DAY — 09

SEAT NUMBER

2022 III 14 | 1030

**J-762** (E)

# MATHEMATICS & STATISTICS (40)
## (ARTS & SCIENCE)

**Time : 3 Hrs.** **(7 Pages)** **Max. Marks : 80**

***General instructions :***

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

*(1)* **Section A :** *Q. 1 contains **Eight** multiple choice type of 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, it is mandatory to write the correct answer along with its alphabet, e.g., (a) ........../ (b) .......... / (c) ........../ (d).........., etc. No marks shall be given, if ONLY the correct answer or the alphabet of correct answer is written. 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 for the following multiple choice type of questions :** [16]

(i) The negation of $p \wedge (q \to r)$ is ______.

(a) $\sim p \wedge (\sim q \to \sim r)$ (b) $p \vee (\sim q \vee r)$

(c) $\sim p \wedge (\sim q \to r)$ (d) $p \to (q \wedge \sim r)$ (2)

(ii) In $\Delta ABC$ if $c^2 + a^2 - b^2 = ac$, then $\angle B =$ ______.

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$

(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{6}$ (2)

(iii) Equation of line passing through the points (0, 0, 0) and (2, 1, –3) is ______.

(a) $\frac{x}{2} = \frac{y}{1} = \frac{z}{-3}$ (b) $\frac{x}{2} = \frac{y}{-1} = \frac{z}{-3}$

(c) $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ (d) $\frac{x}{3} = \frac{y}{1} = \frac{z}{2}$ (2)

(iv) The value of $\hat{i} \cdot (\hat{j} \times \hat{k}) + \hat{j} \cdot (\hat{k} \times \hat{i}) + \hat{k} \cdot (\hat{i} \times \hat{j})$ is ______.

(a) 0 (b) – 1

(c) 1 (d) 3 (2)

(v) If $f(x) = x^5 + 2x - 3$, then $(f^{-1})^1 (-3) =$ ______.

(a) 0 (b) – 3

(c) $-\frac{1}{3}$ (d) $\frac{1}{2}$ (2)

$\boxed{0\,|\,7\,|\,6\,|\,2}$

(vi) The maximum value of the function $f(x) = \frac{\log x}{x}$ is _____.

(a) $e$ (b) $\frac{1}{e}$

(c) $e^2$ (d) $\frac{1}{e^2}$ (2)

(vii) If $\int \frac{dx}{4x^2 - 1} = A \log\left(\frac{2x-1}{2x+1}\right) + c$, then A = _____.

(a) 1 (b) $\frac{1}{2}$

(c) $\frac{1}{3}$ (d) $\frac{1}{4}$ (2)

(viii) If the p.m.f. of a r.v. $X$ is

$$P(x) = \frac{c}{x^3}, \quad \text{for } x = 1, 2, 3$$
$$= 0 \quad , \quad \text{otherwise,}$$

then $E(X)$ = _____.

(a) $\frac{216}{251}$ (b) $\frac{294}{251}$

(c) $\frac{297}{294}$ (d) $\frac{294}{297}$ (2)

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

(i) Find the principal value of $\cot^{-1}\left(\frac{-1}{\sqrt{3}}\right)$. (1)

(ii) Write the separate equations of lines represented by the equation $5x^2 - 9y^2 = 0$ (1)

(iii) If $f'(x) = x^{-1}$, then find $f(x)$ (1)

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

## SECTION – B

**Attempt any EIGHT of the following questions :** **[16]**

**Q. 3.** Using truth table verify that :

$(p \wedge q) \vee \sim q \equiv p \vee \sim q$ **(2)**

**Q. 4.** Find the cofactors of the elements of the matrix $\begin{bmatrix} -1 & 2 \\ -3 & 4 \end{bmatrix}$ **(2)**

**Q. 5.** Find the principal solutions of $\cot \theta = 0$ **(2)**

**Q. 6.** Find the value of $k$, if $2x + y = 0$ is one of the lines represented by $3x^2 + kxy + 2y^2 = 0$ **(2)**

**Q. 7.** Find the cartesian equation of the plane passing through A(1, 2, 3) and the direction ratios of whose normal are 3, 2, 5. **(2)**

**Q. 8.** Find the cartesian co-ordinates of the point whose polar co-ordinates are $\left(\frac{1}{2}, \frac{\pi}{3}\right)$. **(2)**

**Q. 9.** Find the equation of tangent to the curve $y = 2x^3 - x^2 + 2$ at $\left(\frac{1}{2}, 2\right)$. **(2)**

**Q. 10.** Evaluate : $\int_0^{\frac{\pi}{4}} \sec^4 x \, dx$ **(2)**

**Q. 11.** Solve the differential equation $y\frac{dy}{dx} + x = 0$ **(2)**

**Q. 12.** Show that function $f(x) = \tan x$ is increasing in $\left(0, \frac{\pi}{2}\right)$. **(2)**

**Q. 13.** Form the differential equation of all lines which makes intercept 3 on $x$-axis. (2)

**Q. 14.** If $X \sim B(n, p)$ and $E(X) = 6$ and Var $(X) = 4.2$, then find $n$ and $p$. (2)

## SECTION – C

**Attempt any EIGHT of the following questions :** [24]

**Q. 15.** If $2\tan^{-1}(\cos x) = \tan^{-1}(2\operatorname{cosec} x)$, then find the value of $x$. (3)

**Q. 16.** If angle between the lines represented by $ax^2 + 2hxy + by^2 = 0$ is equal to the angle between the lines represented by $2x^2 - 5xy + 3y^2 = 0$, then show that $100(h^2 - ab) = (a + b)^2$. (3)

**Q. 17.** Find the distance between the parallel lines $\frac{x}{2} = \frac{y}{-1} = \frac{z}{2}$ and

$$\frac{x-1}{2} = \frac{y-1}{-1} = \frac{z-1}{2}$$ (3)

**Q. 18.** If A $(5, 1, p)$, B$(1, q, p)$ and C$(1, -2, 3)$ are vertices of a triangle and G$\left(r, \frac{-4}{3}, \frac{1}{3}\right)$ is its centroid, then find the values of $p$, $q$, $r$ by vector method. (3)

**Q. 19.** If A$(\bar{a})$ and B$(\bar{b})$ be any two points in the space and R$(\bar{r})$ be a point on the line segment AB dividing it internally in the ratio $m : n$ then prove that $\bar{r} = \frac{m\bar{b} + n\bar{a}}{m+n}$. (3)

**Q. 20.** Find the vector equation of the plane passing through the point A$(-1, 2, -5)$ and parallel to the vectors $4\hat{i} - \hat{j} + 3\hat{k}$ and $\hat{i} + \hat{j} - \hat{k}$. (3)

Q. 21. If $y=e^{m\tan^{-1}x}$, then show that $(1+x^2)\frac{d^2y}{dx^2}+(2x-m)\frac{dy}{dx}=0$ (3)

Q. 22. Evaluate : $\int\frac{dx}{2+\cos x-\sin x}$ (3)

Q. 23. Solve $x+y\frac{dy}{dx}=\sec(x^2+y^2)$ (3)

Q. 24. A wire of length 36 meters is bent to form a rectangle. Find its dimensions if the area of the rectangle is maximum. (3)

Q. 25. Two dice are thrown simultaneously. If $X$ denotes the number of sixes, find the expectation of $X$. (3)

Q. 26. If a fair coin is tossed 10 times. Find the probability of getting at most six heads. (3)

## SECTION – D

**Attempt any FIVE of the following questions :** **[20]**

Q. 27. Without using truth table prove that

$(p\wedge q)\vee(\sim p\wedge q)\vee(p\wedge\sim q)\equiv p\vee q$ (4)

Q. 28. Solve the following system of equations by the method of inversion

$x-y+z=4,\ 2x+y-3z=0,\ x+y+z=2$ (4)

Q. 29. Using vectors prove that the altitudes of a triangle are concurrent. (4)

Q. 30. Solve the L. P. P. by graphical method,

Minimize $z=8x+10y$

Subject to $2x+y\geq 7,$

$2x+3y\geq 15,$

$y\geq 2,\ x\geq 0$

(4)

**Q. 31.** If $x = f(t)$ and $y = g(t)$ are differentiable functions of $t$ so that $y$ is differentiable function of $x$ and $\frac{dx}{dt} \neq 0$, then prove that :

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$$

Hence find $\frac{dy}{dx}$ if $x = \sin t$ and $y = \cos t$. (4)

**Q. 32.** If $u$ and $v$ are differentiable functions of $x$, then prove that :

$$\int uv\,dx = u\int v\,dx - \int\left[\frac{du}{dx}\int v\,dx\right]dx$$

Hence evaluate $\int \log x\,dx$ (4)

**Q. 33.** Find the area of region between parabolas $y^2 = 4ax$ and $x^2 = 4ay$. (4)

**Q. 34.** Show that : $\int_0^{\frac{\pi}{4}} \log(1 + \tan x)\,dx = \frac{\pi}{8}\log 2$ (4)

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