Programme	BSc Mathematics Honours			
Course Code	MAT2CJ101 / MAT2MN100			
Course Title	**INTEGRAL CALCULUS**			
Type of Course	**Major**			
Semester	II			
Academic Level	100-199			
Course Details	Credit	Lecture/Tutorial per week	Practicals per week	Total Hours
	4	4	-	60
Pre-requisites	Basic knowledge of Functions, Limits, Continuity and Differentiation (MAT1CJ101 - Differential Calculus).			
Course Summary	The course provides a comprehensive exploration of integral calculus, covering techniques such as indefinite integrals, Riemann sums, definite integrals, properties of integrals, the Fundamental Theorem, L'Hopital's Rule, basic integration formulas, and applications in finding areas between curves, volumes of solids, lengths of plane curves, and areas of surfaces of revolution. Through these topics, students gain proficiency in solving a wide range of mathematical problems involving integration and its applications in various fields.			

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Solve definite and indefinite integrals of functions.	Ap	P	Internal Exam/Assignment/ Seminar/Viva/ End Sem Exam
CO2	Apply the Fundamental Theorem of Calculus and properties of logarithmic and exponential functions to solve differentiation and integration problems.	Ap	P	Internal Exam/Assignment /Seminar/Viva/ End Sem Exam
CO3	Apply L'Hôpital's Rule and differentiation techniques to evaluate limits, derivatives, and integrals of inverse trignometric functions.	Ap	P	Internal Exam/Assignment/ Seminar/Viva/ End Sem Exam

CO4	Apply basic integration techniques, including integration by parts and partial fractions, to evaluate integrals of algebraic and hyperbolic functions.	Ap	P	Internal Exam/Assignment/ Seminar/Viva/ End Sem Exam
CO5	Apply integration techniques to find areas between curves, volumes of solids, and lengths and surface areas of plane curves.	Ap	P	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:

Textbook	**Calculus and Analytic Geometry, 9th Edition, George B. Thomas, Jr. Ross L. Finney, Pearson Publications, 2010, ISBN: 978-8174906168.**			
Module	**Unit**	**Content**	**Hrs (48+12)**	**Marks** Ext: 70
I	**Module I**		**14**	**Min.15**
	1	Section 4.1 - Indefinite Integrals.		
	2	Section 4.3 - Integration by Substitution - Running the Chain Rule Backward.		
	3	Section 4.5 - Riemann Sums and Definite Integrals. (Example 9 is optional.)		
	4	Section 4.6 - Properties, Area, and the Mean Value Theorem - Topics up to and including Example 6.		
	5	Section 4.6 - Properties, Area, and the Mean Value Theorem- Topics from The Average Value of an Arbitrary Continuous Function onwards.		

II	**Module II**		**11**	**Min.15**
	6	Section 4.7 – The Fundamental Theorem (Example 6 is optional).		
	7	Section 4.8 - Substitution in Definite Integrals.		
	8	Section 6.2 - Natural Logarithms- Topics up to and including The Graph and Range of ln x.		
	9	Section 6.2 - Natural Logarithms. -Topics from Logarithmic Differentiation onwards.		
	10	Section 6.3 - The Exponential Function- Topics up to and including Example 4.		
	11	Section 6.3 - The Exponential Function- Topics from the Derivative and Integral of e^x onwards.		
III	**Module III**		**12**	**Min.15**
	12	Section 6.6 - L' Hopital's Rule		
	13	Section 6.9 - Derivatives of Inverse Trigonometric Functions; Integrals.		
	14	Section 7.1 - Basic Integration Formulas.		
	15	Section 7.2 - Integration by Parts		
	16	Section 7.3 Partial Fractions.		
IV	**Module IV**		**11**	**Min.15**
	17	Section 5.1 - Areas Between Curves. - Topics up to and including Example 2.		
	18	Section 5.1 - Areas Between Curves- Topics from Boundaries with Changing Formulas		

	19	Section 5.2 - Finding Volumes by Slicing. (Example 2 may be done as open ended).		
	20	Section 5.3 - Volumes of Solids of Revolution- Disks and Washers - Topics up to and including Example 4.		
	21	Section 5.5 - Lengths of Plane Curves. - Topics up to and including Example 2.		
	22	Section 5.6 - Areas of Surfaces of Revolution- Topics up to and including Example 2.		
V	**Module V (Open Ended)**		**12**	
	Inverse Functions and their Derivatives, a^x and $\log_a x$, Inverse Trigonometric Functions and their derivatives, Hyperbolic Functions, Integrals and their derivatives, Integration using trigonometric substitutions.			

References

1. Howard Anton, Biven, & Stephen Davis, Calculus, 7th Ed., Wiley India
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Ed, John Wiley & Sons. 3. Robert T Smith and Roland B Minton, Calculus, 4th Ed. McGraw-Hill Companies 4. Soo T Tan, Calculus, 9th Ed. Brooks/Cole Pub Co.
5. Tom M. Apostol, Calculus, Vol 1: One Variable Calculus with an Introduction to Linear Algebra, 2nd Ed, John Wiley & Sons.
6. Michael Van Biezen Calculus Lectures: https://youtu.be/YZYxPclo2rg?si=qKCt6ty8m5dBR4DG

***Optional topics are exempted for end semester examination **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 :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	0	1	0	3	1	2	2	3	2	3
CO 2	3	3	3	0	1	0	3	1	2	2	3	2	3
CO 3	3	3	3	0	1	0	3	1	2	2	3	2	3
CO 4	3	3	3	0	1	0	3	1	2	2	3	2	3
CO 5	3	3	3	2	3	0	3	1	2	2	3	2	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		**Multivariable 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	MAT2MN105			
Course Title	**VECTOR SPACES AND LINEAR TRANSFORMATIONS**			
Type of Course	**Minor**			
Semester	II			
Academic Level	100 – 199			
Course Details	Credit	Lecture/Tutorial per week	Practical per week	Total Hours
	4	4	-	60
Pre-requisites	Linear Algebra Course in Semester 1 - Vectors and Matrices			
Course Summary	This course delves into advanced concepts in linear algebra, focusing on general vector spaces, basis and dimension, matrix transformations, and eigenvalues and diagonalization. The course builds on foundational linear algebra principles and explores their applications in higher-dimensional spaces and complex transformations.			

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and apply concepts related to vector spaces, including understanding vector space axioms, subspaces, and the solution space of homogeneous systems.	U	C	Internal Exam/ Assignment/ Seminar/ Viva/ End Sem Exam
CO2	Explore the concepts of linear independence, coordinates, basis, and dimension within vector spaces, including computing basis vectors and understanding coordinate systems relative to a basis.	Ap	P	Internal Exam/ Assignment/ Seminar/ Viva/ End Sem Exam
CO3	Analyse and apply matrix transformations, including basic transformations in R2R2 and R3R3, understanding properties of these transformations, and exploring concepts related to eigenvalues, eigenvectors, and diagonalization of Amatrices.	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: Howard Anton and Chriss Rorres, Elementary Linear Algebra (11/e), Applications version, Wiley				
Module	**Unit**	**Content**	**Hrs (60)**	**Ext. Marks (70)**
I		**General Vector Spaces**	**12**	
	1	Section 4.1: -Real vector spaces – up to and including Example 8.		
	2	Section 4.1:- Rest of the section.		
	3	Section 4.2: - Subspaces (examples 7, 8 are optional) – up to and Example 10.		
	4	Section 4.2: - From Example 10 to Example 15 (proof of theorem .4.2.3 is optional)		
	5	Section 4.2: - Rest of the section (Linear transformation view point is optional)		
II		**Basis And Dimension**	**12**	
	6	Section 4.3: - Linear independence – up to and including Theorem 4.3.3		
	7	Section 4.3: - Rest of the section (proofs of all the results are optional).		
	8	Section 4.4:- Coordinates and Basis -up to and including Example 5		
	9	Section 4.4: - rest of the section from Theorem 4.4.1.		
	10	Section 4.5:-Dimension – up to and including Example 3.		
	11	Section 4.5: - Rest of the section from Example 3 (proofs of all the theorems are optional).		
III		**Matrix Transformations**	**12**	
	12	Section 4.9: - Basic matrix transformations in R^2 and R^{3-} Reflection operators, Projection operators		
	13	Section 4.9:- Rotation Operators – Rotation in R^3		
	14	Section 4.9:- Rest of the section.		
	15	Section 4.10: - Properties of Matrix Transformations – up to and including Example 4.		
	16	Section 4.10:- rest of the section (proofs of theorems are optional)		
	17	Section 4.11: - Geometry of Matrix Operators on R^2 (proof of Theorem 4.11.2 is optional)		
IV		**Eigen Values and Diagonalization**	**12**	
	18	Section 5.1:- Eigen values and eigen vectors – up to Theorem 5.1.3		
	19	Section 5.1; -From Theorem 5.1.3 to Example 7 (including)		
	20	Section 5.1: - Rest of the section (Eigen values of general linear transformation is optional)		
	21	Section 5.2: - Diagonalization – up to and including Example 4 (proofs of theorems are optional)		
	22	Section 5.2; - Rest of the section (Geometric and algebraic multiplicity are optional)		
V		**OPEN ENDED**	**12**	
	Rank space, Null space and Rank- Nullity theorem, General Linear transformations and Matrix representation, Eigen values of general linear transformation, Geometric and algebraic multiplicity.			

References:

1 Advanced Engineering Mathematics, 6th Edition, Dennis G. Zill, Jones & Bartlett Learning LLC (2018) ISBN: 978-1-284-10590-2.
2. Advanced Engineering Mathematics, Erwin Kreyzsig, 10th Edition, Wiley India.
3. Linear Algebra and its Applications: 3rd Edition, David C. Lay, Pearson Publications

Note: 1) Optional topics are exempted for end semester examination. (2) Proofs of all the results are exempted for external 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	2	1	3	1	1	1	3	0	0
CO 2	2	1	2	1	1	1	2	0	0
CO 3	2	1	3	1	1	1	3	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	✓	✓	✓	✓	✓