doubtnut
India's Number 1 Education App

MATHS

BOOKS - CENGAGE MATHS (HINGLISH)

APPLICATIONS OF DERIVATIVES

Multiple Correct Answer Type

1. Equation of a line which is tangent to both the curve $y=x^2+1 \, and \, y=x^2$ is $y=\sqrt{2}x+\frac{1}{2}$ (b) $y=\sqrt{2}x-\frac{1}{2}$ $y=-\sqrt{2}x+\frac{1}{2}$ (d) $y=-\sqrt{2}x-\frac{1}{2}$

A. $y=\sqrt{2}x-\frac{1}{2}$

B. $y=\sqrt{2}x+\frac{1}{2}$

C. $y=-\sqrt{2}x+\frac{1}{2}$

D. $y=-\sqrt{2}x-\frac{1}{2}$

Answer: B::C::D

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2. For the functions defined parametrically by the equations

$$f(t) = x = \begin{cases} 2t + t^2 \sin. \frac{1}{t} & t \neq 0 \\ 0 & t = 0 \end{cases}$$ and

$$g(t) = y = \begin{cases} \frac{1}{t}\text{sint}^2 & t \neq 0 \\ 0 & t = 0 \end{cases}$$

A. equation of tangent at t = 0 is $x - 2y = 0$

B. equation of normal at t = 0 is $2x + y = 0$

C. tangent does not exist at t = 0

D. normal does not exist at $t = 0$

Answer: A::B

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3. Prove that the segment of the normal to the curve $x = 2a\sin t + a\sin t\cos^2 t; y = -a\cos^3 t$ contained between the co-ordinate axes is equal to $2a$.

A. normal is inclined at an angle $\frac{\pi}{2} + t$ with x-axis.

B. normal is inclined at an angle t with x-axis.

C. portion of normal contained between the co-ordinate axes is equal to 2a.

D. portion of normal containned between the co-ordinate axes is equal to 4a.

Answer: A::C

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4. The curve $y = ax^3 + bx^2 + cx$ is inclined at 45° to x-axis at $(0, 0)$ but it touches x-axis at $(1, 0)$, then

A. f'(1) = 0

B. f''(1) = 2

C. f'''(2) = 12

D. f(2) = 2

Answer: A::B::D

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5. If L_T, L_N, L_{ST} and L_{SN} denote the lengths of tangent, normal sub-tangent and sub-normal, respectively, of a curve y = f(x) at a point P(2009, 2010) on it, then

A. $\frac{L_{ST}}{2010} = \frac{2010}{L_{SN}}$

B. $\left|\frac{L_T}{L_N}\sqrt{\frac{L_{SN}}{L_{ST}}}\right| = \text{constant}$

C. $1 - L_{ST}L_{SN} = \frac{2000}{2010}$

D. $\left(\frac{L_T + L_N}{L_T - L_N}\right)^2 = \frac{L_{ST}}{L_{SN}}$

Answer: A::B

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6. Which of the following pair(s) of family is/are orthogonl?

where c and k are arbitrary constant.

A. $16x^2 + y^2 = c \text{ and } y^{16} = kx$

B. $y = x + ce^{-x} \text{ and } x + 2 = y + ke^{-y}$

C. $y = cx^2 \text{ and } x^2 + 2y^2 = k$

D. $x^2 - y^2 = c \text{ and } xy = k$

Answer: A::B::C::D

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7. Let $f(x)=\begin{vmatrix} 1 & 1 & 1 \\ 3-x & 5-3x^2 & 3x^3-1 \\ 2x^2-1 & 3x^5-1 & 7x^8-1 \end{vmatrix}$ then the equation of $f(x)=0$ has

A. f(x) = 0 has at least two real roots

B. f'(x) =0 has at least one real root.

C. f(x) is many-one function

D. none of these

Answer: A::B::C

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8. Which of the following is correct ?

A. $\frac{\tan^{-1}x-\tan^{-1}y}{x-y}\le 1\forall x, y\in R, (x\ne y)$

B. $\frac{\sin^{-1}x-\sin^{-1}y}{x-y}>1\forall x, y\in[-1, 1], x\ne y$

C. $\frac{\cos^{-1}x-\cos^{-1}y}{x-y}<1\forall x, y\in[-1, 1], x\ne y$

D. $\dfrac{\cot^{-1}x-\cot^{-1}y}{x-y}<1\forall x,y\in R, x\neq y$

Answer: A::B

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Comprehension Type

1. A lamp post of length 10 meter placed at the end A of a ladder AB of length 13 meters, which is leaning against a vertical wall as shown in figure and its base slides away from the wall. At the instant base B is 12 m from the vertical wall, the base B is moving at the rate of 5 m/sec. A man (M) of height 1.5 meter standing at a distance of 15 m from the vertical wall.

Rate at which θ decreases, when the base B is 12 m from the vertical wall, is

A. 1 rad/sec

B. 2 rad/sec

C. 5 rad/sec

D. 1/2 rad/sec

Answer: A

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2. A lamp post of length 10 meter placed at the end A of a ladder AB of length 13 meters, which is leaning against a vertical wall as shown in figure and its base slides away from the wall. At the instant base B is 12 m from the vertical wall, the base B is moving at the rate of 5 m/sec. A man (M) of height 1.5 meter standing at a distance of 15 m from the vertical wall.

The rate at which the length of shadow of man increases, when the base B is 12 m from vertical wall, is

A. 15 m/sec

B. 40/27 m/sec

C. 15/2 m/sec

D. 5 m/sec

Answer: B

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3. Let f(x) be a function such that its derovative f'(x) is continuous in [a, b] and differentiable in (a, b). Consider a function $\phi(x) = f(b) - f(x) - (b-x)f'(x) - (b-x)^2$A. If Rolle's theorem is applicable to $\phi(x)$ on, [a,b], answer following questions.

If there exists some unmber c(a lt c lt b) such that $\phi'(c) = 0$ and $f(b) = f(a) + (b-a)f'(a) + \lambda(b-a)^2 f''(c)$, then λ is

A. 1

B. 0

C. $\frac{1}{2}$

D. $-\frac{1}{2}$

Answer: C

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4. Let f(x) be a function such that its derovative f'(x) is continuous in [a, b] and differentiable in (a, b). Consider a function $\phi(x) = f(b) - f(x) - (b-x)f'(x) - (b-x)^2$A. If Rolle's theorem is applicable to $\phi(x)$ on, [a,b], answer following questions.

Let $f(x) = x^3 - 3x + 3, a = 1$ and $b = 1 + h.$ If there exists $c \in (1, 1+h)$ such that $\phi'(c) = 0$ and $\frac{f(1+h) - f(1)}{h^2} = \lambda c,$ then λ=

A. $1/2$

B. 2

C. 3

D. does not exist

Answer: C

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5. Let f(x) be a function such that its derovative f'(x) is continuous in [a, b] and differentiable in (a, b). Consider a function $\phi(x) = f(b) - f(x) - (b - x)f'(x) - (b - x)^2$A. If Rolle's theorem is applicable to $\phi(x)$ on, [a,b], answer following questions.

Let $f(x) = \sin x, a = \alpha$ and $b = \alpha + h$. If have exists a real number t such that $0 < t < 1, \phi'(\alpha + th) = 0$ and $\dfrac{\sin(\alpha + h) - \sin\alpha - h\cos\alpha}{h^2} = \lambda\sin(\alpha + th)$, then $\lambda =$

A. $\dfrac{1}{2}$

B. $-\dfrac{1}{2}$

C. $\dfrac{1}{4}$

D. $\dfrac{1}{3}$

Answer: B

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Subjective Type

1. Prove that for $\lambda > 1$, the equation $x \log x + x = \lambda$ has least one solution in $[1, \lambda]$.

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2. If $f(x)$ and $g(x)$ are continuous and differentiable functions, then prove that there exists $c \in [a, b]$ such that $\frac{f'(c)}{f(a) - f(c)} + \frac{g'(c)}{g(b) - g(c)} = 1$.

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Single Correct Answer Type

1. The equation of the normal to the curve parametrically represented by $x = t^2 + 3t - 8 \text{ and } y = 2t^2 - 2t - 5$ at the point $P(2, -1)$ is

A. $2x + 3y - 1 = 0$

B. $6x - 7y - 11 = 0$

C. $7x + 6y - 8 = 0$

D. $3x + y - 1 = 0$

Answer: C

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2. In the curve $y = x^3 + ax \text{ and } y = bx^2 + c$ pass through the point $(-1, 0)$ and have a common tangent line at this point then the value of $a + b + c$ is

A. 0

B. 1

C. -3

D. -1

Answer: D

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3. If the function $f(x) = x^4 + bx^2 + 8x + 1$ has a horizontal tangent and a point of inflection for the same value of x then the value of b is equal to -1 (b) 1 (c) 6 (d) -6

A. -2

B. -6

C. 6

D. 3

Answer: B

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4. Let $f(x) = x^3 + x + 1$ and let g(x) be its inverse function then equation of the tangent to $y = g(x)$ at x = 3 is

A. $x - 4y + 1 = 0$

B. $x + 4y - 1 = 0$

C. $4x - y + 1 = 0$

D. $4x + y - 1 = 0$

Answer: A

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5. A curve is represented parametrically by the equations $x = t + e^{at}$ and $y = -t + e^{at}$ when $t \in R$ and $a > 0$. If the curve touches the axis of x at the point A, then the coordinates of the point A are

A. $(1, 0)$

B. $(2e, 0)$

C. $(e, 0)$

D. $(1/e, 0)$

Answer: B

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6. The equation of the straight lines which are both tangent and normal to the curve $27x^2 = 4y^3$ are

A. $x = \pm\sqrt{2}(y-2)$

B. $x = \pm\sqrt{3}(y-2)$

C. $x = \pm\sqrt{2}(y-3)$

D. $x = \pm\sqrt{3}(y-3)$

Answer: A

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7. If the tangent at $(1, 1)$ on $y^2 = x(2 - x)^2$ meets the curve again at P, then find coordinates of P

A. (4, 4)

B. (2, 0)

C. $\left(\frac{9}{4}, \frac{3}{8}\right)$

D. $\left(3, 3^{1/2}\right)$

Answer: C

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8. A curve with equation of the form $y = ax^4 + bx^3 + cx + d$ has zero gradient at the point $(0, 1)$ and also touches the $x-$ axis at the point $(-1, 0)$ then the value of x for which the curve has a negative gradient are:

A. $x > -1$

B. $x > 1$

C. $x < -1$

D. $-1 \leq x \leq 1$

Answer: C

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9. Find Distance between the points for which lines that pass through the point $(1, 1)$ and are tangent to the curve represent parametrically as $x = 2t - t^2$ and $y = t + t^2$

A. $\frac{2\sqrt{43}}{9}$

B. 2

C. 3

D. $\frac{2\sqrt{53}}{9}$

Answer: D

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10. The value of parameter t so that the line $(4-t)x+ty+\left(a^3-1\right)=0$ is normal to the curve xy = 1 may lie in the interval

A. $(1, 4)$

B. $(-\infty, 0) \cup (4, \infty)$

C. $(-4, 4)$

D. $[3, 4]$

Answer: B

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11. The tangent at any point on the curve $x = at^3 . y = at^4$ divides the abscissa of the point of contact in the ratio m:n, then $|n + m|$ is equal to (m and n are co-prime)

A. $1/4$

B. $3/4$

C. $3/2$

D. $2/5$

Answer: B

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12. The length of the sub-tangent to the hyperbola $x^2 - 4y^2 = 4$ corresponding to the normal having slope unity is $\frac{1}{\sqrt{k}}$, then the value of k is

A. 1

B. 2

C. 3

D. 4

Answer: C

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13. Cosine of the acute angle between the curve $y = 3^{x-1}\log_e x$ and $y = x^x - 1$, at the point of intersection $(1, 0)$ is

A. 0

B. 1

C. $\frac{\sqrt{3}}{2}$

D. $\frac{1}{2}$

Answer: B

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14. Acute angle between two curve $x^2 + y^2 = a^2\sqrt{2}$ and $x^2 - y^2 = a^2$ is

A. $\frac{\pi}{6}$

B. $\frac{\pi}{3}$

C. $\frac{\pi}{4}$

D. none of these

Answer: C

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15. The minimum distance between a point on the curve $y = e^x$ and a point on the curve $y = \log_e x$ is

A. $\frac{1}{\sqrt{2}}$

B. $\sqrt{2}$

C. 3

D. $2\sqrt{2}$

Answer: B

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16. Tangents are drawn from origin to the curve $y = \sin + \cos x$Â·Then their points of contact lie on the curve

A. $\frac{1}{x^2} + \frac{2}{y^2} = 1$

B. $\frac{2}{x^2} - \frac{1}{y^2} = 1$

C. $\frac{2}{x^2} + \frac{1}{y^2} = 1$

D. $\frac{2}{y^2} - \frac{1}{x^2} = 1$

Answer: D

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17. If $3x+2y=1$ is a tangent to $y=f(x)$ at $x=1/2$, then $\lim_{x\to 0}\frac{x(x-1)}{f\left(\frac{e^{2x}}{2}\right)-f\left(\frac{e^{-2x}}{2}\right)}$

A. $1/3$

B. $1/2$

C. $1/6$

D. $1/7$

Answer: A

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18. Distance of point P on the curve $y=x^{3/2}$ which is nearest to the point M (4, 0) from origin is

A. $\sqrt{\frac{112}{27}}$

B. $\sqrt{\frac{100}{27}}$

C. $\sqrt{\frac{101}{9}}$

D. $\sqrt{\frac{112}{9}}$

Answer: A

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19. If the equation of the normal to the curve $y = f(x) at x = 0$ is $3x - y + 3 = 0$ then the value of

$$\lim_{x \to 0} \frac{x^2}{\{f(x^2) - 5f(4x^2) + 4f(7x^2)\}}$$ is

A. -3

B. $1/3$

C. 3

D. $-1/3$

Answer: D

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20. The rate of change of $\sqrt{x^2+16}$ with respect to $\frac{x}{x-1}$ at $x=3$ is

A. 1

B. $\frac{11}{5}$

C. $-\frac{12}{5}$

D. -3

Answer: C

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21. The eccentricity of the ellipse $3x^2+4y^2=12$ is decreasing at the rate of 0.1 per sec.The time at which it will coincide with auxiliary circle is:

A. 2 seconds

B. 3 seconds

C. 5 seconds

D. 6 seconds

Answer: C

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22. A particle moves along the parabola $y = x^2$ in the first quadrant in such a way that its x-coordinate (measured in metres) increases at a rate of 10 m/sec. If the angle of inclination θ of the line joining the particle to the origin change, when $x = 3$ m, at the rate of k rad/sec., then the value of k is

A. 1

B. 2

C. $1/2$

D. $1/3$

Answer: A

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23. The rate of change of volume of a sphere is equal to the rate of change of its radius, then its radius is equal to (a) 1 unit (b) units (c) unit (d) unit

A. 1

B. 2

C. 0.5

D. none of these

Answer: B

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24. Water is dropped at the rate of $2m^2 / s$ into a cone of semivertical angel of 45°. The rate at which periphery of water surface changes when height of water in the cone is 2 m, is

A. $0.5m/s$

B. $2m/s$

C. $3m/s$

D. $1m/s$

Answer: D

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25. Suppose that water is emptied from a spherical tank of radius 10 cm. If the depth of the water in the tank is 4 cm and is decreasing at the rate of 2 cm/sec, then the radius of the top surface of water is decreasing at the rate of

A. 1

B. $2/3$

C. $3/2$

D. 2

Answer: C

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26. The altitude of a cone is 20 cm and its semi-vertical angle is 30°. If the semi-vertical angle is increasing at the rate of 2° per second, then the radius of the base is increasing at the rate of

A. 30 cm/sec

B. $\frac{160}{3} cm / \sec$

C. 10 cm/sec

D. 160 cm/sec

Answer: B

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27. Let the equation of a curve be $x = a(\theta + \sin\theta), y = a(1 - \cos\theta)$. If θ changes at a constant rate k then the rate of change of the slope of the tangent to the curve at $\theta = \frac{\pi}{3}$ is (a) $\frac{2k}{\sqrt{3}}$ (b) $\frac{k}{\sqrt{3}}$ (c) k (d) none of these

A. $2k / \sqrt{3}$

B. $k / \sqrt{3}$

C. k

D. none of these

Answer: D

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28. Consider $f(x) = |1 - x|, 1 \le x \le 2$ and $g(x) = f(x) + b\sin.\frac{\pi}{2}x, 1 \le x \le 2$ then which of the following is correct?

A. Rolle's theorem is applicable to both f and g with $b = \frac{3}{2}$.

B. LMVT is not applicable to f and Rolle's theorem is applicable to g with $b = \frac{1}{2}$

C. LMVT is applicable to f and Rolle's theorem is applicable to g with b = 1.

D. Rolle's theorem is not applicable to both f and g for any real b.

Answer: C

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29. If $c = \frac{1}{2}$ and $f(x) = 2x - x^2$, then interval of x in which LMVT is applicable, is

A. $(1, 2)$

B. $(-1, 1)$

C. $(0, 1)$

D. $(2, 1)$

Answer: C

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30. If a twice differentiable function f(x) on (a, b) and continuous on [a, b] is such that $f''(x) < 0$ for all $x \in (a, b)$ then for any $c \in (a, b)$, $\frac{f(c) - f(a)}{f(b) - f(c)} >$

A. $\frac{b-c}{c-a}$

B. $\frac{c-a}{b-c}$

C. $(b-c)(c-a)$

D. $\frac{1}{(b-c)(c-a)}$

Answer: B

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31. Let $a, n \in N$ such that $a \geq n^3$. Then $\sqrt[3]{a+1} - \sqrt[3]{a}$ is always

A. less than $\frac{1}{3n^2}$

B. less than $\frac{1}{2n^3}$

C. more than $\frac{1}{n^3}$

D. more than $\frac{1}{4n^2}$

Answer: A

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32. Given $f'(1) = 1$ and $\frac{d}{dx}f(2x)\Big) = f'(x) \forall x > 0.$ If $f'(x)$ is differentiable then there exists a numberd $x \in (2, 4)$ such that $f''(c)$ equals

A. $1/4$

B. $-1/2$

C. $-1/4$

D. $-1/8$

Answer: D

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Question Bank

1. If the slope of the tangent to the curve $2\left(x-y^3\right)^4=x^2\left(1+x^3\right)^5$ at the point (1, -1) is t, then find the value of [|t|].

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2. Let $P(x_0, y_0)$ be a point on the curve $C:\left(x^2-11\right)(y+1)+4=0 where x_0, y_0 \in N$. If area of the triangle formed by the normal drawn to the curve 'C' at P and the coordinate axes is (a/b), $ab \in N$ then find the least value of (a-6b)

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3. If the function $k(x) = \log_e\left(\frac{x^2 - x + 1}{x^2 + x + 1}\right)$ is strictly decreasing in `x in (-t/7, t/7), then find the greatest integral value of t.

View Text Solution

4. The line y = x is a tangent to the curve $y = px^2 + qx + r$ at the point x =1. If the curve passes through the point (-1, 0) then the value of (p+r)/q is

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5. Let $f(x) = \begin{cases} x + 1 & x < 1 \\ \lambda & x = 1 \\ x^2 - x + 3 & x > 1 \end{cases}$ be a strictly increasing function at x =1, then the number of integers in the range of λ, is

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6. If the tangent at a point P on the curve `x^(7).y^(2) = sqrt7+2^(1/7) meets the co-ordinates axes A and B respectively then 2((BP)/(AP)) is

View Text Solution

7. If $f(x) = 2x^3 + 9x^2 + px + 20$ is an increasing function of x in the largest interval (-1,4) then p is equal to

View Text Solution

8. Let $f : [1, 3[\rightarrow [0, \infty)$ be continuous and differentiable function and if $(f(3) - f(1)).\left(f^2(3) + f^2(1) + f(3)f(1) = kf^2(c)f'(c) where c \in (1, 3)\right.$, then find the value of k.

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9. If Rolle's theorem is applicable on the function $g(x) = \begin{cases} \frac{e^{px} - qx - 1}{x} & 0 < x \leq 1 \\ 2 & x = 0 \end{cases}$ in interval $x \in [0, 1], then f \in d the value of f$(p^(2)+q^(2))`.

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10. Given the function $f(x) = 2x^2 - 4x - 5$. If x_1 and x_(2) (x_(1) gt x_(2)) $are the |c| issa eo f p \int son \$ f(x) \$ such t \hat{t} he \tan \geq nts drawn at the m pass throu$

(3x_(1)-2x_(2))` equals

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11. Let y=f(x) be an invertible function such that x -intercept of the tangent at any point P(x, y) on y=f(x) is equal to the square of abscissa of the point of tangency. If f(2)=1, then $f^{-1}\left(\frac{5}{8}\right)$ equals

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12. Let f(x) be the curve passing through (-2,1) such that slope of the normal line at the point (x, y) on the curve is equal to x^2y. The area bounded by the curve $y = xf^2(x)$ and coordinates axes, is

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13. If y=4 x-5 is a tangent to the curve $C: y^2 = px^3 + q$ at M (2,3) then the value of (p-q) is

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14. k is the least positive integer for which the function $f(x) = (2x+1)^{50}(3x-4)^{60}$ is increasing in [k, oo)`. The value of 'k' is

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15. Number of integral values of a for which the function $f(x) = \left(\frac{4a-7}{3}\right)x^3 + (a-3)x^2 + x + 5$ is monotonic for every $x \in R$, is

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16. Let f(x) be a cubic polynomial which has local maximum at x=-1 and $f'(x)$ has a local minimum at x=1. If f(-1) = 10 and f(3) =-22, then find the distance between its two horizontal tangents.

View Text Solution

17. Let $f'(x) = e^{x^2}$ and f(0)=10. If A

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18. Minimum distance between the curves $f(x) = e^x$ and g(x0 = Inx is

View Text Solution

19. f(x) is a polynomial of degree 6 which decreases in the interval $(0, \infty)$ and increases in the interval $(-\infty, 0)$. If $f'(2)=0, f'(0)=0, f(0)=0, f(0)=1$ and f(1)-f(-1) = 8/5`, then -3(f(1)+f(-1)) equals

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20. The least positive integral value of λ for which $f(x)=\frac{3x^3}{2}+\frac{\lambda x^2}{3}+x+7$ has a point of maxima is

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21. Minimum positive integral value of : k for which $f(x)=k\cos 2x-4\cos^3 x$ has exactly one critical point in (0, pi), is

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22. Let the radius and height of right circular cylinder is related as $r^2 + h = 5$. Let λ is maximum volume. Then $\frac{16\lambda}{25\pi}$, is

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23. A solid box is formed by placing a cylinder, having equal height and radius on top of a cube such that, the circular base of cylinder is the inscribed circle for square top of the cube. If the radius of cytinder is changing at the rate $\frac{1}{2\pi + 16} c\frac{m}{s}$, then the rate of change of volume of the box when radius is 2 cm, is (Assuming that box always remain in the given shape)

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24. On the curve $x^{m+n}. y^n = a, mn \in N, a \in R^+$, if the ratio of slopes of tangent at any point P and that of line segment OP(O being origin) is -4 , then the value of m/n is

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25. If $a \in (a_1, a_2)$ is the complete set satisfying the condition that the. point of local minima and the point of local maxima is less than 4 and greater than -2, respectively for the function $f(x) = x^3 - 3ax^2 + 3(a^2 - 1)x + 1$, then $(a_2 - a_1)$ is

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26. x and y are sides of two squares sach that $y = x - x^2$. Let f(x) denote the rate of change of area of the second square with respect to the area of the first'square, then f(2) is

View Text Solution

27. If the tangent at a point P on the curve `x^(7).y^(2) = sqrt7+2^(1/7) meets the co-ordinates axes A and B respectively then 2((BP)/(AP)) is

View Text Solution

28. Number of solutions of the equation $(x-k)e^{-x}=\frac{1}{e^2}$, where $k<1$ is

View Text Solution

29. The total number of local maxima and local minima of the function $f(x)=\left(\frac{2-x}{\pi}\right)\cos(\pi x+3\pi)+\frac{1}{\pi}\sin(\pi x+3\pi)$, where $0<x<x$ is equal is

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