Learn… Unlearn… Relearn…

Explore Questions

TNPSC – Agricultural Engineer (AE)

Equip for Learning… Prepare for Unlearning… Practice for Relearning…

Paper I AGRI. ENGINEERING

As per the Revised & Updated Syllabus of TNPSC

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Content

Foreword

Dear Friends,

Greetings from SAAI Academy!

- **DON'T USE THIS BOOK, AT THE LAST MOMENT!**
- **STUDIES AND PRACTICES HELP YOU TO SUCCEED!**

This comprehensive guide prepared candidates for the TNPSC Agricultural Engineer exam, covering core subjects like General Engineering, Surveying, Soil Conservation, Watershed Management, Farm Irrigation, Structures and Drainage, Farm Power, Farm Machinery, Unit Operations in Food and Agricultural Processing, Process Engineering of Agricultural and Horticultural Crops and Renewable and Bioenergy with content distilled from 20000+ pages of authoritative sources, strictly following the TNPSC syllabus.. It includes 2306 important questions as a question bank to improve your learning capacity. Four sets of previous years' papers for practice are available on SAAI web page https://saaiacademy.in/2025/02/10/tnpsc-agricultural-engineering-syllabus-model-question-paper/.

Presented in a student-friendly format, the material reflects current exam trends. Aspirants should practice various question types discussed during orientation while maintaining disciplined self-study. Regular tests and analysis of past papers are crucial for success. The book emphasizes SMART preparation techniques to build confidence and performance. For queries, contact saaistudies@gmail.com or call +91-93821 32593.

Best Regards

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Agricultural, Mechanical, Automobile and Civil Engineering

(Degree Standard)

Code: 562

Unit I: General Engineering (20 Questions)

Statics of Particles, Equilibrium of Rigid bodies, Properties of Surfaces and Solids, Centroid, Centre of Gravity, Dynamics of Particles, Friction in Machine Elements, Stress, Strain and Deformation of Solids, Theories of Failures, Design of Shafts and Couplings, Fluid statics, equations of continuity and momentum, Bernoulli's equation, Flow through pipes, head losses in pipes, bends, Pumps and its applications, Valves and Types, Iron Carbide Phase Diagram, ferrous and nonferrous alloys, Heat treatment of ferrous and non-ferrous metal, Engineering and commodity polymers, composites, nano-materials, Foundry Technology- Metal Forming Processes, Metal Joining processes, Manufacturing of Thermo Setting and Thermo Plastic Products, Inventory control - Economic Order Quantity (EOQ) - quantity discounts, ABC Analysis, Operations Research, Assignment Model, Critical Path Method (CPM) and Program Evaluation Review Technique (PERT), Queuing Models, Industrial Safety.

Unit II: Surveying and Hydrology (20 Questions)

Surveying – Instruments - Methods of surveying – Linear measurements - Computation of area – Triangulation, intersection, traversing, cross staff survey – Plane table survey – Earth work computation -Simpson's and trapezoidal rule - Levelling - Definition - Types of benchmarks - Different types of levels – Reduced level by rise and fall method and height of collimation method - Contouring – Profile surveying - Cross section survey - Use of Minor instruments - Theodolite survey - Total station - GPS survey. Hydrology – Measurement of rainfall, evaporation and infiltration – Estimation of runoff – Factors affecting runoff – Computation of volume of runoff and peak flow – Unit hydrograph - Occurrence and movement of ground water - ground water exploration techniques - hydraulics of wells, types of wells and their construction - Well drilling – Methods and machinery - Techniques for different formations - Well logging - Types of well screen - Design of well screens - Well development - Yield testing.

Unit III: Soil Erosion and Conservation (15 Questions)

Soil erosion – Types – Factors affecting erosion by water and wind - Stages of water erosion - Biological control measures and their suitability - Contour farming, strip cropping, mixed cropping, intercropping and mulching - Mechanical control measures and their suitability – Design and construction of contour bunds, graded bunds, terraces, contour stone walls, contour trenches, staggered trenches and diversion drain - Gully control structures - Drop spillway, chute spillway, pipe inlet spill way and check dams - Wind erosion – Types and control - Wind breaks and shelter belts - Dry farming techniques for improving crop production - Estimation of soil erosion - Universal Soil Loss Equation.

Unit IV: Watershed Development and Management (15 Questions)

Watershed – Concept, types and delineation - Land capability classification - Participatory Rural Appraisal Technique – Watershed development plan – Estimation of cost and benefits - Gully and ravine reclamation – In-situ & Ex-situ water harvesting, micro catchments – Ground water recharge - Artificial recharge techniques and methods - Farm pond and percolation pond – Selection of suitable soil and water conservation practices – Afforestation – Holistic planning - Watershed based rural development – Use of aerial photography and remote sensing in watershed management - Applications of Remote sensing and GIS in planning and development of watersheds including forest cover and water resources.

Unit V: Farm Irrigation, Structures and Drainage (30 Questions)

Irrigation - Sources – Soil- water- Plant relationship - Water requirement of crops – Measurement of irrigation water - Weirs and flumes - Methods of irrigation - Surface, Sprinkler, Rain gun and drip irrigation - Irrigation automation - Drip irrigation – Components and design - Wetting pattern - Filters and Fertigation tanks - Pump capacity - Operation and maintenance - Sprinkler irrigation - Components - Sprinkler performance - Hydraulic design of sprinkler systems - Duty and delta relationship – Irrigation scheduling - Irrigation efficiencies and their estimation - Pumps - Types, selection and installation - Design and construction of farm structures – Site selection – Quality – RCC - Foundation, basement and superstructure – Types of roofs – building plan and estimation, requirements of farm house, threshing floor, drying floor, poultry house, dairy farm, rat proof go down and farm roads - Design features earthen dams and gravity dams - Water conveyance structures – Earthen channels and lined channels – Advantages of lining – materials of lining – Design of channel cross section – Crossing control structures – Road crossing structures – Culvert, inverted siphon aqueduct – Their uses - Underground pipe line system – Components and their functions – Structures for plant environment – Green houses, poly houses and shade nets – Construction and utilization - Soilless culture. Drainage - Causes of water logging and salt problem - Methods of drainage - Design of surface, sub-surface and vertical drainage systems - Improvement and utilization of poor quality water - Reclamation of saline and alkali soils.

Unit VI: Farm Power (20 Questions)

Sources of Farm Power- Construction and working of Spark Ignition (SI) and Compression Ignition (CI) engines- Thermodynamic principles of SI and CI engine - Two stroke and Four stroke engines - Turbo charging – Fuel injection systems, Ignition, Lubrication and Cooling systems, Speed governors, Electrical systems of Internal Combustion engines - Different types of tractors, bull dozers and power tillers - power transmission systems, Types of Clutches and Gearboxes, Differential, Final drive system, Braking system – types, constructional details and operation, Steering system - – types, constructional details and operation, Suspension system – types, constructional details, uses of hydraulic system in tractors, hitching system, three point linkage- tractor power outlets. Resistances to vehicle motion, vehicle performance

characteristics, Operations using bulldozer, Types of wheels and tyres – Battery: types, constructional details and working principle. Tractor stability - mechanics of tractor implement combination, weight transfer - Ergonomic considerations in operation of tractors, Safety devices in tractors, Maintenance of tractors. Single phase induction motor - three phase power measurement methods- Power factor Electrical pump sets - regulated DC power supply, DC machine, DC generator, DC motor, starter - torque and efficiency - Electronics in Agriculture - Semi -conductors, transistors, operational amplifiers – Digital electronics, counters, encoders, decoders, Digital to Analog and Analog to digital converter Instrumentation - transducers - strain gauges, types and gauge factor - force measurement using strain gauges, Torque measurement, pressure measurement, flow measurement temperature measurement, thermocouples, speed measurement microprocessors, microcontrollers, PID controllers, PLC - Electric vehicles in Agriculture.

Unit VII: Farm Machinery (20 Questions)

Earth moving equipment - Backhoe with front end loader, Crawler excavator - Bull dozer - bladesshovels-soil digging machines-primary tillage implements- indigenous plough, Mould board plough, disc plough, chisel plough, sub soiler, methods of ploughing – secondary tillage implements-cultivators, harrows, rotary tillers, rotavator, land shaping machinery- laser leveller, ridger, bund former, raised bed former, puddler. Calculation of field capacity and field efficiency. Sowing and transplanting –seed drills, types - different types of metering mechanisms, planters, broadcasters and rice transplanters, pneumatic planters- intercultural implements - dryland weeders, wetland weeders, manual and power operated weeders - plant protection equipments – sprayers - types of sprayers - Drone sprayer - calibration of sprayer, types of nozzles, drift – harvesters - sickle, mower, cutter bar, reaper, binders, windrowers - threshers - principle of threshing, types of threshers, threshing drums, calculation of output capacity, combines, working principles, components of combine. Root crop harvesters, cotton harvesters, cotton strippers, sugarcane harvester, maize harvesters, vegetable and fruit harvesters, crop residue management machinery - cost estimation of farm machinery.

Unit VIII: Unit Operations in Food and Agricultural Processing (20 Questions)

Heat transfer principles – Conduction, convection and radiation - Types of heat exchangers - Unit operations – Evaporators - Types - Mechanical separation – Filtration – Sedimentation – Settling – Centrifugal separation – Cyclone separation - Size reduction – Mixing – Blending – emulsification - Food processing operations - Pasteurization – Sterilization – Canning - Retort processing - Extrusion processing of foods - Methods of drying of foods – Preservation of food by irradiation - Microwave and dielectric heating - Fats and oil processing – Extraction methods and equipment - Food packaging – Materials and characteristics – Suitability - Processing of milk and milk products, packaging of milk - Principles of refrigeration and applications in food industries – Cold storage of fruits and vegetables - Design aspects

Unit IX: Process Engineering of Agricultural and Horticultural crops (20 Questions)

Engineering properties of food materials – Moisture content – Methods of determination – Psychrometry - Drying – Thin layer and deep bed drying – Types of heat sources and types of dryers - Cleaning and grading – Principles – Separators – Efficiency – Performance index - Shelling and decortication – Seed processing and layout of seed processing units - Rice processing – Parboiling and dehusking of paddy – Machines used - Milling of corn, pulses and millets - Material handling equipments - Conveyors and elevators - Storage – Conditions for safe storage – Bag and bulk storage – Silo storage - Design aspects - Modified atmosphere storage – Storage structures - Equipment used for processing of horticultural crops – Preservation of fresh fruits and vegetables – Drying and dehydration – Processing of coffee, tea, rubber, cashew nut, coconut, oil palm, aromatic plants, flowers and spices

Unit X: Renewable and Bioenergy (20 Questions)

Solar energy – Solar collectors – Air heaters - Solar dryers – Water heaters - Solar cold storage– Solar photovoltaic systems and applications- Solar PV pump, fencing - Wind energy - Suitable sites – Types of wind mills – Wind mill components – Applications – Performance of wind mills - Biomass resources – Agro residues – Characteristics - Conversion technologies – Biochemical conversion – Biogas plant – Types and selection, construction, operation and maintenance - Slurry handling - Thermochemical conversion – Stoves – Types - Improved stoves – Pyrolysis – Charcoal production – Gasification – Briquetting – Alternate renewable energy systems - Hydro power, Geothermal, ocean and hydrogen energy- Energy storage systems- Energy Conservation- Cogeneration - Energy plantation and environmental impact – Global warming – Clean development mechanism (CDM) and role of afforestation - Biofuels – Biodiesel feedstock, production and by-product utilization – Ethanol – Production and utilization – Emission - Standards and control.

Unit I: General Engineering

Statics of Particles, Equilibrium of Rigid bodies, Properties of Surfaces and Solids, Centroid, Centre of Gravity, Dynamics of Particles, Friction in Machine Elements, Stress, Strain and Deformation of Solids, Theories of Failures, Design of Shafts and Couplings, Fluid statics, equations of continuity and momentum, Bernoulli's equation, Flow through pipes, head losses in pipes, bends, Pumps and its applications, Valves and Types, Iron Carbide Phase Diagram, ferrous and nonferrous alloys, Heat treatment of ferrous and non-ferrous metal, Engineering and commodity polymers, composites, nano-materials, Foundry Technology-Metal Forming Processes, Metal Joining processes, Manufacturing of Thermo Setting and Thermo Plastic Products, Inventory control - Economic Order Quantity (EOQ) - quantity discounts, ABC Analysis, Operations Research, Assignment Model, Critical Path Method (CPM) and Program Evaluation Review Technique (PERT), Queuing Models, Industrial Safety.

1. FUNDAMENTALS OF ENGINEERING MECHANICS

ENGINEERING MECHANICS: The subject of Engineering Mechanics is that branch of Applied Science, which deals with the laws and principles of Mechanics, along with their applications to engineering problems.

The subject of Engineering Mechanics may be divided into the following two main groups:
1. Statics, and 2. Dynamics

STATICS: It is that branch of Engineering Mechanics, which deals with the forces and their effects, while acting upon the bodies at rest.

DYNAMICS: It is that branch of Engineering Mechanics, which deals with the forces and their effects, while acting upon the bodies in motion. The subject of Dynamics may be further sub-divided into the following two branches:

1. Kinetics, and 2. Kinematics

KINETICS: It is the branch of Dynamics, which deals with the bodies in motion due to the application of forces.

KINEMATICS: It is that branch of Dynamics, which deals with the bodies in motion, without any reference to the forces which are responsible for the motion.

RIGID BODY: A rigid body (also known as a rigid object) is a solid body in which deformation is zero or so small it can be neglected. The distance between any two given points on a rigid body remains constant in time regardless of external forces exerted on it. A rigid body is usually considered as a continuous distribution of mass.

FORCE: It is defined as an agent which produces or tends to produce, destroys or tends to destroy motion. *e.g.*, a horse applies force to pull a cart and to set it in motion. Force is also required to work on a bicycle pump. In this case, the force is supplied by the muscular power of our arms and shoulders.

SYSTEM OF FORCES: When two or more forces act on a body, they are called to form a system of forces. Following systems of forces are important from the subject point of view;

1. **Coplanar forces**: The forces, whose lines of action lie on the same plane, are known as coplanar forces.
2. **Collinear forces**: The forces, whose lines of action lie on the same line, are known as collinear forces

GRAPHICAL METHOD FOR THE EQUILIBRIUM OF COPLANAR FORCES:

We have studied that the equilibrium of forces by analytical method. Sometimes, the analytical method is too tedious and complicated. The equilibrium of such forces may also be studied, graphically, by drawing the vector diagram. This may also be done by studying the

1. Converse of the Law of Triangle of Forces
2. Converse of the Law of Polygon of Forces

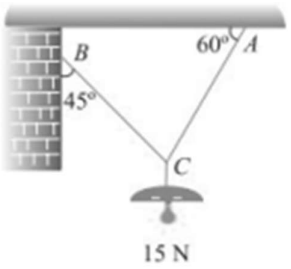
CONVERSE OF THE LAW OF TRIANGLE OF FORCES:

If three forces acting at a point be represented in magnitude and direction by the three sides a triangle, taken in order, the forces shall be in equilibrium.

CONVERSE OF THE LAW† OF POLYGON OF FORCES:

If any number of forces acting at a point be represented in magnitude and direction by the sides of a closed polygon, taken in order, the forces shall be in equilibrium.

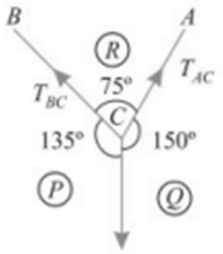
EXAMPLE: An electric light fixture weighing 15 N hangs from a point C, by two strings AC and BC. The string AC is inclined at 60° to the horizontal and BC at 45° t
o the horizontal as shown in Fig.



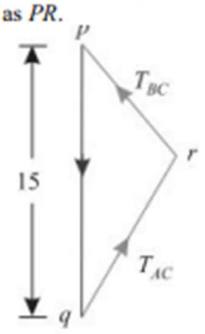
SOLUTION: Given. Weight at $C = 15$ N

TAC = Force in the string AC, and
TBC = Force in the string BC.

First of all, draw the space diagram for the joint C and name the forces according to Bow's notations as shown in Fig. The force TAC is named as RQ and the force TBC as PR.



(*a*) Space diagram



(*a*) Vector diagram

from the subject point of view :

1. Force acting along the inclined plane.
2. Force acting horizontally.
3. Force acting at some angle with the inclined plane.

EQUILIBRIUM OF A BODY ON A ROUGH INCLINED PLANE SUBJECTED TO A FORCE ACTING ALONG THE INCLINED PLANE:

Consider a body lying on a rough inclined plane subjected force acting along the inclined plane, which keeps it in equilibrium as shown in Fig.(*a*) and (*b*).
Let W = Weight of the body,
α = Angle, which the inclined plane makes with the horizontal,
R = Normal reaction,
μ = Coefficient of friction between the body and the inclined plane, and φ =
Angle of friction, such that $\mu = \tan \varphi$.
A little consideration will show that if the force is not there, the body will slide down the plane.
EQUILIBRIUM OF A BODY ON A ROUGH INCLINED PLANE SUBJECTED TO A FORCE ACTING HORIZONTALLY:
Consider a body lying on a rough inclined plane subjected to a force acting horizontally, which keeps it in equilibrium as shown in Fig.(*a*) and (*b*).

W = Weight of the body,
α = Angle, which the inclined plane makes with the horizontal,
R = Normal reaction,
μ = Coefficient of friction between the body and the inclined plane, and φ =
Angle of friction, such that $\mu = \tan \varphi$.

A little consideration will show that if the force is not there, the body will slide down on the plane.
Now we shall discuss the following two cases:

1. *Minimum force (P_1) which will keep the body in equilibrium, when it is at the point of sliding downwards.*

(*a*) Body at the point of sliding downwards

(*b*) Body at the point of sliding upwards

Fig. 8.13.

In this case, the force of friction ($F_1 = \mu . R_1$) will act upwards, as the body is at the point of sliding downwards as shown in Fig. 8.13. (*a*). Now resolving the forces along the plane,

$$P_1 \cos \alpha = W \sin \alpha - \mu R_1 \quad ...(i)$$

and now resolving the forces perpendicular to the plane,

$$R_1 = W \cos \alpha + P_1 \sin \alpha \quad ...(ii)$$

Substituting this value of R_1 in equation (*i*),

$$P_1 \cos \alpha = W \sin \alpha - \mu (W \cos \alpha + P_1 \sin \alpha)$$
$$= W \sin \alpha - \mu W \cos \alpha - \mu P_1 \sin \alpha$$
$$P_1 \cos \alpha + \mu P_1 \sin \alpha = W \sin \alpha - \mu W \cos \alpha$$

Unit II: Surveying and Hydrology

Surveying – Instruments - Methods of surveying – Linear measurements - Computation of area – Triangulation, intersection, traversing, cross staff survey – Plane table survey – Earth work computation - Simpson's and trapezoidal rule - Levelling - Definition - Types of benchmarks - Different types of levels – Reduced level by rise and fall method and height of collimation method - Contouring – Profile surveying - Cross section survey - Use of Minor instruments - Theodolite survey - Total station - GPS survey. Hydrology – Measurement of rainfall, evaporation and infiltration – Estimation of runoff – Factors affecting runoff – Computation of volume of runoff and peak flow – Unit hydrograph - Occurrence and movement of ground water - ground water exploration techniques - hydraulics of wells, types of wells and their construction - Well drilling – Methods and machinery - Techniques for different formations - Well logging - Types of well screen - Design of well screens - Well development - Yield testing.

SURVEYING

Surveying serves as the fundamental science for precise measurement and mapping of land, water bodies, and infrastructure, playing a vital role in engineering projects and spatial planning.

The discipline encompasses various approaches including geodetic surveying for large-scale projects accounting for Earth's curvature, plane surveying for smaller areas under 250 km², topographic mapping of natural and artificial features, and specialized hydrographic surveys of underwater terrain.

Modern surveyors employ sophisticated instruments like total stations for combined angle and distance measurements, theodolites for precise angular readings, GPS/GNSS systems for real-time positioning, and leveling equipment for elevation determination.

Hydrology's integration with surveying enables critical water resource management through watershed delineation, floodplain mapping, and rainfall-runoff analysis.

Surveyors employ specialized techniques such as cross-sectional river surveys, bathymetric mapping using sonar technology, and remote sensing applications with LiDAR to support hydrological studies. Fundamental calculations include contour interval determination, water discharge measurements ($Q=AV$), and flow velocity estimation using Manning's Equation.

The field adheres to strict standards like IS 1498 for hydrological data collection in India, emphasizing error reduction through measurement redundancy and instrument calibration.

Contemporary advancements are transforming the discipline through GIS spatial analysis, drone-assisted rapid surveys, and IoT-enabled real-time water monitoring systems. Together, these surveying and hydrological practices provide essential data for flood prediction, irrigation planning, and environmental conservation, while maintaining rigorous safety protocols for fieldwork near water bodies.

The convergence of traditional surveying methods with cutting-edge technologies continues to enhance accuracy and efficiency in water resource management and infrastructure development projects.

Primary Divisions of Surveying: Surveying is broadly classified into **two main categories**, each serving distinct purposes based on the area covered and the Earth's curvature:

Classification based upon the Nature of the Field/purpose

(a) **Topographical survey:** These surveys are used to obtain maps which shows details of natural and man-made features on the earth surface including elevation.

Scale = (1 : 25000 to 1 : 10 lakh)

(b) **Engineering survey:** These are surveys used for engineering works like railway, highway, canal, bridge, etc.

Building: 1 : 50 to 1 : 200

Bridge and other Civil Engineering Works: 1 : 500 to 1 : 2500

Highway: 1 : 1250 to 1 : 50000

(c) **Cadastral survey:** The surveys which are generally plotted to a larger scale then topographical surveys and are carried out for fixing the property lines.

Scale: 1 : 1000 to 1 : 5000

(d) **Hydrographic survey:** The survey which deals with the mapping of large water bodies for the purpose of navigation, construction of harbour works, prediction of tides and determination of mean sea level are called Hydrographic Survey.

- Hydrographic survey consists of preparation of topographical maps of the shores and banks, by taking soundings end determining the depth of water at a number of places and ultimately surveying bathymetric contours under water.

The equipment needed for sounding are:

(i) Sounding boat (ii) Sounding rod or poles
(iii) Lead lines (iv) Sounding machine
(v) Fathometer

(e) **Astronomical survey:** With the help of this survey we can determine latitude, longitude and LMT at any place on the earth's surface.

(f) **Geological survey:** It is done to determine information about various strata of earth surface.

Classification based on Instrument

(a) **Chain survey:** It is simplest type of surveying in which only linear measurements are done with the help of chain or tape and no angular measurements are done.

(b) **Compass surveying:** It is a branch of surveying in which horizontal angles and direction of lines are measured with compass and length of line are measured with chain and tape.

(c) **Theodolite surveying:** In this surveying horizontal and vertical angles are measured with theodolite and distances are measured with chain or tape.

(d) **Levelling:** In this type of surveying elevations of various points are measured with a levelling instrument and vertical staff.

(e) **Plane table survey:** In plane table surveying plan or map is produced by determining direction of various points and taking linear measurement with chain or tape.

(f) **Tacheometric surveying:** In this surveying horizontal and vertical distances are measured with a instrument called tacheometer.

(g) **Photogrammetric surveying:** In this survey photographs are taken for an area which are inaccessible or time available is less and area to be survey is large.

Type of Vernier

Direct Vernier

- In direct vernier, n divisions on vernier scale are equal to (n – 1) division on main scale

$$\eta v = (n-1)s$$

$$\therefore \quad LC = S - V$$

$$= S - \left(\frac{n-1}{n}\right)S$$

$$LC = \frac{S}{n}$$

Retrograde Vernier

- In case of retrograde vernier, n division on vernier scale are equal to (n + 1) divisions on main scale

$$nv = (n+1)S$$

$$LC = v - S$$

$$= \left(\frac{n+1}{n}\right)S - S = \frac{S}{n}$$

- In direct vernier, vernier division and main scale division increases in same direction whereas in retrograde vernier both increases in opposite direction.

Double Vernier: Principle: Two verniers (left and right) to eliminate index error. Used in precise theodolites for angle measurements.

Extended Vernier: Principle: Provides higher resolution (e.g., 20 divisions for 19 main scale divisions). Used in micrometers and some tachometers.

$$nv = (2n-1)S$$

$$LC = 2S - v$$

$$= 2s - \left(\frac{2n-1}{n}\right)S$$

$$LC = \frac{S}{n}$$

Classification of Surveyors

1. General Practice Surveyors: Focus on valuation and investment. Deal with property markets, land values, and valuation procedures. Assist investors (pension funds, insurance companies) in property purchases/sales. Specialize in housing policy advice, development, and management.
2. Planning and Development Surveyors: Prepare planning applications. Negotiate with local authorities for planning permissions.
3. Building Surveyors: Advise on the construction, maintenance, and repair of residential/commercial properties. Analyze building defects and provide solutions.
4. Quantity Surveyors: Evaluate project costs and suggest cost-effective alternatives. Ensure projects stay within budget.

Unit III: Soil Erosion and Conservation (15 Questions)

Soil erosion – Types – Factors affecting erosion by water and wind - Stages of water erosion - Biological control measures and their suitability - Contour farming, strip cropping, mixed cropping, intercropping and mulching - Mechanical control measures and their suitability – Design and construction of contour bunds, graded bunds, terraces, contour stone walls, contour trenches, staggered trenches and diversion drain - Gully control structures - Drop spillway, chute spillway, pipe inlet spill way and check dams - Wind erosion – Types and control - Wind breaks and shelter belts - Dry farming techniques for improving crop production - Estimation of soil erosion - Universal Soil Loss Equation.

SOIL EROSION

Soil is an essential natural resource that supports a majority of plant and animal life on the earth. It is a renewable resource.

The loss of soil cover due to natural agents like wind and running water is called soil erosion. The roots of plants and trees keep the soil moist and hold the soil particles together. Humans destroy vegetation cover by deforestation, overgrazing, construction and mining activities.

Without vegetation cover, soil becomes dry and loose, and gets easily eroded. Defective farming methods, like ploughing up and down a slope, increase the speed of water flowing down the slope increase the rate of soil erosion.

Running water carves deep channels through clayey soils, called gully erosion, which converts the land into bad-land making it unsuitable for cultivation.

When flowing water washes away the entire sheet of top soil in a region, it is called sheet erosion. Wind erosion occurs generally in areas of little or no vegetation. It happens in places that receive scanty rainfall.

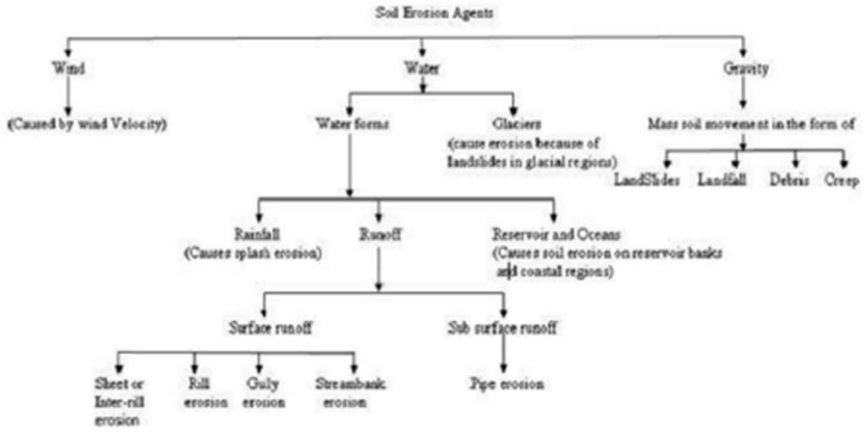
The prevention of soil erosion is called soil conservation and the ways can be:

- Terrace farming is one way to do so and involves cutting terraces along a slope. These terraces reduce the speed of water flowing down the slope and help in soil conservation.
- Contour ploughing is also beneficial in reducing the flow of water down the slope and involves ploughing at right angles to the natural slope of land.
- Effective farming techniques further help in soil erosion. In plain areas, strip cropping can be used for soil conservation where strips of grass are allowed to stand between crops in large fields. These strips of grass reduce the force of wind and thus prevent soil erosion.

Principles of Soil Erosion

Causes of Soil Erosion

No single unique cause can be held responsible for soil erosion or assumed as the main cause for this problem. There are many underlying factors responsible for this process, some induced by nature and others by human being.



Geologic Erosion sometimes referred to as natural or normal erosion; represent erosion under the cover of vegetation. It includes soil as well as soil eroding processes that maintain the soil in a favourable balance, suitable for the growth of most plants. The rate of erosion is so slow that the loss of soil is compensated by the formation of new soil under natural weathering processes. The various topographical features such as existing of streams, valleys, etc. are the results of geologic erosion.

Wind Erosion is the detachment, transportation and redeposition of soil particles by wind. A sparse or absent vegetative cover, a loose, dry and smooth soil surface, large fields and strong winds all increase the risk of wind erosion. Air movement must attain a certain velocity (with enough speed to generate visible movement of particles at the soil level) before it can generate deflation and transport of particles. Winds with velocities of less than 12-19 km/hr seldom impart sufficient energy at the soil surface to dislodge and put into motion sand-sized particles. Drifting of highly erosive soil usually starts when the wind attains a forward velocity of 25-30 km/hr.

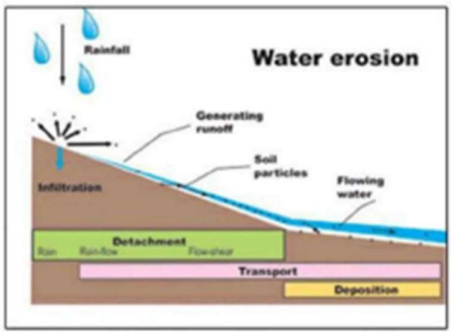
Saltation: Saltation occurs when the wind lifts larger particles off the ground for short distances, leading to sand drifts. Fine and medium sand-sized particles are lifted a short distance into the air, dislodging more soil as they fall back to the ground.

Suspension: Suspension occurs when the wind lifts finer particles into the air leading to dust storms. Very fine soil particles are lifted from the surface by the impact of saltation and carried high into the air, remaining suspended in air for long distances.

Surface Creep: The movement of large soil particles along the surface of the soil after being loosened by the impact of saltating particles

Water Erosion

The soil erosion caused by water as an agent is called water erosion. In water erosion, the water acts as an agent to dislodge and transport the eroded soil particle from one location to another.



Forms of Water Erosion: The impact of rainfall causes splash erosion. Runoff water causes scraping and transport of soil particles, leading to sheet, rill and gully erosion. Water waves cause erosion of bank sides of reservoirs, lakes and oceans. The subsurface runoff causes soil erosion in the form of pipe erosion, which is also called tunnel erosion. The glacial erosion causes heavy landslides. In India, glacial erosions are mainly confined to the Himalayan regions.

Hydraulic Action: The hydraulic action takes place when water runs over the soil surface compressing the soil, as a result of which the air present in the voids exerts a pressure on the soil particles and this leads to the soil detachment. The pressure exerted by the air voids is called hydraulic pressure. The soil particles so detached from their places, are scoured by the running water. The hydraulic action is more effective when the soil is in loose condition.

Abrasion: Soil particles mixed with the running water create an abrasive power in the water which increases the capacity of flowing water to scour more soil particles. Due to this effect, larger soil particles are eroded by the flowing water. Attrition: This form includes mechanical breakdown of loads running along the moving water due to collision of particles with each other. The broken particles are moved along with the flow velocity, which generate abrasion effect on the bottom and banks of the water course. This effect pronounces the water erosion.

Solution: This form is associated with the chemical action between running water and soil or country rocks. This type condition is observed in areas where existing rocks or soils are easily dissolved in the running water.

Transportation: The process of soil transportation by running water is completed under the following forms:

Saltation: the water soluble contents present in the water are transported by the water in solution form.

Suspension: it involves the transportation of finer soil particles, which are present in suspension form in the flowing water.

Unit IV: Watershed Development and Management (15 Questions)

Watershed – Concept, types and delineation - Land capability classification - Participatory Rural Appraisal Technique – Watershed development plan – Estimation of cost and benefits -Gully and ravine reclamation – In-situ & Ex-situ water harvesting, micro catchments – Ground water recharge - Artificial recharge techniques and methods - Farm pond and percolation pond – Selection of suitable soil and water conservation practices – Afforestation – Holistic planning - Watershed based rural development – Use of aerial photography and remote sensing in watershed management - Applications of Remote sensing and GIS in planning and development of watersheds including forest cover and water resources.

WATERSHED

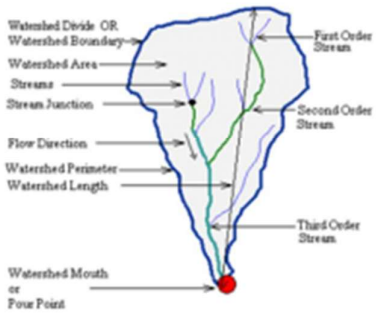
A watershed is a natural geomorphic unit that collects and drains water, sediment, and dissolved materials to a common outlet, such as a stream, river, or lake.

It is defined by topographic divides, which are high-elevation boundaries that separate adjacent drainage basins. Watersheds play a crucial role in estimating erosion rates by analyzing river flow, watershed area, and the composition of the materials. They also serve as practical units for measuring precipitation, solar radiation, and water discharge, making them essential for hydrological studies and land management.

Ecologically and geomorphologically, watersheds function as important management units, providing a structured framework for scientific assessments that guide environmental decision-making.

Key components of a watershed include the watershed boundary (or water divide), which separates adjacent basins, and the pour point, the lowest exit point where water flows out, often marked by features like river mouths, dams, or gauging stations. Inside a watershed, water flows through a network of streams of varying orders (from small 1st-order streams to larger rivers), with junctions where streams merge. Other defining characteristics include the watershed's length, width, perimeter, and total area.

Watershed analysis is widely used in flood prediction, soil conservation, and water resource planning. By examining the source raster cell (such as a gauging station), hydrologists can determine the contributing area and assess water flow patterns.



Watershed and its nomenclatures

WATERSHED CHARACTERISTICS

Watershed characteristics play a crucial role in regulating energy inputs from climate and controlling hydrological and denudation processes.

These characteristics include geology, soil properties, relief morphometry, drainage morphometry, morphology, and vegetation, each influencing water flow, sediment transport, and ecological balance.

Geology determines variations in water discharge and silt delivery rates, as different rock units respond differently to rainfall. Soil depth and texture directly impact rainwater infiltration, soil moisture retention, and groundwater recharge, affecting overall water availability.

Relief morphometry, including altitude, slope, and aspect, influences hydrological behavior; steep slopes enhance runoff, while aspect affects temperature distribution and evaporation rates.

Drainage morphometry measured through parameters like drainage density, stream frequency, bifurcation ratio, and watershed shape plays a key role in watershed dynamics.

High drainage density and stream frequency lead to increased overland flow, reduced infiltration, and higher erosion rates.

Watershed shape affects the timing of peak flow and hydrograph characteristics, with elongated basins having delayed peaks compared to circular ones. Stream order and watershed size further regulate how climatic energy is distributed within the system.

Morphologically, watersheds consist of three zones:

1. Crest zone (upland) – Dominated by erosional processes.
2. Mid-crest zone (midland) – Transitional area with mixed erosion and deposition.
3. Valley zone (lowland) – Characterized by sediment deposition and fluvial landforms.

Vegetation significantly controls hydrological processes by reducing interception loss, enhancing infiltration, minimizing overland flow, and preventing erosion through rain splash, sheet wash, and mass wasting.

Watershed Input-Output Balance

A watershed functions as a dynamic system where its environmental conditions and physical form are shaped by the interaction between input parameters (climate and tectonic forces) and watershed characteristics (geology, soils, morphometry, morphology, and vegetation). When inputs and outputs are in balance or equilibrium, the watershed remains healthy, with minimal environmental degradation or pollution.

5	Little/no erosion, but other restrictions (e.g., wetness, stones)	Best for pasture, rangeland, forestry, wildlife.
6	Severe limitations (unsuitable for cultivation)	Mainly grazing, forestry, wildlife habitat.
7	Very severe limitations (cannot be cultivated)	Restricted to grazing, forestry, wildlife.
8	Extremely limited (no commercial plant production)	Only for recreation, watershed, wildlife, aesthetics.

2. Capability Subclasses (e, w, s, c)

Subclasses indicate the primary limitation within a class (except Class 1, which has none).

Subclass	Limitation	Description
E	Erosion hazard	Needs erosion control (e.g., cover crops, reduced tillage).
W	Wetness/drainage issues	May require artificial drainage for crop use.
S	Soil limitations (shallow, droughty, stony)	Poor root zone or water retention.
C	Climatic limitations (extreme cold/dry)	Only in some U.S. regions.

- Class 5 has only w, s, or c (no erosion risk).
- Class 1 has no subclasses (minimal limitations).
- Classes 1-4: Suitable for cultivation with increasing restrictions.
- Classes 5-7: Best for non-crop uses (grazing, forestry, wildlife).
- Class 8: Only for non-agricultural purposes (conservation, recreation).
- Subclasses help identify specific constraints (erosion, wetness, soil quality, climate).

LCC SYSTEM IN INDIA

The LCC system adapted for India is based on the USDA framework but is tailored to local agricultural and environmental conditions.

It assesses soil suitability for sustained agricultural use by considering factors like Soil characteristics (depth, fertility, texture), Topography (slope, erosion risk), Climate (rainfall, temperature),

Unit V: Farm Irrigation, Structures and Drainage (30 Questions)

Irrigation - Sources – Soil- water- Plant relationship - Water requirement of crops – Measurement of irrigation water - Weirs and flumes - Methods of irrigation - Surface, Sprinkler, Rain gun and drip irrigation - Irrigation automation - Drip irrigation – Components and design - Wetting pattern - Filters and Fertigation tanks - Pump capacity - Operation and maintenance - Sprinkler irrigation - Components - Sprinkler performance - Hydraulic design of sprinkler systems - Duty and delta relationship – Irrigation scheduling - Irrigation efficiencies and their estimation - Pumps - Types, selection and installation - Design and construction of farm structures – Site selection – Quality – RCC - Foundation, basement and superstructure – Types of roofs – building plan and estimation, requirements of farm house, threshing floor, drying floor, poultry house, dairy farm, rat proof go down and farm roads - Design features earthen dams and gravity dams - Water conveyance structures – Earthen channels and lined channels – Advantages of lining – materials of lining – Design of channel cross section – Crossing control structures – Road crossing structures – Culvert, inverted siphon aqueduct – Their uses - Underground pipe line system – Components and their functions – Structures for plant environment – Green houses, poly houses and shade nets – Construction and utilization - Soilless culture. Drainage - Causes of water logging and salt problem - Methods of drainage - Design of surface, sub-surface and vertical drainage systems - Improvement and utilization of poor quality water - Reclamation of saline and alkali soils.

IRRIGATION – SOURCES

Irrigation is the process of applying water to the crops artificially to fulfil their water requirements. Nutrients may also be provided to the crops through irrigation. The various sources of water for irrigation are wells, ponds, lakes, canals, tube-wells and even dams. Irrigation offers moisture required for growth and development, germination and other related functions.

Types of Irrigation There are different types of irrigation practised for improving crop yield. These types of irrigation systems are practised based on the different types of soils, climates, crops and resources. The main types of irrigation followed by farmers include:

Surface Irrigation In this system, no irrigation pump is involved. Here, water is distributed across the land by gravity.

Localized Irrigation In this system, water is applied to each plant through a network of pipes under low pressure.

Sprinkler Irrigation Water is distributed from a central location by overhead high-pressure sprinklers or from sprinklers from the moving platform.

Drip Irrigation In this type, drops of water are delivered near the roots of the plants. This type of irrigation is rarely used as it requires more maintenance.

Soil Moisture Terms

- **Field Capacity (FC)**: Maximum water soil retains after drainage.
- **Permanent Wilting Point (PWP)**: Minimum moisture for plant survival.
- **Available Water (AW)**:

$$AW = FC - PWP$$

Infiltration Rate (f)

$$f = f_c + (f_o - f_c)e^{-kt}$$

where:

- f_o = Initial infiltration rate
- f_c = Constant rate
- k = Decay coefficient

Evapotranspiration (ET)

- **Blaney-Criddle Formula**:

$$ET = k \times \frac{p}{40}(1.8T + 32)$$

where:

- k = Crop coefficient
- p = % daylight hours
- T = Mean temperature (°C)

Net Irrigation Requirement (NIR)

$$NIR = ET - R_e + \text{Leaching Requirement}$$

where R_e = Effective rainfall.

5. Canal Design

(A) Kennedy's Theory (Non-Scouring Velocity)

$$V_o = 0.55\, m\, D^{0.64}$$

where:

- V_o = Critical velocity (m/s)
- m = Critical velocity ratio (~1.1–1.2)
- D = Depth of flow (m)

(B) Lacey's Theory (Regime Channel)

- **Wetted perimeter (P)**:

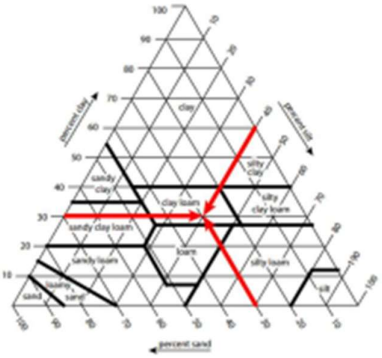
$$P = 4.75\sqrt{Q}$$

- **Slope (S)**:

$$S = \frac{f^{5/3}}{3340\, Q^{1/6}}$$

where f = Silt factor (~0.8–1.6).

soil has low porosity and thus a greater bulk density. A loose soil has a greater porosity and a lower bulk density. Like soil structure, a soil's bulk density and porosity can be affected by weather-related factors, biological activities, and soil management practices.



A soil textural classification triangle, showing a clay loam soil composed of 30 percent sand, 30 percent clay, and 40 percent silt.

Soil Texture	Bulk Density	Percentage by Mass			Fraction by Volume		
		Field Capacity	Wilting Point	Available Water Capacity	Field Capacity	Wilting Point	Available Water Capacity
Sand	1.70	7.0	3.0	4.0	0.12	0.05	0.07
Loamy Sand	1.70	10.0	4.2	5.8	0.17	0.07	0.10
Sandy Loam	1.65	13.4	5.6	7.8	0.22	0.09	0.13
Fine Sandy Loam	1.60	18.2	8.0	10.2	0.29	0.13	0.16
Loam	1.55	22.6	10.3	12.3	0.35	0.16	0.19
Silt Loam	1.50	26.8	12.9	13.9	0.40	0.19	0.21
Silty Clay Loam	1.45	27.6	14.5	13.1	0.40	0.21	0.19
Sandy Clay Loam	1.50	26.0	14.8	11.2	0.39	0.22	0.17
Clay Loam	1.50	26.3	16.3	10.0	0.39	0.24	0.15
Silty Clay	1.40	27.9	18.8	9.1	0.39	0.26	0.13
Clay	1.35	28.8	20.8	8.0	0.39	0.28	0.11

Soil Water Content. Soil water content is the amount of water stored in the soil at a given time. The most commonly defined soil water content values are saturation, field capacity, wilting point, and oven dried. At saturation, which usually occurs immediately after a heavy rainfall or an irrigation application, all pore spaces in the soil are filled with water. When the soil is at or near saturation, some of the water is free to drain or percolate due to the force of gravity. This excess water is referred to as gravitational water. Since this percolation takes time, some of this extra water could be used by plants or lost to evaporation. Field capacity is defined as the amount of water remaining in the soil after rapid percolation has occurred. This is not a definite soil water point; therefore, field capacity often is defined as approximately one-third atmosphere tension. Tension is defined in a following section. Wilting point is defined as the soil water content at which the potential or ability of the plant root to absorb water is balanced by the water potential

Unit VI: Farm Power (20 Questions)

Sources of Farm Power- Construction and working of Spark Ignition (SI) and Compression Ignition (CI) engines- Thermodynamic principles of SI and CI engine - Two stroke and Four stroke engines - Turbo charging – Fuel injection systems, Ignition, Lubrication and Cooling systems, Speed governors, Electrical systems of Internal Combustion engines - Different types of tractors, bull dozers and power tillers - power transmission systems, Types of Clutches and Gearboxes, Differential, Final drive system, Braking system – types, constructional details and operation, Steering system – types, constructional details and operation, Suspension system – types, constructional details, uses of hydraulic system in tractors, hitching system, three point linkage- tractor power outlets. Resistances to vehicle motion, vehicle performance characteristics, Operations using bulldozer, Types of wheels and tyres – Battery: types, constructional details and working principle. Tractor stability - mechanics of tractor implement combination, weight transfer - Ergonomic considerations in operation of tractors, Safety devices in tractors, Maintenance of tractors. Single phase induction motor - three phase power measurement methods- Power factor Electrical pump sets - regulated DC power supply, DC machine, DC generator, DC motor, starter - torque and efficiency - Electronics in Agriculture - Semi -conductors, transistors, operational amplifiers – Digital electronics, counters, encoders, decoders, Digital to Analog and Analog to digital converter Instrumentation - transducers - strain gauges, types and gauge factor - force measurement using strain gauges, Torque measurement, pressure measurement, flow measurement temperature measurement, thermocouples, speed measurement microprocessors, microcontrollers, PID controllers, PLC - Electric vehicles in Agriculture.

Sources of Farm Power

Classification of Farm Power Based on Source:

Human Power - Derived from human beings. Used for light operations: sowing, weeding, harvesting. Power output: ~0.1 hp (continuous work). Advantages: Easily available, low cost. Limitations: Low efficiency, fatigue, and health-dependent.

Animal Power - Bullocks, buffaloes, horses, camels, elephants. Power output: Bullock (~1 hp), Horse (~1.5 hp). Advantages: Low initial cost, multipurpose. Limitations: Slow speed, seasonal use, and maintenance cost.

Mechanical Power - Tractors, power tillers, engines. Most common source in modern agriculture. Advantages: High efficiency, timely operations. Limitations: High initial investment, fuel dependency.

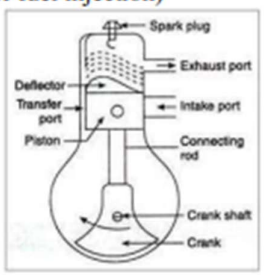
Electrical Power - Electric motors for irrigation, processing. Advantages: Clean, efficient, low operating cost. Limitations: Requires grid availability, safety issues.

Renewable Energy Sources - Solar, wind, biomass. Growing importance for sustainable agriculture.

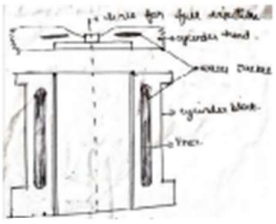
Tractor Power - Types of Tractors:

1. **Wheel Tractors** - 2-wheel drive (common). 4-wheel drive (for heavy operations)
2. **Crawler Tractors** - Track-type for soft/wet fields. Better traction, lower ground pressure

- Injector (in diesel engines for fuel injection)



Cylinder:



Classification of IC engines

- **Based on Fuel:** Diesel, Petrol, Gas.
- **Based on Ignition:** Spark Ignition (SI - Petrol), Compression Ignition (CI - Diesel).
- **Based on Cycle:** Four-Stroke (1 cycle = 2 crankshaft revs), Two-Stroke (1 cycle = 1 crankshaft rev).

Key IC engine components

Component	Primary Function & Key Details
Cylinder Block	Main engine body housing the piston. Made of grey cast iron or aluminium with steel sleeves to withstand high pressure/temperature.
Cylinder Liner/Sleeve	Inserted into block to resist wear. Wet liner contacts coolant; Dry liner has metal-to-metal contact with block.
Cylinder Head	Bolted atop block. Houses inlet & exhaust valves, injector/spark plug, and cooling jacket. Made of cast iron or aluminum alloy.
Piston	Cylindrical part providing a gas-tight seal. Transfers explosion force to crankshaft via connecting rod. Made of cast iron/aluminum alloys. Crown (top), Skirt (sides with T-slots for expansion), Grooves hold rings.
Piston Rings	Compression Ring: Seals high-pressure gases (at least 2 used). Oil Ring: Scrapes excess oil off cylinder walls, returning it to the sump. Made of cast iron/chrome-plated alloys.
Piston Pin (Gudgeon/Wrist Pin)	Connects piston to the small end of the connecting rod; provides a flexible hinge.

Cylinder volume – sum of swept volume and clearance volume. $V = V_S + V_C$

Compression ratio – The ratio of volume when the piston is at bottom dead centre to volume when the piston at top dead centre. $V/V_c = V_S + V_C/V_C$.

IC engine classification

Basis of Classification	Types	Key Feature
Operating Cycle	1. Four-Stroke Engine	Cycle completed in two revolutions of crankshaft.
	2. Two-Stroke Engine	Cycle completed in one revolution of crankshaft.
Fuel & Ignition	1. Petrol Engine (SI Engine)	Carburetor/MPFI. Spark plug ignition. Air-fuel mixture sucked in.
	2. Diesel Engine (CI Engine)	Fuel injector. Compression heat ignition. Only air sucked in.

Four-stroke diesel (CI) engine cycle

Stroke	Piston Movement	Valve Position	Key Process & Conditions
1. Suction/Induction	TDC → BDC (Down)	Inlet: Open Exhaust: Closed	Only fresh air drawn into cylinder (P_{cylinder} < P_{atm}).
2. Compression	BDC → TDC (Up)	Both Valves: Closed	Air is compressed. CR = 12:1 to 18:1. P ≈ 3500–4000 kN/m², T ≈ 600–700°C.
3. Power/Expansion	TDC → BDC (Down)	Both Valves: Closed	Fuel injected (atomized) → auto-ignition due to high T & P. Pressure pushes piston.
4. Exhaust	BDC → TDC (Up)	Inlet: Closed Exhaust: Open	Burnt gases pushed out (P_{cylinder} > P_{atm}).

COMPARISON: 4-STROKE PETROL vs. DIESEL

Parameter	4-Stroke Petrol (SI)	4-Stroke Diesel (CI)
Intake Charge	Air-Fuel Mixture	Air Only
Compression Ratio	Low (6:1 to 10:1)	High (12:1 to 18:1)
Ignition Source	Spark Plug	Compression Heat
Peak Pressure	Lower	Very High
Fuel System	Carburetor/Injector	Fuel Injector & Pump
Efficiency	Lower	Higher
Primary Agri-Use	Small Tools	Tractors, Harvesters

Unit VII: Farm Machinery (20 Questions)

Earth moving equipment - Backhoe with front end loader, Crawler excavator - Bull dozer - bladesshovels-soil digging machines-primary tillage implements- indigenous plough, Mould board plough, disc plough, chisel plough, sub soiler, methods of ploughing – secondary tillage implements-cultivators, harrows, rotary tillers, rotavator, land shaping machinery- laser leveller, ridger, bund former, raised bed former, puddler. Calculation of field capacity and field efficiency. Sowing and transplanting –seed drills, types - different types of metering mechanisms, planters, broadcasters and rice transplanters, pneumatic planters- intercultural implements - dryland weeders, wetland weeders, manual and power operated weeders - plant protection equipments – sprayers - types of sprayers - Drone sprayer - calibration of sprayer, types of nozzles, drift – harvesters - sickle, mower, cutter bar, reaper, binders, windrowers - threshers - principle of threshing, types of threshers, threshing drums, calculation of output capacity, combines, working principles, components of combine. Root crop harvesters, cotton harvesters, cotton strippers, sugarcane harvester, maize harvesters, vegetable and fruit harvesters, crop residue management machinery - cost estimation of farm machinery.

Concept of farm machinery

Agricultural mechanization, a cornerstone of modern agriculture, fundamentally involves the application of engineering principles to enhance all farming operations. It encompasses the design, manufacture, use, and servicing of tools and machines, drawing power from human, animal, and especially mechanical sources like tractors and engines. The primary objective is to increase crop yield and productivity while reducing human drudgery and cultivation costs. Beyond field operations, its scope extends to irrigation control, material handling, storage, and processing. The benefits are multifaceted: it improves the efficiency of other inputs, ensures the safety and comfort of workers, and enhances the quality and value of the produce. Ultimately, by enabling practices like multi-cropping and improving overall efficiency, farm mechanization transforms agriculture from a subsistence activity into a viable, attractive, and commercial way of life.

Earth Moving Equipment

Earth moving equipment is essential in agricultural engineering for land development, irrigation, drainage, pond construction, terracing, and farm infrastructure. These machines help in excavating, grading, leveling, and transporting soil and other materials efficiently.

Types and Functions

A. Backhoe Loader (Backhoe with Front End Loader)

- **Description:** A versatile tractor-mounted or self-propelled machine combining a **loader** at the front and a **backhoe** at the rear.
- **Components:**
    - **Front End Loader:** Bucket used for lifting, loading, and transporting loose soil, sand, or gravel.
    - **Backhoe:** Hydraulically operated digging arm used for trenching, excavation below machine level.

- **Project scale** (small farm vs. large land development)
- **Cost and availability**

Maintenance & Safety

- Regular checking of hydraulic systems, tracks, and blades.
- Proper operator training required.
- Safety: Avoid working on steep slopes, ensure roll-over protection (ROPS) in cabins.

Primary Tillage

The first major soil-working operation, designed to deeply plough soil to reduce soil strength, cover plant residues, rearrange soil aggregates, and control weeds and pests.

Main Objectives: Reduce soil strength, Rearrange soil aggregates, Bury weeds and plant materials, Control insects and pests.

Implements:

- **Animal-drawn:** Indigenous ploughs, mouldboard ploughs (e.g., Victory plough)
- **Tractor-drawn:** Mouldboard plough, disc plough, subsoil plough, chisel plough, heavy-duty disc harrow

Indigenous Plough (Country Plough)

Indigenous plough is the **most basic, traditional primary tillage implement** used in Indian agriculture for centuries. It is primarily **animal-drawn**, made from locally available wood and iron. Suitable for light soil working in small and marginal farms.

Main Components

1. **Body (Wooden Frame)**: Main structure, usually made of wood.

Commonly Used Woods in Tamil Nadu/India:

1. **Teak (*Tectona grandis*)**: Highly durable, strong, and weather-resistant. Commonly used for high-quality traditional ploughs.
2. **Red Cedar/Indian Cedar (*Toona ciliata*)**: Lightweight, moderately durable, and easy to work with.
3. **Babul/Karuvelam (*Acacia nilotica*)**: Hard, tough, and durable; suitable for beams and handles.
4. **Neem (*Azadirachta indica*)**: Termite-resistant, strong, and locally available.
5. **Pala/Jackfruit (*Artocarpus heterophyllus*)**: Durable, termite-resistant; used in rural areas.
6. **Mango (*Mangifera indica*)**: Moderately durable; often used for smaller wooden parts.
7. **Terminalia/Tan Wood (*Terminalia spp.*)**: Good strength and resilience; used in tool handles and frames.

2. **Share (or Coulter)**: Small iron point attached to the body to cut and lift the soil.
3. **Handle**: Used by the operator to control depth and direction.
4. **Beam**: Connects plough to bullocks/yoke.

Working Action: The iron share cuts a **'V'-shaped furrow**. It **loosens the soil** but does not invert it completely. Results in **intermittent furrows** with unploughed strips (*maunds*) between them.

Special Methods

A. Ridge & Furrow Method: Creating **alternate ridges and furrows**. Used for **row crops** and **surface drainage**. Common in **sugarcane, potato, cotton cultivation**.

B. Ladder / Box Ploughing: Ploughing is done **first in one direction**, then **crosswise**. Ensures **complete pulverization** and leveling. Often used in **paddy fields**.

C. Circular Ploughing: Used in **orchards and plantations** around trees. Avoids damage to plant roots.

Modern & Mechanized Methods

A. Ploughing with Reversible MB Plough: Allows **continuous ploughing in alternate directions** without dead furrows or ridges. Suitable for **large-scale, efficient tractor ploughing**.

B. Offset Discing: Using **offset disc harrows** for tillage without ridges/furrows.

Method	Best Used For	Key Feature
Continuous	Small, irregular fields	Forms central ridge
Gathering	Flat, large fields	Forms central dead furrow
Contour	Sloping lands	Reduces erosion
Ridge & Furrow	Row crops & drainage	Alternate ridges & furrows
Reversible Plough	Large-scale tractor farming	No dead furrows or ridges

Secondary Tillage & Cultivators

Lighter, finer tillage operations performed **after primary tillage** to prepare the final seedbed.

- **Characteristics:** Works on **surface soil** without significant inversion. Consumes **less power per unit area** than primary tillage.
- **Objectives:** Break clods and level the soil for seeding. Destroy weeds and grasses. Cut and mix crop residues into topsoil.

Secondary Tillage Implements

Include: **Harrows, cultivators, sweeps, clod crushers, levellers, bund formers, ridge ploughs.**

Cultivator

Implement for **inter-cultivation** between crop rows; can be used for seedbed preparation and sowing. **Main Types:**

Type	Description
Disc Cultivator	Fitted with discs for soil cutting.
Rotary Cultivator	Blades/tines on a **power-driven horizontal shaft** (rotary tiller).
Tine Cultivator	Fitted with tines having shovels.

Tractor-Drawn Cultivator

- **Two main designs:**
  1. **Trailed Type**: Has own wheels, hitch at front, frame with staggered tines. Depth controlled by screw lever.
  2. **Mounted Type**: Mounted on tractor's **three-point hydraulic linkage**. Tines arranged in staggered lines. Shovel types: Single-point, Double-point, Spear head, Sweep, Half sweep, Furrower.

Unit VIII: Unit Operations in Food and Agricultural Processing (20 Questions)

Heat transfer principles – Conduction, convection and radiation - Types of heat exchangers - Unit operations – Evaporators - Types - Mechanical separation – Filtration – Sedimentation – Settling – Centrifugal separation – Cyclone separation - Size reduction – Mixing – Blending – emulsification - Food processing operations - Pasteurization – Sterilization – Canning - Retort processing - Extrusion processing of foods - Methods of drying of foods – Preservation of food by irradiation - Microwave and dielectric heating - Fats and oil processing – Extraction methods and equipment - Food packaging – Materials and characteristics – Suitability - Processing of milk and milk products, packaging of milk - Principles of refrigeration and applications in food industries – Cold storage of fruits and vegetables - Design aspects

Unit operations involve a physical change or chemical transformation such as separation, crystallization, evaporation, filtration, polymerization, isomerization, and other reactions. A process may require many unit operations to obtain the desired product from the starting materials, or feedstocks.

Heat Transfer & Processing Equipment

Core Heat Transfer Principles

Driving Force: Temperature difference (ΔT) – alters food properties (texture, flavor, preservation).

Conduction

Heat transfer through solid without bulk movement.

Mechanism: Molecular vibration & free electron diffusion.

Fourier's Law: $Q = -kA\, dT/dx$. *k* = Thermal Conductivity (W/m·K)

Applications: Cold storage walls, baking ovens, can retort heating.

Convection

Heat transfer by macroscopic fluid movement.

Mechanism: Mass movement of fluid carrying energy.

Newton's Law: $Q = hA(T_s - T_\infty)$. *h* = Heat Transfer Coefficient

Types:

- **Natural:** Density differences (slow water heating)
- **Forced:** External source – pump/fan (plate heat exchangers)

Applications: Milk pasteurization, air blast freezing.

Radiation

Heat transfer by electromagnetic waves (infrared); no medium required.

Mechanism: Electromagnetic waves at light speed.

Stefan-Boltzmann Law: $Q = \sigma \epsilon A T^4$

Applications: Electric grills, infrared grain drying, microwave heating.

Heat Exchangers

Transfers heat between fluids without mixing (indirect method).

Tubular Heat Exchanger Types:

- **Double Pipe:** Two concentric tubes

Climbing/Rising Film	Feed BOTTOM; vapor expansion pushes film upward	5-10 sec	Fruit juice (heat-sensitive)
Falling Film	Feed TOP; gravity + vapor shear	Very short	Dairy, juice – MOST WIDELY USED
Rising/Falling Combined	Both sections; intermediate separation	Ultra-short	Maximum thermal efficiency

Critical Distinction:

- **Climbing Film:** Vapor lift (thermal driving force)
- **Falling Film:** Gravity + vapor shear
- Tube dia: Climbing = 2.5-5 cm; Falling = ~8 cm

Forced Circulation

Type	Mechanism	Application
Forced Circulation	Pumps increase velocity; separate separator	Viscous liquids; prevents fouling
Agitated Thin Film/Scraped Surface	Rotating scraper blades; forced film; 10-50 sec retention	EXTREMELY VISCOUS; tomato paste, meat slurries, crystallization

Plate Evaporators

Design: Corrugated plates, gasketed frame, 4-6 m height.

Features: Strong turbulence, flexible capacity (add/remove plates), easy CIP.

Climbing/Falling Film Plate: Ultra-short residence time; premium heat-sensitive products.

Advanced Systems

System	Principle	Benefit
Multiple-Effect	Vapor from one effect heats next	3-effect uses ⅓ steam of single-effect
Vapor Recompression (MVR/TVR)	Compressor/steam jet recycles vapor	Maximum energy savings
Waste-Heat	Uses dryer exhaust/surplus heat	Sustainability

Industry Specific Applications

Industry	Evaporator Type
Sugar	Vertical short-tube (Calandria)
Dairy	Falling film (predominant)
Fruit Juice	Rising/falling film – Short Residence Time Critical
Tomato/Meat	Scraped surface (high viscosity)

Critical Distinction

Parameter	Mixing	Blending
Intensity	Vigorous, aggressive	Gentle, careful
Goal	Homogenization; indistinguishable	Uniform; identifiable components
Example	MAYONNAISE (smooth, uniform)	GRANOLA BAR (oats, nuts, fruit visible)
Process	Involves shear, size reduction	"Folding in"

Applications in Food:

- **Mixing:** Mayonnaise, emulsions
- **Blending:** Smoothies, doughs, nutritional supplements

Applications in Agriculture: Fertilizer blending. Animal feed rations

Summary Table – Quick Revision

Operation	Principle	Key Equipment	Critical Point
Conduction	Fourier's Law	-	k = Thermal conductivity
Convection	Newton's Law	-	h = Heat transfer coefficient
Radiation	Stefan-Boltzmann	-	No medium required
PHE	Forced convection	Corrugated plates	Turbulence at low Re; CIP
SSHE	Conduction + Convection	Scraper blades	Viscous products; anti-fouling
Climbing Film	Vapor lift	Long tubes (L/D ~100:1)	5-10 sec; juice
Falling Film	Gravity + shear	Tubes ~8 cm dia	Dairy; most widely used
Sedimentation	Gravity; Stokes' Law	Tanks, clarifiers	Low energy, slow
Filtration	Pressure; Darcy's Law	Plate & frame, rotary	Cake + Filtrate
Centrifugation	Centrifugal force	Disc bowl, decanter	CLARIFIER vs SEPARATOR
Grinding	Kick's (coarse)	Hammer mill (impact)	BOND'S LAW – Industrial standard
	Rittinger's (fine)	Attrition mill (shear)	Work Index (Wi)
Emulsification	Droplet dispersion	Homogenizer	O/W (milk) vs W/O (butter)
Mixing	Vigorous; homogenizing	High-shear mixer	4 phases dissolution
Blending	Gentle; identifiable	Ribbon blender	DISTINCT FROM MIXING

Cyclone Separation

Core Principle: Inertial separation using centrifugal force generated by geometry and fluid velocity – **No Moving Parts**.

Types: Gas cyclone (gas-solid), Hydrocyclone (liquid-solid), Gas-liquid (deaeration/mist removal).

Unit IX: Process Engineering of Agricultural and Horticultural crops (20 Questions)

Engineering properties of food materials – Moisture content – Methods of determination – Psychrometry - Drying – Thin layer and deep bed drying – Types of heat sources and types of dryers - Cleaning and grading – Principles – Separators – Efficiency – Performance index - Shelling and decortication – Seed processing and layout of seed processing units - Rice processing – Parboiling and dehusking of paddy – Machines used - Milling of corn, pulses and millets - Material handling equipments - Conveyors and elevators - Storage – Conditions for safe storage – Bag and bulk storage – Silo storage - Design aspects - Modified atmosphere storage – Storage structures - Equipment used for processing of horticultural crops – Preservation of fresh fruits and vegetables – Drying and dehydration – Processing of coffee, tea, rubber, cashew nut, coconut, oil palm, aromatic plants, flowers and spices

Fundamentals of Engineering Properties

Introduction to Engineering Properties

Engineering properties of food materials are the physical, thermal, mechanical, rheological, electrical, and optical characteristics that govern the behavior of agricultural products during handling, processing, and storage. These properties serve as essential input parameters for the scientific design, analysis, optimization, and control of processing equipment and storage structures.

The study of engineering properties bridges the gap between the biological nature of food materials and the mechanical systems used to process them. Agricultural products are unique because they are: Biologically active (continue respiration after harvest), Anisotropic (properties vary with direction), Hygroscopic (absorb or release moisture depending on ambient conditions), Variable in properties with moisture content, temperature, and variety

Importance in Agricultural Engineering: Equipment design (dryers, conveyors, graders, mills). Quality evaluation and sorting. Storage structure design. Process optimization and control. Prediction of product behavior during processing

Key Categories of Engineering Properties

Physical Properties: Physical properties are those that can be determined without applying external force or changing the chemical nature of the material, except for moisture content determination.

Size and Shape: Size is the most fundamental physical property, typically expressed in terms of length, width, thickness, geometric mean diameter, or equivalent diameter. For irregularly shaped materials like grains and fruits, size is represented by three principal dimensions.

Key Parameters:

- **Length (L):** Longest dimension
- **Width (W):** Intermediate dimension
- **Thickness (T):** Smallest dimension
- **Geometric Mean Diameter (Dg):** $Dg = (L \times W \times T)^{(1/3)}$
- **Sphericity (φ):** $\varphi = (Dg)/L \times 100$

Hardness: Resistance to permanent indentation or abrasion. Important for: Milling energy requirements, Breakage susceptibility, Flour particle size distribution

Measurement Methods: Particle Size Index (PSI), Near-Infrared Reflectance (NIR), Brabender hardness tester, Penetrometer

Toughness and Fracture Behavior: The ability to absorb energy before fracture. Critical in: Shelling and milling operations, Impact damage during handling, Grinding characteristics

Angle of Repose: The angle formed by the sloping surface of a freely flowing bulk solid heap with the horizontal plane. Essential for: Hopper and bin design, Chute angle determination, Maximum filling angle of storage structures, Flowability assessment

Typical Values:

Material	Angle of Repose (degrees)
Wheat	23-28
Paddy	30-35
Maize	27-32
Soybean	25-30
Groundnut	30-38

Factors Affecting Angle of Repose: Moisture content (increases with moisture). Particle size and shape. Surface roughness. Presence of fines. Foreign material content

Coefficient of Friction: The ratio of the force required to move a material over a surface to the normal force. Two types:

- **Static friction:** Force to initiate movement
- **Kinetic friction:** Force to maintain movement

Typical Values (on steel surface):

Material	Static Coefficient	Kinetic Coefficient
Wheat	0.35-0.55	0.30-0.45
Maize	0.40-0.60	0.35-0.50
Paddy	0.45-0.65	0.40-0.55

Applications: Conveyor design. Hopper slope determination. Power requirements for material handling. Chute and spout design

Thermal Properties: Thermal properties govern heat transfer in food materials during processing operations like drying, heating, cooling, and freezing.

Specific Heat (c_p): The amount of heat required to raise the temperature of 1 kg of material by 1°C (kJ/kg·°C).

Significance: Essential for calculating heating and cooling loads in dryers, pasteurizers, and cold storage.

Formula (Based on Siebel's equation for materials above freezing): $c_p = 0.837 + 3.349M$

Where: c_p = Specific heat (kJ/kg·°C), M = Moisture content (wet basis decimal)

Alternative Formula (Siebel's equation in calories): $c_p = 0.2 + 0.6M$

Where: c_p = Specific heat (cal/g·°C), M = Moisture content (wet basis decimal)

Pseudoplastic	Viscosity decreases with shear rate (shear-thinning)	Fruit concentrates, purees
Dilatant	Viscosity increases with shear rate (shear-thickening)	Concentrated starch suspensions
Bingham plastic	Requires yield stress before flowing	Tomato ketchup, mayonnaise
Viscoelastic	Exhibits both viscous and elastic behavior	Dough, cheese, gels

Yield Stress: The minimum stress required to initiate flow in materials like pastes, purees, and suspensions. Below this stress, the material behaves as a solid; above it, it flows as a fluid.

Significance in Agricultural Engineering: Pump sizing and selection. Pipeline design. Mixer and agitator design. Extrusion process design. Texture evaluation. Quality control

Electrical and Dielectric Properties

Electrical Conductivity: The ability of a material to conduct electric current. Important for: Moisture content measurement. Ohmic heating applications. Electrostatic separation.

Dielectric Properties: The interaction of food materials with electromagnetic fields, characterized by:

- **Dielectric constant (ε'):** Ability to store electrical energy
- **Dielectric loss factor (ε''):** Ability to convert electrical energy to heat

Applications: Microwave heating and drying. Radio-frequency drying. Moisture meters (capacitance type). Quality sorting

Factors Affecting Dielectric Properties: Moisture content (primary factor). Frequency of electromagnetic field. Temperature. Density and composition

Frictional Properties

Coefficient of Friction (μ): The ratio of frictional force to normal force. Essential for designing chutes, hoppers, and conveyors.

Angle of Internal Friction: The angle at which granular material fails under shear stress. Important for: Calculating bin and silo wall pressures. Flow pattern prediction. Structural design

Optical Properties

Light Interaction Properties:

- **Color:** Quality indicator measured in CIE L*a*b* coordinates
- **Reflectance:** Surface quality evaluation
- **Transmittance:** Internal quality assessment
- **Absorbance:** Chemical composition analysis

Applications: Color sorting machines. Quality grading. Maturity determination. Defect detection. Near-infrared (NIR) spectroscopy for composition analysis

Aerodynamic Properties

Terminal Velocity: The constant velocity achieved when the drag force equals the gravitational force on a particle falling through a fluid. Important for: Pneumatic conveying design. Aspiration cleaning systems. Winnowing operations. Dust collection systems

Typical Terminal Velocities:

Unit X: Renewable and Bioenergy (20 Questions)

Solar energy – Solar collectors – Air heaters - Solar dryers – Water heaters - Solar cold storage– Solar photovoltaic systems and applications- Solar PV pump, fencing - Wind energy - Suitable sites – Types of wind mills – Wind mill components – Applications – Performance of wind mills - Biomass resources – Agro residues – Characteristics - Conversion technologies – Biochemical conversion – Biogas plant – Types and selection, construction, operation and maintenance - Slurry handling - Thermochemical conversion – Stoves – Types - Improved stoves – Pyrolysis – Charcoal production – Gasification – Briquetting – Alternate renewable energy systems - Hydro power, Geothermal, ocean and hydrogen energy- Energy storage systems- Energy Conservation- Cogeneration - Energy plantation and environmental impact – Global warming – Clean development mechanism (CDM) and role of afforestation - Biofuels – Biodiesel feedstock, production and by-product utilization – Ethanol – Production and utilization – Emission - Standards and control.

Solar Energy Applications

Solar Collectors: The Core of Thermal Systems

Solar collectors are devices that capture solar radiation and convert it into heat, transferring it to a fluid (air or water).

Types of Solar Collectors :

Flat Plate Collectors (FPC):

Description: An insulated, weatherproof box with a dark absorber plate, covered with glass.

Best For: Warm, sunny climates; low to medium-temperature applications (up to ~80-100°C).

Advantages: More affordable (20-40% less than ETC), durable, and easier to maintain.

Performance: Highest specific yields at lower temperatures (e.g., 25°C). Simple FPCs are the best choice for industrial heating up to 120°C.

Evacuated Tube Collectors (ETC):

Description: Rows of parallel glass tubes, each with a vacuum between two layers to insulate the absorber.

Best For: Cold, cloudy, or snowy climates; higher temperature needs.

Advantages: Superior heat retention due to vacuum insulation; performs well in sub-zero temperatures. Outperforms other collectors for industrial heat above 140°C.

Disadvantages: Higher initial cost, more fragile (glass tubes can crack), and more complex maintenance.

Concentrating Collectors (e.g., Parabolic Troughs, Linear Fresnel):

Description: Use mirrors or lenses to focus sunlight onto a small receiver area. Often requires sun tracking.

Advantage: Achieve much higher temperatures with flatter efficiency curves, meaning lower thermal losses at higher temperatures.

Performance: Better performance at temperatures above 50°C. Large concentrating collectors can have gross areas over 800 m^2.

A project in Kenya tested a **500L solar-powered PCM freezer** for cold transport.

Components: The system uses three **535W solar panels (49.8V)**, a battery bank, and a charge controller to run a freezer containing Phase Change Material (PCM).

Working: Solar energy freezes the PCM during the day. The "cold" stored in the PCM is then used to maintain low temperatures inside the insulated box during the night or transport, reducing reliance on diesel-powered cooling units.

Impact: Farmers using this technology fetched **over 50% better prices** for their produce. Key challenges identified include ensuring sufficient battery capacity for overnight operation during periods of cloudiness.

Solar Photovoltaic (PV) Systems

Function: Converts sunlight directly into electricity using semiconductor cells.

Key Components of an Off-Grid Solar PV System :

PV Panels (Solar Array): Generate DC electricity. Monocrystalline silicon panels offer an efficiency of 22-24%. The array should be oversized by 20-30% to account for losses.

Charge Controller: Regulates voltage and current from panels to the battery. **MPPT (Maximum Power Point Tracking) controllers** are superior, recovering 15-25% more energy than older PWM types.

Battery Bank: Stores energy for use at night or during cloudy periods. **Lithium Iron Phosphate (LiFePO4)** batteries are preferred due to their **95% depth of discharge** and longer cycle life (3,500-7,000 cycles) compared to lead-acid batteries.

Inverter: Converts DC electricity from the battery (or panels) into standard AC electricity for powering appliances.

Performance Metrics :

Performance Ratio (PR): Measures the efficiency and energy conversion performance of a PV system. An average PR of **67.8%** suggests about **32% total system losses** (from inverter, cables, temperature, etc.).

Solar PV Pump

Function: A Solar Photovoltaic Water Pumping System (SPVWPS) uses solar power to operate a water pump for irrigation or other water supply needs.

System Components: PV array, pump controller, motor (AC or DC), and the water pump itself.

Design Case Study (1-ha Bean Farm) :

Location: Kaleo, Ghana (Tropical climate). The optimal tilt angle for panels was found to be **16° facing south**.

System Size: A **2.43 kWp** solar array powering a 1.3 kW brushless DC motor.

Performance: The system met **92.6%** of the annual water demand for the farm and was found to be **82% efficient**.

Economic Viability: The project showed a positive Net Present Value (NPV) and a very short **payback period of 1.3 years**, proving its economic feasibility. The highest costs were for well drilling and drip emitters, not the solar components.

Lignin: A complex, amorphous, heterogeneous organic polymer that provides structural strength and acts as a barrier to hydrolysis. It contains approximately **21–30%** of non-fossil organic carbon.

Other Characteristics :

Volatile Matter: Agro-residues typically have high volatile matter content (e.g., Brazilian residues ranged from **70.57% to 85.36%** on a dry ash-free basis), which improves thermochemical conversion.

Energy Content: The Lower Heating Value (LHV) of biomass can vary. For example, Brazilian agro-industrial residues had an LHV ranging from **14.31 to 29.14 MJ/kg** (dry ash-free basis).

Ash Content: Inorganic matter like calcium, potassium, and sand can affect conversion processes and lead to fouling or slagging.

C:N Ratio: The carbon-to-nitrogen ratio is a critical factor, especially for biochemical processes like anaerobic digestion. European crop residue data provides mean values for C and N content by crop type.

Biomass Conversion Technologies

There are three main technological routes for the productive utilization of biomass :

1. **Biomass-based Power Generation (Combustion):** Similar to a conventional coal-based thermal power plant. Biomass is burnt in boilers to generate steam, which drives a turbo-alternator to produce electricity.
2. **Cogeneration:** The sequential production of more than one form of energy from a single fuel. It is widely used in the **sugar industry (bagasse-based cogeneration)**, where heat and electricity are produced simultaneously for process heating and power generation.
3. **Biomass Gasification:** A thermochemical process that converts solid biomass into a combustible gas mixture (producer gas) through partial combustion with a restricted air supply. Temperatures can reach up to **1100°C** in the oxidation zone. The clean producer gas can be used in IC engines for power generation.

Biochemical Conversion

Biochemical conversion involves using enzymes and microorganisms as catalysts to break down biomass into biofuels. The four main routes are digestion, fermentation, photobiological hydrogen production, and bioelectrochemical processes.

A. Anaerobic Digestion (AD) :

Process: Breakdown of organic matter by microorganisms **in the absence of oxygen**.

Product: Biogas, a clean fuel consisting primarily of **methane (60%)** and carbon dioxide, with traces of other gases. The byproduct is **digestate**, a nutrient-rich residue that can be used as fertilizer.

Feedstocks: A variety of organic wastes, including animal manure, agricultural residues, and industrial wastewater.

Potential: The estimated potential of household biogas plants based on animal waste in India is **12 million**.

Agricultural, Mechanical, Automobile and Civil Engineering
Important One LINER

Question Bank

S. No.	Unit	No. of Questions
1.	General Engineering	150
2.	Surveying and Hydrology	150
3.	Soil Erosion and Conservation	150
4.	Watershed Development and Management	150
5.	Farm Irrigation, Structures and Drainage	250
6.	Farm Power	256
7.	Farm Machinery	300
8.	Unit Operations in Food and Agricultural Processing	300
9.	Process Engineering of Agricultural and Horticultural crops	300
10.	Renewable and Bioenergy	300
Total no. of questions		**2306**

Unit I: General Engineering

1. For a body to be in translational equilibrium, the vector sum of all forces acting on it must be _____. **Answer:** zero
2. A rigid body is said to be in mechanical equilibrium if both its linear momentum and _____ are not changing with time. **Answer:** angular momentum
3. The point through which the whole weight of a body acts, regardless of its orientation, is known as the _____. **Answer:** Centre of Gravity
4. The centre of area of a plane figure is known as its _____. **Answer:** Centroid
5. A lamina has only area but no _____. **Answer:** mass
6. The first moment of an area about an axis is the product of the area and the perpendicular distance of its _____ from that axis. **Answer:** centroid
7. The Parallel Axis Theorem states that the moment of inertia about any axis is equal to the moment of inertia about a parallel axis through the centroid plus the product of area and the square of the _____ distance between the axes. **Answer:** perpendicular
8. The Perpendicular Axis Theorem applies only to _____ bodies. **Answer:** planar (or 2D)
9. The distance from an axis at which the entire area could be concentrated without changing the moment of inertia is called the _____. **Answer:** Radius of Gyration
10. The property of matter by which it resists any change in its state of rest or uniform motion is called _____. **Answer:** Inertia
11. The rotational inertia of a body is termed as its _____. **Answer:** moment of inertia
12. Section Modulus is defined as the ratio of the moment of inertia to the distance of the _____ fibre. **Answer:** extreme
13. The axis about which the product of inertia is zero is known as the _____ axis. **Answer:** principal
14. Coulomb's laws of dry friction state that the friction force is proportional to the _____ reaction and is independent of the apparent area of contact. **Answer:** normal

37. Thermosetting polymers, once set, cannot be re-melted or reshaped due to the formation of _____ bonds. **Answer:** cross
38. A composite material is a combination of two or more materials with different properties, resulting in a material with _____ characteristics. **Answer:** superior (or enhanced)
39. In foundry technology, the process of making a cavity or mold in which molten metal is poured is called _____. **Answer:** molding
40. The process of joining two metal pieces by heating their surfaces to a plastic state and then hammering them together is known as _____ welding. **Answer:** forge
41. In arc welding, the electrode that melts and supplies filler metal to the joint is called a _____ electrode. **Answer:** consumable
42. Injection molding is the most common method for manufacturing products from _____ materials. **Answer:** thermoplastic
43. Economic Order Quantity (EOQ) is the order quantity that minimizes the total cost of _____ and holding inventory. **Answer:** ordering
44. In inventory control, the ABC analysis classifies items based on their _____ consumption value. **Answer:** annual
45. 'A' category items in ABC analysis are typically small in number but account for a _____ percentage of the total inventory cost. **Answer:** high (or large)
46. The assignment model is a special case of the _____ transportation model, where each source is assigned to one destination. **Answer:** linear programming
47. In a transportation problem, if total supply is not equal to total demand, it is called an _____ problem. **Answer:** unbalanced
48. In CPM (Critical Path Method), the longest path in the network, determining the minimum project completion time, is called the _____ path. **Answer:** critical
49. PERT (Program Evaluation Review Technique) is used for projects where activity times are _____ and not deterministic. **Answer:** probabilistic
50. The difference between the latest and earliest start time of an activity is known as _____. **Answer:** total float
51. In queuing theory, the term describing the number of customers waiting in line for service is called the _____ length. **Answer:** queue
52. A system where arrivals are random and service times are variable is often modeled using _____ distribution. **Answer:** Poisson
53. The primary objective of industrial safety is to prevent _____ and promote a safe working environment. **Answer:** accidents
54. Personal Protective Equipment (PPE) is the last line of defense to protect workers from _____ hazards. **Answer:** occupational
55. A measure of the probability and severity of an adverse effect to health, property, or the environment is known as _____. **Answer:** risk
56. A machine is said to be in equilibrium when the sum of all forces and the sum of all _____ acting on it are zero. **Answer:** torques (or moments)
57. A book kept on a table is an example of a body in _____ equilibrium. **Answer:** static
58. For a two-force member to be in equilibrium, the forces must be equal, opposite, and _____. **Answer:** collinear

16. The method of locating the plane table station by sighting to three well-defined points is known as the _____ point problem. **Answer:** three
17. The area of an irregular figure with a curved boundary is most accurately calculated using _____ rule. **Answer:** Simpson's
18. The rule for calculating area which assumes that the boundaries between the ordinates are straight lines is the _____ rule. **Answer:** trapezoidal
19. Simpson's rule can be applied only when the number of segments (or divisions) is _____. **Answer:** even
20. The mechanical instrument used for directly measuring the area of a plotted figure is called a _____. **Answer:** planimeter
21. The volume of earthwork for a long and narrow work such as a road or canal is generally calculated by the _____ method. **Answer:** mean sectional area
22. The prismoidal formula for volume calculation is also known as _____ rule. **Answer:** Simpson's
23. In earthwork calculations, the trapezoidal method generally gives a slightly _____ volume than the actual. **Answer:** higher
24. The art of determining the relative heights of points on the surface of the earth is called _____. **Answer:** levelling
25. A fixed point of reference whose reduced level is known is called a _____. **Answer:** benchmark
26. A benchmark established by the Survey of India with great precision at several places is called a _____ benchmark. **Answer:** Great Trigonometrical Survey (GTS)
27. A benchmark temporarily established in the field for reference during a survey project is called a _____ benchmark. **Answer:** temporary
28. The horizontal line of sight through a level is called the line of _____. **Answer:** collimation
29. The first staff reading taken on a benchmark or any point of known elevation is called a _____ sight. **Answer:** back
30. The last staff reading taken before shifting the level instrument is called a _____ sight. **Answer:** fore
31. Staff readings taken on points other than the change points are called _____ sights. **Answer:** intermediate
32. The method of recording levels where each reading is compared with the previous one is called the _____ and fall method. **Answer:** rise
33. In the rise and fall method, if the instrument reading at a point is less than the previous reading, the point is at a _____. **Answer:** higher level (or rise)
34. In the height of collimation method, the reduced level of a point is obtained by subtracting its staff reading from the _____ of collimation. **Answer:** height (or plane)
35. The arithmetic check for levelling work is that the difference between the sum of back sights and sum of fore sights equals the difference between the _____ of the last and first points. **Answer:** reduced levels
36. Lines drawn on a map connecting points of equal elevation are called _____. **Answer:** contours

Unit VI: Farm Power (20 Questions)

Sources of Farm Power- Construction and working of Spark Ignition (SI) and Compression Ignition (CI) engines- Thermodynamic principles of SI and CI engine - Two stroke and Four stroke engines - Turbo charging – Fuel injection systems, Ignition, Lubrication and Cooling systems, Speed governors, Electrical systems of Internal Combustion engines - Different types of tractors, bull dozers and power tillers - power transmission systems, Types of Clutches and Gearboxes, Differential, Final drive system, Braking system – types, constructional details and operation, Steering system – types, constructional details and operation, Suspension system – types, constructional details, uses of hydraulic system in tractors, hitching system, three point linkage- tractor power outlets. Resistances to vehicle motion, vehicle performance characteristics, Operations using bulldozer, Types of wheels and tyres – Battery: types, constructional details and working principle. Tractor stability - mechanics of tractor implement combination, weight transfer - Ergonomic considerations in operation of tractors, Safety devices in tractors, Maintenance of tractors. Single phase induction motor - three phase power measurement methods- Power factor Electrical pump sets - regulated DC power supply, DC machine, DC generator, DC motor, starter - torque and efficiency - Electronics in Agriculture - Semi -conductors, transistors, operational amplifiers – Digital electronics, counters, encoders, decoders, Digital to Analog and Analog to digital converter Instrumentation - transducers - strain gauges, types and gauge factor - force measurement using strain gauges, Torque measurement, pressure measurement, flow measurement temperature measurement, thermocouples, speed measurement microprocessors, microcontrollers, PID controllers, PLC - Electric vehicles in Agriculture.

Sources of Farm Power

Classification of Farm Power Based on Source:

Human Power - Derived from human beings. Used for light operations: sowing, weeding, harvesting. Power output: ~0.1 hp (continuous work). Advantages: Easily available, low cost. Limitations: Low efficiency, fatigue, and health-dependent.

Animal Power - Bullocks, buffaloes, horses, camels, elephants. Power output: Bullock (~1 hp), Horse (~1.5 hp). Advantages: Low initial cost, multipurpose. Limitations: Slow speed, seasonal use, and maintenance cost.

Mechanical Power - Tractors, power tillers, engines. Most common source in modern agriculture. Advantages: High efficiency, timely operations. Limitations: High initial investment, fuel dependency.

Electrical Power - Electric motors for irrigation, processing. Advantages: Clean, efficient, low operating cost. Limitations: Requires grid availability, safety issues.

Renewable Energy Sources - Solar, wind, biomass. Growing importance for sustainable agriculture.

Tractor Power - Types of Tractors:

1. **Wheel Tractors** - 2-wheel drive (common). 4-wheel drive (for heavy operations)
2. **Crawler Tractors** - Track-type for soft/wet fields. Better traction, lower ground pressure

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