

## CUET Mathematics Test

Chapter: Calculus (Higher Order Derivatives, Increasing/Decreasing, Maxima/Minima)

### General Instructions

1. Total Questions: **20**
2. Duration: **60 Minutes**
3. All questions are compulsory.
4. Each question carries **5 marks**.
5. For each correct answer: **+5 marks**.
6. For each incorrect answer: **-1 mark**.
7. No negative marking for unanswered questions.
8. Use of calculator or electronic devices is strictly prohibited.
9. Choose the most appropriate answer from the given options.

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1. Find the second order derivative of the function  $y = x^3 \log x$  with respect to  $x$ .
2. Determine the intervals in which the function  $f(x) = 2x^3 - 15x^2 + 36x + 6$  is strictly increasing.
3. Find the maximum and minimum values of the function  $f(x) = \sin x + \cos x$  in the closed interval  $[0, \pi]$ .
4. If  $y = Ae^{mx} + Be^{nx}$ , prove that  $\frac{d^2y}{dx^2} - (m+n)\frac{dy}{dx} + mny = 0$ .
5. Find the local maximum and local minimum values, if any, for the function  $f(x) = \frac{x}{2} + \frac{2}{x}$  for the domain  $x > 0$ .
6. Find the absolute maximum value and absolute minimum value of the function  $f(x) = 4x - \frac{1}{2}x^2$  on the interval  $[-2, \frac{9}{2}]$ .
7. Determine the value of  $x$  for which the function  $f(x) = x(x-2)^2$  is an increasing function.
8. Show that the function  $f(x) = \tan^{-1}(\sin x + \cos x)$  is strictly increasing in the interval  $(0, \frac{\pi}{4})$ .
9. Find the points of local maxima and local minima for the function  $f(x) = \sin 2x - x$  where  $-\frac{\pi}{2} < x < \frac{\pi}{2}$ .
10. If  $x = a(\theta + \sin \theta)$  and  $y = a(1 - \cos \theta)$ , calculate the value of  $\frac{d^2y}{dx^2}$  at  $\theta = \frac{\pi}{2}$ .
11. An isosceles triangle is inscribed in a circle of radius  $R$ . Show that the area of the triangle is maximum when it is an equilateral triangle.
12. Find the shortest distance from the point  $(0, c)$  to the parabola  $y = x^2$ , where  $0 \leq c \leq 5$ .
13. Show that the function  $f(x) = \log(1+x) - \frac{2x}{2+x}$  is increasing for all  $x > -1$ .
14. Find the second order derivative of  $y = e^x \sin 5x$ .
15. Divide the number 15 into two parts such that the square of one part multiplied by the cube of the other part is maximum.
16. Find the intervals in which the function  $f(x) = \sin x - \cos x$  is strictly decreasing in the range  $0 < x < 2\pi$ .
17. If  $y = (\sin^{-1} x)^2$ , show that the following relation holds:  $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - 2 = 0$ .
18. Find the maximum volume of a cylinder that can be inscribed in a sphere of radius  $R$ .
19. Find the slope of the tangent to the curve  $y = x^3 - x + 1$  at the point where the curve attains its local minimum.
20. Determine the dimensions of a rectangle of area 96 square units whose perimeter is the least possible.

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