DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code: MTM-A-SEC-A-TH

LECTURE PLAN

C is a programming language that was developed by Dennis Ritchie. It is primarily used for creating system applications that interact directly with hardware devices such as drivers and kernels. Due to its efficiency, versatility, and widespread use, C programming is considered the foundation for other programming languages, earning it the title of the "mother of all programming languages." The purpose of this course is to provide mathematics students, both Honours and Pass, with an understanding of the basic syntax and structure of the C programming language. They will learn to identify its key features and advantages and write basic programs using C. In this subject, students will attend a minimum of 50 theory lectures that cover various concepts and principles of C programming. They will also apply C programming to solve practical mathematical problems, enhancing their problem-solving skills and understanding of the language. To achieve a passing grade in this subject, students must maintain a minimum attendance of 95% in all classes.

Lecture No		Lecture Schedule	Learning outcomes	Cumulative Classes
L 1.1		An overview of theoretical computers, history of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming.	◆ Student learn about the historical background on computers and different programming languages	1, 2
L 1.2		Constants, Variables and Data type of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.	◆ Students learn the basic introduction on C programming, different data types, different constants (e.g. int and float) and different variables (int, float, and char), assignment a value to a variable. Some examples are provided	3, 4, 5, 6, 7, 8
L 1.3		Operation and Expressions: Arithmetic operators, relational operators, logical operators	◆ Student learn different arithmetic operators in C and rule of precedence. They also learn operators that are used during conditional statements.	9, 10, 11, 12, 13, 14
L 1.4		Decision Making and Branching: decision making with if statement, if-else statement, Nesting	◆ Students learn different conditional statements such as if-else, if else if else, nested if statements are discussed. They will also be familiar with switch, break,	15, 16, 17, 18, 19, 20, 21, 22

		if statement, switch statement, break and continue statement.	and continue statements.	
L.1.5		Control statements: While statement, do-while statement, for statement	Students learn different loop in C. Some examples are shown.	**23, 24, 25, 26**
L.1.6		Arrays: One dimension, two dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.	One, two and multidimensional arrays are discussed. Students also learn character array to store a string. Matrix addition, multiplication using two-dimensional array are shown.	**27, 28, 29, 30, 31, 32, 33, 34**
L.1.7		User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function.	Students are familiar with different types of user defined function in C.	**35, 36, 37, 38, 39, 40**
L.1.8		Introduction to Library functions: stdio.h, math.h, string.h stdlib.h, time.h etc	Usage of library functions like stdio.h, math.h, string.h stdlib.h, time.h are discussed.	**41, 42**
L.1.9		Course conclusion	Finally different mathematical problems solving using C programming are shown to the students.	**43, 44, 45, 46, 47, 48, 49, 50**

TEXT BOOKS

1. E. Balagurnsamy, “Programming in ANSI C” Tata McGraw Hill, 2004.
2. V. Rajaraman, “Computer Oriented Numerical Methods” Prentice Hall of India, 1980.
3. Y. Kanetkar, “Let Us C” BPB Publication, 1999.

WEB BASED RESOURCES

https://onlinecourses.nptel.ac.in/noc20_cs91/preview

https://ocw.mit.edu/courses/6-087-practical-programming-in-c-january-iap-2010/

Internal Marks Total: 20

Internal Marks split up: **Attendance 10**

Internal Assessment 10

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code: MTM-G-CC-3/GE-3-3-TH

LECTURE PLAN

The purpose of studying integral calculus is to gain a thorough understanding of the concept of integration and its applications in various fields like physics, engineering, economics, and statistics. Integral calculus is a powerful tool that allows us to solve complex problems related to the integration of functions, which are not always easily solvable through other methods. It helps us calculate areas under curves, volumes of three-dimensional shapes, and solve differential equations.
The objective of studying numerical analysis is to equip students with the necessary skills to arrive at approximate solutions for complex problems. Many mathematical problems in science and engineering are challenging to solve accurately, and in some cases, it's impossible. To simplify a difficult mathematical problem, approximations are necessary.
The purpose of studying LPP is to familiarize students with the mathematical concept used to find the optimal solution of a linear functional subject to certain constraints. This problem is known as a Linear Programming problem. Linear Programming has a vast real-world application and is used to solve various types of problems. Linear programming is used in various industries such as shipping, manufacturing, transportation, telecommunications, and others.
In this course, students will attend a minimum of 70 theory lectures that cover various concepts on these three subjects. To achieve a passing grade in this subject, students must maintain a minimum attendance of 95% in all classes.

	Unit-1		
Lecture No	**Lecture Schedule**	**Learning outcomes**	**Cumulative Classes**
L1.1	Evaluation of definite integrals	◆ In this section students learn about fundamentals of definite integrals.	1, 2
L1.2	Integration as the limit of a sum (with equally spaced as well as unequal intervals).	◆ Concept of definite integral as a limit of sums and its properties.	3, 4
L1.3	Reduction formulae	◆ Construct the recurrence relations of several integrals for various integral values involved in the integrand. ◆ Evaluation techniques of numerous critical integrals with trigonometrical functions.	5, 6, 7, 8, 9
L1.4	Definition of Improper Integrals: Statements of (i) μ-test (ii) Comparison test (Limit from excluded) - Simple problems only. Use of Beta and Gamma functions (convergence and important relations being assumed).	◆ Concept of improper integrals and their properties. ◆ Idea of convergence of improper integrals. ◆ Definition of Gamma and Beta functions and their properties. ◆ Several techniques to analyse the convergence of improper integrals.	10, 11, 12, 13, 14, 15, 16, 17, 18, 19
L1.5	Working knowledge of double integral.	◆ Definition of double integral and its properties. ◆ Evaluation technique of double integrals and its convergence.	20, 21, 22, 23
L1.6	Applications: Rectification, Quadrature, volume and surface areas of solids formed by revolution of plane curve	◆ Application of double integral to evaluate of volume and surface areas. ◆ Evaluation of surface areas of solids	24, 25, 26, 27, 28, 29, 30

	and areas problems only.	formed by revolution of plane curves.	
UNIT-2			
L 2.1	Approximate numbers, Significant figures, Rounding off numbers. Error: Absolute, Relative and percentage.	- Students will be familiar with different errors and their stability and convergence	**31, 32, 33, 34**
L 2.2	Operators - Δ, ∇ and E (Definitions and some relations among them).	- In these lectures students learn forward, backward and shift operators. They also learn relationship between these operators.	**35, 36**
L 2.3	Interpolation: The problem of interpolation Equi-spaced arguments Difference Tables, Deduction of Newton's Forward Interpolation Formula, remainder term (expression only). Newton's Backward interpolation Formula (Statement only) with remainder term. Unequally- spaced arguments Lagrange's Interpolation Formula (Statement only). Numerical problems on Interpolation with both equally and unequally spaced arguments.	- Basic concepts of interpolation are discussed. Different types of interpolation like Lagrange, divided difference, Newton forward and backward interpolations are shown to the students. Students also learn the error produced during interpolating a function by a polynomial.	**37, 38, 39, 40, 41, 42, 43, 44**
L 2.4	Numerical Integration: Trapezoidal and Simpson's 1/3 formula (statement only). Problems on Numerical Integration	- Basic concept of mechanical quadrature methods is discussed. Formula of Trapezoidal and Simpson's 1/3 rule is shown to the students and several problems are solved using these formulae.	**45, 46, 47, 48, 49, 50**
L 2.5	Solution of Numerical Equation: To find a real root of an algebraic or transcendental equation. Location of root (tabular method), Bisection method, Newton-Raphson method with geometrical significance, Numerical Problems. (Note: Emphasis should be given on problems)	- Students will be familiar with the numerical approximation of the simple root of the equation F(x) = 0, where F can be algebraic or transcendental function. Formula of different methods like Bisection, Newton Raphson and their geometrical significance are shown. Several problems are solved using this formula.	**51, 52, 53, 54, 55, 56**
UNIT-3			

L 3.1	Motivation of Linear Programming problem. Statement of L.P.P. Formulation of L.P.P. Slack and Surplus variables. L.P.P. is matrix form. Convex set, Hyperplane, Extreme points, convex Polyhedron, Basic solutions and Basic Feasible Solutions (B.F.S.). Degenerate and Non-degenerate B.F.S.	♦ Student will be familiar with formulation of different Linear programming problems from real-life scenarios. ♦ Student learn the difference between basic and non-basic solution of a LPP. Some important theorems are discussed. They also learn the relationship between extreme points of a convex set and the B.F.S of a LPP. Finally, they learn geometrical method for solving a LPP with two variables.	**57, 58, 59, 60, 61**
L 3.2	The set of all feasible solutions of an L.P.P. is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme print of the convex set of feasible solutions, A.B.F.S. to an L.P.P. corresponds to an extreme point of the convex set of feasible solutions. Fundamental Theorem of L.P.P. (Statement only) Reduction of a feasible solution to a B.F.S.	♦ Fundamental theorem of a LPP is discussed and students learn how to reduce a F.S. to a B.F.S. Some examples are shown	**62, 63, 64**
L 3.3	Solution by graphical method (for two variables), by simplex method and method of penalty. Concept of Duality. Duality Theory. The dual of the dual is the primal. Relation between the objective values of dual and the primal problems. Dual problems with at most one unrestricted variable, one constraint of equality. Transportation and Assignment problem and their optimal solutions.	♦ Students will be familiar with different methods for solving a LPP with no standard basis. Also, different degenerate solutions of the LPP and their resolutions are discussed ♦ Students learn duality theory for transforming minimization problem to a maximization problem and vice versa. Some theorems are discussed. Relation between the solution of the primal and dual problem are shown. ♦ Students learn different methods for solving assignment, transportation and travelling salesman problems.	**65, 66, 67, 68, 69, 70**

TEXT BOOKS

1. R.K. Ghosh and K.C. Maity, An Introduction to Analysis: Integral Calculus: Part -II, New Central Book Agency, New-Delhi. Thirteenth Edition, 2011
2. Isaacson E. and Keller, H.B., “Analysis of Numerical Methods” Dover Publication, 1994.

3. Philips G.M and Taylor P.J., "Theory and Applications of Numerical Analysis", Academic Press, 1996.
4. Jain M.K, "Numerical Methods for Scientific and Engineering computation", 3rd Edition, New Age International, 1999.
5. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
6. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore,2009.
7. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.

WEB BASED RESOURCES

https://onlinecourses.nptel.ac.in/noc24_cs03/preview
https://archive.nptel.ac.in/courses/111/106/111106101/
https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring-2012/

Internal Marks Total: 35

Internal Marks split up: **Attendance 10**
Internal Assessment 10
Tutorial 15

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code: MTM-A-CC-1-1-TH

LECTURE PLAN

Calculus has numerous practical applications in fields such as physics, engineering, economics, and more. For example, in physics, calculus is used to describe the motion of objects and the behaviour of forces. In engineering, calculus is used to design and optimize structures, systems, and processes. In economics, calculus is used to model and analyse complex systems of supply and demand.
Geometry is a subject that can challenge you to think critically and creatively, and it can help you develop a deeper appreciation for the beauty and symmetry of the world around us. Two-dimensional geometry is concerned with objects that have only two dimensions, such as points, lines, angles, polygons, and circles. Three-dimensional geometry, on the other hand, deals with objects that have three dimensions, such as cubes, spheres, pyramids, and cylinders. By studying both 2D and 3D geometry, you'll learn how to analyse and solve problems involving shapes and figures in both types of space.
Vector analysis is a subject that can challenge you to think critically and creatively, and it can help you develop a deeper appreciation for the power and versatility of vectors in mathematics and physics. Vector analysis is the study of the properties and behaviours of vectors, which are quantities that have both magnitude and direction. By studying vector analysis, you'll learn how to analyse and solve problems involving vectors, including addition, subtraction, dot product, cross product, and more. You'll also develop your understanding of vector calculus, which has numerous applications in physics, engineering, and other fields.
In this course, students will attend a minimum of 90 theory lectures that cover various concepts on these three subjects. To achieve a passing grade in this subject, students must maintain a minimum attendance of 95% in all classes.

	Unit-1		
Lecture No	**Lecture Schedule**	**Learning outcomes**	**Cumulative Classes**
L 1.1	Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of type $e^{(ax+b)}\ sinx$, $e^{(ax+b)}\ cosx,\ (ax+b)^n$ $sinx$, $(ax+b)^n\ cosx$	Students learn the concepts of Hyperbolic function and its application. Leibnitz rule for successive derivative of the product is shown and several problems are solved using this rule.	**1, 2, 3, 4, 5, 6**
L 1.2	Curvature, concavity and points of inflection	In these lectures, students learn the concept of bending of a curve. Several examples are shown. Furthermore, condition for concavity and points of inflection of a curve are discussed.	**7, 8, 9, 10, 11, 12, 13, 14, 15**
L 1.3	Envelopes, rectilinear asymptotes (Cartesian & parametric form only)	Students learn condition for existence of an envelopes, rectilinear asymptote of a curve. Several examples are discussed	**16, 17, 18, 19, 20, 21, 22, 23, 24**
L 1.4	Curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves	In these lectures, students learn the properties of a given curve using curve tracing method.	**25, 26, 27, 28, 29, 30**

L 1.5	L'Hospital's rule, applications in business, economics and life sciences.	◆ In these lectures, students become familiar with L'Hospital's rule and its application in various field.	**31, 32**
L 1.6	Reduction formulae, derivations and illustrations of reduction formulae of different types	◆ Several examples on the reduction of an integration formula are shown.	**33, 34, 35, 36, 37, 38**
L 1.7	Parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	◆ Application of integral calculus are shown to students like arc length, area under the curve, etc.	**39, 40, 41, 42, 43, 44**
Unit-2			
L2.1	Rotation of axes and second-degree equations, classification of conics using the discriminant, tangent and normal, polar equations of conics.	◆ In this section students learn about the coordinate transformation and some elementary properties. ◆ Geometrical representation of second-degree quadratic equation in two variables. ◆ Properties of tangent and normal. ◆ Polar equation of conics.	**45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55**
L2.2	Equation of Plane: General form, Intercept and Normal forms. The sides of a plane. Signed distance of a point from a plane. Equation of a plane passing through the intersection of two planes. Angle between two intersecting planes. Parallelism and perpendicularity of two planes.	◆ Geometrical representation of Coordinate planes and some important properties. ◆ Relation between two or more planes.	**56, 57, 58, 59, 60**
L2.3	Straight lines in 3D: Equation (Symmetric & Parametric form). Direction ratio and direction cosines. Canonical equation of the line of intersection of two intersecting planes. Angle between two lines. Distance of a point from a line. Condition of coplanarity of two lines. Equation of skew lines. Shortest distance between two skew lines.	◆ Concept of Straight lines in 3D in different forms. ◆ Intersection of two straight lines and its consequences. ◆ Skew line and their properties.	**61, 62, 63, 64, 65, 66, 67, 68, 69, 70**
L2.4	Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, classification of quadrics, illustrations of graphing standard quadric surfaces like cone, ellipsoid. Tangent and normals of conicoids.	◆ Concept of several characteristics of sphere and cylindrical surfaces. ◆ Properties of several central conicoids and generating lines. ◆ Equations of tangent and normal of conicoids.	**71, 72, 73, 74, 75, 76, 77, 78, 79, 80**
Unit-3			
L3.1	Triple product, vector equations, applications to geometry and mechanics — concurrent forces in a plane, theory of couples, system of parallel forces. Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions,	◆ In this section students learn about the vector/scalar triple products and its consequences. ◆ Concept of vector equations of straight lines, planes and sphere. ◆ Application of vector calculus in several aspects of mechanics.	**81, 82, 83, 84, 85, 86, 87, 88, 89, 90**

	differentiation and integration of vector functions of one variable.	◆ Idea of differentiation, integration of a vector function of one variable and its important properties.	

TEXT BOOKS

1. Tom M. Apostol, Mathematical Analysis, 2nd edition, Pearson, Narosa Publishing House, New Delhi, 2002.
2. S. Goldberg, Calculus and mathematical analysis, Oxford & IBH Publishing Co, Pvt. Ltd., New Delhi, 2010
3. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. J. G. Chakravorty and P. R. Ghosh, ANALYTICAL GEOMETRY AND VECTOR ANALYSIS, U. N. Dhur & Sons Pvt. Ltd, 21st edition, 1973.
5. Nanigopal Datta and Rabindrnath jana, Analytical geometry and vector algebra, Shreedhar Prakashani, 1st edition, 1996.

WEB BASED RESOURCES

https://onlinecourses.nptel.ac.in/noc22_ma03/preview

Internal Marks Total: 35

Internal Marks split up: **Attendance 10**
Internal Assessment 10
Tutorial 15

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Dinabandhu Andrews College

Department of Mathematics

Lesson Plan

Paper Code: MTM-A-CC-3-5-TH

The objective of this lesson plan is to provide students with a comprehensive understanding of fundamental concepts in calculus. Students will learn the precise definition of limits using the ϵ-δ approach, and apply algebraic properties and sequential criteria to evaluate limits. They will explore continuity at points and over intervals, understanding how oscillation relates to continuity, and recognizing well-known continuous functions. The plan covers bounded functions and their neighbourhood properties, the intermediate value theorem, and various types of discontinuities, including those in monotone functions. Finally, students will delve into differentiability, mastering the chain rule, and exploring theorems like Rolle's, Mean Value, and Taylor's, as well as techniques for determining local extrema and applying L'Hospital's rule. This foundational knowledge will enable students to solve complex calculus problems and apply these concepts in practical scenarios.

Limits and Continuity:

	Lesson Schedule	**Learning Outcomes**	
1	**Limits of functions** ($\epsilon - \delta$ approach), sequential criterion for limits.	Understand and apply the $\epsilon - \delta$ definition of limits. Utilize the sequential criterion for limits to determine the limit of a function.	2
2	**Algebra of limits** for functions, effect of limit on inequality involving functions, one-sided limits.	Perform algebraic operations on limits. Understand how limits affect inequalities involving functions. Evaluate one-sided limits.	2
3	**Infinite limits and limits at infinity.** Important limits like sin(x)/x, log(1+x)/x, (a^x−1)/x (a>0) as x→0.	Evaluate infinite limits and limits at infinity. Compute specific important limits such as sin(x)/x, log(1+x)/x, and (a^x−1)/x as x approaches 0.	2
4	**Continuity of a function** on an interval and at an isolated point. Sequential criteria for continuity.	Define and test the continuity of functions on intervals and isolated points using sequential criteria.	3
5	****Concept of oscillation of a function** at a point. A function is continuous at x if and only if its oscillation at x is zero. Familiarity with figures of some well-known functions: y = x^a (a = 2, 3, 1/2, −1),	x	3
6	**Algebra of continuous functions** as a consequence of algebra of limits. Continuity of composite functions. Examples of continuous functions. Continuity at a point does not imply continuity in a neighborhood.	Apply algebraic properties of limits to continuous functions. Determine the continuity of composite functions and understand that pointwise continuity does not necessarily imply continuity in a neighborhood.	3

7	**Bounded functions.** Neighborhood properties of continuous functions regarding boundedness and maintenance of same sign. Continuous function on [a,b] is bounded and attains its bounds. Intermediate value theorem.	Identify bounded functions and their properties. Understand neighborhood properties of continuous functions related to boundedness and sign maintenance. Prove that continuous functions on closed intervals are bounded and apply the intermediate value theorem.	3
8	**Discontinuity of functions,** types of discontinuity. Step functions. Piecewise continuity.	Classify and identify different types of discontinuities in functions. Understand and analyze step functions, piecewise continuous functions.	3
9	**Monotone functions.** Monotone functions can have only jump discontinuity. Monotone functions can have at most countably many points of discontinuity. Monotone bijective function from an interval to an interval is continuous and its inverse is also continuous.	Understand and analyze monotone functions, including their properties and discontinuities. Prove that monotone bijective functions and their inverses are continuous.	3
10	**Uniform continuity.** Functions continuous on a closed and bounded interval are uniformly continuous**.**	Define and differentiate uniform continuity from regular continuity. Prove that functions continuous on closed and bounded intervals are uniformly continuous.	3
11	**A necessary and sufficient condition** under which a continuous function on a bounded open interval I will be uniformly continuous on I.	Understand necessary and sufficient conditions for uniform continuity on bounded open intervals.	3
12	A sufficient condition under which a continuous function on an unbounded open interval I will be uniformly continuous on I (statement only). Lipschitz condition and uniform continuity.	Understand sufficient conditions for uniform continuity on unbounded open intervals. Apply the Lipschitz condition to determine uniform continuity.	2
		Total Hours	32

Differentiable functions:

	Lesson Schedule	**Learning Outcomes**	
13	Differentiability of a function at a point and in an interval.	Understand and determine the differentiability of a function at a specific point and over an interval.	2
14	Algebra of differentiable functions. Meaning of the sign of the derivative. Chain rule.	Apply the algebraic properties of differentiable functions. Interpret the sign of a derivative. Use the chain rule to differentiate composite functions.	2
15	Darboux theorem.	Understand and apply Darboux's theorem to continuous and differentiable functions.	3
16	Rolle’s theorem.	Learn and apply Rolle's theorem and understand its significance in calculus.	2

17	Mean value theorems of Lagrange and Cauchy — as an application of Rolle's theorem.	Understand and apply Lagrange's and Cauchy's mean value theorems as extensions of Rolle's theorem.	3
18	Taylor's theorem on a closed and bounded interval with Lagrange's and Cauchy's form of remainder.	Learn Taylor's theorem, including the Lagrange and Cauchy forms of the remainder, and understand their derivations from the mean value theorems.	3
19	Expansion of e^x, log(1 + x), (1 + x)^m, sin(x), cos(x) with their range of validity.	Expand functions like e^x, log(1 + x), (1 + x)^m, sin(x), and cos(x) using Taylor series and determine their range of validity.	3
20	Application of Taylor's theorem to inequalities.	Apply Taylor's theorem to solve and understand inequalities involving differentiable functions.	2
21	Statement of L'Hospital's rule and its consequences.	Understand and apply L'Hospital's rule to evaluate limits involving indeterminate forms.	2
22	Point of local extremum (maximum, minimum) of a function in an interval. Sufficient condition for the existence of a local maximum/minimum at a point (statement only). Determination of local extremum using first-order derivative.	Identify points of local extremum (maximum and minimum) of functions within an interval. Understand and apply the sufficient condition for the existence of local extrema at a point. Use the first-order derivative to determine local extrema.	3
23	Application of the principle of maximum/minimum in geometrical problems.	Apply the principles of maximum and minimum to solve geometrical problems involving differentiable functions.	3
		Total Hours	28

REFERENCES

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis,Prentice Hall, 2001.
4. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
5. T. Apostol, Mathematical Analysis, Narosa Publishing House [6] Courant and John, Introduction to Calculus and Analysis, Vol I, Springer

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Dinabandhu Andrews College

Department of Mathematics

Lesson Plan

Paper Code: MTM-A-DSE-A-5-1-TH

The objective of this advanced algebra course is to provide students with a deep understanding of key concepts in ring theory and its applications. Students will explore principal ideal domains, principal ideal rings, and the significance of prime and irreducible elements in various ring structures. The course will cover the concepts of greatest common divisor (gcd) and least common multiple (lcm) within rings, and teach methods for expressing gcd and identifying scenarios where gcd does not exist. Students will gain insights into Euclidean domains and their relationship with principal ideal domains.

Additionally, the course will delve into polynomial rings, the division algorithm, and the structure of factorization domains, including unique factorization domains (UFDs). The relation between principal ideal domains, unique factorization domains, factorization domains, and integral domains will be examined. The Eisenstein criterion for polynomial factorization and unique factorization in Z[x] will also be covered. Students will learn about ring embeddings, quotient fields, and the properties of regular rings, including their ideals. By the end of the course, students will have a comprehensive understanding of advanced algebraic structures and their interrelationships, preparing them for further study and research in algebra.

Group Theory:

Lecture No	Lesson schedule	Learning outcomes	Hours
1.	Group actions.	Understand the concept of group actions, including examples and properties. Learn how groups can act on sets in various ways.	2
2.	Stabilizers.	Define and identify stabilizers in the context of group actions, and understand their significance and applications.	2
3.	Permutation representation associated with a given group action.	Learn how to construct permutation representations from group actions and understand their properties.	2
4.	Applications of group actions: Generalized Cayley’s theorem.	Apply group actions to prove and understand the Generalized Cayley’s theorem and its implications in group theory.	2

5.	Applications of group actions: Index theorem.	Explore the Index theorem through the lens of group actions and understand its applications in algebra.	2
6.	Groups acting on themselves by conjugation.	Understand how groups can act on themselves via conjugation, and learn the significance of this action in group theory.	2
7.	Class equation and consequences.	Learn the class equation, derive it from group actions, and understand its consequences in the study of group structure.	2
8.	Conjugacy in Sn.	Explore conjugacy classes in the symmetric group Sn, and understand their properties and significance.	2
9.	P-groups, Sylow's theorems and consequences.	Understand the structure and properties of p-groups, learn Sylow's theorems, and explore their consequences in group theory.	2
10.	Cauchy's theorem, Simplicity of An for n ≥ 5, non-simplicity tests.	Learn and apply Cauchy's theorem, understand the proof of the simplicity of the alternating group An for n ≥ 5, and explore tests for non-simplicity of groups.	2
		Total Hours	20

Ring Theory:

Lecture No	**Lesson schedule**	**Learning outcomes**	**Hours**
1.	Principal ideal domain.	Understand the definition and properties of a principal ideal domain (PID), and learn to identify and work with examples.	2
2.	Principal ideal ring.	Learn the concept of principal ideal rings and understand their relation to principal ideal domains.	2
3.	Prime element.	Define and identify prime elements in rings, and understand their significance in ring theory.	2
4.	Irreducible element.	Define and identify irreducible elements in rings, and distinguish them from prime elements.	2
5.	Greatest common divisor (gcd).	Understand the concept of the greatest common divisor in rings, and learn methods for computing gcd.	2
6.	Least common multiple (lcm).	Understand the concept of the least common multiple in rings, and learn methods for computing lcm.	2

7.	Expression of gcd.	Learn to express the gcd of two elements in terms of their linear combination, and understand its applications.	2
8.	Examples of a ring R and a pair of elements a, b ∈ R such that gcd(a, b) does not exist.	Explore examples of rings where gcd does not exist for certain pairs of elements, and understand the reasons why.	2
9.	Euclidean domain.	Define Euclidean domains, understand their properties, and learn to identify examples.	2
10.	Relation between Euclidean domain and principal ideal domain.	Explore the relationship between Euclidean domains and principal ideal domains, and understand the implications for ring structure.	2
11.	Polynomial rings.	Understand the structure and properties of polynomial rings, and learn to work with polynomials in a ring.	2
12.	Division algorithm and consequences.	Learn the division algorithm for polynomials, and understand its consequences for polynomial factorization.	2
13.	Factorization domain.	Define factorization domains, and understand their role in ring theory and polynomial factorization.	2
14.	Unique factorization domain (UFD).	Understand the concept of unique factorization domains, and learn to identify and work with UFDs.	2
15.	Irreducible and prime elements in a unique factorization domain.	Explore the properties of irreducible and prime elements within UFDs, and understand their significance.	2
16.	Relation between principal ideal domain, unique factorization domain, factorization domain, and integral domain.	Understand the hierarchical relationship between PIDs, UFDs, factorization domains, and integral domains.	2
17.	Eisenstein criterion and unique factorization in Z[x].	Learn and apply the Eisenstein criterion for polynomial factorization, and understand its role in proving unique factorization in Z[x].	2
18.	Ring embedding and quotient field.	Understand the concepts of ring embeddings and quotient fields, and learn to identify and work with these structures.	2
19.	Regular rings and their examples.	Define regular rings, explore examples, and understand their properties and significance in ring theory.	2
20.	Properties of regular rings, ideals in regular rings.	Learn the properties of regular rings, and understand the structure and behavior of ideals within regular rings.	2
		Total Hours	40

REFERENCES

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.

4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.

5. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

6. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code: MTM-A-DSE-B-5-1-TH
LECTURE PLAN

The purpose of this course is to provide students familiar with the mathematical concept that is used to find the optimal solution of a linear functional subject to certain constraints. This problem is known as Linear programming problem. Linear Programming has a huge real-world application and it is used to solve various types of problems. Linear programming is used in various industries such as shipping industries, manufacturing industries, transportation industries, telecommunications, and others. The subject consists of at least 70 theory lectures. To pass the subject, students must maintain at least 95% attendance in all classes.

			UNIT I	
Lecture No		**Lecture Schedule**	**Learning outcomes**	**Cumulative Classes**
L 1.1		Definition of Linear Programming Problem (L.P.P.). Formation of L.P.P. from daily life involving inequations.	◆ Student will be familiar with formulation of different Linear programming problems from real-life scenarios.	**1, 2, 3, 4**
L 1.2		Graphical solution of L.P.P. Basic solutions and Basic Feasible Solution (B.F.S) with reference to L.P.P. Matrix formulation of L.P.P. Degenerate and Non-degenerate B.F.S. Hyperplane, Convex set, Cone, extreme points, convex hull and convex polyhedron. Supporting and Separating hyperplane. The collection of a feasible solutions of an L.P.P. constitutes a convex set. The extreme points of the convex set of feasible solutions correspond to its B.F.S. and conversely.	◆ Student learn the difference between basic and non-basic solution of a LPP. Some important theorems are discussed. They also learn the relationship between extreme points of a convex set and the B.F.S of a LPP. Finally, they learn geometrical method for solving a LPP with two variables.	**5, 6, 7, 8, 9, 10, 11, 12**
L 1.3		The objective function has its optimal value at an extreme point of the convex polyhedron generated by the set of feasible solutions (the convex polyhedron may also be unbounded). In the absence of degeneracy, if the L.P.P. admits of an optimal	◆ Fundamental theorem of a LPP is discussed and students learn how to reduce a F.S. to a B.F.S. Some examples are shown	**13, 14, 15, 16, 17, 18, 19, 20**

		solution then at least one B.F.S. must be optimal. Reduction of a F.S. to a B.F.S.		
UNIT 2				
L 2.1		Slack and surplus variables. Standard form of L.P.P. theory of simplex method. Feasibility and optimality conditions.	◆ Students learn how standard form a LPP is derived using Slack and surplus variables. Also, they learn the essence of the simplex method for solving a LPP. Some problems are discussed	**21, 22, 23, 24**
L.2.2		The algorithm. Two phase method. Degeneracy in L.P.P. and its resolution	◆ Students will be familiar with different methods for solving a LPP with no standard basis. Also, different degenerate solutions of the LPP and their resolutions are discussed	**25, 26, 27, 28, 29, 30**
	UNIT 3			
L.3.1	Duality theory: The dual of dual is the primal. Relation between the objective values of dual and the primal problems. Relation between their optimal values. Complementary slackness, Duality and simplex method and their applications.		◆ Students learn duality theory for transforming minimization problem to a maximization problem and vice versa. Some theorems are discussed. Relation between the solution of the primal and dual problem are shown.	**31, 32, 33, 34, 35, 36, 37, 38, 39, 40**
UNIT 4				
L.4.1	Transportation and Assignment problems. Mathematical justification for optimality criterion. Hungarian method. Traveling Salesman problem.		◆ Students learn different methods for solving assignment, transportation and travelling salesman problems	**41, 42, 43, 44, 45, 46, 47, 48**
L.4.2	Concept of game problem. Rectangular games. Pure strategy and Mixed strategy. Saddle point and its existence.		◆ Students learn basics about the two player zero sum game, different strategies for the players and determining saddle point using MinMax and MaxMin principle.	**49, 50, 51, 52, 53, 54, 55, 56**
L.4.3	Optimal strategy and value of the game. Necessary and sufficient condition for a given strategy		◆ Students learn different methods for determining optimal strategy for a two player zero sum game.	**57, 58, 59, 60, 61, 62, 63, 64**

	to be optimal in a game. Concept of Dominance. Fundamental Theorem of rectangular games. Algebraic method.		
L.4.4	Graphical method and Dominance method of solving rectangular games. Inter-relation between theory of games and L.P.P.	• Students learn geometrical technique to convert a rectangular game problem to a 2 × 2 game. They also learn the technique to convert a game problem to a LPP problem.	**65, 66, 67, 68, 69, 70**

TEXT BOOKS

1. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore,2009.
3. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.

WEB BASED RESOURCES

https://onlinecourses.nptel.ac.in/noc24_cs03/preview

Internal Marks Total: 35

Internal Marks split up: **Attendance 10**
Internal Assessment 10
Tutorial 15

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code (Theory): MTM-A-CC-2-3-TH

LECTURE PLAN

Real analysis is an important branch of mathematics that deals with the properties of real numbers and their functions. It provides a rigorous foundation for calculus and other areas of mathematics, as well as applications in physics, engineering, and other fields. For example, it can be used to study the behaviour of systems with continuous variables, such as fluid flow, heat transfer, and electromagnetic fields. It can also be used to analyse the convergence and divergence of series and sequences, which is important in signal processing and control systems. In addition, real analysis provides the mathematical foundation for many areas of modern physics, such as quantum mechanics and general relativity. In this subject, students will attend a minimum of 85 theory lectures that cover various concepts on Real analysis. To achieve a passing grade in this subject, students must maintain a minimum attendance of 95% in all classes.

	Unit-1		
Lecture No	**Lecture Schedule**	**Learning outcomes**	**Cumulative Classes**
L 1.1	Intuitive idea of real numbers. Mathematical operations and usual order of real numbers revisited with their properties (closure, commutative, associative, identity, inverse, distributive).	• Students learn the concepts of different types of numbers (Natural numbers, integers, rational numbers, and irrational numbers). Algebraic structure is defined on a real number system. Some properties are discussed.	**1, 2, 3, 4, 5, 6**
L 1.2	Idea of countable sets, uncountable sets and uncountability of R. Concept of bounded and unbounded sets in R. L.U.B. (supremum), G.L.B. (infimum) of a set and their properties.	• In these lectures students learn the cardinality of a set. Countable and uncountable of different subset of R is defined. Cardinality of the set [0,1], P(X), etc. are discussed. • In these lectures students learn bounded and unbounded sets. Supremum and Infimum of a subset of R are defined.	**7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18**
L 1.3	L.U.B. axiom or order completeness axiom. Archimedean property of R. Density of rational (and Irrational) numbers in R.	• Least upper bound axiom and greatest lower bound axiom are defined. Some examples are shown. Archimedean property of R and its application are shown.	**19, 20, 21, 22, 23, 24, 25, 26**
L 1.4	Intervals. Neighbourhood of a point. Interior point. Open set. Union, intersection of open sets.	• In these lectures students learn the concept of neighbourhood, interior of a set. Furthermore, concept of open set is defined and some problems are discussed. Concept of closed set as the complement of an open set is discussed.	**27, 28, 29, 30, 31, 32**
L 1.5	Limit point and isolated point of a set. Bolzano-Weirstrass theorem for sets. Existence of limit point of every uncountable set as a	• Concept of closed set in-terms of Limit point is defined. Concept of isolated point is also discussed. Statement and proof of Bolzano-Weirstrass theorem is discussed. Some application of Bolzano-Weirstrass	**33, 34, 35, 36, 37, 38, 39, 40**

	consequence of Bolzano-Weirstrass theorem.	theorem is shown.	
L 1.6	Derived set. Closed set. Complement of open set and closed set. Union and intersection of closed sets as a consequence. No nonempty proper subset of R is both open and closed. Dense set in R as a set having non-empty intersection with every open interval. Q and R\Q are dense in R.	◆ In these lectures, students learn the concept of derived set. Some properties of closed set are discussed. Possibility of both open and closed set are discussed in the class. Concept of Dense set is discussed. Some examples of dense set are discussed in the class.	**41, 42, 43, 44, 45, 46, 47, 48**
		Unit-2	
L2.1	Real sequence. Bounded sequence. Convergence and non-convergence. Examples. Boundedness of convergent sequence. Uniqueness of limit. Algebra of limits.	◆ In this section students learn about the sequence of real numbers and its elementary properties. ◆ Concept of convergence sequence and its limit. ◆ Relation between the boundedness and convergence of a sequence of real numbers.	**49, 50, 51, 52, 53**
L2.2	Relation between the limit point of a set and the limit of a convergent sequence of distinct elements. Monotone sequences and their convergence. Sandwich rule. Nested interval theorem. Limit of some important sequences. Cauchy's first and second limit theorems.	◆ They can understand the difference between limit of a sequence and the limit point of a set. ◆ Several applications of MCT. ◆ Numerous techniques to test convergence of a monotone sequence.	**54, 55, 56, 57, 58, 59, 60, 61, 62, 63**
L2.3	Subsequence. Subsequential limits, lim sup as the L.U.B. and lim inf as the G.L.B of a set containing all the subsequential limits. Alternative definition of limsup and liminf of a sequence using inequality or as lim sup x_n = infsup{x_n, x_{n+1}, . . . , } and lim inf x_n = sup inf{x_n, x_{n+1}, . . . , } Equivalence between these definitions is assumed. A bounded sequence {x_n} is convergent if and only if lim sup x_n = lim inf x_n. Every sequence has a monotone subsequence. Bolzano-Weirstrass theorem for sequence. Cauchy's convergence criterion. Cauchy sequence.	◆ They can grasp the idea of sub-sequential limit and its consequences. ◆ Concept of supremum and infimum of a sequence of real numbers. ◆ Necessary condition of convergence of a bounded sequence. ◆ In addition, some special types of sequences and its convergence criteria. ◆ How can we calculate the limit od sequence?	**64, 65, 66, 67, 68, 69, 70, 72, 73, 74,75**
		Unit-3	
L3.1	Infinite series, convergence and non-convergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's nth root test, Kummer's test and Gauss test (statements only). Alternating series, Leibniz test.	◆ This section is devoted for infinite series of real numbers. ◆ Concept about the convergence of infinite series. ◆ Idea about the convergent series through numerous well-defined tests. ◆ Series with positive as well as negative	**76, 77, 78, 79, 80, 81, 82, 83, 84, 85**

	Absolute and conditional convergence.	terms and its consequences.	

TEXT BOOKS

1. Tom M. Apostol, Mathematical Analysis, 2nd edition, Pearson, Narosa Publishing House, New Delhi, 2002.
2. Richard R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co, Pvt. Ltd., New Delhi, 2010
3. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
4. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.

WEB BASED RESOURCES

https://archive.nptel.ac.in/courses/111/106/111106142/
https://www.nptelvideos.com/course.php?id=748&pn=0

Internal Marks Total: 35

Internal Marks split up**:** **Attendance 10**
Internal Assessment 10
Tutorial 15

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Dinabandhu Andrews College

Department of Mathematics

Lesson Plan

Paper Code: MTM-A-CC-4-8-TH

This objective is to study Riemann integration of bounded functions over a closed and bounded interval and also to study convergence of the integration where either the interval, the function or both are infinite. The sequences and series of real valued functions along with special series of function known as power series would develop an analytical ability to have a more matured perspective of the key concepts of functions which can be expanded as the power series and their applications.

Riemann Integration:

Lecture No	Lesson schedule	Learning outcomes	Cumulative hours
1	Definition of Darboux integration (Riemann integration), inequalities for upper and lower Darboux sums.	Understand the concept of Darboux integration and its relationship to Riemann integration. Learn to compute and apply inequalities for upper and lower Darboux sums.	2
2	Necessary and sufficient conditions for the Riemann integrability.	Identify and apply the necessary and sufficient conditions for Riemann integrability, and understand their importance in determining integrability.	4
3	Definition of Riemann integration using Riemann sums and equivalence of the two definitions.	Understand the definition of Riemann integration through Riemann sums, and demonstrate the equivalence between Darboux and Riemann definitions.	6
4	Riemann integrability of monotonic functions.	Analyze the Riemann integrability of monotonic functions and understand the conditions under which they are integrable.	8
5	Riemann integrability of continuous functions.	Examine the Riemann integrability of continuous functions and understand their properties in the context of integration.	10
6	Algebraic properties of Riemann integrable functions.	Learn and apply the algebraic properties of Riemann integrable functions, including linearity and additivity.	12
7	Definitions and Riemann integrability of piece-wise monotonic functions.	Define piece-wise monotonic functions and understand their Riemann integrability, including examples and applications.	14

8	Definitions and Riemann integrability of piece-wise continuous functions.	Define piece-wise continuous functions and understand their Riemann integrability, including examples and applications.	16
9	First intermediate value theorem for integrals.	Apply the first intermediate value theorem for integrals and understand its significance in the context of Riemann integration.	18
10	Second intermediate value theorem for integrals.	Apply the second intermediate value theorem for integrals and understand its significance in the context of Riemann integration.	20
11	First fundamental theorem of integral calculus.	Understand and apply the first fundamental theorem of integral calculus, and explore its implications for differentiation and integration.	22
12	Second fundamental theorem of integral calculus.	Understand and apply the second fundamental theorem of integral calculus, and explore its implications for the evaluation of definite integrals.	24
13	Integration by parts.	Learn the technique of integration by parts, and understand its derivation and applications in solving integrals.	26
14	Applications of integration by parts.	Explore various applications of integration by parts, including solving integrals involving products of functions and improving problem-solving skills in integral calculus.	28

Series of Functions:

Lecture No	Lesson schedule	Learning outcomes	Cumulative hours
15	Improper integrals of Type-I: Definition and evaluation.	Define and evaluate improper integrals of Type-I, and understand their convergence properties.	2
16	Improper integrals of Type-II: Definition and evaluation.	Define and evaluate improper integrals of Type-II, and understand their convergence properties.	4
17	Mixed type improper integrals: Definition and evaluation.	Define and evaluate mixed type improper integrals, and understand their convergence properties.	6
18	Conditional convergence of improper integrals.	Understand the concept of conditional convergence for improper integrals and learn to identify conditionally convergent integrals.	8
19	Absolute convergence of improper integrals.	Understand the concept of absolute convergence for improper integrals	10

		and learn to identify absolutely convergent integrals.	
20	Beta function: Definition and properties.	Learn about the definition and properties of the beta function, and understand its convergence behavior.	12
21	Gamma function: Definition and properties.	Learn about the definition and properties of the gamma function, and understand its convergence behavior.	14
22	Relations between beta and gamma functions.	Explore the relationships between beta and gamma functions, and apply these relationships to solve problems.	16
23	Point-wise convergence of sequences of functions: Definitions and examples.	Understand the definition of point-wise convergence for sequences of functions, and analyze examples to illustrate this concept.	18
24	Uniform convergence of sequences of functions: Definitions and examples.	Understand the definition of uniform convergence for sequences of functions, and analyze examples to illustrate this concept.	20
25	Motivation for uniform convergence: Examples and applications.	Develop an understanding of uniform convergence through motivating examples and applications.	22
26	Theorem on the continuity of the limit function of a sequence of functions.	Apply the theorem on the continuity of the limit function of a sequence of functions and understand its significance.	24
27	Theorem on the interchange of the limit function and derivative: Statement and examples.	Learn and illustrate the theorem on the interchange of limit function and derivative with examples.	26
28	The interchange of the limit function and integrability of a sequence of functions.	Understand the interchange of limit function and integrability for sequences of functions, and apply this concept in examples.	28
29	Point-wise and uniform convergence of series of functions.	Analyze point-wise and uniform convergence of series of functions and understand their implications.	30
30	Theorems on the continuity, differentiability, and integrability of the sum function of a series of functions.	Apply theorems on continuity, differentiability, and integrability of the sum function of a series of functions.	32

TEXT BOOK:

1. Introduction to Real Analysis by Bartle, Robert G., & Sherbert, Donald R. ,Wiley India / 4th Edition / 2015.
2. A Course in Calculus and Real Analysis by Ghorpade, Sudhir R. & Limaye, B., Springer/ First Edition / 2006

3. Introduction to Real Analysis by S. K. Mapa, Revised 6th edition, Sarat Book Distributors

REFERENCES

1. Elementary Analysis: The Theory of Calculus by Ross, Kenneth A, Springer/ Second Edition / 2013
2. Elements of Real Analysis by Denlinger, Charles G., Jones & Bartlett (Student Edition). First Indian Edition/ 2011

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code(Theory): MTM-A-CC-6-14-TH
Paper Code(Practical): MTM-A-CC-6-14-P

LECTURE PLAN

The purpose of this course is to provide mathematics (honours) students with the necessary skills to arrive at numerical solutions for complex problems. Many mathematical problems in science and engineering are challenging to solve accurately, and in some cases, it's impossible. In order to simplify a difficult mathematical problem, approximations are necessary. The subject consists of at least 55 theory lectures and 50 practical lectures, where problems are solved using the C programming language. To pass the subject, students must maintain at least 95% attendance in all classes.

	UNIT 1			
Lecture No		**Lecture Schedule**	**Learning outcomes**	**Cumulative Classes**
L 1.1		Representation of real numbers, Machine Numbers - floating point and fixed point.	• Student will be familiar with accuracy and representation of numbers	**1**
L 1.2		Sources of Errors, Rounding of numbers, significant digits and Error Propagation in machine arithmetic operations. Numerical Algorithms - stability and convergence.	• Students will be familiar with different errors and their stability and convergence	**2**
L 1.3 (P)		Calculate the sum 1/1 + 1/2 + 1/3 +….+ 1/N Enter 100 integers into an array and sort them in an ascending order	• Hands on Training on solving numerical problems	**3, 4, 5, 6**
	UNIT 2			
L 2.1		Approximation: The Weierstrass polynomial approximation theorem (statement only), Classes of approximating functions	• Students are familiar with polynomial approximation and sufficient condition for existence of such polynomial	**7, 8**
L.2.2		Types of approximations-polynomial approximation	• Students will be familiar with different types of polynomial approximation	**9, 10**
L.2.3		Interpolation: Lagrange and Newton's methods. Error bounds.	• Students will be familiar with necessity of interpolation and its application	**12, 12, 13**

L.2.4		Finite difference operators. Newton (Gregory) forward and backward difference interpolation. Central Interpolation: Stirling's and Bessel's formulas. Different interpolation zones, Error estimation. Hermite interpolation.	◆ Students will be familiar with interpolation with equispaced arguments. Several problems are discussed	**14, 15, 16, 17**
L.2.5 (P)		Interpolation i) Lagrange Interpolation ii) Newton's forward, backward and divided difference interpolations	◆ Students solve some problems of these two interpolation methods using C programming language	**18, 19, 20, 21**
L.2.6 (P)		Fitting a Polynomial Function (up to third degree)	◆ Students solve some problems on fitting data using polynomial up to degree 3	**22, 23, 24, 25**
	UNIT 3			
L.3.1	Numerical differentiation: Methods based on interpolations; methods based on finite differences	◆ Students learn different technique for numerical differentiation	**26**	
L.3.2	Numerical Integration: Newton Cotes formula	◆ Student learn how interpolation formula is used to derive numerical quadrature formula.	**27, 28**	
L.3.3	Trapezoidal rule, Simpson's 1/3-rd rule, Simpson's 3/8-th rule, Weddle's rule, Boole's Rule, midpoint rule.	◆ Students learn different numerical quadrature formulae for numerical integration	**29, 30, 31, 32**	
L.3.4	Composite trapezoidal rule, composite Simpson's 1/3-rd rule, composite Weddle's rule. Gaussian quadrature formula.	◆ Students learn different composite rules and also learn open types quadrature rules	**33, 34, 35, 36, 37, 38**	
L.3.5 (P)	Numerical Integration i) Trapezoidal Rule ii) Simpson's one third rule iii) Weddle's Rule iv) Gauss Quadrature	◆ Students solve some problems using different numerical integration formulae and C programming language	**39, 40, 41, 42, 43, 44, 45, 46**	
UNIT 4				
L.4.1	Transcendental and polynomial equations: Bisection method, Secant method, Regula-Falsi method, fixed point iteration, Newton-Raphson method	◆ Students learn what is an algebraic equation and a transcendental equation. They learn different iterative methods for solving such equations with some restrictions.	**47, 48, 49, 50**	

L.4.2	Condition of convergence (if any), Order of convergence, Rate of convergence of these methods.	♦ Students learn computational efficiency of these methods by comparing their order of convergence and also their geometrical interpretations.	**51, 52, 53, 54**
L.4.3	Modified Newton-Raphson method for multiple roots, Complex roots of an algebraic equation by Newton-Raphson method. Numerical solution of system of nonlinear equations-Newton's method.	♦ Students learn what will be method in case of multiple roots for the equation of the form F(x) = 0. They also learn the method for determining complex roots and system of nonlinear equations.	**55, 56, 57, 58, 59, 60**
L.4.4 (P)	Solution of transcendental and algebraic equations by i) Bisection method ii) Newton Raphson method (Simple root, multiple roots, complex roots). iii) Secant method. iv) Regula Falsi method.	♦ Students solve problems of different equations of the form F(x) = 0, using different iterative techniques and C programming language	**61, 62, 63, 64, 65, 66**
UNIT 5			
L.5.1	System of linear algebraic equations: Direct methods: Gaussian elimination and Gauss Jordan methods, Pivoting strategies.	♦ Students learn two direct methods for solving system of linear equations of the form Ax = b.	**67, 68**
L.5.2	Iterative methods: Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition method (Crout's LU decomposition method).	♦ Student learn different iterative technique to solve system of linear equations of the form Ax = b and also, we compare these methods in terms of their computational efficiency.	**69, 70, 71, 72**
L.5.3	Matrix inversion: Gaussian elimination and LU decomposition method (Crout's LU decomposition method) (operational counts). The algebraic eigen value problem: Power method	♦ We discussed some matrix inversion method and also studies power method to determine largest and smallest eigen value of a matrix.	**73, 74, 75, 76, 77, 78**
L.5.4 (P)	Solution of system of linear equations i) LU	♦ In these classes, students get training to solve system of linear equations using C programming.	**79, 80, 81, 82, 83, 84,**

	decomposition method ii) Gaussian elimination method iii) Gauss-Jacobi method iv) Gauss-Seidel method. Method of finding Eigenvalue by Power method (up to 4 × 4)	Also, they learn to determine largest and smallest eigen value of a square matrix.	**85, 86, 87, 88**
		UNIT 6	
L.6.1	Ordinary differential equations: Single-step difference equation methods- error, convergence. The method of successive approximations (Picard), Euler's method, the modified Euler method, Runge Kutta methods of orders two and four.	◆ In these lectures, student will learn different numerical methods to solve ordinary differential equations (both explicit and implicit).	**89, 90, 91, 92, 93, 94, 95, 96, 97, 98**
L.6.1 (P)	Solution of ordinary differential equations i) Euler method ii) Modified Euler method iii) Runge Kutta method (order 4) iv) The method of successive approximations (Picard)	◆ In these classes, students get to learn to solve differential equations (both linear and nonlinear) using different numerical methods.	**99, 100, 101, 102, 103, 104, 105**

TEXT BOOKS

1. Isaacson E. and Keller, H.B., "Analysis of Numerical Methods" Dover Publication, 1994.
2. Philips G.M and Taylor P.J., "Theory and Applications of Numerical Analysis", Academic Press, 1996.
3. Jain M.K, "Numerical Methods for Scientific and Engineering computation", 3rd Edition, New Age International, 1999.
4. Conte S.D. and Carl de Boor, "Elementary Numerical Analysis", 3rd Edition, Tata McGraw-Hill Publishing Company. 2004.
5. Atkinson K.E., "An Introduction to Numerical Analysis", Wiley & Sons, 2nd Edition, 1989.
6. Brian Bradie., "A Friendly Introduction to Numerical Analysis", 1st Edition, Pearson Education, New Delhi, 2007.

WEB BASED RESOURCES

https://archive.nptel.ac.in/courses/111/106/111106101/
https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring-2012/

Internal Marks Total: 20

Internal Marks split up**:** **Attendance 10**
Internal Assessment 10

atte lccee of

Dinabandhu Andrews College

Department of Mathematics

Lesson Plan

Paper Code: MTM-A-DSE-B-6-2-TH

The objective of this course is to provide students with a thorough understanding of fundamental concepts in topology, focusing on separation axioms, connectedness, and compactness. Students will explore the definitions and properties of connected and compact spaces, and learn to identify and prove these properties in various contexts, including real numbers and metric spaces. The course will cover first countability and T1/T2 separation axioms, their implications, and applications. Additionally, students will delve into the Heine-Borel Theorem, real-valued continuous functions on connected and compact spaces, and the equivalence of sequential compactness and the Bolzano-Weierstrass property. By mastering these topics, students will develop a solid foundation in topology, essential for advanced mathematical studies and applications.

Topologies and fundamentals:

Lecture No	Lesson schedule	Learning outcomes	Hours
1.	Topological spaces.	Understand the definition and examples of topological spaces, and grasp the concept of open and closed sets within these spaces.	3
2.	Basis and subbasis for a topology.	Learn the definitions and uses of a basis and subbasis in constructing topologies, and understand their significance in defining topological spaces.	3
3.	Neighbourhoods of a point, interior points.	Identify neighbourhoods of a point in a topological space, and understand the concept and significance of interior points.	3
4.	Limit points, derived set.	Define and identify limit points and derived sets, and understand their roles in topological spaces.	3
5.	Boundary of a set.	Understand the concept of the boundary of a set, and learn how to determine the boundary within a topological space.	1
6.	Closed sets, closure and interior of a set.	Define closed sets, and understand the processes of finding the closure and interior of a set in a topological space.	2

7.	Dense subsets.	Identify and understand dense subsets, and learn their significance in topological spaces.	1
8.	Subspace topology.	Learn how to define and work with the subspace topology, and understand how subspaces inherit topological properties.	2
9.	Finite product topology.	Understand the construction and properties of finite product topologies, and learn how to work with them in the context of topological spaces.	1
10.	Continuous functions, open maps, closed maps.	Define and identify continuous functions, open maps, and closed maps, and understand their significance in topological spaces.	3
11.	Homeomorphisms, topological invariants.	Understand the concept of homeomorphisms and topological invariants, and learn how to identify and use them to classify topological spaces.	3
12.	Metric topology, isometry and metric invariants.	Explore metric topology, and understand the concepts of isometry and metric invariants, including their significance in comparing metric spaces.	3
		Total Hours	28

Separation axioms:

Lecture No	**Lesson schedule**	**Learning outcomes**	**Hours**
1.	First countability in topological spaces.	Understand the concept of first countability, identify first-countable spaces, and apply the definition to various topological spaces.	2
2.	T1 and T2 separation axioms.	Learn the definitions of T1 (Frechet) and T2 (Hausdorff) separation axioms, understand their significance, and identify spaces that satisfy these axioms.	2
3.	Convergence and cluster points of sequences in topological spaces.	Define convergence and cluster points in the context of topological spaces, and understand how these concepts relate to the structure of the space.	3
4.	Related concepts on first countable and T2 spaces.	Explore additional properties and concepts related to first countable and T2 spaces, and understand their	3

		implications for the topology of the space.	
5.	Heine’s continuity criterion.	Understand and apply Heine’s continuity criterion in the context of topological spaces, and learn how it relates to the concepts of continuity and convergence.	2
		Total Hours	12

Connected and Compact space:

Lecture No	Lesson schedule	Learning outcomes	Hours
1.	Connected spaces.	Understand the definition and properties of connected spaces, and learn to identify and prove whether a given space is connected.	2
2.	Connected sets in R.	Explore connected sets in the real numbers (R), and understand examples and properties of such sets.	2
3.	Components.	Learn about components of a topological space, and understand how to identify and characterize them.	2
4.	Compact spaces.	Understand the definition and properties of compact spaces, and learn to identify and prove whether a given space is compact.	2
5.	Compactness and T2 spaces.	Explore the relationship between compactness and T2 (Hausdorff) spaces, and understand the significance of this relationship in topology.	2
6.	Compact sets in R.	Identify and understand the properties of compact sets in the real numbers (R), including examples and applications.	2
7.	Heine-Borel Theorem for R^n.	Learn the statement and proof of the Heine-Borel Theorem for R^n, and understand its significance in real analysis and topology.	2
8.	Real-valued continuous functions on connected and compact spaces.	Explore the behavior of real-valued continuous functions on connected and compact spaces, including important theorems and applications.	2
9.	The concept of compactness in metric spaces.	Understand the concept of compactness in the context of metric spaces, and learn to identify and	2

		prove whether a given metric space is compact.	
10.	Sequential compactness of a metric space X and the Bolzano-Weierstrass property of X.	Understand the equivalence between sequential compactness and the Bolzano-Weierstrass property in a metric space, and learn to apply these concepts in proofs and problems.	2
		Total Hours	20

REFERENCES

1. Munkres, J.R., Topology, A First Course, Prentice Hall of India Pvt.Ltd.,New Delhi, 2000.

   Dugundji, J., Topology, Allyn and Bacon, 1966.

2. Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
3. Kelley, J.L., General Topology, Van Nostrand Reinhold Co., New York,1995.
4. Hocking, J., Young, G., Topology, Addison-Wesley Reading, 1961.
5. Steen, L., Seebach, J., Counter Examples in Topology, Holt, Reinhart andWinston, New York, 1970

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code: MTM-A-SEC-B-TH

LECTURE PLAN

The purpose of this course is to provide students familiar with the SageMath programming. SageMath is a python based mathematical software and is widely used to solve different complex Mathematical problems arising in real life. The subject consists of at least 50 theory lectures. To pass the subject, students must maintain at least 95% attendance in all classes.

Lecture No	Lecture Schedule	Learning outcomes	Cumulative Classes
L 1.1	Introduction to SageMath, Installation Procedure, Use of SageMath as a Calculator, Numerical and symbolic computations using mathematical functions such as square root, trigonometric functions, logarithms, exponentiations etc.	◆ Student will learn the installation procedure of SageMath. They also learn how this software can be used as a calculator. Some symbolling calculations using different trigonometric, logarithms, exponential functions are shown.	**1, 2, 3, 4, 5, 6**
L 1.2	Graphical representations of few functions through plotting in a given interval, like plotting of polynomial functions, trigonometric functions	◆ Student learn basics of the plotting curves in 2D and 3D. Some hands-on examples are shown	**7, 8, 9, 10, 11, 12**
L 1.3	Plots of functions with asymptotes, superimposing multiple graphs in one plot like plotting a curve along with a tangent on that curve (if it exists), polar plotting of curves.	◆ Some advance plotting ideas like asymptotes, superimposing multiple graphs, tangent, normal, polar plotting, etc. are shown	**13, 14, 15, 16, 17, 18, 19, 20**
L 1.4	SageMath commands for differentiation, higher order derivatives, plotting f(x) and f0(x) together, integrals, definite integrals etc.	◆ Sage commands for computing differentiation and integration are shown. Students also learn plotting successive derivative curves of a function.	**21, 22**
L 1.5	Introduction to Programming in SageMath, relational and logical operators, conditional statements, loops and nested loops	◆ Students learn to write program using functions, loops, conditional statements.	**23, 24, 25, 26, 27, 28**

L 1.6	Without using inbuilt functions write programs for average of integers, mean, median, mode, factorial, checking primes, checking next primes, finding all primes in an interval, finding gcd, lcm, finding convergence of a given sequence, etc.	• Here, students learn proper programming skill using Sage. They write programs to calculate mean, median, mode, factorial, checking primes, checking next primes, finding all primes in an interval, finding gcd, lcm, etc.	**29, 30, 31, 32, 33, 34, 35, 36, 37, 38**
L 1.7	Use of inbuilt functions that deal with matrices, determinant, inverse of a given real square matrix (if it exists), solving a system of linear equations, finding roots of a given polynomial, solving differential equations.	• Here students learn to write matrices, determinant, matrix inversion, solving transcendental equations, solving differential equations etc.	**39, 40, 41, 42, 43, 44, 45, 46, 47, 48**
L 1.8	SageMath Problems	• Some hand-on examples are shown to the students	**49, 50**

TEXT BOOKS

1. P. Zimmermann et al., Computational Mathematics with SageMath, SIAM, 2018.
2. R.A. Mezei, An Introduction to Sage Programming, Willey, 2016.

WEB BASED RESOURCES

https://onlinecourses.nptel.ac.in/noc21_ma29/preview

Internal Marks Total: 20

Internal Marks split up: **Attendance 10**
Internal Assessment 10

DEPARTMENT OF MATHEMATICS
DINABANDHU ANDREWS COLLEGE
Paper Code: MTM-G-CC-4/GE-4-4-TH

LECTURE PLAN

Abstract algebra is an incredibly intriguing and challenging subject that covers algebraic structures such as groups, rings, and fields. By studying abstract algebra, you'll gain a deep understanding of the fundamental concepts and principles that govern these structures and their properties. This knowledge has a wide range of applications, including computer science, physics, and engineering, among others. In addition to abstract algebra, this course will also introduce you to the basics of computer science and programming. You'll explore various aspects of programming languages, including their historical background, algorithms, and flow charts. These skills are essential in today's technology-driven world, and will open up a wealth of opportunities for you. Finally, you'll dive into probability and statistics, which has a wide range of applications in fields such as physics, biology, and economics. Over the course of 65 theory lectures, you'll learn about various concepts related to these three subjects. It's important to attend all classes, as maintaining a minimum attendance of 95% is required to achieve a passing grade in this subject.

	Unit-1		
Lecture No	**Lecture Schedule**	**Learning outcomes**	**Cumulative Classes**
L 1.1	Introduction of Group Theory: Definition and examples taken from various branches (example from number system, roots of Unity, 2×2 real matrices, non-singular real matrices of a fixed order). Elementary properties using definition of Group. Definition and examples of sub- group - Statement of necessary and sufficient condition and its applications.	• Students will learn the basic definitions of a group, sub-group, cyclic group, etc. Various examples will be covered.	**1, 2, 3**
L 1.2	Definitions and examples of (i) Ring, (ii) Field, (iii) Sub-ring, (iv) Sub- field	• Definitions of these three algebraic structures will be provided and various examples will be solved in the class.	**4**
L 1.3	Concept of Vector space over a Field: Examples, Concepts of Linear combinations, Linear dependence and independence of a finite number of vectors, Sub-space, Concepts of generators and basis of a finite dimensional vector space. Problems on formation of basis of a vector space (No proof required).	• Basic concepts of vector spaces over R are shown to the students. Several examples will be solved in the class.	**5, 6, 7**

L 1.4	Real Quadratic Form involving not more than three variables (problems only). Characteristic equation of square matrix of order not more than three determinations of Eigen Values and Eigen Vectors (problems only). Statement and illustration of Cayley-Hamilton Theorem.	• Procedure to determine Real Quadratic form involving almost three variables are shown to students. Method of determine an eigen values, eigen vectors of a matrix by solving the characteristic equation are shown to the students.	**8, 9, 10**
UNIT-2			
L 2.1	Computer Science and Programming: Historical Development, Computer Generation, Computer Anatomy. Different Components of a computer system. Operating System, hardware and Software	• Students will be familiar with different generations of computers. Furthermore, they will also learn the history of programming languages, operating systems, complier, interpreter, etc.	**11, 12**
L 2.2	Positional Number System. Binary to Decimal and Decimal to Binary. Other systems. Binary Arithmetic. Octal, Hexadecimal, etc. Storing of data in a Computer - BIT, BYTE, WORD etc. Coding of a data-ASCII, etc.	• Students will learn how to convert one number system to another (Decimal to Binary, Binary to Octal, Octal to Decimal). Furthermore, they also learn the concept of BIT, BITE, etc.	**5, 6**
L 2.3	Programming Language: Machine language, Assembly language and High-level language, Compiler and interpreter. Object Programme and source Programme. Ideas about some HLL– e.g. BASIC, FORTRAN, C, C++, COBOL, PASCAL, etc	• Basic concepts of Machine, Assemble and high-level languages. History and some concepts of the progress of programming languages are informed to the students.	**7, 8, 9, 10, 11, 12, 13, 14**
L 2.4	Algorithms and Flow Charts– their utilities and important features, Ideas about the complexities of an algorithm. Application in simple problems. FORTRAN 77/90: Introduction, Data Type Keywords, Constants and Variables - Integer, Real, Complex, Logical, character, subscripted variables, Fortran Expressions.	• Algorithms and flow chart of solving different problems are shown to students. Some concepts on FORTRAN 77/90 are shown to students.	**15, 16, 17, 18, 19, 20**
UNIT-3			

L3.1	Elements of probability Theory: Random experiment, Outcome, Event, Mutually Exclusive Events, Equally likely and Exhaustive. Classical definition of probability, Theorems of Total Probability, Conditional probability and Statistical Independence. Baye's Theorem. Problems, Shortcoming of the classical definition. Axiomatic approach problems, Random Variable and its Expectation, Theorems on mathematical expectation. Joint distribution of two random variables.	◆ In this section students learn about fundamental of probability theory. ◆ Conditional Probability, Bayes Theorem and its consequences. ◆ Concept of Mathematical expectation of Random Variable of one and two variables along with its several properties.	**21, 22, 23, 24, 25, 26, 27, 28, 29, 30**
L3.2	Theoretical Probability Distribution Discrete and Continuous (p.m.f., p.d.f.) Binomial, Poisson and Normal distributions and their properties.	◆ Grasp the idea about Probability distribution of several discrete as well as continuous random variables with its properties.	**31, 32, 33, 34, 35, 36, 37, 38**
L3.3	Elements of Statistical Methods. Variables, Attributes. Primary data and secondary data, Population and sample. Census and Sample Survey. Tabulation Chart and Diagram, Graph, Bar diagram, Pie diagram etc. Frequency Distribution Un-grouped and grouped cumulative frequency distribution. Histogram, Frequency curve, Measures of Central tendencies. Averages: AM,; GM, HM, Mean, Median and Mode (their advantages and disadvantages). Measures of Dispersions - Range, Quartile Deviation, Mean Deviation, Variance / S.D., Moments, Skewness and Kurtosis	◆ Concept of elementary tools of statistics and their properties. ◆ Analysis of primary and secondary data preservation methods. ◆ Central tendency and measure of dispersion of the collected data.	**39, 40, 41, 42, 43, 44, 45, 46, 47, 48**
L3.4	Sampling Theory: Meaning and objects of sampling. Some ideas about the methods of selecting samples, Statistic and parameter, Sampling Proportion. Four fundamental distributions, derived from the normal: (i) standard Normal Distribution, (ii) Chi-square distribution (iii) Student's distribution (iv) Snedecor's F-distribution. Estimation and Test of Significance. Statistical Inference. Theory of estimation Point estimation and Interval estimation. Confidence Interval / Confidence Limit. Statistical Hypothesis - Null Hypothesis and Alternative Hypothesis. Level of significance. Critical Region. Type I and II error. Problems	◆ A fair idea about sampling theory and sampling distribution. ◆ Concept of satistic and sampling distribution of several statistics. ◆ Population parameter and its estimation: Statistical inference. ◆ Hypothesis testing: null/alternate hypothesis, level of significance. ◆ Concept of critical region, type-1/II errors and its applications.	**49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60**
L3.5	Bivariate Frequency Distribution. Scatter Diagram, Co-relation co-efficient Definition and properties. Regression lines	◆ Distribution of 2D random variables. ◆ Correlation coefficients, regression lines and their several properties.	**61, 62, 63, 64, 65**

TEXT BOOKS

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
3. A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers, Seventh Edition, 2017.
4. A. Banerjee, S.K. De and S. Sen, Mathematical Probability, U.N. Dhar & Sons Private Ltd, Kolkata. fourth Edition, 1999
5. S. Ross, Introduction to Probability Models, Academic Press, nineth edition, Indian Reprint, 2007

WEB BASED RESOURCES

https://onlinecourses.nptel.ac.in/noc24_ma26/preview
https://onlinecourses.nptel.ac.in/noc21_ma74/preview

Internal Marks Total: 35

Internal Marks split up**:** **Attendance 10**
Internal Assessment 10
Tutorial 15