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[This question paper contains 3 printed pages.]

Sr. No. of Question Paper : 8895 (12)
Unique Paper Code : 235101
Name of the Course : B.Sc. (Hons.) Mathematics
Name of the Paper : MAHT 101 Calculus-I
Semester : I

Your Roll No. 2019

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Duration: 3 Hours

Maximum Marks: 75

Instruction for Candidates

- 1) Write your Roll No. on the top immediately on receipt of this question paper.
- 2) All the sections are compulsory.
- 3) All questions carry equal marks.
- 4) Use of non-programmable Scientific Calculators is allowed.

Section I

Attempt any four questions from Section I.



1. If $y = (1 - x^2)^{-\frac{1}{2}} \sin^{-1}x$, when $-1 < x < 1$ and $-\frac{\pi}{2} < \sin^{-1}x < \frac{\pi}{2}$, then show that
$$(1 - x^2)y_{n+1} - (2n + 1)xy_n - n^2y_{n-1} = 0$$
2. Sketch the graph of the function $f(x) = 4 + \frac{2x}{x-3}$ by determining all critical points, interval of increase and decrease, point of relative maxima and minima, concavity of the graph, inflection point and horizontal and vertical asymptotes.
3. Evaluate :
$$\lim_{x \rightarrow +\infty} [x - \log(x^3 - 1)]$$
4. Sketch the graph of $r = 5 - 2\cos\theta$ in polar coordinates.
5. When the market price of a certain product is p , then number of units sold will be

$$x = -6 \log\left(\frac{P}{40}\right)$$

It is also estimated that the cost of producing these x units will be

$$C(x) = 4xe^{\left(-\frac{x}{6}\right)} + 30$$

- (a) Find the average cost, the marginal cost, and the marginal revenue for this production process.
- (b) What level of production x corresponds to maximum profit?

Section II

Attempt any four questions from Section II.



6. Find the reduction formula for $\int \sec^n x \, dx$ where $n \geq 2$ is an integer. Hence, evaluate $\int \sec^5 x \, dx$.
7. Find the volume of solid that results when the region enclosed by $x = y^2$ and $x = y$ is revolved about the line $y = -1$.
8. Use cylindrical shell method to find the volume of the solid generated when the region enclosed by the curves $xy = 1$, $x + y = 5$ is revolved about the x -axis.
9. Find the arc length of the parametric curve $x = a(t + \sin t)$, $y = a(1 - \cos t)$ for $-\pi \leq t \leq \pi$.
10. Find the area of the surface generated by revolving the parametric curve $x = \cos^2 t$, $y = \sin^2 t$, $0 \leq t \leq \pi/2$ about the y -axis.

Section III

Attempt any four questions from Section III.

11. Find the equation of the hyperbola passing through the origin with asymptotes $y = 2x + 1$ and $y = -2x + 3$.



12. Find the equation of the ellipse having foci at $(0, \pm 6)$, length of the minor axis 16
13. Identify and sketch the following curve :
 $153x^2 - 192xy + 97y^2 - 30x - 40y - 200 = 0.$
14. Identify and sketch the following curve :
 $y^2 - 8x - 6y - 23 = 0.$

Section IV

Attempt any four questions from Section IV.

15. If $F(t)$ is a differentiable vector valued function of t of constant length then show that $F(t)$ is orthogonal to its derivative for all t .
16. Evaluate $\int_0^{\pi/4} F(t) dt$, where $F(t) = (\sec^2 t, -2 \cos t, 1)$.
17. Express the acceleration of the particle in the form $a_T T + a_N N$, where T is the unit tangent vector and N is the unit normal vector, given that the particle moves so that its position at any time t is $r(t) = (e^t \cos t, e^t \sin t, \sqrt{2}e^t)$, $t > 0$.
18. Find the curvature and radius of curvature of the twisted cubic for a curve $r(t) = (t, t^2, t^3)$ at a general point and at $(0, 0, 0)$.
19. A projectile is fired from ground level at angle 30° with muzzle speed of 80 ft/s. Find time of flight and the range.

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