Department of Engineering Mathematics
QUESTION BANK

Course	CALCULUS & LINEAR ALGEBRA	**Course Code**	1BMATS01
Semester	I	**Scheme**	2025
Modules	Module 1: CALCULUS & Module 2: VECTOR CALCULUS	**Credits**	4

Q. No.	Question	BL	CO
	PART A – MODULE 1: CALCULUS		
1	Show that $u_x + u_y = u$, if $u = e^{x+y} / (e^x + e^y)$.	L2	CO1
2	If $u = \log(\tan x + \tan y + \tan z)$, then show that $\sin 2x\, \partial u/\partial x + \sin 2y\, \partial u/\partial y + \sin 2z\, \partial u/\partial z = 2$.	L2	CO1
3	If $V = f(r, s, t)$ and $r = x/y$, $s = y/z$, $t = z/x$, show that $x\, \partial V/\partial x + y\, \partial V/\partial y + z\, \partial V/\partial z = 0$.	L2	CO1
4	If $u = f(x - y, y - z, z - x)$, prove that $\partial u/\partial x + \partial u/\partial y + \partial u/\partial z = 0$.	L2	CO1
5	Find the total derivative of $u = x^3y^2 + x^2y^3$, where $x = at^2$ and $y = 2at$.	L2	CO1
6	If $u = x + 3y^2 - z^3$, $v = 4x^2yz$, $w = 2z^2 - xy$, find $\partial(u,v,w)/\partial(x,y,z)$ at $(1, -1, 0)$.	L2	CO1
7	If $u = 2yz/x$, $v = 3zx/y$, $w = 4xy/z$, then find $\partial(u,v,w)/\partial(x,y,z)$.	L2	CO1
8	If $u = x + y + z$, $v = x^2 + y^2 + z^2$, $w = xy + yz + zx$, evaluate the Jacobian of (u, v, w) with respect to (x, y, z).	L2	CO1
9	If $x = r \sin\theta \cos\varphi$, $y = r \sin\theta \sin\varphi$, $z = r \cos\theta$, find the Jacobian $\partial(x,y,z)/\partial(r,\theta,\varphi)$.	L2	CO1
10	Apply Maclaurin's series to expand $\cos x \cos y$ in powers of x and y up to second-degree terms.	L3	CO1
11	Expand $e^x \sin y$ in powers of x and y up to the third-degree terms using Maclaurin's series.	L3	CO1
12	Find the extreme values of the function $f(x, y) = xy + a^3/x + a^3/y$.	L3	CO1
13	Examine the function $f(x, y) = x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$ for its extreme values.	L3	CO1
14	Find the extreme values of the function $f(x, y) = x^3 + y^3 - 3axy$.	L3	CO1

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	PART B – MODULE 2: VECTOR CALCULUS		
15	If $f = x^2yz$ and $g = xy - 3z^2$, calculate $\nabla(\nabla f \cdot \nabla g)$.	L2	CO1

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16	Find the directional derivative of $f(x, y, z) = 4e^{2x-y+z}$ at the point $(1, 1, -1)$ in the direction towards the point $(-3, 5, 6)$.	L2	CO1
17	Find the directional derivative of $\varphi = x^2yz + 4xz^2$ at the point $(1, -2, -1)$ in the direction $2\hat{i} - \hat{j} - 2\hat{k}$.	L2	CO1
18	Find the angle between the surfaces $x^2 + y^2 + z^2 = 9$ and $z = x^2 + y^2 - 3$ at the point $(2, -1, 2)$.	L2	CO1
19	Find the values of a and b such that the surfaces $ax^2 - byz = (a + 2)x$ and $4x^2y + z^3 = 4$ intersect orthogonally at the point $(1, -1, 2)$.	L2	CO1
20	Find div F and curl F, where $F = \text{grad}(x^3 + y^3 + z^3 - 3xyz)$.	L2	CO1
21	Given $F = \nabla(xy^3z^2)$, find div F and curl F at $(1, -1, 1)$.	L2	CO1
22	If $F = x^2y\hat{i} + y^2z\hat{j} + z^2x\hat{k}$, find curl curl F.	L2	CO1
23	Show that $F = (x\hat{i} + y\hat{j}) / (x^2 + y^2)$ is both solenoidal and irrotational.	L2	CO1
24	A vector field is given by $F = (6xy + z^3)\hat{i} + (3x^2 - z)\hat{j} + (3xz^2 - y)\hat{k}$. Show that the field is irrotational and hence find its scalar potential.	L2	CO1
25	Show that $F = (y + z)\hat{i} + (z + x)\hat{j} + (x + y)\hat{k}$ is irrotational and find its scalar potential.	L2	CO1
26	Find the constants a, b, c such that $F = (x + y + az)\hat{i} + (bx + 2y - z)\hat{j} + (x + cy + 2z)\hat{k}$ is irrotational. Also find the scalar potential φ such that $F = \nabla\varphi$.	L2	CO1
27	With usual notation, prove that the cylindrical polar coordinate system is orthogonal.	L3	CO1
28	Express the vector $F = 2x\hat{i} + 3y\hat{j} - z\hat{k}$ in cylindrical polar coordinates.	L3	CO1
29	Express the vector $F = x\hat{i} + 2y\hat{j} + yz\hat{k}$ in spherical polar coordinates.	L3	CO1
30	Express $2y\hat{i} - z\hat{j} + 3x\hat{k}$ in terms of spherical polar coordinates.	L3	CO1