Syllabus for the post of Providhik Sahayak Varg-1 Abhiyantran Shakha

Unit – 1

- **Farm Power:** Sources of farm power, conventional and non-conventional energy sources. Familiarization with different makes and models of agricultural tractors, Classification of tractors and IC engines. Thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle. Engine Terminology. Mechanical, thermal and volumetric efficiencies. Engine components and their construction, operating principles and functions. Working of 2-stroke and 4-stroke cycle engines and their comparison, comparison of CI and SI engines. Engine Valve systems- valve mechanism, Valve timing diagram and valve clearance adjustment. Cam profile, valve lift and valve opening area. Importance of air cleaning system. Types of air cleaners and performance characteristics of various air cleaners. Fuel supply system- fuels, properties of fuels, calculation of air-fuel ratio, tests on fuel for SI and CI engines, Detonation and knocking in IC engines. Carburetion system- carburetors and their main functional components. Fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle, Basics of MPFI. Engine governing – need of governors, governor types and governor characteristics. Lubrication system – need, types, functional components. Lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Need and type of thermostat valves. Additives in the coolant. Ignition system of SI engines. Electrical system of tractor engine, Comparison of dynamo and alternator. Familiarization with the basics of engine testing. Transmission system in a tractor– need, types, major functional systems. Clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Gear Box – Gearing theory, principle of operation, gear box types, functional requirements and calculation for speed ratio. Differential system – need, functional components, construction, calculation for speed reduction. Need for a final drive. Brake system – types, principle of operation, construction, calculation for braking torque. Steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Hydraulic system in a tractor – principle of operation, types, main functional components, functional requirements, hydraulic system adjustments and ADDC. Tractor power outlets – PTO, PTO standards, types and functional requirements. Traction- theory and related terminology. Theoretical calculation of shear force and rolling resistance on traction device, traction aids. Introduction to pneumatic tyres and their selection. Tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Three point linkage system and different drawbar types. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing. Deciphering the engine test codes. General repair and maintenance of tractor. Safety rules and precautions for safe driving of tractor.

- **Farm Machinery and Equipment:** Introduction to farm mechanization. Classification of farm machines. Introduction to materials of construction in farm machinery. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction and identification of major functional components of tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators. Forces acting on tillage tools. Sowing, planting and transplanting equipment- seed drills, no-till drills, and strip-till drills, planters, bed-planters and other planting equipments. Furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters and their adjustments during operation. Use of weeders –

manual and powered, Functional requirements of weeders and main components. Plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates. Introduction to intercultural equipment. Familiarization of fertilizer application equipment. Familiarization with working principle of earth moving equipment i.e. bulldozer, trencher, elevators, terracer and laser leveler. Harvesting operation – harvesting methods, harvesting terminology. Mowers – types, constructional details, working and adjustments. Shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Forage harvesting and conditioning machineries. Threshing systems – manual and mechanical systems, types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Factors affecting thresher performance. Grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Straw combines – working principle and constructional details. Root crop harvesters – principle of operation, blade adjustment-approach angle and calculation of material handled. Study of potato and groundnut diggers. Cotton harvesting – Cotton harvesting mechanisms, cotton pickers and strippers, functional components. Maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools. Application of computer software for designing farm implements. Ergonomic consideration in design of farm equipment. Importance of farm machinery testing, testing institutes and introduction to various test codes for farm implements.

Unit - 2

- **Renewable energy:** Concept and limitation of renewable energy sources (RES), Criteria for assessing the potential of RES, Renewable energy options, potential and utilization, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable and non-renewable sources. Solar Energy: energy available from Sun, Solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different types of solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaic : p-n junctions. Solar cells, PV systems, stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basics of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, working principle of wind power plant. Wind farms. Aero-generators. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design and use of different commercial size biogas plant. Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Power generation from biomass (gasification and Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters.

- Fermentation processes and its general requirements, Overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying) energy. Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and

economics. Trans-esterification for biodiesel production. Bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Unit – 3

- **Processing and Food Engineering:** Engineering Properties - Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties: Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials: Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties: force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian fluid, Visco-elasticity, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Application of engineering properties in handling of processing machines and storage structures

- **Agricultural Structures and Environmental Control:** Planning and layout of farmstead. Scope, importance and need for environmental control, Environmental factors affecting physiological reaction of livestock, environmental control systems and their design, method for control of temperature and humidity, Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures, Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, estimation of pressure in bins, Storage of seeds. Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment. Site and orientation of building in regard to sanitation, community sanitation system; sewage system and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing

- **Post Harvest Engineering of Cereals, Pulses and Oil Seeds:** Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment: Types of conveyors - Belt, roller, chain and screw. Elevators: bucket, Cranes and hoists. Pneumatic conveying. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, drying equations, Dryer performance, Methods of drying, batch-continuous; mixing-non-mixing, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI methods, Pressure parboiling method, Types of rice mills, Unit operations and equipment of rice and wheat milling, Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry and wet milling methods-CFTRI and Pantnagar methods. Pulse milling machines. Milling of corn and its products. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran, By-products utilization.

- **Post Harvest Engineering of Horticultural Crops:** Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops, Peeling: Different peeling methods and devices (manual, mechanical, chemical and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic and Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing, Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration, Packaging of horticultural commodities, Types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Post harvest management and equipment for spices and flowers, Quality control in fruit and vegetable processing industry, Food supply chain.

- **Dairy and Food Engineering:** Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Nanotechnology: fundamental concepts, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology. Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow charts for product manufacture, Unit operation of dairy processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, paneer, butter and ice cream, Filling and packaging of milk and milk products; Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression, Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Non-thermal and other alternate thermal processing in Food processing.

Unit - 4

- **Soil and Water Conservation Engineering:** Status of soil erosion and land degradation of India, Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, inter-rill, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation: Universal soil loss equation (USLE) – Rainfall erosivity estimation by KE>25 and EI30 methods. Soil erodibility factor, Slope length factor, slope steepness factor, topographic factor, crop/cover management factor and soil conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design. Terraces – level terrace and graded terrace, broad base terraces, bench terraces and its types, planning, design and layout procedure, Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and its design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification.

- **Watershed Hydrology:** Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequency analysis of point rainfall. Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship. Hydrologic processes: Interception, depression storage, infiltration, evaporation - estimation and measurement. Runoff: Factors affecting runoff, measurement, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method. Geomorphology of watersheds, stream order, drainage density and stream frequency. Hydrograph - Components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations. Flood - design flood and computation of probable flood. Flood routing – channel and reservoir routing. Drought – classification, causes and impacts, drought management strategy
- **Water Harvesting and Soil Conservation Structures:** Water harvesting -principles, importance and issues. Water harvesting techniques - classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Structures - farm ponds, dug-out and embankment reservoir types. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of nala bunds. Hydraulic jump and its application. Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - functional use and design requirements, and stability analysis.. Drop spillway - applicability, design - hydrologic, hydraulic and structural design types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations.
- **Watershed Planning and Management:** Watershed – introduction, types and characteristics. Watershed development - problems and prospects, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting in a watershed. Management measures - rainwater conservation technologies - in-situ and ex-situ storage, Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands, non-arable lands. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

Unit- 5

- **Irrigation Engineering:** Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country, measurement of irrigation water- weir, flumes and orifices and other methods, open channel water conveyance system - design and lining of irrigation field channels, on farm structures for water conveyance, control and distribution; underground pipe conveyance system: components and design; land grading, criteria for land levelling, land levelling methods, estimation of earth work; soil water plant relationship, soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response, water requirement of crops, concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies, surface methods of water application - border, check basin and furrow irrigation-adaptability, specification and design considerations.

- **Drainage Engineering:** Water logging- causes and impacts, drainage, objectives of drainage, surface drainage coefficient, types of surface drainage, design of surface drains, sub-surface drainage: purpose and benefits, hydraulic conductivity, drainable porosity, water table, derivation of Hooghoudt's and Ernst's drain spacing equations, design of sub-surface drainage system, drainage materials, drainage pipes, drain envelope, layout, construction and installation of drains, drainage structures, vertical drainage, bio-drainage, mole drains, salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.
- **Groundwater, Wells and Pumps:** Occurrence and movement of ground water, aquifer and its types, classification of wells, fully penetrating tubewells and open wells, types of bore wells, design of open wells, groundwater exploration techniques, methods of drilling of wells, percussion, rotary, reverse rotary, design of tubewell and gravel pack, installation of well screen, development of well, groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method, well interference, multiple well systems, estimation of ground water potential, quality of ground water, artificial groundwater recharge techniques, pumping systems, water lifting devices, classification and different types of pumps, components of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics, hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics, deep well turbine pump and submersible pump
- **Sprinkler and Micro irrigation Systems:** Sprinkler irrigation- adaptability, problems and prospects, types of sprinkler irrigation systems, design of sprinkler irrigation system, layout selection, hydraulic design of lateral, submain and main pipe line, design steps, selection of pump and power unit for sprinkler irrigation system, performance evaluation of sprinkler irrigation system, uniformity coefficient and pattern efficiency, Micro Irrigation Systems: types-drip, spray and bubbler systems, merits and demerits, different components; Design of drip irrigation system- general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment, fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.