



B.Sc./1st Sem/MTM/25(NEP)

2025

1st Semester Examination (CCFUP : NEP)

MATHEMATICS

Paper : MI 1-T (Minor)

(Calculus, Geometry and
Ordinary Differential Equation)

Full Marks : 60

Time : Three Hours

The figures in the margin indicate full marks.

*Candidates are required to give their answers
in their own words as far as practicable.*

Group - A

Answer any **ten** questions : $10 \times 2 = 20$

1. Show that the point of inflexion of the curve
 $y = x^3 - 6x^2 + 12x - 5$ lies on the line $x + y = 3$.

2. Find the envelope of the family of straight lines

$$y = mx + \frac{a}{m}.$$

3. State the necessary and sufficient condition for the
differential equation $M(x, y)dx + N(x, y)dy = 0$ to be
exact.

P.T.O.

4. Find the length of the curve $y = \log \sec x$ between $x = 0$ and $x = \frac{\pi}{3}$.
5. Find the nature of the conic $3x^2 + 4xy + 2y^2 - 6x + 8y - 1 = 0$.
6. Find the polar equation of the straight line whose intercept on the initial line is a and which makes an angle α with it.
7. Show that the curve $y = x \log_e x (x > 0)$ is everywhere concave upwards.
8. If $I_n = \int_0^{\frac{\pi}{4}} \tan^n x dx$, n being a positive integer greater than 1, then prove that $I_n = \frac{1}{n-1} - I_{n-2}$.
9. Find the radius of the circle $x^2 + y^2 + z^2 - 8x + 4y + 8z - 45 = 0 = x - 2y + 2z - 3$.
10. What do you mean by asymptote? Does asymptote exist for every curve?
11. Find the value of $\lim_{x \rightarrow 1} x^{\frac{1}{x-1}}$.
12. Define point of inflexion of curve.
13. Find the value of b , if the solid generated by the revolution of the curve $xy = 1$, bounded by $y = 0$, $x = 2$, $x = b$ ($0 < b < 2$).

(3)

14. Find the equation of the right circular cone whose axis

is $\frac{x}{1} = \frac{y}{0} = \frac{z}{-2}$ and radius equal to 7.

15. Find the integrating factor of the following differential

equation $\frac{dy}{dx} + \frac{xy}{1-y^2} - y\sqrt{x} = 0$.

Group - B

Answer any **four** questions :

$$5 \times 4 = 20$$

16. Prove that $\int_0^1 x^m (1-x)^n dx = \frac{m!n!}{(m+n+1)!}$ where m, n

are positive integers.

17. Find the asymptotes of the curve

$$x^3 - 3xy^2 - 4x^2 + 6y^2 + 1 = 0.$$

18. If $y = \sin(m \sin^{-1} x)$, then prove that

$$(1-x^2)y_2 - xy_1 + m^2y = 0.$$

Hence, show that

$$(1-x^2)y_{n+2} - (2n+1)xy_{n+1} + (m^2 - n^2)y_n = 0.$$

19. Find the equation of cylinder generated by straight lines

parallel to $\frac{x}{3} = \frac{y}{5} = \frac{z}{-4}$ and whose guiding curve is

$$3x^2 - 4y^2 = 5, z = 2.$$

P.T.O.

(4)

20. Find the solution of $\frac{dy}{dx} - y \tan x = \cos x$ by substitution

$$y = y_1 v(x) \text{ where } y_1 = \sec x. \quad 3+2$$

21. Let $P_n = D^n(x^n \log x)$.

Prove that $P_n = nP_{n-1} + (n-1)!$.

$$\text{Hence show that } P_n = n! \left(\log x + 1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} \right)$$

Group - C

Answer any *two* questions : $10 \times 2 = 20$

22. (a) Reduce the quadratic form $[4x^2 + 9y^2 + 16z^2 + 12xy - 8yz - 16zx]$ to its canonical form.

(b) Solve the differential equation

$$(x^2 + y^2)dx + 2xydy = 0. \quad 5+5$$

23. (a) Find the equation of the right circular cone which passes through the coordinate axes and whose vertex is at the origin.

(b) Show that the general solution of $\frac{dy}{dx} + Py = Q$ can be written in the form

$$y = Ce^{-\int P dx} + e^{-\int P dx} \int Q e^{\int P dx} dx. \quad 5+5$$

24. (a) Find the volume of the solid obtained by revolving one arc of a cycloid $x = a(\theta - \sin \theta)$,
 $y = a(1 - \cos \theta)$ about x -axis.

- (b) Find the area bounded by the curve $x = \cos t + 3$,
 $y = 4 \sin t$. 5+5

25. (a) Prove that the locus of the foot of the perpendicular from a focus of the conic

$$\frac{l}{r} = 1 - e \cos \theta \text{ on a tangent to it is given by}$$

$$r^2(1 - e^2) - 2elr \cos \theta - l^2 = 0.$$

- (b) Show that the curve $y = 3x^5 - 40x^3 + 3x - 20$ is concave upward for $-2 < x < 0$ and $2 < x < \infty$ but convex upwards for $-\infty < x < -2$, and $0 < x < 2$. Also show that $x = -2, 0, 2$ are points of inflexion. 5+(2+2+1)