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Time : 3.00 hrs.

Quarterly Examination - 2024

MATHEMATICS

Reg No.

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Max. Marks : 90

SECTION - A

20 x 1 = 20

Answer all the questions. Choose the correct answer

1. If $A = \begin{bmatrix} 7 & 3 \\ 4 & 2 \end{bmatrix}$, then $9I^2 - A =$ a) A^{-1} b) $\frac{A^{-1}}{2}$ c) $3A^{-1}$ d) $2A^{-1}$
2. If $x^m y^n = e^a$, $x^p y^q = e^b$, $\Delta_1 = \begin{bmatrix} m & n \\ p & q \end{bmatrix}$, $\Delta_2 = \begin{bmatrix} a & m \\ b & n \end{bmatrix}$, $\Delta_3 = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, then the values of x and y are respectively
a) $\frac{(\Delta_2 / \Delta_1)}{(\Delta_3 / \Delta_1)}$, $\frac{(\Delta_2 / \Delta_1)}{(\Delta_3 / \Delta_1)}$ b) $\log(\Delta_2 / \Delta_1)$, $\log(\Delta_3 / \Delta_1)$ c) $\log(\Delta_2 / \Delta_1)$, $\log(\Delta_3 / \Delta_1)$ d) (Δ_2 / Δ_1) , (Δ_3 / Δ_1)
3. If $0 \leq \theta \leq \pi$ and the system of equations $x - (\sin\theta)y - \cos\theta z = 0$, $(\cos\theta)x - y + z = 0$, $(\sin\theta)x + y - z = 0$ has a non-trivial solution then θ is a) $\frac{2\pi}{3}$ b) $\frac{3\pi}{4}$ c) $\frac{5\pi}{6}$ d) $\frac{\pi}{4}$
4. The value of $\sum_{n=1}^{13} (i^n + i^{n-1})$ is a) $1+i$ b) i c) 1 d) 0
5. If $\frac{z-1}{z+1}$ is purely imaginary, then $|z|$ is a) $\frac{1}{2}$ b) 1 c) 2 d) 3
6. The principal argument of the complex number $\frac{(1+i\sqrt{3})^2}{4(1-i\sqrt{3})}$ is a) $\frac{2\pi}{3}$ b) $\frac{\pi}{6}$ c) $\frac{5\pi}{6}$ d) $\frac{\pi}{2}$
7. If f and g are polynomials of degrees m and n respectively, and if $h(x) = (f \circ g)(x)$, then the degree of h is a) mn b) $m-n$ c) m^n d) n^m
8. The number of real numbers in $[0, 2\pi]$ satisfying $\sin^4 x - 2\sin^2 x + 1 = 0$ is a) 2 b) 4 c) 1 d) ∞
9. $\sin^{-1} \frac{3}{5} - \cos^{-1} \frac{12}{13} + \sec^{-1} \frac{5}{3} - \operatorname{cosec}^{-1} \frac{13}{12}$ is equal to a) 2π b) π c) 0 d) $\tan^{-1} \frac{12}{65}$
10. If the function $f(x) = \sin^{-1}(x^2 - 3)$, then x belongs to
a) $[-1, 1]$ b) $[\sqrt{2}, 2]$ c) $[-2, -\sqrt{2}] \cup [\sqrt{2}, 2]$ d) $[-2, -\sqrt{2}]$
11. $\sin(\tan^{-1} x)$, $|x| < 1$ is equal to a) $\frac{x}{\sqrt{1-x^2}}$ b) $\frac{1}{\sqrt{1-x^2}}$ c) $\frac{1}{\sqrt{1+x^2}}$ d) $\frac{x}{\sqrt{1+x^2}}$
12. The radius of the circle $3x^2 + by^2 + 4bx - 6by + b^2 = 0$ is a) 1 b) 3 c) $\sqrt{10}$ d) $\sqrt{11}$
13. If $x + y = k$ is a normal to the parabola $y^2 = 12x$, then the value of k is a) 3 b) -1 c) 1 d) 9
14. The locus of a point whose distance from $(-2, 0)$ is $\frac{2}{3}$ times its distance from the line $x = \frac{-9}{2}$ is
a) a parabola b) a hyperbola c) an ellipse d) a circle
15. If \vec{a} and \vec{b} are parallel vectors, then $[\vec{a}, \vec{c}, \vec{b}]$ is equal to a) 2 b) -1 c) 1 d) 0
16. If the line $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$ lies in the plane $x + 3y - az + \beta = 0$, then (α, β) is
a) $(-5, 5)$ b) $(-6, 7)$ c) $(5, -5)$ d) $(6, -7)$
17. The value of $(1+i)^4 + (1+i)^4$ is..... a) 8 b) 4 c) -8 d) -4
18. $y^2 - 2x - 2y + 5 = 0$ is a..... a) circle b) parabola c) ellipse d) hyperbola
19. The area of the parallelogram having diagonals $\vec{a} = 3\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} - 3\hat{j} + 4\hat{k}$ is.....
a) 4 b) $2\sqrt{3}$ c) $4\sqrt{3}$ d) $5\sqrt{3}$
20. The angle between the vectors $3\hat{i} + 4\hat{j} + 5\hat{k}$ and the z-axis is..... a) 30° b) 60° c) 45° d) 90°

SECTION - B

7 x 2 = 14

Answer any seven. Q.No.30 is compulsory

21. Prove that $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$ is orthogonal.
22. Find the rank of the following matrices by minor method. $\begin{bmatrix} 1 & -2 & -1 & 0 \\ 3 & -6 & -3 & 1 \end{bmatrix}$
23. Simplify the following. $i^{59} + \frac{1}{i^{59}} - 2i$
24. If $z = (2 + 3i)(1 - i)$, then find z^{-1} .
25. If $x^2 + 2(k+2)x + 9k = 0$ has equal roots, find k.

26. Find the principal value of $\cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$
27. Obtain the equation of the circle for which (3, 4) and (2, -7) are the ends of a diameter.
28. For any vector \vec{a} , prove that $\hat{i} \times (\vec{a} \times \hat{i}) + \hat{j} \times (\vec{a} \times \hat{j}) + \hat{k} \times (\vec{a} \times \hat{k}) = 2\vec{a}$
29. Find the angle between the line $\vec{r} = (2\hat{i} - \hat{j} + \hat{k}) + t(\hat{i} + 2\hat{j} - 2\hat{k})$ and the plane $\vec{r} = (6\hat{i} + 3\hat{j} + 2\hat{k}) + 8$
30. Find the equation of the hyperbola whose vertices are (0, ± 7) and $e = \frac{4}{3}$

SECTION - C

7 x 3 = 21

Answer any seven. Q.No.40 is compulsory

31. Solve the following systems of linear equations by Cramer's rule. $5x - 2y + 6z = 0$, $x + 3y - 7z = 0$
32. If $|z| = 2$ show that $3 \leq |z + 3 + 4i| \leq 7$
33. Represent the complex number $1 + i\sqrt{3}$ in polar form.
34. Show that the polynomial $9x^9 + 2x^5 - x^4 - 7x^2 + 2 = 0$ has atleast six imaginary roots.
35. Find the value of $\sin^{-1}\left(\sin\frac{5\pi}{9}\cos\frac{\pi}{9} + \cos\frac{5\pi}{9}\sin\frac{\pi}{9}\right)$
36. Find the equation of the circle with centre (2, 3) and passing through the intersection of the lines $3x - 2y - 1 = 0$, and $4x + y - 27 = 0$
37. The equation of the ellipse is $\frac{(x-11)^2}{484} + \frac{y^2}{64} = 1$ (x and y are measured in centimeters) where to the nearest centimeter, should the patient's kidney stone be placed so that the reflected sound hits the kidney stone?
38. A particle acted upon by constant force $2\hat{j} + 5\hat{j} + 6\hat{k}$ and $-\hat{i} - 2\hat{j} - \hat{k}$ is displaced from the point (4, -3, -2) at the point (6, 1, -3). Find the total work done by the forces.
39. Find the shortest distance between the two given straight lines $\vec{r} = (2\hat{i} + 3\hat{j} + 4\hat{k}) + t(-2\hat{i} + \hat{j} - 2\hat{k})$ and $\frac{x-3}{2} = \frac{y}{-1} = \frac{z+2}{2}$
40. Solve by matrix inversion method $x + y = 3$, $2x + 3y = 8$

SECTION - D

7 x 5 = 35

Answer all questions.

41. a) If $A = \begin{bmatrix} -5 & 1 & 3 \\ 7 & 1 & -5 \\ 1 & -1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 1 & 2 \\ 3 & 2 & 1 \\ 2 & 1 & 3 \end{bmatrix}$, find the products AB and BA and hence solve the system of equations $x + y + 2z = 1$, $3x + 2y + z = 7$, $2x + y + 3z = 2$. (OR) b) Solve the following system of linear equation, by Gaussian elimination method: $4x + 3y + 6z = 25$, $x + 5y + 7z = 13$, $2x + 9y + z = 1$.
42. a) Let z_1, z_2 and z_3 be complex numbers such that $|z_1| = |z_2| = |z_3| = r > 0$ and $z_1 + z_2 + z_3 \neq 0$ prove that $\left| \frac{z_1 z_2 + z_2 z_3 + z_3 z_1}{z_1 + z_2 + z_3} \right| = r$ (OR)
- b) If $z = x + iy$ is a complex number such that $\text{Im}\left(\frac{2z+1}{iz+1}\right) = 0$ show that locus of z is $2x^2 + 2y^2 + x - 2y = 0$
43. a) Solve the equation $6x^4 - 5x^3 - 38x^2 - 5x + 6 = 0$ if it is known that $\frac{1}{3}$ is a solution. (OR)
- b) Prove that $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \tan^{-1} \frac{x+y+z-xyz}{1-xy-yz-zx}$
44. a) Find the equation of the circle passing through the points (1, 1), (2, -1) and (3, 2) (OR)
- b) Assume that water issuing from the end of a horizontal pipe, 7.5 m above the ground, describes a parabolic path. The vertex of the parabolic path is at the end of the pipe. At a position 2.5 m below the line of the pipe, the flow of water has curved outward 3m beyond the vertical line through the end of the pipe. How far beyond this vertical line will the water strike the ground?
45. a) Identify the type of conic and find centre, foci, vertices, and directrices of each of the following: $18x^2 + 12y^2 - 144x + 48y + 120 = 0$ (OR) b) Prove by vector method that $\sin(\alpha + \beta) = \sin\alpha \cos\beta + \cos\alpha \sin\beta$
46. a) Find the parametric form of vector equation and Cartesian equation of the plane containing the line $\vec{r} = (\hat{i} - \hat{j} + 3\hat{k}) + t(2\hat{i} - \hat{j} + 4\hat{k})$ and $\vec{r} \cdot (\hat{i} + 2\hat{j} + \hat{k}) = 8$ perpendicular to plane (OR)
- b) If $\vec{a} = \hat{i} - \hat{j}$, $\vec{b} = \hat{i} - \hat{j} - 4\hat{k}$, $\vec{c} = 3\hat{j} - \hat{k}$ and $\vec{d} = 2\hat{i} + 5\hat{j} + \hat{k}$ find $\left[\frac{(\vec{a} \times \vec{b}) \times (\vec{c} \times \vec{d})}{[\vec{a}, \vec{b}, \vec{d}][\vec{c}, \vec{a}, \vec{c}]} \right]$
47. a) Verify whether the given system of equation is consistent. If it is consistent $x + y + z = 5$, $-x + y - z = 5$, $2x - 2y + 2z = 10$. (OR)
- b) Find the shortest distance between the following pairs of lines $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$ and $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$