



SUB : MATHEMATICS

MARKS : 100

CLASS : XI

TIME : 3.00 hrs

- Instructions:**
- Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.
 - Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

SECTION - I

- Note:**
- All questions are **compulsory**. 20×1 = 20
 - Choose the correct or most suitable answer from the given **four** alternatives. Write the option code and the corresponding answer.

- If two sets A and B have 17 elements in common, then the number of elements common to the set $A \times B$ and $B \times A$ is
(1) 2^{17} (2) 17^2 (3) 34 (4) insufficient data
- If \mathbb{R} is the set of all real numbers and if $f: \mathbb{R} - \{3\} \rightarrow \mathbb{R}$ is defined by $f(x) = \frac{3+x}{3-x}$ for $x \in \mathbb{R} - \{3\}$, then the range of f is
(1) \mathbb{R} (2) $\mathbb{R} - \{1\}$ (3) $\mathbb{R} - \{-1\}$ (4) $\mathbb{R} - \{-3\}$
- If the sum and product of the roots of the equation $2x^2 + (a-3)x + 3a-5 = 0$ are equal, then the value of a is
(1) 1 (2) 2 (3) 0 (4) 4
- Which one of the following is not true?
(1) $|\sin x| \leq 1$ (2) $|\sec x| < 1$
(3) $|\cos x| \leq 1$ (4) $\operatorname{cosec} x \geq 1$ or $\operatorname{cosec} x \leq -1$
- $\cos 1^\circ + \cos 2^\circ + \cos 3^\circ + \dots + \cos 179^\circ$ is
(1) 0 (2) 1 (3) -1 (4) 89
- If 10 lines are drawn in a plane such that no two of them are parallel and no three are concurrent, then the total number of points of intersection are
(1) 45 (2) 40 (3) 10! (4) 2^{10}
- The remainder when 2^{2020} is divided by 15 is
(1) 4 (2) 8 (3) 1 (4) 2
- The harmonic mean of two positive numbers whose arithmetic mean and geometric mean are 16, 8 respectively is
(1) 10 (2) 6 (3) 5 (4) 4
- In the equation of a straight line $ax + by + c = 0$, if a, b, c are in arithmetic progression then the point on the straight line is
(1) (1, 2) (2) (1, -2) (3) (2, -1) (4) (2, 1)
- If two straight lines $x + (2k-7)y + 3 = 0$ and $3kx + 9y - 5 = 0$ are perpendicular to each other then the value of k is
(1) 3 (2) $\frac{1}{3}$ (3) $\frac{2}{3}$ (4) $\frac{3}{2}$

11. If $|\vec{a}|=13$, $|\vec{b}|=5$ and $\vec{a} \cdot \vec{b} = 60^\circ$ then $|\vec{a} \times \vec{b}|$ is
 (1) 15 (2) 35 (3) 45 (4) 25
12. A vector \vec{OP} makes 60° and 45° with the positive direction of the x and y axes respectively. Then the angle between \vec{OP} and the z -axis is
 (1) 45° (2) 60° (3) 90° (4) 30°
13. A vector perpendicular to both $\hat{i} + \hat{j} + \hat{k}$ and $2\hat{i} + \hat{j} + 3\hat{k}$ is,
 (1) $2\hat{i} + \hat{j} - \hat{k}$ (2) $2\hat{i} - \hat{j} - \hat{k}$ (3) $3\hat{i} + \hat{j} + 2\hat{k}$ (4) $3\hat{i} + \hat{j} - 2\hat{k}$
14. $\lim_{x \rightarrow 0} \frac{\sin|x|}{x}$ is
 (1) 1 (2) -1 (3) 0 (4) does not exist
15. If $f: \mathbb{R} \rightarrow \mathbb{R}$ is defined by $f(x) = [x-3] + |x-4|$, $x \in \mathbb{R}$, then $\lim_{x \rightarrow 3} f(x)$ is equal to
 (1) -2 (2) -1 (3) 0 (4) 1
16. If $f(x) = \begin{cases} x^3, & x < 0 \\ 3a + x^2, & x \geq 0 \end{cases}$ is continuous at $x=0$, then a is
 (1) -2 (2) -1 (3) 0 (4) 1
17. The derivative of $f(x) = x|x|$ at $x=-3$ is
 (1) 6 (2) -6 (3) does not exist (4) 0
18. $\int \frac{dx}{x(x+1)}$ is
 (1) $\log \left| \frac{x+1}{x} \right| + c$ (2) $\log \left| \frac{x}{x+1} \right| + c$ (3) $\log \left| \frac{x-1}{x} \right| + c$ (4) $\log \left| \frac{x}{x-1} \right| + c$
19. $\int 2^{3x+5} dx$ is
 (1) $\frac{2^{3x+5}}{\log 2} + c$ (2) $\frac{2^{3x+5}}{2 \log(3x+5)} + c$ (3) $\frac{2^{3x+5}}{2 \log 3} + c$ (4) $\frac{2^{3x+5}}{3 \log 2} + c$
20. If X and Y be two events such that $P(X/Y) = \frac{1}{2}$, $P(Y/X) = \frac{1}{3}$ and $P(X \cap Y) = \frac{1}{6}$, then $P(X \cup Y)$ is
 (1) $\frac{1}{3}$ (2) $\frac{2}{5}$ (3) $\frac{1}{6}$ (4) $\frac{2}{3}$

SECTION - II

Note: (i) Answer any SEVEN questions.

7 × 2 = 14

(ii) Question number 30 is compulsory.

21. From the graph $y = \cos x$, draw $|y| = \cos x$.
22. If $\frac{\log(x)}{y-z} = \frac{\log(y)}{z-x} = \frac{\log(z)}{x-y}$, then prove that $xyz = 1$.
23. Show that $\tan(45^\circ - A) = \frac{1 - \tan A}{1 + \tan A}$
24. How many ways are there to arrange the letters of the word "GARDEN" with vowels in the alphabetical order.
25. Find the sum $1 + \frac{4}{5} + \frac{7}{25} + \frac{10}{125} + \dots$
26. Show that the points whose position vectors are $2\hat{i} + 3\hat{j} - 5\hat{k}$, $3\hat{i} + \hat{j} - 2\hat{k}$ and $6\hat{i} - 5\hat{j} + 7\hat{k}$ are collinear.

27. Examine the continuity of the function $\frac{x^2-16}{x+4}$
28. Find the derivative of $y = \log_{10} x$ with respect to x .
29. Evaluate: $\int \frac{\sin x}{1+\cos x} dx$
30. If $A = \begin{bmatrix} 4 & 2 \\ -1 & x \end{bmatrix}$ and $(A-2I)(A-3I) = O$, find the value of x .

SECTION - III

Note: (i) Answer any **SEVEN** questions.

7×3 = 21

(ii) Question number **40** is compulsory.

31. Check the relation $R = \{(1,1), (2,2), (3,3), \dots, (n,n)\}$ defined on the set $S = \{1, 2, 3, \dots, n\}$ for the three basic relations.
32. Prove that $\frac{\cot(180^\circ + \theta) \sin(90^\circ - \theta) \cos(-\theta)}{\sin(270^\circ + \theta) \tan(-\theta) \operatorname{cosec}(360^\circ + \theta)} = \cos^2 \theta \cot \theta$.
33. In an examination a student has to answer 5 questions out of 9 questions, in which 2 are compulsory. In how many ways a student can answer the questions?
34. Find the coefficient of x^{15} in $\left(x^2 + \frac{1}{x^3}\right)^{10}$.
35. Find the equations of the straight lines, making the y -intercept of 7 and angle between the line and the y -axis is 30° .
36. Prove that $\begin{vmatrix} 1 & 1 & 1 \\ x & y & z \\ x^2 & y^2 & z^2 \end{vmatrix} = (x-y)(y-z)(z-x)$.
37. If \vec{a}, \vec{b} and \vec{c} are vectors with magnitudes 3, 4 and 5 respectively and $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, then find the value of $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$.
38. Evaluate: $\int x \log x \, dx$.
39. If A and B are mutually exclusive events $P(A) = \frac{3}{8}$ and $P(B) = \frac{1}{8}$, then find
(i) $P(\bar{A})$ (ii) $P(A \cup B)$ (iii) $P(\bar{A} \cap B)$
40. Evaluate: $\lim_{x \rightarrow 0} \frac{\sqrt{x+2} - \sqrt{2}}{x}$.

SECTION - IV

Note: Answer **all** the questions.

7×5 = 35

41. (a) If $f, g: \mathbb{R} \rightarrow \mathbb{R}$ are defined by $f(x) = |x| + x$ and $g(x) = |x| - x$, find $g \circ f$ and $f \circ g$.
(OR)
(b) Solve the linear inequalities and exhibit the solution set graphically:

$$x + y \geq 3, 2x - y \leq 5, -x + 2y \leq 3.$$

42. (a) If $A + B + C = \pi$, prove that $\cos A + \cos B + \cos C = 1 + 4 \sin\left(\frac{A}{2}\right) \sin\left(\frac{B}{2}\right) \sin\left(\frac{C}{2}\right)$ =

(OR)

(b) In a $\triangle ABC$, prove that $a \cos A + b \cos B + c \cos C = 2a \sin B \sin C$.

43. (a) Prove by the principle of mathematical induction, the sum of the first n non-zero even numbers is $n^2 + n$.

(OR)

(b) The number of bacteria in a certain culture doubles every hour. If there were 30 bacteria present in the culture originally, how many bacteria will be present at the end of 2nd hour, 4th hour and the n^{th} hour?

44. (a) Show that $\begin{vmatrix} \log x & \log y & \log z \\ \log 2x & \log 2y & \log 2z \\ \log 3x & \log 3y & \log 3z \end{vmatrix} = 0$

(OR)

(b) Show that the vectors $\hat{i} - 2\hat{j} + 3\hat{k}$, $-2\hat{i} + 3\hat{j} - 4\hat{k}$, $-\hat{j} + 2\hat{k}$ are coplanar.

45. (a) Describe the interval(s) on which the function $h(x) = \begin{cases} x \sin \frac{1}{x}, & x \neq 0 \\ 0, & x = 0 \end{cases}$ is continuous.

(OR)

(b) If $\sin y = x \sin(a + y)$, then prove that $\frac{dy}{dx} = \frac{\sin^2(a + y)}{\sin a}$, $a \neq n\pi$.

46. (a) Using the substitution $2x + 1 = t^2$, show that $\int \frac{6x}{\sqrt{2x+1}} dx = 2(x-1)\sqrt{2x+1} + c$

(OR)

(b) A construction company employs 2 executive engineers. Engineer-1 does the work for 60% of jobs of the company. Engineer-2 does the work for 40% of jobs of the company. It is known from the past experience that the probability of an error when engineer-1 does the work is 0.03, whereas the probability of an error in the work of engineer-2 is 0.04. Suppose a serious error occurs in the work, which engineer would you guess did the work?

47. (a) At a particular moment, a student needs to stop his speedybike to avoid a collision with the barrier ahead at a distance 40 metres away from him. Immediately he slows (retardation) the bike under braking at a rate of 8 metre/second². If the bike is moving at a speed of 24m/s, when the brakes are applied, would it stop before collision?

(OR)

(b) Find the separate equations of the pair of straight lines $2x^2 - xy - 3y^2 - 6x + 19y - 20 = 0$.

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