

DAY — **09**

SEAT NUMBER

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2026	II	21	1100	J-165	(E)
MATHEMATICS & STATISTICS (40) (ARTS & SCIENCE)					
Time : 3 Hrs.		(8 Pages)		Max. Marks : 80	

General instructions :

*The question paper is divided into **FOUR** sections.*

(1) **Section A :** *Q. 1 contains **Eight** multiple choice type questions, each carrying **Two** marks.*

*Q. 2 contains **Four** very short answer type questions, each carrying **One** mark.*

(2) **Section B :** *Q. 3 to Q. 14 contain **Twelve** short answer type questions, each carrying **Two** marks.*

*(Attempt any **Eight**)*

(3) **Section C :** *Q. 15 to Q. 26 contain **Twelve** short answer type questions, each carrying **Three** marks.*

*(Attempt any **Eight**)*

(4) **Section D :** *Q. 27 to Q. 34 contain **Eight** long answer type questions, each carrying **Four** marks.*

*(Attempt any **Five**)*

(5) *Use of log table is allowed. Use of calculator is not allowed.*

(6) *Figures to the right indicate full marks.*

- (7) Use of graph paper is not necessary. Only rough sketch of graph is expected.
- (8) For each multiple choice type of question, only the first attempt will be considered for evaluation.
- (9) Start answer to each section on a new page.

SECTION – A

Q. 1. Select and write the correct answer of the following [16]
multiple choice type of questions :

- (i) The converse of contrapositive of $\sim p \rightarrow q$ is _____.
 (a) $q \rightarrow p$ (b) $\sim q \rightarrow p$
 (c) $p \rightarrow \sim q$ (d) $\sim q \rightarrow \sim p$ (2)
- (ii) If $A = \begin{bmatrix} 2 & -4 \\ 3 & 1 \end{bmatrix}$, then the adjoint of matrix A is _____.
 (a) $\begin{bmatrix} 1 & 3 \\ 4 & -2 \end{bmatrix}$ (b) $\begin{bmatrix} -1 & 3 \\ -4 & 1 \end{bmatrix}$
 (c) $\begin{bmatrix} -1 & -3 \\ -4 & 2 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 4 \\ -3 & 2 \end{bmatrix}$ (2)
- (iii) If $\tan^{-1}(2x) + \tan^{-1}(3x) = \frac{\pi}{4}$, then $x =$ _____.
 (a) -1 (b) $\frac{1}{6}$
 (c) $\frac{1}{3}$ (d) $\frac{3}{2}$ (2)

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- (iv) The angle between the line $\vec{r} = (\hat{i} + 2\hat{j} + \hat{k}) + \lambda(\hat{i} + \hat{j} + \hat{k})$ and the plane $\vec{r} \cdot (2\hat{i} - \hat{j} + \hat{k}) = 8$ is _____.

- (a) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (b) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$
 (c) $\sin^{-1}\left(\frac{1}{2}\right)$ (d) $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$ (2)

- (v) If $y = \sec(\tan^{-1} x)$, then $\frac{dy}{dx}$ at $x = 1$ is _____.

- (a) $\frac{1}{2}$ (b) 1
 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$ (2)

- (vi) The approximate value of the function $f(x) = x^3 - 3x + 5$ at $x = 1.99$ is _____.

- (a) 6.09 (b) 6.91
 (c) 7.09 (d) 7.91 (2)

- (vii) $\int_1^2 \frac{1}{x^2} \cdot e^{\frac{1}{x}} dx =$ _____.

- (a) $\sqrt{e} + 1$ (b) $\sqrt{e} - 1$
 (c) $\sqrt{e}(\sqrt{e} - 1)$ (d) $\frac{\sqrt{e} - 1}{e}$ (2)

(viii) If the p.d.f. of a continuous r.v. X is

$$f(x) = \frac{x+2}{18}, \text{ for } -2 < x < 4$$

$$= 0, \text{ otherwise}$$

then $P(|X| < 1) = \underline{\hspace{2cm}}$

- (a) $\frac{1}{9}$ (b) $\frac{2}{9}$
- (c) $\frac{1}{27}$ (d) $\frac{2}{27}$ (2)

Q. 2. Answer the following questions : [4]

(i) Write the dual of $(p \vee q) \vee r \equiv p \vee (q \vee r)$ (1)

(ii) Evaluate : $\cos^{-1}\left(\frac{1}{2}\right) + 2\sin^{-1}\left(\frac{1}{2}\right)$ (1)

(iii) Evaluate : $\int \frac{2x}{1+x^2} dx$ (1)

(iv) Write the degree of the differential equation
 $(y''')^2 + 3(y'')^3 + 3xy' + 5y = 0$ (1)

SECTION – B

Attempt any EIGHT of the following questions : [16]

Q. 3. Construct the switching circuit of the statement pattern
 $(\sim p \wedge q) \vee (p \wedge \sim r)$. (2)

Q. 4. In $\triangle ABC$, prove that $a(b \cos C - c \cos B) = b^2 - c^2$. (2)

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- Q. 5.** Find the general solution of $4 \cos^2 \theta = 3$. (2)
- Q. 6.** Find k , if the sum of the slopes of the lines represented by $x^2 + kxy - 3y^2 = 0$ is twice their product. (2)
- Q. 7.** Find the value of p , for which the vectors $\bar{a} = 3\hat{i} + 2\hat{j} + 9\hat{k}$ and $\bar{b} = \hat{i} + p\hat{j} + 3\hat{k}$ are perpendicular to each other. (2)
- Q. 8.** Find the vector equation of the line passing through the points $A(1,2,3)$ and $B(2,3,4)$. (2)
- Q. 9.** Find $\frac{dy}{dx}$, if $\sqrt{x} + \sqrt{y} = \sqrt{a}$. (2)
- Q. 10.** Find $\frac{d^2y}{dx^2}$, if $y = x^3 + 7x^2 - 2x - 9$. (2)
- Q. 11.** Test whether the function $f(x) = x^3 + 6x^2 + 12x - 7$ is increasing or decreasing for all $x \in R$. (2)
- Q. 12.** A stone is dropped into a quiet lake and waves in the form of circles are generated. Radius of the circular wave increases at the rate of 3 cm/sec. How fast the area enclosed is increasing when the radius is 8 cm? (2)
- Q. 13.** Evaluate : $\int \sqrt{1 + \sin 2x} \cdot dx$ (2)
- Q. 14.** Given that, $X \sim B(n, p)$, if $n = 10, E(X) = 8$ then find $\text{Var}(X)$. (2)

SECTION – C

Attempt any EIGHT of the following questions :

[24]

- Q. 15.** Examine whether the statement pattern $(p \wedge q) \wedge (\sim p \vee \sim q)$ is a tautology or contradiction or contingency. (3)
- Q. 16.** In $\triangle ABC$, if $A = 45^\circ$, $B = 60^\circ$ then find the ratio of its sides. (3)
- Q. 17.** If two vertices of a triangle are $A(3,1,4)$ and $B(-4,5,-3)$ and the centroid of the triangle is $G(-1,2,1)$, then find the coordinates of the third vertex C of the triangle. (3)
- Q. 18.** If D, E, F are the mid-points of the sides BC, CA, AB respectively of $\triangle ABC$, then prove that $\overline{AD} + \overline{BE} + \overline{CF} = \vec{0}$. (3)
- Q. 19.** Show that the lines $\vec{r} = (\hat{i} + \hat{j} - \hat{k}) + \lambda(2\hat{i} - 2\hat{j} + \hat{k})$ and $\vec{r} = (4\hat{i} - 3\hat{j} + 2\hat{k}) + \mu(\hat{i} - 2\hat{j} + 2\hat{k})$ intersect each other. (3)
- Q. 20.** Find the cartesian equation of the plane $\vec{r} = (\hat{i} - \hat{j}) + \lambda(\hat{i} + \hat{j} + \hat{k}) + \mu(\hat{i} - 2\hat{j} + 3\hat{k})$. (3)
- Q. 21.** If $y = f(u)$ is a differentiable function of u and $u = g(x)$ is a differentiable function of x then prove that y is a differentiable function of x and $\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$. (3)
- Q. 22.** Verify LMVT for the function $f(x) = \log x$, on $[1, e]$. (3)
- Q. 23.** Evaluate : $\int \frac{\sin x}{\sin 3x} dx$ (3)

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Q. 24. Solve the D.E. $3e^x \tan y dx + (1 + e^x) \sec^2 y dy = 0$. (3)

Q. 25. Find $E(X)$ and $V(X)$, where X is the number obtained on uppermost face, when a fair die is thrown. (3)

Q. 26. A pair of dice is thrown 4 times. If getting a doublet is considered as success, find the probability of two successes. (3)

SECTION – D

Attempt any FIVE of the following questions : [20]

Q. 27. If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, prove that $A \cdot (\text{adj } A) = (\text{adj } A) \cdot A = |A| \cdot I$ (4)

Q. 28. Show that every homogeneous equation of degree two in x and y i.e. $ax^2 + 2hxy + by^2 = 0$, represents a pair of lines passing through the origin, if $h^2 - ab \geq 0$ (4)

Q. 29. If $A(\bar{a})$ and $B(\bar{b})$ are any two points in space and $R(\bar{r})$ be a point on the line segment AB dividing internally in the ratio $m : n$ then prove that $\bar{r} = \frac{m\bar{b} + n\bar{a}}{m + n}$. (4)

Q. 30. Solve the L.P.P. graphically :
 Minimize : $z = 5x + 2y$,
 Subject to , $5x + y \geq 10, x + y \geq 6$,
 $x \geq 0, y \geq 0$ (4)

Q. 31. Evaluate : $\int \frac{3x^2 + 4x - 5}{(x^2 - 1)(x + 2)} \cdot dx$ (4)

Q. 32. Prove that : $\int_a^b f(x) dx = \int_a^b f(a + b - x) \cdot dx$

Hence, find $\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \sin^2 x \cdot dx$ (4)

Q. 33. Find the area enclosed between the circle $x^2 + y^2 = 1$ and the line $x + y = 1$ lying in the first quadrant. (4)

Q. 34. Solve the differential equation $x^2 \cdot \frac{dy}{dx} = x^2 + xy + y^2$. (4)

