GATE 2026 XE Question Paper with Solutions

Time Allowed :3 Hour	Maximum Marks :100	Total Questions :65

General Instructions

Please read the following instructions carefully:

1. This question paper is divided into three sections:
   - **General Aptitude (GA):** 10 questions (5 questions × 1 mark + 5 questions × 2 marks) for a total of 15 marks.
   - **Environmental Science and Engineering + Engineering Mathematics:**
     - **Part A (Mandatory):** 36 questions (1 questions × 1 mark + 19 questions × 2 marks) for a total of 55 marks.
     - **Part B (Section 1):** Candidates can choose either Part B1 (Surveying and Mapping) or Part B2 (Section 2). Each part contains 16 questions (8 questions × 1 mark + 11 questions × 2 marks) for a total of 30 marks.
2. The total number of questions is **65**, carrying a maximum of **100 marks**.
3. The duration of the exam is **3 hours**.
4. Marking scheme:
   - For 1-mark MCQs, $\frac{1}{3}$ mark will be deducted for every incorrect response.
   - For 2-mark MCQs, $\frac{2}{3}$ mark will be deducted for every incorrect response.
   - No negative marking for numerical answer type (NAT) questions.
   - No marks will be awarded for unanswered questions.
5. Ensure you attempt questions only from the optional section (Part B1 or Part B2) you have selected.
6. Follow the instructions provided during the exam for submitting your answers.

1. The value of the determinant

$$\begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$$

is:

(A) -2
(B) 2
(C) -5
(D) 5

Correct Answer: (A) -2

Solution:

Step 1: Recall the formula for a 2×2 determinant.
For a matrix

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix},$$

the determinant is calculated using the formula:

$$ad - bc$$

Step 2: Identify the matrix elements.
From the given matrix:

$$a = 1, \quad b = 2, \quad c = 3, \quad d = 4$$

Step 3: Substitute the values into the formula.

$$\text{Determinant} = (1 \times 4) - (2 \times 3)$$

Step 4: Perform the calculations.

$$= 4 - 6$$

$$= -2$$

Step 5: Conclusion.
The value of the given determinant is -2.

Quick Tip

For any 2×2 determinant, always remember the shortcut formula:
(Top-left $\times$ Bottom-right) (Top-right $\times$ Bottom-left).

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2. Hooke's law is valid up to:

(A) Breaking point
(B) Yield point
(C) Elastic limit
(D) Ultimate stress

Correct Answer: (C) Elastic limit

Solution:

Step 1: Understanding Hooke's law.
Hooke's law states that within certain limits, stress is directly proportional to strain. Mathematically, it is expressed as:

$$\text{Stress} \propto \text{Strain}$$

or

$$\text{Stress} = E \times \text{Strain}$$

where E is the modulus of elasticity.

Step 2: Meaning of elastic limit.
The elastic limit is the maximum stress a material can withstand without undergoing permanent deformation. Up to this point, the material returns to its original shape once the load is removed.

Step 3: Relationship between Hooke's law and elastic limit.
Hooke's law is valid only in the region where stress and strain remain proportional. This proportional behavior exists only up to the elastic limit. Beyond this limit, the stress–strain relationship becomes non-linear.

Step 4: Analysis of options.
(A) Breaking point: Incorrect — At this point, the material fractures, and Hooke's law no longer applies.
(B) Yield point: Incorrect — Plastic deformation begins near the yield point, violating Hooke's law.
(C) Elastic limit: Correct — Hooke's law holds true only up to the elastic limit.
(D) Ultimate stress: Incorrect — This corresponds to maximum stress before failure, far beyond the elastic region.

Step 5: Conclusion.
Since Hooke's law requires proportionality between stress and strain, it is valid only up to the elastic limit.

Quick Tip

Always remember: **Hooke's law works only in the elastic region** of the stress–strain curve.

3. Which dimensionless number represents the ratio of inertial forces to viscous forces?

(A) Reynolds number
(B) Froude number
(C) Mach number
(D) Weber number

Correct Answer: (A) Reynolds number

Solution:

Step 1: Understanding dimensionless numbers in fluid mechanics.
Dimensionless numbers are ratios of different types of forces acting in a fluid flow. They help in predicting flow behavior and similarity between different flow systems.

Step 2: Definition of Reynolds number.
The Reynolds number is defined as the ratio of inertial forces to viscous forces in a fluid flow. It is given by:

$$Re = \frac{\rho V L}{\mu}$$

where ρ is fluid density, V is flow velocity, L is characteristic length, and μ is dynamic viscosity.

Step 3: Physical significance.
- High Reynolds number indicates dominance of inertial forces, leading to turbulent flow.
- Low Reynolds number indicates dominance of viscous forces, resulting in laminar flow.

Step 4: Analysis of options.
(A) Reynolds number: Correct — It directly represents the ratio of inertial to viscous forces.
(B) Froude number: Represents the ratio of inertial forces to gravitational forces.
(C) Mach number: Represents the ratio of flow velocity to speed of sound.
(D) Weber number: Represents the ratio of inertial forces to surface tension forces.

Step 5: Conclusion.
Since the question asks for the ratio of inertial forces to viscous forces, the correct dimensionless number is the Reynolds number.

Quick Tip

Whenever inertial force vs viscous force comparison is asked, the answer is always **Reynolds number**.

4. For an ideal gas undergoing an isothermal process, which of the following remains constant?

(A) Pressure
(B) Temperature
(C) Volume
(D) Entropy

Correct Answer: (B) Temperature

Solution:

Step 1: Meaning of isothermal process.
An isothermal process is a thermodynamic process in which the temperature of the system remains constant throughout the process. The term "iso" means same, and "thermal" refers to temperature.

Step 2: Ideal gas behavior.
For an ideal gas, the equation of state is given by:

$$PV = nRT$$

During an isothermal process, the temperature T remains constant while pressure and volume may change.

Step 3: Effect on other properties.
- Pressure varies inversely with volume.
- Volume changes with pressure.
- Entropy may change depending on heat transfer.
However, temperature remains unchanged by definition.

Step 4: Analysis of options.
(A) Pressure: Incorrect — Pressure changes during an isothermal process.
(B) Temperature: Correct — Temperature remains constant throughout the process.
(C) Volume: Incorrect — Volume changes to maintain constant temperature.
(D) Entropy: Incorrect — Entropy can change during isothermal processes.

Step 5: Conclusion.
Since an isothermal process is defined by constant temperature, the correct answer is temperature.

Quick Tip

Isothermal = Constant Temperature. Always associate "iso" with "same" in thermodynamics.

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5. Which crystal structure is exhibited by body-centered cubic (BCC) metals?

(A) Iron (α-Fe)
(B) Copper
(C) Aluminum
(D) Nickel

Correct Answer: (A) Iron (α-Fe)

Solution:

Step 1: Understanding BCC crystal structure.
The body-centered cubic (BCC) structure is a type of crystal lattice in which atoms are located at the eight corners of a cube and one atom is present at the center of the cube. This arrangement results in a total of two atoms per unit cell.

Step 2: Characteristics of BCC metals.
BCC metals generally exhibit high strength and hardness due to fewer close-packed planes. Common examples of BCC metals include iron at room temperature, chromium, and tungsten.

Step 3: Analysis of options.
(A) Iron (α-Fe): Correct — Alpha iron (ferrite) has a BCC crystal structure at room temperature.
(B) Copper: Copper has a face-centered cubic (FCC) structure, not BCC.
(C) Aluminum: Aluminum also crystallizes in an FCC structure.
(D) Nickel: Nickel has an FCC crystal structure as well.

Step 4: Conclusion.
Among the given options, only iron in its alpha phase exhibits a body-centered cubic crystal structure.

Quick Tip

Remember common BCC metals: **Iron (-Fe), Chromium, Tungsten**. Most ductile metals like copper and aluminum are FCC.

6. The Poisson's ratio for an incompressible material is:

(A) 0
(B) 0.25
(C) 0.33
(D) 0.5

Correct Answer: (D) 0.5

Solution:

Step 1: Understanding Poisson's ratio.
Poisson's ratio (ν) is defined as the ratio of lateral strain to longitudinal strain when a material is subjected to uniaxial stress. It is given by:

$$\nu = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

Step 2: Meaning of incompressible material.
An incompressible material is one whose volume does not change when subjected to stress. This means the decrease in one dimension is exactly balanced by the increase in another dimension.

Step 3: Relation between Poisson's ratio and volume change.
For a material to be incompressible, the volumetric strain must be zero. From elasticity theory, this condition is satisfied when Poisson's ratio equals 0.5.

Step 4: Analysis of options.
(A) 0**:** Represents perfectly brittle material with no lateral strain.
(B) 0.25**:** Typical for some metals, but not incompressible.
(C) 0.33**:** Common for ductile materials like steel.
(D) 0.5**:** Correct — This value corresponds to incompressible materials.

Step 5: Conclusion.
Since an incompressible material does not undergo any volume change, its Poisson's ratio must be equal to 0.5.

Quick Tip

Poisson's ratio = 0.5 is a key indicator of incompressible materials such as rubber-like substances.

7. The mode of heat transfer which does not require a material medium is:

(A) Conduction
(B) Convection
(C) Radiation
(D) Diffusion

Correct Answer: (C) Radiation

Solution:

Step 1: Understanding heat transfer modes.
Heat transfer occurs through three primary modes: conduction, convection, and radiation. Each mode has different physical mechanisms.

Step 2: Explanation of radiation.
Radiation is the transfer of heat energy in the form of electromagnetic waves. Since electromagnetic waves can travel through a vacuum, radiation does not require any material medium.

Step 3: Comparison with other modes.
- Conduction requires direct contact between molecules.
- Convection requires fluid motion and a material medium.
- Diffusion is related to mass transfer, not heat transfer.

Step 4: Analysis of options.
(A) Conduction: Requires a solid or material medium.
(B) Convection: Requires a fluid medium.
(C) Radiation: Correct — Can occur through vacuum.
(D) Diffusion: Not a mode of heat transfer.

Step 5: Conclusion.
Since radiation can transfer heat without any material medium, it is the correct answer.

Quick Tip

Heat from the Sun reaches the Earth through **radiation**, proving that no medium is required.