M.Sc (Mathematics)

Second Semester

1. Name of the Department: Mathematics						
2. Course Name	**Differential Geometry I**			**L**	**T**	**P**
3. Course Code	**MT413**			3	1	0
4. Type of Course (use tick mark)		**Core (□)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite	**B. Sc. with Mathematics**	6 . **Frequency (use tick marks)**	**Even (✓)**	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: 1. This is an introductory course on curves and surfaces. The aim of this course is to introduce and develop basic analytic concepts of osculating plane, curvature and torsion of the space curves.

2. This course is aimed to provide an understanding of the first and second fundamental forms of a smooth surface and the concepts of various different types of curvature associated to a surface.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the mathematical toosl of tensor calculus and apply it to the geometry of curves and surfaces.
CO2	Able to calculate the curvature and torsion of a space curves and how they suffice to determine the shape of the curve.
CO3	Make logical arguments on fundamental forms, Gaussian and mean curvatures to determine the shape of the curve.
CO4	Characterize the surfaces to totally umbilical and minimal surfaces and Efficiently compute the fundamental equations to the surface.
CO5	Demonstrate the basic concepts of Riemannian manifolds and its submanifolds.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Tensor Analysis**

Coordinate transformation, Covariant, Contravariant and Mixed tensors, Tensors of higher rank, Symmetric and Skew-symmetric tensors, Tensor algebra, Contraction, Inner product, Riemannian metric tensor, Christoffel symbols, covariant derivatives of tensors

Unit-2	**Number of lectures =08**	**Title of the unit: Space curves**

Differentiable curves and their parametric representations, Vector fields, Tangent vector, Principal normal, Binormal, Curvature and torsion, Serret-Frenet formula, Covariant differentiation, The structural equations.

Unit-3	**Number of lectures = 08**	**Title of the unit: Surface Theory**

Surfaces, Differentiable functions on surfaces, Differential forms, Normal vector fields, First fundamental form, Normal curvature, Principal curvatures, Gaussian curvature, Second fundamental form.

Unit-4	**Number of lectures = 08**	**Title of the unit: Fundamental Equations**

Gaussian equations, Weingarten equation, Codazzi-Mainardi equations, Totally umbilical surfaces, Minimal surfaces, Geodesic on surface, Index form of a geodesic.

Unit-5	**Number of lectures = 08**	**Title of the unit: Riemannian Manifolds**

Riemannian manifolds, Riemannian connection, Geodesic in a Riemannian manifold, Riemannian curvature tensor, Submanifolds.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Understand the mathematical tools of tensor calculus and apply it to the geometry of curves and surfaces.	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**3**
CO2	Able to calculate the curvature and torsion of a space curves and how they suffice to determine the shape of the curve.	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**3**
CO3	Make logical arguments on fundamental forms, Gaussian and mean curvatures to determine the shape of the curve.	**3**	**1**	**2**	**1**	**3**	**1**	**1**	**2**
CO4	Characterize the surfaces to totally umbilical and minimal surfaces and Efficiently compute the fundamental equations to the surface.	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**3**
CO5	Demonstrate the basic concepts of Riemannian manifoldsand its submanifolds	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

1. https://www.youtube.com/watch?v=6xgtMQ7WSzQ
2. https://www.youtube.com/watch?v=-iOcBqxTkx0
3. https://www.youtube.com/watch?v=6js84WA8f58&list=PLq-Gm0yRYwTiFb-dfmrz4E8g6v6tg-x3j
4. https://www.youtube.com/watch?v=ImIQP9szMGs

13. Books recommended:

1. Zafar Ahsan, Tensor Calculus, , Anamaya Publications, New Delhi.
2. T.J.Whilmore, An Introduction to Differential Geometry, Oxford University Press, New Delhi, 1993.
3. U.C.De & A.A.Shaikh, Differential Geometry of manifolds, Narosa Publishing House Pvt. Ltd, 2007.
4. Barret O' Neill, Elementary Differential Geometry, Academic Press, 2006.

1. Name of the Department: Mathematics						
2. Course Name	Partial Differential Equations			**L**	**T**	**P**
3. Course Code	**MT414**			3	1	0
4. Type of Course (use tick mark)		**Core (□)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	M.Sc (Mathematics) First Semester	**6. Frequency (use tick marks)**	Even (□)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The objective of this course is to form partial differential equations occurring in the various fields of science and engineering and to provide their analytic solutions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understanding of some modern methods for studying linear and nonlinear partial differential equations.
CO2	Students will be able to solve linear partial differential equations of both first and second order

CO3	Students will be able to apply partial derivative equation techniques to predict the behaviour of certain phenomena.
CO4	Students will be able to extract information from partial derivative models in order to interpret reality
CO5	Students will be able to apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialisation.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Topological spaces**

First order partial differential equation, Formulation of first order partial equations, compatibility of first order partial differential equation, classification of the solutions of first order partial differential equation, solutions of Non-linear partial differential equation of first kind.

Unit-2	**Number of lectures =08**	**Title of the unit: Homeomorphism and separation axioms**

Second order partial differential equation, origin of second order partial differential equations, linear partial differential equations with constant coefficients, methods of solving linear partial differential equations, classification of partial differential equations, Riemann's method.

Unit-3	**Number of lectures = 08**	**Title of the unit: Compactness**

Wave equation, solution by the method of separation of variables and integral transforms, The Cauchy problem, Wave equation in cylindrical and spherical polar coordinates.

Unit-4	**Number of lectures = 08**	**Title of the unit: Connectedness**

Laplace equation, solution by the method of separation of variables and transforms. Dirichlets, Neumann's and Churchills problems, Dirichlets problem for a rectangle, half plane and circle, solution of Laplace equation in cylindrical and spherical polar coordinates.

Unit-5	**Number of lectures = 08**	**Title of the unit: Product Topology**

Solutions of boundary value problems: Green's function method for Hyperbolic, Parabolic and Elliptic equations..

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Understanding of some modern methods for studying linear and nonlinear partial differential equations.	**3**	**1**	**1**		**2**	**1**	**1**	**3**
CO2	Students will be able to solve linear partial differential equations of both first and second order	**3**	**1**	**2**		**3**	**1**	**1**	**3**
CO3	Students will be able to apply partial derivative equation techniques to predict the behaviour of certain phenomena.	**3**	**1**	**2**		**3**	**1**	**1**	**3**
CO4	Students will be able to extract information from partial derivative models in order to interpret reality	**3**	**1**	**1**		**2**	**1**	**1**	**3**
CO5	Students will be able to apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialisation.	**3**	**1**	**1**		**2**	**1**	**1**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

1. https://ocw.mit.edu/courses/mathematics/18-152-introduction-to-partial-differential-equations-fall-2011/
2. https://nptel.ac.in/courses/111/103/111103021/
4. https://online.stanford.edu/courses/me300b-partial-differential-equations-engineering

13. Books recommended:

1. Greenspan Donald, Introduction to Partial Differential Equations, Tata McGraw Hill, New Delhi, 1961.
2. I. N. Sneddon, Elements of Partial Differential Equations, Tata McGraw Hill, New Delhi, 1983.
3. Lolenath Debnath, Nonlinear Partial Differential Equations for Scientists and Engineers, Birkhauser , Boston, 2007.
4. Robert C. McQwen, Partial Differential Equations, Pearson Education, 2004.
5. Shankar Rao, Partial Differential Equations, PHI, 2006.

1. Name of the Department: Mathematics						
2. Course Name	**NUMERICAL ANALYSIS**			**L**	**T**	**P**
3. Course Code	**MT415**			3	1	0
4. Type of Course (use tick mark)		**Core (□)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	M.Sc (Mathematics) First Semester	**6. Frequency (use tick marks)**	Even (□)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The course is aimed to develop the skills in numerical analysis which is necessary for grooming them into successful science graduate. The topics introduced will serve as basic tools for specialized studies in science field.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.
CO2	Familiar with numerical solutions of nonlinear equations in a single variable.
CO3	Familiar with finite difference and different type interpolation technique.
CO4	Familiar with calculation and interpretation of errors in numerical method.
CO5	Familiar with programming with numerical packages like C++ and MATLAB

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Topological spaces**

Solution of algebraic and transcendental equations by Bisection method, Iteration methods based on first degree equation; Secant method, Regula Falsi method, Iteration method based on second degree equation; Newton-Raphson's method, Muller's method, Chebyshev method, Rate of convergence of secant and Newton-Raphson's method.

Unit-2	**Number of lectures =08**	**Title of the unit: Homeomorphism and separation axioms**

Various polynomial forms for approximating a given function by Newton's, Gauss's, Stirling's and Bessel's Interpolation formula, Lagrange and Newton's divided difference interpolation, Hermite interpolation, piecewise and cubic spline interpolation.

Unit-3	**Number of lectures = 08**	**Title of the unit: Compactness**

Numerical differentiation using different interpolation formula, Euler Maclaurin formula, Newton's Cote formula, Simpson's ,Guass , legendre, Gaussian and Rohmberg formula for numerical integration and their error estimation.

Unit-4	Number of lectures = 08	Title of the unit: Connectedness

Solution of initial value problems of first and second order by Runga Kutta method, Solution of initial value problems by finite difference equations, Adam's interpolation method and central difference interpolation method, Two points boundary value problems for second order linear and non-homogeneous differential equations, Shooting method with least square convergence criterion.

Unit-5	Number of lectures = 08	Title of the unit: Product Topology

Classification of partial differential equations, solution of Laplace and Poisson's equations by Liebmann's method, solution of one dimensional heat equation by Bender-schmidt method, solution of one dimensional wave equation by Crank-Nicholson's method.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.	3	2	2	1	1	3	1	1
CO2	Familiar with numerical solutions of nonlinear equations in a single variable.	2	2	2	1	1	2	2	1
CO3	Familiar with finite difference and different type interpolation technique.	3	2	3	1	1	2	1	1
CO4	Familiar with calculation and interpretation of errors in numerical method.	3	2	3	1	1	3	2	1
CO5	Familiar with programming with numerical packages like C++ and MATLAB	3	2	1	1	1	2	1	1

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/111107105/lec6.pdf
2. https://nptel.ac.in/content/storage2/courses/122104018/node114.html
3. https://nptel.ac.in/courses/111107062/
4. https://www.yumpu.com/en/document/view/8662778/derivation-of-runge-kutta-method-nptel
5. https://www.youtube.com/watch?v=ntWKMkXAuDA

13. Books recommended:

1. Numerical Methods for Scientific and Engineering computation by M.K.
2. Jain, S.R.K. Iyengar, R.K. Jain, New Age Int. Ltd., New Delhi.
3. Numerical Methods by P. Kandasamy, S. Chand Publ. New Delhi.
4. Introduction to Numerical Analysis, by S.S. Sastry Prentice Hall Flied
5. S.D. Conte & C.D. Boor, Elementary Numerical Analysis

Lothar Collatz, Numerical treatment of differential equations, Springer Ver. Publications.

1. Name of the Department: Mathematics						
2. Course Name	**Linear Algebra**			**L**	**T**	**P**
3. Course Code	**MT416**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. with Mathematics as a major subject.	**6. Frequency (use tick**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: This course enables the students to understand the basic ideas of vector algebra, linear dependent and independent set and basis. Students of the **course** should master properties of matrices including how to use them to solve **linear** systems of equations and how they are used in **linear** transformations between vector spaces.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME	**ATTRIBUTES**
CO1	Students will be able to explain the concept of vector spaces and linear dependency of vectors.
CO2	Students will be able to describe basis, rank of matrices and direct sum of vector spaces.
CO3	Students will be an understanding of linear operators, their properties and algebra of transformations.
CO4	Students will be able to describe Matrix representation of a linear transformation and their applications.
CO5	Students will be able to explain eigen values, change of basis and diagonalization.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:**
Vector spaces, subspaces, examples, Linear dependence and independence, Spanning set, Linear span, Row space of matrix.		
Unit-2	**Number of lectures =08**	**Title of the unit:**
Basis and dimension, Application to matrices, Rank of matrices, Direct sums and complements, Quotient spaces.		
Unit-3	**Number of lectures = 08**	**Title of the unit:**
Students will be an understanding of linear operators, their properties and algebra of transformations.		
Unit-4	**Number of lectures = 08**	**Title of the unit:**
Students will be able to describe Matrix representation of a linear transformation and their applications.		
Unit-5	**Number of lectures = 08**	**Title of the unit:**
Students will be able to explain eigen values, change of basis and diagonalization.		

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO**
CO1	Students will be able to explain the concept of vector spaces and linear dependency of vectors.	**3**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO2	Students will be able to describe basis, rank of matrices and direct sum of vector spaces.	**3**	**2**	**2**	**2**	**2**	**1**	**3**	**3**
CO3	Students will be an understanding of Elementary row operations and their applications to solution of a system of linear equations.	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**2**
CO4	Students will be able to describe Vector spaces and its properties.	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**3**
CO5	Can explain Linear transformation and their matrix representation, rank nullity theorem.	**3**	**2**	**1**	**2**	**3**	**1**	**2**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

1. https://nptel.ac.in/courses/111/105/111105112/
2. https://nptel.ac.in/courses/111/101/111101115/
3. https://nptel.ac.in/courses/111/106/111106135/

13. Books recommended:

1. Hoffman & Kunze: Linear Algebra
2. V Krishnamurthy: An introduction to linear algebra
3. Schaum's Outline Series: Linear Algebra

	1. Name of the Department: Mathematics						
2. Course Name	**PROBLEM SOLVING AND COMPUTER PROGRAMMING THROUGH C**				**L**	**T**	**P**
3. Course Code	**MT417**				3	1	0
4. Type of Course (use tick mark)		**Core (□)**	**DSE ()**		**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B. Sc. with Mathematics	**6. Frequency (use tick marks)**	Even ()				
	7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**			**Practical = Nil**		

8. COURSE OBJECTIVES: Students will be able to understand the concepts of programming Language and design principles along with understanding of C programming in detail so that they can independently create their own program to solve the mathematical problems. Learning the basic programming constructs, they can easily switch over to any other language in future.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)		**ATTRIBUTES**
CO1		Students will Understand the problem solving strategy and programming environment
CO2		Apply different algorithm and identify the way to write the effective program.
CO3		Understand the basics of C declarations, operators and expressions and control structure.
CO4		Able to manipulate arrays and strings in the programming. Analyze the use of functions and concept of function call for modular programming along with effective use of pointers.
CO5		Create complete program independently to solve the mathematical problems

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**		**Title of the unit:**

Problem Identification, Problem Definition, Goal and Objective, Program Design and Implementation issue: Algorithm, Algorithm Generalization, Algorithm representation, Flow Chart. Program writing: sequence, iterative and selection logic. Type of Programming language: Machine level, assembly level, high level and scripting Languages. Programming language tools: Compiler, Interpreter, Linker, Editor.

Unit-2	**Number of lectures =08**		**Title of the unit:**

C fundamentals: Character set, Constants, Identifiers, keywords, basic data types, Variables, Operators, Expressions, Statements, Input and Output statements – Structure of a C program – simple programs. Control statements: if, if-else, nested if, switch, while, do-while, for, break & continue. Nested loops.

Unit-3	Number of lectures = 08		Title of the unit:
	Single dimensional arrays: defining an array, array initialisation, accessing array elements. Programs for sequential search, binary search and bubble sort. Multidimensional arrays: defining a two dimensional array, array initialisation, accessing elements. Programs for matrix additions and multiplications.		
Unit-4	**Number of lectures = 08**		**Title of the unit:**
	Strings: declaring a string variable, reading and displaying strings, Programs for string matching and sorting. Functions: Function definition, function call, function prototype, parameter passing, void function Recursion of function.		
Unit-5	**Number of lectures = 08**		**Title of the unit:**
	Pointers: declaration, operations on pointers, accessing array elements using pointers, processing strings using pointers, pointer to pointer, array of pointers, pointer to function. Files: Different types of files in C. Opening & closing a file. Writing to and reading from a file. Dynamic memory allocation. Storage class associated with variables: automatic, static, and external and register.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Understand the problem solving strategy and programming environment	3	2	2	1	1	2	2	2
CO2	Apply different algorithm and identify the way to write the effective program.	3	2	1	1	1	1	1	2
CO3	Understand the basics of C declarations, operators and expressions and control structure.	3	2	1	1	1	1	1	1
CO4	Able To manipulate strings in the programming. Analyze the use of functions and concept of function call for modular programs along with effective use of pointers.	3	2	1	1	1	2	1	1
CO5	Create complete C program independently to solve the mathematical problems.	3	2	1	1	1	2	2	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self learning / E-learning component

1. https://nptel.ac.in/courses/106105171/
2. http://www.vssut.ac.in/lecture_notes/lecture1424354156.pdf
3. http://www2.cs.uregina.ca/~hilder/cs833/Other%20Reference%20Materials/The%20C%20Programming%20Language.pdf

13. Books recommended:

1. Programming in C (5e) – E. Balaguruswamy , Mc Graw Hill
2. Let us C – Yashwant Kanetkar, BPB.
3. How to Programme C Deitel & Deitel, Addison Wesley, Pearson Education Asia
4. Programming with C - Byron S. Gottfried, Tata McGraw Hill.
5. Computer Programming in C - Kerninghan & Ritchie, PHI .