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ENGINEERING MATHEMATICS

EC & EE

Date of Test : 30/06/2026

ANSWER KEY >

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

DETAILED EXPLANATIONS

1. (c)

For the system to be consistent,

$$\begin{vmatrix} 1 & -c & -b \\ -c & 1 & -a \\ -b & -a & 1 \end{vmatrix} = 0$$

$$1 + (-abc) + (-abc) - b^2 - a^2 - c^2 = 0$$

$$a^2 + b^2 + c^2 + 2abc = 1$$

2. (a)

$$\ln y = \sin^{-1}x, \quad \ln z = -\cos^{-1}x$$

$$\ln y - \ln z = \sin^{-1}x + \cos^{-1}x$$

$$\ln\left(\frac{y}{z}\right) = \frac{\pi}{2}$$

$$y = ze^{\pi/2}$$

$$\frac{dy}{dz} = e^{\pi/2}$$

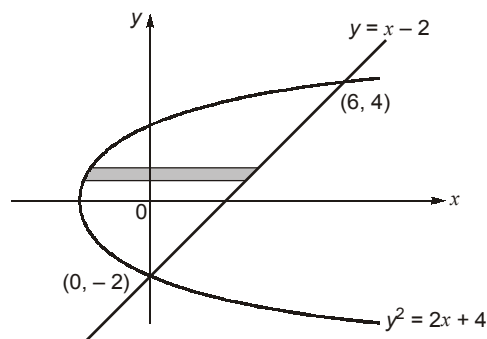
$$\frac{d^2y}{dz^2} = 0$$

3. (a)

$$\begin{aligned} \text{Mean} &= \int_{-\infty}^{\infty} xf(x) dx = \int_0^1 x^2 dx + \int_1^2 (2-x)x dx \\ &= \left. \frac{x^3}{3} \right|_0^1 + \left. \left(x^2 - \frac{x^3}{3} \right) \right|_1^2 = \frac{1}{3} + 4 - 1 - \frac{8-1}{3} = 1 \end{aligned}$$

4. (c)

The point of intersection of line and parabolic are (0, -2) and (6, 4).



$$\begin{aligned} \text{Area} &= \int_{-2}^4 \int_{\left(\frac{y^2-4}{2}\right)}^{y+2} dx dy = \int_{-2}^4 x \Big|_{\frac{y^2-4}{2}}^{y+2} dy \\ &= \int_{-2}^4 \left(y + 2 - \frac{y^2}{2} + 2 \right) dy = \left(\frac{y^2}{2} + 4y - \frac{y^3}{6} \right) \Big|_{-2}^4 = 18 \end{aligned}$$

5. (b)

$$\frac{\partial z}{\partial x} = f(x^2 - y^2) 2x$$

$$\frac{\partial z}{\partial y} = f(x^2 - y^2) (-2y)$$

$$y \frac{\partial z}{\partial x} + x \frac{\partial z}{\partial y} = 0$$

6. (d)

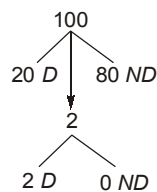
Given function is $y = \frac{1}{x}$ [hyperbolic function]

$$\frac{dy}{dx} = -\frac{1}{x^2}$$

hence, option (d) is correct.

7. (d)

Problem can be solved by hypergeometric distribution



$$p(X=2) = \frac{20C_2 \times 80C_0}{100C_2} = \frac{19}{495}$$

8. (a)

Eigen value of A are, $\lambda_1, \lambda_2, \lambda_3$

$$|A| = \lambda_1 \cdot \lambda_2 \cdot \lambda_3$$

Eigen value of A^{-1} is $\frac{1}{\lambda_1}, \frac{1}{\lambda_2}, \frac{1}{\lambda_3}$

$$\frac{1}{\lambda_1} = 1 \Rightarrow \lambda_1 = 1$$

$$\frac{1}{\lambda_2} = 2 \Rightarrow \lambda_2 = \frac{1}{2}$$

$$\frac{1}{\lambda_3} = 5 \Rightarrow \lambda_3 = \frac{1}{5}$$

$$\lambda_1 \lambda_2 \lambda_3 = (1)\left(\frac{1}{2}\right)\left(\frac{1}{5}\right) = \frac{1}{10} = 0.1$$

$$|A| = 0.1$$

9. (b)

$$(D^2 + 4)y = 10 \sin x$$

to get PI , put

$$D^2 = -1$$

$$PI = \frac{10 \sin x}{D^2 + 4} \Big|_{D^2 = -1} = \frac{10 \sin x}{3}$$

$$A \sin x = 3.33 \sin x$$

$$A = 3.33$$

10. (b)

Given that the partial differential equation is parabolic.

$$\therefore B^2 - 4AC = 0$$

$$\text{Here } A = 3$$

$$\therefore B^2 - 4(3)(3) = 0$$

$$C = 3$$

$$B^2 - 36 = 0$$

$$B^2 = 36$$

11. (b)

$$\begin{bmatrix} (4-\lambda) & 1 \\ 0 & (7-\lambda) \end{bmatrix} = 0$$

$$\Rightarrow (4-\lambda)(7-\lambda) = 0$$

$$\therefore \lambda = 4, 7$$

Putting the value of $\lambda = 4$

$$\Rightarrow \begin{bmatrix} 0 & 1 \\ 0 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ \rho \end{bmatrix} = 0$$

$$\Rightarrow \rho = 0$$

Putting the value of $\lambda = 7$

$$\Rightarrow \begin{bmatrix} -3 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ q \end{bmatrix} = 0$$

$$\Rightarrow q = 3$$

$$\therefore \rho + q = 3$$

12. (c)

$$\frac{\partial M}{\partial y} = 3xy^2 + 1$$

$$\frac{\partial N}{\partial x} = 4xy^2 + 2$$

$$\frac{\partial M}{\partial y} \neq \frac{\partial N}{\partial x}$$

$$IF = e^{\frac{1}{y} dy} = e^{\log y} = y$$

The given equation can be made exact by multiplying with integrating factor, i.e. y for this problem.

13. (a)

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\vec{r} = 2t^2\hat{i} + (t^2 - 4t)\hat{j} + (3t - 5)\hat{k}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = 4t\hat{i} + (2t - 4)\hat{j} + 3\hat{k}$$

$$\vec{v}|_{t=1} = 4\hat{i} - 2\hat{j} + 3\hat{k}$$

Component of velocity in direction $\hat{i} - 3\hat{j} + 2\hat{k}$ will be,

$$\frac{\vec{v} \cdot (\hat{i} - 3\hat{j} + 2\hat{k})}{\sqrt{1^2 + 3^2 + 2^2}} = \frac{(4\hat{i} - 2\hat{j} + 3\hat{k}) \cdot (\hat{i} - 3\hat{j} + 2\hat{k})}{\sqrt{14}} = \frac{4 + 6 + 6}{\sqrt{14}} = \frac{16}{\sqrt{14}} = 4.276$$

14. (b)

$$p = \frac{df(x, y)}{dx} = 2x + 6$$

$$\Rightarrow p = 0 \text{ at } x = -3$$

$$q = \frac{df(x, y)}{dy} = 2y$$

$$\Rightarrow q = 0 \text{ at } y = 0$$

$\therefore (-3, 0)$ is a stationary point

$$r = \frac{d^2f(x, y)}{dx^2} = 2$$

$$s = \frac{d^2f(x, y)}{dx dy} = 0$$

$$t = \frac{d^2f(x, y)}{dy^2} = 2$$

At $(-3, 0)$, $rt - s^2 = 4 > 0$ and $r = 2 > 0$

$\therefore f(x, y)$ has a minimum value at $(-3, 0)$

$$\therefore f(-3, 0) = 1$$

15. (a)

$$\text{Let } f(x) = \int_{-\pi}^{\pi} \frac{\cos^2 x}{1 + a^x} dx \quad (a > 0) \quad \dots(i)$$

$$\text{We know } \int_a^b f(x) dx = \int_a^b f(a + b - x) dx$$

$$\therefore f(x) = \int_{-\pi}^{\pi} \frac{a^x \cos^2 x}{1 + a^x} dx \quad \dots(ii)$$

from (i) and (ii)

$$\Rightarrow 2f(x) = \int_{-\pi}^{\pi} \cos^2 x dx = 2 \int_0^{\pi} \cos^2 x dx$$

$$\Rightarrow 2f(x) = 2 \times 2 \int_0^{\pi/2} \cos^2 x dx$$

$$\Rightarrow 2f(x) = 4 \times \frac{1}{2} \times \frac{\pi}{2}$$

$$\left[\text{By using } \int_0^{\pi/2} \sin^n x \, dx = \frac{n-1}{n} \cdot \frac{n-3}{n-2} \dots \frac{1}{2} \times \frac{\pi}{2} \text{ if } n \text{ is even} \right]$$

$$f(x) = \frac{\pi}{2}$$

16. (c)

$$np = 3$$

$$npq = \sigma^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

from here $q = \frac{3}{4}$

$$p = \left(1 - \frac{3}{4}\right) = \frac{1}{4}$$

$$n \times \frac{3}{4} \times \frac{1}{4} = \frac{9}{4}$$

$$n = 12$$

17. (c)

Given equation are

$$x + 2y + z = 6$$

$$2x + y + 2z = 6$$

$$x + y + z = 5$$

Given system can be written as

$$\begin{bmatrix} 1 & 2 & 1 \\ 2 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 6 \\ 6 \\ 5 \end{bmatrix}$$

Augmented matrix is $\left[\begin{array}{ccc|c} 1 & 2 & 1 & 6 \\ 2 & 1 & 2 & 6 \\ 1 & 1 & 1 & 5 \end{array} \right]$

By gauss elimination

$$\begin{bmatrix} 1 & 2 & 1 & 6 \\ 2 & 1 & 2 & 6 \\ 1 & 1 & 1 & 5 \end{bmatrix} \xrightarrow[\substack{R_2 - 2R_1 \\ R_3 - R_1}]{} \begin{bmatrix} 1 & 2 & 1 & 6 \\ 0 & -3 & 0 & -6 \\ 0 & -1 & 0 & -1 \end{bmatrix}$$

$$\xrightarrow{R_3 - \frac{1}{3}R_2} \begin{bmatrix} 1 & 2 & 1 & 6 \\ 0 & -3 & 0 & -6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$r(A) = 2$$

$$r(A|B) = 3$$

Since the rank of coefficient matrix is 2 and rank of argument matrix is 3, which is not equal. Hence system has no solution i.e. system is inconsistent.

18. (b)

Let
$$I = \int_0^a \frac{\sqrt{x}}{\sqrt{x} + \sqrt{a-x}} dx \quad \dots(i)$$

Since
$$\int_0^a f(x) dx = \int_0^a f(a-x) dx$$

$$I = \int_0^a \frac{\sqrt{a-x}}{\sqrt{a-x} + \sqrt{x}} dx \quad \dots(ii)$$

(i) + (ii) \Rightarrow
$$2I = \int_0^a \frac{\sqrt{x} + \sqrt{a-x}}{\sqrt{x} + \sqrt{a-x}} dx$$

\Rightarrow
$$2I = \int_0^a dx$$

\Rightarrow
$$2I = a$$

\Rightarrow
$$I = a/2$$

19. (a)

$$AB^T = \begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix} \begin{bmatrix} 3 & 8 \\ 7 & 4 \end{bmatrix} = \begin{bmatrix} 38 & 28 \\ 32 & 56 \end{bmatrix}$$

20. (c)

$$\frac{dy}{dt} = -5y$$

$$\int \frac{dy}{y} = -\int 5 dt$$

at
$$\ln y = -5t + C$$

$$t = 0$$

$$y = 2$$

$$\ln 2 = C$$

So,
$$\ln y = -5t + \ln 2$$

$$\ln \frac{y}{2} = -5t$$

$$\frac{y}{2} = e^{-5t}$$

$$y = 2e^{-5t}$$

at
$$t = 3$$

$$y = 2e^{-15}$$

21. (d)

$P(A \text{ wins}) = p(6 \text{ in first throw by } A) + p(A \text{ not } 6, B \text{ not } 6, A 6) + \dots$

$$= \frac{1}{6} + \frac{5}{6} \cdot \frac{5}{6} \cdot \frac{1}{6} + \dots$$

$$= \frac{1}{6} \left(1 + \left(\frac{5}{6}\right)^2 + \left(\frac{5}{6}\right)^4 + \dots \right) = \frac{1}{6} \cdot \frac{1}{1 - \left(\frac{5}{6}\right)^2} = \frac{6}{11}$$

22. (c)

For $f(x)$ to be probability density function $\Rightarrow \int_{-\infty}^{\infty} f(x) dx = 1$

$$\frac{1}{A} \int_2^4 (2x+3) dx = 1$$

$$\frac{1}{A} \left[2 \frac{x^2}{2} + 3x \right]_2^4 = 1$$

$$A = (4^2 - 2^2) + 3(4 - 2)$$

$$= 16 - 4 + 3 \times 2 = 18$$

23. (d)

$$\vec{A} \times \vec{B} \times \vec{C} = (\vec{A} \cdot \vec{C})\vec{B} - (\vec{A} \cdot \vec{B})\vec{C}$$

$$\therefore \nabla \times \nabla \times \vec{A} = (\nabla \cdot \vec{A})\nabla - (\nabla \cdot \nabla)\vec{A} = \nabla(\nabla \cdot \vec{A}) - \nabla^2 \vec{A}$$

24. (c)

Let $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

$$\vec{r} \cdot \hat{i} = x, \quad \vec{r} \cdot \hat{j} = y, \quad \vec{r} \cdot \hat{k} = z$$

$$A = x(\vec{r} \times \hat{i}) + y(\vec{r} \times \hat{j}) + z(\vec{r} \times \hat{k})$$

$$= (\vec{r} \times x\hat{i}) + (\vec{r} \times y\hat{j}) + (\vec{r} \times z\hat{k}) = \vec{r} \times (x\hat{i} + y\hat{j} + z\hat{k}) = \vec{r} \times \vec{r}$$

$$A = 0 \quad (\text{always})$$

25. (a)

Since the probability of occurrence is very small, this follows Poisson distribution

$$\text{mean} = m = np$$

$$= 2000 \times 0.001 = 2$$

Probability that more than 2 will get a bad reaction

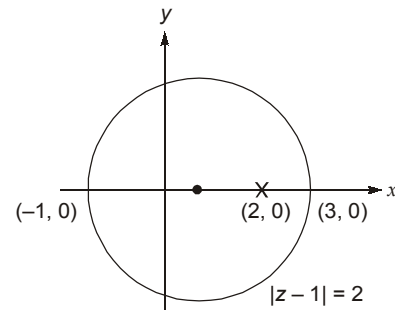
$$= 1 - p(0) - p(1) - p(2)$$

$$= 1 - \left[e^{-m} + \frac{e^{-m} \cdot m^1}{1!} + \frac{e^{-m} \cdot m^2}{2!} \right]$$

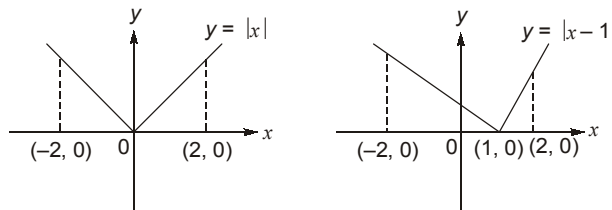
$$= 1 - \left[e^{-2} + \frac{e^{-2} \cdot 2}{1} + \frac{2^2 \cdot e^{-2}}{2} \right] = 1 - \left[\frac{1}{e^2} + \frac{2}{e^2} + \frac{2}{e^2} \right] = 1 - \frac{5}{e^2}$$

26. (d)

$$\begin{aligned}
 \frac{1}{2\pi i} \oint_c \frac{f(z)}{z-a} dz &= f(a) \\
 &= 2 \times x \Big|_{z=2+i0} \\
 &= 2x \Big|_{x+iy=2} \\
 &= 2 \times 2 \\
 &= 4
 \end{aligned}$$



27. (c)



$$\int_{-2}^2 (|x| dx) + \int_{-2}^2 (|x-1| dx) = \text{Area under the curves}$$

$$= 2 \times \frac{1}{2} \times 2 \times 2 + \frac{1}{2} \times 3 \times 3 + \frac{1}{2} \times 1 \times 1 = 4 + \frac{9}{2} + \frac{1}{2} = 9 \text{ unit}^2$$

28. (d)

Let

 $d \rightarrow$ defective $y \rightarrow$ supplied by y

$$P\left(\frac{y}{d}\right) = \frac{P(y \cap d)}{P(d)}$$

$$P(y \cap d) = 0.3 \times 0.02 = 0.006$$

$$\begin{aligned}
 P(d) &= 0.6 \times 0.01 + 0.3 \times 0.02 + 0.1 \times 0.03 \\
 &= 0.015
 \end{aligned}$$

$$P\left(\frac{y}{d}\right) = \frac{0.006}{0.015} = 0.4$$

29. (b)

The maximum variation is in direction of grad T .

$$T = x^2 + 4xy + y^2$$

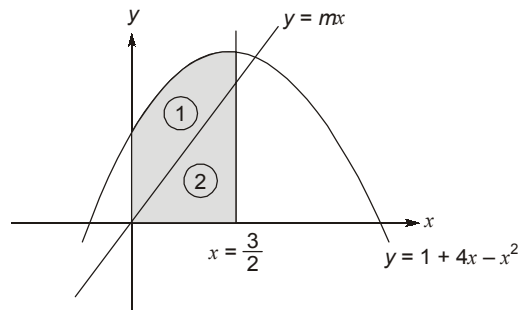
$$\nabla T = \frac{\partial T}{\partial x} \hat{i} + \frac{\partial T}{\partial y} \hat{j} = (2x + 4y) \hat{i} + (4x + 2y) \hat{j}$$

$$\begin{aligned}
 \nabla T|_{(2,2)} &= (4 + 8) \hat{i} + (8 + 4) \hat{j} \\
 &= 12 \hat{i} + 12 \hat{j}
 \end{aligned}$$

The direction in which rate is slowest is perpendicular the direction in which variation is maximum.

$$\nabla T|_{\min} = 12 \hat{i} - 12 \hat{j} \text{ or } \hat{i} - \hat{j}$$

30. (c)



$$\text{Area of (1)} = \text{Area of (2)} = \int_0^{3/2} mx \, dx = \frac{1}{2} [\text{Area of (1)} + \text{Area of (2)}]$$

$$\frac{1}{2} \times \int_0^{3/2} (1 + 4x - x^2) \, dx = \frac{1}{2} \left[x + \frac{4x^2}{2} - \frac{x^3}{3} \right]_0^{3/2}$$

$$\int_0^{3/2} mx \, dx = \frac{1}{2} \left[\left(\frac{3}{2} - 0 \right) + 2 \left(\frac{9}{4} - 0 \right) - \left(\frac{27}{8 \times 3} - 0 \right) \right]$$

$$\left[m \frac{x^2}{2} \right]_0^{3/2} = \frac{1}{2} \left[\frac{3}{2} + \frac{9}{2} - \frac{9}{8} \right]$$

$$m \times \frac{9}{4 \times 2} = \frac{1}{2} \times \frac{39}{8}$$

$$m = \frac{13}{6} = 2.17$$

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