MATH-II ADVANCED CALCULUS

Course Code: SH 104

Lecturer: 3
Tutorial: 2
Practical: 0

Year: I
Part: II
Course Credit: 3

Objectives of the Course:

- Understanding the polar coordinates, sketching the graph and finding the length, area of polar curves
- To explore the concept of calculus for multivariate functions, vector valued functions and advanced vector calculus and their applications
- Understanding the Fourier series and Fourier integrals

Credit Hours	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	100
3	3	2	-	40	-	60	-	

Course Contents:

Unit 1: Polar, Cylindrical and Spherical Coordinates [6 Hours]

1.1 Polar coordinates and relation with Cartesian coordinates, Symmetry, Graphs of polar equations,
1.2 Area and lengths in polar coordinates
1.3 Line, Circles and Conics in polar coordinates
1.4 Cylindrical coordinates and relation with Cartesian coordinates, Cylindrical coordinates and relation with Cartesian coordinates, Spherical coordinates and relation with Cartesian coordinates

Unit 2: Partial Derivatives [9 Hours]

2.1 Function of several variables, Domain and range, Graphs, Level Curves, and Contours of Functions of two variables, Function of three variables and level surfaces
2.2 Limit and continuity of function of two, Two path test for non-existence of limit
2.3 Partial Derivatives of function of two and three variables and geometrical interpretation for partial derivatives for two variables, Higher order partial derivatives and mix derivatives theorem statement only.
2.4 Chain rules for function of two and three intermediate and one independent variables, Chain rule for three intermediate and two independent variables, Implicit differentiation using partial derivatives
2.5 Directional derivative and geometrical interpretation, Gradient vector and directional derivative as a dot product, properties of directional derivative

2.6 Tangent plane and normal lines, Linearization of function of two and three variables
2.7 Local extreme values for function of two variables, first and second derivative tests for local extreme values, Absolute maxima and minima values for function of two variables and finding those values in the bounded and closed regions
2.8 Method of Lagrange multiplies for constraint optimization problems,
2.9 Taylor's series formula for function of two variables

Unit 3: Multiple Integrals [8 Hours]

3.1 Double integrals over a rectangular regions and volume of solid, Fubini's Theorem (First Form)
3.2 Double integrals over general regions and volume of solids, Fubini's Theorem (Stronger Form), Finding limits of interactions, Change of order of integration, Properties of double integrals,
3.3 Area by double integrals, Double integrals in polar forms, Finding limits of integrations, Area in polar coordinates, Cartesian Integrals into Polar Integrals,
3.4 Triple integrals in rectangular coordinates, Volume by triple integrals, Triple Integrals in Cylindrical and Spherical Coordinates
3.5 Applications: Finding mass, first moments, center of mass, Moments of inertia of two dimensional plates

Unit 4: Vector Valued Functions [8 Hours]

4.1 Vector functions and space curves, Limit and continuity of vector function, Derivative of vector function and motion of particle in a space, Differentiation rules
4.2 Definite and indefinite integration of vector functions and application in motion in space Arc length of space curve, Arc length parameter with base point
4.3 Speed on a smooth curve, Unit tangent vector, curvature of a plane curve, Principal unit vector, radius and circle of curvature
4.4 Curvature and normal vectors for space curve, Bio normal vector, Torsion, TNB Frame and three planes determined by TNB frame
4.5 Alternative formulas to calculate curvature and torsion and related problems

Unit 5: Vector Integral Calculus [9 Hours]

5.1 Line integrals of a scalar function over plane and space curves, Mass and moments calculations
5.2 Vectors fields, Gradient vector, Line integrals of vector fields, Work done by force over space curve
5.3 Flow integrals and circulations for vector fields, Flux across a simple closed plane curve
5.4 Path Independence, Conservative Fields, and Potential Functions, Fundamental Theorem of Line Integrals, Finding potential of conservative fields, Exact differential forms and integrals
5.5 Curl and divergence of vector field, Green's Theorem Statements (Tangential Form and normal forms) and related problems
5.6 Parametrizations of Surfaces and surface area, Implicit surfaces and surface area and related problems, Surface integrals of scalar functions, surface integral of vector fields
5.7 Statements of Stokes' Theorem, Divergence Theorem and related problems

Unit 6: Fourier Series [5 Hours]

6.1 Periodic functions and periods, Fourier series and Fourier coefficients of a function of period 2π
6.2 Functions having arbitrary period 2L and its Fourier series representation, Fourier Cosine and Fourier Sine series, Half-range expansions,

6.3 Fourier integral and its applications, Fourier cosine and Fourier Sine integrals,

Text Books:

1. "Thomas' Calculus" by George B. Thomas Jr., Maurice D. Weir, and Joel R. Hass, Pearson India
2. Advanced Engineering Mathematics" by Erwin Kreyszig, Wiley

Reference Books:

1. Calculus: Early Transcendentals" by James Stewart, Publisher: Cengage Learning India
2. Advanced Engineering Mathematics by H. K. Dass, S. Chand, New Delhi.
3. A Text Book of Calculus II by Narayan Prasad Pahari, Santosh Ghimire, Dr. Jeevan Kafle, Arun Kumar Bhandari, Madav Prasad Poudel, Prem Gurung, Durgesh Ojha, Publisher: Asmita Publication, Kathmandu, Nepal
4. A Text Book on Engineering Mathematics Volume II by P. R. Pokharel, H. D. Chaudhary, S. P. Shrestha, Publisher: Vidyarthi Pustak Bhandar, Kathmandu, Nepal

Evaluation Scheme:

The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

Units	Topics	Scheduled Hours	Marks
1	Polar, Cylindrical and Spherical Coordinates	6	7
2	Partial Derivatives	9	12
3	Multiple Integrals	8	11
4	Vector Valued Functions	8	11
5	Vector Integral Calculus	9	12
6	Fourier Series	5	7
Total		**45 Hours**	**60 Marks**

Note: The marks distribution shown in the table above might be subjected to minor changes.