GATE WALLAH

TOPIC WISE
GATE PREVIOUS YEAR
QUESTIONS
WITH VIDEO SOLUTIONS

CIVIL ENGINEERING

- Detailed Text Solutions
- Embedded QR Code for Video Solutions
- Chapter-Wise Weightage Analysis

2008 – 2025

GATE

CIVIL ENGINEERING

CONTENTS

Strength of Materials

Syllabus

Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

Chapter wise Weightage Analysis (Marks)

Chapter / Paper / Year	Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	Ch.7	Ch.8	Ch.9	Ch.10
2008	2	0	3	0	0	0	4	0	2	0
2009	1	0	2	1	0	1	2	0	0	1
2010	1	2	0	1	0	0	1	0	1	0
2011	2	0	0	1	0	0	0	0	0	0
2012	1	0	1	1	1	0	0	0	2	0
2013	1	0	1	1	1	1	0	0	1	0
2014 (P1)	1	0	1	0	1	1	0	0	1	0
2014 (P2)	1	0	0	0	1	0	0	0	0	0
2015 (P1)	1	0	1	1	0	0	0	0	0	0
2015 (P2)	0	0	2	1	0	0	0	0	0	1
2016 (P1)	0	1	2	0	0	0	0	0	0	0
2016 (P2)	1	0	0	1	0	0	0	0	0	0
2017 (P1)	1	1	0	0	0	0	0	0	1	0
2017 (P2)	1	0	1	0	0	0	1	0	0	0
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2018 (P2)	0	0	0	0	1	0	0	0	0	0
2019 (P1)	0	0	0	1	1	1	0	0	0	0
2019 (P2)	0	0	0	1	0	1	1	0	0	0
2020 (P1)	1	1	1	1	0	0	0	0	0	0
2020 (P2)	1	1	1	1	0	0	0	0	0	0
2021 (P1)	1	0	1	1	0	0	0	0	0	0
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2022 (P1)	1	0	0	0	0	1	0	0	0	1
2022 (P2)	2	0	1	0	0	0	0	0	0	0
2023 (P1)	0	1	0	2	0	0	1	0	0	0
2023 (P2)	1	1	1	1	0	0	0	0	0	0
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2024 (P2)	0	0	2	0	0	1	0	2	1	0
2025 (P1)	0	0	0	0	0	0	0	0	0	0
2025 (P2)	1	1	2	1	0	0	0	0	0	0

CHAPTER

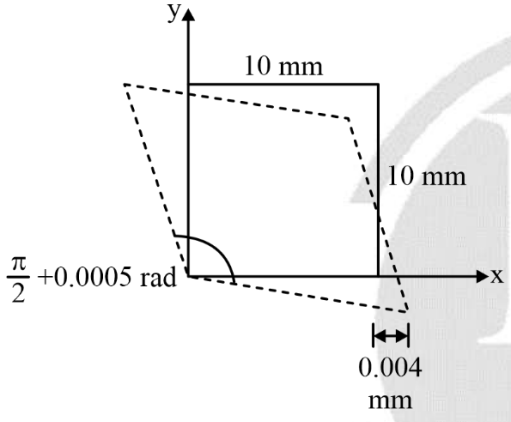
1

PROPERTIES OF MATERIALS

Types of Stress & Strain

1. [MCQ] [GATE-2017:1M]

In a material under a state of plane strain, a 10 × 10 mm square centered at a point gets deformed as shown in the figure.



If the shear strain γ_{xy}, at this point is expressed as 0.001 k (in rad), the value of k is

(a) 0.50
(b) 0.25
(c) –0.25
(d) –0.50

Stress-Strain Curve

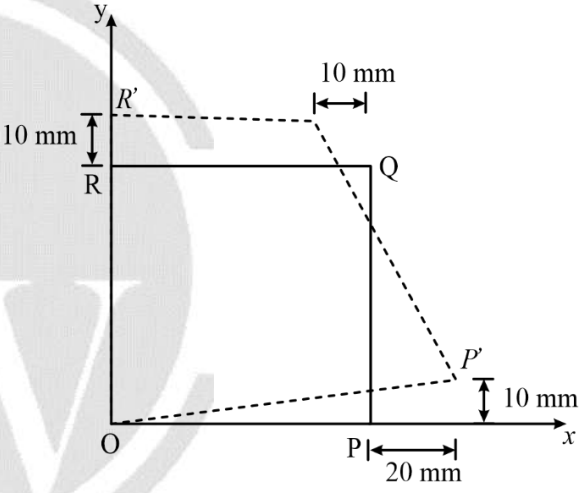
2. [MCQ] [GATE-2021:1M]

Strain hardening of structural steel means

(a) strengthening steel member externally for reducing strain experienced
(b) experiencing higher stress than yield stress with increased deformation
(c) strain occurring before plastic flow of steel material
(d) decrease in the stress experienced with increasing strain

3. [NAT] [GATE-2021:2M]

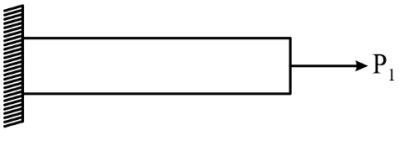
A square plate O-P-Q-R of a linear elastic material with sides 1.0 m is loaded in a state of plane stress. Under a given stress condition, the plate deforms to a new configuration O-P'-Q'-R' as shown in the figure (not to scale). Under the given deformation, the edges of the plate remain straight.

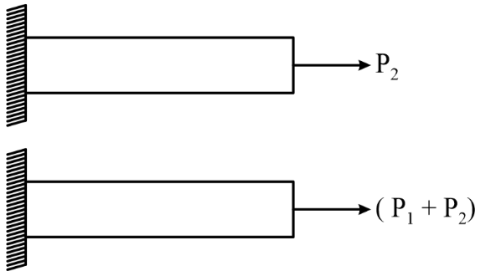


The horizontal displacement of the point (0.5 m, 0.5 m) in the plate O-P-Q-R (in mm, round off to one decimal place) is

4. [MCQ] [GATE-2020:2M]

A prismatic linearly elastic bar of length L, cross-sectional area A, and made up of a material with Young's modulus E, is subjected to axial tensile force as shown in the figures. When the bar is subjected to axial tensile force P_1, and P_2, the strain energies stored in the bar are U_1 and U_2, respectively.





If U is the strain energy stored in the same bar when subjected to an axial tensile force $(P_1 + P_2)$, the correct relationship is

(a) $U = U_1 - U_2$
(b) $U = U_1 + U_2$
(c) $U < U_1 + U_2$
(d) $U > U_1 + U_2$

Properties of materials

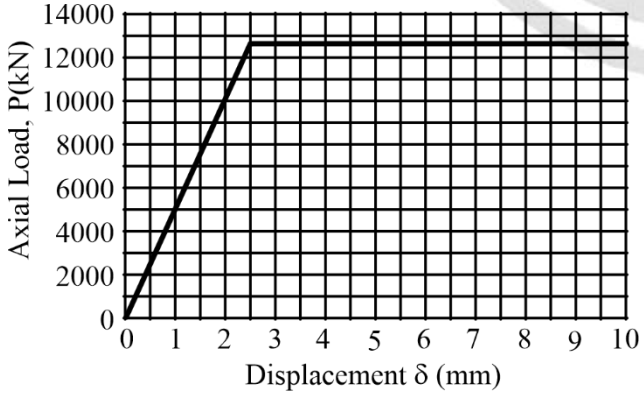
5. [MSQ] [GATE-2024 : 1M]

The elements that DO NOT increase the strength of structural steel are

(a) Sulphur
(b) Carbon
(c) Chlorine
(d) Manganese

6. [NAT] [GATE-2017:2M]

A 2 m long, axially loaded mild steel rod of 8 mm diameter exhibits the load-displacement (P- δ) behavior as shown in the figure.

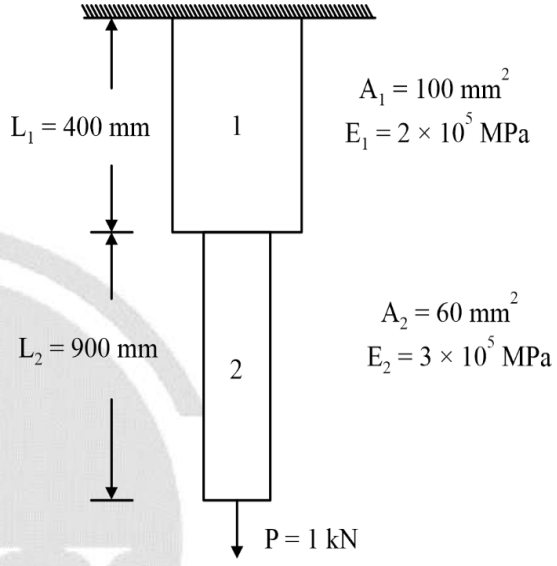


Assume the yield stress of steel as 250 MPa. The complementary strain energy (in N-mm) stored in the bar up to its linear elastic behavior will be_____.

7. [NAT] [GATE-2017:2M]

Consider the stepped bar made with a linear elastic material and subjected to an axial load of 1 kN, as shown in the figure.

Segments 1 and 2 have cross-sectional area of 100 mm^2 and 60 mm^2, Young's modulus of 2×10^5 MPa and 3×10^5 MPa, and length of 400 mm and 900 mm, respectively. The strain energy (in N-mm) up to one decimal place in the bar due to the axial load is



8. [MCQ] [GATE-2013:1M]

Creep strains are

(a) caused due to dead load only
(b) caused due to live load only
(c) caused due to cyclic load only
(d) independent of load

9. [MCQ] [GATE-2012:1M]

The Poisson's ratio is defined as

(a) $\left|\frac{\text{axial stress}}{\text{lateral stress}}\right|$

(b) $\left|\frac{\text{lateral strain}}{\text{axial strain}}\right|$

(c) $\left|\frac{\text{lateral stress}}{\text{axial stress}}\right|$

(d) $\left|\frac{\text{axial strain}}{\text{lateral strain}}\right|$

Elastic Constants

10. [MCQ] [GATE-2022:1M]

For a linear elastic and isotropic material, the correct relationship among Young's modulus of elasticity (E), Poisson's ratio (ν), and shear modulus (G) is

(a) $G = \dfrac{E}{2(1+\nu)}$ (b) $G = \dfrac{E}{(1+2\nu)}$

(c) $E = \dfrac{G}{2(1+\nu)}$ (d) $E = \dfrac{G}{(1+2\nu)}$

11. [MCQ] [GATE-2010:1M]

The number of independent elastic constants for a linear elastic isotropic and homogeneous material is

(a) 4 (b) 3

(c) 2 (d) 1

12. [MCQ] [GATE – 2008: 1M]

A mild steel specimen is under uniaxial tensile stress. Young's modulus and yield stress for mild steel are 2×10^5 MPa and 250 MPa respectively. The maximum amount of strain energy per unit volume that can be stored in this specimen without permanent set is

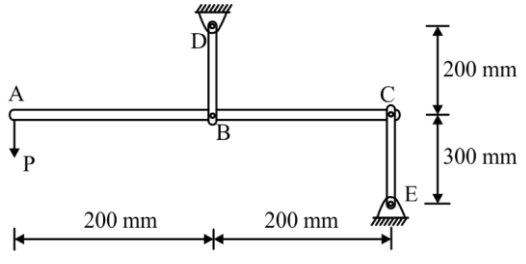
(a) 156 N-mm/mm^3 (b) 15.6 N-mm/mm^3

(c) 1.56 N-mm/mm^3 (d) 0.156 N-mm/mm^3

Effect of Uniaxial Loading

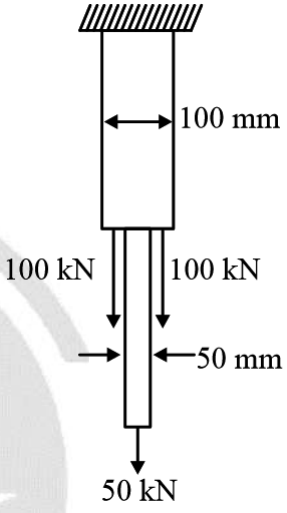
13. [NAT] [GATE-2025-2M]

Consider the rigid bar ABC supported by the pin-jointed links BD and CE and subjected to a load P at the end A, as shown in the figure. The axial rigidities of BD and CE are 22500 kN and 15000 kN, respectively. If CE elongates by 5 mm due to the load P, the magnitude of the downward deflection (in mm) of the end A would be _____ (rounded off to the nearest integer).



14. [MCQ] [GATE-2023:1M]

A hanger is made of two bars of different sizes. Each bar has a square cross-section. The hanger is loaded by three-point loads in the mid vertical plane as shown in the figure. Ignore the self-weight of the hanger. What is the maximum tensile stress in N/mm^2 anywhere in the hanger without considering stress concentration effects?

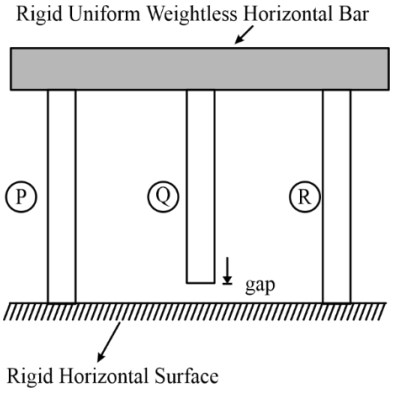


(a) 15.0 (b) 25.0

(c) 35.0 (d) 45.0

15. [NAT] [GATE-2020:2M]

A rigid, uniform, weightless, horizontal bar is connected to three vertical members P, Q and R as shown in the figure (not drawn to the scale). All three members have identical axial stiffness of 10 kN/mm. The lower ends of bars P and R rest on a rigid horizontal surface. When NO load is applied, a gap of 2 mm exists between the lower end of the bar Q and the rigid horizontal surface. When a vertical load W is placed on the horizontal bar in the downward direction, the bar still remains horizontal and gets displaced by 5 mm in the vertically downward direction.



The magnitude of the load W (in kN, round off to the nearest integer), is

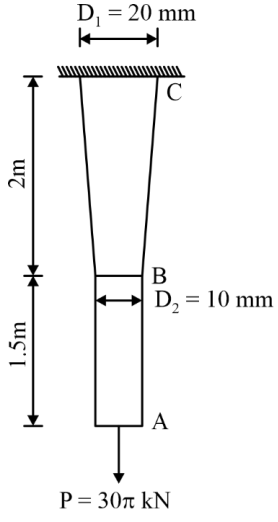
16. [MCQ] [GATE-2008:2M]

A vertical rod PQ of length L is fixed at its top end P and has a flange fixed to the bottom end Q. A weight W is dropped vertically from a height (<L) on to the flange. The axial stress in the rod can be reduced by

(a) increasing the length of the rod
(b) decreasing the length of the rod
(c) decreasing the area of cross-section of the rod
(d) increasing the modulus of elasticity of the material

17. [NAT] [GATE-2015:2M]

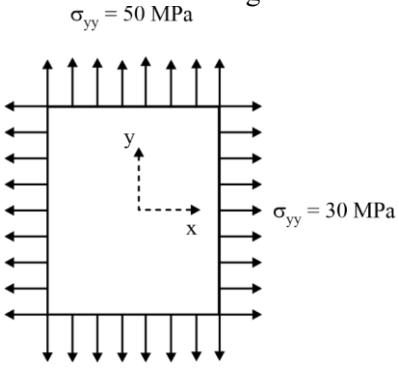
A tapered circular rod of diameter varying from 20 mm to 10 mm is connected to another uniform circular rod of diameter 10 mm as shown in the following figure. Both bars are made of same material with the modulus of elasticity, $E = 2 \times 10^5$ MPa. When subjected to a load $P = 30\pi$ kN, the deflection at point A is_____mm.



Stress-Strain System

18. [MCQ] [GATE-2018:2M]

A plate in equilibrium is subjected to uniform stresses along its edges with magnitude $\sigma_{xx} = 30$ MPa and $\sigma_{yy} = 50$ MPa as shown in the figure

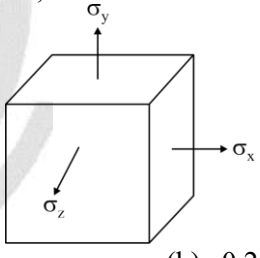


The Young's modulus of the material is 2×10^{11} N/m^2 and the Poisson's ratio is 0.3. If σ_{zz} is negligibly small and assumed to be zero, then the strain ε_{zz} is

(a) -120×10^{-6} (b) -60×10^{-6}
(c) 0.0 (d) 120×10^{-6}

19. [MCQ] [GATE-2016:2M]

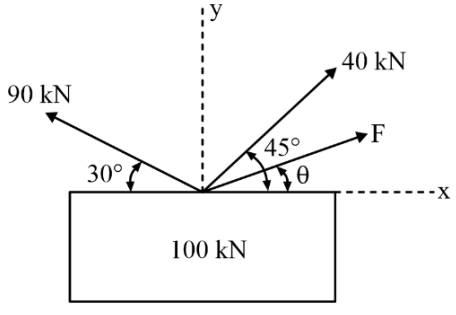
An elastic isotropic body is in a hydrostatic state of stress as shown in the figure. For no change in the volume to occur, what should be its Poisson's ratio?



(a) 0.00 (b) 0.25
(c) 0.50 (d) 1.00

20. [MCQ] [GATE-2014:2M]

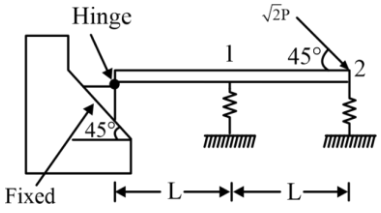
A box of weight 100 kN shown in the figure is to be lifted without swinging. If all the forces are coplanar, the magnitude and direction (θ) of the force (F) with respect to x-axis should be



(a) F = 56.389 kN and θ = 28.28°
(b) F = –56.389 kN and θ = –28.28°
(c) F = 9.055 kN and θ = 1.414°
(d) F = –9.055 kN and θ = –1.414°

Linked Answer Question for 21 and 22:

A rigid beam is hinged at one end and supported on linear elastic springs (both having a stiffness of 'k') at points '1' and '2' and an inclined load acts at '2', as shown.



21. [MCQ] [GATE-2011:2M]

Which of the following options represent the deflection δ_1 and δ_2 at Points '1' and '2'.

(a) $\delta_1 = \frac{2}{5}\left(\frac{2P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{2P}{k}\right)$

(b) $\delta_1 = \frac{2}{5}\left(\frac{P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{P}{k}\right)$

(c) $\delta_1 = \frac{2}{5}\left(\frac{P}{\sqrt{2}k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{2P}{\sqrt{2}k}\right)$

(d) $\delta_1 = \frac{2}{5}\left(\frac{\sqrt{2}P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{\sqrt{2}P}{k}\right)$

22. [MCQ] [GATE-2011:2M]

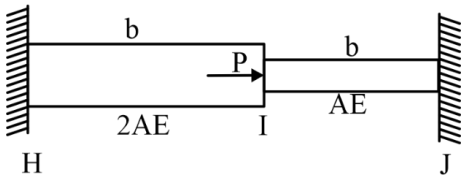
If the load P equals 100kN, which of the following options represents forces R_1 and R_2 in the springs at points '1' and '2'

(a) R_1 = 20 kN and R_2 = 40 kN
(b) R_1 = 50 kN and R_2 = 50 kN
(c) R_1 = 30 kN and R_2 = 60 kN
(d) R_1 = 40 kN and R_2 = 80 kN

Thermal Stress

23. [NAT] [GATE-2022:1M]

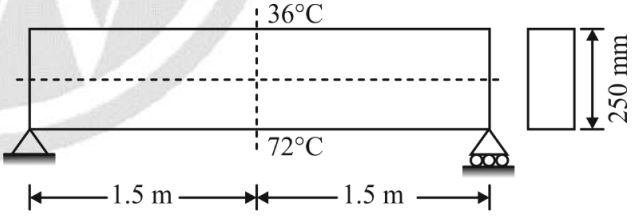
Consider two linearly elastic rods HI and IJ. each of length b, as shown in the figure. The rods are co-linear, and confined between two fixed supports at H and J. Both the rods are initially stress free. The coefficient of linear thermal expansion is α for both the rods. The temperature of the rod IJ is raised by ΔT, whereas the temperature of rod HI remains unchanged. An external horizontal force P is now applied at node I. It is given that $\alpha = 10^{-6}$ °C^{-1}, ΔT = 50° C, b = 2m, AE = 10^6 N. The axial rigidities of the rods HI and IJ are 2 AE and AE, respectively.



To make the axial force in rod HI equal to zero, the value of the external force P (in N) is_____. (Rounded off to the nearest integer)

24. [NAT] [GATE-2014:2M]

The beam of an overall depth 250 mm (shown below) is used in a building subjected to two different thermal environments. The temperatures at the top and bottom surfaces of the beam are 36°C and 72°C respectively. Considering coefficient of thermal expansion (α) as 1.50×10^{-5} per°C, the vertical deflection of the beam (in mm) at its mid-span due to temperature gradient is



25. [MCQ] [GATE-2017:1M]

An elastic bar length L, uniform cross-sectional area A, coefficient of thermal expansion α, and Young's modulus E is fixed at the two ends. The temperature of the bar is increased by T, resulting in an axial stress σ. Keeping all other parameters unchanged, if the length of the bar is doubled, the axial stress would be

(a) σ (b) 2σ
(c) 0.5σ (d) 0.25σ

❑❑❑

ANSWER KEY

1.	**(d)**	**8.**	**(a)**	**15.**	**(130)**	**22.**	**(d)**
2.	**(b)**	**9.**	**(b)**	**16.**	**(a)**	**23.**	**(50)**
3.	**(2.5)**	**10.**	**(a)**	**17.**	**(15)**	**24.**	**(2.43)**
4.	**(d)**	**11.**	**(c)**	**18.**	**(a)**	**25.**	**(a)**
5.	**(a, c)**	**12.**	**(d)**	**19.**	**(0.5)**		
6.	**(15707.96)**	**13.**	**(14-14)**	**20.**	**(a)**		
7.	**(35)**	**14.**	**(b)**	**21.**	**(b)**		

SOLUTIONS

1. (d)

γ_{xy} = 0.001 k rad.

Shear strain = change in angle between mutually perpendicular planes.

From given figure,

$$\gamma_{xy} = -\left\{\left(\frac{\pi}{2} + 0.0005\right) - \frac{\pi}{2}\right\}$$

$$\gamma_{xy} = -0.0005$$

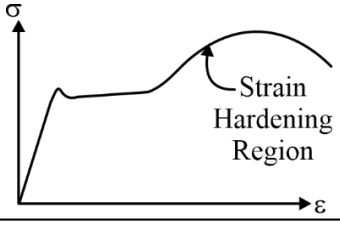
Comparing both the values of shear strain,

0.001 k = – 0.0005

k = – 0.5

Scan for Video solution

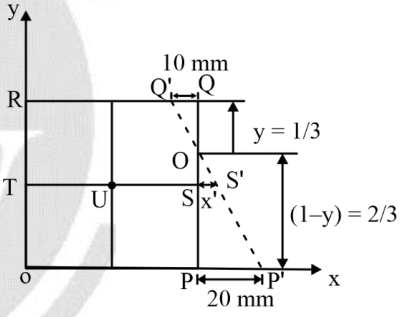
2. (b)



Scan for Video solution

3. (2.5)

Ignoring all vertical displacements.



$\Delta QQ'O \simeq \Delta PP'O$

$$\Rightarrow \frac{y}{1-y} = \frac{10}{20} \qquad \Rightarrow y = \frac{1}{3}$$

$\Delta SS'O \simeq PP'O$

$$\frac{x'}{20} = \frac{OS}{OP} = \frac{\frac{2}{3} - 0.5}{\frac{2}{3}} \qquad \Rightarrow x' = 5mm$$

Horizontal displacement of point U

$$= \frac{\Delta H_T + \Delta H_S}{2} = \frac{0+5}{2}$$

$$\Delta H_U = 2.5mm$$

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GATE WALLAH

TOPIC WISE

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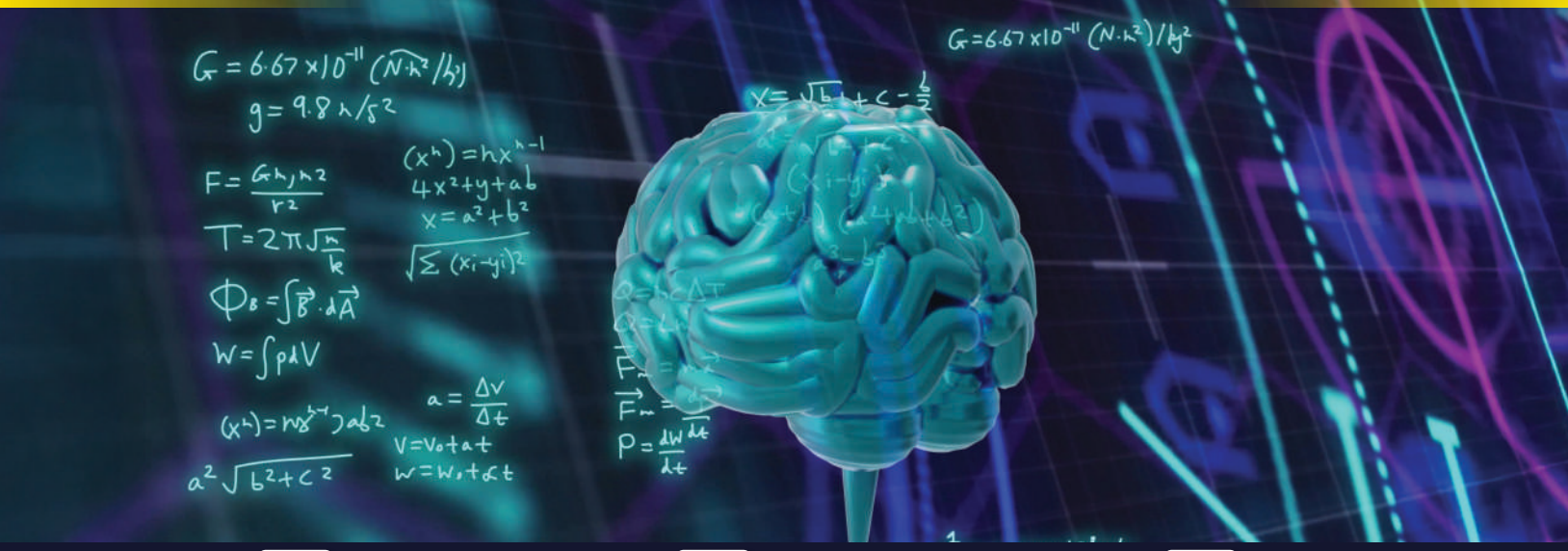
ENGINEERING MATHEMATICS & GENERAL APTITUDE

ME | CE | EE | ECE | CSE & IT



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- Chapter-Wise Weightage Analysis

2008 – 2025

GATE

ENGINEERING MATHEMATICS & GENERAL APTITUDE

CONTENTS

Engineering Mathematics

(Computer Science & IT)

Syllabus

- **Linear Algebra:** Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition.
- **Calculus:** Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration.
- **Probability and Statistics:** Random variables. Uniform, normal, exponential, Poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

CSE & IT Chapter wise Weightage Analysis

Chapter / Paper Year	Ch.1	Ch.2	Ch.3
2008	3	4	6
2009	0	2	0
2010	2	1	4
2011	2	2	6
2012	1	1	3
2013	0	1	1
2014 (P1)	3	3	1
2014 (P2)	2	0	0
2014 (P3)	1	2	2
2015 (P1)	3	2	0
2015 (P2)	1	2	0
2015 (P3)	1	4	0
2016 (P1)	1	1	3
2016 (P2)	2	0	1
2017 (P1)	3	2	2
2017 (P2)	3	1	5
2018	2	1	1
2019	3	1	4
2020	0	1	2
2021 (P1)	1	2	3
2021 (P2)	1	1	1
2022	3	1	0
2023	2	2	0
2024 (P1)	3	1	3
2024 (P2)	2	1	3
2025 (P1)	3	1	3
2025 (P2)	4	1	4

CHAPTER

1

LINEAR ALGEBRA

Algebra of Matrices

1. [MCQ] [GATE-CS-2025: 1M]

Let L, M, and N be non-singular matrices of order 3 satisfying the equations $L^2 = L^{-1}$, $M = L^8$ and $N = L^2$. Which ONE of the following is the value of the determinant of (M – N)?

(a) 0 (b) 1

(c) 2 (d) 3

2. [MCQ] [GATE-CE-2025: 1M]

For the matrix [A] given below, the transpose is

$$[A] = \begin{bmatrix} 2 & 3 & 4 \\ 1 & 4 & 5 \\ 4 & 3 & 2 \end{bmatrix};$$

(a) $\begin{bmatrix} 2 & 1 & 4 \\ 3 & 4 & 3 \\ 4 & 5 & 2 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & 3 & 2 \\ 5 & 4 & 1 \\ 2 & 3 & 4 \end{bmatrix}$

(c) $\begin{bmatrix} 4 & 2 & 3 \\ 5 & 1 & 4 \\ 2 & 4 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} 2 & 3 & 4 \\ 1 & 4 & 5 \\ 4 & 3 & 2 \end{bmatrix}$

3. [MCQ] [GATE-EE-2025 : 1M]

Let $P = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and let I be the identity matrix.

Then P^2 is equal to

(a) $2P - I$ (b) I

(c) P (d) $P + I$

4. [MCQ] [GATE-ME-2025: 1M]

Let A and B be real symmetric matrices of same size. Which one of the following options is correct?

(a) $AT = A^{-1}$ (b) $AB = BA$

(c) $(AB)^T = B^TA^T$ (d) $A = A^{-1}$

5. [MCQ] [GATE-EE-2024: 1M]

Which one of the following matrices has an inverse?

(a) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 0.5 & 2 & 4 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 2 & 9 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 1 & 2 & 4 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 3 & 12 & 24 \end{bmatrix}$

6. [MSQ] [GATE-CS-2024: 2M]

Let A be an n × n matrix over the set of all real numbers $\mathbb{R}$. Let B be a matrix obtained from A by swapping two rows. Which of the following statements is/are TRUE?

(a) If A is invertible, then B is also invertible

(b) The determinant of B is the negative of the determinant of A

(c) If A is symmetric, then B is also symmetric

(d) If the trace of A is zero, then the trace of B is also zero

7. [NAT] [GATE-CE-2024 : 2M]

Consider two matrices

$$A = \begin{bmatrix} 2 & 1 & 4 \\ 1 & 0 & 3 \end{bmatrix} \text{ and } B = \begin{bmatrix} -1 & 0 \\ 2 & 3 \\ 1 & 4 \end{bmatrix}.$$

The determinant of the matrix AB is _____ (in integer).

8. [MCQ] [GATE-CE-2024 : 1M]

The statements P and Q are related to matrices A and B which are conformable for both addition and multiplication.

P: $(A + B)^T = A^T + B^T$

Q: $(AB)^T = A^T B^T$

Which one of the following options is CORRECT?

(a) Both P and Q are FALSE

(b) P is FALSE and Q is TRUE

(c) Both P and Q are TRUE

(d) P is TRUE and Q is FALSE

9. [MCQ] [GATE-CE-2023:2M]

Cholesky decomposition is carried out on the following square matrix $[A]$.

$$[A] = \begin{bmatrix} 8 & -5 \\ -5 & a_{22} \end{bmatrix}$$

Let l_{ij} and a_{ij} be the $(i,j)^{th}$ elements of matrices $[L]$ and $[A]$, respectively. If the element l_{22} of the decomposed lower triangular matrix $[L]$ is 1.968, what is the value (rounded off to the nearest integer) of the element a_{22}?

(a) 5 (b) 7

(c) 9 (d) 11

10. [MCQ] [GATE-EE-2023:1M]

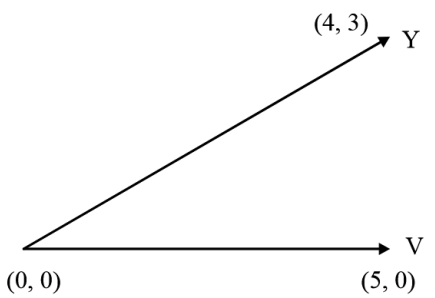
For a given vector $w = [1\ 2\ 3]^T$, the vector normal to the plane defined by $w^T x = 1$ is

(a) $[-2\ -2\ 2]^T$ (b) $[3\ 0\ -1]^T$

(c) $[3\ 2\ 1]^T$ (d) $[1\ 2\ 3]^T$

11. [MCQ] [GATE-EE-2023:1M]

In the figure, the vectors u and v are related as: Au = v by a transformation matrix A. The correct choice of A is



(a) $\begin{bmatrix} \frac{4}{5} & \frac{3}{5} \\ -\frac{3}{5} & \frac{4}{5} \end{bmatrix}$ (b) $\begin{bmatrix} \frac{4}{5} & -\frac{3}{5} \\ \frac{3}{5} & \frac{4}{5} \end{bmatrix}$

(c) $\begin{bmatrix} \frac{4}{5} & \frac{3}{5} \\ \frac{3}{5} & \frac{4}{5} \end{bmatrix}$ (d) $\begin{bmatrix} \frac{4}{5} & \frac{-3}{5} \\ \frac{3}{5} & -\frac{4}{5} \end{bmatrix}$

12. [MCQ] [GATE-CS-2023:2M]

Let $A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$

Let det(A) and det(B) denote the determinants of the matrices A and B, respectively. Which one of the options given below is TRUE?

(a) det(A) = det(B)

(b) det(B) = −det(A)

(c) det(A) = 0

(d) det(AB) = det(A)+det(B)

13. [MCQ] [GATE-CS-2022:1M]

Consider the following two statements with respect to the matrices $A_{m\times n}$, $B_{n\times m}$, $C_{n\times n}$ and $D_{n\times n}$.

Statement 1: tr(AB) = tr(BA)

Statement 2: tr(CD) = tr(DC)

Where tr() represents the trace of a matrix. Which one of the following holds?

(a) Statement 1 is correct and Statement 2 is wrong.

(b) Statement 1 is wrong and Statement 2 is correct.

(c) Both Statement 1 and Statement 2 are correct.

(d) Both Statement 1 and Statement 2 are wrong.

14. [MCQ] [GATE-CE-2022:2M]

The Cartesian coordinates of a point P in a right handed coordinate system are (1, 1, 1). The transformed coordinates of P due to a 45° clockwise rotation of the coordinate system about the positive x-axis are

(a) $(1, 0, \sqrt{2})$ (b) $(1, 0, -\sqrt{2})$

(c) $(-1, 0, \sqrt{2})$ (d) $(-1, 0, -\sqrt{2})$

15. [NAT] [GATE-CE-2022:1M]

The components of pure shear strain in a sheared material are given in the matrix form $E = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$

Here, Trace (E) = 0,

Given, P = Trace (E^8) and Q = Trace (E^{11})

The numerical value of (P + Q) is _____ (in integer)

16. [MCQ] [GATE-ME-2022: 1M]

If $A = \begin{bmatrix} 10 & 2k+5 \\ 3k-3 & k+5 \end{bmatrix}$ is a symmetric matrix, the value of k is _____.

(a) 8 (b) 5

(c) –0.4 (d) $\frac{1+\sqrt{1561}}{12}$

17. [MCQ] [GATE-CE-2021:2M]

If $P = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $Q = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ then $Q^T P^T$ is

(a) $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} 2 & 1 \\ 4 & 3 \end{bmatrix}$

18. [MCQ] [GATE-CE-2021:1M]

If A is a square matrix then orthogonality property mandates

(a) $AA^T = I$ (b) $AA^T = 0$

(c) $AA^T = A^{-1}$ (d) $AA^T = A^2$

19. [MCQ] [GATE-ME-2020: 1M]

Multiplication of real valued square matrices of same dimension is

(a) associative

(b) commutative

(c) always positive definite

(d) not always possible to compute

20. [MCQ] [GATE-ME-2020: 1M]

A matrix P is decomposed into its symmetric part S and skew symmetric part V. If

$$S = \begin{pmatrix} -4 & 4 & 2 \\ 4 & 3 & 7/2 \\ 2 & 7/2 & 2 \end{pmatrix}, V = \begin{pmatrix} 0 & -2 & 3 \\ 2 & 0 & 7/2 \\ -3 & -7/2 & 0 \end{pmatrix}$$

then matrix P is

(a) $\begin{pmatrix} -4 & 6 & -1 \\ 2 & 3 & 0 \\ 5 & 7 & 2 \end{pmatrix}$ (b) $\begin{pmatrix} -4 & 2 & 5 \\ 6 & 3 & 7 \\ -1 & 0 & 2 \end{pmatrix}$

(c) $\begin{pmatrix} -4 & -6 & 1 \\ -2 & -3 & 0 \\ -5 & -7 & -2 \end{pmatrix}$ (d) $\begin{pmatrix} -2 & 9/2 & -1 \\ -1 & 81/4 & 11 \\ -2 & 45/2 & 73/4 \end{pmatrix}$

21. [MCQ] [GATE-EE-2020: 2M]

The number of purely real elements in a lower triangular representation of the given 3×3 matrix, obtained through the given decomposition is _____.

$$\begin{bmatrix} 2 & 3 & 3 \\ 3 & 2 & 1 \\ 3 & 1 & 7 \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{12} & a_{22} & 0 \\ a_{13} & a_{23} & a_{33} \end{bmatrix} \begin{bmatrix} a_{11} & 0 & 0 \\ a_{12} & a_{22} & 0 \\ a_{13} & a_{23} & a_{33} \end{bmatrix}^T$$

(a) 5 (b) 6

(c) 8 (d) 9

22. [MCQ] [GATE-CE-2019:2M]

The inverse of the matrix $\begin{bmatrix} 2 & 3 & 4 \\ 4 & 3 & 1 \\ 1 & 2 & 4 \end{bmatrix}$ is.

(a) $\begin{bmatrix} 10 & -4 & -9 \\ -15 & 4 & 14 \\ 5 & -1 & -6 \end{bmatrix}$ (b) $\begin{bmatrix} -10 & 4 & 9 \\ 15 & -4 & -14 \\ -5 & 1 & 6 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & -\frac{4}{5} & -\frac{9}{5} \\ -3 & \frac{4}{5} & \frac{14}{5} \\ 1 & -\frac{1}{5} & -\frac{6}{5} \end{bmatrix}$ (d) $\begin{bmatrix} -2 & \frac{4}{5} & \frac{9}{5} \\ 3 & -\frac{4}{5} & -\frac{14}{5} \\ -1 & \frac{1}{5} & \frac{6}{5} \end{bmatrix}$

23. [MCQ] [GATE-CS-2019:1M]

Let X be a square matrix. Consider the following two statements on X.

I: X is invertiable.

II: Determinant of X is non-zero.

Which one of the following is TRUE?

(a) I implies II; II does not imply I.

(b) II implies I: I does not imply II.

(c) I does not imply II; II does not imply I.

(d) I and II are equivalent statements.

24. [MCQ] [GATE-EE-2019: 2M]

Consider a 2×2 matrix $M = [v_1, v_2]$, where, v_1 and v_2 are the column vectors. Suppose $M^{-1} = \begin{bmatrix} u_1^T \\ u_2^T \end{bmatrix}$, where u_1^T and u_2^T are the row vectors. Consider the following statements:

Statement 1: $u_1^T v_1 = 1$ and $u_2^T v_2 = 1$

Statement 2: $u_1^T v_2 = 0$ and $u_2^T v_1 = 0$

Which of the following option is correct?

(a) Statement 1 is true and statement 2 is false

(b) Statement 2 is true and statement 1 is false

(c) Both the statements are true

(d) Both the statements are false

25. [MCQ] [GATE-CE-2018:1M]

For the given orthogonal matrix

$$Q = \begin{bmatrix} \frac{3}{7} & \frac{2}{7} & \frac{6}{7} \\ -\frac{6}{7} & \frac{3}{7} & \frac{2}{7} \\ \frac{2}{7} & \frac{6}{7} & -\frac{3}{7} \end{bmatrix}$$ The inverse is

(a) $\begin{bmatrix} \frac{3}{7} & \frac{2}{7} & \frac{6}{7} \\ -\frac{6}{7} & \frac{3}{7} & \frac{2}{7} \\ \frac{2}{7} & \frac{6}{7} & -\frac{3}{7} \end{bmatrix}$ (b) $\begin{bmatrix} -\frac{3}{7} & -\frac{2}{7} & -\frac{6}{7} \\ \frac{6}{7} & -\frac{3}{7} & -\frac{2}{7} \\ -\frac{2}{7} & -\frac{6}{7} & \frac{3}{7} \end{bmatrix}$

(c) $\begin{bmatrix} \frac{3}{7} & -\frac{6}{7} & \frac{2}{7} \\ \frac{2}{7} & \frac{3}{7} & \frac{6}{7} \\ \frac{6}{7} & \frac{2}{7} & -\frac{3}{7} \end{bmatrix}$ (d) $\begin{bmatrix} -\frac{3}{7} & \frac{6}{7} & -\frac{2}{7} \\ -\frac{2}{7} & -\frac{3}{7} & -\frac{6}{7} \\ -\frac{6}{7} & -\frac{2}{7} & \frac{3}{7} \end{bmatrix}$

26. [MCQ] [GATE-CE-2018:1M]

Which one of the following matrices is singular

(a) $\begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & 4 \\ 3 & 6 \end{bmatrix}$ (d) $\begin{bmatrix} 4 & 3 \\ 6 & 2 \end{bmatrix}$

27. [NAT] [GATE-ME-2018: 1M]

If $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 1 \end{bmatrix}$ then $\det(A^{-1})$ is _____ (Correct to two decimal places).

28. [MCQ] [GATE-CE-2017:2M]

If $A = \begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 7 \\ 8 & 4 \end{bmatrix}$,AB^T is equal to

(a) $\begin{bmatrix} 38 & 28 \\ 32 & 56 \end{bmatrix}$ (b) $\begin{bmatrix} 3 & 40 \\ 42 & 8 \end{bmatrix}$

(c) $\begin{bmatrix} 43 & 27 \\ 34 & 50 \end{bmatrix}$ (d) $\begin{bmatrix} 38 & 32 \\ 28 & 56 \end{bmatrix}$

29. [MCQ] [GATE-CE-2017:1M]

The matrix P is the inverse of a matrix Q. If I denotes the identify matrix, which one of the following option is correct?

(a) $PQ = I$ but $QP \neq I$ (b) $QP = I$ but $PQ \neq I$

(c) $PQ = I$ and $QP = I$ (d) $PQ - QP = I$

30. [NAT] [GATE-ME-2017: 2M]

Consider the matrix $A = \begin{bmatrix} 50 & 70 \\ 70 & 80 \end{bmatrix}$ whose eigenvectors corresponding to eigenvalues λ_1 and λ_2 are $x_1 = \begin{bmatrix} 70 \\ \lambda_1 - 50 \end{bmatrix}$ and $x_2 = \begin{bmatrix} \lambda_2 - 80 \\ 70 \end{bmatrix}$, respectively. The value of $x_1^T x_2$ is _____.

31. [MCQ] [GATE-ME-2017: 2M]

Consider the matrix

$$P = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \\ 0 & 1 & 0 \\ \frac{-1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$$

ANSWER KEY

1. (a)
2. (a)
3. (a)
4. (c)
5. (c)
6. (a, b)
7. (10 to 10)
8. (a)
9. (b)
10. (d)
11. (a)
12. (b)
13. (c)
14. (a)
15. (32)
16. (a)
17. (c)
18. (a)
19. (a)
20. (b)
21. (marks to all)
22. (d)
23. (d)
24. (c)
25. (c)
26. (c)
27. (0.25 to 0.25)
28. (a)
29. (c)
30. (0 to 0)
31. (d)
32. (7)
33. (c)
34. (3)
35. (c)
36. (233 to 233)
37. (d)
38. (0.125)
39. (5)
40. (a)
41. (a, b)
42. (a)
43. (a)
44. (d)
45. (49)
46. (1)
47. (d)
48. (200)
49. (c)
50. (23 to 23)
51. (a)
52. (88 to 88)
53. (a)
54. (b)
55. (16)
56. (b)
57. (d)
58. (b)
59. (d)
60. (b)
61. (a)
62. (b)
63. (b)
64. (b)
65. (d)
66. (a)
67. (4)
68. (b)
69. (c)
70. (3)
71. (b)
72. (b)
73. (b)
74. (c)
75. (2)
76. (4)
77. (17)
78. (b)
79. (c)
80. (2 to 2)
81. (a)
82. (a, b, c)
83. (a, d)
84. (b)
85. (b)
86. (b, d)
87. (d)
88. (b, c)
89. (c)
90. (d)
91. (a, b)
92. (b, c)
93. (3 to 3)
94. (a)
95. (c)
96. (2 to 2)
97. (c)
98. (a)
99. (d)
100. (c)
101. (b)
102. (2)
103. (4.49 to 4.51)
104. (b)
105. (b)
106. (a)
107. (d)
108. (1)
109. (c)
110. (b)
111. (a)
112. (d)
113. (c)
114. (b)
115. (b)
116. (c)
117. (d)
118. (a, c)
119. (d)
120. (b)
121. (29 to 29)
122. (a, b)
123. (d)
124. (a)
125. (d)
126. (b, c)
127. (c)
128. (a, b, d)
129. (a, d)
130. (a, c)
131. (2 to 2)
132. (a)
133. (c)
134. (b)
135. (b)
136. (d)
137. (1)
138. (b)
139. (3 to 3)
140. (b)
141. (d)
142. (1 to 1)
143. (3 to 3)
144. (b)

145. (d)
146. (d)
147. (12 to 12)
148. (1.0)
149. (d)
150. (d)
151. (5.5 to 5.5)
152. (c)
153. (b)
154. (5)
155. (a)
156. (c)
157. (b)
158. (5 to 5)
159. (a)
160. (c)
161. (a)
162. (2 to 2)
163. (d)
164. (1)
165. (d)
166. (15 to 15)
167. (a)
168. (d)
169. (3)
170. (b)
171. (a)
172. (9)
173. (d)
174. (d)
175. (d)
176. (6 to 6)
177. (b)
178. (b)
179. (b)
180. (2 to 2)
181. (d)
182. (d)
183. (a)
184. (0.33)
185. (0 to 0)
186. (0)
187. (a)
188. (b)
189. (c)
190. (d)
191. (d)
192. (a)
193. (b)
194. (b)
195. (d)
196. (a)
197. (c)
198. (b)
199. (c)
200. (d)
201. (b)
202. (c)
203. (d)
204. (b)
205. (a)
206. (c)
207. (b)
208. (c)
209. (3.0 to 3.0)
210. (5 to 5)
211. (a)
212. (c)
213. (2)

SOLUTIONS

1. (a)

Given L, M, N are non-singular matrix

$\det(L) \neq 0$; $\det(M) \neq 0$; $\det(N) \neq 0$

$L^2 = L^{-1}$, $M = L^8$, $N = L^2$

$L(L^2) = L \cdot L^{-1} \Rightarrow L^3 = I$

Since, $M = L^8 = L^6 \cdot L^2 = (L^3)^2 \cdot L^2$

$\Rightarrow M = L^2$

Also, $N = L^2$

$\Rightarrow M - N = 0$

$\det(M - N) = 0$

Scan for Video solution

2. (a)

Given,

$$A = \begin{bmatrix} 2 & 3 & 4 \\ 1 & 4 & 5 \\ 4 & 3 & 2 \end{bmatrix};$$

Transpose of 'A' is obtained by interchaning rows & columns.

$$\Rightarrow A^T = \begin{bmatrix} 2 & 1 & 4 \\ 3 & 4 & 3 \\ 4 & 5 & 2 \end{bmatrix}$$

Scan for Video solution

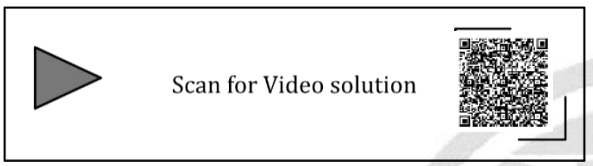
3. (a)

Given $P = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$$\Rightarrow \quad P^2 = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 2 & 0 \\ -2 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 4 & 2 & 0 \\ -2 & 0 & 0 \\ 0 & 0 & 2 \end{bmatrix} - \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 2P - I$$

$\therefore \quad P^2 = 2P - I$



4. (c)

Given A & B are -real symmetric Matrices

$\Rightarrow A = A^T$ & $B = B^T$

Option A:

$A^T = A$ & A Need not be equal to A^{-1}

Option B:

AB = BA; Matrix Multiplication need not be commutative.

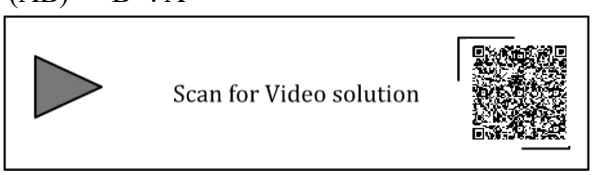
Option C:

For Matrices, $A_1, A_2, \ldots, A_n$ such that the multiplication A_1,

$A_2, \ldots, A_n$ is feasible; We have

$$\left(A_1.A_2....A_n\right)^T = A_n^T \cdot A_{n-1}^T \cdot A_{n-2}^T ... A_3^T \cdot A_2^T \cdot A_1^T$$

$\Rightarrow (AB)^T = B^T . A^T$



5. (c)

For a matrix 'A' to have an inverse, $|A| \neq 0$

(a) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 0.5 & 2 & 4 \end{bmatrix}$

$\rightarrow \quad R_1 = 2R_3 \ \therefore$ Determinant is zero.

(b) $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 2 & 9 \end{bmatrix}$

$\rightarrow \quad C_3 = 2C_1 \ \therefore$ Determinant is zero

(c) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 1 & 2 & 4 \end{bmatrix}$

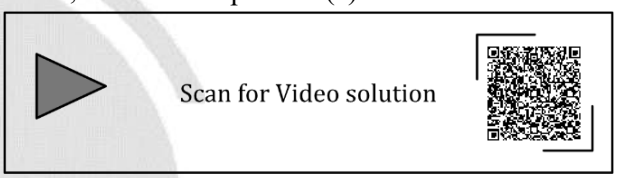
$\rightarrow \quad$ Determinant $= 1(12) - 4(-2) + 8(-4) = -12 \neq 0$

$\therefore \quad$ This matrix has an inverse

(d) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 3 & 12 & 24 \end{bmatrix}$

$\rightarrow \quad R_3 = 3R_1 \ \therefore$ Determinant is zero.

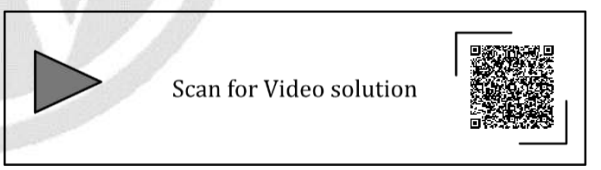
Hence, the correct option is (c).



6. (a, b)

$R_i \leftrightarrow R_j$, $|B| = -|A|$

- If A is invertible, then B is also invertible
- The determinant of B is the negative of the determinant of A



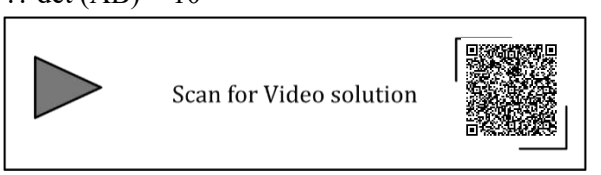
7. (10 to 10)

Given $A = \begin{bmatrix} 2 & 1 & 4 \\ 1 & 0 & 3 \end{bmatrix}_{2\times 3}$; $B = \begin{bmatrix} -1 & 0 \\ 2 & 3 \\ 1 & 4 \end{bmatrix}_{3\times 2}$

$$\Rightarrow AB = \begin{bmatrix} 4 & 19 \\ 2 & 12 \end{bmatrix}_{2\times 2}$$

$\Rightarrow$ det (AB) = 4 (12) – 2 (19) = 48 – 38 = 10.

$\therefore$ det (AB) = 10



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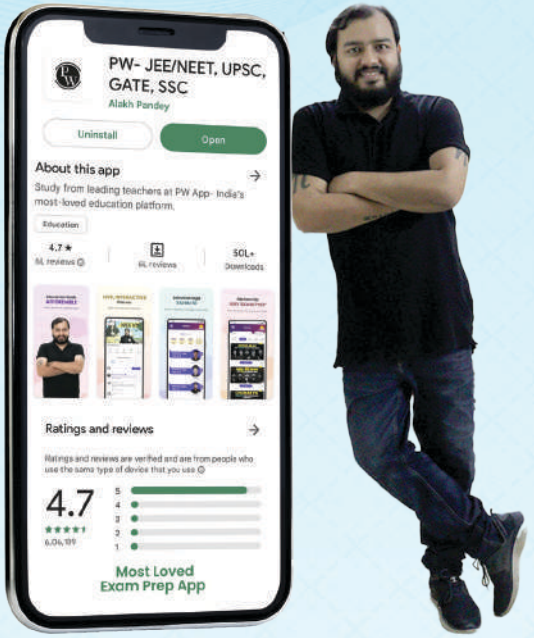

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