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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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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;

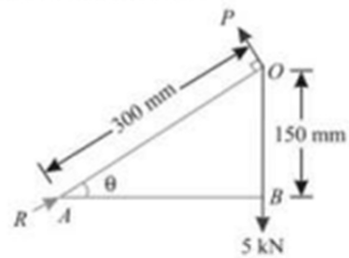
1. **Coplanar forces**: The forces, whose lines of action lie on the same plane, are known as coplanar forces.
2. **Collinear forces**: The forces, whose lines of action lie on the same line, are known as collinear forces

Solution. Given : Diameter of wheel = 600 mm; Weight of wheel = 5 kN and height of the block = 150 mm.

Least pull required just to turn the wheel over the corner.

Let P = Least pull required just to turn the wheel in kN.

A little consideration will show that for the least pull, it must be applied normal to AO. The system of forces is shown in Fig. 3.9. From the geometry of the figure, we find that



$$\sin\theta = \frac{150}{300} = 0.5 \quad \text{or} \quad \theta = 30^\circ$$

and $$AB = \sqrt{(300)^2 - (150)^2} = 260 \text{ mm}$$

Now taking moments about A and equating the same,

$$P \times 300 = 5 \times 260 = 1300$$

$$\therefore \quad P = \frac{1300}{300} = 4.33 \text{ kN} \quad \textbf{Ans.}$$

Reaction on the block

Let R = Reaction on the block in kN.

Resolving the forces horizontally and equating the same,

$$R\cos 30^\circ = P\sin 30^\circ$$

$$\therefore \quad R = \frac{P\sin 30^\circ}{\cos 30^\circ} = \frac{4.33 \times 0.5}{0.866} = 2.5 \text{ kN} \quad \textbf{Ans.}$$

COUPLE: A pair of two equal and unlike parallel forces (*i.e., forces* equal in magnitude, with lines of action parallel to each other and acting in opposite directions) is known as a couple.

As a matter of fact, a couple is unable to produce any translatory motion (*i.e.*, motion in a straight line). But it produces a motion of rotation in the body on which it acts. The simplest example of a couple is the forces applied to the key of a lock while locking or unlocking it.

ARM OF A COUPLE:

The perpendicular distance (a), between the lines of action of the two equal and opposite parallel forces, is known *as the arm of the couple,* as shown in Fig.

MOMENT OF A COUPLE: The moment of a couple is the product of the force (*i.e.*, one of the forces of the two equal and opposite parallel forces) and the arm of the couple.

Mathematically:

Moment of a couple = $P \times a$

Where P = Magnitude of the force, and
a = Arm of the couple.

CLASSIFICATION OF COUPLES:

The couples may be, broadly, classified into the following two categories, depending upon their direction, in which the couple tends to rotate the body on which it acts:

GRAPHICAL METHOD FOR THE EQUILIBRIUM OF COPLANAR FORCES:

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

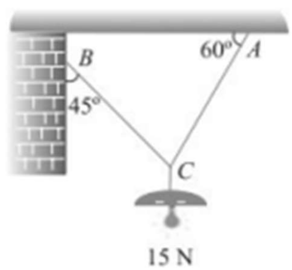
CONVERSE OF THE LAW OF TRIANGLE OF FORCES:

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.

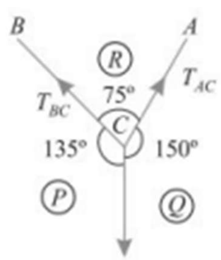
EXAMPLE: An electric light fixture weighing 15 N hangs from a point C, by two strings AC and BC. The string AC is inclined at 60° to the horizontal and BC at 45° t
to the horizontal as shown in Fig.



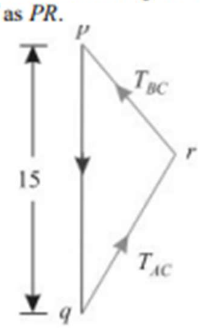
SOLUTION: Given. Weight at $C = 15$ N

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

Now draw the vector diagram for the given system of forces as shown in Fig. (*b*) and as discussed

First of all, consider the load of 1.5 kN subjected to a horizontal force of 2 kN as shown in Fig. 8.14 (*a*). We know that when the force is applied horizontally, then the magnitude of the force, which can move the load up the plane.

$$P = W \tan(\alpha + \phi)$$

or

$$2 = 1.5 \tan(\alpha + \phi)$$

$$\therefore \quad \tan(\alpha + \phi) = \frac{2}{1.5} = 1.333 \quad \text{or} \quad (\alpha + \phi) = 53.1°$$

Now consider the load of 1.5 kN subjected to a force of 1.25 kN along the plane as shown in Fig. 8.14 (*b*). We Know that when the force is applied parallel to the plane, then the magnitude of the force, which can move the load up the plane,

$$P = W \times \frac{\sin(\alpha + \phi)}{\cos \phi}$$

or

$$1.25 = 1.5 \times \frac{\sin 53.1°}{\cos \phi} = 1.5 \times \frac{0.8}{\cos \phi} = \frac{1.2}{\cos \phi}$$

$$\therefore \quad \cos \phi = \frac{1.2}{1.25} = 0.96 \quad \text{or} \quad \phi = 16.3°$$

and

$$\alpha = 53.1° - 16.3° = 36.8° \quad \textbf{Ans.}$$

Coefficient of friction

We know that the coefficient of friction,

$$\mu = \tan \phi = \tan 16.3° = 0.292 \quad \textbf{Ans.}$$

EQUILIBRIUM OF A BODY ON A ROUGH INCLINED PLANE SUBJECTED TO A FORCE ACTING AT SOME ANGLE WITH THE INCLINED PLANE:

Consider a body lying on a rough inclined plane subjected to a force acting at some angle with 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, θ =
Angle which the force makes with the inclined surface,
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.
The following two cases :

First of all, consider the equilibrium of the block. It is in equilibrium under the action of the following forces as shown in Fig. (*a*).

1. Its own weight, 1500 N, acting downwards.
2. Reaction *R*1 on the face *DE*.
3. Reaction *R*2 on the face *DG* of the block.

Resolving the forces horizontally,

$$R_1 \cos(16.7^\circ) = R_2 \sin(10 + 16.7^\circ) = R_2 \sin 26.7^\circ$$

$$R_1 \times 0.9578 = R_2 \times 0.4493$$

or $$R_2 = 2.132\, R_1$$

and now resolving the forces vertically,

$$R_1 \times \sin(16.7^\circ) + 1500 = R_2 \cos(10^\circ + 16.7^\circ) = R_2 \cos 26.7^\circ$$

$$R_1 \times 0.2874 + 1500 = R_2 \times 0.8934 = (2.132\, R_1)0.8934$$

$$= 1.905\, R_1 \qquad \ldots(R_2 = 2.132\, R_1)$$

$$R_1(1.905 - 0.2874) = 1500$$

$$\therefore \quad R_1 = \frac{1500}{1.6176} = 927.3 \text{ N}$$

and $$R_2 = 2.132\, R_1 = 2.132 \times 927.3 = 1977 \text{ N}$$

Now consider the equilibrium of the wedge. We know that it is in equilibrium under the action of the following forces as shown in Fig. 9.14 (*b*).

1. Reaction R_2 of the block on the wedge.
2. Force (*P*) acting horizontally, and
3. Reaction R_3 on the face *AC* of the wedge.

Resolving the forces vertically,

$$R_3 \cos 16.7^\circ = R_2 \cos(10^\circ + 16.7^\circ) = R_2 \cos 26.7^\circ$$

$$R_3 \times 0.9578 = R_2 \times 0.8934 = 1977 \times 0.8934 = 1766.2$$

$$\therefore \quad R_3 = \frac{1766.2}{0.9578} = 1844 \text{ N}$$

and now resolving the forces horizontally,

$$P = R_2 \sin(10^\circ + 16.7^\circ) + R_3 \sin 16.7^\circ = 1977 \sin 26.7^\circ + 1844 \sin 16.7^\circ \text{ N}$$

$$= (1977 \times 0.4493) + (1844 \times 0.2874) = 1418.3 \text{ N} \quad \textbf{Ans.}$$

PROPERTIES OF SURFACES AND SOLIDS includes *Centroid and Areas, Centre of Gravity, Axis of Reference, Methods for Centre of Gravity of Simple Figures, Centre of Gravity by Geometrical Considerations, Centre of Gravity by Moments, Centre of Gravity of Solid Bodies, Centre of Gravity of Sections with Cut Out Holes, Moment of Inertia, and Parallel Axis Theorem*

CENTROID AND MOMENT OF INERTIA

CENTRE OF GRAVITY: The point through which the whole weight of the body acts, irrespective of its position, is known as the centre of gravity (briefly written as C.G.). It may be noted that everybody has one and only one centre of gravity.

CENTROID: The plane figures (like triangle, quadrilateral, circle, etc.) have only areas, but no mass. The centre of area of such figures is known as the centroid. The method of finding out the centroid of a

Unit II: Surveying and Hydrology

Surveying – Instruments - Methods of surveying – Linear measurements - Computation of area – Triangulation, intersection, traversing, cross staff survey – Plane table survey – Earthwork 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 groundwater - groundwater 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 levelling 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:

Length Unit Conversion

Unit	Conversion factor for m
1 astronomical unit	149597870691
1 angstrom	1×10^{-10}
1 chain	20.1168
1 fathom	1.8288
1 foot	0.3048
1 furlong	201.168
1 inch	0.0254
1 light year	9460730472581000
1 mile	1609.344
1 nautical mile	1852
1 yard	0.9144

Area Unit Conversion

Unit	Conversion factor for m^2
1 acre	4046.85
1 are	100
1 hectare	10^4
1 ft^2	0.0929
1 $inch^2$	6.4516×10^4
1 $mile^2$	2589988.11
1 $yard^2$	0.8361

Volume Unit Conversion

Unit	Conversion factor for m^3
1 barrel	0.1589873
1 $yard^3$	0.765
1 US gallon	3.785×10^{-3}
1 UK gallon	4.546×10^{-3}
1 liter	0.001

Pressure Unit Conversion

Unit	Conversion factor for N/m^2
1 atm	101325
1 bar	1×10^5
1 mm Hg	133.3
1 pound per sq. feet (psf)	47.88
1 pound per sq. inch (psi)	6894.75
1 torr	133.32

Various Measurements in Surveying

- In surveying, the direction of gravity can always be taken as reference for all measurements.
- The direction of gravity is established by suspending a plumb bob freely. This direction of gravity is taken as the vertical direction. Thus horizontal direction is at right angles to the vertical direction.
- Any plane which contains the horizontal line and perpendicular to the vertical direction is called as **horizontal plane**. The plane containing the vertical line is called as **vertical plane**.

In surveying, the following basic measurements are made :

(a) **Horizontal distance:** The horizontal distance is measured in horizontal plane. On slopping ground, the distance between two points is reduced to horizontal equivalent.

(b) **Horizontal angle:** The horizontal angle is measured between two lines in horizontal plane. Theoretically the angle between two lines can vary from 0° to 360°.

(c) **Vertical distance:** As stated above, the direction of gravity is taken as vertical direction and thus vertical distances are measured in the direction of gravity. The vertical distances are measured to determine the difference of elevations between the various points.

(d) **Vertical angle:** Vertical angle is measured between two lines in vertical plane.

Surveying Instruments for Basic Measurements

The fundamental measurements in surveying—horizontal distance, horizontal angle, vertical distance, and vertical angle- require specialized instruments. Below are the key tools used for each type of measurement:

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.

5. Rural Practice Surveyors: Advise landowners, farmers, and rural stakeholders. Manage country estates, farms, and rural developments. Handle agricultural, forestry, and property sales.

6. Mineral Surveyors: Plan mineral workings and mining developments. Work with authorities on mining laws, subsidence, and environmental impacts.

7. Land Surveyors: Accurately measure and map land for construction and planning. Assist in positioning and monitoring construction projects. Support local authorities in managing roads, housing, and infrastructure.

CLASSIFICATION BASED ON THE METHOD USED

1. Triangulation Survey In order to make the survey, manageable, the area to be surveyed is first covered with series of triangles. Lines are first run round the perimeter of the plot, then the details fixed in relation to the established lines. This process is called triangulation. The triangle is preferred as it is the only shape that can completely over an irregularly shaped area with minimum space left.
2. Traverse survey: If the bearing and distance of a place of a known point is known: it is possible to establish the position of that point on the ground. From this point, the bearing and distances of other surrounding points may be established. In the process, positions of points linked with lines linking them emerge. The traversing is the process of establishing these lines, is called traversing, while the connecting lines joining two points on the ground. Joining two while bearing and distance is known as traverse. A traverse station is each of the points of the traverse, while the traverse leg is the straight line between consecutive stations.

Traverses either be open or closed. 1. Closed Traverse : When a series of connected lines forms a closed circuit, i.e. when the finishing point coincides with the starting point of a survey, it is called as a 'closed traverse', here ABCDEA represents a closed traverse. Closed traverse is suitable for the survey of boundaries of ponds, forests etc.

Open Traverse : When a sequence of connected lines extends along a general direction and does not return to the starting point, it is known as 'open traverse' or (unclosed traverse). Here ABCDE represents an open traverse. Open traverse is suitable for the survey of roads, rivers etc

Methods of Plane Table Surveying

Four classes of plane tabling surveys are recognized: Radiation method; Intersection method; Traversing method; Resection method.

Radiation Method: The plane table is set up at one station, which allows the other station to be accessed. The points to be plotted are then located by radiating rays from the plane table station to the points. After reducing the individual ground distances on the appropriate scale, the survey is then plotted. This method is suitable for small area surveys. It is rarely used to survey a complete project but is used in combination with other methods for filling in details within a chain length.

Resection in Plane Table Surveying

Resection is a method to locate the plane table station on the map by sighting known plotted points. Used when the instrument's position is unknown but needs to be plotted relative to known control points. Principle are Two or more rays (resectors) are drawn from the unknown station → known points. The intersection of these rays gives the plane table's position. Correct orientation is critical—if the table is misaligned, the resection point will be wrong.

Methods of Orientation for Resection

Method	Procedure	When to Use
1. Resection after Orientation by Compass	- Orient the table using a **magnetic compass**. - Draw rays to known points.	Quick but **least accurate** (affected by magnetic declination).
2. Resection after Orientation by Backsighting	- Align the table by **sighting a previously plotted line in reverse**. - Verify with another known point.	Used when **moving sequentially** between stations.
3. Resection after Orientation by Three-Point Problem	- Uses **3 known points** to orient the table. - Solves orientation mathematically (Lehman's rules).	Most **accurate but complex**; used when only angles are measured.
4. Resection after Orientation by Two-Point Problem	- Requires **2 known points + one auxiliary point**. - Solves orientation via geometric construction.	

Lehmann's Rules :- There are three rules to help in proper choice of the point p'.

1. If the plane table is set up in the triangle formed by the three points (i.e. p lies within the triangle ABC) then the position of the instrument on the plane will be inside the triangle of error; if not it will be outside.

2. The point P' should be so chosen that its distance from the rays Aa, Bb and Cc is proportional to the distance of p from A, B and C, respectively. Since the rotation of the table must have the same effect on each ray.

$$\Sigma \text{B.S.} - \Sigma \text{F.S.} = \Sigma \text{Rise} - \Sigma \text{Fall} = \text{Last R.L.} - \text{First R.L.}$$

Aspect	H.I. Method	Rise & Fall Method
Calculation Approach	Uses a fixed H.I. per section	Computes stepwise elevation changes
Speed	Faster for fewer I.S. points	More systematic but slightly slower
Error Detection	Checks H.I. consistency	Detects misbookings via rise/fall sums
Best Used For	Projects with many I.S. (e.g., profiles)	Precise work with frequent change points

TYPES OF BENCHMARKS

A benchmark (BM) is a fixed reference point with a known elevation (Reduced Level - RL), used as a starting or check point in levelling surveys.

Types of Benchmarks

Type	Description	Uses
GTS Benchmark (Great Trigonometrical Survey)	Permanent mark established by national survey departments (e.g., Survey of India). Usually made of bronze or concrete.	Used for **large-scale surveys**, mapping, and geodetic reference.
Permanent Benchmark	Fixed points set by government/local authorities (e.g., on bridges, buildings, or rock surfaces).	Used for **long-term projects**, legal boundaries, and construction control.
Temporary Benchmark (TBM)	A semi-stable point (e.g., nail in a tree, stone, or metal rod) used for short-term projects.	Used in **construction sites**, roadwork, and small surveys.
Arbitrary Benchmark	A point with an **assumed RL** (e.g., 100.000 m) when no official BM is available.	Used in **small surveys** where absolute elevation is not critical.

Benchmarks serve as crucial reference points in surveying, providing known elevations for various applications. They act as control points for levelling work, ensuring accurate measurements across a site. In construction, benchmarks guide proper grading, foundation placement, and slope determination.

Topographic surveys rely on them for contour mapping, while legal and property surveys use benchmarks to define boundary elevations. Additionally, engineers monitor structural settlement over time—such as in dams or bridges—by regularly checking against established benchmarks.

To establish a benchmark, surveyors first select a stable location, such as a rock outcrop or concrete structure, to prevent movement.

Optical Survey **prisms** are specially designed retroreflectors, specifically a corner reflector that is used to reflect the Electronic Distance Measurement (EDM) beam from a total station. A survey prism reflects the EDM beam to its source with both a wide angle of incidence and with high precision.

A **level staff**, also called a **levelling rod**, is a graduated feet and meter on aluminum rod, used with a **levelling instrument** to determine the difference in height between points or the heights of points above a vertical datum. It cannot be used without a levelling instrument.

A **prism pole** can be used to measure the elevation of a specific ground point by using a sight level, which is important if you want to get accurate results. You can find a **survey pole** in a variety of materials — from metal and fibreglass to a variety of composites.

Find a collection of **aluminium survey bipods**, **carbon fiber bipods**, **quick-release bipods**, and more. Easy level adjustment for better precision & accuracy.

The **measuring wheel**, also known as a **surveyor's wheel**, click wheel, perambulator, odometer, way wiser or trundle wheel, is a tool used to measure distances. **Measuring wheels** have a counting mechanism that counts the number of rotations and uses the **circumference** of the wheel to calculate the distance covered.

A **tripod** is a portable three-legged frame or stand, used as a platform for supporting the weight and maintaining the stability of some other object. It is used to give stability to other survey instruments as a total station, Auto Level, etc.

THEODOLITE SURVEY

A theodolite is a precision optical instrument used to measure horizontal and vertical angles between points, essential for surveying, engineering, and construction. It consists of a telescope mounted on horizontal and vertical axes, enabling accurate angular measurements for tasks like mapping, boundary marking, and infrastructure development. Modern theodolites often integrate with electronic distance measurement (EDM) and GPS, forming total stations for enhanced efficiency.

Types of Theodolites

Transit Theodolite – Telescope can rotate 360° for flexible measurements, ideal for detailed surveys.

Non-Transit Theodolite – Telescope does not invert, used for simpler tasks (less common today).

Vernier Theodolite – Uses a vernier scale for manual readings.

Micrometre Theodolite – Offers higher precision with a micrometre scale.

Surveying Methods

Repetition Method – Measures angles repeatedly to reduce errors.

Reiteration Method – Measures multiple angles around a fixed point for consistency.

Direction Method – Uses a reference line for sequential angle measurements.

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 and 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 topsoil 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.

- *Saltation*: The primary transport mechanism where medium-sized particles (0.1-0.5 mm) move in series of short jumps, accounting for 50-75% of total movement
- *Surface Creep*: Larger particles (0.5-1.0 mm) roll or slide along the surface, driven by impacts from saltating particles
- *Suspension*: Fine particles (<0.1 mm) become airborne and can travel hundreds of kilometers

3. *Deposition* happens when wind velocity drops below the threshold needed to sustain particle movement, often behind windbreaks or topographic barriers.

❖ Effects of Soil Erosion

The soil erosion adversely affects the livelihood of the people in one way or other. The major losses and problem occurs due to the soil erosion from various agents are listed below.

- Siltation of rivers.
- Siltation of irrigation channels and reservoirs.
- Problems in crop irrigation and consequent need of conserving the water.
- Damage to sea coast and formation of sand dunes.
- Disease and public health hazards.
- Soils eroded by water get deposited on river beds, thus increasing their level and causing floods. These floods sometime have various extreme effects, such as killing human and animals and damaging various buildings.
- Soil erosion decreases the moisture supply by soil to the plants for their growth. It also affects the activity of soil micro-organisms thus deteriorating the crop yield.
- Top layer of soil contains most of the organic matter and nutrients, loss of this soil reducing soil fertility and affecting its structure badly.
- Wind erosion is very selective, carrying the finest particles - particularly organic matter, clay and loam for many kilometres. There the wind erosion causes losses of fertile soils from highly productive farming areas.
- The most spectacular forms are dunes - mounds of more or less sterile sand - which move as the wind takes them, even burying oases and ancient cities.
- Sheets of sand travelling close to the ground (30 to 50 metres) can degrade crops.
- Wind erosion reduces the capacity of the soil to store nutrients and water, thus making the environment drier.

Remedial strategies for the prevention of soil erosion

When it comes to finding solutions for soil erosion, the most useful techniques found tend to be those that emphasize reinforcing the structure of the soil, and reducing processes that affect it.

(A) Biological Measures: The following are biological methods to control soil erosion:

(i) Improving the Existing Surface Cover: This can be done by resorting to cover cropping by growing groundnut or berseem (a fodder crop) or through grasslands development by growing grasses like dub, kudzu, pans.

CONTOUR BUNDING

Design of contour bunds

Vertical Interval between bunds (V.I)

$$V.I = \left(\frac{S}{a} + b\right) 0.3$$

where,

S – land slope (%); a and b are constants

a = 3 and b =2 for medium and heavy rainfall zones

a = 2 and b =2 for low rainfall zones

Horizontal Spacing in between bunds (H.I)

$$H.I = \frac{V.I}{S} x\,100$$

Length of bund per hectare (L.B)

$$L.B.\ per\ ha = \frac{100S}{V.I}\ or\ \frac{10{,}000}{H.I}$$

Depth of water impounding before the bund (h)

$$h = \sqrt{\frac{D * R}{500}}$$

where,

D – vertical interval (m)

R – maximum rainwater on area basis (mm)

Actual height of the bund = h + 20% of h as freeboard

Dimensions of the contour bund

Type of soil	Bottom width (m)	Top width (m)	Height (m)	Side slope
Gravel soils	1.2	0.3	0.6	0.75: 1
Red soils	2.1	0.3	0.6	1.5: 1
Shallow to medium black soil	2.4	0.45	0.75	1.3: 1
Deep soils	3.3	0.60	0.675	2: 1

Graded Bunds

Graded bunds are constructed in medium to high rainfall area having an annual rainfall of 600 mm and above and in soils having poor permeability or those having crust forming tendency (black soils), and in the lands having slopes between 2 and 6%. These bunds are provided with a channel if necessary. Uniformly

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 – Groundwater 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

C. Environmental & Social Costs

- **Short-term Disruptions**: Temporary loss of agricultural land during construction.
- **Resettlement Costs** (if applicable).

2. Estimating Benefits

A. Direct Economic Benefits

- **Increased Agricultural Productivity**: Higher crop yields due to improved soil moisture. Shift to high-value crops (horticulture, fodder).
- **Water Availability**: Rise in groundwater levels (measured via well monitoring). Extended irrigation potential.
- **Reduced Erosion & Siltation**: Lower sedimentation in reservoirs, longer dam life.

B. Indirect & Non-Market Benefits

- **Biodiversity Enhancement**: Revival of native flora/fauna.
- **Carbon Sequestration**: Value of CO_2 absorption by new vegetation.
- **Disaster Mitigation**: Reduced flood/drought risks.

C. Social Benefits

- **Livelihood Diversification**: Income from agroforestry, fisheries, or ecotourism.
- **Health Improvements**: Cleaner water reduces waterborne diseases.

Valuation Methods

Benefit Type	Valuation Approach	Example
Market-Priced Goods	Market prices (crop yields, water sales).	Rice production increase valued at local MSP.
Non-Market Benefits	Contingent Valuation (willingness-to-pay surveys).	Villagers' WTP for clean water.
Ecosystem Services	Shadow Pricing (e.g., carbon credits).	Value of carbon stored in new forests.
Avoided Costs	Cost of alternative solutions (e.g., dredging silted reservoirs).	Savings from reduced desilting.

Calculating Net Present Value (NPV)

- Discount future benefits/costs to present value using a social discount rate (e.g., 5–8% in India).

Formula:

$$NPV = \sum \frac{(Benefits - Costs)}{(1+r)^t}$$

Where:

- r = Discount rate
- t = Time period

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, levelling, 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 and excavation below machine level.
- **Uses in Agriculture:** Digging irrigation channels and drains. Trenching for pipelines. Loading and unloading materials. Pond digging and land clearing.

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 with shovels.

Tractor-Drawn Cultivator

- **Two main designs:**
    1. **Trailed Type**: Has its own wheels, a hitch at the 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.
- **Tine Variations: Spring-loaded tines:** Flexible, absorb shocks. **Rigid tines:** Used in **Duck Foot Cultivator** (for shallow ploughing, weeding, moisture retention).

Animal-Drawn Cultivators

1. **Sweep**: V-shaped blades for shallow weeding between rows. Coverage: 1.75–2.5 ha/day. Conserves soil moisture through mulching.
2. **Junior Hoe**: Curved tines with reversible shovels. Spring action avoids damage from obstacles. Coverage: ~1.5 ha/day.

Rotary Tiller (Rotary Cultivator)

- **Importance:** Provides **fine pulverization** and soil mixing; reduces traction demand due to forward thrust from blades.

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. The vertical distance between two consecutive contour lines is called the contour ______. **Answer:** interval
38. Closely spaced contour lines indicate a ______ slope. **Answer:** steep
39. The operation of determining the levels of a series of points at known distances apart along a straight line is called ______ surveying. **Answer:** profile
40. Levels taken at right angles to the centre line of a project to determine the ground surface profile on either side is called ______ sectioning. **Answer:** cross
41. An instrument used for measuring horizontal and vertical angles with high precision is called a ______. **Answer:** theodolite
42. The lower plate of a theodolite is called the ______ plate. **Answer:** scale (or graduated)
43. The process of bringing all the fundamental axes of a theodolite into their correct relative positions is called ______. **Answer:** adjustment
44. A tacheometer is essentially a theodolite fitted with a ______ telescope. **Answer:** stadia
45. The instrument that integrates electronic distance measurement (EDM) and angular measurement capabilities is called a ______ station. **Answer:** total
46. A total station can store data in its internal memory, which can be downloaded to a computer for processing, a process known as ______. **Answer:** data transfer
47. A satellite-based navigation system used to determine precise ground positions is called the ______. **Answer:** Global Positioning System (GPS)
48. The segment of GPS consisting of the satellites orbiting the Earth is known as the ______ segment. **Answer:** space
49. A hand-held level used for quick, approximate levelling work is called a ______ level. **Answer:** hand
50. A telescopic alidade is used in ______ table surveying for sighting and drawing rays. **Answer:** plane
51. The scientific study of water and its occurrence, distribution, and movement on and below the Earth's surface is called ______. **Answer:** hydrology
52. The standard instrument for measuring rainfall is the ______ gauge. **Answer:** rain
53. A rain gauge that records the time and intensity of rainfall automatically is called a ______ rain gauge. **Answer:** recording
54. A common type of recording rain gauge that uses a pair of small buckets that tip with a fixed amount of rain is the ______ bucket gauge. **Answer:** tipping
55. The process by which water is lost from the soil and water bodies as water vapor to the atmosphere is called ______. **Answer:** evaporation
56. The standard instrument used in India to measure evaporation is the ______ pan. **Answer:** Class A (or USWB Class A)
57. The process by which water enters the soil surface from the ground is called ______. **Answer:** infiltration
58. The rate at which water enters the soil surface is called the infiltration ______. **Answer:** rate (or capacity)
59. An instrument used to measure infiltration rate in the field is called an ______. **Answer:** infiltrometer

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