Parishkar College of Global Excellence

(Autonomous), Jaipur

CHOICE BASED CREDIT SYSTEM (CBCS)

M.Sc.(MATHEMATICS)

(2 YEAR PROGRAM)

Faculty Members

RASHMI.R. BHARDWAJ

DIMPLE SHARMA

ANJALI GUPTA

KULDEEP SAINI

Title of the Program: M. Sc. in Mathematics

Welcome to the Department of Mathematics which joins in

Parishkar College of Global Excellence (Autonomous) Jaipur

Our goal to achieve excellence in teaching and research. The department offers both undergraduate and postgraduate courses in the faculty of Science.

I. About the Department:

Department Aim: The Department of Mathematics continues to uphold the high traditions of teaching and research which have shaped it from the very beginning.

The department aims at providing a stimulating teaching environment, best possible facilities for our faculty and students, particularly in the areas of computer facilities, library facilities and administrative support.

The Department has a computer lab equipped with **MATLAB, Mathematica**, etc. , for the benefit of students and faculty.

The M.Sc. Mathematics program, aims to build strong foundations in core areas of higher mathematics in both the pure and applied areas. It is meant for students who would typically take up careers involving mathematical research or mathematical skills – In academia or in industry. The training imparted to the students helps them master the art of **problem solving**, developing **logical reasoning and computational capabilities** which are essential traits in all walks of life.

Additionally, the knowledge of **mathematical modelling and computational training** which the students acquire during the program makes them highly sought after. In keeping with the demands of industry and academia, the syllabus is updated regularly, with inputs taken from various stakeholders including students, alumni and parents at different stages of the preparation of the syllabus.

The curriculum of the department is so designed as to help in imparting and developing soft skills in the students to enhance the commitment at all levels.

II. M.Sc. Mathematics Program Details:

Program Objectives:

The M.Sc. Mathematics program main objectives are

- To inculcate and develop mathematical aptitude and the ability to think abstractly in the student.
- To develop computational abilities and programming skills.
- To develop in the student the ability to read, follow and appreciate mathematical text.
- Train students to communicate mathematical ideas in a lucid and effective manner.

- To train students to apply their theoretical knowledge to solve problems.
- To encourage the use of relevant software such as MATLAB and MATHEMATICA.

Program Specific Outcomes:

On successful completion of the M.Sc. Mathematics program a student will

- Have a strong foundation in core areas of Mathematics, both pure and applied.
- Be able to apply mathematical skills and logical reasoning for problem solving.
- Communicate mathematical ideas effectively, in writing as well as orally.
- Have sound knowledge of mathematical modelling, programming and computational techniques as required for employment in industry.

Program Structure: The M.Sc. Mathematics program is a two-year course divided into four semesters.

	SEMESTER	SEMESTER
PART-I (FIRST YEAR)	**Semester I**	**Semester II**
PART-II (SECOND YEAR)	**Semester III**	**Semester IV**

Semester-I

Course code and Title along with credits details

S. No	Course Code	Name of Course	Credit
1.	MSc/MAT /1/CC1	**Algebra-I**	6
2.	MSc/MAT/1/CC2	**Differential Equation**	6
3.	MSc/MAT/1/CC3	**Real Analysis**	6
4.	MSc/MAT/1/CC4	**Topology**	6
5.	MSc/MAT/1/CC5	**Numerical Analysis -I**	6
6.	MSc/MAT/1/P1	**Practical-1**	2
7.	MSc/MAT/1/P2	**Practical-2**	2
	Total		34

Semester-II

Course code and Name along with credits details

S. No	Course Code	Name of Course	Credit
1.	MSc/MAT /2/CC1	**Algebra-II**	6
2.	MSc/MAT/2/CC2	**Computational Differential Equation**	6
3.	MSc/MAT/2/CC3	**Lebesgue Measure Theory**	6
4.	MSc/MAT/2/CC4	**Differential Geometry**	6
5.	MSc/MAT/2/CC5	**Numerical analysis-II**	6
6.	MSc/MAT/2/P3	**Practical-3**	2
7.	MSc/MAT/2/P4	**Practical-4**	2
	Total		34

Semester-III

Course code and Name along with credits details

S. No	Course Code	Name of Course	Credit
1.	MSc/MAT /3/CC 1	**Functional analysis**	6
2.	MSc/MAT /3/CC 2	**Fluid dynamics**	6
3.	MSc/MAT /3/DSE-1	**Elective paper-1**	6
4.	MSc/MAT /3/DSE-2	**Elective paper-2**	6
5.	MSc/MAT/3/Seminar	**Seminar**	4
7.	MSc/MAT/3/ P5	**Practical-5**	2
8.	MSc/MAT/3/ P6	**Practical-6**	2
	Total		32

Semester-IV

Course code and Name along with credits details

S. No	Course Code	Name of Course	Credit
1.	MSc/MAT /3/DSE-3	**Elective paper-3**	6
2.	MSc/MAT /3/DSE-4	**Elective paper-4**	6
3.	MSc/MAT/3/DSE-5	**Elective paper-5**	6
4.	MSc/MAT/3/P7	**Practical-7**	2
	TOTAL		20

Discipline Specific Elective papers (Credit: 06 each): Choose 1 fromeach

DSE 1

S.No.	Paper Code	Discipline Specific Elective (DSE) Papers Name	Credit
1.	DSE1/MAT-1001	**Special function**	**6**
2.	DSE1/MAT-1002	**Mathematical programming**	**6**

DSE 2

S.No.	Paper Code	Discipline Specific Elective (DSE) Papers Name	Credit
1.	DSE2/MAT-2001	**Integral Transformation**	**6**
2.	DSE2/MAT-2002	**Mathematical Modelling**	**6**

DSE 3

S.No.	Paper Code	Discipline Specific Elective (DSE) Papers Name	Credit
1.	DSE3/MAT-3001	**Probability & Statistics**	**6**
2.	DSE3/MAT-3002	**Integral Equation**	**6**

DSE 4

S.No.	Paper Code	Discipline Specific Elective (DSE) Papers Name	Credit
1.	DSE4/MAT-4001	**Complex Analysis**	**6**
2.	DSE4/MAT-4002	**Partial Differential Equation**	**6**

DSE 5

S.No.	Paper Code	Discipline Specific Elective (DSE) Papers Name	Credit
1.	DSE4/MAT-5001	**Tensor Analysis**	**6**
2.	DSE4/MAT-5002	**Theory of Relativity**	**6**

Course: Mathematical Practicum and Assignment

Practical/Tutorial (Credit: 02 each) :

Sem.	Paper Code	Course Name (Computer Software)	Credit
I	**CP/MAT-101(A)**	**SCILAB**	**2**
I	**CP/MAT-101(B)**	**C Programming**	**2**
II	**CP/MAT-201(A)**	**Power BI**	**2**
II	**CP/MAT-201(B)**	**Wolfram Mathematica**	**2**
III	**CP/MAT-301(A)**	**Sage Math**	**2**
III	**CP/MAT-301(B)**	**Tableau**	**2**
IV	**CP/MAT-401(A)**	**Latex**	**2**

Assessment Pattern:

Evaluation will be done on the basis of

1. **Continuous internal assessment (CIA)**
    - Group discussion
    - Assignments
    - Seminar
    - Presentation
    - Practical
    - Open Book Test
    - Quiz
    - Class Test
2. **Mid Semester Examination (MSE)**
3. **Attendance**
4. **End Semester Examination (ESE)**

SYLLABUS OF M.Sc. MATHEMATICS

M.Sc. Mathematics (Semester-I)

Paper – I

Algebra-I

Credit- 6 **Hours- 60**

Course Objectives:-

Understand the Algebraic number system.

- Develop the idea about set and binary operations.
- Understand the concept of group and its properties.

Learning outcomes:

- Students will describe set, relations functions and groups.
- Students will describe types of functions and binary operation.
- Students will acquire knowledge of klien-4 group, cyclic group and order of group and length of cycles.
- Students will get knowledge permutation and permutation group.

Learning and Teaching Strategies:-

Approach in teaching:- Interactive lectures, Discussion, PPT presentation.

Learning activities for the students:-

Self-learning, peer learning, assignments, effective questions, presentation.

Assessment Strategies:-

Quiz, Poster presentation, PPT, open book test, End Semester exams.

Prerequisites:

Basic group theory, basic linear algebra

UNIT 1.

Direct product of groups (external and internal), Isomorphism theorems, Diamond isomorphism theorem, Butterfly lemma, Conjugate classes.

UNIT 2.

Commutators, Derived subgroups, Normal series and solvable groups, Composition series, Refinement theorem and Jordan-Holder theorem for infinite groups.

UNIT 3.

Modules, Submodules, Quotient modules, **Direct sums and module homomorphisms, Generation of modules, Cyclic modules**

UNIT 4

Extension fields, Algebraic and transcendental extensions, Separable and inseparable extensions, Normal extensions, Splitting fields.

Suggested Readings:

1. D. S. Dummit and R. M. Foote, Abstract Algebra, Third edition, Wiley India, 2011

2. I. N. Herstein, Topics in Algebra, Second edition, John Wiley and sons, 2000
3. J. Rotman, An introduction to the theory of groups, Fourth
4. Dileep S. Chauhan and K.N. Singh, Studies in Algebra, JPH, Jaipur, 2011.
5. P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra,Cambridge University Press, 1995.
6. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.

Paper – II

Differential Equations

Credit- 6 **Hours- 60**

Course Objectives:

The objective of this course is to study the solutions of first order ODE's, linear second order ODE's, boundary value problems, eigen values and eigen functions of Sturm Lioville systems, stability of systems of ODEs and PDEs.

Course Learning Outcomes: After studying this course the student will be able to

CO1.- know about existence, uniqueness and continuity of solutions of first order ODE's, properties of zeros of solutions of linear second order ODE's, boundary value problems.

CO2.-understand with eigen values and eigen functions of Sturm Liouville systems, and the solutions of initial and boundary value problems.

CO3. be well equipped to undertake any advanced course on ordinary as well as partial differential equations..

Learning and Teaching Strategies:-

Approach in teaching:- Interactive lectures, Discussion, PPT presentation.

Learning activities for the students:-

Self-learning, peer learning, assignments, effective questions, presentation.

Assessment Strategies:-

Quiz, Poster presentation, PPT, open book test, End Semester exams.

Contents:

Unit I:

Non-linear ordinary differential equations of particular forms, Riccati's equation: General solution and the solution when one, two or three particular solutions are known, Total differential equations.

Unit II:

Second order partial differential equations: Formulation and classification of second order partial differential equations, Monge's methods: **Canonical forms, classification of second order partial differential equations of the type Rr+Ss+Tt+ f (x,y,z,p,q)=0** and second order partial differential equations in more than two independent variables, **Method of separation of variables, Laplace,**

Unit III:

Linear homogeneous boundary value problems, Eigen values and eigen functions, Strum-Liouville boundary value problems, Orthogonality of eigen functions, Reality of eigen values, Series solution (all four cases).

Unit IV:

Theory of Green's function for Laplace equation in two dimension and application in solution of Dirichlet and Neumann problem for half plane and circle, Theory of Green's function for Laplace equation in three dimension

Suggested Readings:

[1] E.A. Coddington, An Introduction to Ordinary Differential Equations, Dover Publications, 2012.

[2] T. Myint-U, Ordinary Differential Equations, Elsevier, North-Holland, 1978.

[3] S.L. Ross, Differential Equations, Second Edition, John Wiley & Sons, India, 2007.

[4] I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006

Paper – III

REAL ANALYSIS

Credit- 6 **Hours 60**

Course Objectives:-

1. Understand the real number system.
2. Develop the idea about sequence.
3. Compute the limit of different sequence.

Learning outcomes:

1. Students will describe complete ordered field, related properties and theorems.
2. Students will describe intervals, neighborhood, open sets, closed sets, connected sets.
3. Evaluate various limit problems both algebraically and applicable in real life situations.
4. Students will use the knowledge of set, real number, sequence, limit and limit points in encryption and description.

Learning and Teaching Strategies:-

Approach in teaching:- Interactive lectures, Discussion, PPT presentation.

Learning activities for the students:-

Self-learning, peer learning, assignments, effective questions, presentation.

Assessment Strategies:-

Quiz, Poster presentation, PPT, open book test, End Semester exams.

Prerequisites: Basic knowledge of real analysis and linear algebra

UNIT 1. Quick review of basic Real Analysis:

Construction of real numbers, order on real numbers and the least upper bound property, convergence of sequence and series, power series, multiplication of series, absolute and conditional convergence, rearrangements (with proof of Riemann's Theorem). Continuity, uniform continuity, compactness and connectedness in metric spaces. Differentiation: L' Hospital's rule, derivatives of higher orders, Taylor's theorem, differentiation of vector-valued functions.

UNIT 2. The Riemann-Stieltjes Integral:

Definition and existence of the integral, properties of the integral, integration and differentiation, integration of vector-valued functions, rectifiable curves.

UNIT 3. Sequences and Series of Functions:

Pointwise and uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, equicontinuity.

UNIT 4. Calculus of Several Variables:

Differentiation of functions of several real variables (directional derivatives, partial derivatives, differentiability and the total derivative, chain rule, Jacobian, higher derivatives, interchange of the order of differentiation, Taylor's theorem), inverse function theorem, implicit function theorem.

Suggested Readings:

1. T. M. Apostol, Mathematical Analysis, 2nd edition, Addison-Wesley Publishing Company, Reading, Massachusetts, 1974
2. T. Tao, Analysis I and II, Third editions, Texts and Readings in Mathematics, Hindustan Book Agency, New Delhi, 2006
3. M. Spivak, Calculus on Manifolds: A modern approach to classical theorems of advanced Calculus, West View Press, 27th printing, 1998
4. K. Jänich, Vector Analysis, Undergraduate Texts in Mathematics, Springer, 2001
5. S. Lang, Undergraduate Analysis, Second edition, Springer, 2005

Paper – IV

TOPOLOGY

Credit- 6 **Hours 60**

Course Objectives:

The objective of this course is to study optimality conditions, Lagrangian duality and numerical methods of mathematical programming problems with nonlinear objective and nonlinear constraints.

Course Learning Outcomes:

The students will be able to –

CO1: Analyse properties of topological spaces and construct various topologies on a general set.

CO2: Use continuous functions, homeomorphisms, net and filters to understand structure of topological spaces .

CO3: Correlate the concept of continuity to compact and connected spaces.

CO4: Categorize the separation axioms and produce examples for different topological spaces.

CO5: Understand the concept of product spaces and quotient spaces.

CO6: Apply the topological concepts and constructions to some chosen real world problems

Content

Unit I:

Topological Spaces: Definition and examples, Closed sets, Neighborhood, Open base and sub base, Limit points, **Adhere points and derived sets, Closure of a set.**

Unit II:

Subspaces, Continuity and homeomorphism, Nets, Filters.

Unit III:

Compact and locally compact spaces Connected and locally connected spaces, Continuity and compactness, Continuity and connectedness.

Unit IV:

Separation axioms: T0 space, T1 space, T2 space or Hausdroff space,Regular and T3 spaces, Normal and T4 spaces. **Product spaces: Product space of two spaces, Product invariantproperties for finite products, Quotient spaces**.

Suggested Readings:

1. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 2004.
2. Colin Adams and Robert Franzosa, Introduction to Topology, Pearsons united edition press, 2007.
3. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.
4. Dugundji. J, Topology, Prentice Hall of India, New Delhi, 1975.
5. Munkers R James, A first Course in Topology, Pearson Education Pvt. Ltd., Delhi, 2015.
6. Terry Lawson, Topology: A Geometric Approach, Oxford University press, 2003.
7. John L. Kelley, General Topology, Dover Publications; Reprint edition , 2017

Paper – V

Paper Name: Numerical Analysis-I

Credit -6 **Hours-60**

Course Objectives:

- Understand the finite, forward, backward difference.
- Explore the interpolation, Numerical differentiation and Numerical integrations help to prepare students to succeed in higher level mathematics, Science, Engineering and other courses.
- Understand the Newton-Gregory formula.

Learning Outcomes:-

- Students will describe **Error and Difference**.
- Students will **Prepared the Difference Table.**
- Evaluate **Derive Interpolation formula.**
- Students will calculate Numerical Integration using Trapezoidal rule, Simpson's rule, and Weddle rule.

Learning Activities for the Students:-

Approach in teaching: Interactive lectures, Discussion, PPT presentation.

Assessment Strategies:-

Quiz, PPT, open book test, End Semester exams, Seminars.

Syllabus Content:

Unit-I

Iterative methods- Theory of iteration method, Acceleration of the convergence, Chebyshev method. Muler's method. Method of multipleand complex roots.

Unit-II

Newton's –Raphson method for simultaneous equations. Convergence ofiteration process in the case of several unknowns. Solution of polynomialequations – Polynomials equation ,Real and complex roots, Synthetic division, the Birge- Vieta , Bairstow and Graeff's root squaring method.

Unit- III

System of simultaneous Equations (Linear)-Direct method, Method of determinant, Gauss-Jordan, LU –Factorization- Doolitte's, Crout's and Cholesky's .Partition method. Relaxationmethods.

Unit –IV

Eigen value problems-Basic properties of Eigen values and eigen vector, Power methods, Method for finding all Eigen values of a matrix, **Jacobi, Given's and Rutishauser method. Complex Eigen values.**

Suggested Reading:

1. S.S Sastry, Introductory Methods of Numerical Analysis, PHI, 1979.

2. V Rajaraman, Computer Oriented Numerical Methods, PHI, 1993.

3. M.K. Jain, S.R.K. Eyenger and R.K. Jain, Numerical Methods for Mathematics and Applied Physicists, Wiley- Eastern Pub, N. Delhi, 2005.

Practical – 1

SCILAB

Credit- 2 **Hours-30**

Objectives:

This Course will enable be students to:

1. Families with software SCILAB for numerical computations of the fundamental arithmetic operations.
2. Demonstrate plotting of 2D and 3D curves.
3. To study constructions of a vector/ matrix and operations.
4. Compute the Fundamental Concept of single variable and multivariable calculus.
5. Demonstrate algebraic facility with algebraic topics including linear, quadratic, exponential, logarithm and trigonometric functions.
6. Produce and interpret graphs of basic functions of these types.
7. Solve equations and inequalities in both algebraically and graphically.

Learning Outcomes:-

1. Develop programs in SCILAB.
2. Evaluate analyses and plot results.
3. Good understanding of Linear algebra and signal processing concepts.

Learning and Teaching Strategies:-

Interactive lectures, Discussion, PPT presentations, Informative videos.

Assessment:

1. Performance in the Lab.
2. Practical Record
3. Viva

Syllabus content

1. Introduction of SCILAB.
2. Commands for managing a session input and output commands.
3. Some Primary Mathematical functions(Arithmetic functions ,trigonometric, logarithms, exponentfunction)
4. Commonly used operators and special characters.
5. Vector, Metrix and Array commands.
6. Constructions of a vector with operations on vectors.
7. Metrix representations and some of operations of Metrix.
8. Special Metrix and element operations on Metrix.
9. Eigen values Eigen vectors.
10. Plotting Commands.
11. Create 2D graphs and customized line, plot multiple graphs.
12. Scaling and colouring the line, styles in 2D graphs.
13. Add title axis, labels and legend to graph.
14. 3D graph Plotting, Scaling and colouring and line style in 3D graphs

Reading Suggestions:

Open Source of SCILAB: http//:www.scilab.org
Scilab-6.0.2(64 bit)/scilab-6.0.2 (32-bit)

Practical - 2

C-Programming

Credit:2 **Hours: 30**

Practicals with Computer Programming in C Language.

Programming Languages and Problem solving on computer. Algorithm, Flow chart, Programming in C Constant, Variables , Arithmetic and logical expressions , input/output conditional statements , Implementing loops in Programs, Defining and Manipulation Array and functions.

Practical's list:

1. **Printing n terms of Fibonacci sequence.**
2. **Finding $n!$, $\sum n$, $\sum n^2$**
3. **Defining a function and findings sum of n terms of a series / sequence whose general term is given by $a_n = \left(\frac{n^2+3}{n+1}\right)$.**
4. **Printing Pascal Triangle.**
5. **Finding GCD and LCM. of two numbers by Euclid's Algorithm.**
6. **Checking Prime/Composite Numbers.**
7. **Finding number of Primes less then n, $n \in$Z.**
8. **Finding mean, Standard deviation and n_{p_r} , n_{c_r} for different n and r .**
9. **WAP in C to create a pyramids and patterns.**
10. **WAP in C to Print "HELLO WORLD".**
11. **WAP in C to find largest and Smallest number.**
12. **WAP in C to add two given matrix of order $3x3$**
13. **WAP in C to Multiply two given matrix of order $3x3$.**
14. **WAP in C to transpose of a Square matrix.**
15. **WAP in C to Subtract two given matrix of order $3x3$.**
16. **WAP in C to calculate the median.**

Suggested Readings:

C++ Software: Emulated Turbo C++ Turbo

M.Sc. Mathematics (Semester-II)

Paper – I

Algebra-II

Credit-6 **Hours-60**

Course Objectives:-

Understand the Algebraic number system.

- Develop the idea about set and binary operations.
- Understand the concept of group and its properties.

Learning outcomes:

1. Describe vector spaces and their applications in real life problems.
2. Differentiate between linear transformations and functions defined on same domains.
3. Identify eigen values, eigen vector of various metrices
4. Describe bilinear forms, quadratic forms, related properties, theorems and their uses.
5. Use the knowledge of inner product spaces in security systems.
6. Analyse orthogonality, various inequalities and their applications in real life problems**.**

Learning and Teaching Strategies:-

Approach in teaching: Interactive lectures, Discussion, PPT presentation.

Learning activities for the students:-

Self-learning, peer learning, assignments, effective questions, presentation.

Assessment Strategies:-

Quiz, Poster presentation, PPT, open book test, End Semester exams.

SYALLABUS CONTENT

Prerequisites: Basic knowledge of ring theory

UNIT 1

Linear transformation of vector spaces, Dual spaces, Dual basis and their properties, Dual maps, Annihilator.

UNIT 2

Matrices of a linear map, Matrices of composition maps, Matrices of dual map, eigen values, eigen vectors, Rank and nullity of linear maps and matrices, **Invertible matrices, Similar matrices, Diagonalization of matrices**.

UNIT 3

Determinants of matrices and its computations, Characteristic polynomial and eigenvalues, Minimal polynomial, Cayley-Hamiltton theorem.

UNIT 4

Linear forms: Definition and examples, **Matrix of a bilinear form, Orthogonality, Classification of bilinear forms,Quadratic forms**.
Real inner product space, Schwartz's inequality, Orthogonality, Bessel's inequality, Adjoint, Self-adjoint linear transformations and matrices.

Suggested Reading:

1. D.S. Dummit and R.M. Foote, Abstract Algebra, Third edition, Wiley India, 2011
2. I. N. Herstein, Topics in Algebra, Second edition, John Wiley and sons, 2000
3. M. Artin, Algebra, Prentice Hall, Inc., Englewood Cliffs, NJ, 1991
4. S. Lang, Algebra, Graduate Texts in Mathematics 211, revised third edition, Springer-Verlag, New York, 2002
5. E. Artin, Edited and supplemented with a section on applications by Arthur N. Milgram, Second edition, with additions and revisions, Fifth reprinting, Notre Dame Mathematical Lectures, No. 2, University of Notre Dame Press, South Bend, Ind. 1959

Paper – II

COMPUTATIONAL DIFFERENTIAL EQUATIONS

Credit -6 **Hours-60**

Course Objectives:

The aim of this course is to enable students to design and analyze numerical methods to approximate solutions to differential equations for which finding an analytic (closed-form) solution is not possible. This course is devoted to learning basic scientific computing for solving differential equations. The concept and techniques included in this course enable the student to construct and use elementary MATLAB, MATHEMATICA programs for differential equations.

Course Learning Outcomes: After studying this course the student will be able to

1. Understand the key ideas, concepts and definitions of the computational algorithms, originsof errors, convergence theorems.
2. Decide the best numerical method to apply to solve a given differential equation and quantifythe error in the numerical (approximate) solution.
3. Analyze an algorithm's accuracy, efficiency and convergence properties. Contents:

Learning and Teaching Strategies:-

Approach in teaching: Interactive lectures, Discussion, PPT presentation.

Learning activities for the students:-

Self-learning, peer learning, assignments, effective questions, presentation.

Assessment Strategies:-

Quiz, Poster presentation, PPT, open book test, End Semester exams.

SYALLABUS CONTENT

Unit I:

Initial Value Problems (IVPs) for the system of ODEs, Difference equations, **Numerical Methods, Local truncation errors, Global truncation error, Stability analysis, Interval of absolute stability, Convergence and consistency**.

Unit II:

Single-step methods, Taylor series method, Explicit and implicit Runge–Kutta methods and their stability and convergence analysis, Extrapolation method, Runge–Kutta method for the second order ODEs and Stiff-system of differential equations.

Unit III:

Multi-step methods, Explicit and implicit multi-step methods, General linear multistep methods and their stability and convergence analysis,Adams–Moulton method, Adams–Bashforth method, Nystorm method, Multistep methods for second order IVPs.

Unit IV:

Boundary Value Problems (BVPs), Two point non-linear BVPs for second order ordinary differential equations, Finite difference methods, **Convergence analysis, Difference scheme based on quadrature formula, Difference schemes for linear eigen value problems**,

Suggested Readings:

[1] K.E. Atkinson, W. Han and D.E. Stewart, Numerical Solution of Ordinary Differential Equations, John Wiley & Sons, 2009.

[2] J.C. Butcher, Numerical Methods for Ordinary Differential Equations, Third Edition, John Wiley & Sons, 2016.

[3] J.D. Lambert, Numerical Methods for Ordinary Differential Systems: The Initial Value Problem, John Wiley & Sons, 1991

Paper – III

Paper Name: LEBESGUE MEASURE THEORY

Credit -6 **Hours-60**

Learning outcomes: At the end of this module students should be able to:

- Understand the construction and properties of Lebesgue measure, including the notion and properties of null set;
- Understand the construction of the Lebesgue integral and know its key properties;
- Compute Lebesgue integrals using the Fundamental Theorem of Calculus, Monotone and Dominated Convergence Theorems, and the Tonelli and Fubini Theorems.

Learning and Teaching Strategies:-

Approach in teaching: Interactive lectures, Discussion, PPT presentation.

Learning activities for the students:-

Self-learning, peer learning, assignments, effective questions, presentation

Assessment Strategies:-

Quiz, Poster presentation, PPT, open book test, End Semester exams

Prerequisites: Real Analysis, topology

Unit -I

Quick review of Riemann Integration

Lebesgue Measure on R: **Outer measure, outer regularity of outer measure, Lebesgue measure, regularity of Lebesgue measure, non-measurable sets.**

Unit-II

Lebesgue Integral: **Simple functions, almost everywhere property, measurable functions, integrable functions, approximation of integrable functions by step and continuous functions**

Convergence of sequence of functions: **Pointwise, uniform, Egorov's theorem, Lusin's theorem.**

Unit-III

Abstract measure spaces: **Sigma algebras and measurable spaces, measures and measure spaces, completeness of a measure, measurable functions and their integration,**

monotone convergence theorem, Fatou's lemma, dominated convergence theorem, modes of convergence.

Unit-IV

Product measure: **product sigma algebra, sigma-finite measure spaces, existence of product measures, Tonelli's theorem, Fubini's theorem**.

Suggested Books :

1. T. Tao, An Introduction to Measure Theory, GTM 126, American Mathematical Society, 2011 Supplementary
2. G. B. Folland, Real Analysis: Modern Techniques and their Applications, expanded and revised edition, John Wiley and Sons, 2013
3. W. Rudin, Real and Complex Analysis, Third Edition, McGraw- Hill, 1987

Paper – IV

Paper Name: Differential Geometry

Credit -6 **Hours-60**

Course Objectives:

The primary objective of this course is to understand the notion of level sets, surfaces as solutions of equations, geometry of orientable surfaces, vector fields, Gauss map, geodesics, Weingarten maps, line integrals, parametrization of surfaces, areas, volumes and Gauss–Bonnet theorem.

Course Learning Outcomes: After studying this course the student will be able to

1. Uunderstand the concepts of graphs, level sets as solutions of smooth real valued functions vector fields and tangent space.
2. Comfortably familiar with orientation, Gauss map, geodesic and parallel transport on orientedsurfaces.
3. Learn about linear self-adjoint Weingarten map and curvature of a plane curve with applications in geometry and physics.
4. Know line integrals, be able to deal with differential forms and calculate arc length andcurvature of surfaces.
5. Deal with parametrization and be familiar with well-known surfaces as equations in multiplevariables, able to find area and volumes.
6. Study surfaces with boundary and be able to solve various problems and the Gauss–Bonnettheorem.

Learning and Teaching Strategies:-

Approach in teaching: Interactive lectures, Discussion, PPT presentation.

Learning activities for the students: Self-learning, peer learning, assignments, effective questions, presentation.

Assessment Strategies: Quiz, Poster presentation, PPT, open book test, End Semester exams.

Syllabus Content

Unit I:

Graph and level sets, vector fields, tangent spaces

Unit II:

Surfaces, orientation, the Gauss map, geodesics, parallel transport.

Unit III:

Weingarten map, curvature of plane curves, arc length and line integrals, curvature of surfaces.

Unit IV:

Parametrized surfaces, surface area and volume, Surface with boundary, the Gauss Bonnet theorem.

Suggested Readings:

[1] W. Kühnel, Differential Geometry, Curves-Surfaces-Manifolds, Third Edition, American Mathematical Society, 2013.

[2] A. Mishchenko and A. Formentko, A Course of Differential Geometry and Topology, Mir Publishers Moscow, 1988.

[3] A. Pressley, Elementary Differential Geometry, Springer, India, 2004.

[4] J.A. Thorpe, Elementary Topics in Differential Geometry, Springer, India, 2004.

Paper – V

Paper Name: Numerical Analysis -II

Credit -6 **Hours-60**

Course Objectives:

- Understand the finite, forward, backward difference.
- Explore the interpolation, Numerical differentiation and Numerical integrations help to prepare students to succeed in higher level mathematics, Science, Engineering and other courses.
- Understand the Newton-Gregory formula.

Learning Outcomes:-

- Students will describe **Error and Difference**.
- Students will **Prepared the Difference Table.**
- Evaluate **Derive Interpolation formula.**
- Students will calculate Numerical Integration using Trapezoidal rule, Simpson's rule, and Weddle rule.

Learning Activities for the Students:-

Approach in teaching: Interactive lectures, Discussion, PPT presentation.

Assessment Strategies:-

Quiz, PPT, open book test, End Semester exams, Seminars.

Syllabus Content:

Unit I

Curve Fitting and Function Approximations- Least square error criterion. Linear regression, Polynomial fitting and other curve fittings, Approximation of functions by Taylor series and Chebyshev polynomials.

Unit-II

Numerical solution of Ordinary differential Equations-Taylor series method , Picard method, Runge- Kutta methods up to fourth order, Multistep method (Predictor- corrector strategies).

Unit-III

Stability analysis- Single and Multistep methods.BVP's of ordinary differential Equations-Boundary value problems (BVP's), Shooting methods.

Unit-IV

Finite difference methods. Difference schemes for linear boundary value problems of the type

$$y'' = f(x, y), y'' = f(x, y, y') \text{ and } y^{iv)} = f(x, y).$$

Suggested Readings:

1. S.S Sastry, Introductory Methods of Numerical Analysis, PHI, 1979.
2. V Rajaraman, Computer Oriented Numerical Methods, PHI, 1993.
3. M.K. Jain, S.R.K. Eyenger and R.K. Jain, Numerical Methods for
Mathematics and Applied Physicists, Wiley- Eastern Pub, N. Delhi, 2005.
4. B.Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
5. C.F.Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education. India, 7 th edition.2008.
6. C.F.Gerald ,P.O. Wheatley, Applied Numerical Analysis, Addison- Wesley, 1998.
7. S.D. Conte, Cde Boor. Elementary Numerical Analysis, McGraw-Hill.1980.
8. C.E.Froberge, Introduction to Numerical Analysis, (Second Edition), Addition-Wesley, 1979.

Practical – 3

Power BI

Credit- 2 **Hours-30**

Introduction to Power BI:

Need & Importance: Data Visualization, Reporting, Business Intelligence (BI), Traditional BI, Self-Serviced BI, Cloud Based BI, On Premise BI, Power BI Products, Power BI Desktop (Power Query, Power Pivot, Power View), Flow of Work in Power BI Desktop, Power BI Report Server, Power BI Service, Power BI Mobile Flow, of Work in Power BI / Power BI Architecture, A Brief History of Power B Power Query, M Language.

Power Query: Data Transformation, Benefits of Data Transformation, Shape or Transform Data using Power Query, Overview of Power Query / Query Editor, Query Editor User Interface The, Ribbon (Home, Transform, Add Column, View Tabs), The Queries Pane, The Data View / Results Pane, The Query Settings Pane, FormulaBar, Saving the Work, Datatypes, Changing the Datatype of a Column Filter in Power Query, Auto Filter / Basic Filtering, Filter a Column using Text Filters, Filter a Column using Number Filters, Filter a Column using Date Filters, Filter Multiple Columns, Remove Columns / Remove Other Columns, Name / Rename a Column, Reorder Columns or Sort Columns, Add Column / Custom Column Split, Columns, Merge Columns, PIVOT, UNPIVOT Columns, Transpose Columns, Header Row or Use First Row as Headers, Keep Top Rows, Keep Bottom Rows Keep, Range of Rows, Keep Duplicates, Keep Errors, Remove Top Rows, Remove Bottom Rows, Remove Alternative Rows, Remove Duplicates, Remove Blank Rows, Remove Errors, Group Rows / Group By , IF..ELSE Conditions, Transform Column () Types, Remove Columns (), Split Columns (), Replace Value() ,Table. Distinct Options and GROUP BY Options Table. Group (), Table. Sort () with Type Conversions PIVOT, Operation and Table.Pivot (). List Functions Using, Parameters with M Language.

Data Modelling: Data Modelling Introduction, Relationship, Need of Relationship, Relationship Types / Cardinality in General, One-to-One, One-to-Many (or Many-to-One), Many-to-Many, AutoDetect the relationship, Create a new relationship, Edit existing relationships, Make Relationship Active or Inactive, Delete a relationship.

DAX: What is DAX, Calculated Column, Measures, DAX Table and Column Name Syntax, Creating Calculated Columns, Creating Measures Calculated, Columns Vs Measures, DAX Syntax & Operators, DAX Operators, Types of Operators, Arithmetic Operators, Comparison Operators, Text Concatenation Operator, Logical Operator.

Time Intelligence Functions Date and Time Functions:

YEAR, MONTH, DAY , WEEKDAY, WEEKNUM ;FORMAT (Text Function) à Month Name, Weekday Name , DATE, TODAY, NOW ; HOUR, MINUTE, SECOND, TIME ; DATEDIFF, CALENDAR ; Creating Date Dimension Table

Reading Suggestions: **Open Source of POWER BI: https://powerbi.microsoft.com**

Practical – 4

Wolfram Mathematica

Credit- 2 **Hours-30**

OBJECTIVE:

This course will enable the students to -

1. Demonstrate plotting of Cartesian, polar and parametric curves.
2. Produce and draw graphs of basic functions of these types.
3. Demonstrate Graphical plotting of 2D and 3 D figures.
4. Compute the fundamental concepts of integral calculus.

Learning Outcomes:-

The students will be able to –

CO 1: Wolfram Mathematica is software used to perform both simple and complicated mathematical calculations which requires no previous knowledge of or training in computer programming

CO 2: This course is about programming in Mathematica oriented into advanced data analysis and will cover such areas as econometrics in addition to the language of the software itself. Because it can be used for a variety of computational techniques it can be useful for students in mathematics, the sciences, management, economics, finance, accounting and information sciences.

Learning and Teaching Strategies:-

Self-learning assignments, Effective questions, Presentations, Giving tasks,

Assessment: Quiz, Poster Presentations, Individual and group projects,

Syllabus Content

Students are required to familiarize themselves with software MATHEMATICA, for numerical computation on the following topics:

1. Tracing of polar curves. Tracing of multiple polar curves.
2. Tracing of polar curve with angle variation.
3. Plot styling of polar curves.
4. Tracing of parametric curves. Tracing of multiple Parametric curves.
5. Tracing of Parametric curve with angle variation.
6. Plot styling of parametric curves.
7. Tracing of Cartesian line curves of functions of two variables.
8. Tracing of a region of a function of two variables. Tracing of a region of a function of two variables.
9. Plotting of 2 D figures using graphics (points, line, circle, ellipse, disc).
10. Graphical plotting of 3 D figures using graphics (points, line, sphere, cone, cylinder).
11. Indefinite and definite integration of algebraic, trigonometric, exponential and logarithmic functions, their composition & product.
12. Double integration with change the order of integration.

Reading Suggestions:

MATHEMATICA- Stephen Wolfram. Cambridge