CLASS TEST

S.No.:03DLSK_DEFGH_030826

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ENGINEERING MATHEMATICS

CIVIL ENGINEERING

Date of Test : 03/08/2026

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

By stoke's theorem

$$\int_c \vec{F}\cdot\vec{dr} = \int_s \text{curl}\,\vec{F}\cdot\hat{n}\,ds$$

$$\text{curl}\,\vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ (x^2+y^2) & -2xy & 0 \end{vmatrix} = -4y\hat{k}$$

$$\int_s \text{curl}\,\vec{F}\cdot\hat{n}\,ds = \int_0^b\int_{-a}^a (-4y\hat{k})\cdot\hat{k}\,dxdy = -4\,ab^2$$

2. (b)

After the first one selected is defective there are 99 chips left in the lot with 19 chips that are defective. So the probability that second one selected is defective is $P = \dfrac{19}{99}$.

3. (b)

Rank of matrix A = 2

Because the three row vectors are linearly dependent

$$6a_{(1)} - \frac{1}{2}a_{(2)} - a_{(3)} = 0$$

Rank r equals the maximum number of linearly independent row vectors of A.

4. (d)

The probability of missing the target is $q = 1 - P = 0.7$ hence the probability that n missile miss the target is $(0.7)^n$

Thus we seek smallest n for which

$$1 - (0.7)^n > 0.6$$
$$(0.7)^n < 0.4$$
$$(0.7)^2 = 0.49$$
$$(0.7)^3 = 0.343$$

So atleast n = 3 missiles should be fired.

5. (d)

$$f(x) = 2x^3 - 9x^2 + 12x - 5$$
$$f'(x) = 6x^2 - 18x + 12$$
$$f'(x) = 0$$
$$6(x^2 - 3x + 2) = 0$$

$$x = 1, 2$$

Further, $$f(1) = 2(1)^3 - 9(1)^2 + 12(1) - 5 = 0$$
$$f(2) = 2(2)^3 - 9(2)^2 + 12(2) - 5 = -1$$
$$f(0) = -5$$
$$f(3) = 2(3)^3 - 9(3)^2 + 12(3) - 5 = 4$$

The absolute maximum value is 4.

6. (c)

$$f(x) = x^3 - 12x^2 + 36x + 17$$
$$f'(x) = 3x^2 + (-12 \times 2)x + 36$$
$$= 3(x^2 - 8x + 12)$$
$$= 3(x - 2)(x - 6)$$

Now $f'(x) > 0$ when $x > 6$ or $x < 2$

for $x \in (-\infty, 2)\ U(6, \infty)$, $f(x)$ is strictly increasing

for $x \in (2, 6)$, $f(x)$ is strictly decreasing

7. (b)

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

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

$\Rightarrow$ $$(1 - \lambda)(-1 - \lambda) - 1 = 0$$

$\Rightarrow$ $$\lambda = \pm\sqrt{2}$$

So, eigen values of A^{19} $$= \left(\sqrt{2}\right)^{19} \text{ and } \left(-\sqrt{2}\right)^{19}$$
$$= 2^{(19/2)} \text{ and } -2^{(19/2)}$$
$$= 512\sqrt{2} \text{ and } -512\sqrt{2}$$

8. (d)

$$\text{Rank (AB)} \le \min[\text{Rank (A), Rank (B)}]$$
$$\text{Rank (AB)} \le 3$$

$\because$ We don't know the dimension of A and B, we cannot predict the exact rank of AB but its maximum rank will be 3.

9. (c)

Atmost 2 sixes $\Rightarrow$ 0 sixes + 1 six + 2six

$$= {}^6C_0\left(\frac{5}{6}\right)^6 + {}^6C_1\left(\frac{1}{6}\right)\left(\frac{5}{6}\right)^5 + {}^6C_2\left(\frac{1}{6}\right)^2\left(\frac{5}{6}\right)^4$$

$$= \left(\frac{5}{6}\right)^6 + 6 \times \left(\frac{1}{6}\right)\left(\frac{5}{6}\right)^5 + \frac{6 \times 5}{2 \times 1}\left(\frac{1}{36}\right)\left(\frac{5}{6}\right)^4$$

$$= \left(\frac{5}{6}\right)^4 \left[\frac{25}{36} + \frac{5}{6} + \frac{5}{12}\right]$$

$$P = \frac{35}{18}\left(\frac{5}{6}\right)^4$$

10. (a)

Required probability is

$$P = \frac{4}{52} \times \frac{2}{51} + \frac{4}{52} \times \frac{2}{51} = \frac{4}{663}$$

11. (a)

This is a binomial experiment with $n = 3600$

$$p = 0.02$$

$$q = 1 - p = 0.98$$

Then, $E = np = 3600 \times 0.02 = 72$

$$\sigma^2 = npq = 3600 \times 0.02 \times 0.98 = 70.56$$

$$\sigma = \sqrt{70.56} = 8.4$$

12. (d)

Here, $M = \sec x \tan x \tan y - e^x$

$$N = \sec x \sec^2 y$$

$$\frac{\partial M}{\partial y} = \sec x \tan x \sec^2 y = \frac{\partial N}{\partial x}$$

The given equation is exact and its solution is

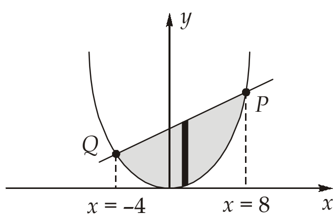
$$\int_{y\,\text{constant}} M dx + \int \text{terms of } N \text{ that do not contain } x) dy = c$$

i.e. $\int (\sec x \tan x \tan y - e^x) dx$

i.e. $\tan y \sec x - e^x = c$

i.e. $\tan y = (c + e^x) \cos x$

13. (c)



Let us find the point of intersection P and Q

$$x^2 = 8y \quad \text{...(i)}$$

$$x = 2y - 8 \quad \text{...(ii)}$$

Substituting the value of y from (ii) in (i),

$$x^2 = 4(x + 8)$$

$\Rightarrow \quad x^2 - 4x - 32 = 0$

$\Rightarrow \quad x = 8, -4$

$$\text{The required area} = \int_{-4}^{8}\int_{\frac{x^2}{8}}^{\left(\frac{x+8}{2}\right)} dy\,dx = \int_{-4}^{8}\left[y\right]_{x^2/8}^{(x+8)/2} dx$$

$$= \int_{-4}^{8}\left[\frac{x}{2}+4-\frac{x^2}{8}\right]dx = \left[\frac{x^2}{4}+4x-\frac{x^3}{24}\right]_{-4}^{8} = 36$$

14. (a)

Let, $\quad y = \lim_{x\to\frac{\pi}{2}}(\tan x)^{\cos x}$

$$\log y = \lim_{x\to\frac{\pi}{2}}\cos x\log\tan x = \lim_{x\to\frac{\pi}{2}}\frac{\log(\tan x)}{\sec x}$$

$$= \lim_{x\to\frac{\pi}{2}}\frac{\left(\frac{1}{\tan x}\right)\sec^2 x}{\sec x\tan x}$$

$\log y = 0$

$y = e^0 = 1$

15. (d)

$$F(u) = \sin u = \frac{x+2y+3z}{\sqrt{x^8+y^8+z^8}}$$

$F(u)$ is a homogeneous function of degree -3

Hence $\quad x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}+z\frac{\partial u}{\partial z} = \frac{nF(u)}{F'(u)} = \frac{-3\sin u}{\cos u}$

$= -3\tan u$

16. (b)

$x^2 = 4y$

and $\quad y^2 = 4x$

Let us find point of intersection,

We have $\quad x^4 = 16y^2 = 16\,(4x) = 64x$

$x(x^3 - 64) = 0$

Hence, $\quad x = 0$

and $\quad x = 4$

Curves intersect at (0, 0) and (4, 4)

for $\quad x^2 = 4y,$

$$\frac{dy}{dx} = \frac{x}{2} = m_1$$

for $y^2 = 4x$

$$\Rightarrow \quad \frac{dy}{dx} = \frac{2}{y} = m_2$$

At point (4, 4), $m_1 = 2$

$$m_2 = \frac{1}{2}$$

$$\theta = \tan^{-1}\left(\frac{m_1 - m_2}{1 + m_1 m_2}\right)$$

$$\theta = \tan^{-1}\left(\frac{2 - \frac{1}{2}}{1 + 2 \times \frac{1}{2}}\right) = \tan^{-1}\left(\frac{3}{4}\right)$$

17. (a)

$$P_x(K) = \frac{e^{-4}4^K}{K!}$$

$$P(X \le 2) = e^{-4}\left[1 + \frac{4^2}{2!} + \frac{4^1}{1!}\right] = 0.238$$

$$P(X > 2) = 1 - P(X \le 2)$$
$$= 1 - 0.238$$
$$= 0.762$$

18. (b)

$$\frac{dx}{dy} = e^{-y^2/2} - xy$$

$$\frac{dx}{dy} + xy = e^{-y^2/2}$$

$$\text{I.F.} = e^{\int p\,dy} = e^{\int y\,dy} = e^{y^2/2}$$

On comparing, $\alpha = \frac{1}{2}$

19. (b)

The arugmented matrix $C = [A, B]$

$$A = \begin{bmatrix} 2 & -3 & 6 & -5 \\ 0 & 1 & -4 & 1 \\ 4 & -5 & 8 & -9 \end{bmatrix}$$

$$C = \left[\begin{array}{cccc|c} 2 & -3 & 6 & -5 & 3 \\ 0 & 1 & -4 & 1 & 1 \\ 4 & -5 & 8 & -9 & b \end{array}\right]$$

$R_3 \to R_3 - 2R_1$

$$C \sim \left[\begin{array}{cccc|c} 2 & -3 & 6 & -5 & 3 \\ 0 & 1 & -4 & 1 & 1 \\ 0 & 1 & -4 & 1 & b-6 \end{array}\right]$$

$R_3 \to R_3 - R_2$

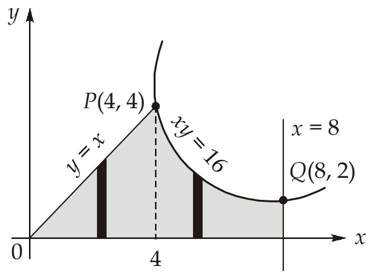
$$C \sim \left[\begin{array}{cccc|c} 2 & -3 & 6 & -5 & 3 \\ 0 & 1 & -4 & 1 & 1 \\ 0 & 0 & 0 & 0 & b-7 \end{array}\right]$$

A

There are infinite solution if $R(A) = R(C) = 2$

$$b - 7 = 0$$
$$b = 7$$

20. (a)



Point of intersection:

$$y = \frac{16}{x}$$
$$y = x$$
$$16 = x^2 \Rightarrow x = \pm 4$$

Point of intersection is $P(4, 4)$

$$xy = 16$$
$$x = 8$$
$$y = 2$$

Second point of intersection is $Q(8, 2)$

$$\iint_A x^2 dx dy = \int_0^4 \int_0^x x^2 dx\, dy + \int_4^8 \int_0^{16/x} x^2\, dx\, dy$$

$$= \int_0^4 x^2 [y]_0^x\, dx + \int_4^8 x^2 [y]_0^{16/x}\, dx$$

$$= \int_0^4 x^3 dx + \int_4^8 16x\, dx$$

$$= \left[\frac{x^4}{4}\right]_0^4 + 16\left[\frac{x^2}{2}\right]_4^8$$

$$= 64 + 384 = 448$$

21. (d)

$$x^2\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} - 4y = x^4 \quad \text{...(i)}$$

Putting, $x = e^z$, $D = \frac{d}{dz}$

$$x\frac{dy}{dx} = Dy$$

$$x^2\frac{d^2y}{dx^2} = D(D-1)y$$

Substituting this values in equation (i),

$$D(D-1)y - 2Dy - 4y = e^{4z}$$

$$(D^2 - 3D - 4)y = e^{4z}$$

$$\text{P.I.} = \frac{1}{D^2 - 3D - 4}e^{4z} = z\frac{1}{2D-3}e^{4z}$$

$$= z\frac{1}{2(4)-3}e^{4z} = \frac{ze^{4z}}{5}$$

$$z = \log x$$

$$\text{P.I.} = \frac{1}{5}x^4 \log x$$

22. (c)

$$E(X) = 2$$

$$E(Y) = 3$$

$$\text{Var}(X) = 1$$

$$\text{Var}(Y) = 2$$

$$Z = 2X - 5Y$$

$$E(Z) = E(2X - 5Y)$$

$$= 2E(X) - 5E(Y)$$

$$= (2 \times 2) - (5 \times 3)$$

$$= -11$$

$$\text{Var}(2X - 5Y) = 4\,\text{Var(X)} + 25\,\text{Var(Y)}$$

$$= (4 \times 1) + (25 \times 2)$$

$$= 54$$

23. (d)

Given, $P(A) = 0.5$

$P(B) = 0.3$

and $P(C) = 0.2$

Let $P(E)$ be the probability of introducing a new product

$$P\left(\frac{E}{A}\right) = 0.7$$

$$P\left(\frac{E}{B}\right) = 0.6$$

$$P\left(\frac{E}{C}\right) = 0.5$$

$$P(E) = P(A)P\left(\frac{E}{A}\right) + P(B)P\left(\frac{E}{B}\right) + P(C)\left(\frac{E}{C}\right)$$

$$= (0.5 \times 0.7) + (0.3 \times 0.6) + (0.2 \times 0.5)$$

$$= 0.63$$

24. (a)

$$[A] = \text{diag}\,[1\times6,\ 2\times1,\ 7\times2] + \text{diag}\,[2, 3, 4]$$

$$[A] = \text{diag}\,[6+2,\ 2+3,\ 14+4]$$

$$|A| = \begin{vmatrix} 8 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 18 \end{vmatrix} = 8 \times 5 \times 18 = 720$$

25. (d)

Three second order principal sub-matrix,

$$\begin{bmatrix} 1 & 3 \\ 5 & 11 \end{bmatrix}, \begin{bmatrix} 1 & 2 \\ 7 & 6 \end{bmatrix}, \begin{bmatrix} 11 & 2 \\ 3 & 6 \end{bmatrix}$$

Three first order principal sub-matrix,

[1], [11], [6]

26. (d)

It is an exact differential equation since

$$\frac{\partial M}{\partial y} = 12xy^2 = \frac{\partial N}{\partial x}$$

$$\Rightarrow \int M dx + \int (\text{Terms of N not containing } x) dy = C$$

$$\int \left(x^4 + 4xy^3\right) dx + \int y^4 dy = C$$

$$\frac{1}{5}\left(x^5 + 10x^2y^3 + y^5\right) = C$$

27. (d)

$$y = \sqrt{a^x + y}$$

$$y^2 = a^x + y$$

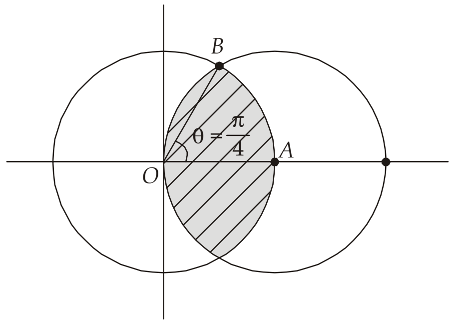
$$2y\frac{dy}{dx} = a^x \ln a + \frac{dy}{dx}$$

$$\frac{dy}{dx} = \frac{a^x \ln a}{(2y-1)}$$

28. (b)

Given: $r = \sqrt{2}a$ and $r = 2a\cos\theta$

Point of intersection,



$$\sqrt{2}a = 2a\cos\theta$$

$$\cos\theta = \frac{1}{\sqrt{2}}$$

$$\theta = \frac{\pi}{4}$$

$$\text{Area, } A = 2\left[\frac{1}{2}\int_0^{\pi/4} r^2 d\theta + \frac{1}{2}\int_{\pi/4}^{\pi/2} r^2 d\theta\right]$$

$$A = \int_0^{\pi/4} \left(\sqrt{2}a\right)^2 d\theta + \int_{\pi/4}^{\pi/2} 4a^2\cos^2\theta d\theta$$

$$A = 2a^2 \times \frac{\pi}{4} + 2a^2\left(\frac{\pi}{2} - \frac{\pi}{4} - \frac{1}{2}\right)$$

$$A = a^2(\pi - 1)$$

29. (a)

$$\text{div}\left(\vec{V}\right) = \frac{\partial V_1}{\partial x} + \frac{\partial V_2}{\partial y} + \frac{\partial V_3}{\partial z}$$

$$\text{div}\left(\vec{V}\right) = 4xy + 3x + 10z$$

At (0, 2, 1), $\text{div}\left(\vec{V}\right) = 4 \times 0 \times 2 + 3 \times 0 + 10 \times 1$

$$= 10$$

30. (b)

$$\int_0^4 f(t)dt = \int_0^1 \left(1 - 3t^2\right)dt + \int_1^4 2t dt$$

$$= t - t^3\Big|_0^1 + t^2\Big|_1^4 = 15$$

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