1. (1) If \( f(x) = 3x - 1 \) and \( g(x) = 2x^2 + 3 \), then \((g \circ f)(2) = \)
   A. 51  B. 53  C. 55  D. 57  E. 59

2. An operation \( \odot \) is defined by \( a \odot b = a^2 - b^2 \). Then \((2 \odot 3)(1 \odot 2) = \)
   A. 4  B. -4  C. 8  D. -8  E. 15

3. When \((2x + k)^{2017} + (x - 1)^2\) is divided by \(x + 1\), the remainder is 5, then \(k = \)
   A. -1  B. 1  C. -3  D. 6  E. 3

4. If \(x - 2\) is a factor of \(x^n + 1 + 5x^8 - 10x - 36\), then \(n = \)
   A. 2  B. 3  C. 4  D. 5  E. 6

5. The term independent of \(x\) in the expansion of \((x^2 + \frac{1}{x})^6\) is 15, then \(a = \)
   A. \(\pm 1\)  B. 1 only  C. -1 only  D. 4 only  E. none of these

6. The sum of all the coefficients of the terms in the expansion of \((3x - 1)^{10}\) is
   A. 256  B. 512  C. 1024  D. 2048  E. none of these

7. The solution set of the inequality \(kx^2 \leq 0\) is \(R\) if
   A. \(k \leq 1\)  B. \(k > 1\)  C. \(k < 0\)  D. \(k > 0\)  E. \(k > 1\)

8. In an A.P., \(S_{15} = 240\). Then \(u_7 + u_8 + u_9 = \)
   A. 36  B. 48  C. 54  D. 60  E. 72

9. If the A.M. between \(x\) and \(y\) is 3, then \(x^3 + y^3 + 18xy = \)
   A. 216  B. 125  C. 64  D. 27  E. 8

10. In a G.P., each term is positive, the third term is 18 and the fifth term is 162, then the common ratio is
    A. \(\pm 3\)  B. -3 only  C. 3 only  D. 6 only  E. \(\pm 6\)

11. Let \(A = \begin{pmatrix} 1 & 2 \\ 0 & 4 \end{pmatrix}\) be a matrix and given that \(\text{det}(xA) = 4\). Then \(x = \)
    A. \(\pm 2\)  B. 4  C. 3  D. \(\pm 1\)  E. 0

12. Given that \(A\) is a \(2 \times 2\) matrix such that \(\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}A = \begin{pmatrix} 2 & -4 \\ -2 & 4 \end{pmatrix}\), then the matrix \(A\) is
    A. \(\begin{pmatrix} 2 & 1 \\ -1 & 2 \end{pmatrix}\)  B. \(\begin{pmatrix} -1 & 2 \\ 1 & -2 \end{pmatrix}\)  C. \(\begin{pmatrix} 1 & -2 \\ -1 & 2 \end{pmatrix}\)  D. \(\begin{pmatrix} 2 & -1 \\ 1 & -2 \end{pmatrix}\)  E. \(\begin{pmatrix} -2 & 1 \\ 1 & 2 \end{pmatrix}\)
(13) If $A$ is an event such that $6(P(A))^2 = P(not \ A)$, then $P(A) =$
A. $\frac{1}{2}$  
B. $\frac{1}{3}$  
C. $\frac{1}{6}$  
D. $\frac{2}{3}$  
E. $\frac{5}{6}$

(14) A die is rolled $x$ times. If the expected frequency of a number which is a multiple of 3 is 30, then the expected frequency of a number not greater than 3 is
A. 90  
B. 80  
C. 75  
D. 60  
E. 45

(15) ABCDEF is a regular hexagon inscribed in a circle AG is a tangent at A, then $\angle FAG =$
A. $30^\circ$  
B. $60^\circ$  
C. $150^\circ$  
D. $120^\circ$  
E. none of these

(16) In circle O, AC is a diameter, PA is a tangent at A, and PBC is a secant meeting the circle at B and C. If the radius of the circle is 2 cm and $\angle APB = 30^\circ$, then the length of the segment PB, in cm, is
A. 2  
B. 4  
C. 6  
D. 8  
E. 9

(17) If $\triangle ABC \sim \triangle PQR$, $\alpha(\triangle ABC) + \alpha(\triangle PQR) = 75 \text{ cm}^2$, AB and PQ are corresponding sides and $AB : PQ = 4 : 3$, then $\alpha(\triangle ABC)$, in $\text{cm}^2$, is
A. 25  
B. 27  
C. 36  
D. 48  
E. 50

(18) Given that $\overrightarrow{OP} = \left( \frac{p}{4} \right)$ and $\overrightarrow{OQ} = \left( \frac{2}{3} \right)$. If $\overrightarrow{PQ}$ is a unit vector, the possible value of $p$ is
A. 1  
B. 2  
C. 3  
D. 4  
E. 5

(19) The map of the point $(2, -3)$ by the reflection matrix in Y-axis is
A. $(2, 3)$  
B. $(2, -3)$  
C. $(-2, -3)$  
D. $(-2, 3)$  
E. $(4, 6)$

(20) If $\log(\cos x) = k$, then $\log(\sec^2 x) =$
A. $-\frac{1}{k}$  
B. $-\frac{1}{3}k$  
C. $3k$  
D. $-3k$  
E. none of these

(21) If $180^\circ < \theta < 360^\circ$ and $\tan \theta = -\sqrt{3}$, then $\theta =$
A. $225^\circ$  
B. $240^\circ$  
C. $210^\circ$  
D. $300^\circ$  
E. $330^\circ$

(22) In $\triangle ABC$, $\angle B = \angle A + 15^\circ$, and $\angle B = \angle C - 15^\circ$. Then $BC : AC =$
A. $1 : \sqrt{2}$  
B. $1 : \sqrt{3}$  
C. $1 : 2$  
D. $\sqrt{2} : \sqrt{3}$  
E. $2 : \sqrt{3}$

(23) The gradient of the curve $3x^2 - y^2 = 11$ at the point $(3, 4)$ is
A. $\frac{4}{9}$  
B. $\frac{2}{4}$  
C. $-\frac{2}{4}$  
D. $-\frac{4}{9}$  
E. $-\frac{4}{3}$

(24) Given that $y = \sin 4x + \cos^4 x$, then the value of $\frac{dy}{dx}$ when $x = \frac{\pi}{4}$ is
A. $-5$  
B. $5$  
C. $-4$  
D. $4$  
E. $6$

(25) A stationary point of the curve $y = x + \ln(\cos x)$ is at $x =$
A. 0  
B. $\frac{\pi}{4}$  
C. $\frac{\pi}{3}$  
D. $\frac{\pi}{2}$  
E. $\frac{2\pi}{3}$

(25 marks)
SECTION (B)
(Answer ALL questions)

2. If \( f \) and \( g \) are functions such that \( f(x) = 2x - 1 \) and \( (g \circ f)(x) = 4x^2 - 2x - 3 \), find the formula of \( g \) in simplified form. (3 marks)

\( OR \)
\[ x^2 - 1 \text{ is a factor of } x^3 + ax^2 - x + b. \] When the expression is divided by \( x - 2 \), the remainder is 15. Find the values of \( a \) and \( b \). (3 marks)

3. Given that \( \sin^2 x \), \( \cos^2 x \) and \( 5\cos^2 x - 3\sin^2 x \) are in A.P., find the value of \( \sin^2 x \). (3 marks)

\( OR \)
\[ x^2 - 1 \text{ is a factor of } x^3 + ax^2 - x + b. \] When the expression is divided by \( x - 2 \), the remainder is 15. Find the values of \( a \) and \( b \). (3 marks)

4. In circle \( O \), \( PS \) is a diameter and \( \angle POQ = 60^\circ \), \( \angle ROS = 70^\circ \), find \( \angle PTQ \). (3 marks)

5. Prove that \( \frac{1 + \cos x + \cos 2x}{\sin x + \sin 2x} = \cot x \). (3 marks)

6. Find \( \lim_{x \to a} \frac{2x^2 - 5(2^x) + 4}{2x - 4} \) and \( \lim_{x \to \infty} \frac{x^2 - 16}{x^4 - 4x^3} \). (3 marks)

SECTION (C)
(Answer any SIX questions)

7.(a) Let \( f \) and \( g \) be two functions defined by \( f(x) = 2x + 1 \) and \( f(g(x)) = 3x - 1 \). Find the formula of \( (f \circ g)^{-1} \) and hence find \( (f \circ g)^{-1}(8) \). (5 marks)

(b) Let \( R \) be the set of real numbers and a binary operation \( \circ \) on \( R \) be defined by \( a \circ b = 2ab - a + 4b \) for \( a, b \in R \).
Find the values of \( 3 \circ (2 \circ 4) \) and \( (3 \circ 2) \circ 4 \). If \( x \circ y = 2 \) and \( x \neq 2 \), find the numerical value of \( y \circ y \). (5 marks)

8.(a) Given that \( 4x^4 - 9a^2x^2 + 2(a^2 - 7)x - 18 \) is exactly divisible by \( 2x - 3a \), show that \( a^2 - 7a - 6 = 0 \) and hence find the possible values of \( a \). (5 marks)

(b) The first four terms in the binomial expression of \( (a + b)^n \), in descending powers of \( a \), are \( w, x, y \) and \( z \) respectively. Show that \( (n - 2)xy = 3nwz \). (5 marks)

9.(a) Find the solution set of the inequation \( 12 - 25x + 12x^2 \leq 0 \) by graphical method and illustrate it on the number line. (5 marks)

(b) Let \( a \) and \( b \) be two numbers, \( x \) be the single arithmetic mean of \( a \) and \( b \). Show that the sum of \( n \) arithmetic means between \( a \) and \( b \) is \( nx \). (5 marks)

[ P. T. O. ]
10.(a) The three numbers \(a, b, c\) between 2 and 18 are such that their sum is 25, the numbers 2, \(a, b\) are consecutive terms of an arithmetic progression, and the numbers \(b, c, 18\) are consecutive terms of a geometric progression. Find the three numbers. (5 marks)

(b) If \(ps \neq qr\), find the \(2 \times 2\) matrix \(X\) such that \(\begin{pmatrix} p & q \\ r & s \end{pmatrix} \times \begin{pmatrix} p \\ q \end{pmatrix} = \begin{pmatrix} q \\ p \end{pmatrix}\). Find also \(X^{-1}\), if it exists. (5 marks)

11.(a) Find the inverse of the matrix \(\begin{pmatrix} 7 & 4 \\ 3 & 2 \end{pmatrix}\), and use it to find the solution set of the system of equations \(\begin{pmatrix} 7x + 4y = 16 \\ 2y + 3x = 6 \end{pmatrix}\). (5 marks)

(b) \(X\) and \(Y\) are two independent events. The probability that the event \(X\) will occur is twice the probability that the event \(Y\) will occur and the probability that \(Y\) will not occur is four times the probability that \(X\) will not occur. Then find the probability that both \(X\) and \(Y\) will not occur. (5 marks)

12.(a) In the figure, O is the centre of the circle, \(AFG \parallel OB\), \(\angle AOB = 120^\circ\) and \(\angle EAG = 80^\circ\). Find \(\angle BFG\) and \(\angle EBO\). (5 marks)

(b) In \(\triangle ABC\), \(AB = AC\). \(P\) is any point on \(BC\), and \(Y\) any point on \(AP\). The circle \(BPY\) and \(CPY\) cut \(AB\) and \(AC\) respectively at \(X\) and \(Z\). Prove \(XZ \parallel BC\). (5 marks)

13.(a) In trapezium \(ABCD\) the diagonals \(AC\) and \(BD\) intersect at \(O\). If \(AB \parallel DC\) and \(16\alpha(\angle AOB) = 25\alpha(\angle COD)\), find the ratios \(AB : CD\) and \(\alpha(\angle AOB) : \alpha(\angle COD)\). (5 marks)

(b) The position vectors of \(A\) and \(B\) relative to an origin \(O\) are \(\begin{pmatrix} 5 \\ 15 \end{pmatrix}\) and \(\begin{pmatrix} 13 \\ 3 \end{pmatrix}\) respectively. Given that \(C\) lies on \(AB\) and has position vector \(\begin{pmatrix} 2t + 1 \\ t + 1 \end{pmatrix}\), find the value of \(t\) and the ratio \(AC : CB\). (5 marks)

14.(a) Solve the equation \(\sin x + \sin \left(\frac{x}{2}\right) = 0\) for \(0 \leq x \leq 2\pi\). (5 marks)

(b) \(A\) and \(B\) are two points on one bank of a straight river, distant from one another 649 m. \(C\) is on the other bank and the measures of the angles \(\angle CAB, \angle CBA\) are respectively \(48^\circ 31'\) and \(75^\circ 25'\). Find the width of the river. (5 marks)

15.(a) Show that the point \(\left(\frac{\pi}{4}, \frac{\pi}{2}\right)\) lies on the curve \(x \sin 2y = y \cos 2x\). Then find the equations of tangent and normal to the curve at the point \(\left(\frac{\pi}{4}, \frac{\pi}{2}\right)\). (5 marks)

(b) If \(y = A \cos (\ln \frac{x}{2}) + B \sin (\ln \frac{x}{2})\), where \(A\) and \(B\) are constants, show that \(x^2 y'' + xy' + y = 0\). (5 marks)