

EN09 101 Engineering Mathematics I

Question Bank – Module I- Differential Calculus

Topic	Question	Mark	Month & Year	Regulation
L Hospital's Rule	Evaluate $\lim_{x \rightarrow 0} \frac{(1+x)^n - 1}{x}$	5	Jan 2004	2K
	Evaluate $\lim_{n \rightarrow \infty} \left(1 + \frac{3}{n^2} + \frac{1}{n^3}\right)^{n^2}$	5		04
	Find the value of $\lim_{x \rightarrow \frac{\pi}{2}} (\sin x)^{\tan x}$	5	Jan 2006 2007	04
	Evaluate $\lim_{x \rightarrow 0} \left[\frac{1}{\sin x} - \frac{1}{x} \right]$	5	Mar 2002	04
	Evaluate $\lim_{x \rightarrow 0} \frac{\log \sec x - \frac{1}{2}x^2}{x^4}$	5	Mar 2009	04
	Find the values of the constraints a and b in order that $\lim_{x \rightarrow 0} \frac{x(1+a \cos x) - b \sin x}{x^3} = 1$	5	Mar 2009	04
Radius of Curvature	If "ρ" is the radius of curvature at any point (x, y) on the curve $y = \frac{ax}{a+x}$, show that $\left(\frac{2\rho}{a}\right)^{\frac{2}{3}} = \left(\frac{x}{y}\right)^2 + \left(\frac{y}{x}\right)^2$	5	April 2012	09
	Define radius of curvature in Cartesian co-ordinates	2	Mar 2010 May 2011	09
	Give the formula for curvature of any given curve in Cartesian form	2	May 2010	09
	Find the radius of curvature at the point $\left(\frac{3a}{2}, \frac{3a}{2}\right)$ on the curve $x^3 + y^3 = 3axy$	5	May 2011 Jan 2006	09
	For the curve $\frac{\sqrt{x}}{\sqrt{a}} + \frac{\sqrt{y}}{\sqrt{b}} = 1$, show that the radius of curvature is $\frac{2(ax+by)^{\frac{3}{2}}}{ab}$	8	Dec 2008	04
	Find the radius of curvature at the point (-4, 0) on the curve $xy^2 = 16(x+4)$	8	Dec 2007	04
	Find the radius of curvature at the point $(a \cos^3 \theta, a \sin^3 \theta)$ of the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$	10	April 2013	09
	Find the radius of curvature at the point (x, y) of the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$	8		04
	Find the radius of curvature of $x = 3a \cos \theta - a \cos 3\theta; y = 3a \sin \theta - a \sin 3\theta$ at the point θ.	8	Jan 2005	04

	Find ρ for $x = a \cos \phi, y = a \sin \phi$. Deuce that the magnitude of ρ at an end point of the major axis is the semi latus rectum	8		04
	Find the radius of curvature of the curve $x^4 + y^4 = 2$ at (1,1)	8	Jan 2004	04
	Find the radius of curvature of $\frac{x^2}{9} + \frac{y^2}{16} = 2$ at (3,4)	8	Jan 2004	04
Centre of curvature	Find the centre of curvature of the curve $x = 3t, y = t^2 - 6$	8	Dec 2007	04
	Find the centre of curvature of the cycloid $x = a(\theta - \sin \theta), y = a(1 - \cos \theta)$	15	Dec 2006	04
	If the centre of curvature of $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ at one end of the minor axis lies at the other end, prove that eccentricity of the ellipse is $\frac{1}{\sqrt{2}}$	15	Jan 2005	04
	Find the centre of curvature of the parabola $y^2 = 12x$ at the point (3, 6).	5	May 2010	09
Circle of Curvature	Give the formula for circle of curvature in Cartesian form.	2	Aug 2012	09
	Find the equation of circle of curvature of the curve $\sqrt{x} + \sqrt{y} = \sqrt{a}$ at $\left(\frac{a}{4}, \frac{a}{4}\right)$	5	May 2010 Dec 2008	09
Evolutes	Prove that the evolute of the parabola $x^2 = 4ay$ is $4(y - 2a)^3 = 27ax^2$	15	Dec 2008	04
	Find the evolute of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$	15	Jan 2007 Nov 2005	04
	Find the evolute of the cycloid $x = a(\theta - \sin \theta); y = a(1 - \cos \theta)$	8	Jan 2004	04
	Find the evolute of the curve given by $x = a \cos^3 \theta, y = a \sin^3 \theta$	8	Dec 2007 Jan 2006	04

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Find the evolute of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$	15	Dec 2006	04
Find the evolute of $x = a(\cos t + t \sin t); y = a(\sin t - t \cos t)$	8	Jan 2005	04
Show that the evolute of the curve $c = a(\cos \theta + \theta \sin \theta), y = a(\sin \theta - \theta \cos \theta)$ is a circle	7	Jan 2006	04
Find the equivalent of $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}$ in polar co-ordinates	10	May 2010	09
Given the transformation $u = e^x \cos y$ and $v = e^x \sin y$ and that f is a function of u and v and also of x and y , prove that $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = (u^2 + v^2) \frac{\partial^2 f}{\partial u^2} + \frac{\partial^2 f}{\partial v^2}$	10	April 2013	09
If $x = r \cos \theta, y = r \sin \theta, z = z$, find $\frac{\partial(x, y, z)}{\partial(r, \theta, z)}$	8	Dec 2009	04
If $u = \sin^{-1}\left(\frac{x^2 + y^2}{x + y}\right)$, prove that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = \tan u$	7	Dec 2008	04
If $u = \log(\tan x + \tan y + \tan z)$, then prove that $\sum \sin 2x \frac{\partial u}{\partial x} = 2$	7	Jan 2007	04
Show that at a point of the surface $x^x y^y z^z = c$ where $x = y = z, \frac{\partial^2 z}{\partial x \partial y} = -(x \log ex)^{-1}$	7	Dec 2007	04
Find $\frac{dx}{\sqrt{1-x^2}} + \frac{dy}{\sqrt{1-y^2}} + \frac{dz}{\sqrt{1-z^2}}$ if $x^2 + y^2 + z^2 - 2xyz = 1$	10	April 2012	09
Express $\iiint \sqrt{xyz(1-x-y-z)} dx dy dz$ in terms of u, v, w given that $x + y + z = u, y + z = uv, z = uvw$	10	April 2012	09
If $z = e^{x(\cos y - y \sin y)}$ show that $\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial y^2} = 0$	8	Jan 2006	04

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	If $x = r \cos \theta, y = r \sin \theta$, verify that $\frac{\partial(x, y)}{\partial(r, \theta)} \times \frac{\partial(r, \theta)}{\partial(x, y)} = 1$	10	May 2010	09
	If $u = \log(\tan x + \tan y + \tan z)$, then prove that $\sum \sin 2x \frac{\partial u}{\partial x} = 2$	8	Jan 2005	04
Euler's Formula	Verify Euler's formula for $f(x, y) = \frac{1}{\sqrt{x^2 + y^2}}$	7	Jan 2007 Nov 2005	04
	State Eulers theorem on homogenous functions. Verify the theorem for $z = \sin^{-1}\left(\frac{x}{y}\right) + \tan^{-1}\left(\frac{y}{x}\right)$	7	Dec 2007	04
	Verify Eulers theorem for $x^3 - 2x^2y + 3xy^2 + y^3$	8	Jan 2006	04
	Verify Eulers theorem for $(x^2 + y^2 + z^2)^{-\frac{1}{3}}$	8	Dec 2006	04
Chain Rule- Change of Variables	If $V = f\left(\frac{x}{z}, \frac{y}{z}\right)$, prove that $x \frac{\partial V}{\partial x} + y \frac{\partial V}{\partial y} + z \frac{\partial V}{\partial z} = 0$	8	Jan 2004	04
Maxima & Minima	Show that the function $f(x, y) = x^3 + y^3 - 63(x + y) + 12xy$ has a maximum at $(-7, -7)$ and minimum at $(3, 3)$	7	Dec 2008	04
	Find maxima and minima of $x^2 + y^2 + 6y + 12$	8	Dec 2009	04
	Give the extreme values of the function $f(x, y) = x^3y^2(12 - x - y)$	5	Aug 2012	09
	Find the minimum value of $x^2 + y^2 + z^2$ where $ax + by + cz = p$	8	Dce 2008	04
	Find the maximum and minimum of $x^m y^n z^p$ such that $ax + by + cz = p + q + r$	8	Dec 2008	04
	Find the maximum of $x^m y^n z^p$ when $x + y + z = a$	8	Jan 2007 Nov 2005	04
	If $xyz = 8$, find the value x, y, z for which $u = \frac{5xyz}{x + 2y + 4z}$ is maximum.	8	Dec 2007	04

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	Investigate the maximum and minimum values of $x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$	7	Dec 2006	04
	Find the maximum and minimum values of $u = x^3y^2(1 - x - y)$	7	Jan 2004	04
	Find maxima and minima of $x^3 + y^3 - 3axy$	7	Jan 2004	04
	Find the minimum value of $x^2 + y^2 + z^2$ if $x + y + z = 10$	7	Jan 2004	04
	Find the minimum value of $x^2 + y^2 + z^2$ when $x + y + z = 3a$	10	April 2013	09
	A rectangular box open at the top is to have a volume 32 cc. Find the dimensions of the box requiring the least material for its construction	8	Dec 2009	04
Errors & Approximations	The area of the triangle ABC is calculated from the lengths of the sides a, b, c . If a is diminished and b is increased by the same small amount k , prove that the change in the area is given by $\frac{\delta(\text{area})}{\text{area}} = \frac{2(a-b)k}{c^2 - (a-b)^2}$	8	Jan 2005	04
	The area of a triangle is calculated from the angles A and C and side b . If δA is the error in measuring A , show that the relative error in the area is approximately $\frac{\sin C \delta A}{\sin A \sin(A + C)}$	8	Dec 2006	04
	Find the Jacobian of y_1, y_2, y_3 with respect to x_1, x_2, x_3 if $y_1 = \frac{x_2 x_3}{x_1}$, $y_2 = \frac{x_3 x_1}{x_2}$, $y_3 = \frac{x_1 x_2}{x_3}$	10	April 2013	09