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HALF YEARLY EXAMINATION -2024

CLASS: XI **MATHEMATICS**

TIME: 3.00 HRS. MAX. MARKS: 90

PART-I

Choose the correct answer: 20*1=20

1. Let A and B be subsets of the universal set $\mathbb{N}$, the set of natural numbers then $A' \cup \left[(A \cap B) \cup B'\right]$ is

   (1) A (2) A' (3) B (4) $\mathbb{N}$

2. The number of constant functions from a set containing m elements to a set containing n elements is

   (1) mn (2) m (3) n (4) $m+n$

3. Find a so that the sum and product of the roots of the equation $2x^2 + (a-3)x + 3a - 5 = 0$ are equal is

   (1) 1 (2) 2 (3) 0 (4) 4

4. The value of $\cos^3\left(\frac{\pi}{8}\right)\cos\left(\frac{3\pi}{8}\right) + \sin^3\left(\frac{\pi}{8}\right)\sin\left(\frac{3\pi}{8}\right)$ is

   (1) $\frac{1}{4}$ (2) $\frac{1}{2\sqrt{2}}$ (3) $\frac{1}{2}$ (4) $\frac{1}{\sqrt{2}}$

5. If $f(\theta) = |\sin\theta| + |\cos\theta|, \theta \in R$, then $f(\theta)$ is in the interval

   (1) $[0,2]$ (2) $[1,\sqrt{2}]$ (3) $[1,2]$ (4) $[0,1]$

6. The product of r consecutive positive integers is divisible by

   (1) $r!$ (2) $(r-1)!$ (3) $(r+1)!$ (4) r

7. The number of 10 digit number that can be written by using the digits 2 and 3 is

   (1) ${}^{10}C_2 + {}^{9}C_2$ (2) 2^{10} (3) $2^{10} - 2$ (4) $10!$

8. The value of $2 + 4 + 6 + \cdots + 2n$ is

   (1) $\frac{n(n-1)}{2}$ (2) $\frac{n(n+1)}{2}$ (3) $\frac{2n(2n+1)}{2}$ (4) $n(n+1)$

9. The coefficient of x^3 in the series e^{-2x} is

   (1) $\frac{4}{3}$ (2) $\frac{-4}{3}$ (3) $\frac{-4}{15}$ (4) $\frac{4}{15}$

10. Equation of the straight line that forms an isosceles triangle with coordinate axes in the I-quadrant with perimeter $4 + 2\sqrt{2}$ is

    (1) $x + y + 2 = 0$ (2) $x + y - 2 = 0$ (3) $x + y - \sqrt{2} = 0$ (4) $x + y + \sqrt{2} = 0$

11. If the two straight lines $x + (2k-7)y + 3 = 0$ and $3kx + 9y - 5 = 0$ are perpendicular then the value of k is

    (1) $k = 3$ (2) $k = \frac{1}{3}$ (3) $k = \frac{2}{3}$ (4) $k = \frac{3}{2}$

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12. The value of x, for which the matrix $A = \begin{bmatrix} e^{x-2} & e^{7+x} \\ e^{2+x} & e^{2x+3} \end{bmatrix}$ is singular is

(1) 9 (2) 8 (3) 7 (4) 6

13. The value of the determinant of $A = \begin{bmatrix} 0 & a & -b \\ -a & 0 & c \\ b & -c & 0 \end{bmatrix}$ is

(1) $-2abc$ (2) abc (3) 0 (4) $a^2 + b^2 + c^2$

14. If $ABCD$ is a parallelogram, then $\overrightarrow{AB} + \overrightarrow{AD} + \overrightarrow{CB} + \overrightarrow{CD}$ is equal to

(1) $2(\overrightarrow{AB} + \overrightarrow{AD})$ (2) $4\overrightarrow{AC}$ (3) $4\overrightarrow{BD}$ (4) $\vec{0}$

15. If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are unit vectors then $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2$ does not exceed

(1) 4 (2) 9 (3) 8 (4) 6

16. The value of $\lim_{x \to \infty} \frac{\sqrt{x^2-1}}{2x+1}$ is

(1) 1 (2) 0 (3) -1 (4) $\frac{1}{2}$

17) Let f be a continuous function on [2,5]. If f takes only rational values for all x and $f(3) = 12$, then $f(4.5)$ is equal to

(1) $\frac{f(3)+f(4.5)}{7.5}$ (2) 12 (3) 17.5 (4) $\frac{f(4.5)-f(3)}{1.5}$

18) If $f(x) = x\tan^{-1}x$, then $f'(1)$ is

(1) $1 + \frac{\pi}{4}$ (2) $\frac{1}{2} + \frac{\pi}{4}$ (3) $\frac{1}{2} - \frac{\pi}{4}$ (4) 2

19) The value of $\log_a a^a \log_b b^b \log_c c^c$ is

(1) 1 (2) $a^3b^3c^3$ (3) abc (4) $3a + 3b + 3c$

20) If $f(x) = x + 2$, then $f'(f(x))$ at $x = 4$ is

(1) 8 (2) 1 (3) 4 (4) 5

PART-II

Answer any seven questions: (Q.No. 30 is compulsory) **7*2=14**

21) If $P(A)$ denotes the power set of A, then find $n\left(P\left(P(P(\phi))\right)\right)$.

22) Evaluate : $\left(\left((256)^{\frac{-1}{2}}\right)^{\frac{-1}{4}}\right)^3$.

23) Find the principal solution and general solutions for $tan\ \theta = -\frac{1}{\sqrt{3}}$

24) How many ways a committee of six persons from 10 persons can be chosen along with a Chair person and a Secretary?

25) Find the distance between the parallel lines $12x + 5y = 7$ and $12x + 5y + 7 = 0$.

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26) Determine the value of a so that the matrix $A = \begin{bmatrix} 7 & 3 \\ -2 & a \end{bmatrix}$ is singular.

27) Find a unit vector parallel along the vector $5\hat{\imath} - 3\hat{\jmath} + 4\hat{k}$.

28) Find the positive integer n so that $\lim\limits_{x \to 3} \frac{x^n - 3^n}{x - 3} = 27$.

29) Find $\frac{dy}{dx}$ if $x = a(t - \sin t), y = a(1 - \cos t)$.

30) Find the middle terms in the expansion of $(x + y)^4$

PART-III

Answer any seven questions : (Q.No. 40 is compulsory) 7*3=21

31) Find the largest possible domain of the real valued function $f(x) = \frac{\sqrt{4-x^2}}{\sqrt{x^2-9}}$.

32) Solve : $\log_{5-x}(x^2 - 6x + 65) = 2$.

33) Prove that $\cos\left(\frac{3\pi}{4} + x\right) - \cos\left(\frac{3\pi}{4} - x\right) = -\sqrt{2}\sin x$.

34) If $nP_r = 11880$ and $nC_r = 495$, find n and r.

35) Write the first 6 terms of the sequences whose n^{th} term $a_n = \begin{cases} n & \text{if } n \text{ is } 1,2 \text{ or } 3 \\ a_{n-1} + a_{n-2} + a_{n-3} & \text{if } n > 3 \end{cases}$

36) Find the equations of the straight lines, making the y-intercept of 7 and angle between the line and the y-axis is 30°

37) Show that $\begin{vmatrix} b+c & bc & b^2c^2 \\ c+a & ca & c^2a^2 \\ a+b & ab & a^2b^2 \end{vmatrix} = 0$

38) Find the angle between the vectors $2\hat{\imath} + 3\hat{\jmath} - 6\hat{k}$ and $6\hat{\imath} - 3\hat{\jmath} + 2\hat{k}$.

39) Show that $\lim\limits_{n \to \infty} \frac{1+2+3+\ldots+n}{3n^2+7n+2} = \frac{1}{6}$.

40) Find y' if $y = \frac{\cos 3x}{x^2}$

PART-IV

Answer all: 7*5=35

41) a) On the set of natural numbers let R be the relation defined by aRb if $2a + 3b = 30$. Write down the relation by listing all the pairs. Check whether it is (i) reflexive (ii) symmetric (iii) transitive (iv) equivalence. ***(OR)***

b) If a, b, c are respectively the p^{th}, q^{th} and r^{th} terms of a GP, show that $(q - r)\log a + (r - p)\log b + (p - q)\log c = 0$.

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42) a) Solve : $\frac{x+1}{x+3} < 3$ *(OR)*

b) If $A + B + C = 180°$, prove that $tan\frac{A}{2}tan\frac{B}{2} + tan\frac{B}{2}tan\frac{C}{2} + tan\frac{C}{2}tan\frac{A}{2} = 1$

43) a) By the principle of mathematical induction, prove that, for $n \geq 1$,

$$1^3 + 2^3 + 3^3 + \cdots + n^3 = \left(\frac{n(n+1)}{2}\right)^2. \ (OR)$$

b) Show that $\begin{vmatrix} b+c & a-c & a-b \\ b-c & c+a & b-a \\ c-b & c-a & a+b \end{vmatrix} = 8abc$

44) a) Show that the equation $9x^2 - 24xy + 16y^2 - 12x + 16y - 12 = 0$ represents a pair of parallel lines. Find the distance between them.(OR)

b) Show that the points whose position vectors $4\hat{i} + 5\hat{j} + \hat{k}, -\hat{j} - \hat{k}, 3\hat{i} + 9\hat{j} + 4\hat{k}$ and $-4\hat{i} + 4\hat{j} + 4\hat{k}$ are coplanar.

45) a) Evaluate $\lim_{x \to \infty} x\left[3^{\frac{1}{x}} + 1 - \cos\left(\frac{1}{x}\right) - e^{\frac{1}{x}}\right]$. *(OR)*

b) Show that the medians of the triangle are concurrent.

46) a) If $y = (cos^{-1} x)^2$, prove that $(1 - x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - 2 = 0$. Hence find y_2 when $x = 0$. *(OR)*

b) Solve : $\sqrt{3}\,sin\,\theta - cos\,\theta = \sqrt{2}$.

47) a) A committee of 5 peoples has to be formed from 4 men and 7 women. In how many ways can this be done when the committee consists of

(i) exactly 2 men? (ii) atleast 2 men? (iii) utmost 2 men?. *(OR)*

b) Find the derivative of (i) $y = e^{-2x} \sin x$ (ii) $y = x^{x^2}$

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