Semester 2

Integral Calculus And Fourier Series

Course Code	Teaching hours per week				Credits	Exam hours	Course type	CIE Marks	ESE Marks
	L	T	P	R					
26NBCBS201	2	1	0	0	3	2 Hrs. 30 Min	Theory	40	60

1. **Preamble:** To provide a comprehensive understanding of multiple integrals, the differentiation and integration of vector-valued functions, emphasizing their applications in engineering contexts.
2. **Prerequisites:** Basic knowledge in single variable calculus.

Module Number	Syllabus Description	Contact Hours
1	**Multiple Integrals:** Double integrals, Reversing the order of integration in double integrals, change of coordinates in double integrals (Cartesian to polar), Evaluating areas using Double integrals, Triple integrals, Volume calculated as triple integral. **(Text 1: Relevant topics from section 14.1, 14.2, 14.3, 14.5)**	9
2	**Vector Differentiation:** Introduction to Vector-valued function of single variable - Directional derivative and Gradient, Vector fields: Divergent and Curl, Line integrals with respect to x, y, and z, Integration of vector field along a curve, Work done as line integral, Conservative vector field, independence of path, Potential function (results without proof) **(Text 1: Relevant topics from section 12.1, 13.6, 15.1, 15.2, 15.3)**	9
3	**Vector Integration:** Green's theorem - Finding work using Green's theorem, finding areas using Green's theorem, Surface integrals over surfaces of the form $z = g(x, y)$, Applications of surface integrals – Flux over surfaces of the form $z = g(x, y)$, Divergence theorem (without proof), Source and Sink, Stoke's theorem (without proof) **(Text 1: Relevant topics from section 15.4, 15.5, 15.6, 15.7,15.8)**	9
4	**Fourier Series:** Fourier Series, Euler Formulae, Convergence	9

	of Fourier Series (Dirichlet's Condition), Fourier Series of 2π periodic functions, Fourier Series of 2L periodic functions, Half range sine series expansion, Half range cosine series expansion. **(Text 2: Relevant topics from section 11.1, 11.2)**	
	Total hours	36

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	**Assignment/ Microproject**	**Internal Examination-1**	**Internal Examination- 2**	**Total**
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3=24marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 sub divisions. **(4x9=36marks)**	60

3. Course Outcomes

At the end of the course students should be able to:

Course Outcome	Description	Bloom Level
CO1	Apply the theoretical concepts of multiple integrals to determine areas and volumes of geometrical shapes.	K3
CO2	Compute the derivatives and line integrals of vector-valued functions and learn their applications.	K3
CO3	Apply the concepts of surface and volume integrals and to learn their inter-relations and applications.	K3
CO4	Compute the Fourier series expansion for different periodic functions.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

4. Mapping of Course Outcomes with Program Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO1	3	3	-	2	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

5. Text Books

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Calculus	H. Anton, I. Biven, S. Davis	Wiley	12^{th} edition, 2024
2	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10^{th} edition, 2016

6. Reference Books

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Thomas' Calculus	Maurice D. Weir, Joel Hass, Christopher Heil, Przemyslaw Bogacki	Pearson	15^{th} edition, 2023
2	Essential Calculus	J. Stewart	Cengage	2^{nd} edition, 2017
3	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10th edition, 2016
4	Bird's Higher Engineering Mathematics	John Bird	Taylor & Francis	9th edition, 2021
5	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39th edition, 2023

7. Video Links or any other Reference Materials

Sl No	Details Like Weblink, Publication Details	Module
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ma50	1,2,3
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ma22	4

8. Model Question Paper

MODEL QUESTION PAPER				
FEDERAL INSTITUTE OF SCIENCE AND TECHNOLOGY (Autonomous) SECOND SEMESTER B. TECH DEGREE EXAMINATION (2026 Scheme)				
Course Code: 26NBCBS201				
Course Name: Integral Calculus And Fourier Series				
Max. Marks: 60		**Duration: 2 hours 30 minutes**		
PART A				
		Answer all questions. Each question carries 3 marks	CO	Marks
1		Evaluate using polar coordinates $\iint_R (x^2+y^2)dA$ where R is the region enclosed by the circle $x^2 + y^2 = 4$.	1	(3)
2		Evaluate $\int_{-1}^{2}\int_{0}^{3}\int_{0}^{2} xy^2z^3 dzdxdy$	1	(3)
3		Find the gradient of $f(x, y) = x^2 + xy$ at (-1, 2).	2	(3)
4		If $\overline{f} = x^2 i - yj + yz^2 k$, find $div\ \overline{f}$.	2	(3)
5		Using the Divergence theorem evaluate $\int\int_S \overline{f}.\hat{n}ds$ where $\overline{f} = 2xi + 4yj - 3zk$ and S is the surface of the sphere $x^2 + y^2 + z^2 = 1$.	3	(3)
6		Use Green's theorem to evaluate $\int_C 2xy\,dx + (x^2 + x)\,dy$ where C is the unit circle in the positive direction.	3	(3)
7		Obtain the Maclaurin series expansion of $\frac{1}{1-x}$	4	(3)
8		Expand e^x as a Taylor's series about x=1.	4	(3)

PART B				
Answer any one full question from each module. Each question carries 9 marks				
Module 1				
9	a)	Use a double integral to find the area of the region R enclosed by the curves $y^2 = 4x$ and $x^2 = 4y$.	1	(5)
	b)	Evaluate $\int_0^1\int_{4x}^{4} e^{-y^2} dydx$ by reversing the order of	1	(4)

		integration.		
10	a)	Evaluate $\iint_R (x^2+y^2)dA$ over the region in the first quadrant for which $x + y \leq 1$.	1	(5)
	b)	Using a triple integral, find the volume of the tetrahedron bounded by the planes x+2y+z=6 and the coordinate planes	1	(4)

		Module 2		
11	a)	Find $\nabla \cdot (\bar{f} \times \bar{g})$ where $\bar{f} = yz\,i + xz\,j + xy\,k$ and $\bar{g} = xy\,i + xyz\,j$		(5)
	b)	Show that $\bar{f} = (\cos y + y\cos x)\,i + (\sin x - x\sin y)\,j$ is a conservative vector field. Hence find a potential function for it.		(4)
12	a)	Find the work done by the force field $\bar{f} = xy\,i + x^3 j$ on a particle that moves along the curve $y^2 = x$ from (0,0) to (1,1).		(5)
	b)	Find the directional derivative of $f = x^3z - yx^2 + z^2$ at (1, 1, 1) in the direction of *2i - j + 2k*.		(4)
		Module 3		
13	a)	Apply Green's theorem to evaluate $\int_C (2x^2 - y^2)dx + (x^2+y^2)dy$ where C is the boundary of the area enclosed by the x- axis and the upper half of the circle $x^2 + y^2 = 4$		(5)
	b)	Use Stokes theorem to evaluate $\int_C \bar{f} \cdot d\bar{r}$ where $\bar{f} = z^2 i - 3xj - y^3 k$ and C is the circle $x^2 + y^2 = 1$ with counter clockwise orientation.		(4)
14	a)	Use divergence theorem to evaluate $\iint_S \bar{f} \cdot \hat{n} dS$ where $\bar{f} = xi + yj + zk$ and S is the surface of the cube bounded by $x = 0, y = 0, z = 0, x = 1, y = 1, z = 1$		(5)
	b)	Evaluate the surface integral $\iint_\sigma xzds$ where σ is the part of the plane x+y+z=1 in the first octant		(4)
		Module 4		
15	a)	Find the Fourier series expansion of $f(x) = x^2, \; -2 < x < 2$.		(5)

	b)	Find a half-range sine series for $f(x) = x, 0 < x < \pi$	4	(4)
16	a)	Obtain the Fourier series for $f(x) = \pi x, 0 < x < \pi$	4	(5)
	b)	Expand $f(x) = e^{-x}, 0 < x < \pi$ in half range cosine series	4	(4)