnaire, schedule analysis, inferences and reporting of research.

Agriculture Project: Meaning, types and their importance in development. Economic and financial analysis of agricultural projects. Cost-benefit estimates of different types of projects, Cash-flow, Shadow price, calculation of economic prices, comparing costs and benefits such as the Net Present Worth (NPW or NPV), the Benefit Cost Ratio (BCR), Internal Rate of Returns (IRR), Cash flow, Pay Back Period (PBP). Guidelines for building up cost and return analysis, project area, characterization and components, financial and economic analysis. Project approach to agricultural leading enterprises practical steps in project formulation. Financial appraisal of a project. Application of Programme Evaluation and Review Technique (PERT,CPM), Sensitivity analysis, Social Cost Benefit Analysis (SCBA).

Agriculture Finance: Nature and scope, importance of agriculture finance. Agricultural finance as a part of public finance. Source of capitals: Meaning and concept of agriculture credit, classification and forms of credit. Credit as a tool of economic development. Cost of credit, interest rates of credit, 3 R's, 5 C's and 5 P's of credit. Credit creation and credit control. Credit rationing and planning. Legal aspects of credit, supervised credit. credit demand and supply, credit institution, credit policy and needed changes. Preparation of proforma of income statement, proforma of balance sheet and cash budget. Portfolio management, financial ratio analysis, Break–even analysis. Investment analysis. Capital market. Operations analysis.

Agricultural Marketing: Definition and concepts, scope and subject matter. Market and marketing: Meaning, definition, components of a market, importance of agricultural marketing, classification, types of markets. Problems of Agril. Marketing: Defects in traditional agril. marketing system and suggestions for improvement. Present status and problems in various marketing functions. Standardization: Standards and standardization, aims of standardization, significance of standardization, demerits of standardization. Basis of standards. Grading: A marketing function. Importance of grading in agriculture, grading in India. Channels of Marketing: Meaning, definition, channels of different products, market functionaries and their role. Marketing Efficiency: Meaning, definition, marketing costs, margin, price spread, factors affecting the cost of marketing, reasons for higher marketing costs of farm commodities, ways of reducing marketing cost. Study of Market Intelligence and Market Integration: Meaning, definition, types of market integration, market function, AGMARK, price trends, market information. co-operative agricultural marketing and public agencies involved in agricultural marketing, viz. FCI, NAFED, STC, etc. Functions of price mechanism, interrelationship between prices of inputs and output. Nature and supply of agricultural products, marketable and marketed surplus. Types and reasons for price movements and their effect on agriculture price stabilization and price support policies, Warehousing: State and Central Warehousing Corporations, objectives, functions, advantages, speculation, future trading and hedging. Hedging: Meaning, chief features of hedging, kinds, purpose, benefits and limitations of Hedging. Future Trading: Characteristics of future trading, organized trade in futures.

Objectives, structure and functioning of Agricultural Marketing Institutions and Organizations. Agricultural Produce Market Committee, Cotton Corporation of India and State Cotton Federation, Food Corporation of India (FCI), State Trading Corporation (STC), National Co-operative Marketing Federation, Agricultural Processed Products and Export Development Authority (APEDA), Maharashtra State Agricultural Marketing Board (MSAMB), The National Agricultural Co-operative Marketing Federation of India (NAFED), Jute Corporation of India, Tobacco Board, Coconut Board, Grape Growers Association (Mahagrape), Mango Growers Association (Mahamango), The Directorate of Marketing and Inspection (DMI), National Dairy Development Board (NDDB).Coffee Board and Rubber Board.

Scope and importance of agricultural input marketing management. Study of demand and supply scenario of major agro-inputs: seeds, fertilizers, agro-chemicals, farm machineries and electricity. Production organizations in seeds, fertilizes, agro-chemicals. New product development, product introduction. Branding and packaging for major agro-inputs. Formulation of marketing strategy. Marketing, planning and implementation for agro-inputs. Market promotion – Advertising, personal selling, sales promotion and publicity. Sales force management. Management of distribution system for major agro-inputs. Pricing of agro inputs. Information system for input marketing. Short term credit loan for procurement of inputs.

Profile of rural marketing, definition, classification, strategies, characteristics, changing pattern of rural market, problems in rural marketing. Rural marketing in India – Difference between urban and rural market, study of rural resources. Rural marketing and research – Sources for conducting marketing research, dos and don'ts for rural marketing and rural industries. Rural segmentation - Targeting and positioning. Rural product and prices – Introduction, packing, pricing methods, rural branding. Rural distribution / channels of distribution, functions of rural sales persons. Rural communication – Introduction, types, factors affecting rural communication, problems. Market infrastructure – Meaning, facilities included and its importance.

Retailing: Concept, types of retailers, supermarkets, factory outlets, hypermarkets. Nonstore retailing. Retailer-marketing decisions. Direct selling, one to one selling, one to many selling, direct marketing and multilevel marketing. Major types of retail organisation, cooperative chain stores, voluntary chain, retailers and consumers cooperatives. Retail Chain Management by Corporate Houses. Procurement decision. Price, promotion and place decision. Role of Consumer, Packaging and Market Segmentation in Retail Marketing. Store Management : Retail location, merchandising, using price to stimulate market sale. Branding Strategy: Manufacturer's brand, private label, brand for a sale. Trends in retailing. Retailing strategy. Impact of retailing on economy and society.

Importance of agricultural commodities in agricultural marketing. Marketing of cerealsrice, wheat and jowar. Marketing of pulses-mung, tur, gram, udid etc. Average cost of processing wheat into wheat flour, paddy to rice, whole pulses in to split pulses, comparison of different rice milling methods. Study on price spread of important crops and producer's share in consumer's rupee. Marketing of mango, citrus and grapes. Marketing of vegetables. Improving efficiency in commodity marketing. Role of co-operative and regulated market in commodity marketing.

Evolution of market legislation. Procedures, need and scope for market legislation.

Regulation of market. Growth and development of regulated markets. Review of Agricultural Produce Market Acts in Maharashtra and India. Regulated Marked Act, 1937, Organization of regulated markets, constitution of market committee, finance of the market committee, functions of market committee. Agriculture Produce (Grading and Marketing) Act- 1937. AGMARK, Cold Storage Order- 1964, Cold Storage- 1980. Fruit Product Order-1955. Meat Food Production Order-1977, Prevention of Food /Adulteration Act-1954. All India Rural Credit Survey Committee Reports - 1954, Maharashtra Agricultural Produce Marketing (Regulation) Act -1963 and New Marketing Model Acts, Consumer Protection Act-1986. Central Warehousing Corporation Act- 1957. National Co-operative Warehousing Board Act -1956. State Warehousing Corporation Act - 1958. Weighing and Measurement Act. NAFED, FCI, Export- Import Policy- 2002-2007.

Marketing of commercial crops with special reference to all marketing functions and price analysis. Commercial commodities - cotton, sugarcane, onion, grapes, banana, citrus, mango, cut flowers –roses, gerbera, gladiolus, etc. vegetables – cauliflower, cabbage, tomato, potato, onion, ladies finger, brinjal. Existing levels of processing and future potential. Export and export potential.

Agri-business: Meaning, definition, history and scope of agri-business (Input, Farm Product Sectors). Importance of agri-business in the Indian economy. Changing dimension of agricultural business. Agri-business Management-distinctive features, nature and components, importance of good management, definition of management and management functions, Five Years Plans and agri-business, characteristics of plans. Organization and operation of farm business, tools of farm business organization and operation, steps in farm business organization. Evaluation of available resources, appraisal and goals of farm business and approach to reorganization of the farm business. Farm adjustment programme under uncertainty, job of proficient farm planner, farm accountancy. Constraints in agri-business management infrastructure, technological, social and cultural. Analysis of farm records; Farm inventories. Financial Management of Agri-business: Importance of Financial Statement, Balance sheet, Income account/ Profit and Loss Statement, Efficiency measures, Partial and Complete budgeting.

Agro-based Industries: Importance and need, classification of industries, role of agroprocessing industries in the Indian economy. Types of agrobased industries-sugar mills, cotton ginning mills, dal mills, rice mills, poha mills, fruit processing industries e.g. NOGA (Nagpur Orange Growers Association), institutional arrangement, steps in setting up of agrobased industries. Constraints in establishing agro-based industries. Basis of development of agro-based industries in specific pocket e.g. sugar mills in Western Maharashtra, Ginning and processing of cotton in Vidarbha, Dal mills and Rice mills etc. Growth and modernization of these Agro based industries in different regions – Modernization of industries, Five Year Plans: Planwise development. Employment and income generation from agro based industries at macro level and overall impact in the development of the region /State. Potential agro-based industries-Grape wine making industries, soybean-processing industries, mango pulp processing industries. Govt. policies relating to agro-processing industries. Problems of agro-processing units. guidelines for financing of agro-processing industry in India.

Disaster Management-Meaning, scope, and importance. Types of disasters- (i) Natural disasters-Earthquake, floods, landslides, hail storms, cyclones, fires, winter freezing, lightening, volcano, tornado, tsunamis, hurricanes, droughts etc. (ii) Man made disastersWar, bomb blasts, chemical leakage, fire etc. Types of damage- Damage to life,

property, and utility services, etc. Assessment and reporting of damage - Damage assessment methods, damage in physical and monetary terms Forewarning –Systems and communication measures- prospective, preventive, and protective. Remedial and precautionary measures-Insurance, Government aid, NGOs etc. Training, education and knowledge of the disaster events for precautions. Case studies-Different types of disasters-Drought, floods, hailstorms, heavy rainfall, winter freezing, fire, etc. Government policies-regarding the disasters. Role of NGOs, co-operative and private institutes.

Introduction to Inventory – Definition, types and its need. Cycle of inventory management. Order Quantity – Economic Order Quantity (EOQ) Model. Safety stock. Pricing of raw material and valuation of stock. Monitoring and control of Inventories – ABC Analysis, Justin-time inventory control. Criteria for judging inventory system. Inventory management in India. Storage and Warehousing. Inventory record keeping and their types. Risk-Meaning, importance and types, minimization of risks.

Agro-tourism: Introduction, importance, scope, forms of agro-tourism, advantages and implementations, introduction to Indian culture. Govt. policies and legislations in respect of tourism and agro-tourism and environment protection laws. Requirements for Agro-tourism. Farm, forest, garden, fish tank/ponds, residential huts, etc. Constraints in operation and management of Agro-tourism activities. Management of resources – Human resources, Natural resources and Garbage management at Agro-tourism centre. Entrepreneurship development: Role and functions, Hospitability: Food and beverages and accommodation services. Communication skill and service; Capital investment, sources and capital budgeting. Project proposal- Preparation and feasibility tests, Accounts and record keeping etc. Marketing strategies for Agro-tourism products and services. Publicity of tourism Advertisement and use of media.

Introduction, meaning and role of production management in agriculture. Elements of production, design and process planning. Effect of technological changes on the production management. Factors influencing the plant location in Agri-business activities. Agricultural Production Planning and Control: Nature, basic functions of production planning and control, its objective, different system of manufacture production cycle, scheduling and control of production and its control procedures and devices. Total quality management, considerations, stage of quality control, standard and specifications, quality assurance and quality circles. Scheduling psychology, methodology and control techniques. Legal aspects of quality control. Resource Planning and Budgeting: Importance and techniques, methods to study work measurement. Nature and objectives of production planning and control. Variables subject to control. Production control for contentment's, intermittent and project system. Production forecasting and production inventories. Aggregate planning, guidelines, graphic and chart planning. Resource Management: Management of resources: Meaning, concept, source of supply of material, selection and evaluation, purchase management-Cost reduction. Store Management location, storage methods and documentation of Government policies.

Role of agro-processing industries in the Indian economy. Status and potential of Indian Agro-processing industries. Foodgrains, commercial crops, fruits and vegetable processing, livestock processing, fishery products etc. A policy environment of agro-processing industries-Development, management structure and communication. Work performance efficiency, public contact and public participation in agro-processing industries. Decision making process and entrepreneurial efficiency. Government policies relating to agro-processing unit. Interdependence of agro-processing industries, Problem of agro-processing units. Guideline for

financing of agro-processing industries in India.

Understanding Marketing Management, Marketing concept, Marketing mix, Market segmentation and Market targeting. Building consumers satisfaction, value and retention. Managing the marketing process and market planning. Development of marketing strategies: Positioning and differentiating the market offering through the product life cycle. Developing new market offerings. Designing global market offerings. Shaping the market offerings: Setting the product and brand strategy. Designing and Managing Services. Developing price strategies and programme. New economic policies for agriculture sector.

Human Resources Management: Concept, objectives, nature and scope of the human resource. Planning: Problems in HR planning. Job Analysis. Job description and job specification. Human Resource Acquisition: Meaning, sources, methods, selection and selection process, placement, induction, socialization. Development of Human Resources: Training–importance, need, methods and procedures. Management Development Programmes-Purposes and methods. Strategic Management- Emergence of strategic management, need of strategic management. Corporate strategy – Concept, components and functions. Nature, components and significance of Environmental Scanning. Analysing external environment opportunities and threats – Economic, technological, competitive, political, social and cultural. Corporate Capability Analysis. Concept and significance of synergy and analysing synergy. Core competence: Concept, cosmic features. Value Chain Analysis – Concept, types, analysis and linkages. Value system, significance in strategy making. Setting corporate objectives: Concept, purpose, mission need and process. Forces interacting with corporate objectives – External and internal. Identifying strategic alternatives. Choice of corporate strategies (CIT, CASCADE and PORTFOLIO Models), formulate implementation and legitimacy.

Product Promotion: Meaning and importance, pricing, promotional policies and practices. Market communication. Planning: Planning in marketing managerial process, steps and strategic options. Product differentiation and product positioning. Product Marketing: Market segmentation of consumer and industrial markets, selecting and promoting target markets. Product-mix: meaning, classification, life cycle and components. Marketing channels-Meaning, push and pull strategies. Promotion skills of wholesalers and retailers. Product Pricing: Definition, price-mix, pricing strategies and communicating prices. Psychology of human behaviour in product promotion - culture and sub-culture, values of consumer behaviour, social groups. Organizational buying, message-source, structure, varieties and contents etc. Advertising: History, definition, classification, function and organization of advertising campaign. Elements, objectives and designing of advertising strategy and opportunities. Measuring advertising performance. Sales promotion, planning, objectives, techniques of consumers' promotion management. Sale force trade promotions and public relations, sales promotion effect. Product Selling: Personal selling, types, process and models. Managing sales force, personal selling and promotion mix, preliminary considerations in planning. Framework, strategies in international marketing, major players in international markets, promoting and international strategies.

Finance- Concept, its relationship with other financial areas. Cash budgeting. Proforma of income statement and balance sheet, estimation and management of working capital, inventory accounts. Capital budgeting cost of capital, appraisal of applications for term loans, management for earning dividend. Determination of dividend and profit. Preparation of trial balance. Cost Accounting - Relationship with financial accounting. Elements of cost - preparation of cost sheet. Materials cost- Materials purchasing, receiving, storing, issuing

including pricing of issues. Labour Cost - time keeping and time booking, idle time, and labour turnover.

Price analysis, importance of prices, trends and fluctuations of prices in agriculture and their impact. Price determination in Agricultural Products. Agricultural Price policy in India. Minimum support price, procurement price, administered price, statutory price, market price, market intervention price. Procedure for determining MSP and trends in MSP over decade. Price parity. Behaviour of agricultural prices, input factor prices in agriculture. Vertical integration and horizontal integration. Price discrimination. Study of arrivals and prices of major farm products. Trends in production. Effects of prices on area allocation in agriculture. Marketing Research: Process, problem, definition, research objectives, research design. Sources of data, data collection, data analysis, report and presentation.

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2. AGRICULTURE

Meaning and scope of Agronomy, Relationship with other sciences, Role of Agronomist National and international agricultural research institutes and SAU's in India, agricultural research stations/centres in Maharashtra. Agro-climatic zones of India and Maharashtra. Soil - Definition, classification, properties, factors affecting soil properties, soil fertility and productivity. Tillage and tilth - Definition, objectives, types of tillage, implements used, modern concepts of tillage, tilth and characteristics of ideal tilth, classification of crops Seeds and sowing - quality of seed, seed testing, seed multiplication, seed treatment, sowing methods, crop stand establishment, planting geometry and its effect on growth and yield - sole, paired and skipped row planting. Manures and fertilizers - Plant nutrients and their role in crop production, classification of manures and fertilizers and green manuring. Weed - Definition, characteristics, harmful and beneficial effects. Cropping systems - Definition, types, advantages and disadvantages, precision, farming, harvesting signs of maturity, methods of harvesting.

Agricultural meteorology, its importance in Agriculture Weather and climate, weather elements and factors affecting them. Earth's atmosphere, composition and structure of atmosphere. Solar radiation - nature, properties, depletion, factors affecting solar radiation, solar constant and energy balance. Atmospheric temperature - factors affecting temperature, importance of air temperature, horizontal and vertical distribution and variations in temperature and global warming Wind - Types, classification, importance of wind in Agriculture, forces acting to produce wind, cyclones, anticyclones and general circulation system of earth. Atmospheric humidity - saturated and actual vapour pressure, specific and relative humidity, diurnal variation of humidity. Process of condensation, formation of dew, fog, frost, mist, snow, rain and hail. Cloud - types, formation and classification. Precipitation - hydrologic cycle, types of rain - thunder and hail storms, types of monsoon, agricultural seasons. Drought - its classification, strategy to mitigate drought. Microclimate, Weather forecasting - Basics, types and importance of weather forecasting. Remote sensing and introduction to crop modelling.

Art, Science and business of crop production, Basic elements of crop production; Factors affecting crop production; History of Agricultural Development; Ancient India Agriculture in Civilization Era, Chronological Agricultural Technology development in India. Indian Agriculture, balance sheet, liabilities; Assets and Contrasting trends (DATA), Agril; growth, contrasting food chains, Diversity in physiographic, Soil groups, marine, livestock and water, Liabilities: Soil factors, weather factors, Economic ecology, dry and irrigated agriculture, Farming Systems approach, value addition, requirements in new technology; Women in Agriculture: multifaceted roles and tasks, work stress factors, Nutritional and rural life standards, role in house hold design making, drudgery reduction for farm women, women friendly agricultural technology; Empowerment of women; Group dynamics for farm women, rural women; The nucleus of Agricultural Extension and Training.

Irrigation: Definition and objectives, Water resources and irrigation development in India and Maharashtra Soil water relationships - physical properties of soil, volume mass relationship, classification of soil water, soil moisture constants, water availability, forces acting on water movement and retention. Plant water relationship - Role of water in plant, plant structure, water absorption, factors affecting absorption and transpiration, rooting characteristics, moisture extraction pattern of crop, soil water plant atmospheric continuum (SPAC) relationship. Methods of soil moisture estimation Evapotranspiration-Evaporation,

transpiration, evapotranspiration, factors influencing ET. Crop water requirement - water requirement, irrigation requirement, methods of estimation of water requirement and factors affecting water requirement. Effective rainfall - Definition, methods for estimation, factors affecting effective rainfall. Scheduling of irrigation - Approaches of irrigation scheduling, frequency and depth of irrigation, measurement of irrigation water. Methods of irrigation Surface, surge, subsurface, sprinkler, raingun, micro-irrigation (Drip and micro-sprinkler) components, merits and demerits, Fertigation - Definition and advantages. Irrigation efficiency - concepts and estimation. Water use efficiency and measures to improve it. Conjunctive use of water Irrigation water quality and its management- water quality parameters, management strategies for utilization of poor quality water. Water management of different crops - cereals, oilseeds, pulses, commercial, vegetable and fruit crops. Agricultural drainage - Definition, causes of water logging, effects of bad drainage on soil and crop, types, measures to improve bad drainage.

Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of kharif crops. Cereals : Rice, Maize, Kharif Sorghum, Pearl Millet and Minor Millets. Pulses: Pigeonpea, Mungbean, Uridbean, Horsegram, Mothbean, Cowpea. Oilseeds: Groundnut, Sesame, Soybean, Castor and Niger. Fibre Crops: Cotton, Jute. Green Manuring Crops: Sunhemp and Dhaincha. Forage Crops: Sorghum, Pearlmillet, Maize, Cowpea, Cluster Bean, Rainfed and Irrigated Grasses.

Origin, geographical distribution, economic importance, soil and-climatic requirements, varieties, cultural practices and yield of rabi crops, Cereals: Wheat, Barley, Rabi Sorghum. Pulses: Chickpea, Lentil, Peas, French Bean Oilseeds: Safflower, Sunflower, Linseed, Rapeseed and Mustard. Sugar Crops: Sugarcane and Sugarbeet. Medicinal And Aromatic Crops : Mentha, Lemon Grass, Citronelia, Palma Rosa, Isabgol And Posta Commercial Crops : Potato And Tobacco. Forage Crops : Maize, Berseem, Lucerne and Oat.

Weeds**:** Introduction, harmful and beneficial effects, classification, propagation and dissemination, Weed biology and ecology, crop weed association, crop weed competition and allelopathy. Concept of weed prevention, control and eradication, Methods of weed control: Physical, cultural, chemical and biological methods. Integrated weed management Herbicides: Definition, advantages and limitation of herbicide usage in India Herbicide: classification, formulations, methods of application Introduction to Adjuvants: their use in herbicides. Mode of action of herbicide: Translocation and absorption, persistence and fate of 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, parasitic and problematic weeds and their control.

Farming systems - Definition, scope, classification and components. Integrated farming system (IFS), models for irrigated and rainfed situation. Cropping systems - Indices for evaluation of cropping systems. Organic farming - Definition, principles and components. Sustainable agriculture - Introduction, Definition, goal and current concepts, Factors affecting ecological balance and ameliorative measures. Land degradation and conservation of natural resources - low external input agriculture (LEIA) and high external input agriculture (HEIA). Irrigation problems Waste lands and their development.

Organic farming - Introduction, concept, relevance in present context, organic production requirements. Biological intensive nutrient management - organic manures,

vermicomposting, green manuring, recycling of organic residues, biofertilizers Soil improvement and amendments. Integrated diseases and pest management - use of biocontrol agents, biopesticides pheromones, trap crops, bird perches Weed management. Quality considerations - certification, labeling and accreditation process, marketing, and export. Rainfed farming - meaning importance and problems, soil and climatic characteristics of rainfed areas; rainfall and its distribution and effectiveness Concept of watershed. Technique of soil and water conservation, in situ moisture conservation, harvesting and recycling of runoff water. Management practices for rainfed crops. Drought management. Crop diversification - cropping systems Crop substitution - sequence/intercropping and their importance in rainfed farming Contingency planning for aberrant weather situations, alternate land use systems. Improved agronomic practices for raising rainfed crops.

Environmental Science-Definition, scope and importance Natural resources-Definition, classification - renewable and non-renewable. Importance and uses and overexploitation of forest, water food and energy resources Ecosystem - Definition, concept, structure and function study of producers, consumers and decomposers of an ecosystem. Food chain and food web and ecological pyramids Types of ecosystem- introduction, types, characteristic features, structures and function of forest. Grassland desert and aquatic ecosystem Biodiversity-Definition, classification, threats to biodiversity and its conservation Environmental pollution-causes, effects and control of air, water, soil, thermal, noise and marine pollution. Study of causes, effects and management of soil, nuclear and industrial wastes. Disaster management-foods, earthquakes, cyclones and land slide. Social issues and the environment, unsustainable to sustainable development. The environment protection act, the air Protection act, the water protection act, and the wild life protection act and forest conservation act.

Definition of genetics, History and role of genetics in Agriculture, relation of Genetics with other of science. Ultra structure of cell and cell organelles and their functions. Study of chromosome structure, morphology, number and types, Karyotype and ideogram, Chromosome number - somatic and gametic number,, chromosome size, chromatid, centromere, telomeres, chrdmonema, matrix. Special types of Chromosome, Lampbrush, Giant Charomosome, B Chromosome, Functions of chromosome. Mitosis stages, importance. Meiosis Stages, importance, their significance and difference. Genetics and its importance, Mendels law of inheritance, monohybrid. Mendels laws of inheritance: Law of segregation: Law of independent assortment. Exceptions to the laws (Gene interaction). Multiple alleles, its characteristics and pseudoalleles. Pleiotropism, xenia, penetrace-complete and incomplete, expressivity, Atavism with examples. Multiple factor hypothesis with example-ear length in maize. Cytoplasmic inheritance-its characteristics features; Examples of Cytoplasmic inheritance, difference between chromosomal and cytoplasmic inheritance. Linkage-defnitation, phases, linkage map, linkage group, number of linkage groups. Types of linkage, linkage value, detection of linkage, significance of linkage. Crossing over-types, theories, mechanism, factors affecting crossing over, coincidence and interference, calculation of crossing over percentage from test cross data, cytological basis of crossing over-experiment of Stern in Drosophillas. DNA & its structure, function, types, modes of replication and repair; Components of DNA, DNAdouble helix structure, forms of DNA-A, B, C, and Z form; modes of replication-theories of DNA replication-conservative, semi-conservative and dispersive, DNA repair direct repair of DNA, Excision repair of DNA, very short patch repair, short patch repair, long patch repair, functions of DNA. RNA and its structure, function and types; components of RNA, types and functions of RNA-rRNA, tRNA, mRNA. Transcription, Translation, Genetic code and outlying of protein central dogma, process of transcription, Genetics code- codon characteristics of Genetics code, process of translation protein synthesis

ribosomes, process- initiation, elongation and termination. Gene expression, promoter gene, operator gene, operon constitutive gene, operon model, components of operon- Regulator, Promoter, operator and structural gene model -induction and repression, example of Lac operon; fine cistron, recon, muton. Mutation: introduction, types of mutation, characteristics of mutation, classification of mutations, induction of mutation physical and chemical mutagenesis classification of mutagenes, detection of mutations, CIB method and Attached X-chromosome technique, significance of mutations. Chromosomal aberration Numerical Polyploidy, characteristics of polyploidy, terminology, examples,. Evolution of wheat, tobacco triticale, brassica, cotton, significance of polyploidy.

Definition, history of plant breeding, Aims and objectives of Plant breeding, classification of plants and Botanical description, floral biology Emasculation and pollination techniques in cereals, millets, pulses and oilseeds and fibers and plantation crops etc., Reproduction sexual and asexual, Apomixis and their classification, Significance in plant breeding, Pollination-modes of pollination, genetic consequences, difference between self and cross pollinated crops. Methods of breeding- Introduction and acclimatization, Selection-Mass selection, Johannson's pureline theory, genetic basis, Pure line selection, Hybridization-aims, objectives and types of hybridization, Methods of handling of segregating generations-Pedigree method, Bulk method, Back cross method and various modified methods. Self incompatibility and male sterility-types and their utilization in crop improvement, Heterosis, In breeding depression, theories of heterosis, Exploitation of hybrid vigour, development of inbred lines, single cross and double cross hybrid, Population improvement programme, recurrent selection, Synthetics and composites, Methods of breeding for vegetatively propagated crops-clonal selection and hybridization, Mutation breeding, ploidy breeding, wide hybridization and significance in crop improvement.

Introduction, Definition, importance in agriculture. Growth and development, Definition. Determinate and inderminate growth, measurement of growth, growth analysis, growth characteristics. Definition and mathematical formulae. Crop water relations : physiological importance of water to plants, water potential and its components, measurement of water status in plants. Transpiration: significance, transpiration in relation to crop productivity, water use efficiency (WUE) in C3, C4 and CAM plants, factor affecting WUE. Photosynthesis: energy synthesis, significance and C3, C4 and CAM pathway, relationship of photosynthesis and crop productivity. Photorespiration : factors affecting photosynthesis and productivity, photosynthetic efficiency, dry matter partitioning, Harvest index of crops. Respiration : respiration and its significance, brief account of growth respiration and maintenance respiration. Translocation: translocation of assimilates, phloem loading, apoplastic and symplastic transport of assimilates, source-sink concept. Nutriophsiology: Definition mengel's classification of plant nutrients-functions of plant nutrients-deficiency and toxicity symptoms of plant nutrients foliar nutrition-hydroponics. Photoperiodism and vernalisation: introduction of photoperiodism and vernalisation in relation to crop productivity-photoperiodism. Plant classification on basis of photoreponses-forigine concept in flowering of phytochrome in flowering process vernalization methods. Plant growth regulators: occurrence -biosynthesis -mode of action of auxins, gibberellins, cytokinins, commercial application of plant growth regulators in agriculture. Senescence and absril Steilll Slioition classification physiological and biochemical' harvest physic climacteric . Senescence and abscission. Post chic changes, climacteric and non- Bning.

Definition, Breeding objectives and important concepts of breeding, self pollinated , cross pollinated and vegetatively propagated crops. Role of National and International Crop

improvement Institutes and organizations. Study in respect of origin, Botanical names, family, Genus, Chromosome numbers, Distribution of species, Wild species and forms. Cereals (Sorghum, Bajra, Maize, Rice, Wheat, Ragi), Pulses (Tur, Gram, Mung, Udid, Soybean), Oilseeds (Ground nut, Soybean, Sunflower, Safflower, Sesame, Linseed), Fiber (Cotton, Kenaf, Roselle, jute), Fruit (Mango, Aonla, Guava, Custard apple, Banana, Papaya), Vegetables (Tomato, Brinjal, Bhendi, Chilli, Cucumber), Flowers (Chrysanthemum, Rose, Galardia, Gerbera, Marigold), Major breeding procedures for development of hybrids/ varieties of various crops: Introduction, Merits and demerits, Procedure flowchart with modifications in short, Achievements. Self pollinated crops: Mass selection, Pureline selection, Pedigree selection, Bulk method, Backcross method, Progeny and Single Seed Descent method. Cross pollinated crops: Population Improvement, (Mass, Progeny selection and Recurrent selection) P Other methods: Clonal selection, Mutation, polyploidy, Distant hybridization plant genetic resources, their conservation and utilization in crop improvement: Germplasm Definition, landrace, Variety, cultivar, wild type, Gene pool concept, Genetic erosion, germplasm collection and conservation types and methods in short. Ideotype concept in crop improvement: Concept, Types of ideotype, Characteristics of a ideotype, Major steps in ideotype breeding, Ideotype of rice, wheat, sorghum, cotton Merits and limitation of ideotype breeding. Breeding for stress resistance: Introduction, Types of stresses. Biotic stresses: History, Types of resistance, Variability in pathogens and pests, , mechanism of pathogen resistance, achievements, Abiotic stresses: Types, Drought and mineral toxicity resistance, achievements. Genetic basis of adaptability for unfavourable environments, salinity, drought, high and low temperature Biometrics: Definition of biometrics, assessment of variability Range, Arithmetic mean, Variance, S.D., S.E., C.V. Multiple factor hypothesis: Explanation of Yule hypothesis given by Nilsson-Ehle(1908),Components of genetic variance. Hoterosis and Inbreeding depression. Combining ability analysis. Genotype x Environment interaction and infuence on yield performance. Stability analysis. IPR and its related issues: History, Need of IPR, Full forms and head quarters of WTO, GATT, UPOV, TRIPs, FAO, WIPO etc , Acts: Need & Objectives: i. Registration and protectio Act 1999 (Geographical Indications of goods) ii. PPV & FRs Act. 2001 iii. Biological diversity Act 2002. Programme, Grow out test plot, Various research stations, other institutions. Hybrids and improved varieties of field crops, forage crops, and horticulture crops. Achievements of stress breeding.

Concept of plant biotechnology, History of plant tissue culture and plant genetic engineering, Scope and importance of plan, biotechnology in cop improvement, Totipotency and morphogenesis, Nutritional requirements of plant tissue culture, Techniques of in vitro culture, Test tube fertilization. Endosperm culture, Factors affecting on test tube fertilization and endosperm culture Applications and achievements and types of somaclonal variation, Somatic embryogenesis and synthetic seed production, Protoplast isolation and culture, Protoplast manipulation and fusion, Somatic hybrids and cybnds and their applications in crop improvement Concept of genetic engineering, Restriction enzymes and their uses, Concept of vectors and their types for gene transfer, Gene cloning, Direct method of gene transfer, Indirect method of gene transfer, Transgenic plant and their applications, Different type of blotting techniques, DNA finger printing, DNA based markers: RFLP, RAPD, SSR and DNA probes, Mapping of QTL and future prospects, MAS and its application in crop improvements. Plant tissue culture laboratory specifications and organization of equipments and their use, Different Sterilization techniques and aseptic manipulations, Preparation of tissue culture media and their composition. Preparation of explants (Banana I Sugarcane) establishment and maintenance of callus cultures from different explants, sub culture of callus, Regulation of morphogenesis from different explants, roots, stem, leaf, bud, Micropropagation with shoot apex culture in different plants (Banana / Sugarcane), Meristem culture, Anther and pollen culture, Embryo and

endosperm culture, Somatic embryogenesis and artificial seed production, Isolation and culturing of protoplast, Isolation of genomic DNA, Gene transfer method: direct method, Gene transfer method: indirect method, Gel electrophoresis technique, Confirmation of genetic transformation.

Introduction to Seed Production, Importance of Seed Production Seed Policy, Seed demand forecasting and planning certified, foundation and breeder seed production, Deterioration of crop varieties, Seed quality, Different classes of seed, production of nucleus and breeders's seed, Maintenance and multiplication of pre-release and newly released varieties in self, and cross pollinated crops, Seed production, foundation and certified seed production (varieties, hybrids, synthetics and composites) in maize, rice, sorghum, bajra, cotton, sunflower, castor, tomato, brinjal, chilli, bhendi, onion, bottle gourd and ridge gourd. Seed certification, phases of certification, procedure for seed certification. Field inspection and field counts etc. Seed Act and Seed Act enforcement, Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency. Central and State Seed Testing Laboratories, Duties and Powers of seed inspectors, offences and penalties. Seed control order, seed control order 1983, seed Act 2000 and other issues related to seed quality regulation. Intellectual property rights, patenting, WTO, plant breeders rights. Varietal identification through grow-out test and electrophoresis, Establishing a seed testing laboratory. Seed testing procedures for quality assessment Seed treatment and Seed Processing, Seed processing plant, Seed packing and seed storage, Seed marketing.

Soil: Pedological and edaphological concepts, Origin of the earth, Earth crust; Composition : Rocks and minerals, Weathering, Soil formation factor and processes .Components of soils; Soil profile, Soil physical properties, So texture, Textural classes, Particle size analysis, Soil structure classification, Soil aggregates, significance, Soil consistency, Soil crushing, Bulk density particle density of soils and porosity, their significance and manipulation, Soil compaction, Soil colour, Elementary knowledge of soil classification and soils India; Soil water, Retention and potentials, soil Moisture constants, Movement of soil water, Infiltration, permeability, Drainage, Methods of determination of soil moisture Thermal properties of soils, Soil temperature, Soil air, Gaseous exchange, Influence of soil temperature and air on plant growth; Soil colloids, properties, nature, types and significance; layer silicate clays, their genesis and sources of charges, adsorption of ions, Ion exchange, Influence of soil temperature and air on plant growth; Soil colloids, properties, nature, types and significance; layer silicate clays, their genesis and sources of charges, adsorption of ions, Ion exchange, CEC and AEC, Factors influencing ion exchange and its Significance. Soil organic matter; composition, Decomposability Humus, Fractionation of organic matter, Carbon cycle, C:N ratio. Soil Biology, Biomass Soil Organism and their beneficial and harmful roles .Soil Survey, Soil Classification Soils in India and Maharashtra, Soil erosion, types .universal soil equation, control measures.

Soil as a source of plant nutrients, Essential and beneficial elements, criteria of essentially, forms of nutrients in soil, mechanisms of nutrients transport to plants, factors affecting nutrient availability to plants, Measures to overcome deficiencies and toxicities. Problem soils - acid, salt affected and calcareous soils, characteristics, nutrient availabilities. Reclamation - mechanical, chemical and biological methods. Fertilizer and insecticides and their effect on soil water and air. Irrigations water - quality of irrigations water ; and its appraisal. Indian standards for water quality. Use of saline water for agriculture. Soil fertility - Different approaches for soil fertility evaluation. Methods, Soil testing - chemical methods. Critical levels of different nutrients in soil. Plant analysis -DRIS methods, critical levels in

plants. Rapid tissue tests. Indicator plants. Biological methods of soil fertility evaluation. Soil test based fertilizer recommendations to crops. Factors influencing nutrients use efficiency (NUE) in respect of N,P,K,S, Fe and Zn fertilizers. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions.

Introduction - Raw materials- Manures - Bulky and concentrated- FYM, Composts, - Different methods, Mechanical compost plants, Vermicompost, Green Manures, Oil cakes, Sewage and sludge-Biogas plant slurry, Plant and animal refuges. Fertilizers-classification, Manufacturing processes and properties of major nitrogen (ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate). Potassic and complex fertilizers their fate and reactions in the soil, Secondary and micronutrients fertilizers, Amendments. Fertilizer Control Order, Fertilizer Storage; Biofertilizers and their advantages, Organic chemistry as prelude to agro-chemicals, Diverse types of agrochemicals, botanical insecticides (Neem), Pyrethrum, Synthetic pyrethroids. Synthetic organic insecticides, Major classes, Properties and uses of' Some important insecticides under each class. Herbicides - Major classes - Properties and uses of 2, 4-D, atrazine, glyphosate, butachlor benthiocarb; Fungicides - Major classes - Properties and uses of carbendazim, carboxin, captain, tridemorph and cropper oxychloride - Insecticides Act. Plant growth regulators.

History, scope and importance of biochemistry, structure and organelles of plant cell and their role., Biomolecules - Definition, types, structure, properties and their applications, Carbohydrates - Definition, classification, structure, properties and functions-Nucleotides and nucleic acid - Definition, components and their structure. Amino acids, peptides and proteins - Definition, classification, structure and properties, Plant proteins and their quality, Essential, amino acids classification, structure, properties and their significance, Fatty acids- Definition, classification, structure and essential fatty acids, Biochemical energetic - Definition, free energy concept of chemical reaction, components of electron transport chain, energy rich compound. Enzymes- Definition, classification, factors affecting enzyme activity Enzyme immobilization (inactivation) and Its Industrial application in agro-industries, Vitamins and their coenzyme derivatives. Metabolic energy and its generation metabolism - glycolysis, citric acid cycle, pentose phosphate pathways, phosphorylation - Definition, cyclic non cyclic and substrate level phosporylation, oxidative phosphorylation. Fatty acid oxidation-Beta-oxidation. Biosynthesis- carbohydrates, lipids protein, nucleic acids, Metabolic regulation- integration of carbohydrate, protein metabolism. Secondary metabolites - glycosides, tannins, Lignin's, and mucilage's -Definition, classification, properties and their physiological rates and application in food and pharmaceutical industries. Secondary metabolites-alkaloids, terpenoids - Definition, classification, properties and their physiological roles and application in food and pharmaceutical industries.

Definition of Horticulture, fruit science : scope, importance, area and production of fruit crops in Maharashtra and India. Export import scenario of fruit crops in India. Classification of fruit crops on Horticultural basis. Climate and soil. Selection of site, fencing, wind break and shelter belts. Planning, layout and planting systems. High density, planting and meadow orcharding. Methods of propagation in fruit crops. Use of rootstocks in fruit crops. Training and pruning of fruit crops. Use of bio-regulators in propagation and fruit production. Nutritional management of fruit crops. Irrigation management of fruit crops. Special horticultural practices : Bahar treatments, notching, ringing, bending, girdling, etc. Origin, B.N., family, area and production, soil and climate, commercial varieties. Propagation and

planting, after cares (irrigation, weed management, nutritional requirement, use of PGR, physiological disorders, plant protection measures and special horticultural practices), Harvesting and yield of horticultural fruit crops : Mango, Banana, Citrus (Sweet orange, Mandarin, Acid lime), Guava and Sapota, Grape, Pineapple, Papaya, Pomegranate, Anonaceous fruits, Ber and fig, Aonla and Jackfruit, Apple. Brief cultivation in tabular form on following crops Strawberry, Cherry, Pear, Plum, Peach, Almond, Karonda, Phalsa and Bael, Recommendations of Joint Agresco (last five years).

Importance and scope of olericulture, Vegetable garden and vegetable classification, Origin, area, production, varieties, package of practices for vegetables: Fruit vegetables : Tomato, Brinjal, Chillies, Okra, Cucurbitaceous vegetables - Cucumber, Ridge gourd, Bottle gourd, Bitter gourd and Melons, Cole crops - Cabbage, Cauliflower and Knolkhol, Bulb crops - Onion and Garlic. Beans and Peas - French beans, Cluster beans, Dolichos beans, Peas and Cowpea. Tuber crops - Potato, Sweet Potato, Root crops - Carrot, Radish. Leafy vegetables _Amaranthus, Palak, Methi. Importance of ornamental horticulture, Types and styles of ornamental gardens, Study of trees, shrubs, climbers, palms, indoor plants and seasonal flowers (Common name, botanical name, family, propagation method and uses), Package of practices for Roses, Jasmine, Chrysanthemum Gladiolus, Marigold and Tuberose.

Importance and cultivation technology of Spices - Ginger, Turmeric, Pepper, Cardamom, Nutmeg, Pimenta, Cinnamon Coriander, Cumin, Fenugreek, Aromatic. Crops - Lemon Grass, Citronella, Palmarose, Vetiver, Geranium, Dawana; Plantation crops - Coconut, Arecanut, Betelvine, Cashew, Cocoa, Coffee, Tea, Oilpalm; Medicinal plants - Diascoria, Rauvolfa, Opium, Ocimum, Perwmkle, Aloe, Guggul, Belladonna, Nux vomica, Solamim khasiamum. Aonla, Senna, Plantago, Stevia, Caleus and Acmrs, Hida. Behada, Arjun, Mahua, Adulsa, Safed. Musali, Gulwel, and Satap.

Importance of post harvest technology in horticultural crops. Maturity, Maturity indices, harvesting and post harvest handling of fruits and vegetables. Ripening, changes during ripening and factors affecting ripening of fruits and vegetables. Pre-harvest factors affecting quality on post-harvest shelf life of fruits and vegetables. Factors responsible for deterioration of harvested fruits and vegetables. Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage, pre-cooling, pre-storage treatments, low temperature storage, controlled atmospheric storage, hypo-baric storage, irradiation and low cost storage structures. Various methods of packing, packaging and cushioning materials and transport. Importance and scope of fruits and vegetables preservation in India. Unit layout - Selection of site and precaution for hygienic conditions of the unit. Principles and methods of preservation by heat, low temperature, chemicals, fermentation, canning, bottling, ultra-violet and ionizing radiation. Spoilage of canned products, biochemical, enzymatic and microbial spoilage.

Economics: Meaning, Definition, Subject matter Division of Economics (production, Exchange, Distribution, Market supply), importance of Economics. Agricultural Economics; Meaning, Definition Basic Concepts: Goods, Service, Utility, Value, Price, Wealth, Welfare. Wants: Meaning, Characteristics, Classifications of Vtints, Importance. Theory of consumption: Law of Diminishing Marginal utility Meaning, Definition, Assumption, Limitations, Importance. Consumer's surplus: Meaning, Definition, Importance. Demand: Meaning, Definition, Kinds of Demand, Demand schedule, Demand Curve, Law of Demand, Extension and Contraction Vs Increase and Decrease in Demand. Elasticity of Demand: Types of Elasticity of Demand, Degrees of price elasticity of Demand, Methods of Measuring Elasticity, Factors influencing elasticity of Demand, Importance of Elasticity of Demand.

Supply: Meaning, Definition, Kinds of Supply, Supply schedule, Supply Curve, Law of supply, Extension and Contraction Vs Increase and Decrease in Supply, Elasticity of Supply: Types of Elasticity of Supply, Degrees of price elasticity of Supply, Methods of Measuring Elasticity Factors influencing elasticity of Supply Importance of Elasticity of Supply. Welfare Economics: Meaning, Pareto's optimality. National Income: Concepts, Measurement. Public Finance: Meaning, Principles. Public Resource: Meaning, Service Tax, classification of Taxes, Cannons of Taxation. Public expenditure: Meaning, Principles. Inflation: Meaning, Definition, Kinds of inflation.

Definition of Statistics, its use, limitations; Frequency Distribution and Frequency Curves, Measures of Central Tendency, Characteristics of Ideal Average. Arithmetic Mean, Median, Mode and their Merits and Demerits; Measures of Dispersion. Standard Deviation, Variance and Coefficient of Variation; Probability. Definition and concept of probability. Normal Distribution and its properties; Introduction to Sampling. Random Sampling; the concept of Standard Error, Tests of Significance Types of Errors, Types of Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis, Large Sample Test SND test for Means, Single Sample and Two Samples and Paired t-test F-test; Chi-square Test in 2 X 2 Contingency Table, Yates' Correction for continuity, Correlation; Types of Correlation, Scatter Diagram, Computation of Correlation Coefficient r and its testing, Linear Regression: of Y on X and on Y. Inter-relation between V and regression coefficients. Experimental Designs; Basic Principles, Completely Randomized Design (CRD), Layout and analysis with equal and unequal number of observations, Randomized Block Design (RBD), Layout and analysis, Latin Square Design (LSD), Layout and analysis.

Production Economics: Meaning, Definition Nature and Scope of Agricultural Production Economics. Basic concepts and terms. Concepts Production. Production Functions: Meaning, Definition, Types. Laws of returns: Increasing. Constant and decreasing. Factor Product Relations. Determination , optimum input and output Factor relations ,p. Produd relationship. Types of enterprise relationships. Returns to scale: Meaning. Definition, Importance. Farm Management: Economic principles applied to Organizations of farm business. Types and systems of farming, Farm planning and budgeting, Risk and uncertainty, Farm budgeting. Linear programming: Assumption, Advantages and Limitations of Linear programming.

Agricultural finance: Nature and scope. Time value of money, Compounding and Discounting. Agricultural credit: meaning, Definition, need, classification, Credit analysis: 3R's 5C's and 7P's of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks. Land ijank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, Insurance and Credit Guarantee Corporation of India. Assessment of crop losses, determination of compensation. Crop insurance, advantages and limitations in application. Estimation of crop yields. Agricultural cooperation; philosophy and principles. History of Indian cooperative Movement, pre-independence and post independence periods, cooperation in different plan periods, cooperative credit structure; PACS, FSCS. Reorganization of cooperative credit structure in Maharashtra and Single Window System, Successful cooperative systems in Gujarat, Maharashtra, etc.

Agricultural Marketing: Concepts and Definition, Scope and subject matter, Market and Marketing: Meaning, Definitions, Components of a market, classification. Market structure, Conduct, performance. Market functionaries or agencies, Producer's surplus: Meaning, Types

of producers surplus, marketable surplus. Marketed surplus, importance, Factors affecting Marketable surplus. Marketing channels: Meaning, Definition, Channels for different products. Market integration: Meaning, Definition, Types of Market Integration. Marketing efficiency: Meaning, Definition, Marketing costs, Margins and price spread, factors affecting the cost of marketing costs. Theories of International Trade: Domestic Trade, Free trade, International Trade, GATT, WTO, Implications of AOA. Market access, Domestic support, Export subsidies, EXIM-Policy and Ministerial conferences. Cooperative Marketing. State Trading. Mre Housing CoipoxatitMi Central and State. Objectives, Functions, Advantages. Food Corporation of India: Objectives and Functions. Quality Control, Agricultural Products, Characteristics of agricultural produce and commodity exchange, AGMARK. Price: Meaning, Need for Agricultural Price Policy. Risk in Marketing: Meaning and importance, Types of Risk in Marketing. Speculations and Hedging, Futures trading, Contract farming.

Agribusiness: Meaning, Definition, structure of Agribusiness, (Input, Farm, Product Sectors). Importance of Agribusiness in the Indian Economy, Agricultural Policy. Agribusiness Management, Distinctive features, Importance of Good Management, Definitions of Management. Management Functions. Planning: Meaning, Definition, Types of Plans (Purpose or Mission, Goals or Objectives, Strategies, Polices, Procedures, rules, programmers, Budget) characteristics of sound plan. Steps in planning:Organization, Staffing, Directing, Motivation, Ordering, Leading, Supervision, Communication, control. Capital and Financial Management of Agribusiness: Importance of Financial Statements, Balance sheet, Profit and Loss Statement, Analysis of Financial statements. Agro-based Industries: Importance and Need, classification of Industries, Types of Agro based Industries, Institutional arrangement, Procedure to set up agro- based industries, Constraints in establishing agro-based industries. Marketing Management: Meaning Definitions, Marketing Mix, 4Ps of Marketing. Mix, market segmentation, Methods of Market, Product life cycle. Pricing policy: Meaning, pricing method. Prices at various stages of Marketing. Project: definitions, project cycle, identification, Formulation, Appraisal, Implementation, monitoring and evaluation, Appraisal and Evaluation techniques, NPW, BCR, IRR, N/K ratio, sensitivity analysis, characteristics of agricultural projects, preparation of project reports for various activities in agriculture and allied sectors: Dairying, poultry, fisheries, agro- industries etc.

History of Entomology in India. Factors for insects' abundance, classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology : Structure and functions of insect cuticle and moulting. Body segmentation, structure of head, thorax and abdomen, Structure and modification of insect antennae, mouth parts and legs. Wing venation, modifications and wing coupling apparatus. Structure of male and female genitalia, Sensory organs. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system in insects. Types of reproduction in insects. Systematics: Taxonomy - importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species. Species, Genus, Family and Order. Classification of class Insecta upto Orders. Orthoptera (Acrididae), Dictyoptera, Mantidae, Odonata, Isoptera (Termitidae), Thysanoptera (Thripidae), Hemiptera (Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Aleurodidae, Coccidae, Pseudococcidae), Neuroptera (Chrysopidae), Lepidoptera (Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae), Coleoptera (Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae), Hymenoptera (Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae), Diptera (Cecidomyiidae, Trypetidae, Tachinidae, Agromyzidae).

Introduction, Environment and its components. Effect of abiotic factors temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors - food competition, natural and environmental resistance. Concepts of Balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem. Pest surveillance and pest forecasting. Categories pests IPM, Introduction, importance, concepts, principles and tools of IPM-Host plant resistance. Cultural, Mechanical, Physical, Legislative, Biological (parasites, predators & insect pathogens such as bacteria, fungi and viruses). Methods of control. Chemical control, Importance, advantages and disadvantages, classification of insecticides, toxicity of insecticides and formulations of insecticides. Botanical insecticides, Organochlorines, Cyclodienes Organophosphates, Carbamates, Synthetic pyrethroids, Neo nicotinoides, Novel insecticides, Chitin synthesis inhibitors, Phenyl pyrazoles, Avermectins, Macrocyclic lactones, Oxadiazines, Thiourea derivatives, pyridine azomethines, pyrroles, etc. Nematicides, Rodenticides, Acaricides and fumigants. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Insecticides Act, 1968 - Important provisions. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Beneficial insects. Parasites and predators used in pest control and their mass multiplication techniques. Important groups of microorganisms, bacteria, viruses and fungi used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers, their importance. Non insect pests - mites, nematodes, rodents and birds. Vermiculture.

Stored grain pests: Coleopteran and Lepidopteran pests, their biology and damage, preventive and curative methods. Distribution, biology, nature and symptoms of damage, and management strategies of insect and non insect pests of rice, sorghum, maize, ragi (*Eteucre coracarta*), wheat, sugarcane, cotton, mesta, sunhemp, pulses, groundnut, castor, ginger, safflower, mustard, brinjal, bhendi, tomato, cruciferous and cucurbitaceous vegetables, potato, sweet potato, colacasia, moringa, amaranthus, chillies, mango, citrus grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut tobacco, coffee, tea, turmeric, betelvine, onion, coriander, garlic, curry leaf, pepper, ginger and ornamental plants.

Introduction. History of Phytonematology, Economic importance, General Characteristics of Plant Parasitic Nematodes. Nematode - general morphology and biology. Classification of nematodes up to family level with emphasis on groups containing economically important genera, classification of nematodes by habitat, identification of economically important plant parasitic nematode upto generic level with the help of keys and descriptions. Symptoms caused by nematodes with examples. Interaction between plant parasitic nematodes and disease causing fungi, bacteria and viruses. Different methods of nematode management. Cultural methods (crop rotation, fallowing, soil amendments, other land management techniques). Physical methods (soil solarization, hot water treatment). Biological methods. Chemical methods (Fumigants and non fumigants) Resistant varieties. IDM.

Introduction, History of Plant Pathology: History and development of Plant Pathology in ancient, dark, premodern, modem and present eras, Contribution made by different scientists, Definitions and objectives of Plant Pathology: Concepts of disease, Disease triangle, Important plant pathogenic organisms: Different groups like fungi, bacteria, fastidious vesicular bacteria and phytoplasma with examples of diseases caused by them, Morphology and reproduction: of spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites with examples of diseases caused by them, Prokayotes - classification of prokaryotes according to Bergey's

manual of Systematic bacteriology, General characters of fungi: mycelium (septate and non-septate), nutrition of fungi – (saprophytes, parasites and symbiosis), Definition of fungus, somatic structures, types of fungal thalli, fungus tissues, modification of thallus, reproduction in fungi (asexual and sexual) - spores (asexual and sexual), spore fruits (asexual and sexual), Asexual reproduction: fission, budding, and fragmentation; Sexual reproduction: plasmogamy, karyogamy and meiosis, Method of reproduction: planogametic copulation, gametangial contact, gametangial copulation, spermatization, dikaryotization; Nomenclature: binomial system of nomenclature, rules of nomenclature; classification of fungi -upto genus

History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Procaryotic and eucaryotic microorganisms. Morphology, cytology and other characters of bacteria, fungi, algae, actinomycetes and mycoplasma. Bacteriophages, structure and properties of bacterial viruses : Lytic and Lysogenic cycles; viroids, prions. Metabolism in bacteria: ATP generation, chemoautotrophy, photoautotrophy, respiration, and fermentation. Bacterial genetics: Gene expression, Genetic recombination: transformation, conjugation and transduction, genetic of bacteria by Pour plate method and Spread plate method, 'eaching Schedule: Theory: engineering, plasmids, episomes, genetically modified organisms. Protection against infections. Plant - Microbe interactions. Applied areas of Microbiology. Soil Microbiology: Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of rhizosphere and phyllosphere microflora, microbes in composting. Miorobiology of Water: potable, irrigation, sewage water and water purification systems. Microbiology of food: microbial spoilage of food and principles of food preservation. Beneficial microorganisms in Agriculture: Biofertilizer (bacterial cyanobacterial and fungal). Methods of application and quality norms of biofertilizers. Microbial insecticides. Microbial agents for control of plant diseases. Biodegradation, Biogas production.

Terms and concepts, survival and dispersal of plant pathogens: Survival - mode of perpetuation of pathogen, facuitatism by dormant mycelium and sclerotia; perpetuation on alternate and collateral hosts; heteroecism, autocism, polymorphism, physiological specialization, Dispersal: continuous dissemination - autonomous dissemination, Role of air, wind, water, animals, birds, insects, nematodes and mites in dissemination of plant pathogens, Discontinuous dissemination - man, seed, soil and agricultural operations, Phenomenon of infection: pre-penetration, penetration and post penetration, Mechanism of infection and avenues of penetration, direct and indirect penetration, Pathogenesis: role of enzymes, toxins, growth regulators and polysaccharides, Defense mechanisms in plant: structural and biochemical (pre and post infection), Plant disease epidemiology and disease forecasting: remote sensing, Epidemiology - Definition, simple interest and compound interest diseases, essential conditions for epiphytotics, decline of epidemics, Plant disease forecasting: methods of disease forecasting, survey and surveillance, forecasting models, satellite imaginary forecasting; General principles of plant disease management: importance, principles - avoidance, exclusion, eradication, protection and resistance remote sensing laboratory, Soil solarization, Handling of plant protection equipments.

Economic importance, symptoms, cause, epidemiology and disease cycle and integrated management of diseases of rice, sorghum, bajra, maize, wheat, sugarcane, ragi, finger millet, turmeric, ginget tobacco, groundnut, sesamum, sunflower, safflower, linseed, castor, cotton, red gram, Bengal gram, black gram, green gram, soybean.

Economic importance, symptoms cause disease cycle and integrated management of diseases of citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, custard, apple, ber, fig, strawberry cashes aonla, jamun. cocum, arecant, coconut, apple, chilli, brinjal, lady finger, potato crucifers, cucurbits, tomato, beans, onion, garlic, leafy vegetables, betelvine, mulberry, coffee, tea, oil palm, rose, chrysanthemum jasmine, aster marigold, gladiolus, carnation, tuberose and gerbera. Study of symptoms, etiology host-parasite relationship and specific control measures of diseases of citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, custard apple, bee fig, strawberry cashew aonla, jamun, cocum, arecanit, coconut, apple, chili, brinjal, ladyfinger, potato, crucifers, cucurbits, tomato, beans, onion, garlic, leafy vegetables, betelvine, mulberry, coffee, tea, oil palm, rose, chrysanthemum and jasmine, aster marigold, gladiolus, carnation, tuberose, gerbera. Field visits at appropriate time during the semester. Survey and collection of disease samples of above crops and their preservation.

Surveying : survey equipment, chain survey, cross staff survey, calculations of area of regular and irregular fields. Plane table survey, Levelling- levelling equipment, terminology, methods of calculation of reduced levels, types of levelling, contouring. Water lifting devices-pumps (for open and tube well), discharge, head and power calculations, Irrigation water measurement through weirs, flumes and orifices. Soil and Water conservation - soil erosion, types of engineering control measures, run off estimation, watershed development.

Introduction to Computers, Anatomy of Computers, Input and Output Devices, Units of Memory, Hardware, Software and classification of Computers., booting of computer, warm and cold booting, Computer Viruses, Worms and Vaccines, Operating System - WINDOWS. Disk Operating System, Some fundamental DOS Commands, FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD, DEL, TREE and DEITREE, Rules for naming files in DOS and "types of files. WINDOWS : GUI, desktop and its elements, V\forking with files and folders using WINDOWS Explorer; setting time and date. Anatomy of a WINDOW, Title Bar, Minimize, Maximize and Close Buttons, Scroll Bars, Menus and Tool Bars. Features of word-processing packages. Creating, Editing, Formatting and Saving a document; Electronic Spreadsheets, concept, Creating, Editing and Saving a spreadsheet. Concept of ceil range and cell reference. Use of in¬built Statistical functions : SUM , Average, LN , LOG, SORT, MEAN , MEDIAN GEOMEAN, ASIN ,STDEV, CORREL. Use of data analysis tools, correlation and regression, t-test for two samples and ANOVA with one and two way classification (RBD & CRD). Creating Graphs, Features of slide presentation package. Concept of Database (RDBMS), creating updating database. Internet: World Wide Web (WWW), Concepts, Web Browsing and Electronic Mail.

Farm power in India : Sources, I.C. engines, working principles, two stroke and four stroke engines. I.C. engine terminology, different systems of I.C. engine. Tractors. Types, Selection of tractor and cost of tractor power tillage implements. Primary and secondary tillage implements, Implements for intercultural operations seed drill, paddy trans-planters, plant protection equipment and harvesting equipment: Equipment for land development and soil conservation.

Green house technology, Introduction, Types of Green Houses, Plant response to Green house environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Materials of construction for green houses, Irrigation systems used in greenhouses, Choice of crops for cultivation under greenhouses, Growing media, soil culture, type of soil required, drainage, flooding and leaching soil pasteurization in peat moss

and mixtures, rock wool and other inert media. Drying, grain drying, types of drying, types of dryers, Storage, grain storage, types of storage structures, Cleaning machinery, Grading, methods of grading, equipment for grading of fruits and vegetables, Size reduction, equipment's for size reduction, Seed processing cleaning and grading, Separators, Storage structures, Quality standards FAQ, ASTA, FPO, FDA.

Sociology- Meaning, Definition. Rural Sociology- Meaning. Definition, scope, importance of rural sociology agricultural extension and interrelationship between Rural sociology & Agricultural extension. lndian Rural Society- Important characteristics, differences and relationship between Rural and Urban societies. Social Groups- Meaning, Definition, classification, factors considered in formation and organization of groups, motivation in group formation and role | of social groups in Agricultural Extension. Social Stratification - Meaning, Definition, functions, basis for stratification, forms of social stratification characteristics and differences between class & caste system. Cultural concepts- Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions- Meaning, Definition and their role In Agricultural Extension. Social Values and Attitudes- Meaning, Definition, types and role of Social Values and Attitudes in Agricultural Extension. Social Institution: Meaning, Definition, major institutions in rural society: Marriage, family and religion, functions and their role in Agricultural Extension Social Organizations- Meaning, Definition, types of organizations and role of social organizations in Agricultural Extension. Social Control- Meaning, Definition, need of social control and means of social control Social Change- Meaning, Definition, nature of social change, dimensions of social change and factors of social change. Leader- Meaning, Definition, types and their role in Agricultural Extension. Psychology and Educational Psychology - Meaning, Definition, scope, any importance of Educational Psychology in Agricultural Extension.-' intelligence - Meaning, Definition, types, factors affecting intelligence. Personality- Meaning, Definition, types, factors influencing personality. Teaching - Learning Process- Meaning and Definition of Teaching, Learning Learning Experience and Learning Situation, Elements of Learning Situation and its Characteristics. Principles of Learning and their implication for Teaching. Perception and Motivation.

Education -Meaning, Definition, Types- Formal, Informal and Non-formal education and their characteristics. Extension Education- Meaning, Definition, concepts, objectives and principles Agricultural Extension- Meaning and Definition. Rural Development- Meaning, Definition, concepts, objectives, importance and problems in Rural Development. Developmental programmes of Pre-independence era- Sriniketan, Marthandam. Gurgaon Experiment and Gandhian Constructive programme Development programmes of Post Independence era- Firka Development, Etawah-Pilot Project and Nilokheri Experiment. Community Development Programme - Meaning, Definition, concepts, philosophy, principles, objectives, differences between Community Development and Extension Education. National Extension Service. Panchayati Raj system - Meaning of Democratic Decentralization and Panchayati Raj. Three tiers of Panchayati Raj system, powers, functions and organizational set up. Agricultural Development programmes with reference to objectives &salient features- intensive Agricultural District Programme (IADP), High Yielding Varieties Programme (HYVP) Institution Village Linkage Programme (IVLP), Watershed Development Programme (WDP), National Agricultural! Technology Project (NATP), ATMA, ATIC, NHM and NAIP. Social Justice and Poverty Alleviation Programmes- Integrated Tribal Development Programme (ITDP), Integrated Rural Development Programme (IRDP), Swarna Jayanthi Gram Swarojgar N6jana (SGSY), Prime Minister Employment Yojana (PMEY). New Trends in Extension-Privatization. Women Development Programmes - Development of Women and

Children in Rural Areas (DWCRA), Integrated Child Development Scheme (ICDS) and Mahila Samriddi Yojana (MSY), Mahila Arthik Vikas Mahamandal (MAVIM). Reorganized Extension System (T & V System)- Salient features, fort¬nightly meeting, monthly workshops, linkages, merits and demerits, Single Window System of Extension in Maharashtra. Broad Based Extension (BBE): Meaning and genesis.

Communication — Meaning, Definition, models, elements and their characteristics. Barriers in communication. Transfer of Technology: Meaning and Definition. Extension Programme Planning - Meaning Definition of planning, programmes and project, importance, principles and steps in programme planning process. Monitoring - Meaning and Definition. Evaluation - Meaning, Definition, types, differences between monitoring and evaluation. Extension Teaching Methods- Meaning, Definition, functions and classification. Individual contact methods- Farm and Home visit, Result Demonstration, Field trials- - Meaning, objectives. steps, merits and demerits. Group contact methods- Group discussion, Method demonstration, Field trips- Meaning, objectives, steps, merits and demerits. Group discussion techniques- Lecture, Symposium, Panel, Debate, Forum, Buzz group, Workshop, Brain Storming. Seminar and Conference. Mass contact methods- Campaign, Exhibition, Farmers Rally, Radio & Television, Community Radio Stations (CRS). Factors influencing the selection of Extension Teaching Methods and Combination (Media Mix) of teaching methods. Advanced Information Sources- Internet, Cyber Cafe, Video and Tele conferences, Kisan Call Centers, Consultancy clinics. Agricultural Journalism- Meaning, scope and importance News- Definition, meaning, sources of news, types merits and limitations Diffusion and Adoption of Innovations- Meaning, Definition, Innovation- Decision Process- adopters categories and their characteristics, factors influencing adoption process. Capacity Building of Extension Personnel and Farmers- Meaning, Definition, training process (steps) types of training, training to extension personnel, farmers, farm women and rural youth, FTC and KVK.

Entrepreneur: Meaning, Definition, characteristics and role, demands of entrepreneur, identifying potential entrepreneurs, functions. Entrepreneurship Development- Concept of entrepreneurship, process of entrepreneurship development, motivation and entrepreneurship development, importance of planning, monitoring and follow-up, managing competition, entrepreneurship development programmes. Current Status of Indian Agricultural Processing and Export Industries. SWOT analysis generation, incubation and commercialization of ideas and innovations. Agri. Partnership -Definition, Importance, agri. Clinics & agri. business centers Entrepreneurial Behaviour- Concept, dimensions, factors affecting entrepreneurial behaviour Government schemes and incentives for promotion of entrepreneurship, Government policy on small and Medium Enterprises (SMES)/ Small Scale Industries (SSIs). ICT's in rural enterprises. Market survey, formulation of project, financial analysis of project. Communication skills: Communication - Meaning and process of communication. Advertisements- Meaning, types, forms and functions Writing Skill: Business letters, Letters of inquiry, quotation orders and tenders complaints letter. Constraints perceived by rural entrepreneur.

Place of livestock in the national economy, different livestock development programmes of Govt, of India. Terminologies used in livestock and poultry management. Important exotic and Indian breeds of cattle, buffalo and swine. Male and female reproductive system of Cattle. Measures and factors affecting fertility in livestock, reproductive behavior like oestrus, parturition, etc. Milk secretion, milking of animals and factors affecting milk yield and composition. Feeding and management of calves, growing heifers and milch animals and other classes and types of animals, housing principles and space requirements for different

species of livestock. Disease control measures, sanitation and care, breeding, feeding and production records. Breed characteristics of poultry, their' methods of rearing, breeding, feeding and management, incubation, hatching and brooding, vaccination and prevention of diseases, preservation and marketing of eggs, its economics and keeping quality. Cost of production of milk, economical units of cattle, buffalo and swine.

History and concept of Animal Breeding. Cell and cell division. Gene: Functions and role in Animal Genetics, Gene actions, Gene and Genotypic frequencies Gene expression and mutation. Mendelian principles and Hardy Weinberg law. Chromosomes and its abnormalities. Laws of probabilities and Animal breeding. Variations in economic traits of farm animals. Methods of selection. Quantitative and qualitative traits. Composition of plant and animal body, classification of feeds and fodders. Important food ingredients and their functions in animal body. Digestive system, digestion and absorption of different nutrients in ruminants and non-ruminants. Feed supplements and feed additives, method of measuring food values. Feeding standard & their principles. Concept of preparation of complete feed block.

Present status of Dairy Industry in Maharashtra and India. Definition and composition of milk. Physico-chemical properties of milk. Microbial quality of raw milk. Factors affecting composition of milk. Physico-chemical and microbial standards for different types of milk. Nutritional importance of milk and its constituents. Reception and processing (Platform test, Chilling? Standardization, Homogenization, Pasteurization, Storage, Marketing) of milk, classification and composition of milk products (Heat coagulated, Heat and acid coagulated, Evaporated, Fermented Frozen and Fat riched products). IS PFA and Agmark standards for milk products. International requirement for export of milk. Preservation of milk and milk products by-Bio, Herbal, Chemical and physical preservatives in use. Utilization of dairy by-product: whey and high acid milk. Packaging of milk and milk products with modern techniques.

Importance of Sheep and Goat production in national economy. Important Indian and Exotic breeds of Sheep and Goat. Housing requirement of Sheep and Goat. Breeding seasons for Sheep and Goat. Methods of breeding Sheep and Goat. Feeding practices for Sheep and Goat. Flushing of ewes and does. Care and Management of pregnant ewes I does. Care and Management mbs ws and rams / bucks. Composition and utilization of Sheep and Goat Uak Grading and marketing of wool. Marketing of Sheep and Goat. Cooling help an Goat. Preparation of animal tor slaughter and different me hods (slaughter. Dressing percentage and Meat bone ratio. Different Meat cut and edible and non-edible offal's. Study of common ailments and control sites in Sheep and Goat. Preventive measures (vaccination) against were, diseases of Sheep and Goat. Systems of rearing of sheep and goat. Insurance of sheep and goats.

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3. AGRICULTURAL BIOTECHNOLOGY

Biochemistry: Definition, scope and importance in Agril. Biotechnology Concept of life and living processes: Introduction, nature of biological material, properties, the identifying characteristics of a living matter, molecular logic of life, The Cell-A Brief introduction : Structure of prokaryotic and organization; elementary idea of cellular constituents : nucleus, mitochondria, golgi bodies, endoplasmic reticulum, lysosomes and microbodies; bacterial and plant cell walls. Biomolecules: Carbon and its brief chemistry, general properties and derivatives, common disaccharides, structure and function, occurrence of storage and structural polysaccharides, glucosaminoglycans, glycoproteins: structure and function. Lipids: Fatty acids, traicylglycerol, phospholipids, sphingolipids: sphingomyelins, cerebrosides gangliosides, cholesterol, micelles, bilayers, liposomes, lipoproteins: structure and function Amino acids and proteins: Amino acids: structure, nomenclature and general properties, peptide bond, primary structure of proteins, end group analysis, amino acid composition, specific peptide cleavage and sequence determination. Secondary structure: peptide group, Ramanchandran diagram, helical structure: alpha-helix and other polypeptide helices, ß-pleated sheets. Protein stability: electrostatic interaction, hydrogen bond and hydrophobic forces, disulphide bond. Tertiary and quaternary structures of proteins. Vitamins and enzymes: Water soluble vitamins, their coenzyme forms, sources and biochemical functions. Fat soluble vitamins: sources and functions. Enzymes: historical perspective, naming and classification, factors affecting enzyme activity, mechanism of enzyme action, enzyme units. Nucleic acids and chromosomes: Nucleic acid structure and function, physical and chemical properties, spectroscopic and thermal properties, *in vitro* denaturation and renaturation of DNA, DNA as genetic material. Bioenergetics: Principles of thermodynamics and their applications in biochemistry – introductiona dn thermodynamic state functions, first and second law of thermodynamics, concept of free energy, standard free energy change, biological oxidation-reduction reactions, redox potential. High energy phosphate compounds, free energy of hydrolysis of ATP and sugar phosphates.

Review of brief history, enzymes as biological catalysts, classification, nomenclature, proximity and orientation, covalent catalysis, acid-base catalysis. Isolation and purification of enzymes: objectives, strategy, choice of source, methods of homogenization and separation. Enzyme assays, specific activity, enzyme activity units. Factors affecting the rate of enzymatic reactions : substrate concentration, enzyme concentration, pH, temperature, coenzymes and cofactors. Specificity of enzymes : absolute specificity, broad specificity, intermediate specificity, sterospecificity. Active site of enzymes : common features, enzyme-substrate complex formation, evidences. Enzyme kinetics: Monousubstrate reactions, Michaelis-menten equation and its linear transformations, Km and Vmax: definition, determination and significance. Enzyme inhibition: Reversible inhibition, competitive, non-competitive and uncompetitive inhibition. Irreversible inhibition, specific examples. Identification of functional groups essential for catalysis, ribonuclease and chymotrypsin as specific examples. Bisubstrate enzyme reactions : Single and double displacement reactions, random and ordered mechanisms. Enzyme regulation : allosteric enzymes, cooperativity, special characteristics, Monod and Koshland models, covalent modification of enzymes, specific examples to be studied: ATCase, phosphorylase, lactate dehydrogenase. Mechanism of enzyme action : specific examples, chymotrypsin, lysozyme, ribonuclease A, carboxypeptidases. Isoenzymes : Characteristics and importance. Enzyme as tools in biotechnology : Methods of enzyme immobilization and its industrial applications.

Introduction to microbial genetics. Prokaryotes : bacteria, cyanobacteria, mycoplasma etc. The evolution of prokaryotic genetics; early concept of bacterial variation; adaptation mutation and selection. Prokaryotic chromosome structure: bacterial chromosome, supercoiling of the genome, circular and super helical DNA, Plasmids: Types, properties and roles, Conjugal transfer of plasmid DNA – stage in transfer process, effective contact and pilli, mobilization and transfertra genes of F plasmids, host restriction in transfer; plasmid replication. transposase, excision of transposons, transposons and evolution. Mutations: Biochemcial basis of mutations, spontaneous mutation, isolation of mutants, mutagenesis, conjugation and transduction. Transformation : Discovery of transformation, competence and DNA uptake. Conjugation. Insertion of F plasmid into the *E. coli* chromosome, *Hfr* transfer, Transduction: generalized and specialized, sexduction, Viruses: different genomes; bacteriophages with lytic (T4 phage) and lysogenic (lambda phage) in detail.

Chromosome structure: basic chemical aspects- DNA, histones and non-histones; basic structural aspects- the nueleosomes, euchromatin and heterochromatin. Organization of the genome in eukaryotes: Gene and gene number; C-value paradox; organization of replication; gene amplification, chromosomal redundancy, repetitive DNA an dits relevance to plants and animals, inverted and tandem repeats. DNA replication: DNA replication and its overview: semiconservative mechanism of DNA replication, replicons, origins and termini, semi-discontinuous replication, RNA priming, replication in prokaryotes and eukaryotes. DNA damage and repair: Biological indications of damage to DNA, evidence for repair systems, repair of thymine dimmers. Regulation of gene expression : Basic principles of transcription, transcription in prokaryotes. Transcription in eukaryotes, its regulation, RNA Processing and RNPs- multiple RNA polymerases, sigma like factors in eukaryotes; heterogeneous nuclear RNA; messenger RNA- structure and complexity; interrupted genes and RNA splicing; expression of specific genes; genes for ribosomal RNA; histone genes; globin genes; heat-shock genes; the dynamic genome: Mobile genetic elements in eukaryotes (jumping genes)-relevance to plants; studies in maize. Brief introduction to the complexity of eukaryotic genome. Molecular biology of organelles; Genomes of mitochondria and plastids- interaction with nucleus;

Introduction to metabolism : anabolism and catabolism, metabolic compartments, thermodynamic, transport systems, translocators, Carbohydrate metabolism: Photosynthesis : photosynthetic pigments in relation to their functions, photosynthetic electro transport and generation of NADPH and ATP, cyclic, non-cyclic and pseudocyclic photophosphorylation. Carbon reduction in C_3 plants – reaction of Clavin cycle (reductive pentose phosphate pathway), oxidative pentose phosphate pathway, regulation of reductive and oxidative pentose phosphate pathway, photorespiration. Carbon reduction in C_4, plants- leaf anatomy of C_4 plants, biochemical pathway of CO_2 assimilation and CAM plants, Sucrose metabolism: Transport of sugar from source to sink, phloem loading and unloading of sucrose, sucrose metabolizaing enzymes, sucrose synthesis, sucrose storage and utilization, sucrose-starch inter-conversion, Starch metabolism : Starch biosynthesis, regulation and degradation Metabolism of nitrogen-amino acids and nucleotides : Pathway of nitrate assimilation, incorporation of NH_3 into amino acids and proteins, biosynthesis of amino acids, sulfate assimilation, biosynthesis of nucleotides- *de novo* and salvage pathway, biological nitrogen fixation- a scheme for nitrogenase action, protection of nitrogenase against damage by oxygen in non-symbionts, role of leghemoglobin, regulation of nitrogenase activity, hydrogen evolution and uptake, energetic of N_2 fixtation vis-à-vis nitrate assimilation, molecular biology of nitrogen fixation – genes involved in *Rhizobium*-legume symbioses; Protein synthesis : Major components of protein synthesizing machinery, steps in polypeptide synthesis; Lipid metabolism: Saturated and

unsaturated fatty acid biosynthesis, biosynthesis of triacylglycerols and phospholipids, catabolism of lipids – lipid degrading enzymes, fatty acid oxidation (a, a, u); Catabolism : Glycolysis, gluconeogensis, citric acid cycle, electron transport chain and oxidative phophorylation, intrrelationships of metabolic pathways; Biochemistry of seed germination and development; biochemistry of fruit ripening.

Introduction to immunology. Immune systems-overview, immunity with historical perspective. Molecular and cellular basis of immune system, self verses non-self recognition; antigen-antibody and their structure, and function. Concepts of Ag-Ab reactions. Immunoglobulins – structure, biological characters and functions, isotypes, structure and function. Theories of antibody synthesis, complement system and their reactions. Organisms and cell involved in immunity. The humoral immune respons; antibodies-structure, diversity of function and mechanism of action. The cell mediated immune response; recognition of antigen by T cells; antigen precipitation; the major histocompatibility proteins; the role of cytokinins and the regulation of immune responses, hypersensitivity reactions. Lympohocytes. Differentiation of stem cells and generation of lymphocytes, mechanisms. Lymphocyte traffic, effector mechanisms in immune response, immunity to infectious diseases, vaccines. Generation of monospecific antibodies: hybridoma technology.

General principles of biochemical investigations. Units in biochemistry and molecular biology. Principle methods of separation of bimolecules. Centrifugation techniques – Basic principles, analytical and preparative centrifugation, their applications. Spectrophotometer :UV-Visible spectrophotometer, fluorimeter. Chromatographic techniques-Basic principles, types-adsorption, partition, ion exchange, molecular sieve, affinity, GLC and HPLC and mass spectrometery, flow Cytomtery and its application in DNA estimation. Elctrophoresis : theory techniques : Nature, detection and measurement of radioactivity. Molecular biology techniques- Southern hybridization, northern hybridization, western blotting, microrrav technology, complementation techniques. Polymerase chain reaction (PCR); radioactive/ non radioactive labeling, RFLP, AFLP, RAPD; RT-PCR and DNA sequencing.

Recombinant DNA: Definition, recombinant DNA and evolution, Host controlled restriction-modification system; The range of manipulative enzymes – nucleases, ligases, polymerases, modifying enzymes, topoisomerases, restriction endonucleses – Types of restriction enzymes, characteristics of RE II, nomenclature, restriction sites, unit of restriction enzymes, cleavage pattern, restriction mapping, linkers, adaptors, hompolymer tailing, Vectors : Definition, properties of the good vectors, plasmid – pBR322 and pUC vector properties and physical maps. Bacteriophage vectors- lambda phage vector, M13 vectors, insertion vectors, replacement vectors, cosmids, phasmid, YAC, BAC, and MAC; Introduction of the vector into suitable host : Properties of good host, preparation of competent cells, transformation, transfect ion and *in vitro* packaging; Selection of recombinant clones : Selection of clones containing recombinant vectors. Reporter genes, elimination of non-transformed cells, identification of clones having recombinant vectors; selection of clones having specific DNA insert – colony hybridization, hybrid arrested translation, nucleic acid hybridization, complementation, unique gene products, immunochemical methods- antibodies specific to the protein product, colony/ plaque screening with antibodies; Gene library : Construction cDNA library and genomic library, screening of gene libraries – screening by DNA hybridization, immunological assay and protein activity, methods of labeling nucleic acids and probes- nick translation, primer extension method, methods based on RNA polymerases; Important genome sequencing projects of plants. Application of recombinant DNA technology in crop improvement.

Historical developments of virology. General classification, purification, structure and replication of plant viruses. Transmission of virus, virus-vector relationship and virus assaying. Translocation of viruses in plants, physiology of virus-infected plants, chemical composition and nature of viruses, methods of virus detection and identification. Methods of virus disease management. Virus resistance: Coat protein genes, movement protein genes, replicase, RNA polymerase genes. Antisense and hairpin loop based on small interfering RNA.

Comb pattern in fowls, Complementary genes; Supplementary factors; Epistasis: Plumage colour in poultry, Duplicate factos, Flower colour in sweet peas, Different Interaction of genes, Variation on dominace, Multiple alleles, Multiple allelism: Blood groups in human beings. Lethal alleles, Pleiotropism; Several genes affecting the same character, Penetrance and expressivity, Chromosomes: Chemical composition structural organization of chromatids, centromeres, telomeres, and chromatin. Chromosomal Variations, A general account of structural and numerical aberrations, Linkage: Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Theories of crossing over, Types of crossing over's, Three point testcross, interference Structure of DNA and RNA, Hardy-Weinberg Law, Darwin's revolution, Variation and its modulation, The effect of sexual reproduction on variation, The sources of variation, Selection, quantitative genetics, Multiple factors- Skin colour in human beings Sex Determination Plants and animals. Concepts of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types, Mutations Types : spontaneous and induced, Mutagens; Physical and chemical, Mutation at the molecular level. Mutations in plants, animals, and microbes for economic benefit of man. Plant karyotype, Inherited disorders- Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome, Haemophilia and Sickle cell anaemia).

Cellular basis of life, Application of Microscope, Evolution of cell theory, Cell structure, organelles and their function, types of cells, Eukaryoties / Prokaryotes cells its organization plant and animal cells, Plasma membrane, endoplasmic reticulum mitochondria, cytoskeleton, nucleus, Golgi appeartus, cytosomes and chromatin. Cell division, differentiation- mitosis meiosis Inter and intracellular communication. Cell growth and proliferation, molecular constituents of cells. Regulation of cellular function by growth factors and hormones. Cell pigments, cell viability, Active and passive transport, movements of molecules into and out of cells.

Introduction Definition, Classical vs moder biotechnology. Basic concepts and history of biotechnology, Different branches of biotechnology, Tools of Genetic Engineering: Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, virus based vectors, Methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agro-bacterium mediated gene transfer, Preparation and application of molecular probes : DNA probes, RNA probes, Radioactive labeling, Non radioactive labeling, use of molecular probes, NDA fingerprinting, Analysis and expression of cloned gene in host cells : Expression vectors, Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins, Gene libraries- cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, Identifying the products of cDNA clones, Isolation, Sequencing and synthesis of gene: Different methods of gene: Different methods of gene isolation, Techniques of DNA sequencing, Artificial DNA synthesis, Polymerase Chain

reaction (PCR): Basic principles, modifications, applications, Modifying Genes: Site-directed mutagenesis, Insertion & Delection of Mutagenesis.

Historical milestones in Plant breeding. Aims and objectives of plant breeding Significance of plant breeding in crop development. Various methods of plant breeding in self and cross pollinated crops, acclimatization, selection pure line theory, Reproductive systems of plants, Floral biology, flower parts, Self and cross pollinated crops. Genetic consequences and differences between self and cross pollinated crops. Clonal selection, population improvement programme. Heterosis, Genetical and physiological basis. Male sterility Types of male sterility. Combining ability-geeneral and specific, its explitation. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression. Polypliody its types. Mutation breeding gene actions, heritability, genotype and environmental interactions. Its importance in plant breeding, introduction to seed production (Nucleus, breeder, foundation, certified) Maintenance of genetic purity during seed production.

Distinction between various morphological, biochemical and molecular markers with their strength and weaknesses. Types of molecular markers. PCR technology and its implications on molecular biology. Isozymes, RFLP; RAPD; ISSR; STMS; AFLP; SCAR; CAPS; RAMP; and SSCP markers (techniques, methodology and its application in plant breeding). Functional expression markers. Application of molecular markers in plant breeding especially in varietal identification; germplasm divergence analysis; phylogentic relationship in crops; markers assisted selection; QTL, mapping and map based cloning, mapping strategies- NIL, RIL, BSA. Mapping genes on specific chromosomes: somatic cell hybrids, in situ hybridization, transposan tagging, genetic linkage mapping, expressed sequence tags (EST).

Historical Perspective of Plant Cell./ tissue culture, Scope and importance in crop improvement, totipotency and morphogeneis, Organogenesis, Rhizogeneisis., Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture – Micro-propagation, Anther culture, Pollen culture, ovule culture, Embryo culture, *in-vitro* pollination, *in-vitro* fertilization, Endosperm culture, Factors affect in vitro culture. Achievements, Somaclonal variation, types, causes, Somatic embryogenesis and synthetic seed production. Protoplast isolation, culture Manipulation and fusion. Cybrids, Products of somatic hybridization, Cryopreservation of germplasm. Secondary metabolites production, extraction of secondary metabolites. Hardening techniques of micro-propagated seedlings.

Prospects & Perspective of Biotic & abiotic stress resistant plants, Genetics of host-pathogen interactions, Mechanism of plant resistance. Role of jasmonates and salicylic acid in systematic resistance induction on wounding. Insect pest resistance- Structural / morphological changes; Protease and amylase inhibitors; polyphenol oxidases; peroxidases; lectins; chitinase; seed proteins; their limitations and significance in multi-gene phyramiding. Vertical and Horizontal resistance to pathogens. Hypersensitive host response (HRGP) and apoptosis in relation to plant defense. Virulence – Avirulence in host- pathogens interaction. Race specific Resistance Gene Analogues (RGAs). Pathogenesis related proteins – groups with examples (Glucanases; chitinases; osmotin, chitin binding proteins; thaumation like proteins; micropeptidal defensins; phytoallexins) and their role. Role of Phenylalanine ammonia lyase, callose synthases, detoxification for pathogen resistance. RIP. Field testing of transgenic for fungal, bacterial, viral and pest resistance. Prospects and perspectives. Biopesticides Developing antagonistic strains suitable for varying stress conditions.

Biochemical basis of abiotic stresses namely osmotic (drought, Salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of praline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation. Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for importing tolerance against biotic and abiotic stress.

Definition, Historical and geographical causes of diversity. Types of diversity- Genetic, Species and population diversity. Distribution of diversity in life forms. Ecological diversity and stability. Biodiversity and centers of origins of plant. Hot spots in India. Principles of conservation biology. Biosphere concept, Genetical and evolutionary principles of conservation. Collection Maintenance and conservation of biodiversity. Assessing and documenting of vulnerability and extinction of biodiversity; red list categories as per IUCN (International Union for the Conservation of Nature and Natural resources): Extinct, Extinct in the wild, Critically Endangered, Endangered, Vulnerable, Lower risk, Data deficient and Non evaluated. Bio-village concept: *in situ* and *ex situ* conservation. Community level Gene banks, Utilization of biodiversity. Global biodiversity system. Intellctual property Rights and legal concerns of Bio-resources. Biodiversity and human welfare.

Introduction, Scope and application of Bioinformatics. Biological database, NCBI, ENSEMBL, EBI, EXPASY, Genbank, AgriCola. Computer tutorial, introductory programming. Computers and biology, online resources for bioinformatics. Simple pair wise alignment, Induction to Blast, FASTA, BLAST searching, BLAST and PHI/PSI-BLAST. Introduction to gene expression and microarrays. Introduction Micro array data analysis, Introduction to protein structure and structural databases, Molecular visualization, Basics of Proteomics, Bioinformatics methods for studying proteins, Sequence alignment, Pairwise alignment multiple sequence alignment tools for alignments (CLUSTALX, CLUSTAL W), Concepts in protein structure prediction, Phylogeny, cladistics, and evolution, Phylogenetic trees.

Definition, Biosafety concerns. Biosafety regulation in various countries. International agreements related to biosafety. Regulatory frame work of biosafety in Inida. Guidelines for recombinant DNA technology. Status, Prospectus and concerns of GM crops, Biosafety of environment and human health. Guidelines for research in transgenic plants and drugs. Social and ethical issues; Biosafety issues related to genetically modified organisms (GMOs) by Biotechnology Consortium India Ltd. and Department of Biotechnology Govt. of India. Gene contamination, Super weed and super pest.

Definition, Scope and introduction in agriculture, Osmosis, DPD, TP. Water absorption by plants. Ascent of sap. Transpiration-Mechanism, factors affecting it, Structure and function of stomata. Osmotic pressure, guttation. Plant Nutrition : Major and minor nutrients; their roles and deficiency symptom; Active and passive mineral uptake mechanisms. Photosynthesis-Structure and function of chloroplast; Light and dark reactions; Cyclic and non-cyclic electron transfer; C_3, C_4, Crassulacean acid metabolism and photorespiration. Respiration types. R.Q. Hormones: types and role in agriculture biotechnology. Growth phases, photoperiodism, and vernalization. Stress physiology (Drought, heat, frost and salinity); mechanism of resistance to above types. Physiological aspects and problems of cereals, pulses, oilseeds, cotton and sugarcane.

Meaning and scope of Agronomy, Field crops-classification with examples. Tillage-Definition, types of tillage, importance and implements used for tillage, manures and fertilizer application and their types, Irrigation-water management, method of irrigation, micro irrigation, Weeds : classification of weeds, methods of weed control, cropping systems, organic farming. Agronomy of important field crops of the region-cereals, pulses, oilseeds, commercial crops, soil and climatic requirements, Land preparation, varieties, seeds and sowing, cultural practices, manuring, irrigation, weed management practices, plant protection measures, harvesting and yield, seed production of important crops.

Definition, importance and scope for Entomology, place of insects in animal Kingdom. Insect in relation to man, Insect integument: Structure and function, cuticular process and appendages. Structure of insect; head, thorax, abdomen, their functions and modifications, Wing venation and wing coupling apparatus. Metamorphosis, sense and sound producing oranges. Study of digestive, excretory, respiratory, circulatory, reproductive, endocrine and nervous system.

Introduction to the science of phytopathology, its objectives, scope and historical background. Terms and concepts in Plant Pathology. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (Fungi, Bacteria, Viruses, Phytoplasma, Protozoa, algae and flowering parasitic plants), their characteristics and classification, Non-prasistic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment, Principels and methods of plant disease management. Integrated plant disease management.

History of Microbiology : Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Protection against infections, Applied areas of Microbiology Metabolism in bacteria : ATP generation, echemoutotrophy, photo autotrophy, respiration, fermentation. Bacteriophages: structure and properties of bacterial viruses- Lytic and Lysogenic cycles: Viroids, prions. Microbial groups in soil, microbial transformation of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting. Microbiology of food : microbial spoilage and principles of food preservation. Beneficial microorganisms in Agriculture : Biofertilizer (Bacterial Cyanobacterial and Fungal), Microbial insecticides, Microbial agents for control of plant diseases, Biodegradation, Biogas production, Biodegradable plastics, plant- Microbe interactions.

Horticulture - Definition, scope, importance, and branches of horticulture. Classification of horticultural crops. Climatic zones of Maharashtra and India in relation to horticultural crops. Area, production and export. Propagation methods. Growth habit, training and pruning objectives, methods and season. Special horticultural practices for horticultural crops production, plant growth regulators and their uses in horticulture. Package of practices for production, plant growth regulators and their uses in horticulture. Package of practices for cultivation of major horticultural crops Fruits: mango, banana, guava, pomegranate, grape, sapota, citrus, ber, fig, aonla, cashewnut, coconut, areacanut, jackfruit. Vegetables : Chilli, brinjal, tomato, okra, peas, beans, cucurbitaceous crops (Cucumber, watermelon, muskeolon, bottle gourd, bitter gourd, ridge gorud); bulb (onion and garlic) and tuber crops (sweet potato, radish, carrot), cole crops (cabbage, caulifower). Flowers: rose, chrysanthemum, marigold, gladiolus, carnation, tuberose. Major pest and diseases of horticultural crops and their control.

Types of green house, importance, functions and features of green house. Scope and development of green house technology. Location, Planning of various components of green house. Design criteria and calculation. Construction material, covering material and its characteristics, growing media, green house irrigation system. Computer controlled environment. Phytotrons, fertigation, roof system, containers and benches, Growing of ornamentals and vegetables under protected environment, physiology of plants in green house, pest and disease control.

Importance and application, Tabulation and classification of data, Frequency distribution and Graphical distribution of data, Measures of central tendencies, Mean, Median, Mode and their properties, Measures of Dispersion, Mean deviation, Variance, Standard deviation and coefficient of Variation, Correlation, liner and nonlinear regression. Hypothesis testing F.T. and Chisquare test Probability and distribution Concepts and problems on probability. Binomial, Poisson, Normal Distribution and their applications. Besic principles of design CRD and RBD design. Different models of data presentation with special reference to biological samples.

IPR : meaning, Nature and Scope of IPR, Recent developments in Registration of inventions and protection of IPR, WIPO and its role, World Trade Organization regimes, GATT agreement and its impact on agriculture and biotechnology. WTO and Agreement on Agriculture (AoA). Trade Related Aspects of Intellectual Property Rights (TRIPS). History of IPRs. Categories of IPRs- Copyrights, Patents, Trademark, Geographical Indications. Industrial Designs, Layouts. Design of integrated circuits. Recent amendments in Indian acts and regulations related to IPR. Products patent and Process Patent, Current status of Plant variety protection in India as well as in other countries (USA; Australia & Japan) with historical perspective. UPOV revisions. Sui generic system for protection of plant varieties, Registration of new varieties, Farmers Rights on indigenous knowledge, Benefit sharing. Biological Diversity Act. IPRs in WTO regime. Current status of patenting of gene and genetically engineered organisms in Indian and world. Patent filing-opposition-retrieval. Recent developments, advances in IPR.

Introduction to computers and window O.S. introduction to MS word, MS Power Pint, MS Excel. Network & its type Internet, www. Multimedia and its types. Data base management sys. Introduction to programming with C-language. Introduction to web sites, E-mail, programming in Perl.

Scientific names taxonomic position, host range, nature of damage life history, bionomics and management of important pests infesting cereals, fibres, oilseeds, pulses, sugarcane, forage crops, vegetables and fruit crops. Different pest control method, IPM concept, Integrated management of major diseases for rice, sorghum, bajra, wheat, sugarcane, turmeric, ginger, groundnut, sunflower, safflower, cotton, red gram, Bengal gram, soybean, citrus, mango, banana, grapevine, pomegranate, papaya, guava, betelvine, chili, brinjal, lady finger, potato, crucifers, cucurbits, tomato, onion, beans, rose, chrysanthemum, gladdiolous, carnation, tuberose, and gerbera.

External trade in Agricultural products, Present status, policy and prospects under WTO regime, Export import policy, Regulation of Agricultural marketing system, Infrastructural facilities for exporting efficiency, Biotechnological Products in India, Quality parameters and quarantine procedures of export. Market integration : Types and effects Marketing costs

margins and price spread. Biotech industries & institutes in India & world, Concepts of Biotech park / Biotech Hub.

Nutritional Science – historical perspective, importance and functions of food, Food constituents: Carbohydrates, Proteins, lipids, mineral and vitamins-their role and functions, dietary requirements of food for infants, pre-school children, adults, Pregnant and nursing mothers. Under nutrition and malnutrition. Nutrition and aging, Nutrition and human genetics – genetic determinants of nutrient needs, genetic abnormalities, racial differences in nutrient needs or nutritional processing the frequency of genetic abnormalities, gene stability, genetic change and carcinogenesis, genetic basis of obesity, nutrition and immune system, nutritional disorders, Food in relation to health and diseases. Inborn errors of metabolism. Losses of vitamins and minerals due to food processing. Food pattern. Food policies- applied nutrition programme.

Histological land marks. Screening of microorganisms for new products. Improvements of strain, mutant selection. Fermentation process development. Shake flask, Scale up of process and bioreactors. Metabolite antibiotics enzymes, bipesticides, growth regulators, steroids organic acids, bio ethanol and enzymes production. Genetically engineered microbes (GEMs). Metabolic engineering. Process and types of bioreactors, production of yeast and antibiotics, ethanol, lactic acids. Various methods of fermentation.

General Introduction : Introduction, historical developments, applications and business of enzymes, enzyme safety, enzyme therapy, enzyme specificity, measurement and expression of enzyme activity, enzyme stability and denaturation; Regeneration of cofactors for biocatalysis- common cofactors required for biotransformation and their representative *in situ* regeneration methods : regeneration of NAD(P)(H), $NAD(P)^{+}$,ATP/NTP, Sugar nucleotide, PAPS, Acetyl coenzyme A; Potential, selection and application of some of the important enzymes in food. Carbohydrases: amylases(s), glucoamylase(s), hemicellulase(s) and Cellulase(s). Proteolytic enzymes: proteases; cathepsin(s), trypsin, papain, bromelain and ficin, rennin, pepsin, lipase(s): lipoxygenase(s), lipoxidase, etc. Oxidoreductase (S): glucose oxidase, catalase, peroxidase, polyphenol oxidase and ascorbic acid oxidase. Importance of enzymes in various food and agro process industry.

Classification, chemical composition and nutritional values of food grains (Cereals including millets, legumes and pulses). Anti-nutritional factors- chemistry and methods of their removal. Importance and scope of food preservation and storage. Food spoilages-causes and effects. Principles and methods of food preservation and processing of food crops. Starch-Role in cookery. Mechanism of starch isolation and applications. Molecular biology of starch, glutens with their role in dough quality. Bakery and confectionary-types, ingredients used with their role. Other processing techniques- Fermentation, malting, brewing, puffing, flaking, pearling, sprouting, roasting. Enrichments- Methods, need and fortification. Genetic engineering for value addition from economic point of view as well as nutritional composition-Transgenes for altered composition of oil/ starch / amino acid / vitamins / anti-nutrients with their sources. Golden rice, high quality protein maize, hypoallergenic rice, wheat gluten modification. Biosol concept. Spheroplast fusion technology. Biocatalysts and worldwide food industry market.

Recent trends in food processing. Techniques and applications of immobilized enzymes in food industry. Applications of glucose oxidase, catalse and pectinase in food processing. Single cell proteins for human food consumption. Biotechnology for food flavour production,

oils and fats, Molecular High Intensity Low Calorie sweeteners. Essential oils. Sources and production of vitamins under controlled conditions. Safety issues related processed foods, parealization, nanotechnology, hardle technology, bio-preservation/ Natural preservation. High electric light pulse technology. Aseptic packaging/ vaccum packaging, biodegradable plastics, extrusion cooking.

Importance of post harvest loss management . Pre-and Post-harvest factors affecting shelf life of Horticultural crops. Post harvest molecular biology-ripening (role of ethylene, climacteric vs. non-climatric fruits), fruit softening (Pectinase and polygalacturonases), flavor fragrance and senescence. Genetic engineering plants for delayed ripening and better shelf life. Packing techniques-grading, containers, cushioning, vacuum packing, canning, bottling, freezing, dehydration, drying, UV and Ionizing radiations. Principles of preservation by heat, low temperature, chemicals and fermentation. Preservatives and colour permitted and prohibited in India. Storage techniques-Zero Energy Cold Storage Chambers and On Farm Storage facilities. Microbial contaminants and post-harvest pathology. Export Quality Standards. Biotechnology for recycling Horticultural waste as manures and livestock feed. Phytosanitation, HACCP, GM fruits and vegetables.

International aspects of the quality and safety of Foods derived from modern Biotechnology, Application of ELISA for detection of Toxins in food, Biosensors for food quality Assessment, Malnutrition, Consequences, causes, prevention and controal. Applied community nutrition. Food safety and food faddism. Safety testing for toxicity, allergen city, anti nutritional effect Native toxins and toxins produce during storage, health hazards.

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4. AGRICULTURAL ENGINEERING

Differential calculus: Taylors & Maclaurins expansions, indeterminate form, curvature, asymptotes, tracing, function of two or more independent variables, partial differentiation homogeneous functions and Euler's theorem, Composite functions, total derivatives, derivative of an implicit functions, change of variable, maxima and minima, integral calculus reduction formulae, rectification of standard curve, double and triple integrals, change of order of integration, gamma and beta functions. application of double and triple integral to find area, ordinary differential equation exact and Bernoulli's differential equation, equation reducible to exact form by integrating factors, equation of first order and higher degree. Clairauts equations, differential equations of higher orders, method of finding complimentary function and particular integrals, method of variation of parameters, Cauchy and Legendres linear equations, simultaneous linear differential equation with constant coefficients, series solution techniques, Vector calculus: differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of scalar point function, Divergence and curl of a vector point function, identities involved in Del, second order differential operator lines, surface and volume integrals, stokes, divergence and Greens theorems (without proofs).

Surface tension Capillarity, surface tension by capillary rise method and Jaegers method, Viscosity Flow of liquids. Laminar flow/streamline flow, turbulent flow, critical velocity, Viscosity, coefficient of viscosity, poiscilluics equation for flow of liquid through pipes, Bernouliies theorem, Semiconductor Distinction between metals, insulators and semi conductor instrinsic and extrinsic semiconductor. Determination of Energy band gap in, Semiconductor Donor & acceptor levels, LASER: Spontaneous and stimulated emission. A & B Enisteins coefficient, population inversion, He-Ne & Ruby laser, Ammonia and Ruby MASER, Hologrophy-Note, Illumination: law of illumination, luminous flux, illumination intensity, candle power, brightness, Optic Fiber: Physical structure, basic theory, mode type, put out put characteristics of optic fiber and applications, Introduction to dia, para and (croimagnetism, classification, Quantum mechanics Wave particle duality, debroglies concept, uncertainty principle, wave function, time dependent and time in dependent Schrodinger wave equation, introduction to superconductivity, Meissner effect, Isotope effect, Type-I and II superconductors, Josephson's effect DC and AC, Squids.

Introduction to High Level Languages *i.e.* "C" language, Primary Data types, U defined data type, variable, operator, building & evaluating expression, standard libra function, managing input and output, decision making, branching, looping, array, defined function, passing the argument and returning the value, recursion, string functioning structure and union, pointer, stack, push/pop operation, queue, insertion deletion operation linked list.

Matrices: elementary transformation,, rank of matrix, reduction to normal forms, Gauss Jordon method to find inverse of a matrix, consistency and solutions of Linear equations, cigen values and eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformation, diagonalization of matrixes, bilinear and quadratic forms, function of complex variable: limit, continuity and derivative of complex functions, analytic function, Cauchy-Reimann equation, conjugate functions, harmonic function. Fourier series, infinite series and its convergence, periodic functions, Eulers formulae, Dirichlet conditions, function having arbitrary period, even and odd functions, half range series, Harmonic analysis, partial differential equation: formation of partial differential equations.

Basic database concept, DBMS Concept, introduction to RDBMS, Concept of normalization, SQL command, DML, DDL, select command, join and function, group function, set function, basic of HTML, developing the web page using meta tag, static and dynamic page, interlinking the web pages, project.

Numerical analysis, finite differences various difference operators and there relationship, factorial notation interpolation with equation interval, Newton's forward an backward interpolation formulae, Newton's divided difference formula, lagranges interpolation formula, numerical differentiations: differentiation based on equal interval interpolations, first and second order derivative by using Newton's forward and ackward maxima and minima of a tabulated functions, numerical integration by Trapezoidal Simpson's, rules, difference equations: order of a difference equations, solution of linear difference equations, rules for finding complimentary functions and particular integral numerical solution of a ordinary differential equations by Picards methods, Taylor series method, Eulers method, modified Eulers method, Laplace transforms: definition of Laplace transform, Laplace transform of elementary functions, properties of Laplace transform inverse Laplace transform, transform of derivative, integrals, transform of function multiplied by in, transform of function divided by t. Convolution theorem application of Laplace transform to solve ordinary differential equation and simultaneous differential equation Laplace transform of unit step function, unit impulse function, periodic function. One credit for tutorial is to be utilized for practice of solving example on the guidelines of illustrative examples, (Preferably the first and second illustrative examples on above article) given in the textbooks.

Statistics, Scope, population parameter and Estimates. Measures of Central Tendency: Arithmetic, Weighted, Geometric and Harmonic means, median and Mode for grouped and ungrouped data. Measures of Dispersion: Mean Deviation Variance, Standard Deviation and Coefficient of Variation. Concepts of probability, compound events, Additive, multiplicative, Theorems, independent Events, Discrete and continuous Theoretical Probability Distributions, Density functions, Binomial, Poisson, Normal, Chi-square, t, F distributions. Simple, partial, multiple correlations Theory of regression, Multiple Regression models and orthogonal polynomials. Tests of significance Null and Alternative hypotheses Critical Region, Level of significance, Degrees of freedom, Types of Errors, Confidence intervals.

General-Workshop terminology, Ferrous and non ferrous metals, Steels and Alloy steels, alloys, Non ferrous heavy metals, corrosion, plastic, Glue, Grease, Paints, Varnish and Carpentry-Timber classification, defects in timber, description and use of tools in carpentry, seasoning and preservation of timber. Smithy-Nature of work in smith's furnace, tools and their uses, safety precautions in smithy and cold working of metals, forging drawing and spinning etc. Fitting-Description and use of files chisels, hacksaw, vices, hammers and other measuring marking tools, precision measuring tools, dial gauges and inspection gauges. Welding shop-types of welding, oxy-acetylene gas welding, electric arc welding, argon are welding, MIG and TIG welding, Resistance welding, Brazing and soldering, use of fluxes. Sheet metal shop- Description and uses of tools and equipments used in sheet metal different joints, riveting Lacquers.

Construction and use of scale, lettering, construction of plane, geometrical figures parabola, hyperbola and ellipse and special plane curves, cycloid, epicycloids, hypocycloid, involutes and spirals, helix and simple loci, orthographic projection of points, lines, their

traces and inclinations, projections of solids like prism, cylinder, cone, pyramid, sections of solid and development of surfaces Construction of isometric scales, isometric and orthographic projections of simple objects.

Iron Carbon phase diagram, lattice type of lattice, ferrous non ferrous metals and their alloys, introduction to welding, types of welding oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Casting processes. Classification, constructional details of center lathe, Main accessories and attachments, Main operations and tools used on center lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding classification. Constructional details and principles of operation of column and knee type universal milling machines. Plairt milling cutter. Main operations on milling machine.

Machine Drawing: Methods of projection, preparation of working drawing from models and is a metric views, Drawing of missing views, methods of dimensioning, concept of sectioning revolved and oblique section. Sectional views of machines parts. Types of rivets and revolved and oblique section. Sectional views of machine parts. Types of rivets and riveted joints, leak proof joints. Welded joints, Threads (nomenclature, single start, multi start threads, nuts, and bolts, screwed fasteners, shaft coupling and shaft bearings). Machine Graphics: Graphic standards, primitives graphic software, points, lines and polygons, co-ordinate systems, geometric modelling, wire frame modelling, solid modelling, surface modelling, preparation of computerized drafting by drafting software. Introduction to Auto CAD, Pro-E, workbench Ansys, 3-D software or any other available drafting software.

Elements, links, pairs, kinematics chain, and mechanisms. Classification of pairs mechanisms Lower and higher pairs. Four bar chain, slider crank chain and their invers Determination of velocity and acceleration using graphical (relative velocity acceleration) method. Instantaneous centers. Types of gears. Law of gearing, velocity sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear nomenclature, interference and undercutting. Introduction to helical, spiral, bevel and work gear. Simple, compound, reverted, and epicyclic trains. Determining velocity ratio by tabular method. Turning moment diagrams, co-efficient of fluctuation of speed and energy, weigh of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension creep and slip on power transmission, Chain drives. Types of friction, laws of dry friction Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction. anti friction bearings. Types of governors, constructional details and analysis of Wall, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting isochronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes. Partial primary balancing of reciprocating meases.

Sources of farm power conventional & non-conventional energy sources Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. Study of engine components their construction. operating principles and functions. Engine systems: valves & valve mechanism. Fuel & air supply, cooling, lubricating, ignition, starting and electrical systems. Study of constructional details, adjustments & operating principles of these systems. IC engine fuels - their properties

& combustion of fuels, gasoline tests and their significance, diesel fuel tests and their significance, detonation and knocking in IC engines, study of properties of coolants, anti freeze and anti-corrosion materials, lubricant types & study of their properties Engine governing systems.

Objectives of farm mechanization. Classification of farm machines. Materials of construction & heat treatment. Principles of operation and selection of machines used for production of crops. Field capacities & economics. Tillage; primary and secondary tillage equipment. Forces acting on tillage tools. Hitching systems and controls. Draft measurement of tillage equipment: Earth moving equipment - their construction & working principles viz Bulldozer, Trencher, Elevators etc.; sowing, planting & transplanting equipment calibration and adjustments. Fertilizer application equipment. Weed control and Plant protection equipment their sprayers and dusters, their calibration, selection, constructional features of different components and adjustments.

Study of transmission systems, clutch, gear box, differential and final drive mechanism Familiarization of brake mechanism. Ackerman and hydraulic steering and hydraulic systems. Tractor power outlets: PTO, belt pulley, drawbar, etc. Tractor chassis mechanics and design for tractor stability. Ergonomic considerations and operational safety.

Principles & types of cutting mechanisms. Construction & adjustments of shear & impact-type cutting mechanisms. Crop harvesting machinery: mowers, windrowers, reapers, reaper binders and forage harvesters. Forage chopping & handling equipment. Threshing mechanics & various types of threshers. Threshers, straw combines & grain combines, maize harvesting & shelling equipment, Root crop harvesting equipment - potato, groundnut etc., Cotton picking & Sugarcane harvesting equipment. Principles of fruit harvesting tools and machines. Horticultural tools and gadgets. Testing of farm machine. Test codes & procedure. Interpretation of test results. Selection and management of farm machines for optimum Topic performance.

Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve and rigid flange couplings Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anifriction bearings. Design of curved beams; Crane hooks, circular rings, etc.

Introduction to various systems of a tractor viz. fuel, lubrication, cooling, electrical, transmission, hydraulic & final drive system. Familiarization with tractor controls & learning procedure of tractor starting and stopping. Driving in forward and reverse gears. Driving safety rules. Hitching, adjustments, settings and field operation of farm machinery. Familiarisation with different makes & models of 4-wheeled tractors. Starting &stopping practice of the tractor. Familiarisation with instrumentation panel & controls; Road signs, traffic rules, road safety, driving & parking of tractor; Tractor driving practice forward & reverse driving practice; Tractor driving practice with two wheeled tractor trailer forward & reverse; Study and practicing the hitching and dehitching of implements; Study operation and field adjustments of MB plough & disk plough; Field operation of trailing & mounted disk harrow; Field operation and adjustments of seed drill/planter/sprayer.

Definition and scope of Agronomy. Classification of crops. Effect of different weather parameters on crop growth and development. Principles of tillage. Tilt and its characteristics. Tillage implements. Water requirement of crops and irrigation scheduling, crop rotation, cropping systems, mono double and multiple cropping. Relay cropping and mixed cropping Cultivation practices of important field crops, improved varieties, seed rate, time and method of sowing, mannuring, fertilization. Concept of dry farming.

Scope of horticultural and vegetable crops. Soil and climatic requirements for fruits vegetables and floriculture crops, improved verities Criteria for site selection. Layout a planting methods Nursery raising, macro and micro propagation methods. Plant growing structures, pruning and training, fertilizer application, fertigation. Irrigation meth traditional and modem methods. Harvesting, harvest practices, grading and packaging Postharvest practices. Garden tools. Management of orchard. (Construction and management of green house) Extraction and storage of vegetable seeds/Layout of lawns and kitchen gardens. Preparation of different fruits and vegetable products, Fruits Citrus, Mango, Gauva, Grapes, banana, sapota, pomegranate, ber, papaya Vegetables Tomato, chilli, brinjal, onion bhendi, cabbage, cauliflower, cucurbit crops. Flowers: Rose, chrysanthemum, jasmine, tuber rose, gaillardia, marigold, gladiolus, and aster.

Importance of livestock in agriculture, Basics of anatomy and physiology of Catties, Buffalo, Sheep, Goat, poultry and their important species and breeds. General principles of breeding. Care and management of livestock and poultry. Artificial insemination, semen preservation. Space and shelter layout and requirement for farm animals, poultry and fish General principles of feeding, processing, preservation and storage of feed and fodder Milking and clean milk production. Livestock products- handling, marketing, economics, ongoing efforts in the country and recent trends in livestock husbandry, poultry and fish production and processed products aspects needing engineering consideration. Draft potential of various breeds of livestock for farm operations.

Soils: Nature and origin of Soil: Soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils, soils taxonomy, orders important soil physical properties; and their important soil particle distributions; soil inorganic colloids - their composition, properties and origin of charge, ion exchange in soil and nutrient availability, soil organic matter- its composition and decomposition, effect of soil fertility, soil reaction acid, saline and sodic soil, quality or irrigation water, essential plants nutrient their functions and deficiency symptoms in plants, important inorganic fertilizers and their reactions in soils.

Basics of agri-business management. Planning; organizing, controlling, Leading; Forecasting for Agril. Business; Location and layout of Facilities: Work force management; Quality management, Maintenance; Financial Analysis of Agribusiness process Strategy; Inventory management.

Entrepreneur: Meaning, definition, characteristics and role demands of entrepreneur, identifying potential entrepreneurs, Entrepreneurship Development-Concept of entrepreneurship, process of entrepreneurship development, motivation and entrepreneurship development, importance of planning. monitoring and follow-up, managing competition, entrepreneurship development programmes. Characteristics of Indian Farm Machinery Industry. SWOT analysis, generation, incubation and commercialization of ideas and innovations. Entrepreneurial Behavior concept, dimensions, factors affecting entrepreneurial

behavior. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) Small Scale Industries (SSIs), Market survey, formulation of project, financial analysis of project. Communication Skills: Communication - Meaning and process of communication Advertisements - meaning types, forms, functions Writing skill: Business letter, Letters of inquiry, quotation orders and senders, complaints letters.

Phase rule and its application to one and two components systems, Fuels: classification, calorific value, Colloids: Classification, properties, Corrosion: Definition of all types of corrosion, corrosion types and method of prevention. Corrosion control, Water: temporary and permanent hardness, disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion, Lubricants: Properties, mechanism, classification and tests, Polymers: types of polymerization, properties, uses and methods for the determination of molecular weight of polymers.

p-n junction, V-I characteristics of p-n junction, diode as a circuit element, rectifier, clip clamper, voltage multiplier, capacitive filter, diode circuits for OR & AND (both positive negative logic), Transistor as an amplifier CB, CE, CC, operating point, classification (A C) of amplifier, various biasing methods (fixed, self, potential divider), h-parameter of transistor, CE amplifier, phase shift oscillator, ideal OP-AMP characteristics, linear non- linear applications of OPAMP (Adder, subtractor, integrator, active rectifier comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diod voltage regulator, transistor series regulator, current limiting, OP-AMP voltage regulator Basic theorem of Boolean algebra, Combinational logic circuits (basic gates), binary lad D/A converter, successive approximation A/D converter, generalized instrumentation ,measurement of displacement, temperature, velocity, force and pressure using potentiometer resistance thermometer, thermocouples, bourden tube, LVDT, strain gauge and tech generator.

Average and effective value of sinusoidal and linear periodic waveforms. Independent and dependent sources, loop current and loop equations (Mesh current method), node voltage and node equations (Nodal voltage method), Network theorems: Thevenin's, Norton's, Superposion, Reciprocity and Maximum power transfer, Star-Delta conversion solution of DC circuit by Network theorems, Sinusoidal steady state response of circuits, Instantaneous and average power, power factor, reactive and apparent power, Concept and analysis of balanced polyphase circuits, Disadvantages of low power factor and power factor improvement, Various methods of single and three phase power measurement, Stair case and Godown wiring.

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere turns for series and parallel magnetic circuits, hysteresis and eddy current losses Transformer principle of working, construction of single phase transformer, EMF equation transformer on load, equivalent circuit, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machines (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting shunt and senes motor, starters, speed control methods- field and armature control, polyphase induction motor: construction, operation, effect of rotor, resistance, torque equation, starting and speed control methods, single phase induction motors: double field revolving theory. characteristics, phase split, shaded pole motors,

Classification of energy sources; Introduction to renewable energy sources; characterization biomass; types, construction, working principle, uses safety/environmental aspects different renewable plants, passive energy, ocean energy, briquetting of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

Surveying: Introduction, classification and basic principles, Linear measurement Chain surveying. Compass survey. Errors in measurements, their elimination and correction Plane table surveying. Levelling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves.

Introduction of soil mechanics, field of soil mechanics, phase diagram physical and index properties of soil classification of soils, general classification based on particles size, textural classification and I.S. soil classification system stress condition in soils, effective and neutral stress, Permeability and seepage, Shear strength mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress mohr-coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear to be circle, theoretical test. Numerical exercise based on various types of tests. Compaction composition of soils standard and modified protector test, abbot compaction and Jollipur mini compaction text field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory Laboratory consolidation text, calculation of void ratio and coefficient of volume change, Taylor's and Casagrand' s method, determination of coefficient of consolidation. Earth pressure: Plastic equilibrium in soils Active and passive states, Rankine's theory of earth pressure active and passive earth pressure for cohesive soils, simple numerical exercise. Stability of slopes: Introduction to stability Analysis of infinite and finite slopes friction circles method Taylor's stability number.

Introduction, hydrologic cycle; precipitation forms, rainfall measurement, ma curve, hyctograph, mean rainfall depth, frequency analysis of point rainfall, plotting posit estimation of missing data, test for consistency of rainfall records; interception; infiltration evaporation, evapo-transpiration estimation and measurement, geomorphology o watersheds - stream number, stream length, stream area, stream slope and Horton's law runoff factors affecting, measurement; stage and velocity, rating curve, extension of rating curve; estimation of peak runoff rate; rational method, Cook's method, SCS method and volume by Curve number method; hydrograph; components, base flow separation, unit hydrograph theory unit hydrograph of different durations, dimensionless unit hydrograph distribution hydrograph, synthetic unit hydrograph, uses and limitations of unit hydrograph, head water flood control methods, flood routing - graphical methods of reservoir flood routing, hydrology of dry land areas - drought and its classification; introduction to watershed management and planning.

Introduction, soil erosion causes, types and agents of soil erosion; water erosion. forms of water erosion, mechanics of erosion, gullies and their classification, stages of gully development, soil loss estimation - universal soil loss equation and modified soil loss equation, determination of their various parameters; erosion control measures - agronomical measures - contour cropping, strip cropping, mulching; mechanical measures - terraces level and graded broad base terraces and their design, bench terraces & their design, layout procedure, terrace planning, bunds - contour bunds, graded bunds and their design; gully and ravine reclamation - principles of gully control - vegetative and temporary structures;

wind erosion factors affecting wind erosion, mechanics of wind erosion, soil loss estimation. wind erosion control measures - vegetative, mechanical measures, wind breaks & shelter belts, sedimentation - sedimentation in reservoirs and streams, estimation and measurement, sediment delivery ratio, trap efficiency; characteristics of contours and preparation of contour maps; land use capability classification; grassed water ways and their design; introduction to water harvesting techniques; introduction to stream water quality and pollution.

Introduction, classification of structures, functional requirements of soil erosion Control structures, flow in open channels-types of flow, state of flow, regimes of flow, energy momentum principles, specific energy and specific force, hydraulic jump and its plication, type of hydraulic jump, energy dissipation due to jump, jump efficiency, relative of energy, runoff measuring structures-parshall flume, H- flume and weirs, drop way-general description, functional use, advantages and disadvantages, structural parts functions, components of spillway, hydrologic and hydraulic design, free board and e tree board, structural design of a drop spillway- forces on retaining wall, determination of saturation line, seepage under the structure, uplift pressure estimation, safety against ng over turning, crushing and tension; chute spillway general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations, drop inlet spillway- general description, functional use, design criteria; design diversions, small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures.

Watershed management - problems and prospects; watershed based land use planning, watershed characteristics physical and geomorphologic, factors affecting watershed management, hydrologic data for watershed planning, watershed delineation, delineation of priority watershed, water yield assessment and measurement from a watershed; hydrologic and hydraulic design of earthen embankments and diversion structures; sediment yield estimation and measurement from a watershed and sediment yield models; rainwater conservation technologies - in-situ and storage, design of water harvesting tanks and ponds; water budgeting in a watershed; effect of cropping system, land management and cultural practices on watershed hydrology; evaluation and monitoring of watershed programmes; people's participation in watershed management programmes; planning and formulation of project proposal; cost benefits analysis of watershed programmes; land use models; case studies.

Basic concepts, Force systems, Centroid, Moment of inertia. Free body diagram and equilibrium of force. Frictional forces. Analysis of simple framed structures using methods of moment diagrams. Stresses in beams. Torsion. Analysis of plane and complex stresses.

Stones: Properties of stones, Classification quarrying of stones. Bricks: Constituents, winning, moulding drying and burning of bricks, types of bricks, Cement: Composition of ordinary cement, functions of cement ingredients, harmful constituents of cement, settling action of cement, field and laboratory tests, storage, uses various types of cements, Mortars: Types of mortars and mortar mill, Concrete: Types, properties of concrete, aggregate, water cement ration, Measurement of material properties of concrete workability, consolidation and curing. Titles: Types, tile making process, properties of tiles. Timber: Classification, structures, defects, qualities, decay preservation, seasoning. conversion and market forms, plywood and other timber substitutes.

Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method Columns and struts. Riveted and welded connections. Stability of masonry dams. Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution method.

Planning and layout of farmstead Physiological reaction of livestock to solar radiation and other environmental factors, livestock production facilities. BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, silo, fencing and implement sheds. Design and construction of rural grain storage system and development of rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Sewage system its design, design of septic tank for small family. Scope, importance and need for environmental control for protected agriculture/precision farming.

Loads and use of BIS Codes. Design of connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Thermodynamics properties. Closed and open system. Flow and non-flow processes. Gas laws, Laws of thermodynamics. Internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Kelvin Planck and Clausius statements. Entropy, Physical concept of entropy, Change of entropy of gases in thermodynamics processes. Difference between gas and vapour, Change of phase during constant pressure process. Generation of steam, triple point and critical point. Internal energy and entropy of steam. Use of steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction. Classification of steam. boilers, Cochran, Lancashire, locomotive and Babcock-Wilcox boilers. Boiler mountings and accessories.

Importance of engineering properties of biological materials. Study of different physical and thermal characteristics of important biological materials like shape, volume, density, roundness, sphericity, surface area, specific heat, thermal conductivity thermal diffusivity, etc. measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Rheological characteristics like stress, strain time effects, theological models and their equations. Aerodynamic characteristics and functional properties. Application of engineering properties in handling processing machine and storage structures. Concept, objectives and need of quality, quality control, methods of quality control, sampling, purpose, sampling techniques, requirements and sampling procedures for liquid, powdered and granular materials, sensory quality control, pane selection methods, interpretation of sensory results in statistical quality control, TQM and TQC, consumer preferences and acceptance.

Introductory concepts, Modes of heat transfer. Thermal conductivity of materials measurement General differential equation of conduction One dimensional steady state action through plane and composite walls, tubes and spheres Electrical analogy insulation materials, critical thickness of insulation. Free and forced convection. Newton's of cooling, heat transfer coefficient in convection Dimensional analysis of free connection Laminar

forced convection on a flat plate and in a tube. Combined free and od connection. Introduction. Absorptivity, reflectivity and transmissivity of radiation Flack body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff s grey bodies and emissive power, solid angle, intensity of radiation. Types of heat angers, fouling factor, log mean temperature difference. at exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Fick's law, mass transfer coefficients Types of mass transfer.

Scope and importance of food processing, principles and methods of food processing. Processing of farm crops: cereals, pulses, oil seeds, fiber crops, fruits and vegetables and their products for food and feed. Principal of size reduction, grain shape, size reduction machines; crushers, grinders, cutting machines etc. operation, efficiency and power requirement - Rittinger's, Kick's and Bond's equation, fineness modulus. Theory of mixing, types of mixtures for dry and paste. materials, rate of mixing and power requirement, mixing index. Theory of separation, size and un-sized separation, types of separators, size of screens, sieve analysis, capacity and effectiveness of screens, pneumatic separation. Scope & importance of material handling devices. Study of different types of material handling systems; belt, chain and screw conveyor, bucket elevator, pneumatic conveying, Design consideration, capacity and power requirement.

Dairy development in India, Engineering, thermal and chemical properties of milk and milk products. Unit operations of various dairy and food processing systems. Process flow charts for product manufacture. Material and energy balances. Working principles of equipments for receiving, pasteurization, sterilization, homogenisation, filling & packaging Dairy plant design and layout. Composition and proximate analysis of food products. Deterioration in products and their controls. Physical, chemical and biological methods of food preservation, changes undergone by the food components during processing, evaporation, drying, freezing juice extraction, filtration, membrane separation, thermal processing. Food packaging. Plant utilities requirement.

Moisture content and methods for determination. Importance of EMC and methods of determination, EMC curve and EMC model. Principle of drying. Theory of diffusion, Mechanism of drying falling rate, constant rate, thin layer, deep bed and their analysis. Critical moisture content. Drying models, calculation of drying air temperature and air flow rate. Air pressure, within the grain bed, Shedd's and Hukill's equation. Different methods of Jing including puff drying, foam mat drying, freeze drying, etc. Study of different types of dryers- performance, energy utilization pattern and efficiency. Study of drying and dehydration of agricultural products.

Types and causes of spoilage in storage. Conditions for storage of perishable products, Functional requirements of storage. Air movement inside the storage, Storage of grains. Destructive agents, Respiration of grains, Moisture and temperature changes in stored grains. Conditioning of environment inside storage through natural ventilation, mechanical ventilation. Artificial drying, Grain storage structures including Silo, CAP, Warehouse Storage of grains and their products, Storage of seeds, hermetically sealed and air-cooled storages-refrigerated. Control of temperature and relative humidities inside storage. Modified atmospheric storage and Control of its environment, Controlled atmosphere, modified atmospheric and frozen storages. Storage condition for various fruits and vegetables under cold and CA storage system. Economic aspects of storage.

Principles of refrigeration. Second law of thermodynamics applied to refrigeration. Reversed Camot cycle. Coefficient of performance, Unit of refrigeration. Refrigeration in food industry, Types of refrigeration system, Mechanical vapour compression, Vapour absorption system. Components of mechanical refrigeration, refrigerant, Desirable properties of ideal refrigerant, steam jet refrigeration systems, Thermoelectric refrigeration systems, Vertex tube refrigeration systems. Cold storages. Insulation material, design of cold storages, defrosting. Thermodynamic properties of moist air. Perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning, principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution. Fundamentals of design of complete air conditioning systems, humidifiers and dehumidifiers, cooling and calculations, types of air conditioners, applications.

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy. metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies, Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon, Flow through notches, weirs and open channel; Laminar flow. Stress-strain relationships, flow between infinite parallel plates - both plates fixed, one plate moving, discharge, average velocity, shear stress and pressure gradient, Laminar and turbulent flow in pipes, general equation for head loss-Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, power transmission through pipe; Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

Irrigation Engineering Irrigation, impact of irrigation on Human Environment, some major and medium irrigation schemes of India, purpose of irrigation, sources of irrigation water, present status of development and utilization of different water resources of the country. Measurement of irrigation water: weir, notches, flumes and orifices and other methods; water conveyance, design of irrigation field channels, underground pipe conveyance system, irrigation structures, channel lining, land grading, different design methods and estimation of earth work and cost; soil water plant relationship, soil water movement, infiltration and its equations, evapo-transpiration, soil moisture constants, depth irrigation, frequency of irrigation, irrigation efficiencies, surface irrigation methods of water application, border, check basin, furrow and contour irrigation.

Occurrence and movement of ground water, aquifer and its types, classification wells, steady and transient flow into partially, fully and non-penetrating and open well, familiarization of various types of bore wells common in the state, design of open well, groundwater exploration techniques, methods of drilling of wells, percussion, rotary, reverse rotary, design of assembly and gravel pack, installation of well screen, completion and development of well, groundwater hydraulics-determination of aquifer parameters of wells, by different method such as Theis, Jacob and Chow's etc. Theis recovery method, well interference, multiple well systems, surface and subsurface exploitation and estimation of ground water potential, quality of ground water, artificial groundwater recharge planning.

modelling, ground water project formulation. Pumping Systems: Water lifting devices, different types of pumping machinery, classification of pumps, component parts of centrifugal pumps; pump selection, installation and trouble shooting, design of centrifugal pumps, performance curves, effect of speed on head capacity, power capacity and efficiency curves, effect of change of impeller dimensions on performance characteristics, hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; priming, self priming devices, rotodynamic pumps for special purposes such as deep well turbine pump and submersible pump.

Drainage, objectives of drainage, familiarization with the drainage problems of the state. Surface drainage, drainage coefficient, types of surface drainage, design of open channel, sub-surface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc, drainage criteria, types and of subsurface drainage system, Design of surface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudt's) and Ernst's drain spacing equations Steady and unsteady state groundwater condition, dynamic equilibrium concept, Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio- drainage. Tile Drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkaline soils. Leaching requirements, conjunctive use of fresh and saline waters Economic aspects of drainage.

Pasi, present and future need of micro-irrigation systems, Role of Govt. for the promotion of micro-irrigation in India, Merits and demerits of micro-irrigation system, types and components of micro-irrigation system, Basic variables involved in design irrigation methods. Sprinkler Irrigation: system types, planning for design, uniformity and efficiency. out of set sprinkler system, lateral, manifold and main delivery system. Pressure requirement and pump power unit selection. Economical pipe selection and system economics, rain gun irrigation system. Tickle Irrigation: Different types of trickle, components of trickle system, planning the trickle system and design strategy Selection and design criteria for emitters. Lateral/ manifold and main pipe system design. Clogging, filtration, fertigation and chemigation. Maintenance and upkeep of trickle Irrigation. Cost economics of the system.

Major, medium and minor irrigation projects their comparative performance, development and utilization of water resources. Basic concepts of command area - definition, need and scope: historical perspective, command area development Interaction/collaboration of irrigation water use efficiency and agricultural production. Farmers participation in command area development. Description of components of irrigation canal system, their functions, planning and layout of canal irrigation system, preliminary design procedure for irrigation project and command area, crop water requirement, duty and delta, specific discharge of canal, design of canal by Kennedy and Lacey's theory and tractive force approach, Canal seepage and lining of canal, design of lined and economics. Diversion head works and canal head regulators, hydraulic jump and its usefulness in the design of irrigation structures, theories of seepage, cross drainage works, canal falls, irrigation structures on distributory and minor, regulator and modules, operation maintenance of canal.

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5. COMPUTER SCIENCE / IT

Programming Structure : Sequence, Selection, Iteration and Modular. Problem Solving techniques: Development Tools: Algorithm, Flowcharts and Pseudo code (Definition and its characteristics) Developing Algorithm and Drawing flowcharts. C Character set, Tokens, Identifier, Keywords, Variables, Data types, Qualifiers. Operators and Expressions: Arithmetic, Relational, Logical, Bit-Wise, Increment, Decrement, Conditional and Special operators. typedef, Type Conversion, Constants, Declaring Symbolic Constants, Character Strings, Enumerated Data Types, Operator Precedence and Associativity. Library functions. : Maths, string handling Functions. Control Structure: Compound Statement, Selection Statement: if, if-else, Nested if, switch. Iteration statement: for, while, do while, Nested loops, Jump statement: break, continue, goto. (Special emphasis on problem solving). Arrays: Need, Types: Single and Two Dimensional Array. Strings: Strings Manipulation, Arrays of Strings, Evaluation order. Function: Function Components, Return Data type, Parameter Passing, Return by Reference, Default Arguments, Recursive Functions, Arrays with Functions, Storage Classes. (Special emphasis on problem Solving). Structure: Declaration, Definition, Accessing structure members, Initialization, Nesting of Structures. Union: Unions, Differences between Structure and Union. Pointer: Introduction, Address Operator (&), Pointer variables, void pointers, Pointer Arithmetic, Pointers to Pointers. File handling : Hierarchy of File Stream Classes, Opening & closing a file, Testing for errors, File Modes, File pointers and their manipulations, Sequential Access, Random Access , Command Line arguments.

Basic Components of Digital Computers: Block Diagram. CPU: Functions of Each Unit: Primary Memory, ALU and CU, Instruction format. Bus: Data, Control and Address Bus Number Systems: Binary, Octal, Decimal, HexaDecimal, Their Conversions, Binary Arithmetic. ASCII, BCD, EBCDIC. Language Evolution : Generation of Languages : Machine, Assembly, High Level Languages. Characteristics of Good Language Translators : Compiler, Interpreter and Assembler. Source and Object Program. Memory: Static & dynamic, RAM, ROM, PROM, EPROM, EEPROM, flash and Cache. Storage Devices: Hard Disk, Zip Disk and Optical Disk. Pen Drive, Blue Ray. Input Devices: Keyboard, Mouse, Light Pen, Touch Screen, Voice Input , MICR, OCR, OMR, Barcode Reader and Flatbed Scanner. Output Devices: VDU, Printers: Dot Matrix, Laser and Inkjet. Plotters: Drum, Flat-Bed and Inkjet. Network: Network terminology, Topologies : Linear, Circular, Tree and Mesh. Types of Networks: LAN, WAN, MAN. Repeaters, Bridge, Routers, Brouters and Gateway. Modem for Communication between pc's, wi-fi network, Introduction of Bluetooth and Infrared devices. Network protocols. Architecture : Peer-to-Peer, Client/Server.

Object Oriented Methodology: Elements of Object Oriented programming, Objects, Classes, OOPs features. Classes & Objects: Specifying a Class, Creating Objects, Accessing Class members, Defining member function, Outside Member Functions as inline, Accessing Member Functions within the class, Static data member, Access Specifiers: Private, Protected and Public Members. CONSTRUCTORS & DESTRUCTORS: Introduction, Parameterized Constructors, Constructor Overloading, Constructors with Default Arguments, Copy Constructor, Destructor, Order of Construction and Destruction, Static data members with Constructor and Destructors. OPERATOR OVERLOADING: Definition, Overloadable Operators, Unary Operator Overloading, Unary & Binary overloading, Rules for Operators Overloading. DYNAMIC OBJECTS: Pointers to Objects, Creating and Deleting Dynamic Objects: New and Delete operators, Array of Objects, Array of Pointers to Objects, Pointers to Object Members, this Pointer. INHERITANCE: Defining, Abstract classes, Single, Multilevel, Multiple, Hierarchical, Hybrid Inheritance, Constructor and Destructor in Derived Classes.

VIRTUAL FUNCTIONS: Need for Virtual Functions, definition, Pure Virtual Functions, Abstract Classes, Rules for Virtual Functions. EXCEPTION HANDLING: Exception Handling Model, List of Exceptions, Handling Uncaught Exceptions, Fault Tolerant Design Techniques, Memory Allocation Failure Exception, Rules for Handling Exception Successfully.

Introduction : System, Subsystems, Components of Computerized Information System, Systems Analysts, SDLC, Prototyping. Feasibility Study and Analysis: Identifying Problems, Organizing Feasibility Analysis: Economic, Financial, Organizational and Technological. Feasibility Decision, Choice of a solution. Data Collection: Interviews, Brain Storming, Questionnaires, Document Search, Observation. Structured tools and techniques of Data analysis : Structured English, Process Charts, SOP, Decision Tables and Decision Trees, Data Flow Diagram, Data Dictionary. (Special emphasis on problem solving). System Design : Input design: Input Validation, Human factor Consideration, Messages, System Tolerance. Output design: Categories of output, Design Principles, Control of Output. Forms: Principles of Form Design, Ways to ensure Quality Forms. Codes: Types, Physical Representation of Codes, Principle of Code Design. Implementation: Training, Operational Training and Related Activities, Planning to Implement Change, Change Strategies. Testing: Preparation for Testing, Test Execution: Levels of Testing, Component, Function, Subsystem, System, Test Evaluation, Acceptance. Conversion: Cold Turkey, Parallel, Pilot, Modular and Sequential Methods. Conversion Period Length. System Evaluation. Project Planning, Metrics for Project Size Estimation, Project Estimation Techniques, Scheduling: Work Breakdown Structure, Activity Networks and CPM, Gantt Charts, PERT Charts, Project Monitoring and Control. Risk Management, Software Configuration Management: Necessity, Configuring Management Activities. Software Reliability and Quality Management: Software Reliability, Software Quality, ISO 9000. Software Maintenance: Characteristics of Software Maintenance, Maintenance Process Models, Estimation of Maintenance Cost. Software Reuse: What can be reused, Why no reuse so far, Basic Issues.

LINKED LIST : Linked List, Representation of Single, Double, Header, Circular Single and Double Linked list, All possible operations on Single and Double linked List using Dynamic representation, Polynomial Representation and its Manipulation. STACKS : Stacks terminology, Representation of Stacks in Memory, Operation on Stacks, Polish Notations, Translation of infix to postfix & prefix expression, Infix to Postfix Conversion, Evaluation of Postfix Expression, Recursion, Problems on Recursion, Quick Sort and Tower of Hanoi Problem. QUEUE: Representation of Queues in Memory, Circular Queue. Dequeue and Priority Queue. Operations of above Structure using Array and Linked Representation. SORTING AND SEARCHING: Selection Sort, Insertion Sort, Merge Sort, Efficiency of Sorting Methods, Big-O Notations. Hash Tables, Hashing Technique, Collision Resolution Technique. TREES : Basic Terminologies, Representation of Binary Trees in Memory, Traversing of Binary tree, Binary Search Tree, Operation on Binary Search Tree, Heap Tree, Operation on Heap Tree, Heap Sort Method. GRAPHS : Basic Terminologies, Definition and Representation of Graphs in Memory: Linked List and Matrix Representation. Traversing graphs : BSF, DFS Method.

Structure of Operating System, Operating System functions, Characteristics of Modern OS. Process Management: Process states, Creation, Termination, Operations on Process, Concurrent process, Processes Threads, Multithreading, Micro Kernels. CPU Scheduling: Schedulers, Scheduling Methodology, CPU Scheduling Algorithm: FCFS, SJF, RR, Priority Scheduling. Performance comparison : Deterministic Modelling , Queuing analysis,

Simulators. Deadlock and Starvation: Resource Allocation Graph, Conditions for Dead Lock, Dead Lock Prevention, Dead Lock Detection, Recovery from Deadlock. Memory Management: Logical Vs. Physical Address Space, Swapping, Memory Management Requirement, Dynamic Loading and Dynamic Linking, Memory Allocation Method: Single Partition allocation, Multiple Partitions, Compaction, paging, segmentation, Segmentation with paging. Protection. I/O Management: I/O hardware, I/O Buffering, Disk I/O, Raid, Disk Cache. File Management: File Management system, File Accessing Methods, File Directories, File Allocation Methods, File Space Management, Disk Space Management, Record blocking. Protection Mechanisms: Cryptography, Digital Signature, User Authentication.

Introduction to Java: -History of Java, features of Java, getting started with Java. Java programs:-Introduction of Application & Applets. Variables: -Variable naming, variable initialization, assign values, Rules of variables, Scope of variable. Operators: -Arithmetic, Assignment, Unary, Comparison, Shift, Bit- Wise, Logical, Conditional, New, Special, Relational. Data types:-Integers, Char, String, Float etc. Typecasting: Tokens: -Java tokens Order of precedence of operators Streams: - Input and output. Creating a class & subclass: - Declaring a class, Naming class, Rules to assign Class & Subclass, Creating a new object, Class of an object. Data members: -Declaring data member, Naming variables, using class members. Methods: -Using data members, Invoke a method, passing arguments to a method, calling method. Access Specifier & Modifiers: -Public, Private, Protected, Static & Final. Overloading: -Method overloading, Constructor overloading. Java class library: - Different types of classes. Decision making & loops:-If-then-else, Switch,? : operator, While-loop, do-while loop, for. Array: -Creating an array, one-dimensional array, two-dimensional array. String: -String array, string methods. Inheritance: -Single & multiple inheritances Interfaces: - Defining interfaces, extending interfaces, implementing interfaces. Packages: -Java API packages, creating packages, accessing packages, adding a class to packages. Import statement: - Introduction & implementation of import statement. Applets:-Introduction to Applets & Application, how applets application are different creating An applet. Applets life cycle, designing a web page, creating an executable applet, running the applet, applet tags, passing a parameter to applet, HTML tag, Converting applet to application. Threads:-Overview of threads, single & multiple threads, lift cycle of threads, stopping & blocking threads, working with threads, priority to thread, synchronization. Exceptions & Errors:-Introduction, types of error, exception, syntax of exception, handling techniques, exception for Debugging. Event: - Event driven programming, handling an (AWT) events. Graphic class:-Introduction, the graphic classes, drawing & filling of lines, rectangle, circle & ellipse, arcs, polygons, text & fonts, creating a font class, font objects, text, coloring object. Streams:-Introduction, Abstract stream classes, file input & output. AWI Applications: -Creating a GUI using AWT toolkit, using component class, frames. Components & Control: -Textfield, textarea class, label, button, choice, list, checkbox, class, and combo. Menus: -Creating a popup menus. Image: - Type of image, Properties of an image, Displaying an image. Layouts: -Using Window Listener interface, Different types of Layout, Layout manager, Flow manager, Grid manager. Container: -Different types of container (Frame, Dialog, Panel)

Logging In and Logging Out, Anatomy of Linux OS, Directory Structure, /usr Directory, File Types: User datafiles, System data files, Executable files. Naming files and directories, Spawning Processes. Shell: Creating User Account, Shell Program, bash shell, Changing shell prompt. Commands: Basic Syntax for a command, Exploring the Home Directory, ls, mkdir, rmdir, stat, cat, rm, mv, cp. Editor: Vi editor. Hooking up Hardware Devices: Formatting a Floppy Disk, Gathering important system information. Backing Up and restoring the File System: Simple Backup, gzip, gunzip, tar. Printing files: Print Spool

directory, Sending files to Printer. Sharing Files with other Users: Maintaining User Accounts, Changing Password, Creating Group Accounts, Granting Access to files, Changing File Ownership, Protecting Files, Making a File Read-Only. Working with Processes: Types of processes, ps Command, Creating process, killing process, free command and top utility. Managing Disk Space: df, du commands, Creating Additional Free Disk Space, Locating Unused Files, Setting System Clock. Communication Utilities: who, who am i, finger, mesg, write, wall, talk, Creating a message of the day. X Window System, Graphical User Interfaces: KDE and GNOME Desktop Environment.

Working with Visual Basic Window Components: Menu Bar, Tool Bar, Project Explorer Window, Form Layout Window, properties Window, Toolbox, Code Editor Window Working with Forms: Properties, Events, Methods Working with Basic Controls:Label, Command Button, Text Box, Option Button, Frame, Check Box, List Box, Combo Box, Image, Scroll, Picture, Timer, Drive List Box, DirListBox, FileListBox and Shape Controls. Basic Programming Fundamentals: Variables, Data types, Constant, Conversion Function. Scope of Variable: Public, Private Static. Operators: Logical, Arithmetic, Concatenation, Comparison. Decision Structure: If.. Then, If..Then..Else, Select Case.. End Case. Loop Structure: Do.While, While.. Wend, For.. Next, With..EndWith. DoEvents. Arrays: Dynamic Array, Preserve and Control arrays. Procedure: General procedure, General Methods for Passing Arguments to a Procedure, Functions: User-Interaction, String, Math, Date, Conversion Functions. Modules: Form, Standard. Menus: Creating, Adding Menu Items, Creating Shortcut, Adding Separators Bars, Submenus, Code for Menus. Creating Popup Menu: System, Custom. Database Handling: Database Concepts, Creating and Accessing Database, Using Data Control. Using DAO: Creating Search Programs, Numeric Search and Complex Search Programs. Using ADO Data Control, Data Link, ODBC Data Source name, Using Connection String, Creating Navigating buttons. Working with Advanced Data Controls : DataList Control, DataCombo Control, DataGrid Control and Msflexgrid Control. Handling Errors : Run Time, Trapping and Handling Error, ERR Object. Data Environment and Data Reports.

DBMS : Definition: Databases, DBMS, Problems with traditional file processing system, Objectives of the database systems, Three level architectures of DBMS, Component of DBMS, Database Administrator, Database Users, Data model, Different types of data models, Concepts of Hierarchical, Network Models. E-R Models : Basic Concepts, Entity, Attributes, Relation Ship, Mapping, Keys, Weak and Strong Entity Set, Problems on E-R Diagrams, Extended E-R Features: Specialization, Generalization, Aggregation, Problems on Reduction of an E-R Schema to Tables, Tabular representation of Strong, Weak entity Sets and Relationship Sets. Relational Model: Structure, Relational Algebra, Fundamental Operations, Set –Intersection, Natural Join, Division and Assignment Operation. Extended Relational Algebra Operations, Aggregate Functions. Functional Dependency: Functional Dependency, Fully Functional Dependency, Partial Dependency, Transitive Dependency, Multi Valued Dependency. Normalization, Normal Forms (1NF, 2NF, 3NF, BCNF, 4NF, 5NF). Problems on Normal forms.

Compilers and translators, need, the structure of a compiler, Lexical Analysis, Syntax analysis, Intermediate code Generation, Optimization, Code Generation, Book keeping, Error Handling, High Level programming languages, Definitions of programming languages, The lexical and syntactic structure of a language, Data elements, structures, Operators, Assignment Statements, Data Environments, Parameter transmission, Storage management. The role of the lexical analyzer, Approach to the design of lexical analyzer, Implementation of lexical analyzer, Context free grammars, Derivations and parse trees, Ambiguous grammar. Parsers,

Shift-reduce parsing, Operator precedence parsing, Top-down parsing, predictive parsers, Symbol Table , Code Optimization: The principal source optimization, Loop optimization, The DAG representation of basic blocks, Code Generation : A machine model, a simple code generator, Register Allocation and assignment.

CODD'S Rules, Oracle Database Objects, Sub Languages of SQL, Data types, Operators. DDL Statement: Creating Tables, Deriving Table from existing table, Altering, Dropping Tables. Integrity Constraints, Specifying Names for the Constraints, Viewing Integrity Constraints, Adding and Dropping Constraints. DML Statements: SELECT statement, Insert, Update, Delete, Working with Sequences and Synonyms. Built-in functions: Arithmetic, Date, Character, Conversion, Single row, Aggregate, Decode. Joins, Set Operators and Sub queries. DCL and TCL Statements: Grant, Revoke, Commit, Rollback and Save points. VIEWS: Creating Views, Dropping Views, Inserting, Updating and Deleting Data using Views, Types of Views. PL/SQL Programming: PL/SQL Data Types, Identifiers, Operators and Expressions, Iterative Statements, Conditional Statements, emphasis on Problems. Exception Handling : Predefined Exceptions, User defined Exceptions. Cursors: Declaring Cursors, Opening and Retrieving Records, Closing cursors. Attributes of Explicit and Implicit Cursors, Parameter Passing in Cursors. Procedures : Create and Drop Procedure, Creating Procedures with Parameters, Calling Procedures, Granting the EXECUTE Permission Problems on Exception Handling, Cursors and Procedures. Function: Creating and Dropping Function, Purity Levels in Functions, Executing Functions. Triggers: Create Triggers, Type of Triggers, Creating BEFORE and AFTER Triggers, INSTEAD-OF Triggers, Trigger Predicates, Inserting, Updating and Deleting Triggers, Enabling , Disabling and Dropping Triggers. Problems on Functions and Triggers.

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6. FOOD TECHNOLOGY

Introduction, sources of food, scope and benefit of industrial foodpreservation, perishable, non perishable food, causes of food spoilage Preservation by salt and sugar – Principle, method, equipment and effect on food quality Thermal processing methods of preservation – Principle andequipments : Canning, blanching, pasteurization, sterilization, evaporation. Use of low temperature – Principal, equipment and effect on quality. Chilling, cold storage, freezing. Preservation by drying dehydration and concentration – Principle, Methods, equipment and effect on quality : Difference, importance of drying and dehydration over other methods of drying and dehydration, equipments and machineries, physical and chemical changes in food during drying and dehydration Need and principle of concentration, methods of concentration – Thermal concentration, freeze concentration, membrane concentration, changes in food quality by concentration. Preservation by radiation, chemicals and preservatives. Definition, methods of irradiation, direct and indirect effect, measurement of radiation dose, dose distribution, effect on microorganisms. Deterioration of irradiated foods- physical, chemical and biological; effects on quality of foods. Preservation of foods by chemicals, antioxidants, mould inhibitors, antibodies, acidulants etc. Preservation by fermentation- Definition, advantages, disadvantages, types, equipments, Recent methods in preservation : Pulsed electric field processing, High pressure processing, Processing using ultrasound, dielectric, ohmic and infrared heating. Theory, equipments and effect on food quality.

Food demand and supply – Qualitative and quantitative requirements, Expected technological advances to meet the needs, Future priorities in food production needs –status of food industry in India and abroad, Magnitude and inter dependence of food production and processing agencies. Food availability, production trends – factors of production – types of foods like processed semi processed, ready to eat foods, fast foods. Food characteristics nutritional significance of major food groups. Present trends of consumption, further requirements. Consumers change of aptitude in food products consumption, New food products developed programmes aimed for making more foodavailability to increasing population and their prospects – merits and drawbacks, prospects for future growth in India. National and international trends and programmes in food handling, processing and marketing, Potentials and prospects of developing food industry in India. Food losses –factors affecting – programmes and strategies to eliminate the looses and meet the required demand. Global demand for food. World food day – importance and action plans.

Post harvest technology of fruits and vegetables: An overview concept and science, importance loss reduction, role in export, economy and employment generation. Morphology, structure and composition of fruit andvegetable. Physical, textural characteristics, structure and composition. Maturity standards - Importance, methods of maturity determinations maturity indices for selected fruits and vegetables, Harvesting of important fruits and vegetables, Fruit ripening- chemical changes, regulations, methods. Storage practices: Controlled atmospheric, Beadatmosphere, hypobaric storage, cool store, zero energy cool chamber, Commodity pretreatments- chemicals, wax coating, prepackaging, Physiological post harvest diseases, chilling injury and disease. Handling and packaging of fruits and vegetables, Post Harvest handling system for citrus, mango, banana, pomegranate, tomato, papaya and carrot packaging house operations, Principles of transport and commercial transport operations.

Present status and future prospects of cereals (Rice, Wheat, Corn, Sorghum, Rye), Morphology of Rice : Physical properties: Density, Bulk density, Angle of repose - hardness, asperity, porosity, stack of milling and moisture on physical properties. Chemical composition: Distribution of nutrients and Aroma ofrice. Drying of paddy : general principles and methods of drying, cracking phenomenon - prevention. Methods of drying, batch type, continuous type driers, Parboiling of rice : Milling of rice : i) Conventional Milling ii) Modern milling iii) Advantages and disadvantages of milling machineries. iv) Byproducts of rice milling, Aging of rice : Enrichment: Need of Enrichment, Methods of enrichment, enrichment levels, fortification of amino acids. - Processed Foods from rice: Breakfast cereals, flakes, puffing, canning andinstant rice. Corn : Morphology, Physico-chemical properties, Corn milling,Milling fractions and modified starches, Barley : Morphology, Physico-chemical properties and processing(Malting). Sorghum : Morphology, Physico-chemical properties, Milling, Malting, Pearling and industrial utilization. Millets – Oat / Rye : Importance of Millet, composition, processing of millets for food uses.

Present status and future prospectus of legumes and oil seeds morphology of legume and oilseeds, Classification and types of legumes and pulses. Chemical, composition and nutritional value. Antinutritional factors, theirchemistry, methods of removal of antinutritional factors, Processing of legumes of home scale, cottage scale and commercial methods of dehulling. Modern techniques in dehulling. Processing of red gram,. bengal gram, green gram, black gram. Dal milling – principles, methods, equipments and effect onquality. Principle products, dry and wet milling of pulses, fermentedproducts of legumes. Soaking – principles, methods of soaking - sprouting, puffing, roasting and parboiling of legumes, physical and bio-chemicalchanges during these processes, Cooking quality of dhal – methods, factors affecting quality of dhal and cooking of dhal. quick cooking dhal, instant dhal. Introduction, present and future prospects of oil seeds, chemical composition and characters of oil seed and oils, antinutritional factors, elimination methods. Post harvest technology of oil seeds, handling drying, storage, grading, pretreatments, cleaning, dehulling, size reduction and flaking Oil extraction: traditional methods, ghani, power ghanis, expellers –principle of expeller, structure design of expeller. Solvent extraction process : principle, pretreatment - breaking,cracking, flaking. extraction principle, factors affecting the extraction process. Desolventization Refining of oils – degumming, neutralization, bleaching, filtration, deodorization, their principles and process controls. New technologies in oil seed processing, utilization of oil seedmeals of different food uses. high protein product like protein concentrate and isolates.

Sources and developments of meat and poultry industries and importance in national economy, Muscle structure, chemical composition and physico-chemical, properties of meat muscle Abattoir design and layout, Pre-slaughter transport and care and antimortem inspection, Slaughtering of animals and poultry, post-mortem inspection and grading of meat. Factors affecting post-mortem changes, properties and shelf life of meat. Egg structure: Composition, quality characteristics, processing and preservation of eggs, Processing and preservation of meat- mechanical deboning, aging or chilling, freezing, pickling, curing, cooking and smoking of meat. Meat tenderization –Principles and methods. Meat emulsions. Technology of manufacture of meat and poultry products. Meat plant sanitation and safety By-products utilization of abattoir Fish-Classification, composition, quality characteristics and preservation.

Wheat – importance, production varities, Types of wheat, grading and quality of wheat, Structure of wheat, chemical constituents, their distribution, Physico-chemical and Rheological properties Enzymes in wheat, damage wheat. Conditioning of wheat – principles and methods of conditioning, Milling of wheat –Roller flour milling process, Break rolls,

reduction rolls, The design and operationWheat milling process, Products of wheat milling industry, Flour grades, Supplementation, Fortification, Flour additives, flour improvers, Bleaching, Oxidizing agents, Bakery products, role of bakery ingredients (major and minor), from hard wheat: bread processes of bread making using straightand sponge, dough methods role of each ingredient, quality control Testing of raw material testing of final product, Bread faults, staleness, roppynes, Baked Products from soft wheat: cookies, crackers, biscuits, cakes: types, ingredients, process, causes, remedy, Other bakery products: using very hard wheat. pizza, pastry and its types. Macaroni products: Including spaghetti, noodles, vermicelli-process. Nutritional improvement of bakeryproducts. Setting of bakery unit, bakery norms, specifications for raw materials Packaging, marketing of products, project report on bakery.

History, traditional confectionery goods, types of confectionary,classification, Basic technical considerations, TS, TSS, pH, acidity, ERH, sugar,invert sugar, glucose syrup, RH, crystallization, Raw materials, Sugar, sugar qualities, physical, chemical, optical properties. Sugar grinding, dextrose, fructose, lactose, caramel, maltose, honey, sorbitol,xylitol, iso malt, soy maltose, polydextrose, lactitol, maltitol. whipping, release agent, thickeners, acidulents, milk and milk products, flavours, for confectionery, emulsifiers and other additives, starch derivatives, colours used in confectionary. Production of glucose syrup, acid hydrolysis, enzyme hydrolysis Cocoa processing: cocoa bean, processing, roasting, fermentation, production of cocoa butter cocoa powder, its quality. Chocolate processing : Ingredients, mixing, refining, conching, tempering, molding, cooling, coating, fat bloom High boiled sweets: Introduction, composition, properties of high boiled sweets, preparation of high boiled sweets, traditional, batch andcontinuous method of preparation. different types of higher boiled sweets, recipes. Caramel: Definition, composition, factors affecting quality of caramel, caramel manufacture process, batch type, continuous types,checking of faults in caramel. Toffee: Definition, composition, types of toffee ingredient and their role. batch and continuous method of toffee. Fondant: Fudge/Creamy: ingredients, methods, productivity, Lozenges: definition recipe, method of manufacture, compositions,factors affecting quality, industrial production, checklist of faults. Tablets: Definitions, recipe, composition, wet granulation, slugging, manufacture of tablet, and checklist of tablet faults marshmallow and nougat: Definition, composition, recipe, and methodof manufacture of nougat. Panning: Process, types of panning, soft and hard panning. quality of confectionery, standards and regulations, packaging requirements of confectionery, economics and marketing of confectionary goods.

Production and processing scenario of fruits and vegetables in India and World. Scope of fruit and vegetable preservation industry in India. present status, constraints and prospects. Overview of principles and preservation methods of fruits and vegetables, Commercial processing technology of following fruits and vegetables. Mango: pulp, RTS, squash, canned pulp. toffee amchur, pickle, powder, bar Banana: wafers, puree, powder, banana fig Papaya: jam, candy, RTS, nectar, squash, papain. Pomegranate: juice, squash, syrup, anardana, dalimb manuka, anargoli. Guava; jelly, cheese, juice, canned guava, squash, toffee Grape: raisin, juice, wine. Fig : pulp, dried fig, toffee, powder, bar Citrus fruits: jelly, marmalade, RTS, squash, candy. Aonla ; preserve, jam, candy, juice, squash, powder, dried shreds, chavanprash, pickle, chutney, sauce, sweets. Tamarind: pulp, powder, toffee, bar, RTS, slab. Jamun : jelly, RTS, syrup, wine, flakes, bar, powder. Wood apple: jelly, marmalade, Tomato: ketchup, sauce, puree, soup, chutney, pickle, Ginger: preserve, candy, dried ,ginger pickle, RTS, syrup. Onion: dried onion, powder Garlic : dried garlic, powder, Potato : wafer, starch, papad, Carrot: preserve, candy, pickle, jam Cauliflower and Cabbage: dried cauliflower and cabbage, sauerkraut, pickle, Leafy vegetables; dried leafy vegetables (spinach, fenugreek, coriander leaves, curry leaves) Bitter gourd: pickle, dried bitter gourd.

Food quality, its role in industry definition of quality, quality control, factors affecting quality control Quality attributes, dominant attributes, hidden attributes, Colour-role of colour in quality spectra, different types of colour measuring instruments. Viscosity- types of fluids, different viscometers to measure Viscosity. Consistency- Methods used to measure consistency of product, Difference between viscosity and consistency, Size and shape- Its role, method to find shape and size of food and food products Defects: classification, genetic- physiological defects- structural,off color, character, Entomological defects: holes, scars, lesions, off coloring, curled leaves, Pathological defects Mechanical defects, Extraneous or foreign material defects. Measurement of defects: Improving visibility by dilution, white background, color differences, standardization of conditions,reference standards, counts and measures, isolation of defects by floatation, elution, electronic sorting, Internal defects Texture- Classification, definition and role of firmness, yielding quality, juiciness, chewiness, fibrousness, grittiness, mealiness, stickiness,, measurement of texture/ kinesthetic characteristics.- by compression, mechanical thumb, puncture tester, succulometer, shearing by tenderometer, texturometer, maturometer, fibro meter, moisture content, by barbender moisture tester, alcohol insoluble solids, color, consistency & sound measurement for kinesthetics Flavour- definition and its role in food quality, Taste, classification,taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes,interaction of tastes Odour- definition, classification, neutral - mechanisms, olfactoryabnormalities, odor testing, techniques, thresholds, odor intensities Visual, auditory, other senses, vision, audition, oral perception other than taste Factors influencing sensory measurements: Attitudinal factors, motivation psycological errors in Judgment, relation between stimulus and perception adaptation. Correlation of sensory and instrumental analysis. Quality Measurements: Laboratory measurement: types of tests, panel selection andtesting environment, serving procedures, instruction to judges, different tests, directional difference tests, classification of difference tests, two-sample tests, three sample tests, multisample tests, comparison of procedures, ranking, scoring, hedonic scaling, dilution procedures, descriptive sensory analysis, contour method, other procedures. Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained fromconsumer study, factors influencing results from consumersurveys, methods of approach, development of the uestionnaire, types of questionnaires, serving procedures. Comparison of laboratory panels with consumer panels, limitations of consumer survey Quality of raw materials: Physical, Chemical and microbial quality. Quality of products during processing & after processing color,taste, texture, flavour, appearance. Factors influencing the Food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditionsof finished products. Recording and reporting of quality.

Milk – Definition, composition of milk from different species, colostrum. Physico – Chemical properties of milk. Nutritive value of milk and milk products. Effect of heat on milk. Processing of milk- pasteurization by L T H T and HTST and UHT – filtration, UF and RO, clarification, cream separation, homogenization andheat processing. Classification of milk products. Manufacture of butter and butter oil (Ghee) Fermented milks, Preparation of yoghurt and cheese. Ice-cream – Method of manufacture. Manufacture of indigenous milk products – ghee, khoa, chhanna, paneer, dahi and shrikand. Indian milk confectionary – Khoa and Chhanna based sweets. By products of dairy Industry and their utilization. Packaging and storage of milk and milk products – Defects – Standards.

Production and processing scenario of spice, flavour & plantation, crops and its scope. Major Spices: (1) Post Harvest Technology composition, processed products offollowing spices (2) Ginger (3) Chill (4) Turmeric (5) Onion andgarlic (6) Pepper (7) Cardamom (8) Cashew nut, coco nut. Minor spices, herbs and leafy vegetables: processing and utilization, All spice, Annie seed, sweet Basil, Caraway seed,Cassia, Cinnamon, Clove, Coriander, cumin, Dill seed Fern seed nutmeg mint marjoram, Rose merry, saffron, sage. Savory, Thyme, Ajowan, Curry leaves, Asafoctida, Tea, Coffee, Cocoa: Processing quality control, Vanilla and annatto-processing, Spice oil and oleoresins, Chemistry and physiology of taste, flavouring compounds in Foods, Separation, purification and identification of natural flavouring Materials, Synthetic flavouring agents and their stability, Flavours of soft drinks, Baking and confectionery industry, Standards specification of spices and flavours, Packaging of spices and spice products.

Industrial byproducts and waste. Potentials and prospects of developing by-products industry in India. Agricultural waste and agro based industrial waste management. By products of cereals. By products of legumes. By products of oil seeds. By products of dairy. By products of fruit and vegetables processing industries. By products of meat, poultry and eggs. By products of fish processing units. By products of plantation crops and spices. Uses of byproducts of agro based industries in various sector. Byproducts of fermentation industries. By products of sugar and bakery industries.

History and types of soft drinks. Water treatment and quality. Specification for beverage water. Alkalinity reduction ,filteration of water,water softening. Sweeteners used in soft drink and their properties ,non nutritive Sweetners. Natural colorants used in soft drinks. Synthetic colorants used in soft drink. Acidulants used in soft drink. Mid term examination. Clouding agents for soft drink. Flavouring agents used in soft drink. Carbon dioxide and carbonation for sift drink. Equipments and machineries used in soft drink. Packaging aspects in soft drink. Quality control in soft drink –Chemical and sensory. Quality control in soft drink – Microbiological quality.

Need, importance and objectives of formulation for new product development. Ideas, business philosophy and strategy of new product. Formulation based on sources availability and cost competitiveness for concept developments of new products. Standardization of various formulation and product design. Adaptable technology and sustainable technology for standardized formulation for process development. Process control parameters and scale-up, production trials for new product development at lab and pilot scale. Quality assessment of new developed products. Market testing and marketing plan. Costing and economic evaluation of developed products. Commercialization / product launch for marketing.

Need and scope of specialty foods. Speciality food based on ease in preparation for cost health benefits Functional foods, Convenience food, Health care and medical benefits Nutritional status, Low cost foods, Speciality foods based on sources, Cereals and millets, Legumes and pulses. Fruits and vegetables, Animal food sources, By product based, Non conventional foods. Speciality foods based on process, Innovative process technology, Food additives basis, Bioactive components, Novel neutraceuticals products, Packaging techniques, Adaptable technology basis, Fast and PET foods. Speciality food based on Genetically modified foods,Transgenic foods, Biotechnological aspects of detoxification, Proprietary foods. Supplementary foods. Therapeutic foods, Modification of diets in disorders, feeding purposes. Disease oriented of different organs ex: digestive trac, liver, cardiovascular system, kidney, metabolic disorders, allergy, endocrine disorders. Specific consumer oriented foods.

Defence persons Space / astronought High altitude mountain climbers Disaster situation – crises, care, maintenance. Speciality foods based on growing condition - organic , inorganic farming.

Food proteins Types, sources, availability, need, properties etc. food problems, role, means for increasing food supply. Amino acid fortification of foods i.e. break fast cereals, infant foods, bread, baked products. Legumes and oilseed foods Isolate, concentrate, and substitute to milk, variation in composition andnutritive value. Meat Analogue, commercial development, nutritional aspect, marketing Aspect. New protein foods, tofu, miso, texturized vegetable protein, hydrolyzed vegetable protein, formulation and quality control. Extrusion Technology Importance, principles of extrusion cooking, methods of extrusioncooking. Extruders- Types of extruders, single screw, twin screw, their applications, effects of dependent and independent variables on the product quality. Extruded products- Raw materials, process of manufacture, properties, quality, evaluation,packaging requirement, marketing.

Quality inspection, quality control, quality management and qualityassurance. Total quality management:Good manufacturing practices, Good agricultural practices, Good laboratory practices, Quality management systems (QMS). Quality Circles, SQC., ISO System. HACCP, principles, implementation. Plan documentation, types of records. Auditing, surveillance Audit, mock audit, third party quality certifying audit, Auditors and Lead auditors. Certification, certification procedures, certifying bodies, accrediting bodies, international bodies.

Biochemistry & it's scope. Cellular Biochemistry- Cell-structure – plant and animal, composition and function of cell organelle. Carbohydrates- Occurrence ,Classification & Structures, Physicochemical and Metabolic functions, Metabolism – Glycolysis, TCA cycle, HMP pathway, ETC, oxidative phosporylation andgluconeogenesis. Proteins - Occurrence, Classification & Structures Physicochemical & Metabolic functions, Metabolism- Transmination, deamination and decarboxylation, amino acids- classification, structure biosynthesis of amino acids. Lipids- Occurrence, Classification & Structure, Physicochemical and metabolic functions. Metabolism- degradation of fats, ß- oxidation, fatti acids, classification and biosynthesis. Nucleic Acids- classification, structure& biosynthesis of nucleicacid,- Metabolism RNA and DNA metab olism. Vitamins- Sources and classification- Chemistry and Metabolic functions, deficiencysyndromes. Enzymes - Chemical Nature and nomenclature Classification, sources and properties Mechanism of action, coenzyme and prosthetic groups.

Nature Scope and development of food chemistry, role of food chemist. Moisture in foods- Role and type of water in foods. Functional properties of water, role of water infood spoilage. Water activity and sorption isotherm, Molecular mobility and foods stability. Dispersed systems of foods - Physicochemical aspects of food dispersion system a) Sol b) gel c) foam d) emulationsRheology of diphase systems. Carbohydrates- Functional characteristics of different carbohydrates (sugars- water relationship, sweetness). Maillard reaction, caramelizateion, methods tocontrol non enzyjmatic reactions. Modification of carbohydrates- unmodified andmodified starches, modified celluloses. Dietary fibres NDF, ADF, Cellulose,emicellulose, pectin and carbohydrates digestibility – sugars and starch and their energy values. Functional properties of kpolysaccharides, natural vegetable gums, carbohyderate composition of various natural foods. Proteins in foods- Physicochemical properties- ionic properties, protein denaturation, gelation and hydrolysis. Protein content and

composition in various foods- cereal grains, legumes and oilseed proteins, proteins ofmeat, milk,egg and fish. Functional properties of proteins in foods – waterand oil binding, foaming, gelation, emulsification. Effects of processing on functional properties of proteins-heat processing alkali treatments, chilling, freezing, dehydration and radiations. Unconventional sources of proteins- SCP fish. protein concentrates, leaf proteins. Lipids in foods- Role and use of lipids /fat, occurrence, fat group classification, Physicochemical aspects of fatty acids in natural foods, hydrolysis, reversion, polymorphism and its application. Chemical aspects of lipolysis, auto oxidation, antioxidants, Technology of fat and oil processing: Refining, Hydrogenations, Inter etherification, Safety use of oils and fats in food formulation. Enzymes in food industry, Carbohydrases (Amylases, cellulases, pectinases, vertases)Proteasase Lipases and oxidases in food processing.

Chemistry of food flavour: Philosophy and definitions of flavour, Flavourmatics / flavouring compounds, Sensory assessment of flavour, Technology for falavour retention. Food additives and TechnologyGeneral attributes, Buffer systems/ salts / Acids, Chelating agents and sequestrants Antioxidants, Antimicrobial agents, Non-nutritive and low calorie sweetners Stabilizer and thickeners, Fat replacers, Texturizers and improvers. Pigments in animal and plants kingdoms Heme pigments, Chlorophyll Carotenoids Phenolic and flavonoids Betalins Effect of processing on pigment behavior Technology for retention of natural colours of food stuffs. Food colorants- Regulatory aspects –Nartural and synthetic permitted food colours, Properties of certified dyes, Use of regulatory dyes, Colour losses during thermal processing. Vitamins and minerals- Dietary sources requirements Allowances, Enrichment Restorations Fortifications, Losses of vitamins and minerals, Optimization and retention of vitamins and minerals. Food toxicology: Inherent toxicants – antinutritional factors their occurrence, effects and methods of elimination or inactivation- protease inhibitions, lectins, lathyrogens, phytates and flatulence factors. Terms in toxicology, Safety evaluation using traditional and modern approach Food Contaminants, Pesticidal residues – permitted limits Toxicology and public health. Enzymes in foods – Role of endogenous enzymes in maturation and Ripening. Enzymatic browning- mechanism, methods of regulation or control.

Concepts and content of nutrition, Nutrition agencies, Nutrition of community, Nutritional policies and their implementationMetabolic function of nutrients Water and energy balance Water intake and losses Basal metabolism- BMR Body surface area and factors affecting BMR, Formulation of diets Classification of balanced diet, Preparation of balanced diet for various groupsDiets and disorders. Recommended dietary allowancesFor various age group, According physiological status , Athletic and sports man, Geriatric persons. Malnutrition: Type of Malnutrition Multi-factorial causes, Epidemiology of under nutrition and over nutrition, Nutrition infection and immunity, Nutrition education. Assessment of nutritional status, Diet surveys, Anthropometry, Clinical examination, Biochemical assessment, Additional medical information. In-born error of metabolism: Blood constituents, Nutrients, Hormones and enzymes,Miscellaneous disorders. Food fad and faddism, Potentially toxic substance in human food.

Nature and concepts of food analysis: Rules and regulations of food analysisSafety in laboratory, Sampling techniques. Principles and methodology involved in analytical techniques PH Meter and use of ion selective electrodes Spectroscopy: Ultra violet visible, florescence, Infrared spectro, Atomic absorption and emission, Mass spectroscopy, Nuclear magnetic resonance, Chromatography- Adsorption Column Partition. and electron spinresonance, Gel-filtration, Affinity, Ion-exchange, Size-exclusion method, Gas liquid, High performance liquid chromatography, Separation techniques, Dialysis, Electrophoresis, Paper, SDS gel

electrophoresis, Immuno electrophoresis, Sedimentation, ultra filtration, ultracentrifugation, Iso-electric focusing, Isotopic techniques, Manometric techniques. Principles and methodology involved in analysis of foods: Rheological analysis, Textural profile, Immuno assay techniques in food analysis: Isotopic and Non-isotopic immuno assay, Enzyme-immuno assay. Evaluation of analytical data: Accuracy and precision, Statistical significance, Co-relations regression, Computers for data analysis and result interpretation. Sensory analysis of food: Objective method, Subjective method.

Intentional and unintentional food additives their toxicology and satry evaluation, Naturally occurring food additives, Food colour (natural and artificial). Pigments their importance and utilization as food colour, Taste and flavour inducer, potentiater, Food preservatives and their chemical action, Role mode of action salt, chelating agents stabilizers and thickners, polyhydric alcohol, anticaking agent, firming and colouring agent, flour bleaching agent, antioxidants, non-nutritional sweetness and antimicrobial agents.

Environmental science: An introduction, Ecosystem: kinds, structure, characteristics, functioning, Biochemical cycles, Natural resources and their managements, Environmental pollution, Air pollution, Water pollution, Solid waste pollution, Noise pollution, Soil pollution, Radio active pollution, Food processing industry waste and its management, Management of urban waste water, Recycling of organic waste, Recycling of factory effluent, Control of environmental pollution through low, Composting of biological waste, Sewage, uses of water disposal effluent treatment, microbial Examination.

Properties of fluids, Static pressure of liquids : Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular surfaces. Compressible and non compressible fluids. Surface tension. Pressure measuring devices: Simple, differential, micro, inclined manometer, mechanical gauges. Floating bodies : Archimede's principle, stability of floating bodies. Equilibrium of floating bodies. Fluid flow : Classification, steady, uniform and non-uniform, laminar and turbulent, Bernoulli's theorem and its applications. Flow through pipes: Loss of head. Flow through orifices, discharge losses. Time for emptying a tank.Venturi meter, pitot tube, Rota meter. Water level point gauge, hook gauge. Reynold's number. Pumps:Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Types of chambers, selection and sizing.

Units and dimensions, Basic concepts : systems, processes, cycles, energy, The Zeroth Law of Thermodynamics. Ideal gases : Equation of state, Compression and expansion of gases. The first Law of Thermodynamics : Internal energy, enthalpy. Renewable energy sources like solar, wind and biogas and their utilization in food processing. Related equipment and machineries to renewable energy sources. Fuels : Chemical properties, air for combustion, Calorific value and its determination, Burners, firing of fuels. Properties of steam : Wet, dry saturated, superheated steam, Use of steam tables. Steam generators : Fire tube boilers, Water tube boilers. Boiler mountings and Boiler accessories. Measurement of Height of boiler chimney. Condensers, Layout of pipe-line and expansion joints, Boiler trial : Codes, Indian Boiler Regulation acts. Air Compressors : Reciprocating, Single and two stage air compressors.

Basic heat transfer process, thermal conductivity, Overall heat transfer co-efficient, physical properties related to heat transfer. One-dimensional steady state conduction : Theory of heat conduction,Fourier's law, Derivation of Fourier's equation in Cartesian co-ordinates, Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Heat transfer through composite walls and insulated pipelines, Steady-state heat conduction with

heat dissipation to environment :Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Introduction to unsteady state heat conduction. Convection : Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number. Radiation : emissivity, absorptivity, transmissivity, Radiation throughblack and grey surfaces, determination of shape factors. Heat Exchangers : General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers. Application of different types of heat exchangers in dairy and foodindustry. Mass transfer : Fick's law of diffusion, steady state diffusion of gases and liquids through solids, isothermal evaporation of water into air, mass transfer coefficient, applications in Dairy and Food industry.

Material handling : Material handling machines and conveyors. Pretreatment unit operations: Cleaning, Dehulling and Dehusking, Sorting & Grading. Peeling and Forming, Size reduction and separation, Agitation and Mixing, Engineering properties of Food materials: Its significance in equipment design, processing and handling of food products. Hygienic design of Food processing equipment. Sanitary requirement, Sanitary pipes and fittings. Rheology and texture of food materials: Concept of rheology, elastic,plastic and viscous behaviour, methods of texture evaluation, subjective and objective measurements. Methods of texture evaluation, subjective and objective measurements, Evaporation: Principles of evaporation, types and selection ofevaporators, mass and energy balance. Design of single and multiple effect evaporators, recompression heat and mass recovery and vacuum creating devices. Drying: Principles of drying, drying rate kinetics, Classification, massand energy balance. Different types of dryers and components - roller, spray, tray, fluidized bed etc. Thermal processing: Blanching, Pasturization and Sterilization- principles, different methods and equipments. Processing in containers,process time, T-evaluation, Design of batch and continuous sterilization.

Introduction to subject, Packaging situations in World, India, need of packaging, plastic consumption/use in World, India etc. Package requirements, package functions, Hazards acting on package during transportation, Storage and atmospheric package, labeling laws. Package Materials: classification packages, paper as package material its manufacture, types, advantages corrugated and paper board boxes etc. Glass as package material, Manufacture, Advantages, disadvantages. Metal as package material- manufacture, Advantages, disadvantages, Aluminum as package material,. Its advantages and disadvantages, plastic as package material classification of polymers, properties of each plastics, uses of each plastics, chemistry of each plastic such as polyethylene, Polypropylene, polystyrene, polycarbonate, PVC, PVDC, Cellulose acetate, Nylon etc. Lamination Coating and Aseptic packaging, Lamination, need of lamination, types, properties, advantages & disadvantages of each type Coating on paper & films, types of coatings. Need of coating, methods of coatings. Aseptic packaging-Need, Advantaged, process, comparison of conventional & aseptic packaging, system of aseptic packaging and materials used in aseptic packaging. Machineries used in Packing foods. Packaging of Specific Foods-Packaging of specific foods with its properties, Like bread, Biscuits, Coffee, Milk powder, egg powder, carbonated beverages. Snack foods etc. Mechanical and functional tests on Package- Various mechanical and functional testes perform in laboratories on package boxes and package materials.

Mechanical separations : Centrifugation:liquid-liquid centrifugation, liquid- solid centrifugation, clarifiers, de sludging and decanting machines. Filtration : Principles involved

in filtration. Pressure and vacuum Filtration. Expression : batch and continuous type. Baking, Roasting and Frying equipment. Extraction and Leaching, Crystallization and Distillation : Basic principles involved. Membrane processes : Ultra filtration, Reverse osmosis. Electro dialysis, Pre-evaporation and micro filtration. Microwave and Dielectric & Infrared heating : Physical parameters. Heat transfer phenomenon. Equipment and application. Irradiation - Principle and its equipments. Blending and pulverization equipments.

Definition of refrigeration and air conditioning, necessity of refrigeration and air conditioning. History of refrigeration. Refrigerants, definition, classification, nomenclature, methane and ethane series. Desirable properties of refrigerants- physical, chemical,safety, thermodynamic and economical. Azeotropes. Components of vapour compression refrigeration system, evaporator,compressor, condenser and expansion valve. Ice manufacture, principles of ice production, different systems Treatment of water for making ice, Brines, Freezing tanks, ice cans, air agitation, quality of ice. Applications of refrigeration in different food products – fruit and vegetable products, meat products, fish, poultry products, dairy products etc. Food Freezing: Freezing systems: indirect contact systems, plate freezers, air blast freezers, and freezersfor liquid foods. Direct contact systems, air blast immersion, frozen food properties, density, thermal conductivity enthalpy, apparent specific heat and thermal diffusivity, freezing time, factors influencingfreezing time, freezing rate, thawing time. Frozen food storage: Quality changes in foods during frozen storage.

Biochemical Engineering and their scope: Definition, necessity, value engineering, good manufacturing practices. Standard operating procedures, good laboratory practices. History of Biochemical Engineering: Theory of scientists Pfizer, Alexander Fleming Salman Waksmen. Instrumentation and their control, physical and chemical parameters. Role of biochemical engineering in development of modern fermentor: Scale up, management of cellular process, design, operation and their problems. Basis for biochemical engineering in fermentation industry: Unit operation, unit process, process design, chemical reaction kinetics, process variables, biochemical properties, process control Kinetics of microbial growth and death: Definition, fermentation kinetics rate of cell synthesis, product formation and effect of environment. Types of kinetics, Batch and continuous type, control Measures. Simple enzyme kinetics: Simple kinetics model for enzyme substrate interaction. Derive the equation of Michelin Menton, for reaction rate,product formation, calculation of Km and V max values. Complex enzyme kinetics: Oxidation – reduction form of enzymes,observed apparent rate constant, factors affecting the inhibition, competitive, non competitive inhibition, substrate interaction. Kinetics pattern of various fermentations: Classification of kinetics pattern, as per different scientists, simple, simultaneous, consecutive,stepwise, complex reactions and their examples. Media and air sterilization: Definition, thermal death time, media heatsterilization, advantages of continuous sterilization. Aeration and agitation, Product recovery of different process: Mass transfer resistance, extraction, leaching, drying and evaporation, sorption and storage,permeability law. Product formation for value added products using bioconversions techniques Production of single cell protein, alcohol, raw material forrequired for product formation, production of antibiotics, economic process, utilization of damaged grain through bioconversion, present mode of utilization and their nutritional value.

Introduction, definition, recorders and monitors, panel boards. General characteristics of instruments, static and dynamiccharacteristics. Temperature and temp. scales, various types of thermometers - mercury-in-glass, bimetallic, pressure-spring thermometers, thermocouples, resistance thermometers and pyrometers. Pressure and pressure scales, manometers, pressure elementsdifferential pressure. Liquid level measurement, different methods of liquid level

measurement. Flow measurement, kinds of flow, rate of flow, total flowdifferential pressure meters, variable area meters. Transmission, pneumatic and electrical, Control elements, control actions, pneumatic and electrical controlsystems.

Overall design of an enterprise : Plant design, sales planning for plant design. Strength of material – engineering materials, material science, use of various metals, including plastic, glass, etc in food industry, selection and specification – material design, concepts and manufacturing of various equipments and machineries for food processing plant. Plant Location, levels of Plant location. Location of layout : locationfactors, plant site selection. Location theory and models, industrial buildings and grounds. Classification of Dairy and Food Plants, farm level collection and chillingcentre, space requirement. Preparation of a Plant Layout : Plant Layout problem, importance,objectives, classical types of layouts. Evaluation of Plant Layout. Advantages of good layout. Organizing forPlant Layout, Data forms. Common Problems in Plant Layout and Process scheduling. Siting of Process sections, Equipment selection and capacity determination. Arrangement of process, and service equipment. Estimation of Services and Utilities. Office layout, line balancing, Flexibility. Practical Layouts. Maintenance of Food Plant Building, Illumination and ventillation, Cleaning and sanilization, painting and colour coding, Fly and insect control.

Evolution and scope of Microbiology. General morphological, cultural characteristics and reproduction of bacteria, yeasts, molds, actinomycetes, algae, protozoa, and rickettsia. Nutrient transport phenomenon and physiology of microorganisms. Genetic recombination, transduction, transformation and bacterial conjugation, mutation and mutagenesis. Growth curve: Physical and chemical factors influencing growth and destruction of microorganisms (including thermal death time, Z, Fand D values). Viruses: Structure and replication with particular reference to food borne viruses. Control of Microorganisms by physical and chemical agents, antibiotics and other chemotherapeutic agents. Preservation of microbial cultures.

Microbial spoilage of foods. Chemical changes caused by microorganisms. Principles of food preservation. Control of microorganisms by use of low and high temperature. Asepsis, water activity, drying, preservatives, radiation and pressure for control of microorganisms. Sources of contamination, spoilage and prevention and microbiology of milk and milk products, fruits and vegetables, cereal and cereal products, meat and meat products, fish and other sea foods, poultry and eggs, sugar and sugar products salts, spices and canned foods.

Microbes as friends, primary and secondary metabolites, screeningand isolation of microorganisms, the organizations involved microbiological work. Industrially important secondary metabolites, organic acids, antibiotics, probiotics, compounds of therapeutic and medicinalvalue. Bacteriocins, nisin, biocolours, carotenoids, B-carotene, lycopane, ang kak, production of microbial enzymes, down stream processingof enzymes and application of microbial enzymes in food and alliedindustries. Production and purification of microbial polysaccharides, and theirapplications production of important amino acids, vitamins and Bioinsecticides. Plant cell cultures and metabolites, production of SCP, fermented dairy products, bakers yeast. Fermented foods and alcoholic beverages, microbial standards. Industrial fermentors and accessories. (instrumentation). Economic feasibility studies of few products, advances in strain improvements for high yields of metabolites, blue green algae. Mushrooms – production, reservation and quality.

Hazards in food chain physical, chemical, biological. Toxins in food, naturally occurring, bacterial and fungal. Intrinsic toxins produced during processing and storage. Metals as toxins–sources, contamination, toxicity and Elimination. Pesticide residues as toxin: Chlorinated, Non – chlorinated. Permitted and non permitted food additives as and when amended. Microbial standards of fresh and processed foods. Risk assessment and management during food preparation.

Prospectus of Bio-Technology, Molecular genetics *i.e.* fundamentals of molecular biology withspecial reference to chemistry and biology and DNA. (Primary, secondary and tertiary) structures. Biological role of DNA in cell metabolism. Genetic recombination mechanisms and technique used for improvement in microbial strains. Applications of genetic control mechanism in industrial fermentation process, (Induction, manipulation and recombination). Recombinant-DNA technology (plasmids and cloning). Cell and tissue culture, Continuous cultures, Secondary metabolites synthesis, Expression of foreign genes. promoter (Enzyme), biomass production by using various micro organisms. Application of Biotechnology in food (Food industries), pharmaceuticals and agriculture. Bio-gas plant, Bio technology approach for the exploitation of food and industrially important microorganisms.

Principles of Food Hygiene, hygiene in urban and rural areas with respect to food preparations. Food handling habits and personal hygiene. Sources of water and impurities in water, hardness of water. Water supply systems and water purification, chlorination. Types of Soil (Food residues on equipment surfaces) and its properties. Cleaning procedures, types of cleaning agents and their properties. Acid and alkaline cleaners. Types of sanitizing agents and their properties. Chlorine, iodine and their compounds as a sanitizers, Quaternaly ammonium compounds, phonolic compounds as sanitizers.Advantages and disadvantages of these sanitizers. Physical sanitizing agents example Hot water, Steam and UV light. Sanitation facilities and procedures in food plant operations. CIP system. Cleaning premises and surroundings. Common Pests in food services rodents, insects, birds, house flies, cockroaches, ants and their control. Sanitation regulations, phytosanitary requirements. Hygiene and sanitation of preparation, storage and retail shops. Plant and equipments design, requirements for ease in maintenance of hygiene and sanitation. Study of food sanitation check lists.

Co-operation–Philosophy and principles. History ofIndian Co-operative movement. Co-operative credit structures in regional level and theirstudy and single window systems. Marketing – importance in economic development. Classification of Markets, Marketing functions and Market functionaries. Marketable and Marketed surplus, Marketing costs, margins and price spread, problems in marketing of agricultural commodities – perishables, grains, oilseeds and processed foods. Remedial measures for problems in agricultural marketing. Agricultural marketing institutions, Regulated markets and Co-operative marketing societies. MARKFED, NAFED, Ware Housing Corporation and Food Corporation of India. Nature of agricultural product prices, Agricultural price policy and need for price stabilization. Methods of fixation of MSP for agricultural commodities. Commission on agricultural costs and prices. Finance – nature and scope, Credit – meaning, definition and classification. Credit analysis and repayment plans and History of financing agriculture in India. Commercial banks – Nationalization of Commercial banks, Lead Bank scheme and Regional Rural Banks. Scale of finance, Higher financing agencies – RBI, NABARD, AFC, ADB, World Bank. Insurance and credit guarantee corporation of India and Crop Insurance. Contract farming – strategy and scope.

Business Management: introduction, theories and functions Food industry management: Purchase management and production management, Financial management and marketing management –retail management, Human resource development and personnel managementSectors in food industry and scale of operations in India. International trade: Basics, Classical theory, Theory of absolute advantage, Theory of comparative advantage, Modern theory, Freetrade – protection, methods of protection quotas, bounties, exchange control, devaluation, Commercial treaties, terms of tradebalance of payments, exim policy, foreign exchange, mechanics offoreign exchange, GATT and WTO. World Trade Agreements Related With Food Business, Export Trends And Prospects Of Food Products In India. World Consumption of Food: Patterns and Types of Food Consumption across the Globe Developed Nations, Developing Nations Under Developed Nations, Ethnic Food Habits of Different Regions. Govt. institutions related to international food trade: APEDA, Tea Board, Spice Board, MFPI, etc. Management of export import organization. Registration, documentation, export import logistics.

Enterpreneur – Meaning, Definetion, Characterstics & Rloe demands of Enterpreneur, Identifying Potential Enterpreneurs. Enterpreneurship Development- Concept of Enterpreneur ship , process of Enterpreneurship Development, Motivation & Enterpreneurship Development, Importance of Planning, Monotering & follow-up, Managing competition, Enterpreneurship Development Programmes. Characterstics of Indian Food Processing Industries and Export. SWOT analysis, Generation, Incubation and commercialization of ideas and innovations. Enterpreneurial behaviour-Concept, dimensions, factors affecting Enterpreneurial behavior. Govt. schemes & Incentives for promotion of Enterpreneurship. Govt. policy on small & medium enterprises. Market survey, Formulation of project & financial analysis of project. Communication- Meaning & process of communication. Advertisements- Meaning, types, Forms, functions. Writing skill- Business letter, letter of enquiry, Quotation, Order & tenders, Complaints letters.

Introduction to subject, Need of enforcing the laws and various types of laws. Mandatory food laws Food safety and standards act 2006- Food safety and standard authority of India, food advisory committee, scientific panels and scientific committees, state food safety authority, standards for food articles, food recall procedures, tribunal, offences and penalties, general principles to be followed in administration of act, general provisions as to articles of food, special responsibility as to safety of food. Prevention of Food Adulteration Act (1954) Definition, object of act, central committee for food standards; public analysis, food inspector, duties of Food inspectors, Report of Public analyst, sealing, fastening and dispatch of samples and powers of court. Other Mandatory acts: The Standards of Weights and Measure Act (1976), The Packaged Commodity Rules (1977), Essential Commodities Act(1955), Consumer Protection Act (1986), The Environment Protection Act (1986) and the Environment Protection Rules (1989), Insecticide Act (1968), The Export (Quality Control andInspection) Act (1963), The Atomic Energy Act (1962), Control of Irradiation of Food Rules (1991). Food Product Orders: The Fruit Products Order (1955), The Milk and Milk Products Order (1992), The Meat Food Products Order (1973), The Vegetable Oil Products (Control) Order (1947), The Edible Oils Packaging (Regulation) Order (1998), The Solvent Extracted Oil,De oiled Meal, and Edible Flour (Control) Order (1967), The Infant Milk Substitutes, Feeding Bottles and Infant Foods (Regulation of Production, Supply and Distribution) Act (1992). Optional food standards: -Scope of these standards, their need, procedure to obtain that standard, The Bureau of Indian Standards Act (1986), The Agricultural Produce (Grading and Marketing) Act (1937) – AGMARK. Codex Standards -Scope of codex standards, codex standards for cereals, pulses, fruit & vegetables, Meat & Poultry products, Recommended international code of hygiene for various products.

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7. FORESTRY

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India. Site factors - climatic, edaphic, physiographic, biotic and their interactions. Classification of climatic factors. Role played by light, temperature, rainfall, snow, wind, humidity and evapo-transpiration in relation to forest vegetation. Bioclimate and micro climate effects. Edaphic factors - influence of biological agencies, parent rock, topography on thesoil formation. Soil profile - physical and chemical properties, mineral nutrient and their role, soil moisture and its influence on forest production. Physiographic factors - influence of altitude, latitude, aspect and slope on vegetation. Biotic factors - influence of plants, insects, wild animals, man and domestic animals on vegetation. Impacts of controlled burning and grazing. Influence of forests on environment. Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration. Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

Introduction, definition, objectives and scope of forest mensuration. Scales of measurement (nominal, ordinal, interval and ratio scale). Units of measurement, standards of accuracy implied in their expression. Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes. Comparison between tape and calliper measurements. Measurements of upper stem diameter and instruments such as Ruler, Finish Parabolic Calliper, Relaskop, Pentaprism. Bark measurements - objectives, thickness, surface area and volume. Crown measurements - objectives, diameter, height, surface area and volume. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Measurement of cross sectional area, basal area, bole surface area, leaf area. The tree stem form, taper and classification of form factors and form quotient. Volume estimation of felled and standing trees and formulae involved. Volume tables-definition and their classification, (general, regional and local volume tables), merchantable volume tables. Preparation of volume tables. Stand growth, site quality, site index, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees. Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables. Forest inventory- definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry.

Propagation concept, definition, methods and importance. Site selection, planning and layout of nursery area. Types of nursery, types of nursery beds, preparation of beds. Pre-sowing treatments. Methods of seed sowing. pricking. watering methods, weeding, hoeing, fertilization, shading, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Type and size of containers. Merits and demerits of containerized nursery. Preparation of ingredient mixture. Vegetative propagation techniques - macro and

micropropagation. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species.

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems and economic importance of the following conifer and broadleaved tree species of India. Geographical distribution of important Indian trees, native trees, exotic trees, endemism. Conifers: *Abies pindrow, Picea smithiana, Cedrus deodara, Pinus roxburghii, Pinus wallichiana, P. gerardiana and Juniperus macropoda.* Broad leaved species: *Tectona grandis, Shorea robusta, Acacia* spp*., Dalbergia sissoo, D latifolia, Quercus* spp*. Robinia pseudoacacia, Alnus* spp*. Anogeissus spp. Populus* spp*, Eucalyptus* spp, *Casuarina equisetifolia, Terminalia* spp*., Santalum album, Swietenia mahagony, Albizzia spp, Prosopis* spp*. Pterocarpus santalinus, Azardirachta indica, Diospyros melanoxylon, Madhuca indica, Pongamia pinnata, Leucaena leucocephala and Bamboos.*

Geographical distribution of forests and their classification. Critical examination of the worldforest sources, productivity potential and increment of world forests. Forest resources and forestry practices in different regions of the world – North and South America, Europe, Africa, China, Japan, Russia, South-East Asia and Australia. Forest development and economy – forest based industries of the world. Recent trends in forestry development in the world. International forestry organizations.

Silvicultural system - definition, scope and classification. Even aged and uneven aged forests and their crown classes. Detailed study of the silvicultural systems: Clear felling systems including clear strip, alternate and progressive strip systems. Shelterwood system – Uniform system, Group system, Shelterwood strip system, Wedge system, Strip and group system, Irregular shelterwood system, Indian irregular shelterwood system. Seed tree method. Selection system and its modifications. Accessory systems. Coppice system – Simple coppice system, Coppice of the two rotation system, Shelterwood coppice system, Coppice with standard system, Coppice-with- reserve, Coppice selection system, Pollard system. Conversion and its implications. Choice of silvicultural system. Dauerwald concept. Culm selection system in Bamboo. Tending operations - weeding, cleaning, thinning, definitions, objectives and methods, increment felling and improvement felling. Prunning and lopping. Control of climbers and undesirable plants.

Definition, scope and impediments. Plantation forests - planting plan, plantation records, maps. Plantation establishment -legal title of land, survey, site selection. Site preparation - purpose and methods. Planting - layout, time of planting, planting pattern, spacing, gap filling, plantingmethods, direct seedling. Choice of species on ecological aspects - afforestation of dry land, wetland, other adverse sites and taungya. Enrichment planting, nurse and cover crops. Intercultural operations. Plantation maintenance - weed control, climber cutting, staking, singling and pruning. Thinning - definition, objectives. Effects of thinning - physiological and mensurational. Effect of methods of thinning on stand development. Energy and industrial plantation - definition, scope, species, establishment, management and impact on environment. Plantation economics.

Environment: introduction, definition and importance. Components of environment - interactions with organisms. Global and Indian environment - past and present status. Environmental pollution and pollutants. Air, water, food, soil, noise pollution - sources, causes and types. Smog, acid rain, global warming, ozone hole, eutrophication, sewage and hazardpis

waste management. Impact of different pollutions on humans, organisms and environment. Introduction to biological magnification of toxins. Deforestation - forms and causes, relation to environment. Prevention and control of pollution - technological and sociological measures and solutions - Indian and global efforts. India, international and voluntary agencies for environmental conservation - mandates and activities. International conferences, conventions and summits-major achievements. Environmental policy and legislation in India. Introduction to environmental impact assessment. Causes of environmental degradation - socio-economic factors. Human population growth and lifestyle.

Indian agriculture - its structure and constrants. Land use definition, classification and planning. Agroforestry - definition, aims, objectives and need. Traditional agroforestry systems: Taungya system, Shifting cultivation, wind break, shelterbelts, Homestead gardens. Alley cropping, high density short rotation plantation systems, silvicultural woodlots/energy plantations. Classification of agroforestry system -structural, functional, socio-economic and ecological basis. Multipurpose tree species and their characteristics. Tree architecture, canopy management - lopping, prunning, pollarding and hedging. Diagnosis and design. Agroforestry systems in different agroclimatic zones, components, production and management techniques. Nutrient cycling, soil conservation, watershed management and climate change mitigation. Economics of agroforestry systems. People participation, rural entrepreneurship through agroforestry and industrial linkages. Analysisof fodder and fuel characteristics of tree/shrubs. Financial and socio-economic analysis of agroforestry systems. Tree crop Interaction Allelopathy with respect to forest trees.

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson' s Systems. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morpholog and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc. Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts. Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system. Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Caesalpiniaceae, Santalaceae, Mimosaceae, Elaeagnaceae, Papilionaceae, Meliaceae, Salicaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Compositae, Moraceae, Poaceae, Tiliaceae, Liliaceae, Euphorbiaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae, Myrtaceae, Rubiaceae and Combretaceae.

Historical development of ecology as a science. Concept of levels of biological organization. Ecosystem – classification and distribution. Forest environment- Major abiotic and biotic components and their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology - Species interaction, Ecological succession, terminology, basic concepts, climax vegetation types, Methods to study effects of forest management on succession. Biogeography. Autecology of important tree species at Akola/ Dapoli. Biodiversity and

conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices. Principles of conservation biology, Ex situ and In situ methods of conservation, Genetically and evolutionary principles in conservation. Biosphere concept. Conservation – efforts in India and worldwide.

Tree structure, growth, development, differentiation and reproduction. Plant growth functions and growth kinetics, Physiological functions and processes in trees. Environmental effects on growth and development. Productivity of tropical deciduous and evergreen forests. Light use efficiency in forest species, canopy structure, plant phyllotaxis and its importance in translocation. Plant light relationship environment. Branching in isolated plants. Monoculture and mixed tree communities. LAI, Photosynthetic efficiency and respiratory losses, source sink relationship, Factors affecting photosynthesis. Radiation interception, absorption of water, ascent of sap and water balance. Transport processes with special reference to long distance transport in trees and its impact on plant water relations and photosynthesis. Development of seeds and seedlings. Biocides and growth regulators in forest ecosystems. Senescence and abscission. Role of trees in pollution control.

Introduction, history and development of tree improvement, its relation to other disciplines for forest management. Reproduction in forest trees – anthesis and pollination – their importance in tree breeding. Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees. Genetic basis of tree breeding and selection practices in forest trees. Patterns of environmental variation- species and provenance trials in forest trees. Seed stands (seed production areas) Plus tree selection, progeny trials and establishment of seed orchard. Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties. Conservation of forest tree germplasm. Recent techniques in tree improvement. Vegetative propagation and tree improvement.

Introduction – Seed and its importance – afforestation activity and seed requirements in India. Role of seed technology in nursery stock production. Production of quality seed, identification of seed collection areas-seed orchards – maintenance of genetic purity-isolation and rouging, seed source provenance and stands. Selection of seed tree, genotypic and phenotypic selection, plus tree – pure stands, elite seed tree, isolated tree and their location. Locality factors. Seed Collection – Planning and Organization, Collection methods, Factors affecting seed collection, Seed maturity and tests. Seed processing – Seed extraction, drying, blending, cleaning, grading, treating, bagging, labeling and storage. Storage – orthodox and recalcitrant seeds, precautions of handling of recalcitrant seeds, natural longevity of tree seeds, factors affecting longevity – storage conditions, methods and containers. Seed testing, sampling, mixing and dividing, determination of genuineness, germination, moisture, purity, vigour, viability, seed dormancy and breaking of seed dormancy. Different viability and vigour tests, seed pelleting, seed health. Classes of tree seeds, certification procedures of tree seeds.

Definition of wildlife, free living, captive, domesticated and feral animals Justification of wildlife conservation, uses, values and negative impact of wildlife. Zoogeographic regions and biomes of the world. India's uniqueness in biodiversity, reasons and causes of wildlife depletion. Biogeographic classification of India. Status and distribution of wildlife in India. Scientific and common names of important mammals, birds and reptiles. Rare, endangered and threatened species of mammals, birds and reptiles of India. Agencies involved in wildlife

conservation,Govt. and NGO' s. BNHS, WWF, Indian Board for wildlife, CITES. Biological basis of wildlife management. Basic requirements of wildlife– food, water, cover and space, limiting factors. Wildlife ecology: Relevance of basic ecological concepts such as food-chain, food-web, ecological pyramids, habitat, ecological niche, carrying capacity, density, prey-predator relations and population dynamics.

History and importance of forest pathology in India and the world. Relation of plant pathologywith forest pathology and other sciences, classification of tree diseases. Role of microbes and fungi in a natural forest ecosystem. Broad classification of different pathogens causing tree diseases. General characteristics of fungi, bacteria, viruses, phytoplasma and phanerogames. Important characters of ascomycetes and basidiomycetes. Important orders and families of Hymenomycetes with a special reference to Aphyllophoraeae and Agaricaceae that contain members causing tree diseases. Growth and reproduction of plant pathogens, infection and factors influencing disease development. Dissemination and survival of plant pathogens. Distribution, economic importance, symptoms, etiology and management of the following. Diseases of important tree species like teak, *Dalbergia* sp., *Acacia* spp., Neem, Cassia, Sal, *Albizia, Terminalia*, Mango, Jackfruit, Pines, Deodar, Eucalyptus, Bamboo, Casuarina, Rubber, Sandal wood, medicinal and aromatic plants grown in different agroforestry systems. Biodegradation of wood in use. Types of wood decay, gross characters of decay, sapstain, different types of rots in hardwoods, softwoods and their prevention. Graveyard test and decay resistant woods. Principlesof forest disease management. Definition and scope of disease management in forestry. Importance of disease cycle and economic threshold in disease management. Principles of disease management such as exclusion, cultural, chemical, biological and immunization. Nature of disease resistance. Fungicides and their use in nurseries and plantations. Integration of cultural, chemical, biological and host resistance in disease management, Meristem and tissue culture techniques in disease management. Nursery diseases of important forest species.

History of wildlife management and conservation in India; cultural background. Habitat management: Purposes, principles, practices and tools-fire, cutting, grazing. Habitat interspersion and edge effect. Provision of water, saltlicks and food. Zoning – core, buffer, tourism and multiple use in protected areas. Wildlife damage control : Mitigating human – wildlife conflict: fences, trenches, walls, lure crops, repellents, translocation and compensation. Captive wildlife : Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife census : Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities. Wildlife (Protection) Act, 1972. Protected areas – Sanctuary, National Park and Biosphere Reserves. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, Red Data Book, Category of threat, CITES. Conservation : Meaning, principles and strategies, in-situ and exsitu conservation, conserving biodiversity. Politics- socioeconomics, role of education and extension.

Definition, importance and scope of Entomology. Definition of insect and its position in theAnimal Kingdom. Important characters of phylum arthropoda and class insecta. Externalmorphology of generalized insect. Insect growth and development, Reproduction in insects, immature stages (Egg. Larvae/Nymph and Pupae); metamorphosis in Insects Taxonomic classification of class Insecta, diagnostic characters of the orders and major families of economic importance. History and importance of Forest Entomology in India. Methods and principles ofpest control: Mechanical, physical, silvicultural, legal, biological

and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests : types ofdamages and symptoms; factors for outbreak of pests. Nature of damage and management: Insectpests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest(Tectona, Dalbergia sp., Sal, Gmelina, Pines); Plantation forest species (Eucalyptus, Bamboo,Casuarina,). Insect pests of freshly felled trees, finished timbers and their management.Morphology of plant parasitic nematodes, brief classification of important genera of nematodes. Important diseases caused by different genera and their management practices.

Definition and scope of ethnobotany. Man and biological resource of earth with respect to plants. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic - people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, etc. Symbolic relationships including mythology mainly from the following families. Guttiferae (Clusiaceae), Rosaceae, Malvaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae, Thymeliaceae.

Introduction to Wood Anatomy. The plant body – Cell and organelles, meristems, promeristem, primary meristem, secondary meristem, apical and intercalary meristems. Simple tissues- parenchyma, collenchyma, sclerenchyma. Complex and vascular tissues. Anatomy of stems and roots of dicots and monocots. The secondary growth in woody plants. Mechanism of wood formation. Formation of early and late wood, growth rings, transformation of sapwood to heartwood. The macroscopic features of wood, bark- sapwood, heartwood, pith, growth rings, wood rays, resin or gum-canals. Cell inclusions. Physical properties of wood; colour, hardness, weight, texture, grain, lusture, etc. Abnormalities in wood -- deviation from typical growth form (leaning, bending, crook, fork, buttress), grain deviation, false and discontinuous growth rings. Reaction wood-compression and tension wood. Disruption of continuity of inner wood, shakes, included bark, resin pockets, pith flecks, knots (live and dead).

Definition and scope of logging, logging plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction. Implements used in logging operation- traditional and improved tools. Felling rules and methods. Conversion, measurement and description of converted material. Means of transport of timber- carts, dragging, skidding, overhead transport, ropeways, skylines. Transport by road and railways. Transport by water- floating, rafting and concept of booms. Grading and Storage of timber in the depots for display and disposal, temporary and final storage. Timber Depots- types, lay out and management. Systems of disposal of timber. Size of material in logging operation. Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids. Plants, animals and insect infestations; diseases and their prevention.

Wood as raw material, kinds of woods– hardwood, softwood; bamboos and canes. Merits and demerits of wood as raw material. The physical features of wood. Mechanical properties of wood like tension, compression, bending, shearing cleavage, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Electrical and acoustic properties of wood. Wood water

relationship – shrinkage, swelling, movement, fibre saturation, equilibrium moisture contact. Wood seasoning – merits, principles and types – air seasoning, kiln seasoning and chemicals seasoning. Refractory classes of timbers, kiln schedules. Seasoning defects and their control. Wood preservation – principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.), Classification of timbers based on durability. General idea about fire retardants and their usage. Non-pressure methods – steeping, dipping, soaking open tank process, Boucherie process. Pressure methods – full cell process, empty cell process (Lowry and Rueping). Wood machining. Sawing – techniques, kinds of saws – cross cut, edging, cudless, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Various stages in wood working. Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.

Pulp and paper industry. Introduction and raw material; pulping-mechanical, chemical, semi chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products. Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board. Adhesives used in manufacture of composite wood. Improved wood-definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Specialized wood products.

History, scope, opportunities and constraints in the cultivation and utilization of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and aftercare, training and pruning, nutritional and water requirements. Plant protection, harvesting, processing and economics of under mentioned important medicinal and aromatic plants. Medicinal Plants : Amla, Bel, Chandan, Ashwagandha, Tinospora, Abrus, Gymnema, Guggal, pepper, cardamom, clove, ginger, turmeric, betelvine, periwinkle, *Rauvolfia*, *Dioscorea*, isabgol, pyrethrum and other species relevant to local conditions. Aromatic Plants : Citronella grass, khus grass, geranium, patchouli, bursera, *Mentha*, *Ocimum* and other species relevant to the local conditions. Endangered medicinal and aromatic plants of India and their conservation. Study of chemical composition of a few important medicinal and aromatic plants, their extraction and use. Therapeutic and pharmaceutical uses of important species.

Introduction, methods of collection, management and importance of Non-Timber Forest Products(NTFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non-essential oils – nature, occurrence, methods ofextraction, classification and uses. Important fixed oil yielding trees. Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gumyielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch –sources, extraction and uses. Drugs, wild fruits, spices, poisons and bio-pesticides.

Nature and scope of economics and its relationship with other sciences. Theory of consumption. Marshallion theory of utility, equimarginal utility and Hicks-Allen approach for determining consumer equilibrium. Concept and types of demand, laws of demand and factors affecting demandof commodities. Elasticity – its kinds, measurement and factors

affecting it. Factors of production, their definition and characteristics, Law of diminishing marginal returns. Supply – definition, law and elasticity. Market – its classification and price determination under different market situation. Introduction to distribution theories with particular reference to Ricardian Theory of Rent. Marginal productivity theory of wages, Liquidity preference theory of interest, Marginal Productivity theory, risk taking and uncertainty bearing theories of profit. National Income and its concepts. Concept and types of inflation.

Introduction; Forest soils Vs. cultivated soils. Properties of soils under different forest ecosystems. Soil colloids and exchange phenomenon. Essential nutrient elements-occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N,P and K, Macro andmicronutrient fertilizers and their uses. Brief history of Microbiology. Forest soil environment- distribution of various microorganisms in soil ecosystem and their interaction effects. Mineral Transformation-carbon cycle with reference to organic matter decomposition and humusformation, Microbial degradation of cellulose & lignin. Bio-fertilizers – their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N2 fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur and micro nutrients. Mycorrhizae: types,biology and importance with specific relevance to tree crops and mobilization of phosphorus andmicro-nutrients. Rhizosphere and phyllosphere concept.

Engineering survey, scope and types of surveying, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chain of sloppy grounds, chaining across obstacles; cross staff surveying, compass surveying, chain and compass traversing, magnetic and true bearings, prismatic compass, local attraction. Computation of interior angles and balancing of closed traverse. Plane table surveying; plane table and its accessories, methods of plane table surveying. Leveling: terms used, types of levels, dumpy level and its adjustments, booking of staff readings, calculation of reduced levels. Theodolite and its uses. Contour surveying. Building materials – types, strength and characteristics, site selection for building construction. Forest roads – alignment, construction and drainage; retaining walls, breast walls, waterways and culverts; bridges – types, selection of site, simple wooden beam bridges, check dams, spurs, farm ponds, earth dams.

Methods of soil survey, types of soil survey. Land use classes and planning. Soil sampling methods, Soil mapping unit, soil survey interpretation, soil survey report. Scope and objective; soil survey, sampling methods; planning, inventory, permanent sample plots; sample size allocation, land use classes and planning. Aerial photography and remote sensing-definition, meaning, scope, merits and brief history. Electromagnetic spectrum; radiations, differential reflections by surfaces, active and passive remote sensing, earth observation satellites. Equipment and materials-aerial bases, cameras, filters, stereoscopes, computers, radars. Photogrammetry: Vertical and oblique photography. Photographs and images, scales, resolution, photo interpretation, photogrammetry, image analysis, mapping. Agencies involved in remote sensing and acquiring information from them. Remote sensing; principles, uses in forestry, status monitoring, fire, vegetation/cover classification and mapping, species identification, height and volume – estimation. Identification of tree species and their form stand delineation. Interpretation of land forms and soils; use of micro-level survey of farm forests, large scale photos in forest inventory, site selection. Imagery and image analysis –

video satellite, computer and radars. Geographic Information systems- Computer softwares used.

Anthropology – definitions, nature and scope of Anthropology. Branches of Anthropology &methods of anthropological study, Concepts of Culture, Society, Community, Groups andInstitutions. Race – concept criteria of racial classification, major races of India and the world. Social Institutions: Family – forms and functions, Marriage – forms and functions, Kinship –decent, residence, Systems terminology and usages, Tribal Economy, Tribal religion. Meaning, definitions and characteristics of Tribes. History of Indian Tribes. Tribal Demography. Tribal -Social and Political organization. Tribal Law and Justice. Tribal taboo and Totem. Socio-cultural and socio-economic problems of tribes with special reference to indebtedness, land alienation,shifting cultivation, migration, depopulation, un-employment, impact of urbanization andindustrialization, education and forest problems. Social and cultural change – its meaning andcharacteristics and difference between social & cultural change and recent changes among the tribals. Forest and Tribes – their relationship–forest ecosystem and cottage industries. Role ofTribals in Forest protection, development & conservation. Tribal welfare and social forestry, Tribals and Co-operative movements. History of tribal welfare and administration - theConstitutional safeguards for the scheduled tribes. Policies, plans and programmes of tribal development and their implementations. The role of anthropology in tribal development.

Introduction and definition. Relationship with other disciplines. History and development Types and distribution around world. Grasses: characters and classification. Characteristics of rangelands: components of vegetation, nutrient value of forages and environmental factors. Importance of rangelands. Indian rangelands: origin, distribution, characteristics, status and management. Ecology in relation to grazing – Ecological concepts relevant in rangeland management, animal – plant interactions, effect on vegetation and plant succession. Plant morphology and physiology in relation to grazing factors – factors influencing food synthesis and reproduction. Range inventory – mapping, methods of sampling and evaluation, purposes and principles, Carrying capacity. Range utilization. Intensity and frequency of use. Range management – topography, animal species, forage preference, density. Grazing – grazing intensity, season of grazing, types – their merits and demerits. Animal unit (A.U.). Fire – controlled burning, effect of fire on vegetation and fauna. Weed control – types, their characteristics, chemical and biological control. Range improvement– range seeding, introduction of grasses and legumes, fertilization, soil and water conservation strategies. Multiple use.

Nature and scope of forest economics, importance of forestry in economic development Concepts of demand, derived demand and supply with special reference forestry outputs. Basics of marginal analysis and its applications in economic analysis of forestry production systems. Basics of Linear Programming. Financial and economic rotations. Fundamentals of project planning and evaluation and network scheduling techniques. Valuation of timber and non-timber forest products.

Introduction: definition and scope. Peculiarities of forest management. Principles of forestmanagement and their applications. Objects of management, purpose and policy. Sustained andprogressive yield concept and meaning. General definitions – management and administrative units, felling cycle, cutting section. Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Normal forest: definition and concept. Even aged anduneven aged models. Estimation of growing stock,

density, quantity and increment. Yieldregulation – general principles of even aged and uneven aged forest crop. Yield regulation basedon area, volume, area and volume, increment and number of trees. Working Plan – definition, objects and necessity. Forest Policy: definition, necessity and scope. Legal and institutional approaches to forest resource management. National Forest Policies. Forest Law: legal definition. Objects of special forest law. Indian Forest Act. Detailed study of IFA, 1927. Maharashtra StateForest Acts and Rules.

Nature and Function of money. Finance – Definition, Aims, and objectives need and importance. Role of capital in forestry. Classification and sources of credit. Principles of financial management, Economic feasibility test for credit, three R's and three C's credits. Role of different agencies in supplying credit. Co-operative credits structure in India. Regional rural banks and NABARD – Objectives, working and functions. Concepts of supervisory credits andits organization, problems of overdues and recoveries. Forest credit policy. Credit squeeze and its effect. Balance sheet and its role in financial management. Business management – meaning scope and principles of management. Tools and steps involved in business management.

Nature and scope of marketing. Approaches to marketing and the study of marketing functions with special reference to forestry. Classification of market, market structure and conduct of important timber and non-timber markets. Marketing channels, costs, margins and price spread – concepts and applications. Concepts of market integration and marketing efficiency. Role of public and private agencies in marketing of forest produce. Market inefficiencies in the trade of forest produce and measures to check the same. Fundamentals of international trade. Domestic and international trade in timber and non-timber forestry outputs. Demand forecasts – conceptand methods. WTO – background, structure, functions and decision making process. IPRs and their implications for forestry and allied sectors in the country.

Composition of earth' s crust, soil as a natural body-major components by volume-pedology, rocks- types- Igneous-sedimentary and metamorphic-classification-soil forming minerals definition- classification-silicates-oxides carbonates – sulphides - phosphates-occurrence. Weathering of rocks and minerals-weathering factors-physical-chemical-biological agents involved, weathering indices-factors of soil formation, land forms-parent material-climate organism- relief-time- soil forming processes-eluviations and illuviation-formation of various soils. Problem soils: salted soils, permeable, flooded, sandy soils properties. 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. PD-Practical Problem. Pore space-definition-factors affecting capillary and noncapillary porosity-soil colour- definition-its significance-colour variable-hue, value, chroma, Munsell colour chart-factors influencing-parent material-soil moisture-organic matter, soil structure-definition-classification-clay prism like structure-factors influencing genesis of soil structure, soil consistency plasticity- Atterberg's constants. Soil air-air capacity-composition factors influencing-amount of air space-soilair renewal, soil temperature-sources and distribution of heat-factors influencing-measurement, chemical properties-soil colloids organic- humus-inorganic-secondary silicate-clay-hydrous oxides. Soil organic matter decomposition-pH-nutrient availability-soil buffering capacity, 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-saturated and unsaturated infiltration and percolation-soil survey – classification–aerial photography–satellite–their interpretation, soil orders- land capability-classification, soils of different eco-systems and their properties; water quality parameters and assessment.

Agrometeorology-definition, aim and scope. Factors and elements of weather and climate. Composition and structure of atmosphere. Air and soil temperature regimes, atmospheric humidity, types of clouds and precipitation, hails and frost. Cyclones, anticyclones and thunderstorms. Solar radiations-components and effect on plant growth. Wind as a source of energy. Effect of weather and climate on the growth and development of crops. Climatic normals for crops. Agroclimatic zones of India and Himachal Pradesh. Evaporation and transpiration. Use of remote sensing techniques in agrometerology. Agriculture weather forecasting.

History of genetics and hypothesis-theories. Physical basis of heredity, cell reproduction – mitosis - meiosis and its significance. Gametogenesis and syngamy in plants. Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance pentrance and expresivity. Chromosome theory of inheritance, gene interaction: modification of monohybrid and dihybrid ratios. Multiple alleles, quantitative inheritance, linkage and crossing over, sex determination - theories, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. Chemical basis of heredity: Structure of DNA and its replication. Evidences to prove DNA as genetic material. Mutation and its classification. Chromosomal aberrations: Changes in chromosome structure and number.

Water relations in plants: role of water in plant metabolism, osmosis, imbibition, diffusion, water potential and its components, absorption of water, mechanisms of absorption, ascent of sap. Stomata, structure, distribution, classification, mechanisms of opening and closing of stomata, guttation, transpiration, factors affecting transpiration. Different types of stresses: water, heat and cold tolerance, mechanism of tolerance. Plant nutrition: essentiality, mechanism of absorption, role in plant metabolism, Photosynthesis, importance of photosynthesis, Structure and function of chloroplast, dark and light reactions, CO2 fixation, C3, C4 and CAM, advantages of C4 pathway, photorespiration and its implications. Factors affecting the photosynthesis. Respiration, glycolysis, TCA cycle and Electron transport chain, ATP synthesis and factors affecting the respiration. Photohormones, physiological role in controlling plant process. Environmental stimuli for plant development.

Economic importance and classification of horticultural crops and their culture and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery management practices, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops, 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 in horticultural crops, cropping systems, intercropping, multi-tier cropping, mulching, bearing habits, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming.

Definition and importance of Hydrology, Hydrological cycle, weather and hydrology, rainfallmeasurement and analysis, hydrologic properties, infiltration, runoff, water holding

capacity of soils, free water, capillary water, hygroscopic water, ground water, evapotranspiration, wateryield, interception by stemflow through fall, study of hydrographs. Recharging of water wells and springs. Wasteland Management: Objectives, components, runoff, factors affecting runoff, streamflow and stream gauging. Sedimentation, factors affecting sedimentation, flood and its control measures. Afforestation and forest management in wasteland areas. Soil erosion, universal soilloss equation, soil and water conservation practices and soil conservation structure like contour and graded bunding. Bench terracing and bench bank stabilization. Waterways their design,layout, construction, stabilization and maintenance. Methods of land leveling, its cost estimation, their location and design. Water harvesting structures and farm ponds. Irrigation Source: Waterwells, aquifers, water application methods; surface, subsurface, drip and sprinkler irrigationsystem. Drainage: types of drainage systems, their selection, design, installation and maintenance.

Important breeds of cattle, buffalo, sheep and goat. Breeding and reproductive management for higher productivity – breeding systems, estrous cycle, heat detection and artificial insemination. Feeding management – types of feedstuffs available for feeding livestock. Feed nutrients and their functions in animal body. Assessing nutritive value of feed – estimation of feed nutrients by proximate and Van Soest methods, estimation of digestible nutrients and energy in feedstuffs. Principles of rationing. Milk – definition, composition and nutritive value. Factors affecting quantity and quality of milk. Prevention and control of diseases.

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles, for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poison and normal distributions, sampling, basic concepts, sampling vs. complete enumeration parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of Significance: Basic concepts, tests for equality of means, and independent and paired t-tests, chi- square test for application of attributes and test for goodness of fit of mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient. Experimental Designs: Basic concepts, completely randomized design, randomized block design, latin square designs, factorial experiments, basic concepts, analysis of factorial experiments up to3 factors – split plot design, strip plot design, long term experiments, plot size, guard rows.

Introduction to computer, Anatomy of Computers, Input and Output Devices. Memory,Hardware, Software and Classification of Computers. Classification of Computer applications. Generation of Computers. Computer Viruses. Number Systems. Operating Systems- DOS andWindows. Disk Operating System (DOS), Fundamental DOS Commands- FORMAT, DIR,COPY, PATH, LABEL, VOL, MD, CD,DEL, TREE. Rules for naming the file in DOS and types of Files. Windows: - GUI, Desktop and its elements, Windows Explorer, working with files andfolders; setting time and date, starting and shutting down Windows. Anatomy of Windows, Titlebar, Minimize, Maximize and Close buttons, Scroll bars, Menus and Tool bars. Programming Concepts - Flow Charts and Algorithm, executing simple programs in C- language. Applications:- MS-Word, Processing and units of document,

feature of word processing package. Editing,formatting and saving a document in MS-Word. Mail- Merge in Microsoft Word. MS-Excel:-Introduction of Spreadsheet, concept, packages. Creating, editing and saving spreadsheet in MS- Excel. Creating Graphs. MS-Power Point: - Features of Power Point package. MS-Access :-Concept of Database, SQL commands, database creation, form designing, query and reportdesigning. Safeguards for Data security. Computer Network-LAN and its components, WAN,MAN, Network protocols-TCP/IP, HTTP and other. Internet- World Wide Web (WWW), WebBrowsing and Electronic Mail.

Extension education: meaning, definition, nature, scope, objectives, principles, approaches andhistory. Forestry extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in forestry programmes. Motivation ofwomen community, children, youth and voluntary organizations for forestry extension work.Rural Development: meaning, definition, objectives and genesis. Transfer of technology programes like lab to land programme (LLP) national demonstration (ND), front linedemonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Programming planningprocess – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts ofhuman resource development (HRD), rural leadership.

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to forestry sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of forestry inputs industry. Characteristics of Indian forestry processing and export industry. Social Responsibility of Business. Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

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8. HORTICULTURE

Economics, importance, area and production of Horticultural crops, Export-import scenario of Horticultural crops, Classification of Horticultural crops, Agroclimatic zones of India for fruit sand vegetables cultivation, Soil and climatic requirements of Horticultural crops, Vegetable gardens-Nutrition, garden, kitchen garden and other types, Ornamental gardens, Selection of site for establishing orchard, Layout and planting of an orchard, Planting systems and planting densities, Management of orchards, Special horticultural practices, Principles and methods of training and pruning of fruit crops, Classification of bio-regulators and their uses in Horticulture, Water management, weed management, mulching and nutritional management of Horticultural crops, Cropping systems-inter cropping, mixed cropping, mixed farming and multistoried cropping, Bearing habits in fruit crops, Fruitfulness, unfruitfulness; factors affecting unfruitfulness and remedies, Rejuvenation methods- top working, crown working, bridge grafting, etc, Canopy management of fruit crops, Organic farming – Definition and principles.

History importance and scope of ornamental gardening, Types of gardens, Ornamental industry: Area, production and industrial importance, Principles of gardening, Garden components and adornments, Types of lawn grasses and methods of lawn making, Rockery and methods of designing rockeries, Water Garden and methods of designing water gardens, Special types of garden (Japanese, English, Mughal), Walk, paths, bridges, constructed features etc, Types of trees, their propagation and their planting, Types of shrubs and herbacious perennials and planting, Types of climbers, creepers, cacti and succulents, Flower arrangement and Ikebana, Bioasthetic planting, its importance, urban planning, beautifying railway station, residential colonies etc, Bonsai and bonsai culture.

Composition of earth's crust, soil as a natural body – major components. Eluviations and illuviation formation of various soils. Problem soils; salt soils, permeable, flooded, sandy soil properties. 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 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 colour – definition, its significance, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal. Soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance soil organic matter decomposition, pH and nutrient availability, soil buffering capacity, soil, water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-system and their properties, management of problem soils – soils environmental quality. Irrigation water quality, determination of quality parameters, empirics equation management of irrigation water.

Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, Mitosis, meiosis and its significance. Gametogenesis and syngamy in plants. Mendelian genetics-Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Modification of monohybrid and dihybrid rations. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and characters. Cytoplasmic inheritance and material effects. DNA and RNA – as genetic material. Mutations and their classification. Chromosomal aberrations, changes in chromosome structure and number.

Extension education – History, Meaning, definition, nature, scope, objectives, principles and approaches. Horticultural extension - Selected programmes of leading national and international Horticultural institutes. Peoples participation in Horticultural programmes. Motivation of women community, children, youth and voluntary organizations for Horticultural extension work. Rural Development - Meaning, definition and objectives. Transfer of technology programmes like Lab to Land Programmes (LLP), National Demonstration Schemes (NDS), Front Line Demonstration (FLD), Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) of ICAR. Communication - Meaning, definition, elements and selected models. Audio-visual aids - Importance, classification and selection. Programme planning process – Meaning, scope, principles and steps. Evaluation- Meaning, Importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA). Management and Administration - Meaning, definition, principles and functions. Concepts of human resource development (HRD). Leader- Meaning, Definition, types and role in Horticultural Extension.

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engil' s law of family expenditure – consumer' s surplus. Theory offirm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization – merits and demerits. Laws or return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures.

Agricultural meteorology, its importance in Agriculture Weather and climate, weather elements and factors affecting them. Earth's atmosphere, composition and structure of atmosphere. Solar radiation – nature, properties, depletion, factors affecting solar radiation, solar constant and energy balance. Atmospheric temperature – factors affecting temperature, importance of air temperature, horizontal and vertical distribution and variations in temperature and global warming. Soil temperature – importance of soil temperature, variation of soil temperature. Air pressure – Variations, isobars and pressure gradients. Wind – Types, classification, importance of wind in Agriculture, forces acting to produce wind, cyclones, anticyclones and general circulation system of earth. Atmospheric humidity – saturated and actual vapour pressure, specific and relative humidity, diurnal variation of humidity. Process

of condensation, formation of dew, fog, frost, mist, snow, rain and hail. Cloud – types, formation and classification. Precipitation – hydrologic cycle, types of rain – thunder and hail storms, types of monsoon, agricultural seasons. Drought – its classification, strategy to mitigate drought. Microclimate Weather forecasting – Basics, types and importance of weather forecasting. Remote sensing and introduction to crop modeling.

Introduction to Computers, Anatomy of Computers, Input and Output Devices. Units of Memory, Hardware, Software and Classification of Computers. Personal Computers, Types of Processors, booting of computer, warm and cold booting. Computers Viruses, Worms and Vaccines. Operating System – DOS and WINDOWS. Disk Operating System (DOS): Some fundamental DOS Commands, FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD and DELTREE, Rules for naming files in DOS and Types of files. WINDOWS: GUI, Desktop and its elements, WINDOWS Explorer, working with files and folders; setting time and date, starting and shutting down of WINDOWS. Anatomy of a WINDOW, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars. Applications – MSWORD: Word, processing and units of document, features of word-processing packages. Creating, Editing, Formatting and Saving a document in MSWARD; MSEXCEL: ELECTRONIC Spreadsheets, concept, packages. Creating, Editing and Saving a spreadsheet with MSEXCEL. Use of in-built Statistical and other functions and writing expressions. Use of Data Analysis Tools, Correlation. Creating Graphs. MS Power Point: Features of Power Package. MSACCESS: Concept of Database, Units of database, creating database; Principles of Programming: Flow Charts and Algorithms, illustration through examples. Internet: World Wide Web (W W W), Concepts, Web Browsing and Electronic Mail.

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial degradation of organic and inorganic matter. Development of microbiology. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Composition of microbial world. Morphology and general characters of bacteria, fungi, algae, actinomycetes and related organisms. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth: growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. General principle of bacterial genetics, DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association.

Propagation: Definition and potentialities for plant multiplication Sexual and asexual methods of propagation their advantages and disadvantages, different methods for breaking dormancy. Seed dormancy internal and external factors affecting seed dormancy different seed treatments. Apomixis, monoembrony, polyembrony, chimera etc. Propagation Structures:- Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly houses, etc. Use of growth regulators in (seed, vegetables, tissue culture) propagation. Methods and techniques of vegetative propagation - cuttings, layering, grafting and budding, Physiological and bio chemical basis of rooting, factors influencing rooting of cuttings and layering, factors affecting grafting, graft incompatibility. Anatomical studies of bud union. Selection and maintaince of mother trees. Collection, storage and transport of scion sticks, scion and root stock relationship. Bud wood certification. Techniques of propagation through specialized organs, such as bulbs, tubers, rhizomes, corms, runners. Suckers, etc. Micropropagation, hardening of plants in nursery. Selection of site for nursery. Features of nursery. Nursery registration act. Plant protection in nursery management.

Growth and development, definition, components growth, phases in Horticultural crops. Different stages of growth, growth analysis in Horticultural crops. Plant bioregulators auxin, gibberellin, cytokinine, ethylene, inhibitor and retardants: Basic functions and bio synthesis. Role of bio regulators in crop growth and development. Role of bio regulators flowering, fruit setting, fruit thinning, fruit drop, fruit ripening. Factors affecting flowering, physiology of flowering. Photoperiodism long day short day and neutral plants, utilization and its application in horticulture. Developmental processes like juvenility, scenesance. Physiology of seed development and maturation. Seed dormancy and bud dormancy, causes and dormancy breaking methods in Horticultural crops. Physiology of fruit growth and development. Factors affecting fruit set and fruit development. Physiology of ripening of fruits climacteric and non climacteric fruits. Sex expression and its relationship.

Soil as medium for plant growth. Soil fertility and productivity, meaning & difference. Methods of soil fertility evaluation, Visual, chemical and biological methods. Essential plant nutrients macro & micro nutrients forms, moment, their role and deficiency symptoms and Correction measures. Mechanism of nutrient uptake active & passive. Problematic soils : Saline, saline-sodic, sodic, acid and calcareous soils their reclamation and management. Green manuring types, advantages, disadvantages their method. Organic manures, sources, biogas slurry, sewage, sludge. Agro industrial and urban waste, sewage water. Organic manures, composion, role and importance in soil fertility. Organic and natural farming. Nitrogenous fertilizer, Classification, content and reaction in soil. Phosphatic & potashic fertilizers, classification Properties their behavior in soil. Mixed, Complex and Compound fertilizers. Fertigation. Slow release fertilizers. Biofertilizers, Classification, importance & rote. Fertilizer management Rain fed & irrigated. Fertilizer use efficiency, improvement. Handling and storage of fertilizers. Integrated nutrient management Concept, Component & utility. Ecofriendly farming & sustainable agriculture. Soil pollution by agrochemicals.

Importance of water. Water resources in India. Irrigated area of different crops. Functions of water for plant growth. Effect of moisture stress and excess moisture on crop growth. Available and unavailable soil moisture, water budgeting. Distribution of soil moisture, classification of crops on the basis of rooting depth. Water requirement of horticultural crops. Use of pan evaporation, it's relation to requirement of water for plant growth. Critical stages of crop growth in respect of irrigation. Scheduling of irrigation – approach to fruit crops. Scheduling irrigation to vegetables. Methods of irrigation. Pressurized methods – Sprinkler and drip irrigation system. Merits and demerits along with suitability of irrigation system. Quality of irrigation water – it's role in horticultural crop production.

Plant Breeding as dynamic science, genetic basis of Plant Breeding- classical, quantitative and molecular, Plant Breeding in India – limitations major achievements, goal setting for future, Sexual reproduction (cross and self pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding. Hybridization and selection – goals of hybridization, selection f plants; population developed by hybridization- simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis-concepts, estimation and its genetic basis.

Water Relation in Plants: role of water in metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomats. Osmotic pressure, guttation, from bleeding: transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic election transfer, CO_2 fixation – C_3, C_4 and CA metabolism, Advantages of C_4 pathway. Photorespiration and its implication, factors affecting photosynthesis. Phytohormones, physiological role in controlling plant process. Environmental stimuli for plant development.

Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, fastidious bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases. Infection process - host pathogen relationship, avenues of penetration, parasitism. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management.

Definition, division and scope of entomology, classification of phylum Arthropoda and relationship of class insecta with other classes of Arthropoda. Importance of class insecta- Harmful insects and beneficial insects, dominance of class Insecta. Body segmentation, structure of head, thorax and abdomen. Structure and functions of insect cuticle and moulting. Structure and modification of mouthparts (Chewing and bitting, piercing and sucking, chewing and lapping, sponging). Structure and modifications of insect antenna. Structure and modifications of insect leg. Wing venation, modifications and wing coupling apparatus. Sensory organs. Anatomy of digestive system and circulatory system. Anatomy of excretory system. Anatomy of nervous system and endocrine system. Anatomy of male and female reproductive system. Postembryonic development – eclosion, metamorphosis, its types and dipause in insects. Classification of class insecta upto order. Distinguished characters and economic importance of orders (Lepidoptera, Coleoptera and Hemiptera). Distinguished characters and economic importance of orders (Hymenoptera, Diptera, Neuroptera, Orthoptera and Isoptera).

Definition of Statistics, its use, limitations; Frequency Distribution and Frequency Curves; Measures of Central Tendency; Characteristics of Ideal Average, Arithmetic Mean; Median, Mode and their Merits and Demerits; Measures of Dispersion;- Standard Deviation, Variance and Coefficient of Variation; Probability:- Definition and concept of probability; Normal Distribution and its properties; Introduction to Sampling:- Random Sampling; the concept of Standard Error, Tests of Significance – Types of Errors, Types of Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis;- Large Sample Test – SND test for Means, Single Sample and Two Samples (all types); Small Sample Test for Means, Student's t-test for Single Sample, Two Samples and Paired t-test. F-test; Chi-Square Test in 2 X 2 Contingency Table, Yates' Correction for continuity; Correlation:- Types of Correlation, Scatter Diagram, Computation of Correlation Coefficient 'r' and its testing, Linear Regression: of Y on X and X on Y. Inter-relation between 'r' and regession coefficients. Experimental Designs:- Basic Principles, Completely Randomized

Design (CRD), Layout and analysis with equal and unequal number of observations, Randomized Block Design (RBD), Layout and analysis, Latin Square Design (LSD), Layout and analysis.

Horticultural classification of fruits. Horticultural zones of India importance and scope of tropical and sub-tropical fruit crops, 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, 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, Litchi, fig. and pomegranate. Bearing habits in mango and citrus, causes and control measures of special production problems, alternate and bearing in mango and citrus, overcome, control measures., citrus decline andcasual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Importance and scope of tropical and sub tropical vegetable and tuber crops, Area, production, export potential of tropical and sub-tropical vegetable and tuber crops, vegetable farming and its types. Climate and soil requirements, seed rate, land preparation, Raising of nursery, transplanting of vegetable crops and planting for directly sown/ transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management, improved varieties and hybrids, deficiencies, physiological disorder use of growth regulators harvesting, grading, storage and yield economic crops and marketing of tomato, brinjal, chilli, capsicum okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, dolichos bean, cucurbits, moringa, curry leaf, agathi, portulaca and basella, sweet potato, colocasia, dioscorea, amorphophallus xanthosoma, tapioca.

Importance and present status of post harvest technology in horticultural crops in India and Maharashtra. Maturity, types of maturity and factors affecting maturity of horticultural crops. Maturity indices of fruits and vegetables Harvesting grading and handling of fruit, vegetables and cut flowers. Maturity indices of cut flowers, rose, gerbera, carnation, anthurium, lily, tuberose, chrysanthemum. Harvesting, grading, handling of above cut flowers. Maturity indices, harvesting, grading, handling of medicinal and aromatic plants. Pre-harvest factors affecting post harvest quality of horticultural crops. Handling of commodity before packaging. Physiological and biochemical changes during ripening of fruits. Ripening of fruits, role of ethylene. Hastening and delaying ripeningprocess. Post harvest treatments of horticultural crops to increase the shelf life. viz. disinfection treatments like VHT, Hot water treatment fungicidal chemical irradiation etc. Quality parameters & specification of fruits, vegetables and flowers for export. Methods of storage for local and export market. Packaging- importance, methods and types,cushioning.

History, scope and importance, area and production, uses, export potential and role of spices and condiments in national economy. Classification, soil and climate, propagation-seed, vegetative and micro-propagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and

shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, black pepper, ginger, turmeric, clove, nutmeg, kokum, cinnamon, allspice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

History, scope of gardening aesthetic values Gardens in India, types of garden Landscaping, historical background and values of landscaping Principles, basic components and elements of landscape design Plant material for landscaping symbols, tools and implements used in landscape design Layout of formal gardens, informal gardens Special types of gardens (bog garden, sunken garden, terrace garden, rock garden) Special types of gardens trees their design and walk paths, bridges, constructed features Principles of gardening, garden components, adornment, lawn making, methods of designing rockery, water garden Floriculture industry, importance, area and production industrial importance in India Green house and lath house Propagation, planting shrubs and herbaceous perennials Importance, design values, propagation, planting climbers and creepers Propagation, planting palms, ferns, grasses, cacti and succulant Flower arrangement, importance production details, cultural operations and constraints Post harvest practices, bioaesthetic planning, definition need Country planning, urban planning Planting avenues, schools and villages Beautifying railway stations, dam sites, hydro electric stations, colonies, river banks Planting material for play grounds vertical gardens and roof gardens Culture of bonsai, art of making bonsai, parks and public gardens Landscape design for specific areas.

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

Symptoms, etiology, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chili, okra, cabbage, cauliflower, radish, knol-khol, broccoli, pea, beans, beet root, onion, garlic, fenugreek, and other leafy vegetables, ginger, potato, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, gerbera, crossandra, tuberose, carnation, chrysanthemum, marigold, gladiolus, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

Carbohydrates : Occurrence, classification and structure, physical and chemical properties; isomerism, optical activity, reducing property reactions with acid and alkalies , osazone formation. Lipids – definition, classification, important fatty acids , triglycerides, essential fatty acids. Physical and chemical properties of oil/ fat, rancidity

, phospholipidsits types and importance Plant pigments – definition. Classification. Structure and function of chlorophyll and carotenoidsSterols : definition, classification, structure, role of brassinosterols in plant. Proteins : definition, classification, function, solubility, Amino acids classification, structure, essential amino acids, properties of amino acids, different reactions like colour reactions, amphoteric nature and isomerism. Structure of proteins – primary tertiary and quaternary proteins, their properties and reactions. Enzymes – definition, classification, mechanism of action and factors affecting enzymes action. Co-factor and co-enzymes; vitamins and minerals as coenzymes / co-factor Carbohydrate metabolism, glycolsis and TCA cycle Metabolism of lipids and fatty acid biosynthesis of fatly acids Electron transport chain, bioenergitics of glucose and fatty acid Nucleic acid replication, transcription and translation.

Fruit breeding - History, Centers of origin, importance of centre of origin and scope of fruits breeding, objectives of fruit and plantation breeding, modes of reproduction apomixes and its t1pes, agencies of pollination, type of incompatibility, sterility distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding methods in production, selection – clonal selection, mutation, polyploidy and hybridization in crop improvement policy manipulations *in vitro* breeding tools (important fruit mango, banana , papaya, citrus, grape, guava sapota, pomegranate, arecanut, cashew, coconut, coffee, cocoa, oil palm, rubber, tea,and annona, ber, onla, kokum.).

Definition, importance and scope, present status of Arid fruit crops, classification of Arid regions in the country, Problems and constraints in fruit production in arid regions. Soil and agro-climatic condition of the arid regions, Detail cultivation of Aonla, Tamarind, Annona, Ber, Karonda,W oodapple, Jamun and phalsa with respect to origin, botany, soil, climate, propagation, layout and planting, spacing, nutrition and irrigation management, interculture horticultural practices, varieties, harvestingy, yield, grading and storage, important pest and diseases and their management, Brief information about cultivation on above aspects of Jamun, woodapple, Charoli, Marking nut, passion fruit, Loquat, Litchi, Phalsa, Jackfruit. special horticultural practices for arid and minor fruit crops such as training, pruning use to plant growth regulators and chemicals, mulching, terracing, intercropping. Handling and storage.

Importance and scope 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. Marketing of cabbage, cauliflower, Knolkhol, Sprouting broccoli, Brussels sprout, Lettuce, Palak, Chinese cabbage, Spinach, Garlic, Onion, Leek, Radish, Carrot, Turnip, Beet root, Peas, Broad beans, Rhubard, Asparagus, Globe artichoke and Potato.

Scope and importance of commercial floriculture in India and Maharashtra. Production techniques of floricultural plants like Rose, Chrysanthemum. Carnation, Gerbera, Gladiolus, Marigold, Gaillardia Tuberose, Jasmine, China Aster, Dehlia and Lily*. Production of above crops for domestic and export market with special reference to maturity, packaging and transport needs. Production techniques of above floricultural crop under poly house and net house conditions. Post harvest management of cut flowers. Dehydrated flower trade in India. it's scope and present status. Post harvest technology for loose flowers. Flower arrangement and value addition in Floriculture.

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

Symptoms, etiology, modes of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz . mango, banana, grape, citrus, guava, sapota, papaya, jackfruit, pineapple, pomegranate, ber, apple, pear, each, plum, almond, walnut, strawberry, atoca nut, coconut, custard apple, fig, pineapple, jamun, aonla, oil palm, coffes, tea, cocoa, cashew, rubber, betelvine, senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint; opium, Solanum khasianum and tephrosia. Important post-harvest diseases of fruit, plantation, medicinal and aromatic crops and their management.

History, scope and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin and distribution, area, production, climate and soil requirements, propagation and nusery techniques, planting and after care, cultivation practices, training and pruning, nutritional and water requirement. Plant protection, haresting and processing of under mentioned important medicinal and aromatic plants, extraction, use and economics of drugs and essentials oils in medicinal aromatic plants. Therapeutic and pharmaceutical uses of important species. Medicinal Plants : Betelvine, periwinkle, rauvolfia, dioscorea, isabgol, belladonna, cinchona, ashwangandha, safed musali, stevia, aloevera, adulsa, panpimpli, asparagus, wild brinjal and other species relevant to local conditions. Aromatic plants : Citronella grass, palma rosa grass, lemon grass, khas grass, lavender, geranium, patchouli, menthe and other species relevant to the local conditions.

Farm management definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concept, curves and functions- factors, product, relationship factors relationship, product relationship, optimum conditions, principles of opportunity cost equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types planning meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations - forms of Business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction - guiding, leading, motivating, Supervising, Coordination - meaning. types and methods of controlling evaluation. Control system and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management operations management physical facilities, implementing the plan, scheduling the work, controlling productioni n terms of quantity and quality. Materials management - types of inventories, inventory costs. Managing the inventories, economic order quantity (EOQ), Personnel management-recruitment, selection training, job specialization. Marketing management-definition, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and rations, capital budgeting. Project management- project preparation evaluation measures.

Importance and scope vegetable breeding. History, Centres of origin, plant bio-diversity and its conservation. Methods of reproduction, agencies of pollination and mechanism in self and cross pollinated crops. Self-incompatibility and male sterility, its classification and application. in crop improvement objective of breeding of vegetable crops, exploitation of hybrid vigour, polyploidy breeding resistance breeding, mutation breeding. Breeding methods for crop improvement in Crops viz., Solanaceous vegetables, cole crops, cucurbits, bulb crops, root crops, leafy vegetables, okra, leguminous crops, tropical tuber crops.

Importance and scope of temperate fruits and plantation crops. Classification of temperate fruits and plantation crops. Area and production of temperate fruit in India and Maharashtra. Export and import potential of temperate fruits and plantation crops. Role of temperate fruit crops and plantation crops in national economy, Uses and industrial importance. Propagation techniques in Apple, Pear, Peach, Apricot, Cherry, Persimmon, Strawberry, Kiwi, Almond, Walnut, Pecan nut, Coconut, Areca nut, oil palm, Cacao, Cashew nut, Coffee, Tea, and Rubber. Training, Pruning, Use of plant growth regulators, Nutrient and weed management, harvesting of above crops. Important insect pest and diseases and their control measures on above crops.

Definition, objectives and importance, integration, advantages and constraints. Distinction between agroforestry and social forestry. Status of Indian forests and role in India of agroforestry. Classification of agroforestry system, subsystem and practice : agri silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry - constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry. MPTS - their management practices, economics of cultivation - nursery and planting (Acacia *catechu, Dalbergia sissoo" Tectona, Populus, Moros, Grewia, Eucalyptus, Quercus spp.* and bamboo, tamarind, neem etc.).

Importance and scope of protected cultivation, scope in India. Different types of protective cultivation.. Plant environment interaction. Crops for green house cultivation. Green house ventilation, cooling system, green house heating, C02 enrichment, light control. Irrigation and nutrient management. Disease and pest control of green house plant. Green house production, handling packaging and marketing of green produce. Recommendations of last five years Joint Agresco.

Environment: introduction, definition and importance. Components of environment - interactions with organisms. Global and Indian environment – past and present status. Environmental pollution and pollutans. Air, water, food, soil, noise pollution- sources, causes and types. Smog, acid rain, global warming, ozone hole, eutrophication, sewage and hazardous waste management. Impact of different pollutions and humans, organisms and environment. Introduction to biological magnification of toxins. Deforestation- forms and causes, relation to environment, Prevention and control of pollution – technological and sociological measures and solutions- Indian and global efforts. India, international and voluntary agencies for environmental conservation- major achievements. Environmental policy and legislation in India. Introduction to environmental impact assessment. Causes of environmental degradation – socio- economic factors. Human population growth and lifestyle.

General-economic classification of insects. Ecology and insect pest management with reference to fruit, plantation, medicinal and aromatic crops. Pest survey and monitoring and its importance in IPM. Distribution, host range, bio-ecology, injury integrated management of important pests affecting. Citrus : Major : Lemon butterfly, leaf miner, citrus psylla white fly and black fly, fruit sucking moth bark eating caterpillar. Minor : Aphid, Mea bug and Nematodes. Mango : Major : Jassids/hoppers; fruit fly, stone weevil stem borer, mealy bugs, bark eatingcaterpillar. Minor : Scale, Red ants, shoot borer. Grapevine : Major : Flea beetle, Thrips, Mealy bug mites,Minor : Stem irdler, cockchafer beetle. Pomegranate : Major : Fruit borer, Mealy bug, Thrips, Scale insects, white fly. Minor : Aphid, fruit sucking moth, mites,pin hole borer. Guava and fig : Major : Pest of Guava - fruit fly, spiraling, white fly, bark eatingcaterpillar. Minor: Scales, mealy bugsFig Major : Jassids, scales, mealy bugs, Minor: Mite, stem borer. Banana, Papaya and Castard apple Banana Major: Root stock weevil, Aphid. Minor: Burrowing nematodesPapaya Major :Aphid, whitefly, Custard apple : Meal bug. Ber : Major : Ber fruit borer, ber fruit flyMinor : Hairy caterpillar, jassids, Sapota : Major: Chiku moth, Seed borer IMinor: Mealy bugs. Cashewnut : Major : Tea mosquito, Minor: Leaf eating caterpillar Coconut, Arecanut and other plam trees and cashewnutMajor: Rhinoceros beetle, Red palm weevil, Black headedcaterpillar, Rat. Minor: Termite, mite, scales, mealy bugs. Tea , Coffee Apple, pear, peach, plum Beetlevine and Rubber Insect pests of stored fruits plantation of medicinal andaromatic plants and their management. IPM of stored fruits, plantation and medicinal and Aromatic Plants, Pests of Shatawari and Ashwaganda. Pests of Opium and Mentha, Pests of Wild brinjal and Sweet flag, Pests of Cinchona, Senna, belladonna, Pests Pachouli Isabgol and Dhatura. Pest of Rose, Pests of Vetivar and Davana. Pests of Kevara and Citronella. Pests of Geranium, Palmarose and lemongrass, Pests of Eucalyptus, Pests of Sandalwood, Pests of Neem, Tephrosia and Camphur, Insecticide residue problems in fruit plantation, medicinaland aromatic plants and their tolerance limits.

Studies on pests of potato : Tubber moth, cutworm, aphids. jassids, leaf eating caterpillar, epilachna beetle, mites. Sweet potato and Yam : - Sweet potato : Sweet potato leaf eating caterpillar, sweet potatoweevil, Yam : Yam beetle, mealy bugs, scale insects, sawfly. Brinjal : Shoot and fruit borer, jassids, aphids, white fly, greyweevil, hadda beetle, mites. Bell pepper-Thrips, mites, cutworm, fruit borer, whitefly capsicum. Onion and garlic: Onion thrips, cutworm, onion fly, Earwig. Toamto : Fruit borer, leaf eating caterpillar, white fly, mealy bugs, aphids,leaf miner. Okra : Shoot and fruit borer, leaf roller, jassids, aphids, mites, whitefly. Peas and beans : Pod borer, aphids, stem fly, pulse beetle, mites. Cruciferous and root crops : Diamond back moth, mustard sawfly, aphids,(Cabbage, cauliflowers, radish, carrot) cabbage butterfly, leaf miner. Cucurbits : Fruit fly, pumpkin beetles, blister beetle, Hadda beetle. Leafy vegetables : Cutworm, leaf eating caterpillar, aphids, leaf miner,(Amaranthus, coriander, methi, spinach, radish, salad crops)leaf hopper, mustard sawfly. Roses : Aphids. jassids, thrips, mites scale insects, bud borer, leaf eating caterpillar, leaf cutting bees, Digger wasp, termites. Chrysanthemum & marigold : Aphids, thrips, white fly, jassids, leaf miner, lace bug, mites, bud borer, leaf miner, slugs. Jasmin & Tuberose : Bud worm, gallary worm, tingid bug, mites, scales,rose bud borer, aphids thrips, mites. Aster : Leaf hopper, black blister beetle, leaf miner, aphids, mites. Gladiolus : Seed corm maggot, aphids, thrips, mites, cutworm. Gerbera & : White fly, leaf miner, mites, leaf eating caterpillar, rosebud borer. Carnation : Red spider mite, aphids, thrips, rose bud borer. Studies on pest of lily, anthurium and orchids. Integrated pest management in polyhouse. Studies on pests of black pepper. Clove. Cinnamon I Cardamom Nutmeg and Mace Curry leaf Coriander, Cumin and Fennel Turmeric and Ginger, Chilli - Thrips, mites, cutworm, aphids, termites, white fly. Studies on polyphagous pests. Studies on non-insect pests and their management.

Sources of farm power in India Human, Animal, Mechanical, electrical, Wind Power, Scope of Mechanization, Principle of operation of I.C. engine I.C. engine working principles, Two and Four stroke engine, Engine terminology and examples, I.C. Engine systems Fuel supply system, cooling system, Air cleaner, Tractor Tractor types and their selection, fixed and operating cost of tractors with examples, Tillage Tillage, objectives of tillage, classification and types of tillage, Tillage implements, Primary tillage implements M. B. plough and Disc plough with examples, ploughing of land and method of ploughing, Secondary tillage implements Harrows, cultivators and examples, Seed drills Sowing methods, seed drill, components of seed drill, seed metering mechanism, types of furrow openers, calibration of seed drill, examples, Study of planter Planter, Functions, seed metering devices, type of planters, Plant protection equipments Classification, types of spraying and types of dusting machines, Harvesting and threshing equipments Definition of harvesting and threshing, harvesting/threshing methods, implements and combine harvester-thresher, Equipment for land development and soil conservation Clod crusher, leveler, bund former, animal drawn scoop, earth moving machinery.

History of improvements of ornamental plants, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants. Breeding for disease resistance. Development of promising cultivars of important ornamentals. Role of heterosis and its exploitation, production of FI hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

History of seed industry in India. Definition of seed.. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production. Isolation distances in vegetables and agencies of pollination. Methods of seed production of cole crops, root vegetables, solanaceous vegetables, cucurbits, leafy vegetables, bulb crops, leguminous vegetables, okra. Seed testing and purity analysis. Field and seed standards. Seed processing, drying and extraction. Seed act.

Importance and scope, current status, future prospects and problems of protected cultivation. Protected structures, designs and fabrication. Classification of green houses and factors affecting the construction of green house. Environment control in green house viz. Temperature, light, relative humidity (RH), CO_2 enrichment and ventilation or air circulation. Production system and media for protected cultivation. Drip irrigation and fertigation in protected vegetable cultivation. Production of green house Capsicum, Cucumber , Melons, Tomato, Cherry Tomato. Production of vegetables under net houses (Capsicum, Beans, Tomato, Coriander, Methi) and offseason cultivation of vegetables under plastic low tunnels. Disease management and pests management of vegetable crops under protected cultivation. Grading, packaging, transport technology of Vegetables. Constraints in green house vegetable cultivation.

Importance and scope of fruit and vegetable preservation industry in India, Post harvest losses. Principles and guide lines for processing unit. Principles and methods of preservation viz.,heat, pasteurization, canning and bottling. Preservation by sugar and chemicals. Fruit Beverages. Preparation and preservation of unfermented fruit beverages viz., juices, squash, syrup and cordial etc. Fermented beverages-nira , wine, Cidar. Preparation of jam jelly and marmalade. Preserve ,candied and crystallized fruits. Preservation with salt and vinegar. Preparation of chutneys and sauces/ ketchups. Mushroom processing. Processing of Plantation crops. Spoilage in Processed foods. Quality control of

Processed products, Govt. policy on import and export of Processed fruits, food laws. Recommendations of JOINT AGRESCO of last five years.

History, scope and importance of biotechnology, organogenesis and effect of plant growth regulators, somatic embryogenesis and artificial seeds, callus culture and single cell culture, suspension culture and secondary metabolites, micropropagation, meristem culture and production of disease free plants, anther and pollen culture, embryo culture and embryo rescue technique, somaclonal variation, protoplast isolation and protoplast culture and protoplast fusion, somatic hybridization and cybridization, methods of plant transformation, transgenic plants and their application, molecular markers and their application, cryopreservation.

History of development of Nematology- Definition, economic importance. General characteristics of plant parasitic nematodes. Nematode general morphology, taxonomy and biology. Classification of nematodes. Symptomatology. Control of important plant parasitic nematodes of fruit crops : Pomegranate, Grapes, Fig,Citrus, strawberry, Cashewnut. Vegetable crops : Tomato, Brinjal, Okra, Chilli and Cucurbitsetc. Tuber and bulb crops : Potato, Sweet potato, Carrot, Radish, and Onion. Ornamental crops : Chrysanthemum, Rose, Tuberose, Gladiolus, Carnation and Gerbera.Spices : Turmeric, Ginger, Cardamom and Clove. Plantation crops : Banana, Arecanut and Coconut.

Entrepreneur: Meaning, definition, characteristics and role, demands of entrepreneur, identifying potential entrepreneurs. Entrepreneurship development - Concept of entrepreneurship, process of entrepreneurship development, motivation and entrepreneurship development, importance of planning, monitoring and follow-up, managing competition, entrepreneurship development programmes. Characteristics of Indian Horticultural Processing and Export Industry. SWOT analysis, Generation, incubation and commercialization of idea and innovations. Entrepreneurial behavior-Concept, dimensions, factors affecting entrepreneurial behaviour. Government schemes and incentives for promotion of entrepreneurship Government policy on Small and Medium Enterprises (SMEs)/ SSIs. Market survey, formulation of project, financial analysis of project. Communication skills : Communication - Meaning and process of communication. Advertisements - Meaning, types, forms, functions. Writing Skill : Business letter, Letters of inquiry, quotation orders andtenders, complaints letters

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