TEACHING PLAN: Vector Calculus and Geometry

SCHOOL: (SOBAS) SCHOOL OF BASIC AND APPLIED SCIENCE		**ACADEMIC SESSION: 2023 - 2024**		**FOR STUDENTS' BATCH: B.Sc 2nd Sem.**	
1	**Course No.**	MA-106			
2	**Course Title**	**Vector Calculus and Geometry**			
3	**Credits**	**2**			
4	**Learning Hours**	Per week two lectures Total hours; 28			
5	**Course Objective**	1. Master vector operations including scalar and vector products, and understand reciprocal vectors. 2. Analyze vector calculus concepts such as vector differentiation, directional derivatives, and gradient of scalar functions. 3. Apply vector calculus principles to understand divergence, curl, and Laplacian operator, along with related vector identities. 4. Explore vector integration techniques including line, surface, and volume integrals, and apply theorems of Gauss, Green & Stokes.			
6	**Course Outcomes**	1. Proficiency in performing scalar and vector products, and understanding reciprocal vectors. 2. Ability to differentiate scalar and vector-valued point functions along curves, and interpret gradients geometrically. 3. Competence in analyzing divergence, curl, and Laplacian operator, and applying related vector identities. 4. Mastery in performing line, surface, and volume integrals, and applying Gauss, Green & Stokes theorems to solve problems.			
7	**Outline syllabus:**				
7.01	**Paper Code**	**Unit**	**Introduction**	**Page Numbers[1]**	**Lectures**
7.02	**Unit I**	(a)	Scalar and vector product of three vectors, product of four vectors.	1.1 to 1.11	1,2
		(b)	Reciprocal vectors. Vector differentiation.	2.1 to 2.15	3,4
		(c)	Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives.	3.1 to 3.16	5,6,7
7.03	**Unit II**	(a)	Gradient of a scalar point function, geometrical interpretation of grad , character of gradient as a point function.	**3.17 to 3.30**	**8,9,10**
		(b)	Divergence and curl of vector point function, characters of Div and Curl as point function, examples.	**3.31 to 3.35**	**11,12**
		(c)	Gradient, divergence and curl of sums and product and their related vector identities.	**4.1 to 4.50**	**13,14**
7.04	**Unit III**	(a)	Vector integration; Line integral, Surface integral, Volume integral.	**5.1 to 5.13**	**15,16**
		(b)	Theorems of Gauss, Green & Stokes and problems based on these theorems.	**6.1 to 6.25**	**17,18, 19**

		(c	Vector integration; Line integral, Surface integral, Volume integral. Theorems of Gauss, Green & Stokes	**6.26 to 6.30**	**20,21**
7.05	**MA 303 Unit IV**	(a)	General equation of second degree, Tracing of conics Parabola, Ellipse and Hyperbola.	**7.1 to 7.17**	**22,23**
		(b)	Polar Equation of conic.	**7.18 to 7.30**	**24,25, 26**
		(c)	General equation of second degree, Tracing of conics Parabola, Ellipse and Hyperbola. Polar Equation of	**8.1 to 8.13**	**27,28**

8	**Course Evaluation**	
8.1	**Attendance**	5%
8.2	**Homework**	4 Assignments, 5%
8.3	**Quizzes**	2Quizzes, 5%
8.4	**Projects**	1 Project, 5%
8.5	**Presentation**	1 Presentation, 5%
8.2	**MTE**	20%
8.3	**End-term examination: 60%**	
9	**Text Books & References**	
9.1	**Text book**	1. Vector Calculus and Geometry, Jeevansons publication 2. Vector Calculus and Geometry , Wiley Eastern Ltd., New Delhi
9.2	**References**	
9.3	**Video References**	

a) Define the Scalar triple product?

b) Find the value of parallelepiped whose edge are represent by $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$, $\vec{c} = \hat{i} + 2\hat{j} - \hat{k}$

c) Find the value of β so that the following vector are coplanar $\vec{a} = 2\hat{i} - 4\hat{j} + 5\hat{k}$, $\vec{b} = \hat{i} - \beta\hat{j} + \hat{k}$, $\vec{c} = 3\hat{i} + 2\hat{j} - 5\hat{k}$

d) If $\emptyset(x,y,z) = x^2y + y^2 + z^2$; Find the $grad\ \emptyset$ at the point (1,2,3)

e) If $\vec{r} = 5t^2\hat{i} + \sin t\,\hat{j} + t\hat{k}$, **find** $\frac{d\vec{r}}{dt}$

f) Find the unit vector to any point on the curve x = acost ,y = a sint,z= bt

[Q.2]

To prove that $(\vec{a} \times \overrightarrow{b}) \times \vec{c} = (\vec{a}.\vec{c})\,\vec{b} - (\vec{b}.\vec{c})\,\vec{a}$

[Q.3]

Show that the Following vector are coplanar

$\vec{a} = \hat{i} + 2\hat{j} + \hat{k}$, $\vec{b} = 3\hat{i} + 2\hat{j} - 7\hat{k}$ $\vec{c} = 5\hat{i} + 6\hat{j} - 5\hat{k}$

[Q.4]

Find the directional derivative of the $\emptyset$ **(x,y,z)** $= x^2yz + 4xz^2$ at the point **(1,-2,1)** in the direction $2\hat{i} - \hat{j} - 2\hat{k}$

[Q.5]

I. **If f** $= x^2y^3z^4$ Find the **div(gradf)**

II. Prove that the **div** $\vec{r} = 3$ **where** $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

[Q.6]

If $\vec{F} = 3xy\hat{i} - y^2\hat{j}$ **evaluate** $\int \overrightarrow{F}.\, d\vec{r}$ where c is the curve in **the** **x y** plane , $y^2 = 2x^2$ from **(0,0) to (1,2)**

[Q.7]

Evaluate by Green theorem $\int(e^{-x}\sin y\, dx + e^{-x}\cos x dy)$ where c is

the rectangle with vertex (0,0),(π,0),($\pi,\frac{\pi}{2}$) and (0, $\frac{\pi}{2}$)

[Q.8]

If $\vec{f} = (2x^2-3z)\hat{\imath} - 2xy\hat{\jmath} - 4x\hat{k}$ $\iiint_v \nabla.\vec{f}\, dv$ where v is the region

bonded by the coordinate planes and the plan **2x+2y+z =4**

[Q.9] Determine the constant a show that the vector

$\vec{f} = (x+3y)\hat{\imath} + (y-2z)\hat{\jmath} + (x+az)\hat{k}$ **is solenoidal**