

Maharashtra Public Service Commission

Civil Services Exam – Mains Optional

Agricultural Engineering

(Code No : 102)

Paper - I

Standard : Degree in Agricultural Engineering

Total Marks : 200

Nature of Paper : Conventional Type

Duration : 3 Hours

- Note :**
- 1) Answers to this paper must be written in English only.
 - 2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise subject matter related to the topics/sub-topics mentioned below.
 - 3) For judging candidates' conceptual understanding, appropriate number of numerical problems will be asked.
 - 4) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub-topics mentioned below.

Section - A (Marks : 50)

1) Drying of Farm Crops :

- .01) Importance and need for drying; Moisture content and its measurement, Equilibrium moisture content; Heat and mass transfer in drying, Moisture migration and prevention of moisture accumulation, Psychrometry, psychrometric chart and its application for drying process.
- .02) Design of dryers; Types of food grains dryers such as Batch dryer, Recirculating batch type (RPEC) dryer, Louisiana State University (LSU) dryer, Baffle dryer, Rotary dryer and Solar (cabinet) dryer.

2) Engineering Properties and Handling of Biological Materials :

- .01) Physical characteristics such as shape, size, spatial dimensions, roundness, sphericity, volume, density, specific gravity, surface area, porosity. Mechanical properties like hardness of grain, compressive strength, impact and shear resistance. Thermal properties such as specific heat, thermal conductivity, thermal diffusivity. Electrical properties like electrical conductance, capacitance and dielectric properties.
- .02) Aero and hydrodynamic characteristics such as drag coefficient, terminal velocity. Rheological properties such as force deformation behavior, ideal elastic behavior, ideal plastic behavior, ideal viscous behavior, viscoelastic behavior; Material handling devices such as conveyors and elevators, Design of material handling devices like belt conveyor, screw conveyor and bucket elevator.

3) Processing of Biological Materials :

Importance and need of processing, Unit operations such as cleaning, sorting, grading, drying, dehydration, storage, milling, handling, mixing, packaging and transportation; Screen effectiveness, cleaning efficiency, sieve analysis, fineness modulus, uniformity index and particle size estimation; Principles and operations of air screen cleaner, specific gravity separator, spiral separator, disc separator,

indented cylinder separator, magnetic separator and pneumatic separator.

Section - B (Marks : 50)

4) Dairy and Food Engineering :

- .01) **Mass and energy balance; heat transfer and heat exchangers (Double pipe, Shell and tubes, and coils); Pasteurization (vat, HTST and UHT pasteurization), Homogenization; Principle and operations of spray, drum, vacuum and freeze dryer. Evaporation, design of single effect and multiple effect evaporators; Principle and operations of pan, natural convection, forced convection, long tube, short tube, rising film, falling film evaporators; Vapour absorption system.**
- .02) Refrigeration, vapour compression refrigeration system; Heating and cooling load calculation; Precooling, cold storage and its design; Controlled atmospheric (CA) storages and modified atmospheric (MA) packages for horticultural crops; Freezing, estimation of freezing time using planks method; Principles of fruits and vegetables preservations - canning, drying, slicing, blanching, sterilization, thermal processing; Need and importance of food packaging, functions, general requirements, types of packaging materials, forms of packaging.

5) Agricultural Structures :

- .01) Farm stead and Farm house design, Farm fencing – woven wire, close mesh type, barbed wire, plain wire, welded wire, electric; Cost estimation of barbed wire fencing; Dairy barn – stanchion and loose housing barn, milking parlour, pen barn, community barn; Poultry houses – wire floored and deep litter type.
- .02) Design of pit and trench silo; Calculation of lateral pressure on cylindrical grain bin wall using Airy and Janssen formulae; Design of bag storage structures; Greenhouses – meaning, types, advantages, importance and scope, procedure of erection of Quonset type pipe framed greenhouse.

6) Size Reduction of Biological Material :

Size reduction and estimation of energy requirements using Kicks, Rittengers and Bonds law. Size reduction procedures such as cutting, grinding, crushing, impact and shearing. Principles and operations of size reduction machinery like gyratory crushers, roller crusher, attrition mill, hammer mill and ball mill.

Section - C (Marks : 50)

7) Farm Power :

- .01) Sources of farm power, classification of I.C. engines; Working principle of two stroke & four stroke cycle engines; cycles of I.C. engine – Otto & Diesel Cycle; Performance of I.C. engine, Calculations of power, specific fuel consumption.
- .02) Working and construction of engine systems - cooling, lubrication, ignition, fuel supply; Working and construction of tractor systems - steering, clutch and brake, transmission and hydraulic system; Weight transfer and determination of Center of gravity; Periodic maintenance of agricultural tractors.

8) Farm Mechanization :

- .01) Status, constraints and prospects of farm mechanization; Selection of farm machineries for higher field efficiency; Objectives of soil tillage, types of tillage; Construction and working of primary & secondary tillage equipments, seed drills, planters, reapers, mowers, combine harvesters, threshers.

- .02) Calculations on performance of farm machinery, field capacity, field efficiency, cost analysis, calibration of seed drills and sprayers; Sprayers- classification, construction & operation of hydraulic sprayer- knapsack, rocker, foot and compression sprayer, air assisted sprayer.

Section – D (Marks : 50)

9) Farm Machinery Design :

- .01) Design of power transmission – V- belts and roller chain drives; Design parameters of agricultural implements, Ergonomical considerations in design of agricultural equipments.
- .02) Force analysis of single bottom mould board plough; Design considerations of seed drills, planters and threshers.

10) Renewable Energy Sources :

- .01) Different types of renewable energy sources, Solar water heating systems (working principle and components) – natural circulation type (pressurized), natural circulation type (non pressurized), forced circulation type; basic photovoltaic system for power generation; Design principle and constructional details of box type solar cooker; Multi rack natural convection type solar dryer;
- .02) Basic principles of wind energy conversion – the nature of the wind, power in the wind, forces on the blades and thrust on turbines; Wind energy- site selection considerations; Basic components of wind energy conversion systems; Wind mill types – horizontal and vertical axis; Water pumps- solar/wind. Biomass conversion technologies; Biogas generation; Factors affecting bio digestion; Types of biogas – floating dome (KVIC) type and fixed dome (Janata) type. Principle and types of Gasifiers.

Paper - II

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Section – A (Marks : 50)

1) Irrigation Engineering :

- .01) Importance of irrigation; Techniques of measuring soil moisture – laboratory and in-situ; Soil water plant relationship – infiltration and it's measurement.
- .02) Water requirement of the crops, consumptive use, evapo-transpiration (ET) and it's measurement; Measurement of irrigation water using orifices, weirs,

flumes; Methods of irrigation – surface, sub- surface, drip, sprinkler.

- .03) Design of irrigation methods – basin, border, furrow, drip and sprinkler; irrigation efficiencies and their estimation; Design of lift irrigation scheme.

2) Drainage Engineering :

- .01) Drainage design criteria – hydrologic and hydraulic design; Soil permeability, hydraulic conductivity and its measurement, drainage porosity and its measurement.
- .02) Methods of land drainage, drainage coefficient and its estimation; Design of open ditch; Sub- surface drainage. Reclamation of saline and alkali soils.

Section – B (Marks : 50)

3) Wells and Pumps :

- .01) Aquifer and types of aquifers; Darcy's law, hydraulic conductivity, transmissivity, coefficient of storage, steady and unsteady flow of water in tube well.
- .02) Design of irrigation well; Pumps and types of pumps, design of centrifugal pump; pump selection and installation.

4) Canal Irrigation :

- .01) Components of canal irrigation, terms used in canal irrigation, design of lined canal; Kennedy's and Lacey's theory (problems).
- .02) Diversion head works, canal head regulators, cross drainage works, canal falls; Operation and maintenance of canal.

Section – C (Marks : 50)

5) Surveying and Leveling :

Survey– Definitions, Object of survey; Principles of surveying; Distance measurement - Chaining, types of chains, offsets and their types, computation of areas, errors in length, area and volume due to incorrect chain, obstacles in chaining; Methods of surveying – Triangulation and Traversing; Methods of Traversing - Chain angles, Free needle, Fast needle, Measurement of angles between successive lines; Bearing of lines – designation and calculation of angles; Plane Tabling – Principle, Instrument and accessories, advantages and disadvantages; Leveling - Principles, terms used, types of levels and leveling staff, steps in leveling; Reduction of levels – collimation system and rise and fall system.

6) Soil Mechanics :

Preliminary definitions, Functional relationship, engineering properties of soil; Consistency limits of soil; Soil classification-Textural classification, Particle size classification, Unified soil classification, Indian standard classification; Soil water- Modes of occurrence of soil water, Adsorbed water, capillary water; Stress conditions in soil-Submerged soil mass, Soil mass with surcharge, Saturated soil with capillary fringe; Permeability-factors affecting permeability, Coefficient of permeability by-constant head method, falling head method; Seepage analysis-Head gradient and potential, Seepage pressure, Upward flow, quick condition; Consolidation and Compaction-Spring analogy of One-dimensional consolidation, Standard Proctor test of compaction, Factors affecting compaction; Earth pressure-active and passive state, Earth pressure at rest.

7) Hydrology :

- .01) Water resources of India and Maharashtra; Hydrological cycle; Meteorological parameters in Agricultural context - temperature, relative humidity, wind velocity, sunshine hours; Evaporation - factors affecting evaporation and measurement of evaporation; Precipitation – types, forms, measurement; Rain gauge types - recording type, non- recording type, estimation of missing data, adequacy of rain gauge stations and network design.
- .02) Runoff - factors affecting runoff, rainfall –runoff relationship; Design runoff rate by - rational method and curve number method; Hydrograph - components of hydrograph, factors affecting shape of hydrograph, unit hydrograph (only concept)

8) Erosion and Sedimentation:

Problems of soil erosion in India and Maharashtra; Agents of soil erosion; Water Erosion, factors affecting water erosion, classification of water erosion, erosivity and erodibility; Wind erosion, mechanics of wind erosion, types of soil movement in wind erosion; Estimation of soil loss by USLE; Gully control structures – types, description, advantages and disadvantages; Sedimentation, sources of sedimentation, sediment control in reservoirs.

Section – D (Marks : 50)**9) Soil and Water Conservation Structures :**

- .01) Criteria for selection of erosion control measures; Classification of measures - Engineering measures, Biological measures; Engineering measures-Contour bund- design and function; Graded bund- design and function; Bench terraces- types, design and function; CCT-Design and function, Wind break and shelter belt- functions; Drainage line treatment; Drop Spillway - design and function; Chute spillway - design and function; Gabion structure - design and function; Loose boulder - function and adaptability; Vegetated waterways – design and function; Water harvesting structure.
- .02) Farm Pond – types, functions, site selection, water storage requirement; Lining for seepage control- puddling, compaction, clay blanket, bentonite treatment, sodium salts, soil cement lining, cement concrete lining, asphalt

lining, polyethylene, plastic lining stone slab, brick lining.; Gully control

structures - types, description advantages and disadvantages, stages of gully

development; Gravity dam - forces acting on gravity dam, modes of failure.

10) Watershed Development and Management :

- .01) Watershed Concept, Types, Morphological characteristics, Watershed management, Objectives, Steps, Development, components in watershed programme; Measures in watershed developments - Engineering measures - contour bund, graded bund, bench terracing, CCT; Biological measures - contour farming, fuel fodder plantation, vegetable bunds; Drainage line treatments - drop spillway, chute spillway, loose boulders, Gabion structures.
- .02) Water storage structures, Rainwater harvesting, storage and recycling; Farm pond - embankment type, dugout type, only significance, adaptability, alignment, advantages and disadvantages of aforesaid measures; Land capability classification- I to VIII classes; Land use planning measurements; Crop

management for erosion control; Drought analysis - onset of effective Monsoon, dryspell, wetspell, Critical dry spell; Evaluation of Soil and water conservation work in watershed; Peoples' participation in watershed development; Socio-economic benefits of watershed programme.

11) Advanced Technologies in Natural Resources Management :

Remote sensing and GIS-Principles, Electro-magnetic radiation and its properties; platform and sensors (LISS III, IV, PAN); Fundamentals of GIS and its significance in Agril. planning; application of remote sensing and GIS in land, water and forest resource management in watershed; Merits and demerits of traditional and remote sensing approaches; Types of satellite images;

Computer application in Irrigation, Processing, Green House and Farm Machinery Design.