UNIVERSITY OF MADRAS

SYLLABUS

M.Sc. Mathematics

(for the academic year 2021-2022)

S.No	Faculty Name	QUALIFICATION
1	Mrs.K.Malligeswari	M.Sc., M.Phil
2	Mrs.J.Prabha	M.Sc., M.Phil, B.Ed, SLST ‘90
3	Mrs.P.P.Sharmishta	M.Sc., M.Phil, SET
4	Mrs.N.K.Vinodhini	M.Sc., M.Phil, SET
5	Mrs.K.Sheela	M.Sc., M.Phil, SET
6	Mrs.R.Mahalakshmi	M.Sc., M.Phil
7	Mrs.C.D.Kalpana	M.Sc., M.Phil
8	Mrs.R.Mary Mercy Priya	M.Sc., M.Phil
9	Dr. M.Arunma	M.Sc., M.Phil, PGDAOR, Ph.D, SET
10	Dr .S.Geetha	M.Sc., M.Phil, Ph.D, SET
11	Mrs.S.Gayathri	M.Sc., M.Phil, PGDCA, SET
12	Dr .V.Sathyavathy	M.Sc., M.Phil, M.Ed, Ph.D, SET
13	Mrs.B.Kavitha	M.Sc., M.Phil, B.Ed, SET

M.Sc. DEGREE COURSE IN MATHEMATICS

SYLLABUS

<u>Semester –I</u>

SUBJECT NAME: ALGEBRA-I

SUBJECT CODE: MFF1A

COURSE OBJECTIVES:

1. To develop a strong foundation in linear algebra that provide a basic for advanced studies.
2. To Study of Linear Transformations, Algebra of Polynomials, Invariant space and their properties.
3. Give particular attention to canonical forms of linear transformations, diagonalizations of linear transformations, matrices and determinants.

Title of the Course		**ALGEBRA-I**					
Paper Number		**I**					
Category	Core	**Year**	**I**	**Credits**	**4**	**Course Code**	
		Semester	**I**				
Pre-requisite		An introductory course in Abstract Algebra					
Course Outline		UNIT-I :Group actions on a set, Sylow theorems - Applications of Sylow theorems. **Chapter 3: Section 3.6** **Chapter 4 – Sections 4.2 and 4.3** from J.B. Fraleigh					
		UNIT-II : Direct products - Finite abelian groups- Modules **Chapter 2: Sections 2.13 and 2.14** **Chapter 4: Section 4.5** **f**rom I.N. Herstein					
		UNIT-III : Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations. **Chapter 6: Sections 6.4 , 6.5** from I.N. Herstein					
		UNIT-IV : Jordan form - rational canonical form. **Chapter 6 : Sections 6.6 and 6.7** from I.N. Herstein					
		UNIT-V: Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form. **Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit 6.9)** from I.N. Herstein					
Recommended Text		1. J.B. Fraleigh, A first course in Abstract Algebra, 5th edition. 2. I.N. Herstein. Topics in Algebra (II Edition) Wiley, 2002.					
Reference Books		1. M.Artin, *Algebra*, Prentice Hall of India, 1991. 2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S.Luther and I.B.S.Passi, *Algebra*, Vol. I –Groups(1996); Vol. II Rings(1999), Narosa Publishing House , New Delhi 4. D.S.Dummit and R.M.Foote, *Abstract Algebra*, 2^{nd} edition, Wiley, 2002. 5. N.Jacobson, *Basic Algebra*, Vol. I & II W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.					

LEARNING OUTCOMES:

Students will be able to

1.Understand the basic concepts of determinants and its additional properties.

2.Recognize the concepts of Invariant subspaces and diagonalization process.

3. Analyze canonical Form, Jordan Form and Rational canonical Form.

SUBJECT NAME: REAL ANALYSIS –I
SUBJECT CODE: MFF1B

COURSE OBJECTIVES:

1. To provide a deeper and rigorous understanding of functions of bounded variation.
2. To understand sequences of functions ,infinite series and infinite product
3. To provide deep insight into the concept of Riemann-Stieltjes integral..

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REAL ANALYSIS –I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">An introductory Real Analysis course</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on
[a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.
Chapter – 6 : Sections 6.1 to 6.8
Infinite Series : Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.
Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18</td></tr>
<tr><td colspan="6">UNIT-II : The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition - Comparison theorems.
Chapter - 7 : Sections 7.1 to 7.14</td></tr>
<tr><td colspan="6">UNIT-III : The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of Riemann-Stieltjes integrals- Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus-Change of variable in a Riemann integral-Second Mean Value Theorem for Riemann integral-Riemann-Stieltjes integrals depending on a parameter-Differentiation under the integral sign-Lebesgue criteriaon for the existence of Riemann integrals.
Chapter - 7 : 7.15 to 7.26</td></tr>
<tr><td colspan="6">UNIT-IV :Infinite Series and infinite Products - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series - Cesarosummability - Infinite products.
Chapter - 8 Sec, 8.20, 8.21 to 8.26
Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem
Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23</td></tr>
<tr><td colspan="6">UNIT-V: Sequences of Functions - Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series</td></tr>
</table>

	of functions - Uniform convergence and Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **Chapter -9 Sec 9.1 to 9.6, 9.8,9.9, 9.10,9.11, 9.13**
Recommended Text	Tom M.Apostol :*Mathematical Analysis*, 2nd Edition, Narosa,1989.
Reference Books	1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976. 2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976. 3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991. 4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991. 5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964. 6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.

LEARNING OUTCOMES:

Students will be able to

1 .Acquire knowledge of real variable theory for further exploration of the subject for going into research.

2. Understand the effect of uniform convergence on the limit function with respect to continuity, differentiability and integrability.

3.Learn the theory of Riemann's Stieltjes integrals, to be aquainted with the details of the Total variation and to be able to deal with the functions of bounded variation.

SUBJECT NAME: ORDINARY DIFFERENTIAL EQUATIONS
SUBJECT CODE: MFF1C

COURSE OBJECTIVES:

1.To study solutions of linear differential equations with constant and variable coefficients.

2.To Understand and able to apply various theoretical ideas that underlined in existence and uniqueness theorems .

3.To provide knowledge in Linear dependence and independence, Wronskian etc.,

<table>
<tr><td>Title of the Course</td><td colspan="7">ORDINARY DIFFERENTIAL EQUATIONS</td></tr>
<tr><td>Paper Number</td><td colspan="7">III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">UG level Calculus and Differential Equations</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="7">UNIT-I : Linear equations with constant coefficients
Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.
Chapter 2: Sections 1 to 6</td></tr>
<tr><td colspan="7">UNIT-II : Linear equations with constant coefficients
Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation.
Chapter 2 : Sections 7 to 11.</td></tr>
<tr><td colspan="7">UNIT-III : Linear equation with variable coefficients
Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.
Chapter : 3 Sections 1 to 8 (Omit section 9)</td></tr>
<tr><td colspan="7">UNIT-IV : Linear equation with regular singular points
Second order equations with regular singular points –Exceptional cases – Bessel equation .
Chapter 4 : Sections 3, 4 and 6 to 8 (omit sections 5 and 9)</td></tr>
<tr><td colspan="7">UNIT-V :Existence and uniqueness of solutions to first order equations:
Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.
Chapter 5 : Sections 1 to 6 (Omit Sections 7 to 9)</td></tr>
<tr><td>Recommended Text</td><td colspan="7">E.A.Coddington, A introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd.,New Delhi, 1987.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1.Williams E. Boyce and Richard C. Di Prima, Elementary differential equations and boundary value problems,John Wiley and sons, New York, 1967.
2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.
4. W.T.Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania,Advanced Differential Equations, S.Chand& Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.</td></tr>
</table>

LEARNING OUTCOMES:

Students will be able to

1. Recall the types of linear homogeneous equations of second order equations.
2. Analyse non homogeneous OE using the method of underlined coefficients.
3. Understand and apply the theorems on IVP to ODE and comprehend the EULERS equation and Bessel's equations, and Regular singular points.

SUBJECT NAME: GRAPH THEORY
SUBJECT CODE : MFF1D

COURSE OBJECTIVES:

1. To give indepth knowledge about types of graphs, vertex and edge connectivity.
2. To understand matchings and colourings
3. To provide knowledge on independent sets , cliques and few applications of graph theory.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">GRAPH THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">An elementary course in algebra</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Graphs, subgraphs and Trees : Graphs and simple graphs – Graph Isomorphism – The Incidence and Adjacency Matrices – Subgraphs – Vertex Degrees – Paths and Connection – Cycles – Trees – Cut Edges ana Bonds – Cut Vertices.
Chapter 1 (Section 1.1 – 1.7)
Chapter 2 (Section 2.1 – 2.3)</td></tr>
<tr><td colspan="6">UNIT-II :Connectivity, Euler tours and Hamilton Cycles : Connectivity – Blocks – Euler tours – Hamilton Cycles.
Chapter 3 (Section 3.1 – 3.2)
Chapter 4 (Section 4.1 – 4.2)</td></tr>
<tr><td colspan="6">UNIT-III : Matchings, Edge Colourings : Matchings – Matchings and Coverings in Bipartite Graphs – Edge Chromatic Number – Vizing's Theorem.
Chapter 5 (Section 5.1 – 5.2)
Chapter 6 (Section 6.1 – 6.2)</td></tr>
<tr><td colspan="6">UNIT-IV : Independent sets and Cliques, Vertex Colourings : Independent sets – Ramsey's Theorem – Chromatic Number – Brooks' Theorem – Chromatic Polynomials.
Chapter 7 (Section 7.1 – 7.2)
Chapter 8 (Section 8.1 – 8.2, 8.4)</td></tr>
<tr><td colspan="6">UNIT-V: Planar graphs : Plane and planar Graphs – Dual graphs – Euler's Formula – The Five- Colour Theorem and the Four-Colour Conjecture.
Chapter 9 (Section 9.1 – 9.3, 9.6)</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">J.A.Bondy and U.S.R. Murthy ,Graph Theory and Applications , Macmillan, London, 1976.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1. J.Clark and D.A.Holton ,A First look at Graph Theory, Allied Publishers, New Delhi , 1995.
2. R. Gould. Graph Theory, Benjamin/Cummings, Menlo Park, 1989.
3. A.Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge, 1989.
4. R.J.Wilson and J.J.Watkins, Graphs : An Introductory Approach, John Wiley and Sons, New York, 1989.
5. R.J. Wilson, Introduction to Graph Theory, Pearson Education, 4th Edition, 2004, Indian Print.
6. S.A.Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987.</td></tr>
</table>

LEARNING OUTCOMES:

Students will be able to

1. Identify the properties of different graphs and their applications
2. Demonstrate knowledge of basic concepts of graph theory
3. Apply the concepts of graph theory in practical situations.

SUBJECT NAME: DISCRETE MATHEMATICS
SUBJECT CODE: MFFAB

COURSE OBJECTIVES:

1. To provide students with an overview of Lattices and its applications,
2.To Demonstrate knowledge of basic concepts of Boolean Algebra.
3.To Introduce the concept of Coding Theory.

<table>
<tr><td>Title of the Course</td><td colspan="7">A2. DISCRETE MATHEMATICS</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective-I</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Elementary algebra</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="7">UNIT-I : Lattices: Properties of Lattices: Lattice definitions – Modular and distributive lattice; Boolean algebras: Basic properties – Boolean polynomials, Ideals; Minimal forms of Boolean polynomials.
Chapter 1: § 1 A and B § 2A and B. § 3.</td></tr>
<tr><td colspan="7">UNIT-II : Applications of Lattices: Switching Circuits: Basic Definitions - Applications
Chapter 2: § 1 A and B</td></tr>
<tr><td colspan="7">UNIT-III : Finite Fields
Chapter 3: § 2</td></tr>
<tr><td colspan="7">UNIT-IV : Polynomials : Irreducible Polynomials over Finite fields – Factorization of Polynomials
Chapter 3: § 3 and §4.</td></tr>
<tr><td colspan="7">UNIT-V: Coding Theory : Linear Codes and Cyclic Codes
Chapter 4 § 1 and 2</td></tr>
<tr><td>Recommended Text</td><td colspan="7">Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, Spinger-Verlag, New York, 1984.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1. A.Gill, Applied Algebra for Computer Science, Prentice Hall Inc., New Jersey.
2. J.L.Gersting, Mathematical Structures for Computer Science(3rd Edn.), Computer Science Press, New York.
3. S.Wiitala, Discrete Mathematics- A Unified Approach, McGraw Hill Book Co.</td></tr>
</table>

LEARNING OUTCOMES:

Students will be able to
1. Perform logical proofs.
2. Apply recursive functions and solve recurrence relations.
3. Obtain the knowledge of coding theory.

Semester – II

SUBJECT NAME: ALGEBRA – II
SUBJECT CODE: MFF2A

COURSE OBJECTIVES:
1.To Acquire knowledge on extension fields and roots of polynomials

2. To Analyze the elements of Galois theory and Galois Groups over the rationals

3. To Understand the basic concepts of solvability by radicals and finite fields.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ALGEBRA – II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Algebra-I</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I :Extension fields – Transcendence of e.

Chapter 5: Section 5.1 and 5.2</td></tr>
<tr><td colspan="6">UNIT-II :Roots of Polynomials.- More about roots

Chapter 5: Sections 5.3 and 5.5</td></tr>
<tr><td colspan="6">UNIT-III : Elements of Galois theory.

Chapter 5 : Section 5.6</td></tr>
<tr><td colspan="6">UNIT-IV : Finite fields - Wedderburn's theorem on finite division rings.

Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)</td></tr>
<tr><td colspan="6">UNIT-V :Solvability by radicals – Galois groups over the Rationals -– A theorem of Frobenius.
Chapter 5: Sections 5.7 and 5.8
Chapter 7: Sections 7.3</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">I.N. Herstein. Topics in Algebra (II Edition) Wiley 2002</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1. M.Artin, Algebra, Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups(1996); Vol. II Rings, (1999)Narosa Publishing House , New Delhi.
4. D.S.Dummit and R.M.Foote, Abstract Algebra, 2nd edition, Wiley, 2002.
5. N.Jacobson, Basic Algebra, Vol. I & II Hindustan Publishing Company, New Delhi.</td></tr>
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LEARNING OUTCOMES:

Students will be able to

1. Provide deep knowledge about various algebraic structures.
2. Apply Galois Theory to the solvability of polynomial Equations by radicals.
3. Formulate some special roots of polynomials.

SUBJECT NAME: REAL ANALYSIS – II
SUBJECT CODE: MFF2B

COURSE OBJECTIVES:

1. To provide a deeper and rigorous understanding of Measure theory.
2. To understand the concept of Fourier series and fourier integrals.
3. To provide deep insight into the concepts of Multi variable differential calculus, implicit

functions and extreme problems.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REAL ANALYSIS – II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Real Analysis-I</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Measure on the Real line - Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability
Chapter - 2 Sec 2.1 to 2.5 of de Barra</td></tr>
<tr><td colspan="6">UNIT-II : Integration of Functions of a Real variable - Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals
Chapter - 3 Sec 3.1,3.2 and 3.4 of de Barra</td></tr>
<tr><td colspan="6">UNIT-III : Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point - Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem
Chapter 11 : Sections 11.1 to 11.15 of Apostol</td></tr>
<tr><td colspan="6">UNIT-IV : Multivariable Differential Calculus - Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1
Chapter 12 : Section 12.1 to 12.14 of Apostol</td></tr>
<tr><td colspan="6">UNIT-V : Implicit Functions and Extremum Problems : Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.
Chapter 13 : Sections 13.1 to 13.7 of Apostol</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">1. G. de Barra, Measure Theory and Integration, New Age International, 2003 (for Units I and II)
2. Tom M.Apostol : Mathematical Analysis, 2nd Edition, Narosa 1989 (for Units III, IV and V)</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1. Burkill,J.C. The Lebesgue Integral, Cambridge University Press, 1951.
2. Munroe,M.E. Measure and Integration. Addison-Wesley, Mass.1971.
3. Royden,H.L.Real Analysis, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.</td></tr>
</table>

LEARNING OUTCOMES:

Students will acquire knowledge about
1. The Real Numbers and the Analytic Properties of Real- Valued Functions.
2. The Analytic concepts of Connectedness, Compactness, Completeness And Calculus.
3. Evaluate laplace equation and analyze its application.

SUBJECT NAME: PARTIAL DIFFERENTIAL EQUATIONS
SUBJECT CODE: MFF2C

COURSE OBJECTIVES:
1. To Introduce different methods to solve partial differential equations.
2.To Aquire knowledge in classification of PDE and the methods to solve.
3.To Enables the students to find the solutions of PDE in practical application like Engineering, physics etc.,

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">PARTIAL DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level differential equations</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I : Partial Differential Equations of First Order: Formation and solution of PDE- Integral surfaces – Cauchy Problem order eqn- Orthogonal surfaces – First order non-linear – Characteristics – Compatible system – Charpit method. Fundamentals: Classification and canonical forms of PDE.
Chapter 0: 0.4 to 0.11 (omit 0 .1,0.2,0.3 and 0.11.1)
Chapter 1: 1.1 to 1.5</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT-II : Elliptic Differential Equations: Derivation of Laplace and Poisson equation – BVP – Separation of Variables – Dirichlet’s Problem and Newmann Problem for a rectangle – Interior and Exterior Dirichlets’s problems for a circle – Interior Newmann problem for a circle – Solution of Laplace equation in Cylindrical – Examples. Chapter 2: 2.1, 2. 2 ,2.5 to 2.11&2.13 (omit 2.3 and 2.4&2.12 and Examples)</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT-III :Parabolic Differential Equations: Formation and solution of Diffusion equation – Dirac-Delta function – Separation of variables method – Solution of Diffusion Equation in Cylindrical .
Chapter 3: 3.1 to 3.6 and 3.9 (omit 3.7,3.8 & 3.10)</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT-IV :Hyperbolic Differential equations: Formation and solution of one-dimensional wave equation – canocical reduction – IVP- d’Alembert’s solution – Vibrating string – Forced Vibration – IVP and BVP for two-dimensional wave equation – Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate systems – vibration of circular membrane – Uniqueness of the solution for the wave equation
Chapter 4: 4.1 to 4.8,4.10&4.11(omit 4.9,4.12&4.13)</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT-V: Green’s Function: Green’s function for laplace Equation – methods of Images – Eigen function Method – Green’s function for the wave and Diffusion equations. Laplace Transform method: Solution of Diffusion and Wave equation by Laplace Transform.
Chapter 5: 5.1 to 5.6 Chapter 6: 6.13.1 and 6.13.2 only (omit (6.14)</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">S, Sankar Rao, Introduction to Partial Differential Equations, 2^{nd} Edition, Prentice Hall of India, New Delhi. 2005</td></tr>
</table>

Reference Books	1. R.C.McOwen, *Partial Differential Equations*, 2nd Edn. Pearson Eduction, New Delhi, 2005. 2. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983. 3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968. M.D.Raisinghania,*Advanced Differential Equations*,S.Chand& Company Ltd., New Delhi, 2001.

LEARNING OUTCOMES:

Students will be able to

1. Understand and remember the physical situations with real world problems to construct mathematical models using PDE.
2. Analyze the type of PDE and different methods to solve.
3. Evaluate Laplace equation and analyze its application

SUBJECT NAME: PROBABILITY

SUBJECT CODE: MFF2D

COURSE OBJECTIVES:

1. To Develop the mathematical probability and their applications
2.To Acquire knowledge about characteristic functions and properties of theoretical distributions.
3.To Study unbiasedness and consistency of limit theorems .

Title of the Course		**PROBABILITY**					
Paper Number		**VIII**					
Category	Core	**Year**	**I**	**Credits**	**4**	**Course Code**	
		Semester	**II**				
Pre-requisite		**UG level calculus and real analysis**					
Course Outline		**UNIT-I : Random Events and Random Variables:** Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables. **Chapter 1: Sections 1.1 to 1.7** **Chapter 2 : Sections 2.1 to 2.9**					
		UNIT-II : Parameters of the Distribution : Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types. **Chapter 3 : Sections 3.1 to 3.8**					
		UNIT-III:Characteristic functions : Properties of characteristic functions – Characteristic functions and moments – semi0invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions. **Chapter 4 : Sections 4.1 to 4.7**					
		UNIT-IV :Some Probability distributions: One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions. **Chapter 5 : Section 5.1 to 5.10 (Omit Section 5.11)**					

	UNIT-V:Limit Theorems : Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – LapunovTheroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. **Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9 , 6.11 and 6.12. (Omit Sections 6.5, 6.10,6.13 to 6.15)**
Recommended Text	M. Fisz, *Probability Theory and Mathematical Statistics,* John Wiley and Sons, New York, 1963.
Reference Books	1. R.B. Ash, *Real Analysis and Probability,* Academic Press, New York, 1972 2. K.L.Chung, *A course in Probability*, Academic Press, New York, 1974. 4. R.Durrett, *Probability : Theory and Examples*, (2nd Edition) Duxbury Press, New York, 1996. 5. V.K.Rohatgi*An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., New Delhi, 1988(3rd Print). 6. S.I.Resnick, *A Probability Path*, Birhauser, Berlin,1999. 7. B.R.Bhat , *Modern Probability Theory* (3rd Edition), New Age International (P)Ltd, New Delhi, 1999

LEARNING OUTCOMES:

Students will be able to

1. Apply the concepts and methods to find the moments of the distributions.
2. Study multivariate distributions and the independence of random variables. Further evaluating the marginal distributions from bivariate distributions.
3. Understand the convergence of distributions and central limit theorem

GROUP B : ELECTIVE-II

SUBJECT NAME: MATHEMATICAL PROGRAMMING

SUBJECT CODE : MFFAD

COURSE OBJECTIVES:

1.To make the students understand solving LPP using various methods.
2.To understand the concept of Nonlinear Programming Problems .
3.Solving LPP through Dynamic Programming

Title of the course		**B1.MATHEMATICAL PROGRAMMING**					
Category	**Elective-II**	**Year**	I	**Credits**	**3**	**Course Code**	
		Semester	II				
Pre-requisite		Basic mathematical programming techniques					
Course outline		**UNIT – I : Integer Linear Programming** : Types of Integer Linear Programming Problems – Concept of Cutting Plane – Gomory's All Integer Cutting Plane Method – Gomory's Mixed Integer Cutting Plane Method-Branch and Bound Method **Chapter 7**					
		UNIT – II **: Dynamic Programming** : Characteristics of Dynamic Programming Problem - Developing Optimal Decision Policy- Dynamic Programming under Certainty – DP approach to solve LPP **Chapter 22**					

	UNIT – III: **Classical Optimization Method** : Unconstrained Optimization – Constrained Multi- variable Optimization with Equality Constraints – Constrained Multi-variable Optimization with inequality Constraints **Non-linear Programming Methods** : Examples of NLPP – General NLPP – Graphical Solution – Quadratic Programming – Wolfe's modified simplex method **Chapter 23** **Chapter 24: Sections 24.1 to 24.4 (Omit Beale's method)**
	UNIT – IV :**Linear Programming Problem** – Simple problems. **Parametric Linear Programming** : Variation in the coefficients c_j, Variations in the Right hand side, b_i **Chapter 4 : Section 4.1 to 4.3** **Chapter 29**
	UNIT – V: **Goal Programming** : Difference between LP and GP approach – Concept of Goal Programming – Goal Programming Model formulation – Graphical solution method of Goal Programming. **Chapter 8 : Section 8.1 to 8.5**
Recommended Text	J.K.Sharma, Operations Research,(fourth edition) Macmillan, New Delhi, 2009
Reference Books	1. Hamdy A. Taha, Operations Research, (Seventh edition) Prentice – Hall of India Private Limited, New Delhi, 1997 2. F.S. Hiller &J.Lieberman Introduction to Operations Research (7th edition) Tata – McGraw Hill Company , New Delhi, 2001. 3. Beightler. C, D.phillips, B. Wilde, Foundations of Optomization (2nd edition) Prentice Hall Pvt Ltd., New York, 1979 4. S.S. Rao – Optimization Theory and Applications, Wiley Eastern, New Delhi. 1990

LEARNING OUTCOMES:
Students will be able to

1 .Explain various techniques to solve real life problems expressed in terms of LPP.
2. Explain various techniques to solve real life problems expressed in terms of LPP.
3. Apply the fundamental concept of Integer Programming Problems .

Extra Disciplinary -I

SUBJECT NAME: PROGRAMMING IN C^{++}
SUBJECT CODE: MFFBB

COURSE OBJECTIVES:
1. To give the students an awareness of the object oriented programming.
2. To enable the students to write the C++ programs using classes, functions and interfaces.
3. To make applications using C++ programs.

Title of the course		**2.PROGRAMMING IN C^{++}**					
Category	**Extra Disciplinary -I**	**Year**	**I**	**Credits**	**3**	**Course Code**	
		Semester	**II**				

Pre-requisite	Basics of Computer Programming
Course Outline	UNIT – I : Tokens, Expressions and Control Structures **Chapter 3 : Sections 3.1 – 3.25**
	UNIT – II : Functions in C^{++} **Chapter 4 : Sections 4.1 to 4.12**
	UNIT – III : Classes and Objects **Chapter 5 : Sections 5.1 to 5.19**
	UNIT – IV : Constructors and Destructors **Chapter 6 : Sections 6.1 – 6.11**
	UNIT – V: Operator overloading and Type Conversions **Chapter 7 : Sections 7.1 to 7.9**
Recommended Text	E. Balaguruswamy, Object Oriented Programming with C^{++}, Tata McGraw Hill, New Delhi, 1999
Reference Books	D.Ravichandran, Programming with C^{++}, Tata McGraw Hill, New Delhi, 1996

LEARNING OUTCOMES:

Students will be able to

1. Create Classes, objects, arrays of objects, constructors, and Destructors
2. Analyze over loading operators and inheritance
3. Deliberate files, pointers and templates. Create, design and develop quality programs in c++

<u>Semester – III</u>

SUBJECT NAME: COMPLEX ANALYSIS-I
SUBJECT CODE: MFF3A

COURSE OBJECTIVES:

1.To Evaluate integrals, singularities and determine the values of integrals using residues.
2.To Apply and understand about limits and to know how they are used in series and problems.
3. To Analyze functions of complex variables in terms of continuity and analyticity.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">COMPLEX ANALYSIS-I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">IX</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Real Analysis and UG level Complex Analysis</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I : Cauchy’s Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions :Removable Singularities-Taylors’s Theorem – Zeros and poles – The local Mapping – The Maximum Principle
Chapter 4 : Section 2 : 2.1 to 2.3, Section 3 : 3.1 to 3.4</td></tr>
</table>

	UNIT-II :The general form of Cauchy's Theorem : Chains and cycles-Simple Connnectivity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials-Multilply connected regions - Residue theorem - The argument principle. **Chapter 4 : Section 4 : 4.1 to 4.7, Section 5: 5.1 and 5.2**
	UNIT-III :Evaluation of Definite Integrals and Harmonic Functions: Evaluation of definite integrals - Definition of Harmonic functions and basic properties - Mean value property - Poisson formula. **Chapter 4 : Section 5 : 5.3, Section 6 : 6.1 to 6.3**
	UNIT-IV : Harmonic Functions and Power Series Expansions: Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor Series – Laurent series . **Chapter 4 : Sections 6.4 and 6.5** **Chapter 5 : Sections 1.1 to 1.3**
	UNIT-V: Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula **Chapter 5 : Sections 2.1 to 2.4, Sections 3.1**
Recommended Text	Lars V. Ahlfors, Complex Analysis, (3rd edition) McGraw Hill Co., New York, 1979
Reference Books	1.H.A. Priestly, Introduction to Complex Analysis, Clarendon Press,Oxford, 2003. 2.J.B.Conway, Functions of one complex variable Springer International Edition, 2003 3.T.WGamelin, Complex Analysis, Springer International Edition, 2004. 4.D.Sarason, Notes on complex function Theory, Hindustan Book Agency, 1998

LEARNING OUTCOMES:

Students will be able to

1 .Define and recognise the basic properties of complex numbers.
2. Apply CR equations and harmonic functions to solve problems.
3. Understand the concepts of complex functions and its related theorems.

SUBJECT NAME: TOPOLOGY
SUBJECT CODE: MFF3B

COURSE OBJECTIVES:

1.To Demonstrate knowledge and understanding the concepts of topological spaces.
2. To understand the concepts of continuous functions, connectedness and compactness.
3. To Introduce the conepts of countability and separation axioms.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">TOPOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">X</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Real Analysis</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">Unit I - Topological spaces, Basis for a topology, Product topology on X x Y, Subspace topology, Closed sets and Limit points, Continuous functions.
Chapter 2 - Sections 12, 13, 15, 16, 17, 18.</td></tr>
</table>

	Unit II - Connected spaces, Connected subspaces of the real line, Components and Local connectedness, Compact spaces, Compact subspaces of the real line. **Chapter 3 - Sections 23, 24, 25, 26, 27.**
	Unit III - Countability axioms, Separation axioms, Normal spaces, Urysohn's Lemma, Urysohn metrization theorem, Tietze extension theorem. **Chapter 4 - Sections 30, 31, 32, 33, 34, 35**
	Unit IV - Product topology, Tychonoff theorem **Chapter 2 - Sections 19.** **Chapter 5 - Section 37.**
	Unit V - Homotopy of paths, Fundamental group. **Chapter 9 - Sections 51, 52.**
Recommended Text	James R. Munkres *"Topology"* (Second edition) PHI, 2015.
Reference Books	1. T.W. Gamelin and R.E. Greene, *Introduction to Topology*, The Saunders Series, 1983. 2. G.F. Simmons, *Introduction to Topology and Modern Analysis*, Mcgraw-Hill 3. J. Dugundji, *Topology*, Prentice Hall of India. 4. J.L. Kelly, *General Topology*, *Springer.* 5. S. Willard, *General Topology*, Addison-Wesley.

LEARNING OUTCOMES:
Students will be able to

1. Create new topological spaces by using subspace,product and quotient topology.
2. Construct a variety of examples and counter examples in topology .
3.Understand the properties of the compact spaces and analyse the different types of Compactness.

SUBJECT NAME: OPERATIONS RESEARCH
SUBJECT CODE: MFF3C

COURSE OBJECTIVES:

1. To understand the concept of Network models.
2. To make the students understand and solving Deterministic inventory controls.
3.To understand the application of queuing theory in real life situation and methods of solving related problems.

Title of the Course		**OPERATIONS RESEARCH**					
Paper Number		**XI**					
Category	Core	**Year**	**II**	**Credits**	**4**	**Course Code**	
		Semester	**III**				
Pre-requisite		**UG Level Operations Research**					

Course Outline	**UNIT-I : Decision Theory :** Steps in Decision theory Approach – Types of Decision-Making Environments – Decision Making Under Uncertainty – Decision Making under Risk – Posterior Probabilities and Bayesian Analysis – Decision Tree Analysis – Decision Making with Utilities. **Chapter 10 : Sec. 10.1 to 10.8**
	UNIT-II : Network Models : Scope of Network Applications – Network Definition – Minimal spanning true Algorithm – Shortest Route problem – Maximum flow model – Minimum cost capacitated flow problem - Network representation – Linear Programming formulation – Capacitated Network simplex Algorithm. **Chapter 6 : Sections 6.1 to 6.6** **H.A.Taha :** Operations Research
	UNIT-III : Deterministic Inventory Control Models: Meaning of Inventory Control – Functional Classification – Advantage of Carrying Inventory – Features of Inventory System – Inventory Model building - Deterministic Inventory Models with no shortage – Deterministic Inventory with Shortages **Probabilistic Inventory Control Models:** Single Period Probabilistic Models without Setup cost – Single Period Probabilities Model with Setup cost. **Chapter 13: Sec. 13.1 to 13.8** **Chapter 14: Sec. 14.1 to 14.3**
	UNIT-IV : Queueing Theory : Essential Features of Queueing System – Operating Characteristic of Queueing System – Probabilistic Distribution in Queueing Systems – Classification of Queueing Models – Solution of Queueing Models – Probability Distribution of Arrivals and Departures – Erlangian Service times Distribution with k-Phases. **Chapter 15 : Sec. 15.1 to 15.8**
	UNIT-V : Replacement and Maintenance Models: Failure Mechanism of items – Replacement of Items that deteriorate with Time – Replacement of items that fail completely – other Replacement Problems. **Chapter 16: Sec. 16.1 to 16.5**
Recommended Texts	1. For Unit 2 : H.A. Taha, *Operations Research*, 6th edition, Prentice Hall of India 2. For all other Units: J.K.Sharma, *Operations Research* ,MacMillan India, New Delhi, 2001.
Reference Books	1. F.S. Hiller and J.Lieberman -,*Introduction to Operations Research* (7th Edition), Tata McGraw Hill Publishing Company, New Delhui, 2001. 2. Beightler. C, D.Phillips, B. Wilde ,*Foundations of Optimization* (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979 3. Bazaraa, M.S; J.J.Jarvis, H.D.Sharall ,*Linear Programming and Network flow*, John Wiley and sons, New York 1990. 4. Gross, D and C.M.Harris, *Fundamentals of Queueing Theory*, (3rd Edition), Wiley and Sons, New York, 1998.

LEARNING OUTCOMES:

Students will be able to

1.Explain various techniques to solve real life problems in decision theory.
2.Apply the fundamental concept of Inventory control.
3.Understand the queuing theory.

SUBJECT NAME: MECHANICS

SUBJECT CODE: MFF3D

COURSE OBJECTIVES:

To demonstrate knowledge and understanding of the following fundamental concepts in:

1. The dynamics of system of particles motion of rigid body.
2. Lagrangian and Hamiltonian formulation of mechanics.
3. Derive the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.

Title of the Course		**MECHANICS**					
Paper Number		**XII**					
Category	Core	**Year**	**II**	**Credits**	**4**	**Course Code**	
		Semester	**III**				
Pre-requisite		**Calculus and Differential equations.**					
Course Outline		UNIT-I :Mechanical Systems : The Mechanical system- Generalised coordinates – Constraints - Virtual work - Energy and Momentum **Chapter 1 : Sections 1.1 to 1.5**					
		UNIT-II :Lagrange's Equations: Derivation of Lagrange's equations- Examples- Integrals of motion. **Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)**					
		UNIT-III :Hamilton's Equations : Hamilton's Principle - Hamilton's Equation - Other variational principles. **Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)**					
		UNIT – IV :Hamilton-Jacobi Theory : Hamilton Principle function – Hamilton-Jacobi Equation - Separability **Chapter 5 : Sections 5.1 to 5.3**					
		UNIT-V :Canonical Transformation : Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets. **Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)**					
Recommended Text		D. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.					
Reference Books		1. H. Goldstein, *Classical Mechanics*, (2nd Edition) Narosa Publishing House, New Delhi. 2. N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991. 3. J.L.Synge and B.A.Griffth, *Principles of Mechanics* (3rd Edition) McGraw Hill Book Co., New York, 1970.					

LEARNING OUTCOMES:

Students will be able to

1. Define and understand basic mechanical concepts related to discrete and continuous mechanical systems,
2. Describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
3. Identify canonical transformations and apply Lagrange- Poisson Brackets.

GROUP C: ELECTIVE-III

SUBJECT NAME: NUMBER THEORY AND CRYPTOGRAPHY

SUBJEC CODE: MFFAH

COURSE OBJECTIVES:

1. To provide an exposure in advanced number theory concepts
2. To introduce cryptography and make them to encipher and decipher text messages using number theory and algebra concepts.
3. To learn public key cryptography.

Title of the course		**C2.NUMBER THEORY AND CRYPTOGRAPHY**						
Category	**Elective-III**	**Year**	**II**	**Credits**	**3**	**Course Code**		
		Semester	**III**					
Pre-requisite		**Elementary number theory and calculus**						
Course Outline		UNIT – I : Elementary Number Theory : Time estimates for doing arithmetic – divisibility and the Euclidean algorithm **Chapter 1 : Sections 1 and 2**						
		UNIT - II : Elementary Number Theory :Congruences – Some applications to factoring **Chapter 1 : Sections 3 and 4**						
		UNIT – III : Finite Fields and Quadratic Residues: Finite Fields, Quadratic residues and reciprocity **Chapter 2 : Sections 1 and 2**						
		UNIT – IV : Cryptography : Some simple cryptosystems Enciphering matrices **Chapter 3 : Sections 1 and 2.**						
		UNIT - V : Public Key : Public Key Cryptography - RSA **Chapter 4 : Sections 1 and 2**						
Recommended Text		Neal Koblit, A course in Number Theory and Cryptography, Springer – Verlag, New York, 1987						
Reference Books		1. I. Niven and H.S.uckermann, An Introduction to Theory of Numbers (Edition 3), Wiley Eastern Ltd, New Delhi 1976 2. D.M.Burton, Elementary Number Theory, Brown Publishers, Iowa, 1989 3. K.Ireland and M.Rosen, A classic Introduction to Modern Number Theory, Springer – Verlag, 1972 4. N.Koblit, Algebraic Aspects of Cryptography, Springer- Verlag, 1998						

LEARNING OUTCOMES:

Students will be able to

1. Understand advanced number theory concepts.
2. Gain knowledge in Finite fields and quadratic residues and reciprocity
3. Learn encipher and decipher text messages and Public key cryptography.

Extra Disciplinary –II

SUBJECT NAME: JAVA PROGRAMMING

SUBJECT CODE: MFFBD

COURSE OBJECTIVES:

1.To introduce object oriented design techniques and problem solving using java
2.To provide the insight to programming language the fundamentals of Language
3.To impart the benefits of object oriented language

<table>
<tr><td colspan="2">Title of the course</td><td colspan="6">1.JAVA PROGRAMMING</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Extra disciplinary II</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Knowledge in Programming in C / C^{++}</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT – I : Overview of Java Language: Java Tokens – Java Statements.
Chapter 3 : Section 3.1 to 3.12</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT – II : Constants – Variables – Data Types
Chapter 4 : Section 4.1 to 4.12</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT – III : Operators - Expressions
Chapter 5 : Section 5.1 to 5.16</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT – IV : Decision making and Branching
Chapter 6 : Section 6.1 – 6.9</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT – V : Classes – Objects – Methods – Arrays – Strings
Chapter 8 : Section 8.1 to 8.19
Chapter 9 : Section 9.1 to 9.5</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">E. Balaguruswamy, Programming with Java – A primer, Tata McGraw Hill Publishing Company Limited, New Delhi, 1998</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1. Mitchell Waite and Robert Lafore, Data Structure and Algorithms in Java, Tech media (Indian Edition) New Delhi, 1999
2. Adam Drozdek, Data Structures and Algorithms in Java (Brown /Cole) Vikas Publishing House, New Delhi 2001.</td></tr>
</table>

LEARNING OUTCOMES:

Students will be able to

1.Use an integrated development environment to write ,compile, run,and test
2.Make relational operations in Java
3.Understand the communication process through the web

<u>Semester –IV</u>

SUBJECT NAME: COMPLEX ANALYSIS- II
SUBJECT CODE: MFF4A

COURSE OBJECTIVES:

1. To study and Understand Weierstrass function and its applications.
2. To define and recognize the basic properties of the Riemann Zeta function .
3. To enable the students to understand the concepts of Riemann mapping Theorems,conformal mappings and harmonic functions

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">COMPLEX ANALYSIS- II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">XIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Complex Analysis-I and Real Analysis</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Riemann Zeta Function and NormalFamalies :
Product development – Extension of $\zeta(s)$ to the whole plane – The zeros of zeta function – Equicontinuity – Normality and compactness – Arzela's theorem – Families of analytic functions
Chapter 5 : Sections 4.1 to 4.4, Sections 5.1 to 5.4</td></tr>
<tr><td colspan="6">UNIT-II :Riemann mapping Theorem : Statement and Proof – Boundary Behaviour – Use of the Reflection Principle.
Conformal mappings of polygons :Behaviour at an angle Schwarz-Christoffel formula – Mapping of a rectangle.
Harmonic Functions : Functions with mean value property – Harnack's principle.
Chapter 6 : Sections 1.1 to 1.3 (Omit Section1.4)
Sections 2.1 to 2.3 (Omit section 2.4), Section 3.1 and 3.2</td></tr>
<tr><td colspan="6">UNIT-III : Elliptic functions : Simply periodic functions – Doubly periodic functions
Chapter 7 : Sections 1.1 to 1.3, Sections 2.1 to 2.4</td></tr>
<tr><td colspan="6">UNIT-IV :Weierstrass Theory : The Weierstrass $\wp$-function – The functions $\zeta(s)$ and $\sigma(s)$ – The differential equation – The modular equation $\lambda(\tau)$ – The Conformal mapping by $\lambda(\tau)$.
Chapter 7 : Sections 3.1 to 3.5</td></tr>
<tr><td colspan="6">UNIT-V: Analytic Continuation :The Weiesrtrass Theory – Germs and Sheaves – Sections and Riemann surfaces – Analytic continuation along Arcs – Homotopic curves – The Monodromy Theorem – Branch points.
Chapter 8 : Sections 1.1 to 1.7</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">Lars V. Ahlfors, Complex Analysis, (3rd Edition) McGraw Hill Book Company, New York, 1979.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1.H.A. Priestly, Introduction to Complex Analysis, Clarendon Press,Oxford, 2003.
2.J.B.Conway, Functions of one complex variable, Springer International Edition, 2003
3.T.WGamelin, Complex Analysis, Springer International Edition, 2004.
4.D.Sarason, Notes on Complex function Theory, Hindustan Book Agency, 1998</td></tr>
</table>

LEARNING OUTCOMES:

Students will be able to

1. Use Riemann mapping theorem in applications.
2. Have a fundamental understanding of Elliptic functions.
3. Have a good background for studying these more advanced topics.

SUBJECT NAME: DIFFERENTIAL GEOMETRY
SUBJECT CODE: MFF4B

COURSE OBJECTIVES:

1. To get introduced to the concept of a regular parameterized , the concept of curvature of a space curve and signed curvature of a plane curve. the fundamental theorem for plane curves, the notion of Serret-Frenet frame for space curves and the involutes and evolutes of space curves with the help of examples.
2. To be able to compute the curvature and torsion of space curves,able to understand the fundamental theorem for space curves, get introduced to the concept of a parameterized surface with the help of examples,Understand the idea of orientable/non-orientable surfaces, get introduced to the idea of first fundamental form/metric of a surface.
3. To Understand the normal curvature of a surface, its connection with the first and second fundamental form and Euler's theorem, Understand the Weingarton Equations, mean curvature and Gaussian curvature, understand surfaces of revolution with constant negative and positive Gaussian curvature , prove Theorema Egregium of Gauss.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">DIFFERENTIAL GEOMETRY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">XIV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Linear Algebra and Calculus</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">Unit I - Curves in the plane and in space :
Curves, parametrisation, arc length, level curves, curvature, plane and space curves.
Chapters 1 and 2.</td></tr>
<tr><td colspan="6">Unit II - Surfaces in space :
Surface patches, smooth surfaces, tangents, normals, orientability, examples of surfaces, lengths of curves on surfaces, the first fundamental form, isometries, surface area
Chapter 4 - 4.1, 4.2, 4.3, 4.4, 4.7 and Chapter 5 - 5.1, 5.2, 5.4</td></tr>
<tr><td colspan="6">Unit III - Curvature of surfaces:
The second fundamental form, Curvature of curves on a surface, normal, principal, Gaussian and mean curvatures, Gauss map. Chapter 6 - 6.1, 6.2, 6.3 and Chapter 7 - 7.1, 7.5,7.6</td></tr>
</table>

	Unit IV - Geodesics : Geodesics, geodesic equations, geodesics as shortest pat geodesic coordinates. **Chapter 8 - 8.1, 8.2, 8.4, 8.5**
	Unit V - Theorema Egregium of Gauss : Theorema Egregium, isometries of surfaces, Codazzi-Mainardi equations, compact surfaces of constant Gaussian curvature **Chapter 10**
Recommended Text	A. Pressley, *Elementary Differential Geometry*, Springer-Indian Edition, 2004.
Reference Books	1. J.A. Thorpe, Elementary Topics in Differential Geometry, Springer-Indian edition. 2. E.D. Bloch, A First Course in Geometric Topology and Differential Geometry, Birkhauser, 1997. 3. M.P. do Carmo, Differential Geometry of Curves and Surfaces, Prentice-Hall, 1976.

LEARNING OUTCOMES:

Students will be able to

1. Calculate the curvature and torsion of a curve,Find the osculating surface and the osculating curve at any point of a given curve.
2. Calculate the first and the second fundamental forms of a surface,
3. Calculate the Gaussian curvature, the mean curvature, the curvature lines, the asymptotic lines, the geodesics of a surface.

SUBJECT NAME: FUNCTIONAL ANALYSIS
SUBJECT CODE: MFF4C

COURSE OBJECTIVES:

1. To get an overview of normed spaces and familiarize on Banach space, Hilbert space , conjugate space
2. To understand the concepts of bounded linear operators and spectral theory.
3. To study Orthogonal complements, Orthonormal sets and conjugate space.

Title of the Course		**FUNCTIONAL ANALYSIS**					
Paper Number		**XV**					
Category	Core	**Year**	**II**	**Credits**	**4**	**Course Code**	
		Semester	**IV**				
Pre-requisite		**Basic Analysis, Topology and Linear Algebra**					
Course Outline		**Unit I -** Normed spaces, Continuity of linear maps, Hahn-Banach Theorems, Banach Spaces. **Chapters II (omit sections 6.8, 7.11, 7.12, 8.4)**					
		Unit II - Uniform boundedness principle, Closed Graph and Open Mapping theorems, Bounded Inverse Theorem, Spectrum of a bounded operator. **Chapter III (omit sections 9.4 to 9.7, 11.2, 11.4, 11.5, 12.6, 12.7)**					

	Unit III - Duals and Transposes, Weak and weak *convergence, Reflexivity **Chapter IV (omit sections 13.7, 13.8, 14, 15.5 to 15.7, 16.5 to 16.9)**
	Unit IV - Inner Product Spaces, Orthonormal sets, Best approximation, Projection and Riesz Representaion theorems. **Chapter VI (omit sections 23.2, 23.4, 23.6, 24.7, 24.8)**
	Unit V - Bounded operators and adjoints, Normal, unitary and self adjoin Operators, Spectrum and Numerical range, Compact selfadjoint operators **Chapter VII (omit sections 26.4, 26.5 26.6, 27.4 to 27.7, 28.7, 28.8)**
Recommended Text	B.V. Limaye, Functional Analysis, New Age International, 1996.
Reference Books	1. W.Rudin Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi , 1973 2. G.Bachman & L.Narici, Functional Analysis Academic Press, New York , 1966. 3. C. Goffman and G.Pedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987 4. E. Kreyszig, Introductory Functional Analysis with Applications, John wiley & Sons, New York.,1978.

LEARNING OUTCOMES:

Students will be able to

1. Familiarize with the concepts of normed linear spaces and operators on normed linear space.
2. Demonstrate an understanding of the concepts of Hilbert spaces and Banach spaces, and their role in mathematics.
3. Understand the concepts of linear operators, self adjoint, unitary operators , isometric isomorphism on Hilbert spaces ,Determinants ,the spectrum of an operator, Banach algebra .

SUBJECT NAME: FLUID DYNAMICS
SUBJECT CODE: MFFAJ

Group D: Elective IV

COURSE OBJECTIVES:

1. To introduce fundamental aspects of fluid flow behaviour.
2. To learn to develop steady state fluid flow , apply Eulers and Bernoullis equation of motion .
3. To understand axis symmetric flow, stress components of fluidflow and Navier stokes equation of motion.

Title of the Course		**D1. FLUID DYNAMICS**					
Category	Elective-IV	**Year**	**II**	**Credits**	**3**	**Course Code**	
		Semester	**IV**				
Pre-requisite		**Basic Differential Equations, Vector Calculus and Complex Analysis**					

Course Outline	**UNIT-I : Kinematics of Fluids in motion.** Real fluids and Ideal fluids- Velocity of a fluid at a point, Stream lines , path lines , steady and unsteady flows- Velocity potential - The vorticity vector- Local and particle rates of changes - Equations of continuity - Worked examples - Acceleration of a fluid - Conditions at a rigid boundary. **Chapter 2. Sec 2.1 to 2.10**.
	UNIT-II: Equations of motion of a fluid : Pressure at a point in a fluid at rest.- Pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immiscible fluids- Euler's equation of motion - Discussion of the case of steady motion under conservative body forces. ***Chapter 3. Sec 3.1 to 3.7***
	UNIT-III :Some three dimensional flows. Introduction- Sources, sinks and doublets - Images in a rigid infinite plane - Axis symmetric flows - Stokes stream function **Chapter 4 Sec 4.1, 4.2, 4.3, 4.5.**
	UNIT-IV : Some two dimensional flows : Meaning of two dimensional flow - Use of Cylindrical polar coordinates - The stream function - The complex potential for two dimensional , irrotational incompressible flow - Complex velocity potentials for standard two dimensional flows - Some worked examples - Two dimensional Image systems - The Milne Thompson circle Theorem. **Chapter 5. Sec 5.1 to 5.8**
	UNIT-V Viscous flows: Stress components in a real fluid. - Relations between Cartesian components of stress- Translational motion of fluid elements - The rate of strain quadric and principle stresses - Some further properties of the rate of strain quadric - Stress analysis in fluid motion - Relation between stress and rate of strain- The coefficient of viscosity and Laminar flow - The Navier – Stokes equations of motion of a Viscous fluid. ***Chapter 8. Sec 8.1 to 8.9***
Recommended Text	F. Chorlton, *Text Book of Fluid Dynamics* ,CBS Publications. Delhi ,1985.
Reference Books	1. R.W.Fox and A.T.McDonald. Introduction to Fluid Mechanics, Wiley, 1985. 2. E.Krause, Fluid Mechanics with Problems and Solutions, Springer, 2005. 3.B.S.Massey, J.W.Smith and A.J.W.Smith, Mechanics of Fluids, Taylor and Francis, New York, 2005 4. P.Orlandi, Fluid Flow Phenomena, Kluwer, New Yor, 2002. 5. T.Petrila, Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics, Springer, berlin, 2004.

LEARNING OUTCOMES:

Students will be able to

1. Describe the physical properties of a fluid and calculate the pressure distribution for incompressible fluids.
2. Describe the principles of motion for fluids and the areas of velocity and acceleration.
3. Apply stokes stream function for axis symmetric flow and understand rate of stress and strain quadric.

Group E: Elective V

SUBJECT NAME: TENSOR ANALYSIS AND RELATIVITY
SUBJECT CODE: MFFAM

COURSE OBJECTIVES:

1. To develop steady state mechanical energy balance equation for fluid flow systems.
2. To estimate pressure drop in fluid flow systems.
3. To determine performance characteristics of fluid machinery.

Title of the Course		**E1.TENSOR ANALYSIS AND RELATIVITY**					
Category	Elective - V	**Year**	**II**	**Credits**	**3**	**Course Code**	
		Semester	**IV**				
Pre-requisite		**Vector Calculus and Mechanics**					
Course Outline		**UNIT-I : Tensor Algebra :** Systems of Different orders – Summation Convention – Kronecker Symbols - Transformation of coordinates in S_n - Invariants – Covariant and Contravariant vectors - Tensors of Second Order – Mixed Tensors – ZeroTensor – Tensor Field – Algebra of Tensors – Equality of Tensors – Symmetric and Skew-symmetric tensors - Outer multiplication, Contraction and Inner Multiplication – Quotient Law of Tensors – Reciprocal Tensor – Relative Tensor – Cross Product of Vectors. **Chapter I : I.1 – I.3,I.7 and I.8 and Chapter II : II.1 – II.19**					
		UNIT-II :Tensor Calculus : Riemannian Space – Christoffel Symbols and their properties. **Chapter III: III.1 and III.2**					
		UNIT-III : Tensor Calculus(contd) : Covariant Differentiation of Tensors – Riemann–Christoffel Curvature Tensor – Intrinsic Differentiation **Chapter III:III.3 – III.5**					
		UNIT-IV :Special Theory of Relativity : Galilean Transformations – Maxwell's equations – The ether Theory – The Principle of Relativity. **Relativistic Kinematics :** Lorentz Transformation equations – Events and simultaneity – Example – Einstein Train – Time dilation – Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example – twin paradox – addition of velocities – Relativistic Doppler effect. **Chapter 7 : Sections 7.1 and 7.2**					
		UNIT-V : Relativistic Dynamics : Momentum – Energy – Momentum – energy four vector – Force - Conservation of Energy – Mass and energy – Example – inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations. **Accelerated Systems :** Rocket with constant acceleration – example – Rocket with constant thrust. **Chapter 7 : Sections 7.3 and 7.4**					
Recommended Text For Units I,II and III **For Units IV and V**		U.C. De, Absos Ali Shaikh and JoydeepSengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004. D.Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.					

Reference Books	1. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949. 2. A.S.Eddington. The Mathematical Theory of Relativitity, Cambridge University Press, 1930. 3. P.G.Bergman, An Introduction to Theory of Relativity, Newyor, 1942. 4. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938.

LEARNING OUTCOMES:

Students will be able to

1. Understand basic concepts of tensors, Christoffel symbols and problems
2. Understand tensor differentiation and Christoffel curvature Tensor.
3. Understand principle of equivalance and Accelerated system.

COURSE ASSESSMENT NORMS:

	Assessment of Marks	Maximum Marks
INTERNAL MARKS	Internal Assessment Marks – 10	25
	Assignment - 5	
	Seminar - 5	
	Attendance – 5	
EXTERNAL MARKS	University Examinations	75
TOTAL		100

SHANTHI RAVICHANDRAN

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Signature of HOD

Signature of Principal