JECRC™
UNIVERSITY
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Department of Mathematics

Course Structure and Syllabi

M.Sc. Mathematics Course

Session 2021-23

Faculty of Science

M.Sc. In Mathematics

M.Sc. Mathematics Scheme 2021-23

Total credits for the batch 2021-23 is 98

Summary Sheet

Semester	1st	2nd	3rd	4th	Total
Credits	24	24	24	26	98

Type	Total Credit
Foundation	20
Core	36
Specialization (Including Elective Papers)	62
Interdisciplinary	20
General	0

Semester I

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 24)
Theory	**Algebra-1**	**F**	**MMA001A**	3	1	0	4
	Advanced Analysis	**F**	**MMA002B**	3	1	0	4
	Topology	**F**	**MMA003A**	3	1	0	4
	Riemannian Geometry and Tensor Analysis	**F**	**MMA004A**	3	1	0	4
	Complex Analysis	**F**	**MMA005B**	3	1	0	4
Practical	**Scilab I**	**S**	**MMA030A**			4	2
	Numerical Analysis LAB I	**S**	**MMA031A**			4	2

Semester II

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 24)
Theory	**Algebra-II**	**C**	**MMA006A**	3	1	0	4
	Functional Analysis-I	**C**	**MMA007B**	3	1	0	4
	Integral Transforms	**ID**	**MMA019B**	3	1	0	4
	Calculus of Variation and Special Function	**C**	**MMA009A**	3	1	0	4
	Theory of Optimization	**C**	**MMA010B**	3	1	0	4
	Seminar	**S**	**MMA028A**				2
Practical	**Scilab II**	**S**	**MMA032A**			4	2

Semester III

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 24)
Theory	Differential Equations	S	MMA011B	3	1	0	4
	Functional Analysis-II	C	MMA012B	3	1	0	4
	Numerical Analysis	C	MMA013A	3	1	0	4
ELECTIVES (Any two of the following)							
Theory	Mathematical Modeling	ID	MMA014A	3	1	0	4
	Operations Research	C	MMA015B	3	1	0	4
	Discrete Mathematics	ID	MMA016A	3	1	0	4
	Fluid Dynamics	S	MMA017B	3	1	0	4
	Integral Equations	S	MMA018A	3	1	0	4
	Stochastic Processes & Queuing Theory	S	MMA036A	3	1	0	4
	Probability & Measure Theory	ID	MST002A	3	1	4	4
Practical	Latex LAB	S	MMA033A			4	2
	Numerical analysis LAB II	S	MMA034A			4	2

Semester IV

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 28)
Theory	**Analytic Dynamics**	**ID**	**MMA008C**	3	1	0	4
ELECTIVE (Any three of the following)*							
Theory	**Fractional Calculus**	**S**	**MMA020B**	3	1	0	4
	Hydrodynamics	**S**	**MMA021A**	3	1	0	4
	Numerical Solution of Partial Differential Equations	**S**	**MMA022A**	3	1	0	4
	Number Theory and Cryptography	**S**	**MMA023A**	3	1	0	4
	Fuzzy Sets and Applications	**S**	**MMA024A**	3	1	0	4
	Advanced Graph Theory	**S**	**MMA025A**	3	1	0	4
	Sampling Distribution & Testing of Hypothesis	**S**	**MMA026B**	3	1	0	4
	Non-linear Dynamical Systems	**S**	**MMA027A**	3	1	0	4
	Major Project (Dissertation)	**C**	**MMA029A**				8
Practical	**Latex beamer LAB**	**S**	**MMA035A**			4	2

*More Elective papers can be added subject to the availability of subject experts.

C-Core **F-Foundation**

S-Specialization **ID- Interdisciplinary**

G-General

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

Student can choose following subjects from "Swayam Portal" for fulfillment of their credits in the semester (depending upon the availability of the course on Swayam Portal).

1. **Operation Research**
2. **Functional Analysis**

Note:

1. The maximum number of students taking an elective shall be 35(preferably).
2. The electives will be offered to the students through counselling in the department based on the marks obtained in the first two semesters.

Break-up of practical mark allotment (of 35 marks)
Practical Record: 5 marks
Actual practicals: 20 marks
Question bank answers: 5 marks
(Spiral bound book with the answers in the candidates own handwriting) Viva: 5 marks

Break-up of internal assessment marks for theory (of 20 marks)
Attendance: 5 marks
Assignment: 15 marks

Break-up of internal assessment marks for practical (of 15 marks)

Preparatory practical exam or two internal tests: 15 marks

Break-up of project work mark allotment (of 70 marks)
Project Report : 10 marks
Actual project : 40 marks
Question bank answers : 10marks
(Hard bound book)
Viva : 10 marks

Objectives

Our Master of Science program is a versatile degree that provides students with the optimal balance between a defined sequence of study and flexible course options.

Mathematics is one of the most enduring fields of study, and is essential in an expanding number of disciplines and professions. Our unique program will help you combine your knowledge of mathematics and solve problems in the physical and biological sciences, engineering, information technology, economics, and business. You will learn study essential topics in calculus, linear algebra and differential equations that can be applied directly to build applications in coding and cryptology, mathematical physics, mathematical biology, bioinformatics and finance.

The M.Sc. course in Mathematics aims at developing mathematical ability in students with acute and abstract reasoning. The course will enable students to cultivate a mathematician's habit of thought and reasoning and will enlighten students with mathematical ideas relevant for oneself and for the course itself.

MISSION AND VISION OF THE NEW SYLLABUS IN MATHEMATICS

Mission

- Improve retention of mathematical concepts in the student.
- To develop a spirit of inquiry in the student.
- To improve the perspective of students on mathematics as per modern requirement.
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics.
- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with the help of software tools on a computer.
- To make the learning process student-friendly by having a shift in focus in mathematical teaching, especially in the mathematical learning environment.
- Exploit techno-savvy nature in the student to overcome math-phobia.
- To setup a mathematics laboratory in every college in order to help students in the exploration of mathematical concepts through activities and experimentation.
- To orient students towards relating Mathematics to applications.

Vision

- To remedy Math phobia through authentic learning based on hands-on experience with computers.
- To foster experimental, problem-oriented and discovery learning of mathematics.
- To prove that the activity-center mathematics laboratory places the student in a problem solving situation and then through self-exploration and discovery habituates the student into providing a solution to the problem based on his or her experience, needs, and interests.
- To provide greater scope for individual participation in the process of learning and becoming autonomous learners.
- To provide scope for greater involvement of both the mind and the hand which facilitates cognition.
- To ultimately see that the learning of mathematics becomes more alive, vibrant, relevant and meaningful; a program that paves the way to seek and understand the world around them. A possible by-product of such an exercise is that math-phobiacan be gradually reduced amongst students.
- To help the student build interest and confidence in learning the subject.

Program Specific Outcome: **M.Sc.** Mathematics program:

PSO1: The Post graduates will become successful professionals by demonstrating logical and analytical thinking abilities (Professional Skills).

PSO2: The Post graduates will work and communicate effectively in inter-disciplinary environment, either independently or in a team, and demonstrate leadership qualities (Problem-Solving Skills).

PSO3: The Post graduates will engage in life-long learning and professional development through self-study, continuing education or professional and doctoral level studies (Successful Career and Entrepreneurship).

Program Outcome(PO's)

Upon completion of the **M.Sc.** Mathematics program, students will be able to:

PO1. Solve complex problems by critical understanding, analysis and synthesis.

PO2. Demonstrate engagement with current research and developments in the subject.

PO3. Evaluate hypotheses, theories, methods and evidence within their proper contexts.

PO4. Select, interpret and critically evaluate information from a range of sources that include books, scientific reports, journals, case studies and the internet.

PO5. Provide a systematic understanding of the concepts and theories of mathematics and their application in the real world to an advanced level, and enhance career prospects in a huge array offields.

PO6. Demonstrate a range of appropriate general skills including ITcompetency.

PO7. Critically interpret data, write reports and apply the basics of rules ofevidence.

SEMESTER- I

MMA001A	Algebra-1	3-1-0 [4]

OBJECTIVE:

- To understand the advanced group theory.
- To understand field extension for metric tensors, Sylow's theorems and Galois theory.
- To develop an understanding of advanced areas inalgebra.

UNIT 1	Conjugate element, Normalizer, The class equation, Cauchy`s theorem for finite abelian group, Sylow *p*-subgroups.
UNIT 2	Direct product of groups. Structure theorem for finitely generated abelian groups.
UNIT 3	Normal and subnormal series. Composition series, Maximal subgroups, Jordan-Holder theorem. Solvable groups. Insolvability of Sn for $n \geq 5$.
UNIT 4	Extension fields. Finite, algebraic, and transcendental extensions, Splitting fields. Simple and normal extensions.
UNIT 5	Perfect fields, Primitive elements, Algebraically closed fields. Automorphisms of extensions. Galois extensions, Fundamental theoremof Galois theory, Galois group over the rationales.

Suggested Readings

1. N. Herstein, Topics in Algebra, Wiley Eastern,1975.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition1977.
3. Ramji Lal, Algebra, Vol.1, Shail Publications, Allahabad 2001.
4. VivekSahai and VikasBist, Algebra, Narosa Publishing House1999.
5. D. S. Malik, J. N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill International Edition,1997.

Course Outcomes

CO1:- Understanding the basic concept of Conjugate element, Normalizer, the class equation, Cauchy`s theorem for finite abelian group, Sylow*p*-subgroups.
CO2:- Understanding the Structure theorem for finitely generated abelian groups.
CO3:- Understanding the basics concepts of normal, subnormal series and solvable groups.
CO4:- Understanding the basic concept of extension of fields.
CO5:- Developing the ability to understand Galois extensions, Fundamental theorem of Galois theory, Galois group over the rationales.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H		L					L	L	H
CO2	M		L		L			L	L	H
CO3	H	L	M	L	H			M	L	M
CO4	M	L	M	L	H	L	L	M	L	M
CO5	H	H	M	M	L	L	L	M	L	M

H = Highly Related; M = Medium; L = Low

MMA002B	Advanced Analysis	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of Real Analysis.
- To focus on basic mathematical concepts in measurable functions.
- To focus on theoretical and mathematical concepts in Lebesgue integral and summable functions.
- To develop an understanding of real analysis.

UNIT 1	Functions of several variables, Derivative of functions in an open subset of $\Re n$ into $\Re m$ as a linear transformation, Chain rule, Partial derivatives
UNIT 2	Algebra and algebras of sets, Algebras generated by a class of subsets, Borel sets, Lebesgue measure of sets of real numbers, Measurability and Measure of a set, Existence of Non-measurable sets.
UNIT 3	Measurable functions, Realization of non-negative measurable function as limit of an increasing sequence of simple functions, Structure of measurable functions, Convergence in measure, Egoroff's theorem.
UNIT 4	Weierstrass's theorem on the approximation of continuous function by polynomials, Lebesgue integral of bounded measurable functions, Lebesgue theorem on the passage to the limit under the integral sign for bounded measurable functions.
UNIT 5	Summable functions, Space of square summable functions. Fourier series and coefficients, Parseval's identity, Riesz-Fisher Theorem.

Text Books:

1. Walter Rudin, Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, International Student Edition,1976.

Reference Books:

1. H. L., Royden, Real Analysis, 4th Edition, Macmillan,1993.
2. E. Hewitt and K. Stromberg, Real and Abstract Analysis, Springer, 1969

Course Outcomes:

CO1:- Understanding the basics concepts of Derivative of functions.
CO2:- Understanding the basics concepts of Lebesgue measure.
CO3:- Understanding the basics concepts of Measurable functions.
CO4:- Understanding the fundamental concept of Lebesgue integral.
CO5:- Developing the ability to understand summable functions.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	L		H	H	M
CO2	H	M		M	H			H	M	M
CO3	M	M	L	M	H		L	M	H	M
CO4	H	M	L	M	L			M	H	M
CO5	H	H	M	M	L	L		H	M	M

H = Highly Related; M = Medium L = Low

MMA003A	Topology	3-1-0 [4]

OBJECTIVE:

- To explain how to distinguish spaces by means of simple topological invariants compactness, connectedness and the fundamental group.
- To explain how to construct spaces by gluing and to prove that in certain cases that the result is homeomorphic to a standardspace.
- To construct simple examples of spaces with given properties e.g. compact but not connected or connected but not pathconnected.

Unit 1	Topological Space; Definition and examples of topological spaces. Closed sets. Closure. Dense sets. Neighborhood, interior, exterior, and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology.
Unit2	Continuous functions and homeomorphism. First and second countable space. Lindelof spaces. Alternative methods of defining a topology in terms of Kuratowski closure operator and neighborhood systems.
Unit 3	Separable spaces. The separation axioms $T0$, $T1$, $T2$, $T3½$, $T4$; their characterizations and basic properties. Urysohn's lemma. Tietze extension theorem.
Unit 4	Compactness. Basic properties of compactness. Compactness and finite intersection property. Sequential, countable, and B-W compactness. Local compactness. One-point compactification. Connected spaces and theirbasic properties. Connectedness of the real line.
Unit 5	Components. Locally connected spaces. Tychonoff product topology in terms of standard sub-base and its characterizations. Product topology and separation axioms, connectedness, and compactness (incl. the Tychonoff's theorem), product spaces. Nets and filters, their convergence, and interrelation. Hausdorffness and compactness in terms of net/filter convergence.

Suggested Readings

1. J. L. Kelley, General Topology, Van Nostrand,1995.
2. K. D. Joshi, Introduction to General Topology, Wiley Eastern,1983.

3. James R. Munkres, Topology, 2nd Edition, Pearson International,2000.
4. J. Dugundji, Topology, Prentice-Hall of India, 1966.
5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
6. N. Bourbaki, General Topology, Part I, Addison-Wesley,1966.
7. S. Willard, General Topology, Addison-Wesley,1970.
8. S.W. Davis Topology, Tata McGraw Hill,2006.

Course Outcomes

CO1:- Understanding the Topological spaces and their properties.
CO2:- Understanding the basics concepts of First and second countable space over deferent spaces.
CO3:- Understanding the basics concepts of Separable spaces.
CO4:- Understanding the compact spaces and connected spaces and their basic properties
CO5:- Developing the ability to understand Nets and filters and their convergence
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MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L		M			H		L	M	H
CO2		L		M	M			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA004A	Riemannian Geometry and Tensor Analysis	3-1-0 [4]

OBJECTIVE:

- To understand the Transformation rules from Cartesian coordinates to curvilinear coordinates.
- To describe methods for metric tensors, Cristoffel symbols, curl, divergence, gradient of tensors calculations.
- To develop an understanding of Riemanniangeometry.

UNIT 1	Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surface of revolution, Geodesic curvature and torsion, Gauss-Bonnet Theorem.
UNIT 2	Tensor Analysis– Coordinates, vectors, Tensors, Transformation of coordinates, Kronecker delta. Contra-variant and Covariant tensors, Symmetric tensors, Fundamental operations with tensors, Quotient law of tensors, Relative tensor.
UNIT 3	Riemannian space. Metric tensor, Indicator, Associate tensors, Length of a curve, Magnitude of a vector, unit vector, Null vector, Angle between two non-null vectors, Permutation symbols and Permutation tensors.
UNIT 4	Christoffel symbols and their properties, Covariant differentiation of tensors. Ricci's theorem, Intrinsic derivative, Geodesics, Differential equation of geodesic, Geodesic coordinates, Fieldof parallel vectors.
UNIT 5	Reimann-Christoffel tensor and its properties. Co-variant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flat space, Isotropic point, Schur's theorem.

Suggested Readings

1. R. S. Mishra, A Course in Tensors with Applications to Riemanian Geometry, Pothishala,Allahabad,1965.
2. Y. Matsushima, Differentiable Manifolds, Marcel Dekker,1972.
3. B. B. Sinha, An Introduction to Modern Differential Geometry, KalyaniPrakashan, New Delhi,1982.
4. Y. Talpiert, Differential Geometry with applications to Mechanics and Physics, Marcel DekkarInc.2001.
5. N.J. Hicks, Notes on Differential Geometry, D. Van Nostrand Inc.,1965.
6. Bansal, J.L. and Sharma, P.R., Differential Geometry: Jaipur Publishing House (2004).
7. Bansal, J.L., Tensor Analysis, Jaipur Publishing House,(2004).

<u>CourseOutcomes</u>

CO1:-Understanding the difference between Cartesian coordinates and curvilinear coordinates.

CO2:-Understanding the basics concepts of Tensors and its components.

CO3:- Understanding the basics concepts of Riemann space metric.

CO4:-Understanding the various techniques to calculate Christoffel symbols, Covariant differentiation oftensors.

CO5:-Developing the ability to understand Einstein space, Bianchi's identity.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA005B	Complex Analysis	3-1-0 [4]

OBJECTIVE:

- To understand the concept of analytic functions, varieties of operations, analyses and problems that may arise within the context of a complex variable
- To study power series and the useful techniques for evaluating contour integrals based on the 'calculus of residues'
- To understand the complex mapping with their applications.

UNIT 1	**Analytic functions**: Introduction. Cauchy Riemann's equations. Complex Integration. Cauchy–Goursat Theorem, Proof of the Theorem ,Simply Connected Domains ,Multiply Connected Domains, Cauchy Integral Formula ,An Extension of the Cauchy Integral Formula, Some Consequences of the Extension, Liouville's Theorem and the Fundamental Theorem of Algebra. Maximum Modulus Principle.
UNIT 2	**Series**: Convergence of Sequences ,Convergence of Series, Taylor Series, Proof of Taylor's Theorem, Laurent Series, Proof of Laurent's Theorem, Absolute and Uniform Convergence of Power Series **Residues and Poles**: Isolated Singular Points, Residues, Cauchy's Residue Theorem, Residue at Infinity, The Three Types of Isolated Singular Points ,Residues at Poles, Zeros of Analytic Functions, Zeros and Poles, Behavior of Functions Near Isolated Singular Points.
UNIT 3	**Application of Residues**: Evaluation of Improper Integrals, Improper Integrals from Fourier Analysis, Jordan's Lemma, Indented Paths, Definite Integrals Involving Sines and Cosines, Argument Principle, Rouch´e's Theorem.
UNIT 4	**Mapping by Elementary Functions**: Linear Transformations ,Linear Fractional Transformations, Mappings of the Upper Half Plane ,Riemann Surfaces **Conformal Mapping, Applications of Conformal Mapping**: Steady Temperatures, Steady Temperatures in a Half Plane, Temperatures in a Quadrant, Electrostatic Potential, Potential in a Cylindrical Space .The Bilinear or Fractional Transformation, The Schwarz–Christoffel Transformation.
UNIT 5	Analytic continuation. Schwarz's Reflection Principle, Infinite Products, Absolute, Conditional and Uniform Convergence of Infinite Products, Some Important Theorems on Infinite Products, Weierstrass' Theorem for Infinite Products, Some Special Infinite Products.

Suggested Readings

1. Brown and Churchill, Complex Variables and Applications, McGraw-Hill Education; 9 edition, 2013
2. Schaum's Outline of Complex Variables, 2ed (Schaum's Outlines) 2nd Edition
3. E. C. Titchmarsh, The Theory of Functions, Oxford UniversityPress,1990.
4. J. B. Conway, Functions of One Complex Variable, Narosa Publishing House,1980.
5. E. T. Copson, Complex Variables, Oxford UniversityPress,1998.
6. L. V. Ahlfors, Complex Analysis, McGraw-Hill,1977.
7. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi,1994.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

CO1 Understand the significance of Cauchy-Riemann equations for analytic function. Differentiability for complex functions and be familiar with the Cauchy-Riemann equations. Will able to evaluate integrals along a path in the complex plane.

CO2 Able to compute the Taylor and Laurent expansions of simple complex functions. Determine the nature of the singularities and calculating residues.

CO3 Will able to solve improper integrals of various types.

CO4 Understand the concept of complex mapping

CO5 Able to identify analytic continuation with their related problems

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							**Program Specific Outcome**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M				M	H	M	L
CO2	H	M	L				M	M	H	M
CO3	H	L	L				M	H	L	L
CO4	H	M	L				M	M	M	L
CO5	H	M	M				L	M	H	L

H = Highly Related; M = Medium; L = Low

MMA030A	Scilab I	0-0-4 [2]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of SCILAB PACKAGE and as a foundation for the development of more advanced concepts inSCILAB.
- Study of this course promotes the development of basic programming skills in SCILAB and some basic introduction of MAXIMAsoftware.

List of programs

1. Introduction to Scilab and commands connected withmatrices.
2. Computations withmatrices.
3. Solving system of equation and explainconsistence.
4. Find the values of some standard trigonometric functions in radians as well as indegree.
5. Create polynomials of different degrees and hence find its real roots.
6. Find $\sum_{n=1}^{500} n$ using loopingstructure.
7. Display Fibonacci series using Scilab program.
8. Display non-Fibonacci series using Scilab program.
9. Introduction to Maxima and matrices computations.
10. Commands for derivatives and n^{th} derivatives.
11. Scilab and Maxima commands for plotting functions.

TEXT BOOKS/OPEN SOURCE MATERIALS

1. http://maxima.sourceforge.net/docs/intromax/intromax.pdf
2. www.scilab.org.
3. Wxmaxima.sourceforge.net

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the SCI LAB mathematical programming environment

CO2: Apply working knowledge of SCI LAB package to simulate and solve matrices, system of equations, trigonometric functions, Fibonacci series and applications.

CO3: Solve, simulate and analyze various matrices.

CO4: Solve, simulate and analyze various system of equations.

CO5: Solve, simulate and analyze trigonometric functions, Fibonacci series.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H							L	M	L
CO2		H						H	H	M
CO3					H	M		L	M	H
CO4		H					H	H	M	M
CO5								H	H	H

H = Highly Related; M = Medium; L = Low

MMA031A	Numerical Analysis I	0-0-4 [2]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of numerical analysis on SCILABPACKAGE.

List of programs:

1. Introduction to Scilab – 2 weeks
2. Fixed Point iterative method
3. Newton-Raphson's method
4. Ramanujan's method
5. Gauss Eliminationmethod
6. Gauss-Seidel iterative method
7. Thomas Algorithm
8. Lagrange Interpolation method
9. Cubic Spline Interpolation method
10. Rational function approximation of Pade Numerical integration over rectangularregion
11. Gaussian Quadrature method
12. Gauss-Chebyshev method

TEXT BOOKS/ OPEN SOURCE MATERIALS

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern (1979), Second Edition.
2. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), Sixth Edition.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).
4. www.scilab.org

REFERENCE BOOKS

1. S.C. Chapra, and P.C. Raymond: Numerical Methods for Engineers, Tata Mc Graw Hill, New Delhi(2000).
2. R.L. Burden, and J. Douglas Faires: Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourthedition.
3. S.S. Sastry: Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi(1998).
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical methods for scientific and Engineering computation, Wiley Eastern(1993).
5. G.D. Smith: Numerical Solutions of partial differential equations 2nd edition London, Oxford University Press(1978).
6. ParuizMoin: Fundamentals of Engineering Numerical analysis, Cambridge University Press(2006).
7. SCILAB- A Free software to MATLAB by Er. Hema Ramachandran and Dr. Achuthsankar
8. S. Nair., S. Chand and Company Ltd.(2008)

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the SCI LAB mathematical programming environment.

CO2: Solution of equations: Newton-Raphson's method, Ramanujan's method, Gauss Elimination method, Gauss Elimination method and Gauss-Seidel iterative method(Using SCI LAB).

CO3: Interpolation: Cubic spline interpolation (Using SCI LAB).

CO4: Numerical integration: Rational function approximation of Pade Numerical integration over rectangular region (Using SCI LAB).

CO5: Gaussian Quadrature method and Gauss-Chebyshevmethod (Using SCI LAB).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H							H	M	H
CO2		H		M		M	H	L	L	M
CO3								L	M	L
CO4								M	M	M
CO5					H			L	L	L

H = Highly Related; M = Medium; L = Low

SEMESTER - II

MMA006A	Algebra-II	3-1-0 [4]

OBJECTIVE:

- To understand the advanced modulus theory.
- To understand advanced ring theory and Canonicalf orms.
- To develop an understanding of advanced areas in algebra.

UNIT 1	Modules, submodules, Quotient Modules, Isomorphism theorems.
UNIT 2	Cyclic modules, simple modules and semisimple modules and rings Schur's lemma. Free modules.
UNIT 3	Noetherian and Artinian modules and rings.
UNIT 4	Hilbert basis theorem. Solution of polynomial equations by radicals. Insolvability of the general equation of degree ≥ 5 by radicals.Finite fields.
UNIT 5	Canonical forms: Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent transformation. The primary decomposition theorem. Jordan blocks and Jordan form.

Suggested Readings

1. N. Herstein, Topics in Algebra, Wiley Eastern,1975.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (2nd Edition),CambridgeUniversity Press,1997.
3. K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Prentice Hall of India,1971.
4. D. S. Malik, J. N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra, McGraw- HillInternational Edition,1997.
5. VivekSahai and VikasBist, Algebra, Narosa Publishing House,1999.
6. Ramji Lal, Fundamentals in Abstract Algebra, Chakra Prakashan, Allahabad,1985.
7. J.S. Golan, Modules & the Structures of Rings, MarclDekkar.Inc.

Course Outcomes

CO1:-Understanding the basic concept of Modules, submodules, Quotient Modules, Isomorphism theorems.

CO2:-Understanding the cyclic modules, simple modules and semisimple modules, rings, Schur's lemma and free modules.

CO3:- Understanding the basics concepts of Noetherian, Artinian modules and rings.

CO4:-Understanding the basic theory of Hilbert basis theorem and solution of polynomial equations.

CO5:-Developing the ability to understand the Canonical form, Jordan blocks, Jordan form and transformations.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L		M		L			M	L	M
CO2	L		M		L			M	L	M
CO3	L	M	M	L	H		L	M	L	H
CO4	L	L	M	L	H		L	H	L	M
CO5	L		L		L	L		L	L	L

H = Highly Related; M = Medium; L = Low

MMA007B	Functional Analysis- I	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of metric spaces.
- To develop an understanding of normed linear spaces and linear transformations.
- To develop an understanding few important applications of normed linear spaces analysis to other branches of both pure and applied mathematics.

UNIT 1	Metric Space, Subspace of a metric space, Product space, Continuous mappings, Sequence in a metric space, Convergence, Cauchy sequence. Complete metric space, Examples of Complete & Incomplete metric spaces.
UNIT 2	Banach contraction theorem and applications. Baire's category theorem, Ascoli-Arzela theorem, compact sets, compact spaces and connected metric spaces. Separable metric space with examples.
UNIT 3	Normed linear spaces. Quotient space of normed linear spaces and its completeness. Banach spaces and examples. Bounded linear transformations. Normed linear space of bounded linear transformations
UNIT 4	Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness. Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundness theorem.
UNIT 5	Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding and Reflexivity of normed spaces. Dual spaces with examples. Inner product spaces.

Text Books:

1. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wileyand Sons (Asia). Pvt. Ltd. 2006.
2. George Bachman and Lawrence Narici, Functional Analysis, Dover,2000.

Reference Books:

1. Jchn B. Conway. A course in Functional Analysis, second edition, Springer-Verlag. 2006.
2. Martin Schechter, Principles of Functional Analysis, second edition. AMS Bookstore, 2002.
3. V.S. Sunder. Functional Analysis. Spectral Theory, Birkhauser Texts, Basel. 1997.

Course Outcomes:

CO1:- Understanding the basic concept of Metric Space, Subspace of a metric space, Convergence.
CO2:- Understanding the compact sets, compact spaces and connected metric spaces
CO3:- Understanding the Normed linear spaces
CO4:- Understanding the Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundness theorem.
CO5:- Understanding the Continuous linear functionals. Hahn-Banach theorem and its consequences, Dual spaces with examples.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	L		H	H	M
CO2	H	M		M	H			H	M	M
CO3	M	M	L	M	H		L	M	H	M
CO4	H	M	L	M	L			M	H	M
CO5	H	H	M	M	L	L		H	M	M

H = Highly Related; M = Medium; L = Low

MMA019B	Integral Transforms	3-1-0 [4]

OBJECTIVE:

- Students will learn theoretical concepts and uses of various Integral Transforms.
- Understand the importance of Laplace, Mellin and Fourier transform
- To solve several technical problems using Laplace Mellin and Fourier transform.

Unit 1	Laplace transform– Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals.
Unit 2	Properties of inverse Laplace transform. Convolution theorem and applications of Laplace transform.
Unit 3	Fourier transform – Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives.
Unit 4	Mellin transform– Definition and elementary properties. Mellin transform of derivatives and integrals. Inversion theorem. Convolution theorem.
Unit 5	Complex inversion formula. Infinite Hankel transform– Definition and elementary properties. Hankel transform of derivatives. Inversion theorem. Parseval Theorem.

Suggested Readings

1. Lokenath Debnath, Dambaru Bhatta, INTEGRAL TRANSFORMS ANDTHEIR APPLICATIONS, 2E (English) 2 2nd Edition, Taylor & Francis India,2006.
2. Mohammad Ahmad, A. N. Srivastava, Integral Transforms and Fourier Series, Narosa Book Distributors Pvt Ltd,2012.
3. Pandey R K, INTEGRAL TRANSFORM AND ITS APPLICATION (English) 01 Edition, Anmol Publications,2007.

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO1 Find Laplace transforms using table and properties. Will able to solve linear differential equations and systems of equations with input functions, such as: continuous, piecewise continuous, unit step, impulse and periodic.

CO2 Students will solve inverse Laplace transforms using table and properties. Solve certain types integral, and integro-differential equations Solve certain classes of linear partial differential equations.

CO3: Find Fourier transforms. Can able to solve certain types of PDE.

CO4: Able to find Mellin transforms.

CO5: Understand Hankel transform with it's definition and properties.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M				M	H	M	L
CO2	H	M	L				M	M	H	M
CO3	H	L	L				M	H	L	L
CO4	H	M	L				M	M	M	L
CO5	H	M	M				L	M	H	L

H = Highly Related; M = Medium; L = Low

MMA009A	Calculus of Variation and Special Function	3-1-0 [4]

OBJECTIVE:

- To understand the basic variational problem and Euler's equation
- To determine types of DEs, which may be solved by application of special functions.
- To analyze properties of special functions by their integral representations and symmetries.
- To classify differential equations by their singularities

UNIT 1	Calculus of variation – Functionals, Variation of a functional and its properties, Variation problems with fixed boundaries, Euler's equation, Extremals, Functional dependent on several unknown functions and their first order derivatives. Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable. Variational problems in parametric form.
UNIT 2	Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Differentiation formulae.
UNIT 3	Linear relation between the solutions of Gauss hypergeometric equation, Kummer's confluent hypergeometric function and its properties, Integral representation, Kummer's first transformation and
UNIT 4	Series solution of Legendre's equation, Legendre polynomials and functions Pn(x) and Qn(x).Besselfunctions Jn(x). Properties of Pn(x) and Qn(x).
UNIT 5	Hermite polynomials Hn(x), Laguerre and Associated Laguerre polynomials.

Suggested Readings

1. A.S. Gupta. Calculus of Variation, Prentice Hall of India Pvt. Ltd,2002.
2. I.M.Gelfand and S. V. Francis. Calculus of Variation, Prentice Hall, NewJersey.
3. Rainiville, E.D. Special Functions. Macmillan & Co. New York(1960).
4. Labedev, W.N. Special Functions and their Applications. Dover,(1972).

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO1 Students will be able to formulate variational problems and analyze them to deduce key properties of system behavior.

CO2 Will able to identify Gauss hypergeometric function with it's solution and integral representation

CO3 Derive the properties of Gauss hypergeometric function (such as recursion relations, derivative relationships, and orthogonality conditions)etc.

CO4 Understand Bessel's and Legendre's equation with it's solution and various properties.

CO5 Understand Hermite's polynomial and Laguerre's equation with it's solution and various properties

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M				M	H	M	L
CO2	H	M	L				M	M	H	M
CO3	H	L	L				M	H	L	L
CO4	H	M	L				M	M	M	L
CO5	H	M	M				L	M	H	L

H = Highly Related; M = Medium; L = Low

MMA010B	Theory of Optimization	3-1-0 [4]

OBJECTIVE:

This course is designed to introduce basic optimization techniques in order to get best results from a set of several possible solutions of different problems viz.

- Linear programming problems,
- Transportation problem,
- Assignment problem and unconstrained and
- Constrained problems etc.
- The major focus will be on formulation of real world phenomena from its physical considerations and implementation of optimization algorithms for solving these problems.

UNIT 1	Formulation of linear programming problem (LPP) -graphical method, Basic Feasible Solution, Extreme Points, Convex set, Convex linear combination, optimal solution of LPP using Simplex, BigM and two-phase methods, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.
UNIT 2	General Primal-Dual pair, Formulating a dual problem, Weak and strong duality theorems, Complementary slackness theorem, Dual simplex method, Economic interpretation of primal-Dual problems. Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.
UNIT 3	Initial basic Feasible solution of transportation problem, Balanced and unbalanced transportation problems, Optimal solutions of transportation problem using U-V /MODI methods
UNIT 4	Assignment problems; Mathematical formulation of assignment problem, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's All-IPP Method, All IPP Algorithm, Branch and Bound Technique
UNIT 5	Concept of convexity and concavity, Maxima and minima of convex functions, Single and multivariate unconstrained problems, constrained programming problems, Kuhn-Tucker conditions for constrained programming problems.

Suggested Readings

1. Edwin K. P. P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Johan Welly.
2. M. C. Joshi & K.M. Moudgalya, Optimization Theory & Practice, Narosa Publ. New Delhi 2004.
3. S.S.Rao, Engg. Optimization: Theory & Practice, New Age Intl. Pub. New Delhi, 2003.
4. Laurence, Fausett, Fundamentals of Neural Networks, Pearson education Ltd,2005.
5. D.E. Goldberg, Genetic Algorithms in neural optimization and machine learning, Pearson Education.Ltd.2004.
6. Sharma S. D., Operations Research: Theory, Methods & Applications, KEDAR NATH RAM NATH-MEERUT, 2011.
7. Kapoor V.K., Operations Research, Sultan Chand & Sons,2004.

Course Outcomes:

At the end of the course, the students will be able to

CO1 Apply the knowledge of basic optimization techniques in order to get best possible results from a set of several possible solution of different problems viz. linear programming problems, transportation problem, assignment problem and unconstrained and constrained problems etc.

CO2 Formulate an optimization problem from its physical consideration.

CO3 Select and implement an appropriate optimization technique keeping in mind its limitations in order to solve a particular optimization problem.

CO4 Understand theoretical foundation and implementation of similar type optimization techniques available in the scientific literature.

CO5 Continue to acquire knowledge and skills of optimization techniques that are appropriate to professional activities.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA032A	Scilab II	0-0-4 [2]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of advance numerical analysis on SCILAB PACKAGE and Plot graphs usingSCILAB.

List of Program:

1. Milne Predictor CorrectorMethod
2. Adam Moulton Predictor CorrectorMethod
3. Runge–Kutta–Fehlbergmethod
4. Finite difference method for BVP(ODE)
5. Finite difference method for Laplace/Poisson equations
6. Initial Boundary Value Problem using Explicit Finite DifferenceMethod
7. Schmidt Method
8. Crank-Nicolsonmethod
9. Crank Nicolson Scheme for DiffusionEquation
10. Shooting method for BVPsODE.
11. Explicit Finite difference method for 1-d waveequation
12. Galerkin Finite Element Methods for ODEBVPs

TEXT BOOKS

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern(1979),Second Edition.
2. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), SixthEdition.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific publications(1991).

REFERENCE BOOKS

1. S.C. Chapra, and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi(2000).
2. R.L. Burden, and J. Douglas Faires: Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourthedition.
3. S.S. Sastry: Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi(1998).
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical methods for scientific and Engineering computation, Wiley Eastern(1993)

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the SCI LAB mathematical programming environment.

CO2: Apply working knowledge of SCI LAB package to simulate and solve ordinary differential equations.

CO3: Solution of ODE: Milne Predictor Corrector Method, Adam Moulton Predictor Corrector Method and Runge–Kutta–Fehlberg method (Using SCI Lab).

CO4: Solution of ODE: Finite difference method for Laplace/Poisson equations, Initial Boundary Value Problem using Explicit Finite Difference Method (Using SCI Lab).

CO5: Solution of 1-D wave equation and BVPs ODE: Shooting method, Explicit Finite difference method and Galerkin Finite Element Methods (Using SCI Lab).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			M				H	L		H
CO2		H						H	M	L
CO3					H	M				M
CO4				M				M	H	
CO5				H					L	

H = Highly Related; M = Medium; L = Low

Semester –III

MMA011B	Differential Equations	3-1-0 [4]

OBJECTIVE:

- To develop an understanding of Non-linear ordinary differential equations of particular forms.
- To develop an understanding the series solution, radius of convergence and method of differentiation.
- To develop an understanding of Partial differential equations of second order with variable co-efficient.
- To develop an understanding of linear homogeneous boundary value problems.
- To develop an understanding of Non-homogeneous boundary value problems.

UNIT 1	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. Forms and solutions, necessary and sufficient condition, Geometrical Meaning Equation containing three and four variables, total differential equations of second degree.
UNIT 2	Series Solution: Radius of convergence, method of differentiation, Cauchy-Euler equation, Solution near a regular singular point (Method of Forbenius) for different cases, Particular integral and the point at infinity.
UNIT 3	Partial differential equations of second order with variable coefficients- Monge's method. Classification of linear partial differential equation of second order, Canonical forms, Cauchy's problem of first order partial differential equation.
UNIT 4	Linear homogeneous boundary value problem, Eigen values and eigen functions, Sturm-Liouville boundary value problems, orthogonality of eigen functions, Lagrange's identity, properties of eigen functions, important theorems of Sturm Liouville system, Periodic functions.
UNIT 5	Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of eigen function expansion). Method of separation of variables, Laplace, wave and diffusion equations. Green's Functions: Non-homogeneous Sturm-Liouville boundary value problem (method of Green's function), Procedure of constructing the Green's function and solution of boundary value problem, properties of Green's function, Inhomogeneous boundary conditions, Dirac delta function, Bilinear formula for Green's function, Modified Green's function.

Reference Books:

1. J.L. Bansal and H.S. Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Rai singhania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
4. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.
5. E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.
6. Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.
7. D.A. Murray, Introductory Course on Differential Equations, Orient Longman,1902.
8. A.R.Forsyth, A Treatise on Differential Equations, Macmillan & Co. Ltd., London, 1956.

Course Outcomes: At the end of the course, the student should be able to:

CO1:- Develop an understanding of Non-linear ordinary differential equations of particular forms.
CO2:- Develop an understanding the series solution, radius of convergence and method of differentiation.
CO3:- Develop an understanding of Partial differential equations of second order with variable co-efficient.
CO4:- Develop an understanding of linear homogeneous boundary value problems.
CO5:-Develop an understanding of Non-homogeneous boundary value problems.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	L	L	M	M	M	H	M	H
CO2	L		M	L	M	M	H	L	L	H
CO3	H	H	M	H			M	M	H	M
CO4	H	M		L	M	L		H	M	H
CO5	H	H	M		L		H	H	H	L

H = Highly Related; M = Medium L = Low

MMA012B	Functional Analysis-II	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of Hilbert space and its properties.
- To develop an understanding of Orthonormal sets and Hilbert space.
- To develop an understanding few important applications of Differential calculus in Banach Space and Integral Calculus in Banach Space.

UNIT 1	Hilbert space and its properties. Cauchy-Schwartz inequality, Orthogonality and Functionals in Hilbert Spaces. Phythagorean theorem, Projection theorem, Separable Hilbert spaces and Examples.
UNIT 2	Orthonormal sets, Bessel's inequality, Existence of orthonormal bases by Gram-schimidt orthogonalization process. Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.
UNIT 3	Adjoint of an operator on a Hilbert space. Self-adjoint, Positive, Normal and Unitary operators and their properties. Projection on a Hilbert space. Invariance. Reducibility. Orthogonal projections. Eigen values and eigen vectors of an operator. Spectrum of an operator Spectral theorem.
UNIT 4	Differential calculus in Banach Space, Differentiability of Mappings between Banach Space, Derivatives of a Composite Map, Directional Derivative, Mean Value Theorem and its Applications, Partial Derivatives, Projection and Canonical Mappings, Derivative Matrix, Continuously differential Maps, Higher Derivatives, Taylor's Formula, Implicit and Inverse Function Theorems.
UNIT 5	Integral Calculus in Banach Space, Fundamental Theorem of Calculus, Mean Value Theorem, Ordinary Differential Equations in a Banach, k-Lipschit Mapping, Existence and Uniqueness Theorems for Approximate Solutions.

Text Books:

1. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wileyand Sons (Asia). Pvt. Ltd.,2006.
2. George Bachman and Lawrence Narici, Functional Analysis, Dover,2000.

Reference Books:

1. Jchn B. Conway. A course in Functional Analysis, second edition, Springer-Verlag. 2006.
2. Martin Schechter, Principles of Functional Analysis, second edition. AMS Bookstore, 2002.
3. V.S. Sunder. Functional Analysis. Spectral Theory, Birkhauser Texts, Basel. 1997.

Course Outcomes:

CO1:- Understanding the basic concept of Hilbert space and its properties, Cauchy-Schwartz inequality.
CO2:- Understanding the Orthonormal sets and its applications.
CO3:- Understanding the Adjoint of an operator on a Hilbert space, Eigen values and eigen vectors of an operator, Spectrum of an operator Spectral theorem.
CO4:- Understanding the Differential calculus in Banach Space, Differentiability of Mappings between Banach Space.
CO5:- Understanding the Integral Calculus in Banach Space, Fundamental Theorem of Calculus, Mean Value Theorem, Ordinary Differential Equations in a Banach, k-Lipschit Mapping, Existence and Uniqueness theorems for approximate solutions.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L	L	H		M			L	M	H
CO2	L		L	M	L			M	M	M
CO3		L	M	M	M			L	L	M
CO4		M	M	L	H	L			M	H
CO5	H	H	M	M	M		L	M	L	H

H = Highly Related; M = Medium L = Low

MMA013A	Numerical Analysis	3-1-0 [4]

OBJECTIVE:

- This course helps students to have an in-depth knowledge of various advanced methods in numericalanalysis.
- This includes solution of algebraic and transcendental equations, finite element method and ordinary and partial differentialequations.

Unit 1	Numerical solutions of integral equations using Newton- Cotes, Lagrange`s linear interpolation and Chebyshev polynomial.
Unit 2	Matrix Computations: System of linear equations, Conditioning of Matrices, Matrix inversion method, Matrix factorization, Tridiagonal systems.
Unit 3	Numerical solutions of system of simultaneous first order differential equations and second order initial value problems (IVP) by Euler and Runge-Kutta (IV order) explicit methods.
Unit 4	Numerical solutions of second order boundary value problems (BVP) of first, second and third types by shooting method and finite difference methods.
Unit 5	Finite Element method: Introduction, Methods of approximation: Rayleigh-Ritz Method, Gelarkin Method and its application for solution of ordinary BVP.

Suggested Readings

1. M. K. Jain, S. R. K. Iyenger and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age Publications,2003.
2. M. K. Jain, Numerical Solution of Differential Equations, 2nd edition,Wiley-Eastern.
3. S. S. Sastry, Introductory Methods of Numerical Analysis,2008.
4. S. Gupta, Text Book on Calculas of Variation, Prentice-Hall of India,2002.

Course Outcomes

CO1:- Understanding the difference between Cartesian coordinates and curvilinear coordinates.
CO2:- Understanding the basics concepts of Tensors and its components.
CO3:- Understanding the basics concepts of Riemann space metric.
CO4:- Understanding the various techniques to calculate Christoffel symbols, covariant differentiation of tensors.
CO5:- Developing the ability to understand Einstein space, Bianchi's identity.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

ELECTIVE (Any two of the following)

MMA014A	Mathematical Modeling	3-1-0 [4]

OBJECTIVE:

- To develop an understanding of MathematicalModeling.
- To develop an understanding of linear growth and decay models, nonlinear growth and decay models, Compartmentmodels.
- To develop an understanding of Basic theory of linear difference equations with constantcoefficients.
- To develop an understanding through linear programming, linear programming models in forest management, Transportation and assignmentmodels.

Unit 1	Simple situations requiring mathematical modeling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models, Some simple illustrations.
Unit 2	Mathematical modeling through differential equations, linear growth and decay models, Nonlinear growth and decay models, Compartment models, Mathematical modeling in dynamics through ordinary differential equations of first order.
Unit 3	Mathematical models through difference equations, some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in economic and finance, Mathematical modeling through difference equations in population dynamic and genetics.
Unit 4	Situations that can be modeled through graphs. Mathematical models in terms of Directed graphs, Mathematical models in terms of signed graphs, Mathematical models in terms of weighted digraphs.
Unit 5	Mathematical modeling through linear programming, Linear programming models in forest management. Transportation and assignment models.

Suggested Readings

1. J. N. Kapur, Mathematical Modeling, Wiley Eastern,2002
2. D. N. Burghes, Mathematical Modeling in the Social Management and Life Science, Ellie Herwood and John Wiley,2000.
3. Edward A. Bender, An Introduction to Mathematical Modeling, Dover publication, 2000.
4. J. N. Kapur, Mathematical Modelling (English) 1st Edition, New Age International Publishers Ltd.-New Delhi,1998.

Course Outcomes

CO1:- Understanding the Simple situations requiring mathematical modeling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models.

CO2:- Understanding the Mathematical modeling through differential equations, linear growth and decay models, Non-linear growth anddecay models, Compartment models, Mathematical modeling in dynamics through ordinary differential equations of first order.

CO3:- Understanding the Mathematical models through difference equations, some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in economic and finance, Mathematical modeling through difference equations in population dynamic and genetics.

CO4:- Understanding the Situations that can be modeled through graphs. Mathematical models in terms of Directed graphs, Mathematical models in terms of signed graphs, Mathematical models in terms of weighted digraphs.

CO5:- Understanding the Mathematical modeling through linear programming, Linear programming models in forest management. Transportation and assignment models.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H		L					L	L	H
CO2	M		L		L			L	L	H
CO3	L	H	M	L	H	H	H	M	L	H
CO4	M	H	M	H	H	L	L	H	L	M
CO5	H	H	M	H	M	L	H	M	L	M

H = Highly Related; M = Medium; L = Low

MMA015B	Operations Research	3-1-0 [4]

OBJECTIVE:

- To understand the queueingtheory.
- To describe methods for solving multi-objective programmingmethods.
- To develop an understanding of linear fractional and goalprogramming.
- To develop an understanding of Game theory.
- To understand the solving Methods for Network problems and project management.

Unit 1	Introduction to Queues and Queueing Theory, Characteristics of queueing systems, Birth-Death Process, Basic Queueing Theory (M/M/-/- Type Queues.
Unit 2	Basic Concept of Multi Objective and Multi Level Optimization. Integer Programming Mixed Integer Programming.
Unit 3	Linear Fractional Programming. Goal Programming.Sensitivity Analysis.
Unit 4	*Game Theory:* Introduction, Competitive Situations, Characteristics of Competitive Games, Maximin – Minimax Principle, Dominance.
Unit 5	Network Problems: Dijkstra's Algorithm, maximum flow problem and minimum spanning tree.NetworkScheduling by PERT/CPM.

Suggested Readings

1. F. S. Hiller and G. J. Leiberman, Introduction to Operations Research (6th Edition), McGraw-Hill International Edition,1995.
2. G. Hadley, Nonlinear and Dynamic Programming, AddisonWesley,1998.
3. H. A. Taha, Operations Research –An Introduction,Macmillan,2002
4. KantiSwarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi,2004.
5. S. S. Rao, Optimization Theory and Applications, WileyEastern,1998
6. N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., NewDelhi,2004.

Course Outcomes

CO1:-Understanding the basics concepts of queueing theory.
CO1:-Understanding the multi-objective programming methods.
CO3:- Understanding the basics concepts of linear fractional and goal programming.
CO4:-Understanding the various techniques to game theory.
CO5:-Developing the ability to understand network problems and project management.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA016A	Discrete Mathematics	3-1-0 [4]

OBJECTIVE:

- Students will learn core ideas in graph theory, advance graph theory andtrees.
- Understand the importance of the discrete mathematical topics for appliedscience.
- To construct mathematical models for several technical problems using theory of Computation.

Unit 1	Graph Theory: Definition of a graph, applications, Incidence and degree, Matrix representations of graph. Isolated and pendant vertices, Null graph, Isomorphism, Subgraphs, Walks, Paths and circuits, connected graphs, disconnected graphs, and components.
Unit 2	Graph Theory: Bipartite graphs. Planar graphs and their properties. Euler and Hamiltonian graph. Euler's formula for connected planar graphs. Dijkstra's algorithm Warshal's algorithm.
Unit 3	Trees: Trees and its properties, minimally connected graph, Pendant vertices in a tree, distance and centers in a tree, rooted and binary tree. Levels in binary tree, height of a tree, Spanning trees, rank and nullity. Minimal spanning trees, Kruskal's Algorithms., Directed trees, Search trees, Traversals
Unit 4	Theory of Computation: Finite automata, Deterministic and non-deterministic finite automata, Moore and Mealy machines. Regular expressions. Grammars and Languages, Derivations, Language generated by a grammar. Regular Language and regular grammar. Regular and Context free grammar, Context sensitive grammars and Languages. Pumping Lemma, Kleene's theorem.
Unit 5	as language acceptors. Universal Turing machines. Turing machine halting problem. Turing Machines: Basic definitions. Turing machines

Suggestd Readings

1. F. Harary, Graph Theory, Narosa,2002.
2. NarsinghDeo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India,2003
3. W. T. Tutte, Graph Theory, Cambridge University Press,2001
4. J. E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata,Languages, and Computation (2nd edition), Pearson Edition,2001.
5. P. Linz, An Introduction to Formal Languages and Automata, 3rd Edition, 1998.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

CO1 Students will understand the language of graphs andtrees.

CO2 Students will understand the use of graphs asmodels.

CO3 Students will understand various types of trees and methods for traversingtrees.

CO4 Apply the knowledge and skills obtained to investigate and solve a variety ofdiscrete mathematicalproblems

CO5 Communicate both technical and non-technical information in a range of forms (written, oral, electronic, graphic). Make effective use of appropriatetechnology. Reflect on your own learning and that ofpeers.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M				M	H	M	L
CO2	H	M	L				M	M	H	M
CO3	H	L	L				M	H	L	L
CO4	H	M	L				M	M	M	L
CO5	H	M	M				L	M	H	L

H = Highly Related; M = Medium; L = Low

MMA017B	Fluid Dynamics	3-1-0 [4]

OBJECTIVE:
• To teach students fundamental of fluid dynamics.
• To teach student's flow between parallel flat plates and flow between cylinders.
• To teach students Navier-Stokes equations of motion and its applications.
• To teach students Momentum integral theorems with applications.
• To teach students viscosity and non-dimensional parameters.

Unit 1	The concept of a fluid. Forces act on a fluid. Lagrangian and Eulerian equation of motion. Boundary surface. Stream lines. Path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vortex lines.
Unit 2	Flow between parallel flat plates: Couette and plane Poiseuille flows. Flow through a pipe: Hagen Poiseuille flow, flow between two co-axially cylinders and two concentric rotating cylinders.
Unit 3	Navier-Stokes equation of motion. Complex velocity potential. Sources, sinks, doublets and their images. Conformal mapping, Milne-Thomson circle theorem. Theorem of Blasius
Unit 4	Boundary layer displacement and momentum thicknesses. Momentum integral theorems with applications. Effect of pressure gradient on the boundary layer development. Separation of boundary layer flow.
Unit 5	Viscosity. Analysis of stress and rate of strain. Stoke's law of friction. Thermal conductivity and generalized law of heat conduction. Non dimensional parameters and their physical importance.

Suggested Readings

1. F. Charlton, A Text Book of Fluid Dynamics, CBC, 1985.
2. S. W. Yuan, Foundations of Fluid Mechanics, Prentice-Hall, 1976.
3. Bansal, J.L., Viscous Fluid Dynamics, Oxford & IBH Publishing Co Pvt.Ltd, 1997.
4. Klaus Gersten H Jr Oertel H Schlichting Hermann Schlichting Herrmann Schlichting K Gersten, Boundary-Layer Theory 0008 Edition (English), Springer, 2000.

Course Outcomes: On completion of the course the student shall be able to:
1. Understand the fundamentals of Lagrangian and Eulerian equation of motion
2. Understand the niceties of different types of flows.
3. Understand the basics of Navier-Stokes equation of motion.
4. Understand the importance of Momentum integral theorems.
5. Understand can convert a dimensional equation to non- dimensional equation.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		M	H		M			M	M	H
CO2			M	M	H			M	M	H
CO3		M	M	M	H			M	L	M
CO4		M	M	M	H	M			M	M
CO5	H	H	M	M	M		M	M	M	H

H = Highly Related; M = Medium; L = Low

MMA018A	Integral Equations	3-1-0 [4]

OBJECTIVE:

- To understand the modeling of problems as integral equations.
- To understand existence of the solutions of integral equations.
- To develop an understanding of advanced areas in integral equations.

Unit 1	Classification of integral equations of Volterra and Fredholm types. Conversion of intitial and boundary value problem into integral equation. Conversion of integral equations into differential equations
Unit 2	Volterra and Fredholm integral Fredholm integral equations: Degenerate kernels, Method of successive approximation.
Unit 3	Resolvent kernels and Neumann series method for solution of integral equations
Unit 4	Integral equation with symmetric kernels.Use of Laplace and Fourier Transformto solve integral equations.
Unit 5	Definition of a boundary value problem for an ordinary differential equation of the second order and its reduction to a Fredholm integral equation of the second kind; Dirac Delta Function; Green Function for ordinary differential initial and boundary value problem.

Suggested Readings

1. Abdul J. Jerry, Introduction to Integral Equations with applications, Marcel Dekkar Inc. NY,1990.
2. L.G.Chambers, Integral Equations: A short Course, Int. Text Book Company Ltd. 1976,
3. R. P. Kanwal, Linear Integral Equations, Springer Science & Business Media, 07-Nov-2012 Harry Hochsdedt, Integral Equations, John Wiley and Sons,1973.

Course Outcomes

CO1:- Understanding the basic concept of integral equations.
CO2:- Understanding the theory of Volterra integral equations and their numerical solutions.
CO3:- Understanding the basics concepts of Greens function for Fredholm Integral equations.
CO4:- Understanding the basic theory of Fredholm integral equations and their solutions.
CO5:- Developing the ability to understand the existence of the solutions of integral equations.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L				L	L	M	L	L	M
CO2	M	L	L		L		L	M	L	M
CO3	H	L	L	L	H		L	M	L	M
CO4	H	L	M	L	H		L	M	L	H
CO5	M	H	H	L	L			H	L	H

H = Highly Related; M = Medium; L = Low

MMA036A	Stochastic Processes & Queuing Theory	3-1-0 [4]

OBJECTIVE:

- To develop the Basic concepts of discrete and continuous random variables and probability distributions.
- Understanding the Joint distributions, Conditional distribution and law of large numbers.
- To develop the basics of Stochastic Process with Markov chain and Markov Process.
- Making students familiar with Queuing Theory and it's different models.

Unit 1	**Random Variables:** Introduction, Distribution and density functions, Discrete and continuous random variables, Bernoulli, Binominal, Poisson, (Gaussian), Exponential, Rayleigh, Uniform distributions. Functions of one random variable: distribution, mean, variance, moments and characteristics functions.
Unit 2	**Multiple Random Variables:** Distributions, Two functions of two random variables, Joint moments, Joint characteristics functions, Conditional distributions, conditional expected values, statistical independence. Multiple random variables: multiple functions of multiple random variables, jointly Gaussian random variables, sums of random variable, Multivariate normal distribution, Distribution of quadratic forms. Transforms and generating functions, laws of large numbers, Central limit theorem.
Unit 3	**Stochastic Processes:** Definitions, Random process concept, Introduction to Stochastic Processes (SPs): Definition and examples of SPs, classification of random processes according to state space and parameter space, types of SPs, elementary problems. Stationary Processes: Weakly stationary and strongly stationary processes, moving average and auto regressive processes. Power spectrum of stochastic processes, Gaussian and White processes, Properties of power spectral density.
Unit 4	Discrete-time Markov Chains (DTMCs): Definition and examples of MCs, transition probability matrix, Chapman-Kolmogorov equations; calculation of n-step transition probabilities, limiting probabilities, classification of states, ergodicity, transient Markov Chain, Markov Analysis.
Unit 5	**Queuing Theory**: Pure birth, pure death and birth-death processes. Mathematical models for M/M/1, M/M/N, M/M/S and M/M/S/N queues. Discrete Parameter Markov chains: M/G/1 Queuing model, Discrete parameter birth-death process.

Recommended Books:

1. Devor –Probability and statistics for engineering and sciences, Cengage learning 2011
2. Mendenhall – Introduction to probability and statistics, Cengage learning 2012
3. Probability Theory and Stochastic Processes for Engineers, Bhat, Pearson 2011
4. Probability and Random Processes with Application to Signal Processing, 3/e, Stark, Pearson 2002
5. Stochastic Processes, J. Medhi 3rd Edition, New Age International 2009.
6. Stochastic Process, S. M. Ross,2nd Wiley , 1996.
7. Random Processes: Filtering, Estimation and Detection, Ludeman, Wiley 2002 8 An Introduction to Probability Theory & Its App., Feller, Wiley 1969
8. R. Nelson, Probability, Stochastic Processes, and Queueing Theory: The Mathematics of Computer Performance Modelling, Springer-Verlag, 1995.
9. E. Gelenbe, and G. Pujolle, Introduction to Queueing Networks, 2nd Edition, John Wiley, 1998.
10. R.B. Cooper, Introduction to Queueing Theory, 2nd Edition, North-Holland, 1981.
11. Probability, Statistics And Random Processes, Veerarajan.

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO1 Understand the Basic concept of a random variable and probability distributions.

CO2 Understanding the basics concepts of Joint distributions, Conditional distribution and law of large numbers.

CO3 Understand the Properties of random processes and Stochastic Process.

CO4 Understand the concept of Markov Chain and Transition Probabilities.

CO5 Understand the concept of Queuing Theory.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	M	L	L	M	L	L	H	M	L
CO2	M	M	L	L	M	L	L	H	M	M
CO3	H	H	M	M	H	L	M	H	H	M
CO4	H	H	H	M	H	M	M	H	H	H
CO5	H	H	H	H	H	M	M	H	H	H

H = Highly Related; M = Medium L = Low

MST002A	Probability & Measure Theory	3-1-0 [4]

Objectives:

1. To Explain the foundation of probability theory, random variable.

2. To Explain probability distribution, mathematical expectation, etc. which forms the basis of basic statistics.

3. To exposed about the law of large numbers

UNIT 1	General probability space, various definition of probability, combinations of events, additive and multiplicative law of probability, conditional probability, Bayes' theorem and its application.
UNIT 2	Random variables: discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations.
UNIT 3	Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.
UNIT 4	Classes of sets, fields, σ -fields, minimal σ -field, Borel σ – field in R^K , sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Caratheodory extension theorem (statement only), Lebesgue and Lebesgue-Stieltjes measures on R^K
UNIT 5	Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof)

Suggested Readings:

1. Kingman, J.F. & Taylor, S.J. (1996): *Introduction to Measure and Probability*, Cambridge Univ. Press.
2. Loeve (1996): *Probability Theory*, Affiliated East –West Press Pvt. Ltd. New Delhi.
3. Bhatt, B.R.(2000): *Probability*, New Age International India.
4. Feller,W.(1971): *Introduction to Probability Theory and its Applications*, Vol. I and II. Wiley, Eastern-Ltd.
5. Rohatgi, V.K (1984): *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern.
6. Billingsley, P. (1986): *Probability and Measure*, John Wiley Publications.
7. Dudley, R.M. (1989): *Real Analysis and Probability*, Worlds Worth & Books.
8. Tucket H.G. (1967): *A Graduate Course in Probability*, Academic Press.
9. Basu, A.K. (1999): *Measure Theory and Probability*, PHI.

Course Outcomes
CO1:-Understanding the concept of Probability.
CO2:-Understanding the concept of Mathematical Expectations and MGF.
CO3:-Understanding the concept of Random Variable.
CO4:-Understanding the concept of Sigma Field.
CO5:-Understanding the basic concept of Law of Convergence in Probability.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L			H		M	H		M
CO2	H	L			H		M	H		M
CO3	H	L			H		M	H		M
CO4	H	L			H		M	H		M
CO5	H	L			H		M	H		M

H = Highly Related; M = Medium L = Low

MMA033A	LATEX LAB	0-0-4 [2]

OBJECTIVE:

- Understand the purpose and nature of LaTeX, user interface of LaTeX, understand how LaTeX differs from a word processor, format text in various ways and Learn how to use LaTeX to format mathematical equations.

1. Using environment, type the followingtext

    1. Numbering1
        a. Type1
            • bullet1
            • bullet2
        b. Type2
            o bullet type circle 1
            o bullet type circl 2
    2. Numbering2
        i. Type3
            ▪ Bullet typerectangles

2. Display thefollowing

    i. Roman letters I, II, III, IV so on and i,ii,iii,iv soon
    ii. Alphabetica,b,c, d, soon
    iii. Uppercase alphabeticA,B,C,
    iv. Include special symbols!
    v. Include Mathematical symbols etc.

3. Display the followingequation

    i. $y = ax^2 + bx + c$

    ii. $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \;\; x = 2$

    iii. $y = x + 2, z = 2x + 3y$

    iv. $x_{i+j,k} = \frac{x^i x^j}{x_k}$

    v. $\int_a^b f(x)dx = F(b) - F(a).$

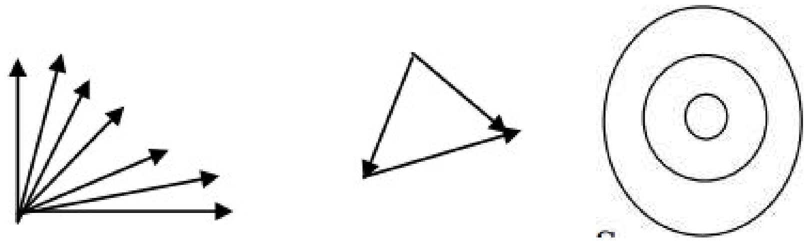
4. Display thefollowing

    i. $f(x) = \{ \begin{matrix} x^3 - \sqrt{x} \\ x^2 + 2 \end{matrix}$

    ii. $y_n = \sum_{n=1}^{\infty} a^n x^n$

5. Create a table of mark sheet as givenbelow.
6. Include few figures in documents
    i. India map
    ii. Bangalore university logo
    iii. Scale the pictures in different sizes.

7. Draw a figure using Latexcommands.



TEXT BOOKS / OPEN SOURCE MATERIALS

1. Bruce E Shapiro : Introducing Latex, California State University, Northridge.,2009.
2. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl : The Not So Short Introduction to Latex, Version 4.20,2006.

Course Outcomes (COs):
Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the LaTeXuser interface of LaTeX, Understand how LaTeX differs from a word processor, format text in various ways and learn how to use LaTeX to format mathematical equations.

CO2: Typing of text in LaTeX

CO3: Typing of text including roman letters, alphabets, special symbols and mathematical symbols in LaTeX.

CO4: Display of equations in LaTeX.

CO5: Creating a table and drawing a figure in LateX.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							**Program Specific Outcomes**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	H						H		H
CO2			M					M	M	
CO3				M						
CO4						H		L		M
CO5							M		M	L

H = Highly Related; M = Medium; L = Low

MMA034A	Numerical Analysis LAB II	0-0-4 [2]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of advance numerical analysis on SCILAB PACKAGE and Plot graphs usingSCILAB.

List of Program:

1. Plots2-D
2. plots3-D
3. Euler'sMethod
4. Modified Euler'sMethod
5. Runge-Kutta 2nd Ordermethod
6. Runga-Kutta 4th Ordermethod
7. Adam's Predictor-correctormethod
8. Trapezoidalrule
9. Simpson's 1/3rule
10. Simpson's 3/8rule
11. Double integration using Trapeziumrule
12. Double integration using Simpson'srule
13. L-U factorizationmethod

TEXT BOOKS

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern(1979),Second Edition.
2. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), SixthEdition.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific publications(1991).

REFERENCE BOOKS

2. S.C. Chapra, and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi(2000).
3. R.L. Burden, and J. Douglas Faires: Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourthedition.
4. S.S. Sastry : Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi(1998).
5. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical methods for scientific and Engineering computation, Wiley Eastern(1993)

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: This course can be used by students in Mathematics as an introduction to the fundamental ideas of advance numerical analysis on SCILAB PACKAGE and Plot graphs using SCILAB.

CO2: Plots 2-D and 3-D graphs (Using SCI LAB).

CO3: Solution of ODE:Euler's Method, Modified Euler's Method, Runge-Kutta 2ndOrder method, Runga-Kutta4th Order method and Adam's Predictor-corrector method (Using SCI LAB).

CO4: Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Double integration using Trapezium rule and Double integration using Simpson's rule (Using SCI LAB).

CO5: L-U factorization method (Using SCI LAB).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H							M	M	L
CO2		M								M
CO3			H	M	M	H		L	H	
CO4										
CO5								M		M

H = Highly Related; M = Medium; L = Low

SEMESTER – IV

MMA008C	**Analytic Dynamics**	**3-1-0 [4]**

OBJECTIVE:

- The mathematical framework plays a role in the formulation of modern quantum and relativity theories.
- Topics studied the kinematics of dynamics of systems of particles.
- Topics studied Lagrangian and Hamiltonian dynamics and rigid body dynamics.
- The emphasis is both on the formal development of the theory and also use of theory in solving actual physical problems.

Unit 1	D'Alembert's principle, General equations of motion of a rigid body, Motion of centre of inertia and motion relative to centre of inertia, Motion about a fixed axis: Finite forces moment of effective forces about a fixed axis of rotation, Angular momentum, Kinetic energy of a rotating body about a fixed line, Equation of motion of the body about the axis of rotation, Principle of conservation of energy.
Unit 2	Motion of a rigid body in two dimensions: Equations of motion in two dimensions, Kinetic energy of a rigid body, Moment of momentum, Rolling and sliding friction, Rolling of a sphere on a rough inclined plane, Sliding of a rod, Sliding and rolling of a sphere on an inclined plane, Sliding and rolling of a sphere on a fixed sphere, Equations of motion of a rigid body under impulsive forces, Impact of a rotating elastic sphere on a fixed horizontal rough plane, Change in kinetic energy due to the action of impulse.
Unit 3	Motion in three dimensions with reference to Euler's dynamical and geometrical equations, Motion under no forces, Motion under impulsive forces, Conservation of momentum (linear and angular) and energy for finite as well as impulsive forces.
Unit 4	Lagrange's equations for holonomous dynamical system, Energy equation for conservative field, Small oscillations, Motion under impulsive forces, Motion of a top.
Unit 5	Hamilton's equations of motion, Hamilton's principle and principle of least action.

Suggested Readings:

1. N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.
2. J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill, 1991.
3. L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge University Press, 1998.
4. Naveen Kumar Generalized Motion of Rigid Body, Narosa, 2004.
5. S.L. Loney - An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Kalyani Publishers, New Delhi, 2004.
6. Bansal, J.L., Dynamics of a Rigid Body, Jaipur Publishing Co., 2004
7. M.D. Raishinghania, Dynamics, S.Chand & Co. New Delhi, 2016.
8. M.Ray and H.S. Sharma, Text Book on Dynamics of Rigid Body, Student's friend &Company, 1960.

Course Outcomes:

CO1:- Understanding the Fundamental laws of mechanics.

CO2:- Understanding the basics concepts of D Alembert's principle.

CO3:- Understanding the basics concepts of Euler's dynamical equation of motion.

CO4:- Understanding the Lagrange's equation of motion.

CO5:- Developing the ability to understand Hamilton's principle and principle of least action.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	M		L			L	M	L
CO2			L	M	H			H	H	H
CO3		L	M	H	L			L	L	M
CO4		M	M	L	H	L			M	M
CO5	M	H	H	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

ELECTIVE (Any Three of the following)

MMA020B	Fractional Calculus	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of fractional calculus.
- To develop an understanding of fractional derivatives and integral.
- To develop an understanding few important application fractional derivative to other branches of both pure and applied mathematics.

UNIT 1	Special functions of fractional calculus: Gamma function, Beta functions, Mittag-Leffler function, Wright function.
UNIT 2	Fractional derivatives and integrals: Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivatives, geometric and physical interpretation of fractional integration and differentiation, sequential fractional derivatives, properties of fractional derivatives.
UNIT 3	Laplace, Fourier and Mellin transforms of fractional derivatives. Linear fractional differential equations: Equation of a general form, existence and uniqueness theorem as a method of solution, dependence of a solution on initial conditions.
UNIT 4	Laplace transform method, standard fractional differential equations, sequential fractional differential equations, fractional Green's function.
UNIT 5	Some methods for solving fractional order equations: Mellin transform, power series, Bebenko's symbolic calculus method, orthogonal polynomials, numerical evaluation of fractional derivatives, approximation of fractional derivatives.

Texts/References:

1. Basic Theory of Fractional Differential Equations, Y. Zhou, World Scientific, 2014.
2. Fractional Differential Equations, I. Podlubny, Academic Press, 1998.
3. The Fractional Calculus: Theory and Applications of Differentiation and Integration to Arbitrary Order, K.B. Oldham and J. Spanier, Dover Publications, 2006.
4. An Introduction to the Fractional Calculus and Fractional Differential Equations, K.S. Miller and B. Ross, Wiley-Interscience, 1993.

Course Outcomes:

CO1:- Understanding the basic concept of fractional calculus.

CO2:- Understanding the fractional derivatives and integrals Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivatives.

CO3:- Understanding the Laplace, Fourier and Mellin transforms of fractional derivatives. Linear fractional differential equations.

CO4:- Understanding the Laplace transform method, standard fractional differential equations, Green's function.

CO5:- Understanding the Mellin transform, power series, Bebenko's symbolic calculus method, orthogonal polynomials, numerical evaluation of fractional derivatives.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA021A	Hydrodynamics	3-1-0 [4]

OBJECTIVE:

- Topics studied the Equation of continuity, Boundary surfaces, irrotational and rotational motions, Vortex lines, Euler's Equation ofmotion.
- Topics studied the Bernoulli's theorem, Impulsive actions Motion in two-dimensions, Conjugate functions, Source, sink, doublets and their images, conformalmapping.
- Topics studied Two-dimensional irrotational motion produced by the motion of circular cylinder in an infinite mass of liquid. Theorem of Blasius, Motion of a sphere through a liquid at rest atinfinity.
- The emphasis is both on the Liquid streaming past a fixed sphere, Equation of motion of a sphere. Stress components in real fluid, Equilibrium equation in stress components, Transformation of stresscomponents.
- Principal stress, Nature of strains, Transformation of rates of strain, Relationship between stressand rate of strain, Navier-Stokes equation ofmotion.

Unit 1	Equation of continuity, Boundary surfaces, streamlines, Irrotational and rotational motions, Vortex lines, Euler's Equation of motion.
Unit 2	Bernoulli's theorem, Impulsive actions. Motion in two-dimensions,Conjugate functions, Source, sink, doublets and their images, conformal mapping.
Unit 3	Two-dimensional irrotational motion produced by the motion of circular cylinder in an infinite mass of liquid. Theorem of Blasius, Motion of a sphere through a liquid at rest at infinity.
Unit 4	Liquid streaming past a fixed sphere, Equation of motion of a sphere. Stress components in real fluid, Equilibrium equation in stress components, Transformation of stress components.
Unit 5	Principal stress, Nature of strains, Transformation of rates of strain, Relationship between stressand rate of strain, Navier-Stokes equation of motion.

Suggested Readings

1. W. H. Besant and A. S. Ramsey, A Treatise on Hydrodynamics, CBS Publishers and Distributors,Delhi,1988.
2. S. W. Yuan, Foundations of Fluid Dynamics, Prentice-Hall of India,1988.
3. Horace Lamb, Horace Lamb , Sir Horace Lamb, Hydrodynamics, Dover Publications Inc,1993.

Course Outcomes:

CO1:-Understanding the Equation of continuity, Boundary surfaces, streamlines, Irrotational and rotational motions.

CO2:-Understanding the Bernoulli's theorem, Impulsive actions. Motion intwo- dimensions, Conjugate functions.

CO3:- Understanding the Bernoulli's theorem, Impulsive actions. Motion intwo- dimensions, Conjugate functions.

CO4:-Understanding the Liquid streaming past a fixed sphere, Equation of motion of a sphere. Stress components in real fluid.

CO5:-Developing the ability to understand Principal stress, Nature of strains, Transformation of rates of strain, Relationship between stress and rate of strain.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	M		L			L	M	M
CO2			L	M	H			H	H	H
CO3		M	M	H	L			L	L	L
CO4	M	L	H	L	H	M			M	M
CO5	L	H	M	M	M		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA022A	Numerical Solution of Partial Differential Equations	3-1-0 [4]

Objectives: This course has the following objectives:

- To teach students the Numerical solutions of parabolic PDE in one space: two and three levels explicit and implicit differenceschemes.
- To expose students to the Numerical solution of parabolic PDE of second order in two space dimension: implicitmethods.
- To expose student's basics of Nonlinear initial BVP. Difference schemes for parabolic PDE in spherical and cylindrical coordinate systems in one dimension. Numerical solution of hyperbolic PDE in one and two space dimension.
- To teach students „Difference schemes for first order equations. Numerical solutions of elliptic equations, approximations of Laplace and biharmonicoperators.
- To teach students Finite element method: Linear, triangular elements and rectangular elements.

Unit 1	Numerical solutions of parabolic PDE in one space: two and three levels explicit and implicit difference schemes. Convergence and stability analysis.
Unit 2	Numerical solution of parabolic PDE of second order in two space dimension: implicit methods, alternating direction implicit (ADI) methods.
Unit 3	Nonlinear initial BVP. Difference schemes for parabolic PDE in spherical and cylindrical coordinate systems in one dimension. Numerical solution of hyperbolic PDE in one and two space dimension: explicit and implicit schemes. ADI methods.
Unit 4	Difference schemes for first order equations. Numerical solutions of elliptic equations, approximations of Laplace and biharmonic operators. Solutions of Dirichlet, Neuman and mixed type problems.
Unit 5	Finite element method: Linear, triangular elements and rectangular elements.

Suggested Readings

1. M. K. Jain, S. R. K. Iyenger and R. K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern,1994.
2. M. K. Jain, Numerical Solution of Differential Equations, 2nd edition, Wiley Eastern.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India,2002.
4. D. V. Griffiths and I. M. Smith, Numerical Methods of Engineers, Oxford University Press, 1993.
5. C. F. General and P. O. Wheatley Applied Numerical Analysis, Addison- Wesley,1998.

Course Outcomes: On completion of the course the student shall be able to:

1. Understand the fundamentals of the Numerical solutions of parabolic PDE in one space: two and three levels explicit and implicit differenceschemes.
2. Understand the niceties of Numerical solution of parabolic PDE of second order in two space dimension: implicitmethods.
3. Understand the basics of Nonlinear initial BVP. Difference schemes for parabolic PDE in spherical and cylindrical coordinate systems in one dimension. Numerical solution of hyperbolic PDE in one and two space dimension.
4. Understand the importance of Difference schemes for first order equations. Numerical solutions of elliptic equations, approximations of Laplace and biharmonic operators.
5. Understand and get ready to apply Finite element method: Linear, triangular elements and rectangular elements.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		M	H		M			M	M	H
CO2			M	M	H			M	M	H
CO3		M	M	M	H			M	L	M
CO4		M	M	M	H	M			M	M
CO5	H	H	M	M	M		M	M	M	H

H = Highly Related; M = Medium; L = Low

MMA023A	Number Theory and Cryptography	3-1-0 [4]

OBJECTIVE:

- This course is concerned with the basics of analytical numbertheory.
- Topicssuchasdivisibility,congruence's,quadraticresiduesandfunctionsofnumber theory are covered in this course.S
- One of the applications of the said concepts are also included. Cryptography is the science of encrypting and decrypting anyinformation.
- This is one of the finest applications of Number Theory. As a piece of informationis expressed through symbols, representing it in a way that only the intended party would know it is the best part of encryption anddecryption.
- As the world is flooded with information, generation, transfer and acquisition of it is very important. Students with basic background in Number Theory can take up this course.

Unit 1	Number Theory: Introduction, Time estimates for doing arithmetic. Divisibility and Euclidean algorithm. Congruencies. Some applications to factoring.
Unit 2	Finite Fields and quadratic residues: Finite Fields, Quadratic Residues and Reciprocity.
Unit 3	Cryptography: Some simple crypto Systems. Enciphering matrices. Public Key: The Idea of Public key Cryptography.
Unit 4	RSA. Discrete log. Knapsack. Zero-knowledge protocols and Oblivious Transfer.
Unit 5	Pseudo Primes, Rho Method, Fermat factorization and Factor bases.

Suggested Readings

1. Neal Koblitz, A Course in Number Theory and cryptography: A Graduate Text, Springer (Second Ed).
2. David M. Burton, Elementary Number Theory, Wm. C. Brown Publishers,Dubuque, Iowa1989.
3. K. Ireland, and M. Rosen, A Classical Introduction to Modern Number Theory, GTM Vol. 84, Springer-Verlag,1972.
4. G.A. Jones, and J.M. Jones, Elementary Number Theory, Springer-Verlag,1998.
5. W. Sierpinski, Elementary Theory of Numbers, North-Holland, Ireland,1988\

Course Outcomes (CO's)

CO1: Solve problems in elementary number theory and apply elementary numbertheory to cryptography.

CO2: Be able to compute a group of units directly. Compute Euler's function phi,be able to use a formula for phi to study relations between numbers n and phi (n).

CO3: Be able to understand the operations with congruences, linear and non-linear congruence equations (with relatively small moduli)

CO4: Student's will understand and be able to use the founding theorems: Lagrange theorem, Fermat's little theorem, Wilson's theorem, concept of a pseudo prime.

CO5: Understand the basics of RSA security and be able to break the simplest instances.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			H		M			L	M	H
CO2		L	L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4	H	M	M	L	H	L			M	M
CO5	M	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA024A	Fuzzy Sets and Applications	3-1-0 [4]

Objective:

- To develop an understanding of Fuzzy Sets andApplications.
- To develop an understanding of Operations on fuzzy sets, Convex fuzzysets.
- To develop an understanding of Basic theory of Fuzzy Maths.

Unit 1	Basic Concepts of Fuzzy Sets and Fuzzy Logic: Motivation. Fuzzy sets and their representations. Membership functions and their designing.
Unit 2	Types of Fuzzy sets. Operations on fuzzy sets. Convex fuzzy sets. Alpha-level cuts. Geometric interpretation of fuzzy sets. Linguistic variables. Possibility measure and distribution.
Unit 3	Fuzzy rules. Fuzzy Relations and Fuzzy Arithmetic: Composition of fuzzy relations. Fuzzy numbers. Arithmetic operations on fuzzy numbers. Fuzzy reasoning.
Unit 4	Fuzzy mapping rules and fuzzy implication rules. Fuzzy rule-based models for function approximation. Types of fuzzy rule-based models (the Mamdani, TSK, and standard additive models). Fuzzy Implications and Approximate Reasoning. Fuzzy Logic and Probability Theory: Possibility versus probability. Probability of a fuzzy event. Baye's theorem for fuzzy events. Probabilistic interpretationof fuzzy sets. Fuzzy measure.
Unit 5	Decision making in Fuzzy environment: Fuzzy Decisions, Fuzzy Linear programming, Fuzzy Multi criteria analysis, Multi objective decision making. Fuzzy databases and queries: Introduction, Fuzzy relational databases, Fuzzy queries in crisp databases.

Suggested readings

1. J. Yen and R. Langari: Fuzzy Logic: Intelligence, Control, and Information, Pearson Education,2003.
2. G. J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic: Theory andApplications, Prentice-Hall of India, 1997.
3. H.J. Zimmermann, Fuzzy Set theory and its Applications, Kluwer Academic Publ, 2001.

Course Outcomes

CO1: -Understanding the Basic Concepts of Fuzzy Sets and Fuzzy Logic: Motivation. Fuzzy sets and their representations. Membership functions and their designing.

CO2: -Understanding the Types of Fuzzy sets. Operations on fuzzy sets. Convex fuzzy sets. Alpha-level cuts. Geometric interpretation of fuzzy sets. Linguistic variables. Possibility measure anddistribution.

CO3: - Understanding the Fuzzy rules. Fuzzy Relations and Fuzzy Arithmetic: Composition of fuzzy relations. Fuzzy numbers. Arithmetic operations on fuzzy numbers. Fuzzyreasoning

CO4: -Understanding the Fuzzy mapping rules and fuzzy implication rules. Fuzzy rule-based models for function approximation. Types of fuzzy rule-based models (the Mamdani, TSK, and standard additive models). Fuzzy Implications and Approximate Reasoning. Fuzzy Logic and Probability Theory : Possibility versus probability. Probability of a fuzzy event. Baye□s theorem for fuzzy events. Probabilistic interpretation of fuzzy sets. Fuzzy measure.

CO5: - Understanding the Decision making in Fuzzy environment: Fuzzy Decisions, Fuzzy Linear programming, Fuzzy Multi criteria analysis, Multi objective decision making. Fuzzy databases and queries: Introduction, Fuzzy relational databases, Fuzzy queries in crisp databases.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H		L					L	L	H
CO2	M		L		L			L	L	H
CO3	H	L	M	L	H	H	H	M	L	M
CO4	H	M	H	H	M	H	L	M	L	H
CO5	H	M	H	M	H	L	H	M	L	M

H = Highly Related; M = Medium; L = Low.

MMA025A	Advanced Graph Theory	3-1-0 [4]

OBJECTIVE:

- To develop an understanding of basic concepts of GraphTheory.
- To develop an understanding of Advanced GraphTheory.

Unit 1	Trees: Spanning trees and enumeration. Matching: Matching and Maximum Matching, Hall's Matching condition, Minimax Theorems.
Unit 2	Independent Sets and Covers. Dominating Sets. Connectivity: Connectivities of graphs, Cut-sets, Edge Connectivity and Vertex Connectivity.
Unit 3	Menger's Theorem. Network Flow problem, maximum network flows, flow augmenting paths.
Unit 4	Ford-Fulkerson Theorem. Coloring of graphs: Chromatic number and chromatic polynomial of graphs, Brook's Theorem.
Unit 5	Four Color Theorem. Planarity: Planar Graphs, Testing of Planarity, Kuratowski Theorem for Planar graphs, Random Graphs.

Suggested Readings

1. D.B.West, Graph Theory , Pearson Publ.2002.
2. F.Harary, Graph Theory. Narosa Publ. ND,2000.
3. R. Diestel, Graph Theory, Springer,2000.

Course Outcomes

CO1:-Understanding the trees: Spanning trees and enumeration. Matching: Matching and Maximum Matching, Hall's Matching condition, Minimax Theorems.

CO2:-Understanding the Independent Sets and Covers. Dominating sets. Connectivity: Connectivities of graphs, Cut-sets, Edge connectivity and Vertex Connectivity.

CO3:- Understanding the Menger's Theorem. Network Flow problem, maximum network flows, flow augmenting paths.

CO4:-Understanding the Ford-Fulkerson Theorem. Coloring of graphs: Chromatic number and chromatic polynomial of graphs, Brook'sTheorem.

CO5:- Understanding the Four Color Theorem. Planarity: Planar Graphs, Testing of Planarity, Kuratowski Theorem for Planar graphs, Random Graphs.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H		H					L	H	H
CO2	M		H		H			L	L	H
CO3	H	L	M	L	M	H	H	M	H	M
CO4	M	M	H	H	H	L	L	M	H	H
CO5	H	H	M	H	M	L	H	M	L	M

H = Highly Related; M = Medium; L = Low

MMA026B	Sampling Distribution & Testing of Hypothesis	3-1-0 [4]

OBJECTIVE:

- To describe methods of Sampling distribution
- To develop an understanding of Chi-square ,t and F-Distribution in statistics
- To describe methods of Experimental design
- To develop and understand non parametric test

Unit 1	**Basic Concepts:** Theory of sampling, population and estimation Statistical inference, testing of hypothesis. **Statistical Hypothesis and test of significance I** Definition, Simple and Composite hypotheses. Null and Alternative Hypotheses, two Types of errors in sampling ,critical region , level of significance critical and p-values, procedure and testing of hypothesis.
Unit 2	**Sampling Distribution:** Chi Square (X2) Distribution and Its Properties, Chi - Square Test, Application of Chi -Square Distribution: Chi-Square Test for Population Variance, Chi-square Test of Goodness of Fit, Independence of Attributes, T- Distribution & Its Properties, And Applications: Testing of single mean, Difference of two means, paired t-test and sample correlation coefficient. **F-Distribution:** Definition of Snedecor's F-distribution. Application- Testing of equality of two variance.
Unit 3	**Analysis of variance:** One-way and two-way classified data for fixed effects models.
Unit 4	**Experimental designs**: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks. **Basic designs**: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.
Unit 5	**Non Parametric Tests**: Definition merits and limitations, Sign test for univariate and bivariate distributions, Run test and Median test for small and large samples.

Text Books:

1. Gupta, S.C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, S Chand & Company, New Delhi

Reference Books:

1. Gupta, S.C. and Kapoor, V.K.: Fundamentals of Applied Statistics, S Chand & Company, New Delhi
2. Mood Alexander M., GraybillFrankline and Boes Duane C.: Introduction to Theory of Statistics, Mc Graw Hill & Company Third Edition
3. Gupta, O.P.: Mathematical Statistics, Kedarnath Publication, Meerut
4. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall of India (P) Ltd.
5. Serfling R.J. (1980): Approximation Theory of Mathematical Statistics, John Wiley
6. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asis Publishing House.
7. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
8. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn.World Press, Kolkata.
9. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
10. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

Course Outcomes

CO1:- To understand the Basic requirement of Hypothesis

CO2:- To test hypothesis and methodology such as sampling, goodness-of-fit testing, Independence of attributes and mean is testing.

CO3:- To understand about the Analysis of Variance techniques.

CO4:- To understand the Basic concepts of Experimental design and CRD and Understanding the basics concepts of RBD and LSD.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	M	L	M	L	L	M	M	H	H
CO2	H	H	L	H	L	H	H	H	H	H
CO3	H	H	L	H	L	H	H	H	H	H
CO4	M	H	L	H	L	H	H	H	H	H
CO5	H	H	L	H	L	M	L	M	M	M

H = Highly Related; M = Medium; L = Low

MMA027A	Linear Dynamical Systems	3-1-0 [4]

OBJECTIVE:

- The classification of fixed points of autonomous systems, attractors and repellors, natural boundaries, case study: populationgrowth.
- Topics studied the autonomous second order systems, constant coefficient equations, phase curves and fixed points, classification of fixed points of linear systems, analyzing non- linearsystems.
- Topics studied Discrete Systems – examples of discrete systems, some terminology, linear discretesystems.
- The emphasis is both on the Bifurcations in one-dimensional flows – introduction, saddle-node bifurcation, trans critical bifurcation.
- Topics studied Bifurcation in two-dimensional flows – saddle-node, trans critical, and Pitchfork bifurcations, Hopf bifurcation.

Unit 1	First order continuous autonomous systems – some terminology, classification of fixed points of autonomous systems, attractorsand repellors, natural boundaries, case study: population growth.
Unit 2	Second order continuous autonomous systems –autonomous second order systems, constant coefficient equations, phase curves and fixed points,classificationoffixedpointsoflinearsystems,analyzingnon-linear systems, case studies: lead absorption in the body, interacting species.
Unit 3	Discrete Systems – examples of discrete systems, some terminology, linear discrete systems, non-linear discrete systems, quadratic maps.
Unit 4	Bifurcations in one-dimensional flows – introduction, saddle-node bifurcation, trans critical bifurcation, Pitchfork bifurcation.
Unit 5	Bifurcation in two-dimensional flows – saddle-node, trans critical, and Pitchfork bifurcations, Hopf bifurcation

Suggested Readings

1. Introduction to Applied Non-Linear Dynamical systems and Chaos (Vol-2)– S. Wiggins, TAM, Springer-Verlag, NewYork,1990.
2. Differential Equations, Dynamical Sysstems and an Introduction to Chaos – M.W. Hirsch, S. Smale, and R.L. Devaney, Elsevier (2004).
3. Introduction to Non-Linear Systems – J.Berry and Arnold, Great Britain1996.
4. Non Linear Dynamics and Chaos – S. H. Strogatz, Addision- Wesley Publishing Company, USA,1994.

Course Outcomes:

CO1:- Understanding the classification of fixed points of autonomous systems.
CO2:- Understanding the basics concepts of autonomous second order systems, constant coefficient equations, phase curves and fixed points.
CO3:- Understanding the basics concepts of some terminology, linear discrete systems, non-linear discrete systems.
CO4:-Understanding the Bifurcations in one-dimensional flows.
CO5:-Developing the ability to understand Bifurcation in two-dimensional flows.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	M		L			L	M	L
CO2			L	M	H			H	H	H
CO3		M	M	H	L			L	L	M
CO4		L	M	L	M	L			M	H
CO5	H	M	H	M	H		L	M	L	M

H = Highly Related; M = Medium; L = Low

MMA035A	LATEX BEAMER LAB	0-0-4 [2]

OBJECTIVE:

1. Understand, how to deals with tables, graphs in latex. Know beamer in latex, typographical settings in latex for scientific article.

2. Create a frame environment with title "Latex Beamer presentation" and include author name, Institute, current date and footnote.

3. Make a frame title as "What is Beamer?" and include the definition of Beamer in different blocks.

4. Display the following texts 10 times "This is an example for Latex Beamer". For each display change the font size (decreasing order), font style, text color and otherproperties.

5. Make a frame title as "Equations". In different blocks type theequations

$y = ax^2 + bx + c$, call it as (1) and $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$, …….. (2).

Then cross refer eqn. (2) at some other point

6. Create a file and Import the file into latex beamer. Make frame title as " Importing files". Use doc, jpg, pdf and other file formats inthese.

7. Make a frame title as "Tables" and create atable.

Hydrogen Line	Spectral order		
	First	Second	Third
Red	657	656.7	656.3
Blue	487.3	486.7	486.1
Violet	433.5	434.3	()*

8. Create a frame environment. Try to use different back ground pictures.

9. Insert few pictures in single page (frame) and give the frame title as "Graph".

10. Create references using bibliography environment. Name the frame as "References". Use California or Harvard bibliographic system.

11. Make a frame title as "Table of Contents" and list out the following one by one using pause command

(1) Introduction (2) Equations (3) Importing files

(4) Tables (5) Graph and (6) References.

12. Make a beamer presentation. Use a suitable title for thepresentation.

TEXT BOOKS / OPEN SOURCE MATERIALS

1. Charles T .Batts: A Beamer Tutorial in Beamer. (http://www.ctan.org/tex-archive/macros/latex/contrib/beamer/doc/)
2. http:/latex-beamer.sourceforge.net.

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the how to deals with tables, graphs in latex. Know beamer in latex, typographical settings in latex for scientific article.

CO2: Apply working knowledge of SCI LAB package to simulate and solve matrices, system of equations, trigonometric functions, Fibonacci series and applications.

CO3: Solve, simulate and analyze various matrices.

CO4: Solve, simulate and analyze various system of equations.

CO5: Solve, simulate and analyze trigonometric functions, Fibonacci series.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M							M	M	L
CO2		H								M
CO3					H	M		L	H	
CO4				H						
CO5				H				M		M

H = Highly Related; M = Medium; L = Low