

## **ANNEXURE –A**

### **Recruitment to the 17 Posts of Assistant Agriculture Engineer Grade-II In the Department of Agriculture, Govt. of Punjab.**

#### **Syllabus for Bachelor of Technology Agricultural Engineering**

##### **FARM POWER AND MACHINERY ENGINEERING**

###### **Farm Power and Machinery 1+1 Sem. I**

Farm Power in India - Sources. Internal Combustion (IC) engines and terminology. Working principles of two stroke and four stroke engines. Different systems of tractors, types and selection. Primary and secondary tillage implements. Implements for intercultural operation, seed drills, paddy transplanters, their calibration. Plant protection, harvesting and threshing equipment. Cost of operation of tractor and machinery.

###### **FIELD OPERATION AND MAINTENANCE OF TRACTORS AND FARM MACHINERY**

Introduction to various systems of a tractor viz. fuel, lubrication, cooling, electrical, transmission, hydraulic and final drive system. Familiarisation with tractor controls & learning procedure of tractor starting and stopping. Driving in forward and reverse gears. Driving safety rules and road signs. Hitching, adjustments, settings and field operation of farm machinery. Familiarisation with different makes & models of 4- wheeled tractors. Driving practice with two wheeled tractor trailer in forward and reverse. Practising the hitching and dehitching of implements; Study operation and field adjustments of common primary and secondary tillage equipment and seed drills.

###### **FARM MACHINERY AND EQUIPMENT-I**

Objectives of farm mechanization. Classification of farm machines. Materials of construction and heat treatment. Principles of operation and selection of machines used for production of crops. Field capacities and 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 and working principles viz Bulldozer, Trencher, Elevators laser land leveller etc.; Sowing, planting and transplanting equipment - their calibration and adjustments. Minimum tillage, no-tillage and straw management equipment. Fertilizer application equipment. Weed control and Plant protection equipment - sprayers, dusters and their calibration, selection, constructional features of different components and adjustments.

###### **FARM MACHINERY AND EQUIPMENT-II**

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

###### **TRACTOR AND AUTOMOTIVE ENGINES**

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

###### **FIELD OPERATION AND MAINTENANCE OF TRACTORS AND FARM MACHINERY**

Introduction to tractor maintenance procedure and trouble shooting. Scheduled maintenance after 10, 50,100, 250,500 and 1000 hrs. of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance and workshop requirements.

###### **TRACTOR SYSTEMS AND CONTROLS**

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: P.T.O., belt pulley, drawbar, etc. Tractor chassis mechanics and design for tractor stability. Ergonomic considerations and operational safety.

## **TRACTOR DESIGN AND TESTING**

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman Steering and tractor hydraulic systems. Study of special design features of tractor engines and their selection. Design of seat and controls of an agricultural tractor. Tractor Testing.

## **PRODUCTION TECHNOLOGY OF AGRICULTURAL MACHINERY**

Critical appraisal in production of Agricultural Machinery; Modelling and stress analysis of Machinery parts by using standard software; Advances in material used for tractor and Agril. Machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques like powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, chemical vapor deposition (CVD) etc. Limits, Fits and Tolerances, Jigs and Fixtures, Microstructure Analysis. Industrial lay-out planning, Quality management,. Economics of process selection. Techno-economic feasibility of Project Report. Selection of Standard/ critical components. Case studies of manufacturing of agricultural machinery. Servo motors, drives & controllers, CNC controllers for machine tools. CNC programming. Assembly and plant automation. Storage and transportation.

## **MECHANICS OF TILLAGE AND TRACTION**

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress-strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics performance of tillage tools. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, traction prediction, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and geostatistic, application of GIS in soil dynamics.

## **FARM POWER AND MACHINERY MANAGEMENT**

The role of mechanization and its relationship to productivity, employment, social and technological change; performance and power analysis; cost analysis of machinery: fixed cost and variable costs, effect of inflation on cost; selection of optimum machinery and replacement criteria; Break-even analysis, reliability and cash flow problems; mechanization planning; case studies of agricultural mechanization in India.

## **HUMAN ENGINEERING AND SAFETY**

Human factors in system development - concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor and trailer operation etc.

## **HYDRAULIC DRIVES AND CONTROLS**

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump classifications, Performance, Displacement, Designs, Gear Pumps, Vane Pumps, Piston Pumps, Pump Operation. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

## **BIOMASS MANAGEMENT FOR FODDER AND ENERGY**

Introduction to biomass management, biomass resource assessment management techniques/ supply chains, Processing of paddy straw, densification- Extrusion process, pellets, mills and cubes, Baling-classification, uses; residue management for surface mulch and soil incorporation, Paddy Straw choppers and spreaders as an attachment to combine Harvester, Mulch seeder, Paddy Straw Chopper cum-Loader, Baler for collection of straw; Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.

## **PROCESSING AND FOOD ENGINEERING ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS AND FOOD QUALITY**

Importance of engineering properties of biological materials and their applications in processing equipments; Study of different physical and thermal characteristics shape, size, 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, rheological models. Aerodynamic and frictional properties. Concept, and need of quality, quality control, Sampling; sampling techniques for liquid, powdered and granular materials, sensory quality control, panel selection methods, interpretation of sensory results in statistical quality control, Food Laws and Regulations in India. Food grades and standards.

### **PROTECTED CULTIVATION AND POST HARVEST TECHNOLOGY**

Introduction, planning, design and application of green houses. Plant response to greenhouse environment. Green house equipment. Materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses. Cost estimation and economic analysis. Winnowing. Groundnutdecorticators. Maize and castor shellers. Drying- grain drying, types of drying, types of dryers. Storagegrainstorage, types of storage structures. Cleaning and grading equipment for fruits and vegetables. Size reduction equipment. Evaporation- principle and types. Quality standards. Crops selection andconstraints of greenhouse cultivation. Growing media, drainage, flooding and leaching, soilpasteurization, nutrient film technique (NFT) / hydroponics.

### **CROP PROCESS ENGINEERING**

Scope and importance of food processing, principles and methods of food processing. Processing of farmcrops; cereals, pulses, oil seeds, fruits and vegetables and their products for food and feed. Processingof animal products, Principal of size reduction, size reduction machines; crushers, grinders, cutting machinesetc. - operation, efficiency and power requirement - Rittinger's, Kick's and Bond's equation, fineness modulus.Mixing, types of mixtures for dry and paste materials, rate of mixing and power requirement, mixingindex. Separation, types of separators, size of screens, sieve analysis, capacity and effectiveness ofscreens, pneumatic separation. Filtration, different types of filters, rate of filtration, pressure drop duringfiltration. Scope and importance of material handling devices, different types of material handling systems;belt, chain and screw conveyor, bucket elevator, pneumatic conveying, gravity conveyor- designconsideration, capacity and power requirement.

### **DRYING AND STORAGE ENGINEERING**

Importance of moisture content and EMC and methods of their determination, EMC curve and models,principle of drying, theory of diffusion, periods of drying, thin layer, deep bed and their analysis, criticalmoisture content, drying models, calculation of drying air temperature and air flow rate, air pressurewithin the grain bed, Shred's and Hukill's curve, different methods of drying; Dryers- performance, energyutilization pattern and efficiency, Types and causes of spoilage in storage, storage of perishableproducts, functional requirements of storage, control of temperature and relative humidity insidestorage, calculation of refrigeration load; air movement inside the storage; Storage of grains:destructive agents, respiration of grains, moisture and temperature changes in stored grains; naturalventilation inside storage, mechanical ventilation, artificial drying, traditional and modern grain storagestructures; Storage of seeds, hermetically sealed and air-cooled storages-refrigerated, controlledatmosphere, modified atmospheric and frozen storages. Economic, aspects of storage.

### **DAIRY AND FOOD ENGINEERING**

Dairy development in India. Engineering, thermal and chemical properties of milk and milk products, unitoperation of various dairy and food processing systems, process flow charts for product manufacture,working principles of equipment for receiving, pasteurization sterilization, homogenization, filling &packaging, butter manufacture, dairy plant design and layout, composition and proximate analysis of foodproducts. 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, plant utilities requirement.

### **AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL**

Planning, layout, design, construction and cost estimation of farmstead. Physiological reactions of livestock environmental factors; livestock production facilities; BIS. Standards for farm structures; Designand construction of rural grain storage system; Engineering for rural living and development, rural roads,their construction cost and repair and maintenance. Sources and norms of water supply for humanbeing and animals, drinking water standards and water treatment suitable to rural community. Site andorientation of building in regard to community sanitation system; sewage system its design, cost andmaintenance; Power requirement for domestic and irrigation, sources of power supply, electrification ofrural housing; Renewable and non-renewable resources; concept of eco system, biodiversity of itsconservation, environmental pollution and their control, solid waste management system.

### **FOOD PACKAGING TECHNOLOGY**

Factors affecting shelf life of food material during storage; Spoilage mechanism during storage; Definition,requirement, importance and scope of packaging of foods; types and classification of packaging system;advantage of modern packaging system. Different types of packaging materials used. Different forms ofpackaging, metal container, glass container, plastic container, flexible films, shrink packaging, vacuumand gas packaging; Packaging requirement and their selection for the raw and processed foods. Advantages& disadvantages of these packaging materials; effect of these materials on packed commodities,Package testing, Printing, labelling and lamination. Economics of packaging; performance

evaluation of different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

### **WASTE AND BY-PRODUCT UTILIZATION**

Waste and byproducts generation and utilization in different food processing industries; concept scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in wastewaters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, briquetting of biomass as fuel, generation of electricity, producer gas; waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal.

### **DEVELOPMENT OF PROCESSED PRODUCTS AND EQUIPMENTS**

Applications of unit operations to the food industry, analytical processing concepts with regards to mass and energy balances, equipment involved in the commercially important food processing methods and unit operations; value addition to cereals like rice, wheat etc. Parboiling of rice, quality of processed products of rice and wheat. Processing of pulses, spices and condiments; extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry products, technology of milk and milk products. Technology of oilseeds and fat products, snack foods, Fruits and vegetables product: candy, nutraceuticals, food product development trends, food additives and labeling. Process equipment for thermal processing-evaporation, dehydration, drying, blanching, pasteurization, distillation; mechanical separation-filtration, sieving, centrifugation, sedimentation; mechanical handling-conveying and elevation; size reduction and classification-mixing; kneading, blending.

### **FOOD PROCESSING PLANT DESIGN AND LAYOUT**

Meaning and definition of plant layout. Objectives and principles of layout. Types of layout. Salient features of processing plants for cereals, pulses oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Location selection criteria, selection of processes, plant capacity, project design, flow diagrams, selection of equipments, process and controls, handling equipments, plant layout, Plant elevation, requirement of plant building and its components, labour requirement, plant installation, power and power transmission, sanitation. Cost analysis, preparation of feasibility report. Quantitative analysis for Plant Layout: engineering economy. Common Problems in Plant Layout and Process scheduling. Practical Layout. Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Cleaning and sanitization.

### **SOIL AND WATER ENGINEERING IRRIGATION ENGINEERING**

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, orifices and other methods. Water conveyance and design of irrigation field channels. Underground pipe conveyance system and irrigation structures. Channel lining. Land grading, different design methods and estimation of earth work and cost. Soil water plant relationship, soil water movement, infiltration, evapo-transpiration, soil moisture characteristic, crop water requirement, soil moisture constants, depth of irrigation, frequency of irrigation and irrigation efficiencies. Surface irrigation methods of water application, border, check basin, furrow and contour irrigation. Sprinkler and drip irrigation method, merits, demerits, selection, design and evaluation. Irrigation water quality. Participatory irrigation management. Economics of water resources utilization.

### **SOIL AND WATER CONSERVATION ENGINEERING**

Introduction, soil erosion, types and agents of soil erosion. Gullies and their classification. Soil loss measurements and estimation. Erosion control measures. Level and graded broad base terraces and their design. Bench terraces and their design. Contour bunds, graded bunds and their design. Gully and ravine reclamation. Principles of gully control. Vegetative and temporary structures. Wind erosion, mechanics of wind erosion and soil loss estimation. Wind erosion control measures, wind breaks and shelterbelts, sand dunes stabilization. Sedimentation in reservoirs and streams, estimation and measurement. Contours and preparation of contour maps. Land use capability classification. Grassed water ways and their design. Introduction to water harvesting techniques. Stream water quality and pollution.

### **SOIL AND WATER CONSERVATION STRUCTURES**

Introduction, classification and functional requirements of soil erosion control structures. Flow in open channels, types, state and regimes of flow. Specific energy and specific force. Hydraulic jump and its application. Runoff measuring structures. Straight drop spillway. Components of spillway. Hydrologic and hydraulic design. Structural design of a drop spillway. Safety against sliding, overturning, crushing and tension. Chute spillway, general description and its components. Hydraulic design, energy dissipaters and design criteria of a SAF stilling basin. Drop inlet spillway, general description, functional use and

design criteria. Design of diversions. Small earth embankments, types and design principles. Farm ponds and reservoirs. Cost estimation of structures.

### **GROUND WATER, WELLS AND PUMPS**

Occurrence and movement of ground water. Aquifer and its types. Classification of wells. Steady and transient flow into partially, fully and non-penetrating and open wells. Design of open well. Groundwater exploration techniques. Design, construction and development of tubewells. Determination of aquifer parameters. Well interference. Multiple well systems. Surface and subsurface exploitation and estimation of ground water potential. Quality of ground water. Artificial groundwater recharge planning and modeling. Ground water project formulation. Water lifting devices. Types of pump. Design principles, performance curves and selection of centrifugal, submersible, turbine and propeller pumps. Selection of prime mover and pulleys. Trouble shooting in pumping sets. Priming and self priming devices. Positive displacement pumps and Hydraulic ram.

### **DRAINAGE ENGINEERING**

Drainage and familiarization with the drainage problems. Surface drainage and types of surface drainage systems. Sub-surface drainage and types of sub-surface drainage systems. Hydraulic conductivity and drainable porosity. Design of surface drains, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations. 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.

### **MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT**

Major, medium and minor irrigation projects. Development and utilization of water resources through different minor irrigation schemes. Basic concepts of command area. Irrigation water use efficiency and agricultural production. Land development, shaping methods and economics. Farm irrigation planning. Irrigation schedule policies. Rotational and other methods of water distribution. Water balance of a command area. Types and design of canal outlets. Conjunctive use of water. Cropping pattern for maximization of yield. Planning and execution of on farm development activities. Use of remote sensing techniques for command area development. Case studies of some selected commands. Farmer's participation in command area development. Economic aspects of irrigation and pricing of water. Preparation of project plan.

### **DESIGN AND MAINTENANCE OF GREENHOUSE**

History and types of greenhouse; importance, function and features of green house; scope and development of green house technology. Location, Planning and various component of greenhouse; design criteria and calculation; constructional material and methods of construction; covering materials and its characteristics, solar heat transfer, solar fraction for green house, steady state analysis of green house, Greenhouse heating, cooling, shedding and ventilation systems; Carbon Dioxide generation and monitoring and lighting systems, instrumentation and computerized environmental Control Systems. Watering, fertilization, root substrate and its pasteurization, containers and benches, plant nutrition. Alternative cropping systems; plant tissue culture, chemical growth regulation; disease control; integrated pest management; post production quality and handling. Cost analysis of greenhouse production; Applications of green house; its repair and maintenance.

### **MICRO IRRIGATION SYSTEMS DESIGN**

Past, present and future need of micro-irrigation systems. Role of Govt. for the promotion of micro-irrigation in India. Merits, demerits and types of micro-irrigation system. Micro-irrigation system- design, design synthesis, installation, and maintenance. Sprinkler irrigation - types, planning factors, uniformity, hydraulics, lateral, sub-mains and main line design. Pump and power unit selection. Drip irrigation - potential, automation and crops suitability. Fertigation - Fertilizer application criteria, suitability of fertilizer compounds, fertilizer mixing, injection duration, rate and frequency and capacity of fertilizer tank. Quality control in microirrigation components. Design and maintenance of polyhouse. Waste land development - hills, semiarid, coastal areas and water scarce areas. Benefit and Cost analysis.

### **WATERSHED PLANNING AND MANAGEMENT**

Problems and prospects of watershed management. Watershed based land use planning. Watershed characteristics. 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. 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 benefit analysis of watershed programmes. Optimal and use models. Case studies.

### **GULLY AND RAVINE CONTROL STRUCTURES**

Introduction, causes of flood occurrence. Flood classification. Flood estimation and methods of

estimation. Estimation of flood peak - Rational method, empirical methods and Unit hydrograph method. Statistics in hydrology. Flood frequency methods - Log normal, Gumbel's extreme value and Log-Pearson type-III distribution. Depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing and modified Puls's method. Flood control, history of flood control, structural and non-structural methods of flood control measures. Storage and detention reservoirs, levees and channel improvement. Gully erosion and its control. Soil erosion and sediment control measures. River training works. Planning of flood control projects and their economics.

### **REMOTE SENSING AND GIS APPLICATIONS**

Remote Sensing and stage in remote sensing. Modern remote sensing technology versus conventional aerial photography. Visual image interpretation, image interpretation, basic principles of image interpretation and factors governing the quality of an image. Factors governing interpretability. Visibility of objects. Elements of image interpretation, techniques of image interpretation, digital image processing and digital image. Remote sensing in agriculture progress and prospects. Microwave radiometry for monitoring agriculture crops and hydrologic forecasting. Aerial photo interpretation for water resources development and soil conservation survey. GIS, history of development of GIS definition, basic components and standard GIS packages. Data-entry, storage and maintenance. Data types, spatial-non-spatial (attribute data) and data structure. Data format, point line vector- raster. Polygon-object structural model. Files, files organization. Data base management systems (DBMS). Entering data in computer digitizer. Scanner-data compression.

### **RESERVOIR AND FARM POND DESIGN**

Earthen embankments, functions, advantages and disadvantages. Classification of earthen dams. Foundation requirements and grouting. Seepage through dams, estimation of seepage discharge, location of seepage/phreatic line by graphical and analytical methods, flow-net and its properties, seepage pressure and seepage line in composite earthen embankments. Drainage filters, piping and its causes. Design and construction of earthen dam. Stability of earthen embankments against failure by tension, overturning, sliding etc. Stability of slopes and analysis of failure by slice method. Types of reservoirs and farm ponds. Design and estimation of earth work. Cost analysis.

### **CIVIL ENGINEERING SURVEYING AND LEVELING**

Introduction to surveying. Classification of surveying. Basic principles. Linear measurements. Chain surveying. Compass surveying. Errors in measurements, their elimination and corrections. Plane table surveying. Levelling. Contouring. Computation of area and volume. Theodolite traversing. Elements of simple circular curve and setting of simple circular curves.

### **ENGINEERING MECHANICS**

Introduction to engineering mechanics. Basic concepts. Force systems. Centroid. Moment of inertia. Free body diagram. Equilibrium of forces. Frictional forces. Analysis of simple trusses using methods of joints, methods of sections and graphical method. Simple stresses. Shear force and bending moment diagrams. Bending and shear stresses in beams. Torsion in shafts. Plane and complex stresses.

### **WATERSHED HYDROLOGY**

Introduction to watershed hydrology. Hydrological cycle. Precipitation. Measurement of precipitation. Precipitation analysis. Estimation of missing data. Infiltration. Evaporation. Evapo-transpiration. Geomorphology of watersheds. Horton's laws. Runoff. Estimation of average runoff, runoff volume and peak flow/runoff. Hydrograph. Unit hydrograph. S curve hydrograph. Dimensionless unit hydrograph. Synthetic unit hydrograph. Stream flow measurement. Flood control methods. Flood routing. Introduction to watershed management and planning of peak runoff rate and runoff volume. Problems related to hydrograph and unit hydrograph. Exercises on design and location of retards for channel improvement. Flood routing problem.

### **SOIL MECHANICS**

Introduction to soil mechanics. Phase diagram. Index properties of soil. Classification of soils. Permeability. Consolidation. Compaction. Shear Strength. Earth pressure. Introduction to bearing capacity and stability analysis.

### **STRENGTH OF MATERIALS**

Introduction. Slope and deflection of beams using integration techniques, moment area method and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. Statically indeterminate beams. Propped beams. Analysis of fixed beams. Analysis of continuous beams using three moment theorem and moment distribution method.

### **DESIGN OF STRUCTURES**

Introduction to design concepts. Different types of loads and use of BIS Codes (IS 800 and IS 456). Design of steel 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.

Practical: Design of tension members, compression members and steel beams; Design and drawing of steel roof truss. Design of singly and doubly reinforced concrete rectangular beams and T beams. Design of one way and two way slabs. Design of columns, isolated footing and combined foundation. Design and drawing of a simple RCC building. Design and drawing of cantilever retaining wall.

#### **CE 404 ENVIRONMENTAL ENGINEERING**

Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

#### **BUILDING TECHNOLOGY & CONSTRUCTION PRACTICES**

Introduction of building materials. Stone. Bricks. Testing of bricks. Cement. Testing of cement. Cement concrete. Workability and strength of cement concrete. Testing of cement concrete. Reinforced cement concrete. Timber. Miscellaneous materials: plastics, fly ash, bitumen, plywood, corrugated sheets and paints. Brick bonds. Foundations. Damp Proofing Course. Floors and roofs. Doors and windows. Introduction to plumbing and drainage, low cost housing/rural housing and construction practices.

#### **MECHANICAL ENGINEERING ENGINEERING DRAWING**

Introduction of drawing scales, Principles of orthographic projections, Reference planes, Points and lines in space and traces of lines and planes, Auxiliary planes and true shapes of oblique plain surface, True length and inclination of lines, Projections of solids (Change of position method, alteration of ground lines), Section of solids and Interpenetration of solid-surfaces, Development of surfaces of geometrical solids, Isometric projection of geometrical solids.

#### **WORKSHOP PRACTICE**

Introduction to carpentry tools, materials, woods and their characteristics. Operations in wood working; Preparation of Cross halving, Lap joint, T-Halving joint, Dovetail joint and Mortise and Tenon joint; Introduction to Smithy tools and operations; Bending, Shaping etc., Jobs on Drawing, Punching, Riveting; Introduction to tools and measuring instruments for fitting. Jobs on sawing, filing and right angle fitting of MS Flat, Complex fitting job, Operations of Drilling, Reaming, and Threading with tap and dies, Introduction to tools and operations in sheet metal work, Making different types of sheet metal joints using G.I. sheets.

#### **THERMODYNAMICS AND HEAT ENGINES**

Thermodynamic properties, closed and open system, flow and non-flow processes, gas laws; Zeroth law of thermodynamics and temperature measurement; First law of thermodynamics- internal energy, work and heat, application in non-flow and steady flow processes; Second law, Kelvin-Planck and Clausius statements, reversible process, Carnot cycle, Carnot theorem, entropy, change of entropy in thermodynamics processes; gas and vapour, change of phase during constant pressure process, triple point and critical point, generation of steam, internal energy and entropy of steam, steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction, classification of boilers, Cochran, Lancashire, Locomotive and Babcock- Wilcox boilers, mountings and accessories; Rankine cycle, desirable properties of working fluid used for power plants, Expansive and non expansive working. Steam Engine, saturation curve and missing quantity, governing of simple steam engine, calculations of cylinder dimensions. Introduction to compound steam engines. Otto, Diesel and Dual cycles, air standard efficiency, other engine efficiencies and terms., calculation of efficiency, mean effective pressure and their comparison. Measurement of IP, BP and heat balance calculations (not involving combustion). Engine performance.

#### **THERMODYNAMICS**

Thermodynamic 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. Reversible processes, Carnot cycle, 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, mountings and accessories.

#### **WORKSHOP TECHNOLOGY**

Introduction to welding, types, gas welding, types of flames, welding techniques and equipment. Arc welding, equipment and tools. Casting processes. Classification, constructional details of Center Lathe, Accessories and Attachments, operations and tools used. Types of shapers, Constructional details of shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

## **HEAT AND MASS TRANSFER**

Introductory concepts, modes of heat transfer; Conduction- thermal conductivity of materials, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation, electrical analogy, Insulation materials, critical thickness of insulation; Fins- effectiveness, efficiency etc; Free and Forced Convection- Newton's law of cooling, heat transfer coefficient in convection, dimensional analysis of free and forced convection, useful non dimensional numbers and empirical relationships for free and forced convection, equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and in a tube, combined free and forced convection; Radiation- introduction, absorptivity, reflectivity and transmissivity, black body and monochromatic radiation, Planck's law, Stefan-Boltzmann law, Kirchhoff's law, grey bodies and emissive power, solid angle, intensity of radiation, radiation exchange between black surfaces, geometric configuration factor, heat transfer analysis involving conduction, convection and radiation by networks; Heat Exchangers- types, fouling factor, log mean temperature difference, heat exchanger performance, transfer units, heat exchanger analysis restricted to parallel and counter flow heat exchangers; Diffusion-steady state molecular diffusion in fluids at rest and in laminar flow, Fick's law, mass transfer coefficients. Reynold's analogy.

## **THEORY OF MACHINES**

Elements, pairs, kinematics chain, mechanism, their classification. Inversions of mechanisms. Velocity, acceleration-graphical method. Instantaneous centers. Gears, types, nomenclature, law of gearing, teeth profile, interference/undercutting. Simple, compound, reverted, and epicyclic gear trains, analysis by tabular method. Flywheel, turning moment diagrams, size. Belts, flat and V belts, materials, power transmitted, size, centrifugal tension, creep and slip. Chain drives. Friction, types, laws, pivots and collars, single disc, multiple disc, and cone clutches. Rolling friction. Governors, Watt, Porter, Proell governors, Effect of friction, terms relating to governor. Static and dynamic balancing. Balancing of rotating masses in one and several planes. Partial primary balancing of reciprocating masses.

## **FLUID MECHANICS**

Fluids- Properties, 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, stability of submerged and floating bodies; Kinematics - Lagrangian and Eulerian methods, 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 - Bernoulli's theorem, venturimeter, orifice-meter and nozzle, siphon, stress-strain relationships in laminar flow, flow between infinite parallel fixed and moving plates, laminar and turbulent flow in pipes, minor and major hydraulic losses, Moody's diagram, network of pipes, power transmission; Dimensional analysis and similitude- Rayleigh's method and Buckingham's 'Pi' theorem, similarities, dimensional analysis, dimensionless numbers; Introduction to fluid machinery. Practical: Study of manometers, pressure gauges and current meters; verification of Bernoulli's theorem; determination of coefficient of discharge of venturimeter, orifice meter, mouth piece and notches; determination of hydraulic coefficients for orifice; determination of coefficient of friction in pipeline; measurement of force exerted by water-jet on vanes; determination of metacentric height; efficiency of hydraulic ram; performance evaluation of Pelton and Francis turbines; velocity distribution in open channels and determination of Manning's roughness coefficient.

## **HANDS ON TRAINING IN CAD/CAM AND MACHINE DRAWING**

Introduction. Manual drawing from models and isometric views. Drawing of missing views. Sectioning. Sectional drawing of simple machine parts. Types of rivet heads and joints. Symbols for welded joints. Thread profiles. Representation of threads. Types of nuts, bolts, lock nuts, studs, machine screws, capscrews and wood screws etc. Definition and benefits of CAD, CAD system components. Computer hardware for CAD. Line generation. Points and lines, Polygons, filling of polygons. Text primitive. Other primitives. Windowing and clipping, view port. Homogeneous transformations. Planar and space curves design. Analytical and synthetic approaches. Parametric and implicit equations. B-spline and Bezier curves. Geometric modeling techniques. Wire frames. Solid modeling. Introduction to numerical control, basic components of NC system, NC coordinates and motion control systems. Computer numerical control, direct numerical control, combined CNC/DNC. NC machine tools and control units. Tooling for NC machines, part programming, punched tape, tape coding and format, manual and computer assisted part programming.

## **INSTRUMENTATION AND PROCESS CONTROL**

Introduction, definition, recorders and monitors, panel boards. General characteristics of instruments, static and dynamic characteristics. Temperature and temperature scales., various types of thermometers-mercury-in-glass, bimetallic, pressure-spring thermometers, thermocouples, resistance thermometers and pyrometers. Pressure and pressure scales, manometers, pressure elements, differential pressure. Liquid level measurement, different methods of liquid level measurement. Flow measurement, kinds of flow, rate of flow, total flow differential pressure meters, variable area meters. Transmission. Pneumatic and electrical. Control elements, control actions pneumatic and electrical control systems.

## **MACHINE DESIGN**

Design, phases, considerations. Mechanical properties of engineering materials. Types of loads and stresses, theories of failure, Stress concentration, fatigue and creep. Cotter, knuckle and pinned joints, turn buckle. Design of welded joints subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear or subjected to eccentric loading. Design of shafts under



torsion and combined bending and torsion. Design of keys, muff/sleeve, rigid flange couplings, helical and leaf springs, flat belt and V-belt, pulleys, gears, brackets, levers, columns, thin cylindrical and spherical shells, curved beams, crane hooks, circular rings, etc.. Design of screw motion mechanisms like screw jack, leadscrew, etc. Selection of antifriction bearings.

### **REFRIGERATION AND AIR CONDITIONING**

Principles of refrigeration, Carnot cycle, reversed Carnot cycle, coefficient of performance, vapour compression system, vapour absorption system, refrigerants, desirable properties of ideal refrigerant; centrifugal, steam jet, thermoelectric, vortex tube and other refrigeration systems; ultra low temperature refrigeration; cold storages, insulation material, design of cold storages, defrosting. Refrigeration in food industry; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, wet bulb temperature and its measurement, psychrometric chart, elementary psychrometric processes, humidifiers and dehumidifiers; Air conditioning - principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design, design of complete air conditioning systems, types of air conditioners - applications.

### **SCHOOL OF ENERGY STUDIES RENEWABLE ENERGY SOURCES**

Classification of energy sources; Introduction to renewable energy sources; characterization of biomass; types, working principle, uses and safety/environmental aspects of different renewable energy devices like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays; Brief introduction to wind energy, hydroelectric energy, ocean energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

### **RENEWABLE ENERGY TECHNOLOGIES**

Design and operational parameters, performance evaluation and maintenance aspects of different renewable technologies like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays, briquetting machines and balers; bio-diesel utilization in CI engines.

### **ELECTRICAL ENGINEERING**

#### **ELECTRICAL CIRCUITS**

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, Superposition, 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, Laplace transform method of finding step response of DC circuits, Series and parallel resonance, Simple Low, High, Band Pass, Band Reject filter.

#### **ELECTRICAL MACHINES**

Electromotive 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, phasor diagram on load, leakage reactance, transformer on load, equivalent circuit, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, polyphase induction motor: construction, operation, equivalent circuit, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors.

### **ELECTRONICS AND INSTRUMENTATION**

Diode as a circuit element, rectifier, clipper, clamper, voltage multiplier, capacitive filter, bipolar junction transistor: operating point, various biasing methods (fixed, self, potential divider), h-parameter model of a transistor, analysis of small signal, CE amplifier, Timer IC and its application, analysis of differential amplifier using transistor, ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), zener diode voltage regulator, transistor series regulator, current limiting, Basic theorem of Boolean algebra, Combinational logic circuits (basic gates, SOP rule and K-map), binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, Bourdon tube, LVDT, strain gauge and tachogenerator.

### **COMPUTER SCIENCE ENGINEERING**

#### **Introduction To Computer Use**

Parts of Computers, working with windows commands, copy & Moving Files into folders, use of window explorer, Word processing with notepad, wordpad use of paint brush, Introduction to BASIC language and programming.

### **APPLICATIONS IN FOOD INDUSTRY**

Importance of computerization and IT in food industries, role of computers in optimization, introduction to operations research, linear programming problems, modeling of food technology systems and operations, graphical solution, simplex method, degeneracy and duality in linear programming, transportation problems, assignment problems, project management using PERT/CPM.

### **COMPUTER PROGRAMMING AND DATA STRUCTURES**

Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating Expressions, Standard library functions, Managing Input and Output, Familiarizing with Turbo C IDE, Building an executable version of C program, Debugging a C program, Developing and executing simple programs, using decision making statements and looping statements, Using nested control structures, Familiarizing with one and two dimensional arrays, Using string functions, Developing structures and union, Creating user defined functions, passing arguments and returning values, recursion, Using local, global & external variables, scope and visibility of a variable, Using pointers, Implementing Stacks, Implementing push/pop functions, Creating Queues, Developing linked lists in C language, Insertion/Deletion in data structures.

### **SYSTEMS ENGINEERING**

System Concepts, System approach to Agricultural Engineering. Linear Programming Problems. Canonical and Standard forms of LPP, Mathematical formulation. Mathematical Models of physical system, modelling of Agricultural system and operations. Graphical method, Simplex Method, Artificial variable techniques, Big M method and two phase methods. Degeneracy and Duality in Linear problems. Transportation Problems, Assignment Problems. Network Analysis in Project Planning by PERT/CPM. Network (Arrow Diagram) Logic Numbering and Events (Fulkerson's Rule) PERT Computation in Tabular form. Crashing the Networks.