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Web: www.madeeasy.in | E-mail: info@madeeasy.in | Ph: 011-45124612

ENGINEERING MATHEMATICS

COMPUTER SCIENCE & IT

Date of Test : 05/09/2026

ANSWER KEY ➤

- | | | | | |
|--------|---------|---------|---------|---------|
| 1. (b) | 7. (b) | 13. (d) | 19. (a) | 25. (c) |
| 2. (c) | 8. (b) | 14. (d) | 20. (a) | 26. (c) |
| 3. (b) | 9. (d) | 15. (a) | 21. (a) | 27. (b) |
| 4. (b) | 10. (b) | 16. (b) | 22. (b) | 28. (b) |
| 5. (a) | 11. (a) | 17. (b) | 23. (d) | 29. (b) |
| 6. (d) | 12. (c) | 18. (d) | 24. (d) | 30. (a) |

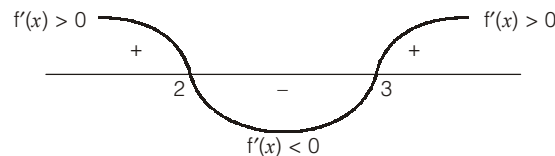
DETAILED EXPLANATIONS

1. (b)

$$\begin{aligned} f'(x) &= 6x^2 - 30x + 36 \\ &= 6(x-2)(x-3) \end{aligned}$$

So, $f'(x) > 0$ when $x < 2$ and also when $x > 3$. $f(x)$ is increasing in $]-\infty, 2[\cup]3, \infty[$.

OR, by Wavy-Curve Method



2. (c)

$$\begin{aligned} A + A' &= \begin{bmatrix} \cos \alpha & \sin \alpha \\ -\sin \alpha & \cos \alpha \end{bmatrix} + \begin{bmatrix} \cos \alpha & -\sin \alpha \\ \sin \alpha & \cos \alpha \end{bmatrix} \\ &= \begin{bmatrix} 2\cos \alpha & 0 \\ 0 & 2\cos \alpha \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \end{aligned}$$

$$\therefore 2\cos \alpha = 1$$

$$\Rightarrow \alpha = \frac{\pi}{3}$$

3. (b)

A is skew-symmetric,

$$\Rightarrow A = -A^T$$

$$\text{Now, } (A \cdot A)^T = A^T \cdot A^T = (-A) \cdot (-A) = A \cdot A$$

$\therefore A \cdot A$ is a symmetric matrix.

4. (b)

$$\lambda = np = \frac{1}{100} \times 100 = 1$$

$$P(X > 2) = 1 - (P(X=0) + P(X=1))$$

$$P(X=0) = \frac{e^{-\lambda} \cdot \lambda^0}{0!} = e^{-\lambda}$$

$$P(X=1) = \frac{e^{-\lambda} \lambda^1}{1!} = e^{-\lambda} \cdot \lambda$$

$$P(X > 2) = 1 - e^{-1}(2) = \frac{1-2}{e} = \frac{e-2}{e}$$

5. (a)

Given
$$P = \int_0^1 x e^x dx$$

$$= \left[x \int e^x dx \right]_0^1 - \int_0^1 \left[\frac{d}{dx}(x) \int e^x dx \right] dx = \left[x e^x \right]_0^1 - \int_0^1 (1) e^x dx$$

$$= (e^1 - 0) - \left[e^x \right]_0^1 = e^1 - [e^1 - e^0] = e - e + 1 = 1$$

6. (d)

$$I = \int_0^{\pi/4} \log\left(\frac{\sin x}{\cos x}\right) dx = \int_0^{\pi/4} [\log(\sin x) dx - \log(\cos x) dx]$$

$$= \int_0^{\pi/2} \log \sin\left(\frac{\pi}{2} - x\right) dx - \int_0^{\pi/2} \log(\cos x) dx$$

$$I = 0$$

7. (b)

$$|A - \lambda I| = 0$$

$$\left| \begin{bmatrix} 1 - \lambda & \sin x \\ \sin x & 1 - \lambda \end{bmatrix} \right| = 0$$

$$(1 - \lambda)^2 - \sin^2 x = 0$$

$$1 + \lambda^2 - 2\lambda - \sin^2 x = 0$$

$$\lambda^2 - 2\lambda + \cos^2 x = 0$$

$$\lambda = \frac{2 \pm \sqrt{4 - 4\cos^2 x}}{2}$$

$$\lambda = 1 \pm \sin x$$

8. (b)

$$\frac{\partial f}{\partial x} = 2 - 2x \qquad \frac{\partial f}{\partial y} = 2 - 2y$$

$$r = \frac{\partial^2 f}{\partial x^2} = -2 \qquad t = \frac{\partial^2 f}{\partial y^2} = -2, \qquad s = \frac{\partial^2 f}{\partial x \partial y} = 0$$

finding stationary points,

$$\frac{\partial f}{\partial x} = 2 - 2x = 0$$

$$\Rightarrow x = 1$$

$$\frac{\partial f}{\partial y} = 2 - 2y = 0$$

$$\Rightarrow y = 1$$

at the stationary point (1, 1)

$$rt - s^2 = (-2)(-2) - 0 = 4 > 0$$

So, $f(x, y)$ is maxima at (1, 1)

Maximum value of $f(x, y) = 2 + 2 + 2 - 1 - 1$
 $= 4$

9. (d)

The constant term in any characteristic polynomial is always $|A|$.

So, $|A| = -\frac{1}{4}$ since constant term of $p(\lambda)$ is $-\frac{1}{4}$.

10. (b)

$$2x + y + 2z = 0$$

$$x + y + 3z = 0$$

$$4x + 3y + z = 0$$

$$[A : B] = \begin{bmatrix} 2 & 1 & 2 & 0 \\ 1 & 1 & 3 & 0 \\ 4 & 3 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 3 & 0 \\ 2 & 1 & 2 & 0 \\ 4 & 3 & 1 & 0 \end{bmatrix}$$

$$R_2 \rightarrow R_2 - 2R_1, R_3 \rightarrow R_3 - 4R_1$$

$$= \begin{bmatrix} 1 & 1 & 3 & 0 \\ 0 & -1 & -4 & 0 \\ 0 & -1 & -11 & 0 \end{bmatrix}$$

$$R_3 \rightarrow R_3 - R_2,$$

$$= \begin{bmatrix} 1 & 1 & 3 & 0 \\ 0 & -1 & 4 & 0 \\ 0 & 0 & -7 & 0 \end{bmatrix}$$

Rank of $[A : B] = 3$

Rank of $[A] = 3 = \text{Rank of } [A : B] = \text{number of unknowns}$

So, unique solution exists

11. (a)

$$\text{Total possible outcomes} = {}^{52}C_2 = 1326$$

Favourable outcomes = Drawing any spade apart from king of spades along with any king left in pack + Drawing king of spades with any three kings left in pack

Note: It is necessary that spade and king's card should be different. So in 2nd case, when king of spade's is drawn it is considered as a spade.

$$\therefore \text{Favourable outcomes} = {}^{12}C_1 \times {}^4C_1 + {}^1C_1 \times {}^3C_1 = 51$$

$$\text{Probability} = \frac{51}{1326} = \frac{1}{26}$$

12. (c)

$$\lim_{x \rightarrow \infty} \left(\frac{x}{2+x} \right)^{2x} = \lim_{x \rightarrow \infty} \left(\frac{2+x}{x} \right)^{-2x}$$

$$\lim_{x \rightarrow \infty} \left(1 + \frac{2}{x} \right)^{-2x} = \lim_{x \rightarrow \infty} \left(1 + \frac{2}{x} \right)^{\frac{x}{2}(-4)}$$

$$\therefore 2x = \frac{x}{2}(-4)$$

$$= e^{-4} \left(\because \lim_{x \rightarrow \infty} \left(1 + \frac{1}{x} \right)^x = e \right)$$

13. (d)

$$a_{ij} = \begin{cases} i; & i = j \\ 0; & i \neq j \end{cases}$$

$$\Rightarrow [A] = \begin{bmatrix} 1 & 0 & 0 & \dots & 0 \\ 0 & 2 & 0 & \dots & 0 \\ 0 & 0 & 3 & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & n \end{bmatrix}$$

Determinant of all n eigen value of A

$$= \text{Product of diagonal elements} = 1 \times 2 \times \dots \times n = n!$$

14. (d)

15. (a)

$[A : B]$

$$\begin{bmatrix} 1 & 2 & -2 & 0 & : & 0 \\ 2 & -1 & -1 & 0 & : & 0 \\ 1 & 2 & -1 & 0 & : & 0 \\ 4 & -1 & -1 & 3 & : & 0 \end{bmatrix}$$

$$R_4 \rightarrow R_4 - R_2, \quad R_3 \rightarrow (R_3 - R_1)$$

$$= \begin{bmatrix} 1 & 2 & -2 & 0 & : & 0 \\ 2 & -1 & -1 & 0 & : & 0 \\ 0 & 0 & 1 & 0 & : & 0 \\ 2 & 0 & 0 & 3 & : & 0 \end{bmatrix}$$

$$R_1 \rightarrow \frac{1}{3}(R_1 + 2R_2 + 4R_3)$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 & : & 0 \\ 2 & -1 & -1 & 0 & : & 0 \\ 0 & 0 & 1 & 0 & : & 0 \\ 2 & 0 & 0 & 3 & : & 0 \end{bmatrix}$$

$$R_2 \rightarrow (2R_1 - R_2 - R_3), \quad R_4 \rightarrow \frac{1}{3}(R_4 - 2R_1)$$

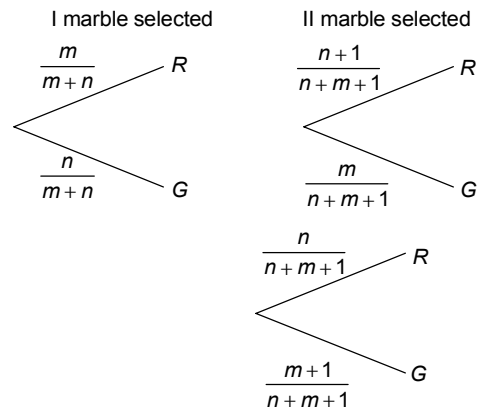
$$= \begin{bmatrix} 1 & 0 & 0 & 0 & : & 0 \\ 0 & 1 & 0 & 0 & : & 0 \\ 0 & 0 & 1 & 0 & : & 0 \\ 0 & 0 & 0 & 1 & : & 0 \end{bmatrix}$$

$$\rho(A : B) = \rho(A) = 4 = \text{number of variables}$$

$\Rightarrow$ System is consistent with trivial solution.

16. (b)

The tree diagram for problem is



$$\begin{aligned}
 p(R) &= \frac{m}{m+n} \times \frac{n+1}{n+m+1} + \frac{n}{m+n} \times \frac{n}{n+m+1} \\
 &= \frac{m(n+1) + n^2}{(m+n)(m+n+1)}
 \end{aligned}$$

17. (b)

$$\begin{aligned}
 \lim_{x \rightarrow 0} \frac{e^{ax} - e^{-ax}}{\log(1+bx)} &= \lim_{x \rightarrow 0} \frac{(e^{ax} - e^{-ax}) \times 2ax \times b}{2ax \times b \times \log(1+bx)} \\
 &= \lim_{x \rightarrow 0} \left(\frac{e^{ax} - e^{-ax}}{2ax} \right) \times \lim_{x \rightarrow 0} \frac{bx}{\log(1+bx)} \left(\frac{2a}{b} \right) \\
 &= \lim_{x \rightarrow 0} \left(\frac{\sinh ax}{ax} \right) \lim_{x \rightarrow 0} \frac{bx}{\log(1+bx)} \left(\frac{2a}{b} \right) \\
 &= 1 \times 1 \times \frac{2a}{b} = \frac{2a}{b}
 \end{aligned}$$

18. (d)

$$\begin{aligned}
 y &= -\int \frac{1 - \sin x - 1}{1 - \sin x} dx \\
 &= -\int 1 \cdot dx + \int \frac{1}{1 - \sin x} dx \\
 y &= -x + \int \frac{dx}{1 - \sin x} \\
 \int \frac{dx}{1 - \sin x} &= \int \frac{1 + \sin x}{(1 - \sin x)(1 + \sin x)} dx = \int \frac{(1 + \sin x)}{(1 - \sin^2 x)} dx \\
 &= \int \frac{1 + \sin x}{\cos^2 x} dx \\
 &= \int \sec^2 x dx + \int \sec x \tan x dx \\
 &= \tan x + \sec x + C \\
 y &= -x + \tan x + \sec x + C
 \end{aligned}$$

19. (a)

$$\int_{-\infty}^{\infty} f(x) dx = 1$$

$$\int_0^2 kx dx + \int_2^4 2k dx + \int_4^6 (-kx + 6k) dx = 1$$

$$\left. \frac{kx^2}{2} \right|_0^2 + 2kx \Big|_2^4 + \left(-\frac{kx^2}{2} + 6kx \right) \Big|_4^6 = 1$$

$$\frac{k}{2}(2^2 - 0) + 2k(4 - 2) - \frac{k}{2}(6^2 - 4^2) + 6k(6 - 4) = 1$$

$$2k + 4k - 10k + 12k = 1$$

$$8k = 1 \Rightarrow k = \frac{1}{8}$$

$$\text{Mean} = \int_{-\infty}^{\infty} xf(x) dx = \int_0^2 \frac{1}{8} x^2 dx + \int_2^4 \frac{1}{4} x dx + \int_4^6 \left(-\frac{1}{8} x^2 + \frac{3}{4} x \right) dx$$

$$= \left. \frac{1}{8} \frac{x^3}{3} \right|_0^2 + \left. \frac{1}{4} \frac{x^2}{2} \right|_2^4 - \left. \frac{1}{8} \frac{x^3}{3} \right|_4^6 + \left. \frac{3}{4} \frac{x^2}{2} \right|_4^6$$

$$= \frac{1}{3} + \frac{3}{2} - \frac{19}{3} + \frac{15}{2} = 3$$

20. (a)

$$|x - 2| = \begin{cases} -(x - 2); & x < 2 \\ (x - 2); & x > 2 \end{cases}$$

$$\int_1^3 \frac{|x - 2|}{x} dx = \int_1^2 \frac{-(x - 2)}{x} dx + \int_2^3 \frac{x - 2}{x} dx$$

$$= \int_1^2 \left(-1 + \frac{2}{x} \right) dx + \int_2^3 \left(1 - \frac{2}{x} \right) dx = -(2 - 1) + (2 \ln x)_1^2 + (x)_2^3 - 2(\ln x)_2^3$$

$$= 2 \ln 2 - 2 \ln \frac{3}{2} = 2 \ln \frac{2}{3} = 2 \ln \frac{4}{3}$$

$$= 0.575$$

21. (a)

To obtain maximum value of $f(x)$, first $f'(x)$ should be equated to zero.

$$\Rightarrow f'(x) = 6x^2 - 6x - 36 = 0$$

$$\Rightarrow x^2 - x - 6 = 0$$

$$\Rightarrow (x - 3)(x + 2) = 0$$

$$\therefore f'(x) = 0$$

$$\text{Now, } f''(x) = 12x - 6$$

$$f''(3) = 30 > 0$$

at $x = 3$, there is local minima

$$\text{and } f''(2) = -30 < 0$$

$\therefore$ at $x = -2$, a local maxima is observed.

at $x = 3$ and -2

22. (b)

$$\begin{aligned}\lambda_1^2 + \lambda_2^2 + \lambda_1 \lambda_2 &= \lambda_1^2 + \lambda_2^2 + 2\lambda_1 \lambda_2 - \lambda_1 \lambda_2 \\ &= (\lambda_1 + \lambda_2)^2 - \lambda_1 \lambda_2\end{aligned}$$

Sum of eigen values, $\lambda_1 + \lambda_2 =$ trace of matrix
 $=$ sum of diagonal elements
 $= 1 - \frac{1}{3} = \frac{2}{3}$

Products of eigen values, $\lambda_1 \lambda_2 =$ determinant of matrix
 $= 1 \left(-\frac{1}{3} \right) - (-1) \left(\frac{4}{9} \right)$
 $= \frac{1}{9}$

$$\begin{aligned}\therefore (\lambda_1 + \lambda_2)^2 - \lambda_1 \lambda_2 &= \left(\frac{2}{3} \right)^2 - \frac{1}{9} \\ &= \frac{4}{9} - \frac{1}{9} = \frac{3}{9} = 0.33\end{aligned}$$

23. (d)

$$\begin{aligned}6(13 \times 11 - 4 \times 37) - 3(32 \times 11 - 10 \times 37) + 7(32 \times 4 - 10 \times 13) \\ = -30 + 54 - 14 \\ = 10\end{aligned}$$

24. (d)

$$|A - \lambda I| = \begin{vmatrix} 1-\lambda & 1 & 3 \\ 1 & 5-\lambda & 1 \\ 3 & 1 & 1-\lambda \end{vmatrix} = 0$$

$$\lambda^3 - 7\lambda^2 + 36 = 0$$

since $\lambda = 3$ is root of the equation

$$(\lambda - 3)(\lambda^2 - 4\lambda - 12) = 0$$

$$(\lambda - 3)(\lambda + 2)(\lambda - 6) = 0$$

$$\text{highest eigen value} = 6$$

$$(A - \lambda I)X = 0$$

for $\lambda = 6$

$$\begin{bmatrix} -5 & 1 & 3 \\ 1 & -1 & 1 \\ 3 & 1 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$$

$$-5x_1 + x_2 + 3x_3 = 0, \quad x_1 - x_2 + x_3 = 0, \quad 3x_1 + x_2 - 5x_3 = 0$$

$$\frac{x_1}{4} = \frac{x_2}{8} = \frac{x_3}{4} \quad \text{or} \quad \frac{x_1}{1} = \frac{x_2}{2} = \frac{x_3}{1}$$

so eigen vector is $[1, 2, 1]^T$

25. (c)

Using Crout's method

$$A = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 4 \\ 6 & 3 \end{bmatrix} = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix}$$

$$l_{11} = 2$$

$$l_{11} u_{12} = 4$$

$$u_{12} = \frac{4}{2} = 2$$

$$l_{21} = 6$$

$$l_{21} u_{12} + l_{22} = 3$$

$$6 \times 2 + l_{22} = 3$$

$$l_{22} = 3 - 12$$

$$l_{22} = -9$$

So, LU decomposition of given matrix is

$$L = \begin{bmatrix} 2 & 0 \\ 6 & -9 \end{bmatrix}$$

$$U = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$$

26. (c)

$$A^2 = \begin{bmatrix} \alpha & \beta \\ \beta & \alpha \end{bmatrix} = \begin{bmatrix} a & b \\ b & a \end{bmatrix} \begin{bmatrix} a & b \\ b & a \end{bmatrix}$$

$$= \begin{bmatrix} a^2 + b^2 & 2ab \\ 2ab & a^2 + b^2 \end{bmatrix}$$

$$\alpha = a^2 + b^2, \beta = 2ab$$

27. (b)

Consider

$$n = 3$$

Then

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix}$$

and

$$|A| = \begin{vmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{vmatrix} \quad \begin{matrix} R_3 \leftarrow 3R_1 - R_3 \\ R_2 \leftarrow 2R_1 - R_2 \end{matrix}$$

$$= \begin{vmatrix} 1 & 2 & 3 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{vmatrix}$$

This if $n = 3$ then Rank (A) = 1.

28. (b)

$$\lim_{x \rightarrow 2^-} f(x) = \lim_{x \rightarrow 2^-} (x - 2) = (2 - 2) = 0$$

$$\lim_{x \rightarrow 2^+} f(x) = \lim_{x \rightarrow 2^+} (x^3 - 8) = (2^3 - 8) = 0$$

Also $f(2) = 2 - 2 = 0$

Thus $\lim_{x \rightarrow 2^-} f(x) = \lim_{x \rightarrow 2^+} f(x) = f(2)$

∴ f is continuous at $x = 2$

$$f'(x) = \begin{cases} 3x^2 & 2 < x < \infty \\ 1 & -\infty < x \leq 2 \end{cases}$$

and $Lf'(2) = 1$ and $Rf'(2) = 12$

∴ f is not differentiable at $x = 2$.

29. (b)

$$|\text{adj}(\text{adj } A)| = |A|^{(n-1)^2}$$

$$\begin{aligned} |\text{adj}(\text{adj } A^2)| &= |A^2|^{(n-1)^2} \\ &= |A^2|^{(3-1)^2} = |A|^{2 \times (4)} \\ &= |A|^8 \end{aligned}$$

30. (a)

Let $A = \lim_{x \rightarrow \pi/2} \frac{\cos x}{\left(x - \frac{\pi}{2}\right)^3}$

By putting $\left(x - \frac{\pi}{2}\right) = t$

when $x \rightarrow \frac{\pi}{2}$, $t \rightarrow 0$

then,

$$\begin{aligned} A &= \lim_{t \rightarrow 0} \frac{\cos\left(\frac{\pi}{2} + t\right)}{t^3} \\ &= \lim_{t \rightarrow 0} \frac{-\sin t}{t^3} = \lim_{t \rightarrow 0} (-1) \frac{\sin t}{t} \cdot \frac{1}{t^2} \\ &= (-1) \cdot 1 \cdot \frac{1}{0} = -\infty \end{aligned}$$

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