

**SCHEME AND SYLLABUS FOR THE POST OF ASSISTANT EXECUTIVE ENGINEERS IN
VARIOUS ENGINEERING BRANCHES**

SCHEME

(Degree standard)

<u>PART-A WRITTEN (OBJECTIVE TYPE) EXAMINATION</u>			
General Studies	150 Marks	150 Qns	150 Minutes
Optional Subject- PAPER-1 Civil OR Agricultural Engineering	150 Marks	150 Qns	150 Minutes
Optional Subject- PAPER-2 Civil OR Agricultural Engineering	150 Marks	150 Qns	150 Minutes
<u>PART-B: INTERVIEW</u>	50 Marks		

SYLLABUS

PAPER-1: GENERAL STUDIES AND MENTAL ABILITY

1. General Science – Contemporary developments in Science and Technology and their implications including matters of every day observation and experience, as may be expected of a well-educated person who has not made a special study of any scientific discipline.
2. Current events of national and international importance.
3. History of India – emphasis will be on broad general understanding of the subject in its social, economic, cultural and political aspects with a focus on AP Indian National Movement.
4. World Geography and Geography of India with a focus on AP.
5. Indian polity and Economy – including the country's political system- rural development – Planning and economic reforms in India.
6. Mental ability – reasoning and inferences.

OPTIONAL SUBJECTS
CIVIL ENGINEERING - PAPER-1

PART – A:

STRENGTH OF MATERIALS:-

Simple stresses and Strains: Types of stresses and strains - Hook's Law, Stress-strain curve for mild steel working stress and factor of safety Poisson ratio - State of simple shear, complementary - Shear Elastic constants and their relations - Compound bars - Thermal stress.

Compound stresses Mohr's circle of stress - Principal stresses and planes.

Shear force and bending moment diagrams: S.F.D. and B.M.D. for cantilevers, simply supported beams and over hanging beams subjected to point loads and uniformly distributed loads. Relations among load, shear force and bending moment.

Bending and shear stress: Basic equation; $M/I = F/Y = E/R$ - Distribution of bending and shear stresses across various cross sections such as rectangular, circular, I and T sections, Torsion of Circular shafts - power transmission.

Columns and struts: Euler's theory and Rankine's Theory - Secant and Perry formulae for eccentrically loaded columns.

Deflections and slopes: Slopes and deflections in cantilevers simply supported beams; propped beams and fixed beams subjected to point loads and uniformly distributed loads.

PART - B:

FLUID MECHANICS AND HYDRAULIC MACHINERY:

Fluid statics: Hydrostatic force on a plane and curved area Centre of pressure and its applications to lockgates and dams Metacentric height.

Fluid Dynamics: Convective and local acceleration, Euler's equation of motion and its integration, Bernoulli's equation motion and its application, flow in curved path. Free and forced vortex.

Flow measurements: Notches and weirs, venturimeters, pitot tube, nozzle meter, current meter.

Compressible Flow: Velocity of pressure wave, wave velocity for adiabatic and isothermal compression, Basic equations of one-dimensional flow continuity, energy and momentum equations.

Laminar and turbulent flow through pipes: Reynolds experiment significance of Reynold's number, formulae for laminar flow through circular pipes, Turbulent flow-Darcy Weisbach equation, friction factor and Mody's diagram.

Turbines: Classification, specific speed velocity triangles Principles of design of reaction and impulse Turbines, characteristic curves.

Pumps: Centrifugal pumps, velocity triangles, Work done and efficiency minimum starting speed, loss of head; specific speed and characteristic curves for centrifugal pumps.

CIVIL ENGINEERING PAPER – 2

1. BUILDING MATERIALS:

Timber: Different types and species of structural timber, density – moisture relationship, strength in different directions, defects, preservations, plywood.

Bricks: Types, Indian standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.

Cement: Compounds of different types, setting times, strength.

Cement mortar: Ingredients, proportions, water demand, mortars for plastering and masonry.

Concrete: Importance of w/c ratio, strength, ingredients including admixtures, workability, testing for strength, mix design methods, non-destructive testing.

2. STRUCTURAL ANALYSIS:

Analysis of determinate structures – different methods. Analysis of indeterminate skeletal frames – Moment distribution, Slope deflection, Kani's, Stiffness and force methods, Energy methods, Muller Breslan principle and application. Plastic analysis of indeterminate beams and simple portal frames – Shape factors.

3. DESIGN OF STEEL STRUCTURES:

Principles of working stress method. Design of connections, Simple members, Built-up sections and Frames, Design of industrial roofs. Principles of ultimate load design. Design of simple members.

4. DESIGN OF CONCRETE AND MASONRY STRUCTURES:

Limit state design for bending, Shear, Axial compression and combined forces. Codal provision for slabs, Beams, Columns and footings. Working stress method of design of R.C. members. Principles of pre-stressed concrete design, Materials, Methods of pre-stressing, losses. Design of simple members and determinate structures. Design of brick masonry as per IS codes.

5. CONSTRUCTION PLANNING AND MANAGEMENT:

Bar chart, Linked bar chart, Work break down structures, Activity – on – arrow diagrams. Critical path, Probabilistic activity durations, Event based networks. PERT network: Time-cost study, Crashing, Resource allocation.

6. HYDROLOGY AND WATER RESOURCE ENGINEERING:

Hydrological cycle, Precipitation and related data analysis, Unit hydrographs, Evaporation and transpiration. Floods and their management, Stream gauging, Routing of floods, Capacity of reservoirs. Multi purpose uses of water: Soil-plant – Water relationships, Irrigation systems. Water demand assessment: Storages and their yields. Ground water yield and well Hydraulics. Water logging and drainage design. Design of rigid boundary canals, Lacey's and tractive force concepts in canal design, Lining of Canals, Sediment transport in canals, Non-overflow and overflow dams and their design, Energy dissipators, Design of head works, Distribution works, Falls, Cross-drainage works, Outlets, River training.

7. ENVIRONMENTAL ENGINEERING:

- a. Water Supplying Engineering: Sources of supply, Yields, Design of intakes and conductors, Estimation of demand. Water quality standards, Control of water borne diseases. Primary and secondary treatment. Conveyance and distribution systems of treated water, Leakages and control. Rural water supply. Institutional and industrial water supply.
- b. Waste Water engineering: Urban rain water disposal, Systems of sewage collection and disposal. Design of sewers and sewerage systems, Pumping. Characteristics of sewage and its treatment. Disposal of products of sewage treatment. Plumbing systems. Rural and semi-urban sanitation.
- c. Solid Waste Management: Sources and effects of air pollution, Monitoring of air pollution, Noise pollution, Standards, Ecological chain and balance. Environmental assessment.

8. SOIL MECHANICS AND FOUNDATION ENGINEERING:

Properties and classification of soil, Compaction, Permeability and Seepage, Flow nets, Inverted filters, Compressibility and consolidation. Shearing resistance, Stresses and failure. Soil testing in laboratories and in-situ, Earth pressure theories, Stress distribution in soils, Soil exploration, Samplers, Load tests, Penetration tests. Types of foundations, Selection criteria, Bearing capacity, Settlement, Laboratory and field tests, Types of piles and their design and layout. Foundations on expansive soils, Swelling and its prevention, Foundation on swelling soils.

9. SURVEYING AND TRANSPORT ENGINEERING:

Classification of surveys, Scales, Accuracy, Measurement of distances, Direct and indirect methods, Optical and electronic devices, Measurement of directions, Prismatic compass, Local attraction, Theodolites, Types, Measurement of elevations, Spirit and trigonometric leveling, Contours, Digital elevation modeling concept, Establishment of control by triangulations and traversing, Measurement and adjustment of observations, Computation of coordinates, Field astronomy, Concept of global positioning system, Map preparation by plane tabling and by photogrammetry, Remote sensing concepts, Map substitutes. Planning of Highway systems, Alignment and geometric design, Horizontal and vertical curves, Grade separation, Materials and construction methods for different surfaces and maintenance. Principles of pavement design, Drainage. Traffic surveys, Intersections, Signaling, Mass transit systems, Accessibility, Networking.

AGRICULTURAL ENGINEERING - PAPER-1

SECTION-A

I. Surveying and Leveling and Theodoliting: Surveying – objectives, primary divisions, classification, principles of surveying units of measurement, difference between a plan and a map. Scales – representative fraction, types of measuring scales, degree of accuracy. Linear measurements – method of measurement of pacing, chains and their constructional details, chain types, folding and unfolding of chains, measuring tapes, instruments for chain survey. Ranging – chaining on flat and sloping grounds, chain and tape correction. Chain surveying – definitions, method of booking field notes, offsets, layout of off-sets, cross staff survey, obstacles in chaining, problems on errors in chaining. Computation of areas by planimeter. Compass survey – types of traverse, meridians bearing – types, designation of bearings, fore and back bearings, calculation of included angles from bearings. Description of prismatic and surveyor compass – method of using prismatic compass, magnetic declination, determination of true bearings from magnetic bearings, running a compass traverse. Local attraction – problems on correction of local attraction. Plane table survey – accessories of plane table, basic definitions, setting of plane table, orientation, methods of plane tabling.

Leveling – basic definitions, methods of leveling, classification of direct leveling. Instruments used in leveling – dumpy level, leveling staff. Temporary adjustments of dumpy level. Bench marks. Booking the staff readings – methods of reducing levels. Leveling difficulties and errors in leveling.

Theodolite – components and temporary adjustments of a theodolite – measurement of horizontal angles by direct method, repetition and reiteration method – measurement of vertical and deflection angles. Measurement of deflection angles, magnetic bearings of line – traversing by included angles – traverse computations and volume computations.

ii. Fluid mechanics and Open Channel Hydraulics: Fluids – classification, properties and dimensions. Fluid pressure – measurement, manometry, classification of manometers. Fluid static force on submerged surfaces – total force on horizontal, vertical and inclined surfaces, center of pressure and practical applications – kinematics of fluid flow – lines of flow, general types of fluid flow, equation of continuity, flow net boundary layer theory. Dynamic of fluid flow – various forms of energy in fluid flow, frictional loss, general energy equation, Bernoulli's theorem, Euler's equation of motion. Practical applications of Bernoulli's theorem. Venturi meter, Pitot tube, orifice meter. Buoyancy Floatation – meta centric height. Flow through orifices and mouthpieces – vena contracta, hydraulic coefficient and their experimental determination. Flow over weirs and notches – classification, discharge measurement thorough rectangular, triangular, trapezoidal weirs, broad crested weirs, flow through pipes – laws of head in pipes, pipes in series and compound pipes, equivalent size. Open channel hydraulics, classification of open channels and definitions, most economical sections of regular cross sections, specific energy concepts – Critical depth, energy diagrams, velocity and pressure profiles in open channels, hydraulic jump – types.

iii. Soil Mechanics: Soil mechanics – definitions and relationships, Classification of soils – particle size distribution, sieve analysis, sedimentation analysis, Stokes law. Consistency of soils – determination of liquid, plastic and shrinkage limits. Permeability – Darcy's law, discharge velocity and seepage velocity, coefficient of permeability. Seepage of Soils – flownet properties and uses. Elasticity applied to soils – stress distribution, Bousinesq's stress distribution theory, Isobar and pressure bulb, Vertical Pressure under uniformly loaded rectangular area, Comparison of Bousinesq's theory with linear theory, Westergard's theory. New mark's influence chart, consolidation – process of consolidation relationship between void ratio and pressure, coefficient of volume change, time factor, settlement of soil. Compaction – introduction, factors. Shear strength – definition, Mohr's circle, Mohr Coulomb failure theory, measurement of shear strength. Earth pressure – active and passive earth pressure, Rankine's theory, slip circle method, Coulomb's wedge theory. Design requirements of retaining wall. Stability of slopes – types of failure and remedial measures. Bearing capacity – Rankine's analysis, Terzaghi's analysis, general and local shear failure, plate load test.

iv. Electronics: Photoelectricity – photoelectric emission, laws of photoelectric emission, phototube and photo multiplier tube. Thermo electricity – Seebeck effect, Peltier effect, variation of e.m.f. with temperature, laws of thermo electricity, thermo couple, thermometer. Alternating currents – average value, r.m.s. value of A.C. circuits with resistance, inductance and capacitance, L.C.R. circuits resonance circuits, watt meter, A.C. frequency measurement, transformers. Electronics – types of emission, methods of heating, vacuum tubes, diode, space charge, diode characteristics, Child's law of diode, rectifiers, half wave and full wave rectifiers, filter circuit types. Triode – action of grid, triode characteristics, tube constants, inter electrode capacitance, multi-electrode tubes, triode as an amplifier, classification of amplifiers. Metals semi conductors and insulators – N type, P type, germanium, P N junction diodes, junction triode transistors NPN and PNP.

v. Fundamentals of soil science: Nature and properties of soil – soil genesis and classification. Soil clay and organic matter. Physical and chemical properties of soils. Soil fertility and its evaluation. Soil water relations. Acidic, saline and alkali soils and their management.

Determinations of the followings: Total soluble salts by EL method, available nitrozens, available P.K. chlorides by mohars method, sulphates, calcium, (ca + mg), sodium, potassium, computation of SAR, RSC.

vi. Strength of materials: Introduction – units and dimensions – simple stresses and strains, elastic limit, compressive stress, tensile stress, principle of super position, stresses in bars of uniform tapering circular section, stresses in composite bars, elastic constants, primary secondary strains, Poisson's ratio, volumetric strain, bulk modulus, shear modulus, and their relationships. Principal stresses and strains – analytical and graphical methods. Strain energy and impact loading – strain energy stored in a body gradually applied, suddenly impact, shock load, proof resilience. Shear force and bending moment of beams – cantilever, over

handing, simply supported, application of point load, uniformly distributed load. Bending stresses in beams – theory of simple bending, neutral axis, moment of resistance, section modulus, bending stress in unsymmetrical sections. Shearing stresses in beams – loaded beam, distribution of shear stresses, different sections. Deflection of simple beams – relation between slope, deflection and radius of curvature. Methods of determination of slope and deflection and radius of curvature. Methods for determination of slope and deflection – double integration. Macaulay's method.

vii. Soil Physics: Dynamic properties of soils – bulk density, particle density, porosity, void ratio, volume expansion, soil consistency, soil compaction, soil strength. Soil texture, soil separates, particle size analysis, stoke's law, derivation, its applicability and limits of validity. Classification of soil types, significance of soil texture, soil structure – definition, genesis, classification, evaluation of soil structure, indices of soil structure – methods of improving soil structure. Soil water, structure of water, properties of water, potential terminology, soil moisture potentials, soil moisture tensions, pF values, soil moisture constants, loss of soil water movement in saturated and unsaturated conditions, general flow equations, water infiltration into soil profile and its redistribution, infiltration equations, seepage and deep percolation losses. Soil temperature – thermal properties of soils, heat transfer in the soils, modifying the thermal regime of soils. Soil air-composition of soil air, movement of gases through soils, influence of aeration on plant growth, measurement of soil aeration. Soil air management. Physically problematic soils and their management.

viii. Fundamentals of Agronomy: Agriculture in India – definition of agriculture and agronomy, development of scientific agriculture, important events in Indian agriculture, important national and international institutes.

Agricultural meteorology – introduction, definition of meteorology, weather and climate and their importance in agriculture. Weather aberrations – inadequate and excess rainfall, unseasonal rains, cyclones, depressions, cold and heat waves, frost, hailstorms, hurricanes. Tornado. Drought and their effect on crop production. Weather forecasting – importance, types of forecasting, synoptic charts, weather forecasting organisations. Agroclimatic zones of Andhra Pradesh. Agricultural seasons in the state.

Tillage and tilth – objectives, characteristics of good tilth, types of tillage, preparatory cultivation, intercultivation, aftercultivation and preparatory cultivation for low land rice. Sowing – Methods of sowing – Time and depth of sowing.

Crops and their classification. Manures and fertilizers – method and time of application, relationship between soil moisture and fertilizer application. Weeds – definitions, their influence on crop production, principles of crop weed competition, critical periods of weed competition in different crops, principles of weed management and methods of weed control. Crop water requirements – critical stages of irrigation in important crops, scheduling of irrigation, methods of irrigation and water use efficiency. Cropping systems – definition. Principles of crop rotation and mixed cropping. Problems of dry land agriculture and water shed management.

ix. Hydrology: Hydrology – definition, hydrologic cycle and its components. Forms of precipitation – rainfall, measurement and analysis, point rainfall analysis, probability analysis, determination of net effective rainfall, phi index. Runoff – components, factors affecting runoff, estimation of design peak runoff rates, rational method, curve number method, rainfall runoff relations. Hydrographs – components, factors affecting hydrographs, separation of hydrographs for simple and complex storms. Unit hydrographs – concept and derivation, conversion of unit hydrographs, superposition method, S curve method. Synthetic units hydrographs – Necessary and derivation, Snyder's method and applications, instantaneous unit hydrograph. Flood routing – introduction, basic equations, hydrologic storage routing, modified Pul's method.

SECTION – B

i. Thermodynamics and Heat Engines: Basic concepts of thermodynamics – thermodynamic equilibrium, energy and forms of energy, heat and work, thermal capacity and specific heat. Ideal gases – introduction, laws of perfect gases. Specific heats of gases. Laws of thermodynamics – zeroth law, first law, thermodynamic processes based on first law, entropy, second law of thermodynamics, refrigerator & heat pump, reversibility and irreversibility, Carnot's theorem. Gas cycles – efficiencies. Air standard cycles – efficiencies. Fuels types, calorific values of fuels, Bomb calorimeter, Boy's gas calorimeter, properties of fuels, apparatus for determination of fuel properties. Combustion of fuels – combustion equations, carbon analysis, flue gas analysis, Orsat apparatus. Heat engines – E.C. and I.C. engines, classification of I.C. engines, principles of operation, S.I. and C.I. engines, two stroke and four stroke engines, valve timing diagrams. Testing of I.C. engines – IHP, BHP, air consumption, fuel consumption, air-fuel ratio, efficiencies, heat balance sheet. Reciprocating air compressors – working, workdone. Horse power, volumetric efficiency, isothermal efficiency, multistage air compressors, inter cooling, condition for maximum power, P V diagrams. Formation and properties of steam, entropy of steam.

ii. Electrical Engineering and Farm Electrification: Basic electrical quantities – specific resistance temperature coefficient. Network theorems – Kirchoff's laws, Maxwell's loop method. Nodal analysis – superposition theorem, Thevenins theorem. Star delta transformation. D.C. generators – classification, lap and wave wound generators, E.M.F. equation of a generator, losses, condition for maximum efficiency, armature reaction, commutation. D.C. motors – maximum power, armature torque, shaft torque, speed regulation. Motor characteristics – series motors, shunt motors, compound motors. Motors starters.

Farm electrification and load estimation. Transformers – introduction, working principles. A.C. motors – types of motors, starting torque, running torque, starting of induction motors. Types of single-phase motors.

iii. Computer Programming in 'C': Computers – introduction, types, generation of computers, input output devices, central processing unit, memory devices, processors, key board, printers, 'C' Language – introduction,

importance of 'C' basic structure of 'C' programme, algorithms, flow charts, programming translation. Programming preliminaries and fundamentals – constants, variables, data types, operators and expressions, input and output in 'C' decision making and branching, decision making and looping, arrays, functions, common programming errors. Writing of complete programmes - programme on mean, standard deviation and coefficient of variation, summation of series, quadratic equations, matrices addition, subtraction and multiplication, correlation and linear regression. Application of 'C' language for solving the problems related to agricultural engineering.

iv. Engineering Mechanics: Introduction – units and dimensions. Classification of force system – coplanar, collinear, concurrent, coplanar parallel forces, resolution of forces. Condition of equilibrium - action and reaction, free body diagram. Support reactions – types of supports, types of loading, finding reactions of simply supported, overhanging, roller and hinged beams, analytical and graphical methods. Analysis of perfect frames – types, reaction of supports of a frames – types, reaction of supports of a frame by method of joints, method of sections and graphical method. Center of gravity and moment of inertia – determination by method of moments, theorems of parallel and perpendicular axes, product of inertia. Friction – definitions, types, laws of friction, angle of repose, equilibrium of a body, analysis of ladder and wedge friction. Lifting machines – definitions, law of machine, study of important lifting machines. Virtual work – principle, units and applications.

v. Refrigeration and Air Conditioning: Principles of refrigeration – units, terminology, production of low temperatures, air refrigerators working on reversed Carnot cycle and bell Coleman cycle. Vapour compression refrigeration – mechanism, PV, PS, PH diagrams, vapour compression cycles, dry and wet compression, superheating and sub cooling, Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration systems. Cold storage plants.

Air conditioning – factors of human comfort, equipment used in A/C cycle, classification of A/C system, winter, summer and central A/C system, design calculations for air conditioning systems.

vi. Mechanical Measurements and Instrumentation: Measurement and its significance – methods of measurement, instruments, classification of instruments, elements of a generalised measurement system, errors in measurement and their uncertainty. Detector transducer elements – introduction, primary and secondary transducers, classification, signal conditioning and data presentation elements, static performance characteristics of instruments. Measurement of pressure – introduction, types of pressure measuring devices, ranges and their application. Measurement of strain – introduction, strain gauge, resistance strain gauge theory, strain gauge circuits, strain gages arrangement for the measurement of axial force, bending force, torque and pressure. Measurement of temperature – introduction, classification of temperature measuring devices, methods of measuring temperature, Measurement of sound – introduction, measurement of sound using microphones. Measurement of vibration – introduction, seismic transducers, types of accelerometers. Study of miscellaneous instruments – tachometers, stroboscope, proving ring, LVDT.

vii. Theory of structures: Theory of structures – introduction, moment, slope, deflection equations and applications of propped, fixed and continuous beams, theorem of three moments. Stresses in thin walled vessels – cylindrical and spherical. Combined bending and axial thrust of columns – Euler's formulae for long struts, practical applications, empirical column formula.

viii. Heat and Mass Transfer: Heat transfer – modes of heat transfer. Heat transfer by conduction – through tubes, composite tube section, plain and composite walls, overall heat transfer coefficient, critical insulation thickness, unsteady state heat conduction with known temperature distribution, with negligible internal thermal resistance, application of Heisler chart heat transfer by convection free and forced convection, determination of Nusselt's number with dimensional analysis. Heat transfer by radiation – black body concept, Planck's law, Stefan Boltzmann's law, gray body, emissive power of gray body, emissivity, Kirchoff's law, combined heat transfer coefficient, fouling factor, LMTD and NTU method of heat exchanger analysis. Mass Transfer – molecular diffusion in gases, liquids and solids, unsteady state diffusion, convective mass transfer coefficients.

AGRICULTURAL ENGINEERING- PAPER-2

Section – A

I. Agricultural process Engineering (Unit Operations): Introduction to unit operations –classification, conservation of mass and energy SI system of units, consistency of units. Size reduction – principles of comminution, characteristics, particle size distribution, energy and power requirements, crushing efficiency, Rittinger's, Kick's and Bond's laws of crushing. Size reduction equipments – crushers, hammer mills, attrition mills and ball mills. Mixing – mixing of solids, pastes and liquids, characteristics of mixtures, blending, emulsification, mixing index, mixing and blending equipments. Evaporation – single and multiple effect evaporators steam economy, vacuum evaporation, vapour compression, boiling point elevation. Evaporation equipments – open pan, short and long tube evaporators, forced circulation evaporators. Mechanical separations – filtration filter cake resistance, filtration equipment, sedimentation, gravitational sedimentation of particles in fluid and gas, setting under combined forces, cyclone separator, centrifugal separator. Moisture content – determination methods, equilibrium moisture content. Psychrometry – terms, chart and application. Drying process – theories in drying, methods of drying, classification of dryers. Contact equilibrium separation process – concentrations, extraction, rate of extraction, stage equilibrium extraction. McCabe and Theile plot. Distillation – stage distillation, steam, vacuum and batch distillation, distillation equipment.

II. Process Engineering for agricultural produce: Engineering properties of agricultural produce – physical, thermal and aerodynamic properties, force deformation curve of food grains. Principles of threshing – threshing equipment, types, care and maintenance. Principles of winnowing – winnower types. Cleaning and separation – principles, equipment, effectiveness of separation, selection of separating machines. Grading – principles equipment. Rice processing – parboiling of paddy, traditional and modern methods of parboiling, drying equipment, methods of rice milling, rice husk and bran utilisation, layout of modern rice mill, manufacturing process for puffed, flaked and extruded products. Cereal processing – wheat milling, maize shelling, Milling, Degerming. Milling of pulses, Red gram, black gram and green gram. Oil seed processing. Sugarcane crushers. Seed technology – terminology, storage of seeds and treatment. Principles of grain storage – parameters affecting storage, changes occurring during storage, moisture migration, storage insects, pests and their control. Fumigation – principles, properties of fumigants and applications, rodent control. Grain storage structures – bag and bulk storage of grains. Grain handling equipment – bucket elevator, belt, screw and pneumatic conveyors. Quality control – Agmark and BI Standards.

III. Process Engineering for Horticultural produce: Engineering properties of horticultural crops – introduction, harvesting indices, methods and equipment. Handling and transportation. Cleaning and grading equipment, Preservation of fruits and vegetables – drying and dehydration, freeze drying, canning, concentration and reverse osmosis techniques, modified atmospheric and control atmospheric storage. Processing and processing machinery of important horticultural produce. Spices and condiments – oleoresins and essential oil extractions from aromatic plants, flowers and spices. Processing of important vegetables. Principles of packaging and packaging materials.

IV. Vegetable oil technology: Oils and facts – occurrence and distribution in nature, enzymatic and chemical spoilage, rancidification and its control, emulsions and emulsification. Processing of Oilseeds and other oil bearing materials – pretreatment and equipments, extraction methods, mechanical expression, solvent extraction, supercritical extraction, oil cake utilisation, refining of oils, hydrogenation, quality factors.

V. Dairy and Food Engineering: Milk – composition, characteristics, nutritive value, physico – chemical properties of milk, standardization, pasteurization, low temperature long time (LTLT), high temperature short time (HTST), ultra high temperature (UHT), plate heat exchanger, sterilization, homogenization, Manufacture of milk products – milk powder, cream, butter and ice cream. Milk and milk products packaging.

Material and energy balances in food engineering. Reaction kinetics – general principles, effect of time and temperature, Food preservation – principles and methods, causes of food spoilage, radiation preservation of food, properties of ionizing radiation, effects of irradiation on living organisms, technology aspects of irradiation preservation. Freezing of foods – freezing point of foods, freezing point depression, calculation of freezing time.

VI. Agro Industries and by-product utilisation: Agro industries – definition, classification, factors responsible for establishment.

Byproducts utilisation – rice husk, rice bran, coconut coir and shell utilisation, mango stone, cashewnut shell, banana pseudo stem, sugarcane bagasse, paper making from agricultural wastes, feed processing plants, layout of feed mills for commercial production. Planning waste management – properties of agricultural waste, waste collection, industrial waste treatment, storage and handling, waste for reuse, briquetting. Establishment of agroprocessing industries in rural areas. Cost benefit ratio for agroprocessing industries. Estimation of BOD, COD, Biological treatment of effluents, tricking filters.

VII. Biomass energy conversion: Energy sources – introduction, classification. Biomass – biomass characteristics, utilisation, biodegradation, microbial species, biogas production, parameters affecting gas production, stirring and dilution, types of biogas plants, comparison, merits and demerits, community biogas plants, constructional details, operation and maintenance, safety measures, slurry utilisation, alternate feed stocks. Biogas appliances – biogas lights, biogas run engines. Agricultural wastes – characteristics, principles of combustion, pyrolysis, incineration, thermodynamic concepts, gasification. Gasifiers – principles, types, stability of operation, design. Charcoal making – principle, methods.

VIII. Solar and Wind Energy: Solar energy and its importance – heat transfer from solar energy by conduction, convection, radiation, reflectivity, transmissivity. Solar radiation analysis – solar constant, terminology connected with solar radiation, solar time, solar radiation measurement and estimation. Solar

collectors – flat plate collectors, principle of conversion of solar radiation into heat, thermal losses, energy balance equation. Solar air heaters – performance and application. Focusing type solar collectors – thermal performance, optical losses. Solar energy storage – solar pond principles, types and applications of solar pond. Solar energy applications – solar furnace, distillation, cooking, grain drying. Photovoltaics – semiconductor principles, cell characteristics, application of photovoltaic systems in pumping.

Nature of wind power – seasonal influence, diurnal variation, characteristics of suitable sites, velocity and direction measuring instruments, anemometer, wind monitor, rotor classification, air foils, comparison of different types, lift and drag characteristics, wind mill components, power transmission, performance of wind mill, application of wind mills.

IX. Greenhouse Technology: Greenhouse technology – introduction, importance of greenhouse, greenhouse effect. Factors responsible for plant growth – heat, light, moisture, carbon dioxide, nutrients, plant response to greenhouse environment. Solar energy in greenhouse – importance, types of radiation, effect on greenhouse environment, parameters. Design criteria of greenhouse for cooling and heating purposes. Greenhouse equipments – materials of construction for traditional and low cost greenhouse, cost estimation and economic analysis. Typical applications – passive solar greenhouse, hot air greenhouse heating systems, greenhouse drying. Natural ventilation, summer and winter cooling – shadenets, polytunnels.

X. Design and Costing of Farm Structures: Farmstead – layout, design and costing of farm structures, farm, house, godowns, threshing and drying yards. Farm roads – types and construction. Farm fencing – types and cost estimation. Dairy barns – types, site selection, design and costing. Types, design and costing of poultry and hog housing. Storage structures – grain pressure theories, design and costing of traditional structures, bag storage structures, grain bins, silos for fodder storage. Design and costing of farm workshop and machinery storage structures.

Section – B

I. Rural water supply, Sanitation and Environmental Engineering: Rural water supply – water demands, sources of water supply. Collection and distribution of water – storage systems, distribution mains, pipes, joints and fittings, pumps and pumping stations. Quality and treatment of water – sedimentation, filtration, types of filters.

Sanitation – septic tanks, preparation of sanitary projects. Sewage disposal – methods, sewage treatment, sludge disposal and treatment methods. Air-pollution – sources and control measures.

II. Wells and Pumps with Special reference to Lift Irrigation: Water resources – introduction, status of ground water development in India. Types of water bearing formations – ground water replenishment and recharge methods. Ground water investigation methods. Hydraulics of wells – aquifer characteristics influencing yield of wells both under steady state and unsteady state conditions, procedure involved in estimation of aquifer characteristics through pumping tests. Wells - classification of wells, design of open wells in unconsolidated formations, methods for increasing the yield in open wells. Types of tube wells – selection of type of tube well, analysis of particle size distribution of the aquifer, design of tube wells, tube well construction procedures and development and testing of tube wells.

Classification of water lifting devices – manual and animal powered devices. Pumps – reciprocating pumps (single and double acting). Centrifugal pumps – components, principle, characteristic curves, power requirements. Deep well pumps – turbine and submersible pumps, their components, working, principle installation and maintenance. Hydraulic ram – installation, working principle. Jet pumps – components, working principle. Selection of pumps and economic evaluation of pumping.

III. Irrigation Engineering: Irrigation – necessity, benefits, sources, soil – water – plant relationships kinds of soil water. Types of Irrigation projects. Infiltration – characteristics, measurement and analysis. Evapotranspiration and its measurement. Water requirements of crops – duty and delta of water. Irrigation requirement – depth, interval, and period, irrigation efficiencies. Water application methods – borders, furrows and check basins and their designs. Measurement of irrigation water – different methods, volumetric, area velocity, measuring devices, weirs, flumes, watermeter. Design of open channels and canals – Lacey's and Kennedy's theories. Design of underground pipeline systems.

IV. Soil and Water Engineering: Importance and phases of soil and water conservation engineering. Soil conservation programmes in India. Erosion – main types of erosion, factors effecting erosion. Water erosion – types of water erosion, control measures. Wind erosion – phases, control measures. Land use capability classification. Measurement of soil loss – universal soil loss equation. Contour and graded bunds – design of bunds, spacing of bunds, determination of height of the contour bund, construction and alignment of bunds, surplus arrangements, contour ditching, area lost under contour bunding. Terracing – types of terraces, planning and design of a terrace system, constructional procedure, equipment needed. Bunch terracing – types, area lost under Bund terracing. Contour trenching – types, alignment and construction. Bed and furrow system. Vegetated waterways – functions, shape of water ways, design of vegetated waterways, maintenance. Gullies – planning for gully control, methods of gully control, temporary gully control structures, permanent gully control structures, phases.

V. Watershed Management: Watershed management – concept and principles – watershed characteristics, watershed protection, analysis, and control measures. Effects of watershed management. Study of watershed management as a multi disciplinary approach – watershed identification, watershed delineation.

VI. Drainage Engineering: Drainage – necessity, benefits, drainage requirements, drainage coefficient, hydraulic conductivity and its measurement, field and lab methods. Types of drainage – surface drainage systems for ponded, flat and slopy areas. Subsurface drainage methods, tile drainage, layout, depth and spacing of drains, steady and unsteady state condition, Hooghoudt's analysis, equivalent depth concept, size,

grade and materials for tile drains, envelope materials and types of outlets. Drainage for salinity control – leaching requirements. Loads on conduits – ditch type and projecting type conditions, strength requirements of tile drains.

VII. Sprinkler and Drip Irrigation: Sprinkler irrigation – adaptability, limitations, types, components of the sprinkler system including fertilizer applicator, precipitation profiles and recommended spacings, effect of wind speed on working of the system, design of sprinkler system, lay out, laterals and mains, selection of pump, operation and maintenance of system. Field evaluation of the system – distribution pattern and uniformity coefficient, cost analysis.

Drip irrigation – advantages and limitations, types, components of the system including fertilizer applicator and pressure regulators, distribution network, main lines, laterals, drippers. Planning and design of the drip system – collection of preliminary data, layout, crop water requirements, hydraulic design, selection of components, installation, operation and maintenance, testing and field evaluation of the system.

VIII. Land Development Machinery: Land Clearing – rock blasting, stump pulling. Land development – terminology, methods, cost of material movement. Land development machinery – types, crawler tractors, track versus rubber tyres. Excavators – shovel, hoe, dragline, clamshell, proclaines, rippers. Combined excavation and hauling units – wagons, trucks and front end dumpers, hydraulic trippers. Compaction rollers. Scrapers – types, bulldozers, levelling blades.

IX. Farm power and Tractor Systems: I.C. engines – introduction, principles of operation of I.C. engines, performance characteristics of diesel engine, different components of I.C. engines. Tractor systems – fuel, lubrication, cooling, electrical, transmission, governing, brakes, steering, hydraulic systems, principle and maintenance of storage battery. Chassis mechanism – determination of center of gravity, maximum drawbar pull. Tractor and power tillers – classification, selection, operation, adjustments, common troubles and remedies, maintenance, comfort, safety, power and its measurement, traction theory, tyres.

X. Farm machinery and agricultural machine design: Tillage – introduction, objectives, primary and secondary tillage, animal and tractor drawn implements. Mould board plough – constructional details, terminology, materials of construction, types of plough bottoms, shares, plough accessories, force analysis and design considerations, problems on M.B. Plough operations, victory plough, turn wrest plough. Disc ploughs – advantages, disadvantages, constructional details of various components, accessories, plough adjustments, disc angle and tilt angle, differences between M.B. plough and disc plough, Ploughing methods. Chisel and subsoiler. Secondary tillage implements – harrows, types, constructional details of single action, double action, tandem and offset disc harrows, spike tooth, spring tooth harrows, differences between vertical disc plough and standard disc plough. Cultivators – rigid, spring type cultivator, types of sweeps and shovels. Weeding, manual and power operated equipments. Other implements – bund former, ridger, APAU puddler, clod breaker, rototiller, green manure trampler. Cost of operation of farm implements. Sowing – methods, seed drill functions, calibration procedure, numerical problems, types of metering mechanisms, types of furrow opener, types of planter, construction and working principles of dibbler. Planting equipments – paddy transplanter, potato planter, sugarcane planter. Manure and fertilizer application – manure applicators spreaders, broadcasters, fertidril.

Plant protection equipments – importance, types, Sprayers – classification, bucket, knapsack, boom sprayers, parts and accessories, atomizers, agitators, determination of particle size distribution, MMD and SMD/VMD, ultra low volume, low volume, high volume spraying, aerial spraying, orchard sprayers, factors affecting drift. Distlers – types, hand, rotary and power operated sprayers cum distlers. Care and maintenance of plant protection equipment. Crop harvesting machinery – mower, reaper, cutting and driving mechanism, adjustments of mower. Combines – working of combines. Harvesting equipment for cotton, maize, potato, groundnut, fruits and vegetables.

Design process – classification of design work. Working stresses – stress concentration, notch sensitivity. Theories of failure – maximum shear stress theory, maximum strain theory, maximum distortion theory. Limits, fits and tolerances. Design of knuckle joints, cotter joints. Design of hand lever, foot lever, crank lever. Design of springs – flat and leaf springs. Design of shafts – design of belts pulleys – keys and key ways. Design of flywheels. Design of couplings – muff, flange couplings. Design of bearings – ball, roller bearing. Design of I.C. engine parts – cylinder, cylinder head, connecting rod.

XI. Design and Costing of Soil Conservation and Irrigation Structures: Introduction to soil and water conservation structures. Design and costing of mechanical structures – contour bund, graded bund, broad based terraces, bench terraces, contour trenches and conservation ditches. Design and costing of gully control structures – drop spillways, drop inlet spillways, chute spillways, check dams. Design and costing of water harvesting structures – farm ponds, percolation tanks. Design and costing of energy dissipaters – stilling basins.

Irrigation engineering structures – design and costing of canal falls, cross drainage works, aqueducts, super passage, inverted syphon aqueduct. Irrigation outlets – non-modular, semi modular, rigid modular outlets, baffle sluice irrigation modules. Regulators – head regulator, cross regulator.

Sd/- Secretary
01/07/2008

MECHANICAL ENGINEERING- PAPER-2

1.THERMODYNAMICS:

Basic concepts, Open and closed systems. Heat and work, Zeroth, First and second law, application to flow and non-flow processes. Entropy, Availability, Irreversibility, T-S relations, Clapeyron and real gas Equations. Properties of ideal gases and vapours. Air standard cycles, Two stage air compressor, CI and SI engines, Valve travel diagram, Pre ignition, Detonation and Diesel knock, Fuel injection, Carburetion, Super charging, Turbo prop and Rocket engines. Cooling, Emission and Control. Measurement of calorific value of fuels. Conventional and Nuclear fuels.

2. HEAT TRANSFER:

Modes of heat transfer. One-dimensional steady and unsteady conduction. Composite slab and equivalent resistance. Heat dissipation from extended surfaces. Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flow, Heat transfer in free and forced convection. Thermal boundary layer over a flat plate. Fundamentals of diffusive and convective mass transfer. Black body and fundamental concepts of radiation. Shape factor, Network analysis.

3. REFRIGERATION AND AIR CONDITIONING:

Heat pump, Refrigeration cycles and systems, Refrigerants, Condensers, Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling. Effective temperature, Comfort indices, Load calculations. Solar refrigeration, Duct design.

4.STEAM GENERATORS AND TURBINES:

Fire tube and water tube boilers. Binary vapour system. Flow of steam through nozzles and Diffusers. Dryness fraction, Condensation. Various types of turbines, Compounding, Velocity triangles, Partial admission, Reheat, Regeneration, Efficiency and Governance. Gas Turbines, Role of Mach number.

5.THEORY OF MACHINES:

Kinematic and DYNAMIC ANALYSIS OF PLANAR MECHANISMS CAMS Gears and Gear trains. Fly wheels, Governors, Balancing of rotating masses, Balancing of single and multi cylinder engines. Linear Vibrations of mechanical systems, Transmissibility and Vibration Isolation. Critical speeds. Two rotor and Three rotor systems. Automatic controls - Order and Type of system, 2nd order system and its characteristics. Frequency analysis. Stability, Routh-Hurwitz criterion, Nyquist criterion.

6.MACHINE DESIGN:

Theories of failure, Design of Cotter joint, Keys, Splines, Welded Joints, Threaded fasteners, Bolt of uniform strength, Screw Jack. Design of Bearings, Couplings, Clutches, BELT DRIVES and Spur gear system. Hydrodynamic and Antifriction bearings. Design of shafts for combined loads. Helical and Leaf Springs. Thin and Thick walled pressure vessels.

7. ENGINEERING MATERIALS:

Basic concepts of structure of solids. Crystalline Materials. Defects in Crystalline materials. Alloys and Binary Phase diagrams. Structure and properties of common Engineering Materials. Heat treatment of Steels. Plastics, Ceramics and Composite materials. Common applications of various materials.

8. PRODUCTION ENGINEERING:

Metal Forming: Basic principles of Forging, Drawing and Extrusion. High energy rate forming. Powder Metallurgy.

Metal Casting: Die casting, Investment Casting, Shell molding, Centrifugal casting, Gating and Rising design, Melting furnaces.

Fabrication processes: Principles of Gas, Arc and Shielded Arc welding. Advanced welding processes. Weldability, Metallurgy of Welding.

Metal cutting: Turning, Methods of Screw production, Drilling, Boring, Milling, Gear Manufacturing, Production of Flat surfaces, Grinding and Finishing processes. Computer controlled manufacturing systems-CNC, DNC, FMS, Automation and Robotics.

Cutting Tool Materials, Tool geometry, Mechanism of Tool Wear, Tool Life and Machinability. Measurement of Cutting Forces. Economics of Machining. Unconventional Machining processes. Jigs and Fixtures. Fits and Tolerances. Measurement of Surface texture. Comparators Alignment Tests and Reconditioning of Machine Tools.

9. INDUSTRIAL ENGINEERING:

Production planning and Control: Forecasting, Moving Averages, Exponential Smoothing, Operations, Scheduling, Assembly line balancing. Product Development, Break-even analysis, Capacity Planning, PERT and CPM.

Control Operations: Inventory Control, ABC analysis, EOQ model, Material requirement Planning. Job Design, Job standards, Work Measurement, Quality Management, Quality Analysis and Control.

Operations Research: Linear Programming – Graphical and simplex methods. Transport and Assignment Models. Single server Queuing Model.

Value Engineering: Value analysis for Cost value.

10. ELEMENTS OF COMPUTATION:

Computer Organization, Flow charting, Features of Common Computer Languages – FORTRAN, d Base III, Lotus1-2-3,C and Elementary Programming.

ELECTRICAL ENGINEERING SUBJECT- PAPER-1

1. **Electric Circuits:** Active and passive network elements – dependent and independent sources – response of passive elements to arbitrary excitations – energy stored in inductance and capacitance – Kirchoff's law – formation of mesh and nodal intergo differential equations – their solutions by classical and Laplace transformation methods – Transient and steady state response of RL, RC elements to impulse, step, ramp and sinusoidal inputs – single phase AC circuits – methods of solutions – poly phase circuits – analysis of balanced and unbalanced circuits – measurements of three phase power.
2. **Electrical Measurements and Instruments:** Absolute and secondary instrument types – Principle of operation of different type of instrument – extension of instrument ranges – measurement of voltage, current, power and energy – localization of cable faults – Murray loop and Varley loop tests – Cathode ray Oscilloscope.
3. **Illumination:** Solid angle, luminous flux, luminous intensity – Illumination and candle power – laws of Illumination – flood lighting, street lighting – electric lamps.
4. **DC Generators and Motors:** Types of DC generators – EMF equation – constructional details – characteristics of shunt, series and compound generators – Armature reaction – types of DC motors – Torque developed in a DC motor – speed controls of DC motors and starters.
5. **Transformers:** Constructional details – Principle of operation – vector diagrams on no load and load – regulation and efficiency – equivalent circuits and tests for the determination of parameters of equivalent circuits – types of three phase transformers and their applications – Scott connection of transformers.
6. **3-Phase Induction Motors:** Principle of operation – Cage and Slip ring motors – torque slip characteristics – methods of speed control.
7. **3-Phase Alternators:** Principle of operation and constructional details – types of Alternators – synchronous impedance – voltage regulation – short circuit ratio and its importance – phasor diagrams of round rotor and salient pole machines – synchronization – behavior of an alternator connected to infinite bus – effect of varying excitation current and mechanical torque – power angle curves – control of active and reactive powers.
8. **3-Phase Synchronous Motors:** Principle of operation – torque developed and methods of starting – V and Inverted V curves – effects of variations of excitation – synchronous condensers.
9. **Single phase induction Motors:** Types of single phase motors – Types of Single phase induction motors – characteristics and methods of starting – shaded pole induction motor.

ELECTRICAL ENGINEERING- PAPER-2

1. **Transmission & Distribution:** Line constants – Inductance and Capacitance calculations – Representation of over head Lines – Short, Medium and Long lines – ABCD constants – Mechanical Design – Sag, Tension Calculations, Tuned Power Lines.
2. **Over Head Line Insulators:** Types of Insulators – Potential distributions over a string of suspension insulators – string efficiency – Methods of improving string efficiency.
3. **Underground Cables:** Insulation of cables – Grading of cables – Capacitance Measurement in cables – Testing of Cables – Power frequency withstand tests.
4. **Fault Calculations:** Balanced Fault calculations on systems – Symmetrical components – Types of faults – Analysis of unbalanced faults.
5. **Generating Stations:** Location and types, types of hydroelectric power stations, layout of a hydro-power plant, types of turbines used – Pumped storage installations – Layout of thermal electric power stations, types of turbines used, condensers, cooling towers, boiler feed pump; energy flow diagram of steam power plant. Nuclear power generation; nuclear fission – types of nuclear power reactors – Principle of a fast breeder reactor.
6. **Protection:** Characteristic of Relays – Over current, directional and distance protection of lines. Protection of Alternators against stator faults, rotor faults, loss of excitation, unbalanced loading, overloading, failure of prime-mover. Over speeding and over voltage. Protection of transformers against winding faults, overloads and external short circuits.
7. **Circuit Breakers:** Air-blast, oil, minimum oil, vacuum – sulphur hexafluoride and d.c. circuit breakers – Relative merits and demerits.
8. **Economic Aspects:** Generation costs and their classification, load curve, load utilization and plant capacity factors. Load sharing between base load and peak-load stations. Load forecasting. Economical distribution of load between unit within a plant and between plants. Modeling of fuel costs for thermal generation. Optimal operation of an all thermal generating system and of a hydro-thermal system. Consideration of transmission losses.
9. **Utilization of Electrical Energy:** Industrial drives – Motors for various drives – Estimating and Rating – Testing of D.C. and A.C. motors – Neutral Earthing.

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