Programme	B. Sc. Mathematics Honours			
Course Code	MAT1MN102			
Course Title	**DIFFERENTIAL CALCULUS**			
Type of Course	**MINOR**			
Semester	I			
Academic Level	100-199			
Course Details	Credit	Lecture/Tutorial per week	Practicum per week	Total Hours
	4	4	-	60
Pre-requisites	Set theory along with an understanding of the real number system.			
Course Summary	This course provides a foundational understanding of calculus concepts: From the beginning sections students learn about limits (including one-sided limits and limits at infinity), continuity (definitions and properties), and the intermediate value theorem. Modules II and III cover differentiation techniques, including tangent lines, the definition of derivatives, rules of differentiation (product, quotient, chain), implicit differentiation, and advanced topics like L'Hopital's Rule for indeterminate forms. Module IV focuses on the analysis of functions, discussing concepts such as increasing/decreasing functions, concavity, inflection points, and techniques for identifying relative extrema and graphing polynomials.			

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyse limit, continuity and differentiability of a function	An	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam
CO2	Apply rules and techniques of differentiation to solve problems, also find limit in indeterminate forms involving transcendental functions	Ap	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam
CO3	Draw a polynomial function by analysing monotonicity, concavity and point of inflection using derivatives test	An	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Text book		Anton, Howard, Irl C. Bivens, and Stephen Davis. *Calculus: early transcendentals*. 10th Edition, John Wiley & Sons, 2021.		
Module	**Unit**	**Content**	**Hrs 60**	**External Marks (70)**
I		**Fundamentals of Limits and Continuity**	**14**	**Min.15**
	1	Section 1.1: Limits (An Intuitive Approach) - Limits, One-Sided Limits, The Relationship Between One-Sided and Two Sided Limits		
	2	Section 1.2: Computing Limits - Some Basic Limits, Limits of Polynomials and Rational Functions as $x \to a$		
	3	Section 1.2: Computing Limits - Limits involving Radicals, Limits of Piecewise-Defined Functions		
	4	Section 1.3: Limits at Infinity; End Behaviour of a Function Limits of Rational Functions as $x \to \pm\infty$ - A Quick Method for Finding Limits of Rational Functions as $x \to +\infty$ or $x \to -\infty$		
	5	Section 1.5: Continuity - Definition of Continuity, Continuity on an interval, Some Properties of Continuous Functions,		
	6	Section 1.5: Continuity - Continuity of Polynomials and Rational Functions, Continuity of Compositions, The Intermediate- Value Theorem.		
II		**Differentiation**	**14**	**Min.15**
	7	Section 2.1: Tangent Lines and Rates of Change - Tangent lines, Slopes and Rate of Change		
	8	Section 2.2: The Derivative Function - Definition of the Derivative Function-Topics up to and including Example 2.		
	9	Section 2.3: Introduction to Techniques of Differentiation - Derivative of a Constant, Derivative of Power Functions, Derivative of a Constant Times a Function, Derivatives of Sums and Differences, Higher Derivatives		
	10	Section 2.4: The Product and Quotient Rules - Derivative of a Product, Derivative of a Quotient, Summary of Differentiation Rules.		
	11	Section 2.5: Derivatives of Trigonometric Functions - Example 4 and Example 5 are optional		
	12	Section 2.6: The Chain Rule Derivatives of Compositions, An Alternate Version of the Chain Rule, Generalized Derivative Formulas		
		Differentiation contd :	**10**	
	13	Section 3.1: Implicit Differentiation - Implicit Differentiation (sub section)		

III	14	Section 3.2: Derivatives of Logarithmic Functions - Derivative of Logarithmic Functions (sub section) Logarithmic Differentiation, Derivatives of Real Powers of x.		**Min.15**
	15	Section 3.3: Derivatives of Exponential and Inverse Trigonometric Functions - Derivatives of Exponential Functions		
	16	Section 3.3: Derivatives of Exponential and Inverse Trigonometric Functions - Derivatives of the Inverse Trigonometric Functions		
	17	Section 3.6: L'Hopital's Rule; Indeterminate Forms - Inderminate Forms of Type 0/0, Indeterminate Forms of Type ∞/∞		
	18	Section 3.6: L'Hopital's Rule; Indeterminate Forms - Inderminate Forms of Type $0 \cdot \infty$, Indeterminate Forms of Type $\infty - \infty$		
IV		**Applications of Differentiation**	**10**	**Min 15**
	19	Section 4.1: Analysis of Functions I: Increase, Decrease, and Concavity - Increasing and Decreasing Functions		
	20	Section 4.1: Analysis of Functions I: Increase, Decrease, and Concavity - Concavity, Inflection Points		
	21	Section 4.2: Analysis of Functions II: Relative Extrema; Graphing Polynomials - Relative Maxima and Minima, First Derivative Test, Second Derivative Test		
	22	Section 4.2: Analysis of Functions II: Relative Extrema; Graphing Polynomials Geometric Implications of Multiplicity, Analysis of Polynomials		
V		**Module V (Open Ended)**	**12**	
		Infinite Limits		
		Differentiability, Relation between Derivative and Continuity		
		Parametric Equations, Parametric Curves		
		Inverse Trigonometric Functions and their derivatives		
		Taylor series expansion of functions		
		Maclaurin series of sin x, cos x, tan x, log(1+x), log(1-x) etc		
		Binomial expansion of $\frac{1}{(1+x)}$, $\frac{1}{(1-x)}$, $\frac{1}{\sqrt{1+x}}$, $\frac{1}{\sqrt{1-x}}$ etc		
		Different coordinate systems: - Cartesian, Spherical, and Cylindrical coordinates		
		Conic sections with vertex other than the origin		
		Indeterminate Forms of Type $0^0, \infty^0, 1^\infty$		
		Graphing Rational Functions		
References				
	1	Calculus and Analytic Geometry, 9 th Edition, George B. Thomas Jr and Ross L. Finney, Pearson Publications.		

	2	Calculus, Soo T. Tan, Brooks/Cole Cengage Learning (2010) ISBN-13: 978-0-534-46579-7.
	3	Marsden, Jerrold, and Alan Weinstein. *Calculus I*. Springer Science & Business Media, 1985.
	4	Stein, Sherman K. *Calculus in the first three dimensions*. Courier Dover Publications, 2016.

Note: 1) Optional topics are exempted for end semester examination. 2) Proofs of all the results are also exempted for the end semester exam. (3) 70 external marks are distributed over the first four modules subjected to a minimum of 15 marks from each module

Mapping of COs with PSOs and POs :

	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	3	1	2	1	3	1	2
CO 2	3	1	3	1	2	1	3	1	2
CO 3	2	1	3	2	3	2	3	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Seminar
- Internal Exam
- Viva
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	Viva	End Semester Examinations
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓

Programme	B. Sc. Mathematics Honours			
Course Code	MAT2MN102			
Course Title	**CALCULUS AND MATRIX ALGEBRA**			
Type of Course	**MINOR**			
Semester	II			
Academic Level	100-199			
Course Details	Credit	Lecture/Tutorial per week	Practicum per week	Total Hours
	4	4	-	60
Pre-requisites	Basic Calculus			
Course Summary	Students learn about antiderivatives, the indefinite and definite integrals, Riemann sums, and the Fundamental Theorem of Calculus. Course explores the average value of functions, evaluating definite integrals by substitution, calculating areas between curves, and finding the length of plane curves. Next it introduces functions of multiple variables, including notation, graphs, limits, continuity, and partial derivatives for functions of two or more variables. Course also focuses on matrix algebra, determinants, eigenvalue problems (including complex eigenvalues), and orthogonal matrices and their properties.			

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate proficiency in applying calculus techniques to solve analytical and geometrical problems involving indefinite and definite integrals, substitution methods, and integration by parts.	Ap	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam
CO2	Apply multivariable calculus concepts, including functions of multiple variables, limits, continuity, and partial derivatives, to model and analyse real-world phenomena and mathematical problems.	Ap	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam
CO3	Apply linear algebra principles, such as matrix operations, determinants, and eigenvalue problems, to analyze and solve systems of equations and geometric problems.	Ap	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Text Book	1. Howard Anton, Bivens and Stephen Davis, Calculus- Early Transcendentals (10th Edition). 2. Advanced Engineering Mathematics(6/e): Dennis G Zill Jones & Bartlett, Learning, LLC (2018) ISBN: 9781284105902			
Module	**Unit**	**Content**	**Hrs 60**	**External Marks (70)**
I	**Indefinite and Definite Integrals**		**12**	**Min 15**
	1	Section 5.2: The Indefinite Integral - Antiderivatives, The Indefinite Integral, Integration Formulas, Properties of the Indefinite Integral, Integral Curves		
	2	Section 5.3: Integration by Substitution - u-Substitution, Easy to Recognize Substitutions, Less Apparent Substitutions		
	3	Section 5.5: The Definite Integral - Riemann Sums and the Definite Integral, Properties of the Definite Integral.		
	4	Section 5.6: The Fundamental Theorem of Calculus - The Fundamental Theorem of Calculus (sub section), The Relationship Between Definite and Indefinite Integrals.		
II	**Techniques and Applications**		**13**	**Min 15**
	5	Section 5.8: Average Value of a Function and its Applications - Average Value of a Continuous Function (up to and including Example 2 only)		
	6	Section 5.9: Evaluating Definite Integrals by Substitution - Two Methods for Making Substitutions in Definite Integrals		
	7	Section 6.1: Area Between Two Curves - Area Between $y = f(x)$ and $y = g(x)$, Reversing the Roles of x and y		
	8	Section 6.4: Length of a Plane Curve - Arc Length		
	9	Section 7.2: Integration by Parts - The Product rule and Integration by Parts, Guidelines for Integration by Parts, Repeated Integration by Parts		
	10	Section 7.5: Integrating Rational Functions by Partial Fractions - Partial Fractions, Finding the form of a Partial Fraction Decomposition, Linear Factors, Quadratic Factors (Example 4 is optional), Integrating Improper Rational Functions.		
III	**Multi Variable Calculus**		**10**	**Min 15**
	11	Section 13.1: Functions of Two or More Variables: Notation and Terminology, Graphs of Functions of Two Variables.		
	12	Section 13.1: Functions of Two or More Variables: Level Curves, Level Surfaces.		
	13	Section 13.2: Limits and Continuity - Limit along Curves		
	14	Section 13.2: Limits Continuity - Continuity		
	15	Section 13.3: Partial Derivatives -		

		Partial Derivatives of Functions of Two Variables, The Partial Derivative Function, Partial Derivative Notation, Implicit Partial Differentiation, Partial Derivatives and Continuity		
	16	Section 13.3: Partial Derivatives Partial Derivatives of Functions with more than Two Variables, Higher order Partial Derivatives, Equality of Mixed Partials.		
IV	**Linear Algebra Essentials**		**13**	**Min 15**
	17	Section 8.1: Matrix Algebra		
	18	Section 8.2: Systems of Linear Algebraic Equations		
	19	Section 8.8: The Eigenvalue Problem - Topics up to and including Example 4		
	20	Section 8.8: The Eigenvalue Problem - Topics from Complex Eigenvalues onwards		
	21	Section 8.10: Orthogonal Matrices - Topics up to and including Theorem 8.10.3		
	22	Section 8.10: Orthogonal Matrices - Topics from Constructing an Orthogonal Matrix onwards		
V	**Module V (Open Ended)**		**12**	
		Fundamental theorems in Vector Calculus such as Green's theorem, divergence theorem, and the Stokes' theorem.		
		Trigonometric Substitutions		
		Integrating Trigonometric Functions		
		Volume of Solids of Revolution, Area of Surfaces of Revolution		
		The Chain Rule in Partial Differentiation		
		Directional Derivatives and Gradients, Tangent Planes and Normal Vectors		
		Basics of Vector Calculus including the differential operators such as gradient, divergence and curl.		
		Simpsons Rule, Trapezoidal rule in Numerical Integration		
		Algebra of Complex Numbers		
References				
	1	Calculus and Analytic Geometry, 9 th Edition, George B. Thomas Jr and Ross L. Finney, Pearson Publications.		
	2	Calculus, Soo T. Tan, Brooks/Cole Cengage Learning (2010) ISBN-13: 978-0-534-46579-7.		
	3	Marsden, Jerrold, and Alan Weinstein. *Calculus I*. Springer Science & Business Media, 1985.		
	4	Stein, Sherman K. *Calculus in the first three dimensions*. Courier Dover Publications, 2016.		
	5	Kreyszig, Erwin. *Advanced Engineering Mathematics 9th Edition with Wiley Plus Set*. Vol. 334. US: John Wiley & Sons, 2007.		
	6	Elementary Linear Algebra, Applications version, 9 th edition, Howard Anton and Chriss Rorres		

Note: 1) Optional topics are exempted for end semester examination. 2) Proofs of all the results are also exempted for the end semester exam.

Mapping of COs with PSOs and POs :

	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	3	1	1	1	3	0	0
CO 2	2	1	2	1	2	1	2	0	0
CO 3	2	1	2	1	2	1	2	0	0

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Seminar
- Internal Exam
- Viva
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	Viva	End Semester Examinations
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓

Programme	B. Sc. Mathematics Honours			
Course Code	MAT3MN202			
Course Title	**DIFFERENTIAL EQUATIONS AND FOURIER SERIES**			
Type of Course	**Minor**			
Semester	III			
Academic Level	200-299			
Course Details	Credit	Lecture/Tutorial per week	Practicum per week	Total Hours
	4	4	-	60
Pre-requisites	Basic Calculus and familiarity with Real Numbers			
Course Summary	In Module I students are introduced to various types of differential equations, including linear, separable, exact equations, and Bernoulli's equation. Module II delves deeper into linear equations, both homogeneous and nonhomogeneous. Module III introduces Fourier series, including trigonometric series, Fourier cosine and sine series, and half-range expansions. Module IV transitions into algebra of complex numbers, , and functions of complex variables, including analytic functions and the Cauchy-Riemann equations, which are fundamental in complex analysis.			

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Apply various methods, such as separation of variables, linear, and exact equations, integrating factors, and substitution, to solve differential equations, including those with constant coefficients and Cauchy-Euler equations.	Ap	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam
CO2	Analyse and solve partial differential equations, including separable ones, and comprehend Fourier series and their applications in solving differential equations and understanding periodic function	An	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam
CO3	Apply complex number theory, including arithmetic operations, polar forms, powers, roots, sets in the complex plane, functions of a complex variable, and Cauchy-Riemann equations, to analyze and solve real-world problems in various fields.	Ap	C	Internal Exam/Assignment/ Seminar/ Viva / End Sem Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Text Book	Advanced Engineering Mathematics(6/e) : Dennis G Zill, Jones & Bartlett, Learning, LLC(2018)ISBN: 978-1-284-10590-2			
Module	**Unit**	**Content**	**Hrs 60**	**External Marks (70)**
I		**Foundations of Differential Equations**		**Min 15**
	1	Introduction to Differential Equations Section 1.1: Definitions and Terminology Introduction, A Definition, Classification by Type, Notation, Classification by Order, Classification by Linearity, Solution.	**10**	
	2	Section 2.2: Separable Equations Introduction, A Definition, Method of Solution.		
	3	Section 2.3: Linear Equations Introduction, A Definition, Standard Form, Method of Solution, An Initial Value Problem		
	4	Section 2.4: Exact Equations Introduction, Differential of a Function of Two Variables (Definition 2.4.1 and Theorem 2.4.1 only), Method of Solution.		
	5	Section 2.4: Exact Equations Integrating Factors		
	6	Section 2.5: Solutions by Substitutions Bernoulli's Equation		
II		**Linear Differential Equations**		**Min 15**
	7	Section 3.1: Theory of Linear Equations 3.1.2 Homogenous Equations, Linear Dependence and Independence, Solutions of Differential Equations,	**11**	
	8	Section 3.1: Theory of Linear Equations 3.1.3 Nonhomogeneous Equations, Complementary Function		
	9	Section 3.3: Homogeneous Linear Equations with Constant Coefficients Introduction, Auxiliary Equation.		
	10	Section 3.4: Undetermined Coefficients Introduction, Method of Undetermined Coefficients (Topics up to and including Example 4.)		
	11	Section 3.6: Cauchy-Euler Equations Cauchy-Euler Equation (Second Order Only), Method of Solution.		
III		**Fourier Series**		**Min 15**
	12	Section 12.2: Fourier Series Trigonometric Series (Definition 12.2.1 onwards), Convergence of a Fourier Series, Periodic Extension	**13**	
	13	Section 12.3: Fourier Cosine and Sine Series Introduction, Even and Odd Functions, Properties, Cosine and Sine Series (Definition 12.3.1 onwards).		
	14	Section 12.3: Fourier Cosine and Sine Series Half-Range Expansions.		

	15	Section 13.1: Separable Partial Differential Equations Introduction, Linear Partial Differential Equation, Solution of a PDE, Separation of Variables.		
	16	Section 13.1: Separable Partial Differential Equations Classification of Equations.		
IV	**Introduction to Complex Analysis**			
	17	Section 17.1: Complex Numbers Introduction, A definition, Terminology, Arithmetic Operations, Conjugate, Geometric Interpretation	**14**	**Min 15**
	18	Section 17.2: Powers and Roots Introduction, Polar Form, Multiplication and Division, Integer Powers of z.		
	19	Section 17.2: Powers and Roots DeMoivre's Formula, Roots.		
	20	Section 17.3: Sets in the Complex Plane Introduction, Terminology.		
	21	Section 17.4: Functions of a Complex Variable Introduction, Functions of a Complex Variable, Limits and Continuity, Derivative, Analytic Functions.		
	22	Section 17.5: Cauchy- Riemann Equations Introduction, A Necessary Condition for Analyticity, Harmonic Functions, Harmonic- Conjugate Functions.		
V	**Module V (Open Ended)**		**12**	
		Initial Value Problems		
		Differential Equations as Mathematical Models		
		Method of Variation of Parameters in solving DE		
		Solving DE with the Runge-Kutte Method		
		Interpolation, Extrapolation		
		Classical PDEs and Boundary Value Problems		
		Heat Equation		
		Wave Equation		
		Fourier Transform		
References				
	1	Advanced Engineering Mathematics, Erwin Kreyszig, 8th Edition, Wiley Student Edition.		
	2	Mathematics For Engineers and Scientist, Alan Jeffrey, Sixth Edition		
	3	Complex Analysis A First Course with Applications (3/e), Dennis Zill & Patric Shanahan Jones and Bartlett, Learning (2015) ISBN 1-4496-9461-6		

Note: Proofs of all the results are also exempted for the end semester exam.

Mapping of COs with PSOs and POs :

	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	3	2	3	3	3	1	2
CO 2	3	1	3	2	3	3	3	1	2
CO 3	3	2	3	2	3	3	3	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Seminar
- Internal Exam
- Viva
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	Viva	End Semester Examinations
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓