

Programme	B. Sc. Mathematics Honours			
Course Code	MAT1MN102			
Course Title	<b>DIFFERENTIAL CALCULUS</b>			
Type of Course	<b>MINOR</b>			
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. <i>Calculus: early transcendentals</i> . 10 <sup>th</sup> Edition, John Wiley & Sons, 2021.		
Module	Unit	Content	Hrs 60	External Marks (70)
I	<b>Fundamentals of Limits and Continuity</b>		<b>14</b>	<b>Min.15</b>
	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 $x \rightarrow a$		
	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 $x \rightarrow \pm\infty$ - A Quick Method for Finding Limits of Rational Functions as $x \rightarrow +\infty$ or $x \rightarrow -\infty$		
	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	<b>Differentiation</b>		<b>14</b>	<b>Min.15</b>
	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		
	<b>Differentiation contd :</b>			
	13	Section 3.1: Implicit Differentiation - Implicit Differentiation (sub section)	<b>10</b>	

<b>III</b>	14	Section 3.2: Derivatives of Logarithmic Functions - Derivative of Logarithmic Functions (sub section) Logarithmic Differentiation, Derivatives of Real Powers of x.	<b>Min.15</b>
	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 - Indeterminate Forms of Type 0/0, Indeterminate Forms of Type $\infty/\infty$	
	18	Section 3.6: L'Hopital's Rule; Indeterminate Forms - Indeterminate Forms of Type $0 \cdot \infty$ , Indeterminate Forms of Type $\infty - \infty$	
<b>IV</b>	<b>Applications of Differentiation</b>		<b>10</b>
	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	
<b>V</b>	<b>Module V (Open Ended)</b>		<b>12</b>
	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			
<b>References</b>			
1	Calculus and Analytic Geometry, 9th 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. <i>Calculus I</i> . Springer Science & Business Media, 1985.
	4	Stein, Sherman K. <i>Calculus in the first three dimensions</i> . 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	✓	✓	✓	✓	✓