VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY,
BALLARI

SYLLABUS

Department of Studies in MATHEMATICS

MASTER OF SCIENCE

(I to IV Semester)

(Approved BOS in 20.6.2016 and Faculty of Science on 2.7.2016)

With effect from 2016-17

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI

Objectives of the PG Programme:

The mission of the Post Graduate programme in the Department of studies in Mathematics is to provide the graduate students with a strong foundation that leads to success in subsequent careers and educational programs. When PG students completed their course, they will be prepared for careers (in industry or academia) or for further graduate studies. This is accomplished by having our students demonstrate deep knowledge in core classes, read, analyze and write proofs, communicate mathematical ideas written and verbally, as evidenced by the successful defense of a thesis, and conduct independent and collaborative research.

The Department of studies in Mathematics supports the University mission of academic distinction in teaching, scholarship and service by providing a superior educational opportunity for students by promoting all aspects of teaching, learning, and researching mathematics.

PROGRAM LEARNING OUTCOMES

Upon completion of the PG Programme in Mathematics the students will be able to:

1. Solve problems in the advanced areas of (a) numerical analysis, (b) linear algebra, (c) real analysis, and (d) Differential equations (e) Fluid Mechanics and (g) Graph Theory.
2. Read, analyze, and write logical arguments to prove mathematical concepts.
3. Communicate mathematical ideas with clarity and coherence, both written and verbally.
4. Perform research in conjunction with others as well as individually.

Department of Studies in Mathematics

CHOICE BASED CREDIT SYSTEM(CBCS)

(w.e.f 2016-2017)

Course Structure and Scheme of Examination

Sl. No	Paper and Title	Credits	No. Hrs/week Theory/ Practical	Duration of Exam in Hrs Theory/ Practical	Internal assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
I semester(w.e.f 2016-17)							
MSM 1.1HC	Algebra-I	4	4	3	30	70	100
MSM 1.2HC	Real Analysis-I	4	4	3	30	70	100
MSM 1.3 HC	Topology-I	4	4	3	30	70	100
MSM 1.4 HC	Complex Analysis	4	4	3	30	70	100
MSM 1.5HC	Ordinary Differential Equations	4	4	3	30	70	100
MSM 1.6SC	1.6(a)Discrete Mathematics or 1.6(b) Calculus of variations and Functions of several vairables	4	4	3	30	70	100
MSM 1.7	C- Lab – I	2	3	3	15	35	50
-	Total of I Semester	26					650
II Semester (w.e.f. 2016-2017)							
MSM 2.1HC	Algebra-II	4	4	3	30	70	100
MSM 2.2HC	Real Analysis-II	4	4	3	30	70	100
MSM 2.3HC	Numerical Analysis – I	4	4	3	30	70	100
MSM 2.4HC	Partial differential equations	4	4	3	30	70	100
MSM 2.5SC	2.5SC(a) Differential Geometry or2.5(b). Classical Mechanics or 2.5SC(c) Fuzzy sets and Fuzzy logic	4	4	3	30	70	100
MSM 2.6Lab	Mat Lab – I	2	4	3	15	35	50
2.7 OEC		4	4	3	30	70	100
	Total of II Semester	26					650

Sl. No	Paper and Title	Credits	No. Hrs/week Theory/ Practical Per batch	Duration of Exam in Hrs Theory/ Practical	Internal assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
			III Semester (w.e.f. 2016-2017)				
MSM 3.1 HC	Topology-II	4	4	3	30	70	100
MSM 3.2HC	Functional Analysis	4	4	3	30	70	100
MSM 3.3HC	Linear Algebra	4	4	3	30	70	100
MSM 3.4HC	Fluid Mechanics – I	4	4	3	30	70	100
MSM 3.5SC	3.5SC(a) Numerical Analysis – II or or 3.5 SC(b) Operation Research or 3.5SC© Number Theory	4	4	3	30	70	100
MSM 3.6	C- Lab-II	2	3	3	15	35	50
3.7 OEC	Open electives	4	4	3	30	70	100
	Total of III Semester	26					650
			IV Semester (w.e.f. 2016-2017)				
MSM 4.1 HC	Measure Theory	4	4	3	30	70	100
MSM 4.2 HC	Mathematical Methods	4	4	3	30	70	100
MSM 4.3 SC	4.3SC(a) Fluid Mechanics –II or 4.3SC(b) Graph Theory or 4.3SC© Wavelets 4.3SC(d) Magnetohydrodynamics 4.3SC(e). Banach Algebras	4	4	3	30	70	100
MSM 4.4	Project	4			30	70	100
	Total of IV Semester	16					400
	Grand total of all semesters (I to IV)	94					2350

Note: HC- Hard Core, SC- Soft core , OEC- Open Elective Course (For other Department Students)

Syllabus of M.A/M.Sc. (Mathematics) under Choice Based Credit System

M.A./ M.Sc. I SEMESTER

Sl. No	Paper and Title	Credits	No. Hrs/week Theory/ Practical	Duration of Exam in Hrs Theory/ Practical	Internal assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
I semester(w.e.f 2016-17)							
MSM 1.1HC	Algebra-I	4	4	3	30	70	100
MSM 1.2HC	Real Analysis-I	4	4	3	30	70	100
MSM 1.3 HC	Topology-I	4	4	3	30	70	100
MSM 1.4 HC	Complex Analysis	4	4	3	30	70	100
MSM 1.5HC	Ordinary Differential Equations	4	4	3	30	70	100
MSM 1.6SC	1.6(a)Discrete Mathematics or 1.6(b) Calculus of variations and Functions of several vairables	4	4	3	30	70	100
MSM 1.7	Lab – I	2	3	3	15	35	50
	Total of I Semester	26					650

MSM-HC 1.1: Algebra-I

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 1.1**

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:
- To train the students in the present relationships between abstract algebraic structures with familiar number system.
- To give sufficient knowledge of the subject, that can be used by student for further applications in their respective domains of interests.

Unit I:

Peano axioms.Natural numbers.Properties of natural numbers. Natural numbers as a well – ordered set. Finite sets and their properties.Schroeder-Bernstein theorem.Cantor's theorem and continuum hypothesis.Zorn's lemma, Axiom of choice and well-ordering principle and their equivalence.

Unit II:

Group, subgroup-definition, examples and elementary properties.Normal subgroup and quotient group.Group homomorphisms.Isomorphism theorems and the correspondence theorem.Center of a group and commutator subgroup of a group.Cyclic group.Lagrange's theorem. Euler's and Fermat's theorems as consequences of Lagrange's theorem..

Unit III: Symmetric group S_n. Structure theorem for symmetric groups. Action of a group on a set.Examples.Orbit and stabilizer of an element.Class equation of a finite group.Cauchy's theorem for finite groups.Sylow theorems.Applications.Wilson's theorem.

Unit IV:

Subnormal series of a group.Solvable group.Solvability of S_n. CompositionSeries of a group.Jordan-Holder theorem.

Out comes:
- Understand the importance of algebraic properties with regard to working within various number systems.
- Explore the properties of groups, subgroups, symmetric groups, permutation groups, cyclic groups and quotient groups.
- Understand Sylow's theorem, solvability of S_n and its applications

REFERENCES

1. C.C. Pinter, Set Theory, Addison-Wesley Publishing Co. Reading, Massechusetts (1971)
2. I.N. Herstein, Topics in Algebra, 2nd Edition, John-Wiley & Sons, New York (1975).

3. Y. F. Lin & S. Y. T. Lin, Set Theory-An Intuitive Approach, Houghton Mifflin Company, Boston (1974).
4. Surijitsingh and QaziZameeruddin, Modern Algebra, Vikas Publishing House (1990)
5. S. K. Jain, P. B. Bhattacharya & S. R. Nagpaul, Basic Abstract Algebra, Cambride University Press (1997)
6. J. J. Rotman, The T heory of Groups, an Introduction, Allya&Bacom (1965)
7. S. Maclane& G. Birkhoff, Algebra, McMillan Co., New York (1967)
8. S.M. Srivastava, A Course on Borel Sets (Chapter-I), Springer-Verlag, New York (1998)
9. M. Artin, Algebra, Prentice Hall of India (2004)

MSM-HC 1.2 : REAL ANALYSIS-I

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 1.2** .
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Define finite, countable and uncountable sets. Recognize convergent, divergent, bounded, Cauchy and monotone sequences.
- Exposure on basic topology on the real line. Recognize open, closed, connected and compact subsets of R.
- Determine if a function on a metric space is discontinuous, continuous, or uniformly continuous.
- Introduce the role and application of mean value theorems.

Unit I:

Finite and infinite sets. Denumerable and Non denumerable sets, Countable and Uncountable sets. Equivalent sets. Concept of Cardinal numbers, Schroeder-Bernstein theorem, Cardinal number of a power set-Addition of cardinal numbers, Exponential of cardinal numbers, Examples of Cardinal Airthmetic, Cantor's theorem, Card X<Card P(X), Relations connection N_0 and C. Continuum Hypothesis. Zorn's lemma.Euclidean spaces

Unit II:

Real number system, Ordered sets, Fields, Real field, Extended real number system, least upper bound property of R. Basic Topology, Metric spaces, Compact sets, Perfect sets, Connected sets, R as complete metric space.

Unit III:

Limits of function, Continuous function, Continuity and Compactness. Continuity and Connectedness, Discontinuity, Monotonic functions, Infinite limits and limits at infinity.

Unit IV:

The derivative of a real function, Mean Value theorems, the continuity of derivatives, derivatives of higher order, Taylor's theorem, Differentiation of vector valued functions.

Out comes:

- Apply mathematical concepts involving of sets and their cardinalities.
- Define and recognize the basic properties of the field of real numbers.
- Ability to apply the theorem in a correct mathematical way.
- Define and recognize the limit, continuity and differentiability of real functions.

Text Books:

1. Walter Rudin, Principles of Mathematic Analysis : . 3rd ed. McGraw Hill Book Co. New York (1986).
2. H. L.Royden, RealAnalysis (Second edition). The McMillan Co. New York(1968).

REFERENCES:

1. Methods of Real Analysis: R.R. Goldberg
2. Mathematical Analysis : T.M.Apostal

MSM-HC 1.3 :TOPOLOGY – I

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 1.3** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To introduce the basic notion of a topological space, continuous mappings between topological spaces, connectedness and compactness properties of a topological space, separation axioms in the topological spaces.
- To study the metric space and its characteristics, Nets and filters.

Unit I:

Topological Spaces: Topological Spaces, open sets, closed sets, closure,Accumulation points, derived sets, interior, boundary. Bases and subbasis, dense sets, closure operator, neighborhood system, subspaces, convergence of sequences.

Unit II:

Continuity and other Maps: Continuous maps, continuity at a point, continuous maps int R, open and closed maps, homeomorphisms, finite product spaces, projection maps.

Unit III:

Connectedness: Connected and disconnected spaces, separated sets, intermediate value theorem, components, local connectedness, path connectedness. **Separation Axioms:** T_0, T_1 and T_2 spaces.

Unit IV:

Compactness: Cover, subcover, compactness, characterizations, invariance of compactness under maps, properties.

Metric Spaces: Metrics on sets, distances between sets, diameters, open spheres. Topology induced by a metric, equivalent metrics, continuity of the distance, convergence in metric spaces.

Nets and Filters: Topology and convergence of nets, Hansdorffness and nets, compactness and nets. Filters, convergence of filters, ultrafilters, Cauchy filters.

Outcomes:

- Understand the basic characteristics to topological spaces, open bases and open sub bases, convergence of sequences in topological spaces.
- Separated sets, connected and disconnected spaces, topological property of connected spaces, locally connected space, separation axioms of the topological space.
- The cover, open cover and finite sub cover, finite intersection property, compactness, Heine-Borel theorem.
- Metric space and geometrical interpretation, Nets and filters.

REFERENCES:

1. James. Dugundji, Topology Allyn and Bacon (Reprinted by PHI and UBS)
2. J. R. Munkres, Topology- A First course PHI (2000)
3. S. Lipschutz, General Topology, Schaum's series, McGraw Hill Int (1981)
4. W. J. Pervin, Foundations of general topology, Academic Press (1964)
5. S. Willard, General Topology, Elsevier Pub. Co. (1970)
6. J. V. Deshpande, Introduction to topology, Tata McGraw Hill Co. (1988)
7. S. Nanda and S. Nanda, General Topology, MacMillan India (1990)
8. G. G. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co. (1963)
9. J. L. Kelley, General Topology, Van Nostrand Reinhold Co. (1995)
10. C. W. Baker, Introduction to topology, W. C. Brown Publisher (1991)

MSM-HC 1.4 : COMPLEX ANALYSIS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 1.4** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- This course is aimed to provide an introduction to the theories for functions of a complex variable.
- The concept of analyticity, Cauchy-Reimann relations and harmonic functions are then introduced.
- Analytic functions, contour integration and calculus of residues will be introduced to the students.

Unit I :

Analytic functions, Harmonic conjugates, Elementary functions, Mobius Transformation, Conformal mappings, Cauchy' s Theorem and Integral formula, Morera' s Theorem, Cauchy' s Theorem for triangle, Cauchy's Theorem in a disk, Zeros of Analytic function. The index of a closed curve, counting of zeros.Principles of analytic Continuation.Liouville' s Theorem, Fundaments theorem of algebra.

Unit II :

Series, Uniform convergence, Power series, Radius of convergences, Power series representation of Analytic function, Relation between Power series and Analytic function, Taylor' s series, Laurent' s series

UnitIII :

Rational Functions, Singularities, Poles, Classification of Singularities, Charecterisation of removable Singularities, poles.Behaviour of an Analytic functions at an essential singular point.

Unit IV :

Entire and Meromorphicfunctions.The Residue Theorem, Evaluation of Definite integrals, Argument principle, Rouche' s Theorem, Schwartz lemma, Open mapping and Maximum modulus theorem and applications, Convex functions, Hadmard's Three circle theorem. Phragmen-Lindelof theorem.

Outcomes:

- Represent complex numbers algebraically and geometrically.
- Evaluate complex contour integrals and apply the Cauchy integral theorem in its various versions and Cauchy integral formula.
- Students realize calculus of residues as one of the power tools in solving some problems, like improper and definite integrals effortlessly.

Text Books:

1. J . B. Conway. Functions of one complex variable, Narosa, 1987.
2. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1986, L.V. Ahlfors.

REFERENCES:

1. Analystic functions, Springer, 1970, R. Nevanlinna.
2. E. Hille, Analytic Teory, Vol. I, Ginn, 1959.
3. S. Ponnaswamy, Functions of Complex variable, Narosa Publications.

MSM-HC 1.5 :ORDINARY DIFFERENTIAL EQUATIONS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 1.5** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Formulate Ordinary Differential Equations (ODEs) and seek understanding of their solutions, either obtained exactly or approximately by analytic or numerical methods.
- Understand the concept of a solution to an initial value problem, and the guarantee of its existence and uniqueness under specific conditions.
- Recognize basic types of differential equations which are solvable, and will understand the features of linear equations in particular.
- Use different approaches to investigate equations which are not easily solvable. In particular, the student will be familiar with phase plane analysis.

Unit I:

Higher Order Linear Differential Equations: Homogeneous equations and general solutions; Initial value problems; existence and uniqueness of solutions, linear dependence and independence of solutions, Solutions of non homogeneous equations by Method of Variation of parameters, Method of Undetermined Coefficients. Homogeneous equation of order n, initial value problems, Non-homogeneous equations.Linear equations with variable coefficients, reduction of order of the equation.

Unit II:

Oscillations of Second Order Equations: Introduction, Ocillatory and non-Oscillatory differential equations and some theorems on it. Boundary value problems; Sturm Liouville theory; Green's function.

Unit III:

Solution in Terms of Power Series: -Solution near an ordinary point and a regular singular point–Frobenius method–, Laguerre, Legendre, Bessel's and Hypergeometric equations and their polynomial solutions, Rodregue's relation, generating functions, orthogonal properties, and recurrence relations.

Unit IV:

System of First Order Equations: Existence and uniqueness theorems, First order systems, Linear system of homogeneous and non-homogeneous equations (matrix method) Non-linear equations-Autonomous systems-Phase plane-Critical points–stability-Liapunov direct method-Bifurcation of plane autonomous systems.

Out comes:

- Apply the fundamental concepts of the basic numerical methods for their resolution.

- Solve higher order and system of differential equations of different types.
- Finding the solutions of differential equation with initial and boundary conditions.
- Solving higher order partial differential equations using various methods.
- Students will understand concept of linear differential equation, Fundamental set Wronskian.
- Students will understand the concept of Liouvilles theorem, Adjoint and Self Adjoint equation, Langrage's Identity, Green's formula, Eigen value and Eigen functions.
- Students will be able to identify ordinary and singular points and the capable of solving the solution by Frobenius Method, Hyper geometric differential equation and its polynomial.

REFERENCES:

1. *An Introduction to Ordinary Differential Equations*: Eurl A. Coddington
2. *Differential Equations with Applications and Historical Note* :Simmons, G.F.
3. *Theory of ordinary differential equations* :M.S.P.Eastham

MSM-SC 1.6 :(a)DISCRETE MATHEMATICS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 1.6(a)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Prepare students to develop mathematical foundations to understand and create a mathematical arguments require in learning many mathematics and computer science courses.
- To motivate students how to solve practical problems using discrete mathematics.

Unit I:Boolean Algebra And Lattices:

Partially ordered sets. Lattices, Complete, Distributive, Complemented lattices. Boolean functions and expressions.Propositional calculus, logical connectives, truth values and tables.Boolean algebra to digital networks and switching circuits.

Unit II :

Ordinary generating function and exponential generating functions, A counting technique. Reccurence relation: First-Order Relations, Second-Order linear Homogeneous relations.

Unit III :

Third order and higher order linear Homogeneous relations, Linear Non-Homogeneous relations of second and higher orders

Unit IV:Graph Theory:

Basic Concepts: Different types of graphs, subgraphs, walks and connectedness. Degree sequences, directed graphs, distances and self-complementary graphs.

Blocks: Cut-points, bridges and blocks, block graphs and cut-point graphs.

Trees and Connectivity: Characterization of Trees, Spanning Trees, centers and centroids, connectivity, edge connectivity, arboricity and vertex arboricity. Eulerian and Hamiltonian graphs.

Out comes:

- Construct mathematical arguments using logical connectives and quantifiers.
- Validate the correctness of an argument using logical connectives and quantifiers.
- Learn how to work with some of the discrete structures which include sets, relations, functions, graphs and recurrence relations.

REFERENCES :

1. C. L. Liu: Elements of discrete Mathematics, McGraw Hill, International (1986)
2. B. Kolman, R. C. Busby and S. Ross: Discrete Mathematical structures, Prentice Hall of India, New Delhi (1998)

3. J. P. Tremblay and R. Manohar: Discrete Mathematical structure with Applications to Computer Science, Tata McGraw Hill Edition(1997)
4. K. D. Joshi: Foundations of Discrete Mathematics, Wiley Eastern (1989)
5. J. A. Bonday and U. S. R. Murthy: Graph Theory with Applications, MacMillan,
    a. London.
6. N. Deo: Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India.
7. F. Harary, Graph Theory, Narosa Publishing House, New Delhi.
8. L. Lovasz, J. Pelikan, K. Vesztergombi, Discrete Mathematics, Springer, Second Edition (2004)
9. V. Krishnamurthy, Combinatory, Theory and Applications, Affiliated East-West Press Pvt. Ltd.

MSM-SC 1.6(b):FUNCTIONS OF SEVERAL VARIABLES

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 1.6(b)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives

- Exposure on basic topology on the Euclidean space. Recognize open, closed, connected and compact subsets.
- Introduce the notion of component functions and their role in vector valued functions.
- Need of generalization of integration. Recognize the functions which are Riemann–Stieltjes integrable.
- Introduce the role and application of line integrals, surface integrals.

Unit I:

Euclidean space R^n as a real vector space and a real inner vector space Topology of R^n. Bolzano-Weirstrass property for R^n Heine-Boral theorem for R^n Functions f: E $\rightarrow$ R^{nm} from a sunset E of R^n into R^m.

Unit II:

Component functions of f. Limits, continuity and differentiation theorem, implicit function theorem, rank theorem. Determinants, Jacobean.

Unit III:

The Riemann-Steilje's Integral: Definition and existence of the integral, Properties of the integral, Integration and Differentiation, Integration of vector valued function.

Unit IV:

The Inverse Functions theorem and its illustrations and examples.The implicit function theorem and illustrations and examples. The rank theorem illustration and examples. Cylindrical and spherical coordinates, line integrals, surface integrals, Theorem of Green, Gauss and Stokes

Out comes:

- Apply mathematical concepts to construct the open, compact subsets etc. in the Euclidean space.
- Write clear and precise proofs for some important theorems of vector valued functions.
- Ability to do analysis of Riemann–Stieltjes integrable functions.
- Application of Green, Gauss and Stokes theorems.
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REFERENCES:

1. W.Rudin: Principles of mathematical analysis, 3rd Edition, McGraw Hill Book Co. (1964).
2. W.R.Wade: An introduction to analysis, Second Edition, Prentice Hall of India (International edition) (2000).
3. C.Goffman; Calculus of several variables, Harper series(1965).
4. M.Spivik; Calculus of manifolds,W.A.Benjamin(1965)
5. W.H.Fleming: Functions of several variables, Addison Wesley(1968

MSM-1.7 : Lab – I

Teaching: 3 hrs/week **Credits: 02**
Max Mark: 50 **Hours : 52**
Code: **MSM-1.7** .
Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

C-PROGRAMS:

List of programs:

1. Program to accept three integers and print the largest among them.
2. Program to check whether the integer is even or odd and also positive or negative.
3. Program to a generate current bill.
4. Program to find roots of quadratic equation.
5. Program to convert binary number to decimal number.
6. Program to convert decimal number to binary number.
7. Program to calculate factorial of a number.
8. Program to print Fibonacci numbers.
9. Program to test whether the number is prime or not.
10. Program to search an element in the array.
11. Program to arrange a set of integers in an ascending order and print them.
12. Program to find sum and differences of two matrices.
13. Program to find the transpose of a matrix.
14. Program to find the product of two matrices.
15. Program to find trace and norm of a matrix.
16. Program to find row sum and column sum of a matrix.

M.A./ M.Sc. II SEMESTER

Sl.NO	Paper and Title	Credits	No. Hrs/week Theory/practical	Duration of exam in hrs Theory/practical	Internal assessment marks Theory/ practical	Marks at the exams	Total Marks
II SEMESTER (w.e.f.2016-17)							
MSM 2.1HC	Algebra-II	4	4	3	30	70	100
MSM 2.2HC	Real Analysis-II	4	4	3	30	70	100
MSM 2.3HC	Numerical Analysis – I	4	4	3	30	70	100
MSM 2.4HC	Partial differential equations	4	4	3	30	70	100
MSM 2.5SC	2.5SC(a) Differential Geometry or 2.5(b). Classical Mechanics or 2.5SC(b) Fuzzy sets and Fuzzy logic	4	4	3	30	70	100
MSM 2.6Lab	Mat Lab – II	2	4	3	15	35	50
MSM 2.7 OEC	MSM2.7OEC(1): COMMERCIAL MATHEMATICS Or MSM2.7OEC(2): MATHEMATICAL STATISTICS Or MSM2.7OEC(3) MATHEMATICAL FINANCE	4	4	3	30	70	100
	Total of II Semester	26					650

MSM-HC 2.1 ALGEBRA-II

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 2.1** .
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To introduce the concepts and to develop working knowledge on rings and fields theory.
- The course gives the student a good mathematical maturity and enables to build mathematical thinking and skills.

Ring theory:

Unit I:

Ring, sub ring, ideal, factor ring-definition and examples. Homomorphism of rings. Isomorphism theorems. Correspondence theorem.Integral theorem.Integral domain, field and embedding of an integral domain in a field.Prime ideal, maximal ideal of a ring. Polynomial ring R[X] over a ring in an indeterminate X.

Unit II:

Principle ideal domain. Euclidean domain .The ring of Gaussian integers as an Euclidean domain. Format's theorem. Unique factorization domain.Primitive Polynomial. Gauss lemma. F[X] is a unique factorization domain for a field F.
Eienstien's criterion of irreducibility for polynomials over a UFD.

Field Theory:

Unit III:

Field, subfield, prime subfield, - definition and examples. Characteristic of a field. Characteristic of a finite field.Field extensions.Finite extensions.Algebraic extensions.Transitivity theorems.Simple extensions.

Unit IV:

Roots of polynomials.Splitting field of a polynomial.Existence and uniqueness theorems.Existence of a field with p^n element for a prime p and a positive integer n.

Out comes:

- Explore the properties of rings, subrings, ideals and Integral domain.
- Understand the concepts of homomorphism and isomorphism between rings.
- Understand Euclidean rings and their properties.
- Provide information on Fields and Splitting field of polynomial.

REFERENCES

1. I.N.Herstein,Topics in Algebra,2nd Edition, John-Wiley & Sons. New York(1975).
2. Surjit Singh & Quasi Zameeruddin,Modern Algebra, Vikas publishing House(1990).
3. S.K,Jain, P. B. Battacharya& S.R. Nagpaul, Basic AbstactAlgebra,Cambridge University Press(1997).
4. J. J. Roatman, Galois theory, 2ndEdition,Universitext, Springer-Verlag(1998).
5. I.N.Herstien, Abstract Algebra, Maxwell- McMillan Publication(1990)

MSM-HC 2.2: REAL ANALYSIS – II

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 2.2** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- What and why on Uniform convergence. Importance of uniform convergence in commuting the limits, continuity etc. in the context of sequence and series of functions.
- Approximation of continuous function on compact set by polynomials. Properties of power series.
- Study the geometry of various subsets in the Euclidean space.
- Introduce the integration in two and three dimensional Euclidean spaces.

Unit I:

Sequences and series of functions: Pointwise and uniform Convergence, Cauchy Criterian for uniform convergence, Weierstrass m-Test, uniform Convergence and continuity Uniform convergence and Riemann-Steiltje's Integration, Uniform convergence and Differentiation. Uniform convergence and bounded variation—equicontinous families functions, Uniform convergence and boundedness,

Unit II:

The stone weierstrass theorem and approximation of continuous function. Illustration of theorem with examples properties of power series, exponential and logarithmic function trignometric functions.

Unit III:

Topology of $\mathbf{R}^n$, Hein-Borel Theorem, Bolzano weierstrass theorem, continuity compactness anduniform continuity.

Unit IV:

Integration on R^2 and R^3 . Line integrals, double integral, double integrals over a region, Green's theorem, Change of variables. Rectifiable curves, Surface integrals, Stock's theorem

Out comes:

- Ability to construct counterexamples for various concepts in the context of sequence and series of functions.
- Describe the properties involving of basic difference between series of functions and power series.
- Write clear and precise proofs for Bolzano-Weirstrass, Heine-Borel, theorems etc. Application of integration of functions in the Euclidean spaces.

Text Books:

1. W.Rudin : Principles of Mathematical Analysis, McGraw Hill, 1983.
2. T.M.Apostol: Mathematical Analysis, 2nd edition, Narosa,1988

REFERENCES:

1. S.Goldberg : Methods of Real Analysis, Oxford & IBH 1970.
2. J.Dieudonne : Treatise on Analysis, Vol-1, Academic press.1960

MSM-HC 2.3: NUMERICAL ANALYSIS-I

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 2.3** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Derive appropriate numerical methods to solve algebraic and transcendental equations.
- Develop appropriate numerical methods to approximate a function.
- Develop appropriate numerical methods to solve a differential equation.
- Derive appropriate numerical methods to evaluate a derivative at a value.
- Derive appropriate numerical methods to solve a linear system of equations.
- Perform an error analysis for various numerical methods.
- Derive appropriate numerical methods to calculate a definite integral.

Unit I:

Solutions of Linear System of Equations: Introduction to Direct Methods via., LU factorization (Cholesky.Crout's and Delittle methods), Triangularisation method, Iteration Methods: Gauss Jordan methods, Gauss-Seidel method, Successive Over relaxation method, Convergence Criteria, and applications.Eigenvalues and Eigenvectors of a matrix:The characteristics of a polynomial, Theeigen values and eigenvectors of a matrix by Jocobi's method, Given's method, House holders method, power method, Inverse Power method

Unit II:

Solutions of Nonlinear/Transcendental Equations: Fixed point iteration, Method of Falsi position, Newton Raphson Method, Secant method, Regula-Falsi Method, Muller's Method, Aitken's Δ^2 method, Orders of convergence of each methods..Extraction of quadratic polynomial by Bairstow's method.

Unit III:

Interpolation Theory: Polynomial interpolation theory, Lagranges interpolation polynomial, truncation error. Hermite interpolation polynomial, Inverse interpolation, Piece wise polynomial interpolation, Trigonometric interpolation, Convergence Analysis,

Unit IV:

Approximation Theory: Introduction, Spline approximation, Cubic splines (natural, and not a Knot), Best approximation property, Least square approximation for both discrete data and for continuous functions, Grams-Schmidthorthogonalisation procedure, Reme's single and multiple exchange algorithm.

Out comes

- Understanding the theoretical and practical aspects of the use of numerical methods.
- Implementing numerical methods for a variety of multidisciplinary applications.

- Establishing the limitations, advantages, and disadvantages of numerical methods.
- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Code various numerical methods in a modern computer language.

REFERENCES:

1. A First Course in Numerical Analysis : A. Ralston
2. Numerical Analysis & Computation : E.K. Blum
3. Elements of Numerical Analysis : P. Henrici
4. Introduction to Numerical Analysis : F.R. Hindebrand
5. Principles & Procedures of Numerical Analysis : F. Szidarovszky& S. Yakowitz.
6. Numerical Analysis for scientists and engineers, : M.K.Jain.
7. Numerical mathematical Analysis : J.B. Scarborough

MSM-HC 2.4 :PARTIAL DIFFERENTIAL EQUATIONS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 2.4** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Introduce the notion of partial differential equations.
- Introduce students to how to solve linear partial differential with different methods.
- Understand the concept of second order partial differential equations like wave equation, heat equation, Laplace equations and their solutions by variable separable method, Laplace and Fourier transform methods.
- Introduce some physical problems in Engineering and Biological models that results in partial differential equations.

Unit I:

First Order Partial Differential Equations: Introduction, Construction of First-order Partial Differential Equations, Solutions of First Order Partial Differential Equations, Solutions Using Charpit's and Lagaranges Method, Method of Cauchy Characteristics, Method of Separation of Variables

Unit II:

Second Order Partial Differential Equations: Introduction, Origin of Second Order Equations, Equations with Variable Coefficients, Canonical Forms.

Unit III:

Parabolic Equations: Introduction, Solutions by Separation of Variables, Solutions by Eigen function Expansion Method, Solutions by Laplace Transform Method, Solutions by Fourier Transforms Method, Duhamel's Principle, Higher Dimensional Equations, Solutions to parabolic equations in cylindrical and spherical coordinate systems.

Unit IV:

Hyperbolic and Elliptic Equations: Introduction, Method of Characteristics (D'Alembert Solution), Solutions by Separation of Variables, Solutions by Eigen functions Expansion Method, Solutions by Laplace Transform Method, Solutions by Fourier Transform Method, Duhamel's Principle, Solutions to Higher Dimensional Equations, Solutions to hyperbolic equations in cylindrical and spherical coordinate systems.

Elliptic Equations: Introduction, Solutions by Separation of Variables, Solutions by Eigen functions Expansion Method, Solutions by Fourier Transform Method, Similarity Transformation Method, Solutions to Higher Dimensional Equations, Solutions to elliptic equations in cylindrical and spherical coordinate systems.

Outcomes:

- Classify partial differential equations and transform into canonical form.
- Solve linear partial differential equations of both first and second order.
- Students will be focused on initial boundary value problem for homogeneous and non-homogeneous PDE.
- Students will be focused on boundary value problem by Dirichlet and Neumann problem.

REFERENCES:

1. *Nonlinear Partial Differential Equations in Engineering*:Ames, W.F.
2. *Integral Transforms and Their Applications* :Debnath, L
3. *Partial Differential Equations for Scientists and Engineers*:Stanley J. Farlow
4. *Partial Differential Equations of Mathematical Physics*:TynMyint-U
5. *Elements of Partial Differential Equations* :I.N. Sneddon
6. *Linear Partial Differential Equations for Scientists and Engineers* :TynMyint-U and LokenathDebnath

MSM-SC 2.5(a) : DIFFERENTIAL GEOMETRY

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 2.5(a)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To acquire knowledge and understanding of the basic concepts of geometry of curves and surfaces.
- To acquire mastery in solving typical problems associated with the theory

Unit I :

Calculus on Euclidean Space: Euclidean space. Natural coordinate functions. Differentiable functions. Tangent vectors and tongent spaces. Vector fields.Directional derivatives and their properties.Curves in E^3.Velocity and speed of a curve. Reparametrization of a curve. 1-forms and Differential forms. Wedge product of forms. Mappings of Euclideon spaces.Derivative map.

Unit II :

Frame Fields : Arc length parametrization of curves. Vector field along a curve. Tangent vector field, Normal vector field and Binormal vector field. Curvature and torsion of a curve.The Frenet formulas Frenet approximation of unit speed curve and Geometrical interpretation.Properties of plane curves and spherical curves. Arbitrary speed curves. Cylindrical helix Covariant derivatives and covariant differentials. Cylindrical and spherical frame fields. Connection forms. Attitude matrix.Structural equations.Isometries of E^3 - Translation, Rotation and Orthogonal transformation. The derivative map of an isometry.

Unit III :

Calculus on a Surface: Coordinate path. Monge path.Surface in E^3.Special surfaces-sphere, cylinder and surface of revolution. Parameter curves, velocity vectors of parameter curves, Patch computation. Parametrization of surfaces-cylinder, surface of revolution and torus. Tangent vectors, vector fields and curves on a surface in E^3. Directional derivative of a function on a surface of E^3. Differential forms and exterior derivative of forms on surface of E^3. Pull back functions on surfaces of E^3.

Unit IV :

Shape Operators: Definition of shape operator. Shape operators of sphere, plane, cylinder and saddle surface. Normal curvature, Normal section.Principal curvature and principal direction.Umbilic points of a surface in E^3. Euler's formula for normal curvature of a surface in E^3.

Outcomes:

- Able to understand the fundamental theorem for plane curves.
- Define and understand space curves with the help of examples.
- Able to compute the curvature and torsion of space curves

Text Books:

1. Barrett O' Neil : Elementary Differential Geometry. Academic Press, New York and London, 1966.
2. T.J.Willmore : An introduction to Differential Geometry. Clarendon Press, Oxford 1959.

REFERENCES:

1. D.J.Struik : Lectures on Classical Differential Geometry, Addison Wesley, Reading, Massachusetts, 1961.
2. NirmalaPrakassh: Differential Geometry- an integrated approach. Tata McGraw-Hill, New Delhi, 1981.

MSM-SC 2.5(b) CLASSICAL MECHANICS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 2.5(b)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To introduce the tensor algebra and tensor calculus.
- To introduce the notion of continuum, deformations, stress and strain, stress-strain relations.
- To introduce the fundamental physical laws (field equations) and constitutive equations.
- To discuss some applications of continuum mechanics to solid and fluid mechanics.

Unit 1: Coordinate transformations, Cartesian tensors, Basic Properties, Transpose, Symmetric and Skew tensors, Isotropic tensors, Deviatoric Tensors, Gradient, Divergence and Curl in Tensor Calculus, Integral Theorems.

Unit 2: Continuum Hypothesis, Configuration of a continuum, Mass and density, Description of motion, Material and spatial coordinates, Translation, Rotation, Deformation of a surface element, Deformation of a volume element, Isochoric deformation, Stretch and Rotation, Decomposition of a deformation, Deformation gradient, Strain tensors, Infinitesimal strain, Compatibility relations , Principal strains.

Unit 3: Material and Local time derivatives Strain, rate tensor, Transport formulas, Stream lines, Path lines, Vorticity and Circulation, Stress components and Stress tensors, Normal and shear stresses, Principal stresses.

Unit 4: Fundamental basic physical laws, Law of conservation of mass, Principles of linear and angular momentum, Equations of linear elasticity, Generalized Hooke's law in different forms, Physical meanings of elastic moduli, Navier's equation.

Unit 5: Equations of fluid mechanics, Viscous and non-viscous fluids, Stress tensor for a non-viscous fluid, Euler's equations of motion, Equation of motion of an elastic fluid, Bernoulli's equations, Stress tensor for a viscous fluid, Navier-Stokes equation.

Outcomes:

- Understand the tensor algebra and tensor calculus which has numerous applications in mechanics.
- The continuum hypothesis, description of motions, various types of deformations, stresses and strains and their interrelation.
- Fundamental physical conservative laws and their governing equations.
- Mathematical modeling of various solid and fluid mechanics problems arising in natural and technological systems. .

REFERENCE BOOKS:

1. D.S.Chandrasekharaiah and L.Debnath: Continuum Mechanics, Academic Press,1994
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.

3. Goldstein, Classical Mechanics, Addison – Wesley, 3rd Edition, 2001.
4. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
5. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977
6. A.S. Ramsey, Dynamics part II, the English Language Book Society and Cambridge University Press,(1972)
7. F. Gantmacher, Lectures in Analytical Mechanics, MIR Publisher, Mascow,1975.
8. Narayan Chandra Rana and Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.
9. F. Chorlton, Text Book of Dynamics, (ELBS Edition), G. Van Nostrand and co.(1969).

MSM-SC 2.5(C): FUZZY SETS AND FUZZY SYSTEM

Teaching: 4 hrs/week **Credits: 04**

Max Marks: 100 **Hours : 52**

Code: **MSM-SC 2.5(c)** .

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

Objectives:

- Develop the skills to gain a basic understanding of fuzzy logic theory.
- Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories.

Unit I:

Brief History of Mathematics, set theory,Logic, Fuzzy set theory,Life History of world famous mathematicians and their works and contributions.

Unit II:

Set theory union,intersection,Complementation,functions, Characteristics functions, Mathematical Logic, Logical Connectives, two valued and three valued logics,Applications.

Unit III:

Boolean algebra, Fuzzy set theory, and Fuzzy logic, Operations on Fuzzy sets, Functions on Fuzzy sets, image and inverse image properties, α-cuts.Fuzzy numbers, Linguistic variables, arithmetic operations on intervals and fuzzy numbers, fuzzy equations

Unit IV: **Fuzzy Relations:**

Crisp and fuzzy relations, Projection and cylindric extensions, binary fuzzy relations, membership matrices and sagittala diagram, inverse compositions of fuzzy relations , binary fuzzy relation on a single set, fuzzy equivalence relation, fuzzy ordering relation, fuzzy morphisms, sup and inf compositions.

Out comes:

- Understand basic knowledge of the fuzzy sets, operations and their properties.
- Understand the fundamental concepts of fuzzy functions and fuzzy logic.
- Be able to distinguish between the crisp set and fuzzy set concepts through the learned difference between the crisp set characteristic function and the fuzzy set membership function.
- Analyze the fuzzy relations, projection and binary fuzzy relations along with its applications.

REFERENCES:

1. George J.Klor.and Yuan Fuzzy sets and Fuzzy logic, Theory and Applications. PHI.
2. George J.Klir and Tina a. Fotger. Fuzzy sets unceratinity and information, PHI(1994)
3. Kaufmann, A., Introduction to the Theory of Fuzzy subsets-vol. Academic press(1975)
4. DriankovD, and others. An Introduction to Fuzzy control.
5. B.Kosko& others, Fuzzy logic with engineering Applications. PHI
6. Fuzzy Sets & Fuzzy Logic-Klir and Yuan, PHI

MSM-2.6: Lab-II

Teaching: 3 hrs/week **Credits: 02**
Max Marks: 50 **Hours : 52**
Code: **MSM-2.6** .

Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

MATLAB PROGRAMMING

List of programs:

1. Program to find the roots of quadratic equation.
2. Program to find solution to system of linear equations by matrix inversion method.
3. Program to find solution to system of linear equations by Cramers rule.
4. Program to find area of one of the geometric figures (circle, triangle, rectangle and square) using switch statements.
5. Program to find the approximate solution of a differential equation with initial condition by Picards method of successive approximation.
6. Program to find the numerical solution of differential equation with initial condition by Euler's method.
7. Program to find the numerical solution of differential equation with initial condition by Euler's modified method.
8. Program to find the numerical solution of differential equation with initial condition by Runge-Kutta II order method.
9. Program to find the numerical solution of differential equation with initial condition by Runge-Kutta III order method.
10. Program to find the numerical solution of differential equation with initial condition by Runge-Kutta IV order method.
11. Program to plot a neat labeled graph of sine and cosine function on the same graph.
12. Program to plot a neat labeled graph of functions f(x)=x^2, g(x)=$x^3 - 1$, and h(x)=e^x on the same graph.
13. Program to obtain the graph of plane curves cycloid and astroid in separate figure on a single run.
14. Program to draw a neat labeled graph of Topologist's sine curve.
15. Program to obtain a neat labeled graph of space curves elliptical helix and circular helix in separate figure on a single run.
16. Program to obtain a neat labeled graph of surfaces elliptic paraboloid and hyperbolic paraboloid in separate figure on a single run.

MSM-2.7 OEC (1) COMMERCIAL MATHEMATICS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-2.7 OEC(1)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To enhance the problem solving skills.
- To improve the basic mathematical skills and to help students who are preparing for any type of competitive examinations.

UNIT I:
General Mental Ability-I Series Completion, Coding and Decoding, Blood relations, Seating Arrangement, Comparison type questions.

UNIT II:
General Mental Ability-II Directions sense test, logical venn diagrams, Inserting the missing character, data sufficiency.

UNIT III:
Arithmetical Ability: Numbers, Simplification, Average, Problems on ages, Percentage, Probability. Profit and loss, ratio and proportion, time and work, simple interest compound interest, calendar, Partnership, Numbers GCD & LCM.

Unit-IV:
Data Interpretation Tabulation, Bar graphs, Pie charts, line graphs.

Outcomes:

- Understand the basic concepts of general mental ability and logical reasoning skills.
- Able to solve arithmetical problems like simplifications, average, percentage, probability, profit loss, simple interest, GCD and LCM etc.

Reference books:

1. Quantitative Aptitude by Dr. R S Aggarwal, Revised edition, ISBN 81-219-2498-7.
2. A Modern Approach to Verbal Reasoning by Dr. R S Aggarwal, S. Chand and Company pvt. Ltd., ISBN 81-219-0552-4.

MSM-2.7 OEC (2) :MATHEMATICAL STATISTICS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-OEC (2)** .
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Able to use statistical reasoning, formulate a problem in statistical terms.
- Perform exploratory analysis of data by graphical and other means, and carry out a variety of formal inference procedures.
- Able to describe important theoretical results and understand how they can be applied to answer statistical questions.

Unit I:

Classification of Data :Objects and Functions, Types, Frequency Distribution- Ungrouped and Grouped series, Terms.

Diagrams and Graphs: Diagrams - Meaning ,Utilities, Limitation, Construction, Types-one dimensional, Two- dimensional, others. Graphs- Meaning ,Utilities, Limitation, Construction, Types-Time series, Frequency Distribution-Histogram, Frequency polygon, Frequency curve and ogives, Terms.

Unit II:

Measures of Central Tendency: Introduction, Types of Averages, Arithmetic Mean-Simple and Weighted, Median and Mode, terms.

Unit III:

Measures of Dispersions: Introduction, Range , Quartile Deviation, mean deviation,standard deviation and Coefficient of variation, terms.

Unit IV:

Correlation and Regression Analysis: Introduction-Meaning of correlation and Regression Analysis, Types, probable Error, Karl pearson's Coefficient of correlation, Spearman's Rank correlation Coefficient, Two line of Regression, Relationship among the measures.

Outcomes:

- Understand the relationship among the measures using examples
- Finding Measures of central tendency and dispersions of some problems.
- Able to define and distinguish between Correlation and regression.
- Analyze the correlated data and fit the linear regression models.

REFERENCES:

1. Probability and Statistics (Schaum's Outline Series)..
2. Rao, A First Course In Probability And Statistics, Cambridge University Press, New Delhi.
3. E. Rukmangadachar, Probability and Statistics Paperback – 2012, Pearsons education.

MSM-2.7 OEC (3) : MATHEMATICAL FINANCE

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-OEC (3)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:.

- The principal aim of this course is to provide students with an appreciation and understanding of how the application of mathematics, particularly stochastic mathematics, to the field of finance may be used to illuminate this field and model its randomness, resulting in greater understanding and quantification of investment returns and basics of option pricing.
- It would also be helpful to understand the fundamentals of LP models and their duals while grasping the proof of the Arbitrage theorem.
- The topics expose the user to fundamental concepts such as cash flows, present value, future value, yield and probability that form the basis for further advanced learning

Unit 1:

Mathematics of Financial Markets.Stocks and their Derivatives, Pricing Futures Contracts, Bond Markets, Computing Rate of Return, Interest Rates and Forward Interest Rates. Yield Curves.

Unit 2:

Methods of Hedging a Stock or Portfolio, Hedging with Puts, Hedging with Collars, Correlation based hedges. Volatility computations, Delta hedging.

Unit 3:

Interest Rates and Forward Rates, Zero coupon Bonds, Forward Rates and Zero Coupon Bonds. Computations based on Y(t), P(t),Swaps and related arbitrage. Pricing and hedging a Swap. Arithmetic and Geometric Interest rates. Interest Rate Models in discrete and continuum setting., Bond price dynamics.

Unit 4:

Binomial Trees, Expected Value Pricing, Arbitrage, Pricing probability Binomial Model for Pricing Options, N-Period Binomial model for Hedging.

Out comes:

- The students would have a clear perception of the power of mathematical ideas and tools and would be able to demonstrate the application of mathematics to problems drawn from industry and financial services.

- They would be able to describe the main equilibrium asset pricing models and perform calculations using such models; understand the relationship between investment risk and return and calculate the option prices using the studied models.
- Demonstrate knowledge of the terminology related to nature, scope, goals, risks and decisions of financial management.
- Predict various types of returns and risks in investments and take necessary protective measures for minimizing the risk.
- Develop ability to understand, analyze and solve problems in bonds, finance and insurance.
- Build skills for computation of premium of life insurance and claims for general insurance using probability distributions.

REFERENCES:

1. Oksendal, Stochastic Differential Equations.Springer.
2. Williams R.J, Introduction to Mathematics of Finance, Universities Press.
3. V.Goodman, J.Stampfli, Mathematics of Finance, Thomson Brooks/Cole,2001.
4. S.Ross, Mathematical Finance, CUP.
5. J.C.Hull, Options, Futures and Other Derivatives, Pearson Publication
6. S.Shreve, Stochastic Calculus and applications, Springer.

M.A. / M.Sc. III- SEMESTER

Sl.no	Paper&title	Credits	No.ofhrs/week Theory/practical	Duration of exam in hrs Theory/practical	Internal assessment marks Theory/practical	Marks at the exams	Total marks
MSM 3.1 HC	Topology-II	4	4	3	30	70	100
MSM 3.2HC	Functional Analysis	4	4	3	30	70	100
MSM 3.3HC	Linear Algebra	4	4	3	30	70	100
MSM 3.4HC	Fluid Mechanics – I	4	4	3	30	70	100
MSM 3.5SC	3.5SC(a) Numerical Analysis -II or 3.5(b) Operation Research Or 3.5© Number theory	4	4	3	30	70	100
MSM 3.6	C-Lab-II	2	3	3	15	35	50
MSM 3.7 OEC	MSM3.7OEC(1) :MATHEMATICAL PHYSICS Or MSM3.7OEC(2) :QUANTITATIVE TECHNIQUES Or MSM3.7OEC(3) :Mathematical Biology	4	4	3	30	70	100
	Total of III Semester	26					650

MSM-HC 3.1 : TOPOLOGY-II

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 3.1** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To gain the knowledge on separation axioms, countability axioms.
- Understand the concepts of metric spaces with theorems and examples
- Understand the concept of product spaces with examples.

Unit I: Separation Axioms:

Regular and T_3 spaces, normal and T_4 spaces, Urysohn's lemma, Tietze's, Extension theorem ,Completely regular and Tychonoff spaces, completely normal and T 5spaces.

Unit II:Countability Axioms:

First and second Axioms of countability.Lindelof spaces, separable spaces, countably compact spaces, Limit point compact spaces .

Unit III: Convergence in Topology:

Sequences and subsequences, convergence in topology. Sequential compactness, local compactness, one point compactification ,Stonecechcompactification .

Unit IV:Metric space and metrizability:

Separation and countability Axioms in metric spaces, Convergence in metric spaces, complete metric spaces.

Product spaces: Arbitrary product spaces, product invariance of certain separation and countability axioms. Tychonoff'stheorem ,product invariance of connectedness.

Outcomes:

- Able to state and prove Urysohn's lemma and Tietze's Extension theorem.
- Distinguish between T_3, T_4 and T_5 spaces.
- Able to describe the properties of T_3, T_4 and T_5 spaces.

REFERENCES:

1. **James Dugundji:** Topology,PHI(2000)
2. **J.R.Munkres:**Topology-A first course, PHI(2000)
3. **S.Willard:**General topology, Addison-Wesley(1970)McGraw hill ,Int,schaum's series(1981)
4. **S.Lipschutz:**General topology, McGraw hill ,Int,schaum's series(1981).
5. **J.V.Deshpande:** Introduction to topology,Tata McGraw hill(1988).
6. **R.Engelking:** General topology ,polish scientific publishers, Warszawa(1977).

7. **J.L.Kelley:** General topology,VanNostrand(1995)
8. **K.D.Joshi:** Introduction to general topology ,wiley Eastern Ltd.(1983).
9. **G.F.Simmons:**Introduction to general topology and morden analysis, McGraw hill (1963).
10. **S.Nanda and S.Nanda:**generalTopology,MacMillan India Ltd.(1990).
11. **C.W.Baker:** Introduction to topology,W.C.Brown(1991).
12. **N.Bourbaki:**General Topology part-I(Trausl),Addison wesley(1966)
13. **M.G.Murdeshwar:** General Topology, WileyEastern(1990)

MSM-HC 3.2 :FUNCTIONAL ANALYSIS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 3.2** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To teach the fundamentals of Functional Analysis.
- The topic includes Hahn-Banach theorem, Open mapping theorem, closed graph theorem, Riesz Representation theorem, etc.
- Define linear operators, self adjoint, isometric and unitary operators on Hilbert spaces.
- This course also includes a few important applications of functional analysis to other branches of both pure and applied mathematics.

Unit I :

Normed linear spaces.BanachSpaces : Definition and examples. Quotient Spaces.Convexity of the closed unit sphere of a Banach Space.Examples of normed linear spaces which are not Banach.Holder' s inequality. Minkowski's inequality.Linear transformations on a normed linear space and characterization of continuity of such transformations. Linear functionals , The conjugate space N*.

Unit II :

The set *B* (*N, N')* of all bounded linear transformations of a normed linear space N into normed linear space N' .The natural imbedding of N into N**.Reflexive spaces.Hahn - Banach theorem and its consequences, Projections on a Banach Space.The open mapping theorem and the closed graph theorem.The uniform boundedness theorem.The conjugate of an operator, properties of conjugate operator.

Unit III:

Hilbert Spaces: Definition and Examples, Schwarz' s inequality. Parallelogram Law, polarization identity. Convex sets, a closed convex subset of a Hilbert Space contains a unique vector of the smallest norm. Orthogonal sets in a Hilbert space. Bessel' s inequality. orthogonal complements, complete orthonormal sets, Orthogonal decomposition of a Hilbert space. Characterization of complete orthonormal set. Gram-Schmidt orthogonalization process.

Unit IV :

The conjugate space H*of a Hilbert space H. Representation of a functional f as f(x)= (x, y) with y unique. The Hilbert space H*. Interpretation of T* as an operator on .Self-adjoint operators, Positive operators.Normal operators.Unitary operators and their properties. Projections on a Hilbert space, Invariant subspace. Orthogonality of projections. Eigen values and eigen space of an operator on a Hilbert Space. Spectrum of an operator on a finite dimensional Hilbert Space.

Out comes:

- To study certain topological-algebraical structures and the methods by which the knowledge of these methods can be applied to analytic problems.

- Study Continuous linear transformations and the Hahn-Banach theorem.
- Understand the Open Mapping Theorem and its applications.
- Obtain Orthogonal complements, Orthonormal sets and conjugate space.
- Understand the relevance of Operator Theory.
- Discuss Determinants and the spectrum of an operator.
- The student will be in a position to take up advance courses in analysis.
- The student will be able to apply the concepts and theorems for studying numerical analysis, design maturity, the evolution of the design and the complexity of the mission, etc.

Text Book:

1. G. F. Simmons: Introduction to Topology and Modern Analysis (McGraw-Hill Intl. Edition).

REFERENCES:

1. G. Backman and L. Narici : Functional Analysis (Academic).
2. B. V. Limaye : Functional Analysis (Wiley Eastern).
3. P.R. Halmos : Finite dimensional vector paces, Van Nostrand, 1958.
4. E. Kreyszig : Introduction to Functional Analysis with Applications, John Wiley & Sons

MSM-HC 3.3: LINEAR ALGEBRA

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 3.3** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Importance of vector spaces. Construction of bases for finite dimensional vector spaces.
- Generalization of angle between two vectors. Study the orthogonal basis.
- Introduce the matrix representation of linear transformations.
- Exposure on eigenvalues and eigenvectors, Canonical form of matrices.

Unit I:

Linear Equations: Fields, System of linear equations, Matrices and Elementary rowoperations, Row- reduced Echelon matrices.

Vector Spaces: Definition and Examples of Vector spaces, Subspaces, Linear span,Linear independence, dependence and their basic properties. Basis of vector spaces.Existence theorem for bases. Dimension of a space, Sums of subspaces. Quotient space and its dimension.

Unit II:

Inner Product Spaces: Annihilator, Schwarz inequality, orthonormal basis, Gram-Schmidt orthogonalization process, orthogonal complement.

Unit III:

Linear Transformations: Definition and Examples. Algebra of Linear transformations,Rank and Nullity theorem.Singular and non-singular linear transformations, Isomorphism.Representation of Transformation by Matrices, Change of basis.Dual space.Bidual space and natural isomorphism. Transpose of a linear transformation.

Unit IV:

Eigenvalues and Eigen vectors of a linear transformations, Cayley-Hamilton Theorem. Minimal polynomial Canonical forms, diagonal form, triangular form, Jordan form.

Out Comes:

- Write clear and precise proofs for theorems needed to construct bases for vector spaces.
- Ability to implement the Gram-Schmidt procedure to construct orthogonal basis.
- Gaining of knowledge between matrices and linear transformations.
- Determination of Jordan form for given a matrix.

Text Books:

1. I.N. Herstein : Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976.
2. Gilbert Strang, Linear Algebra and its applications, Pearson.

REFERENCES:

1. K. Hoffman and R. Kunze, Linear Algebra, PHI.
2. N. Jacobson : Basic Algebra-I, HPC, 1984.

MSM-HC 3.4 :FLUID MECHANICS-I

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 3.4** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To introduce various types of fluids, their properties and different types of flows.
- To introduce some important vector calculus identities in various orthogonal curvilinear coordinates.
- To introduce the ways to describe the fluid motion.
- Fundamental physical laws in fluid mechanics, boundary conditions, two dimensional fluid motions.

Unit I:

Introduction to fluid dynamics, general description, isotropy, some basic properties of fluid, viscosity, different types of fluid, important types of flows, some results of vector analysis , orthogonal curvilinear coordinates.

Unit II:

Kinematics of Fluids in motion:-Methods of describing fluid motion, velocity of a fluid particle, material, local and convective derivatives, acceleration of a fluid particle, equation of continuity by Euler method, equation of continuity by Lagranges method, equation continuity of a liquid flow through a channel or pipe, Boundary conditions, Conditions at a surface, stream line, path line, streak lines, Difference between stream line and path line, velocity potential, Vorticity vector, Rotational and irrotational motion, Annular velocity: Illustrative examples.

Unit III:

Equations of motion of inviscid fluids:-Eulers equation of motion, Equation of motion of an inviscid fluid, equation motion under impulsive forces, Energy equation, Lagrangeshydrodynamical equation; Bernoulli's equation, Pressure equation, Application of Bernoulli's equation.

Unit IV:

Motion in two-dimensions sources and sinks. Stream function, physical significance, spin components, irrotational motion in two-dimensions, complex potential, source and sinks in two dimensions, complex potential due to a source, Doublet in two dimensions, Images, Image of a doublet with respect to a line, The Milne-Thomson circle theorem, Blarius theorem.

Outcomes:

- Understand the fluid characteristics and flow behaviors.
- Description of motion and fundamental physical laws in fluid mechanics and their representing equations.

- Bernoulli’s equation and its applications.
- Stream function, sources and sinks and their image with respect to various geometries.

Text Books:

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press,1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.

REFERENCES:

1. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
2. L.E. Malvern : Introduction to the Mechanics of a Continuous Media, PrenticeHall,1969.
3. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977.

MSM-SC 3.5(a): NUMERICAL ANALYSIS-II

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 3.5(a)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To study the various methods of Numerical differentiation and integration.
- To study iterative methods to solve initial value problems, boundary value problems and numerical solutions of differential equations.

Unit I:

Numerical Integration: Numerical Integration, Newton-Cotes integration methods; Trapezoidal rule, Simpson's 1\3rd rule, Simpson's 3\8th rule and Weddle's rule. Gaussian integration methods and their error analysis.Gauss-Legendre, Gauss-Hermite, Gauss-Legurre and Gauss-Chebyshev integration methods and their error analysis.Romberg integration, Double integration.

Unit II:

Numerical Solutions of Initial Value Problems (Ordinary Differential Equations): Introduction**,** Derivation of Taylor's series method**,** Euler's method, Modified Euler Method, Runge-Kutta Second, Third and Fourth order methods, Runge-Kutta-Gill method, Predictor-Corrector methods; Milne's method, Adam's Bashforth Moulton method.

Unit III:
Solutions of Boundary Value Problems (Ordinary Differential Equations): Introduction, Solution of boundary value problems by the method of undetermined coefficients, Finite difference methods, Shooting Method, and Midpoint method.

Unit IV:
Numerical Solutions of Partial Differential Equations: Introduction, Derivation of finite difference approximations to the derivatives, Solution of Laplace equation by Jacobi, Gauss Seidel and SOR Methods, ADI Method, Parabolic, Solution of heat equation by Schmidt and Crank-Nicolson Methods, Solution of wave equation using Finite difference method.

Outcomes:

- To understand and apply Newton-Cotes integration methods to evaluate the integral of the functions.
- Able to find the Solution of boundary value problems by the method of undetermined coefficients, Finite difference methods, Shooting Method

- Find the numerical Solution of Laplace equation by Jacobi, Gauss Seidel and SOR Methods, ADI Method.
- Able to find the Parabolic Solution of heat equation by Schmidt and Crank-Nicolson Methods, solution of wave equation using Finite difference method.

REFERENCES:

1. A First Course in Numerical Analysis : A. Ralston
2. Numerical Analysis & Computation : E.K. Blum
3. Elements of Numerical Analysis : P. Henrici
4. Introduction to Numerical Analysis : F.R. Hindebrand
5. Principles & Procedures of Numerical Analysis : F. Szidarovszky& S. Yakowitz.
6. Numerical Analysis for scientists and engineers, : M.K.Jain.
7. Numerical mathematical Analysis. : J.B. Scarborough

MSM-SC 3.5(b): OPERATIONS RESEARCH

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 3.5(b)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Introduce the fundamental concepts of Operations Research, LPP.
- Make the learners aware of the importance of optimizations in real scenarios.
- To use linear programming in the formulation of shortest route problem and use algorithmic approach in solving various types of network problems.
- Provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

Unit I :

Linear Programming: Basic concepts, convex sets, open and closed half spaces,simplex, formulation of Linear Problem(LPP), feasible solution, basic feasible solution, optimal solution, graphical method, simplex method, big-M method.

Unit II :

Transportation Problem(TP): Mathematical formulation, existence of feasible solutions,transportation table, initial basic feasible solution ; North-west corner rule, row minima method , column minima method , matrix minima method, .

Unit III :

Assignment Problem: Mathematical formulation, assignment algorithm, routingproblem, traveling salesman problem, **Networks:** Network minimization, shortest route problem, shortest route algorithms foracyclic networks, maximal flow problem.

Unit IV :

Integer Programming: Methods of integer programming problems; Cutting method, search method, mixed integer programming problem.

Out comes:

- Able to analyze the optimization methods and algorithms developed for solving various types of optimization problems and to formulate optimization problems.
- Understand and apply the concept of optimality criteria for various types of optimization problems.
- Solve various constrained and unconstrained problems in single variable as well as multivariable.
- Apply the methods of optimization in real life situation.
- Develop and promote research interest in applying optimization techniques in problems.

Text Books:

1. Hamdy A. Taha Operations Research, Macmillam,(1989).
2. KantiSwarup, P.K. Gupta and Mamohan, Operations Research, S. Chand & Sons, (1980).
3. S.Kalavathy, Operations Research, Vikas(2001) .
4. S.D. Sharma, Operations Research.
5. G.Hadley, Linear Programming, Narosa Publishing House, New-Delhi,(1987)

MSM-SC 3. 5(C) - NUMBER THEORY

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 3.5 (C)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To effectively express the concepts and results of Number Theory.
- Construct mathematical proofs of statements and find counter examples to false statements in Number Theory.
- Collect and use numerical data to form conjectures about the integers.

Unit I:

Basic properties, residue systems, linear Conguences, the theorem of Fermat and Wlison (Revisited). The Chinese Reminder theorem , polynomial Conguences, Diophantine equations Arithmetic functions -Ø(□), d(n) and □(□), their multiplicative properties , mobius Inversion formulas.

Unit II :

Primitive roots – properties recued residue systems , Primitive roots modulo p. Prime numbers – Elementary properties of T(x), Tchebychev'sTheorem.

Unit III :

Quadratic –Conguences – Euler criterion, the Legendre symbol, the quadratic reciprocity low and applications.

Unit IV:

Parial theory – Euler partition theorem, generating functions , Identities between infinite series and products. Geometric Number theory – Lattic points, Gauss's problem ,Dirchelets Division problem.

Outcomes:

- Able to solve systems of linear congruences.
- Find integral solutions to specified linear Diophantine equations
- Understand and apply The Law of Quadratic Reciprocity.
- Apply Euler-Fermat's Theorem to prove relations involving prime numbers
- Understand and Apply Euler partition theorem.
- Apply Dirchelets Division problem.

REFFERENCES:

1. George E. Andrews : number theory , Hindustan publishing Corporation (india) (1989)
2. G. H Hardy and littiewood: number theory, CUP

MSM 3.6 : C- LAB: NUMERICAL METHODS

Teaching: 3 hrs/week **Credits: 02**
Max Marks: 50 **Hours : 52**

Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

List of programs:

1. Write a C-program to read the coefficients of a polynomial, print the polynomial and evaluate the polynomial at given value.
2. Write a C-program to find the transpose of a matrix.
3. Write a C-program to find the product of two matrices.
4. Write a C-program to find trace and norm of a matrix.
5. Write a C-program to accept a matrix and determine whether it is a symmetric matrix or not.
6. Write a C-program to accept a matrix and determine whether it is a skew-symmetric matrix or not.
7. Program to solve system of equations using Gauss Elimination Method.
8. Program to find inverse of the matrix using Gauss Jordan Method.
9. Program to find solution of system of equations using using Jacobi Iterative Method.
10. Program to find solution of system of equations using using Gauss Seidal Method.
11. Program to find real root of a polynomial using fixed point iterative method.
12. Program to find real root of a polynomial using Newton Raphson Method.
13. Program to find real root of a polynomial using Secant Method.
14. Program to find real root of a polynomial using Muller Method
15. Program to find the value of function using Newton Forward Difference Method.
16. Program to find the value of function using Newton Backward Difference Method.

MSM-3.7 OEC (1) :MATHEMATICAL PHYSICS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-3.7 OEC(1)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Unit 1: Laplace Transform:

Integral Transform, Laplace Transform definitions, Linearity Property of Laplace Transform, Piecewise continues functions, existence of Laplace transforms, Functions of Exponential order, Function of class A, First shifting theorem, Second translation, Change of scale property and its examples, Periodic Functions, Some special functions.

Unit 2: The Inverse Laplace Transform:

Inverse Laplace Transform, Linearity Property, Change of Scale Property, Inverse Laplace Transform of derivatives, Heaviside's expansion theorem, Solution of ordinary differential equations with constant coefficients examples, Application to electrical Circuits.

Unit 3: Fourier series

Periodic functions, Fourier Expansions, Half range expansions, Complex form of Fourier series. Practicalharmonic analysis.

Unit 4: Fourier Transforms

Finite and Infinite Fourier transforms, Fourier sine and cosine transforms, properties inverse transforms.Z-transforms.Meline transforms.

Reference:

1) **Mathematical Method of physics :Jon Mathews.**
2) **Mathematical Method in physical sciences : Boas**

MSM-3.7 OEC (2) QUANTITATIVE TECHNIQUES

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-3.7OEC(2)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To train the student in the domain of basic quantitative analysis in the practice of management problems.
- To give sufficient tools for solving programming problems, that can be used for further applications in different areas of interest.

Unit I:

Basic Mathematical Concept: Nature of quantitative analysis in the practice of management-problem definition-Models and their development –concept of trade off-notion of constants-variables and function-Linear and non-linear -simple examples.
Graphical representation of functions and there application-concept of slope and its relevance – plotting graphs of functions.

Unit II:

Introduction to the linear programming – Concepts of optimisation-Formulation of different types of linear programming –Duality and sensitivity analysis for decision –making.

Unit III:

Solving LP using Graphical and simplex method (only simple problem)-interpreting the solution for decision-making other types of linear programming-Transportation-Formulation and solving methods.

Unit IV:

Introduction to the notion of probability –concepts of events-probability of events-joint, conditional and marginal probabilities.

Outcomes:

- Understand the basic mathematical concept like models, constants, variables and graphical representation of functions and its applications.
- Finding optimal or near optimal solutions to complex decision making problems.
- Solving LP by using graphical and simplex methods.
- Compute the probabilities of composite events using the basic rules of probability.

REFERENCES:

1) **A Text of quantitative techniques :N.P.Bali , P.N.Gupta ,C.P.Gandhi.**
2) **Quantitative techniques :Dr.C.R.Kothari.**

MSM-3.7 OEC(3) Mathematical Biology

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-3.7 OEC(3)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To introduce ideas and techniques of mathematical modeling in biology.
- To introduce students to the applications of mathematical modeling in the analysis of biological system including populations of molecules, cells and organisms.
- To show how mathematics, statistics, and computing can be used in integrated way to analyze biological systems.

Unit –I:

Mathematical Aspects of Population Biology

Introduction, Some fundamental concepts, Models, Mathematical modelling, Formation of a Mathematical model

Solution of a Mathematical Model, Interpretation of the solution Types of Models Limitations of Models Areas of modellingSome simple Mathematical Models Mathematical Modelling in Biology or BioMathematics Single speices Models. Statility and Classification of Equilibrium points. Relationship betweenneigen values and critical points.

Unit-II:

Single- SpeicesModels(Non-age structured)

Exponential growth Model, Formulation of the Model Solution and Interpretation Limitations of the Model Effects if immigration and Emigration on population. Logistic Growth model solution and Interpretation Limations of Logistic model Extension of the Logistic Model.

Unit-III:

Single-Species Models (Age Structurerd)

Continus-Time Continuous-Age-Scale population Models

The Lotka Integral Equation, Solution of Lotkas Model for population growth Interpretation.Solution of Lotkas Model Using the Laplace transform continuous-timeContinus-Age structure model in Difference equation.

Unit-IV:

Biological Fluid Mechanics:

Introduction, Some Basic concepts of Fluid Dynamics: Fluid Parameters, Viscosity, Navier-stokes equations of viscous fluid motion. Poiseuilles flow, Model for Blood flow-Formation, Interpretation and limitation of the model.

Properties of Blood.Bifurcation in an Artery.Pulsatile flow of Blood.Trans-Capillary Exchange.

Outcomes:

- Develop the ability to explain mathematical results in language understandable by biologists.
- Have an enhanced knowledge and understanding of mathematical modeling and stastical methods in the analysis of biological systems.
- Formulate discrete and differential equation models that represent in a range of biological problems, including, identifying assumptions that are appropriate for the problem to be solved.

REFERENCES:

1) **Mathematical Biology: James D Murray.**
2) **Mathematics of Medicine and biology : J.G.Gefares ,I.N.Sneddon**

M.A/M.Sc MATHEMATICS

IV- SEMISTER (w.e.f. 2016-2017)

Sl. No	Paper and Title	Credits	No. Hrs/ week Theory/ Practical	Duration of Exam in Hrs Theory/ Practical	Internal assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
MSM 4.1HC	Measure Theory	4	4	3	30	70	100
MSM 4.2HC	Mathematical Methods	4	4	3	30	70	100
MSM 4.3 SC	4.3SC(a) Fluid Mechanics –II or 4.3SC(b) Graph Theory or 4.3SC© Wavelets 4.3SC(d) Magnetohydrodynamics 4.3SC(e). Banach Algebras	4	4	3	30	70	100
MSM 4.5	Project	4	4	3	30	70	100
	Total of IV Semester	16					400

MSM-HC 4.1:MEASURE THEORY

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 4.1** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- An introduction to the theories for Lebesque measurability and Integral. It begins with the exploration of the Existence of the integral.
- The concepts of vector valued functions and Rectifiable curves are introduced.
- The notion of sequences and series is presented and to help the students to visualize the uniform convergence.
- Understanding of the fundamental concepts of some special functions.
- The skill of Lebesque measure to evaluate them via examples.

Unit I :

Sigma algebras, open subsets of the real line.F_σ and G_δ sets, Borel sets, Outer measure of a subset of R ' Lebesgue outer measure of a subset of R Existence, non-negativity and monotonicity of Lebesgue outer measure; Relation between Lebesgue outer measure and length of an interval; Countable subadditivity of Lebesgue outer measure; translation invariance.(Lebesgue) measurable sets, (Lebesgue) measure; Complement, union, intersection and difference of measurable sets; denumerable union and intersection of measurable sets; countable additivity of measure; The class of measurable sets as a algebra, the measure of the intersection of a decreasing sequence of measurable sets.

Unit II :

Measurable functions; Scalar multiple, sum, difference and product of measurable functions.Measurability of a continuous function and measurability of a continuous image of measurable function.Convergence pointwise and convergence in measures of a sequence of measurable functions.

Unit III :

Lebesgue Integral; Characteristic function of a set; simple function; Lebesgue integral of a simple function; Lebesgue integral of a bounded measurable function; Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a non-negative function; Lebesgue integral of a measurable function; Properties of Lebesgue integral.

Unit IV :

Convergence Theorems and Lebesgue integral; The bounded convergence theorem; Fatou's Lemma: Monotone convergence theorem; Lebesgue convergence theorem. Differentiation of Monotone functions. Vitali covering lemma.Functions of Bounded variation.Differentiability of an integral.Absolute continuity and indefinite integrals.

Outcomes:

- Extend the concepts of Riemann integral.
- Differentiate and Integrate Complex functions.

- Carry out Stone Weierstrass theorem.
- Compute sequence and series of functions.
- Apply techniques of measurable functions in varies fields.
- To state some of the classical theorems in of Advanced Real Analysis.
- Know about the concepts of functions of bounded variations and the absolute continuity of functions with their relations.

Text Books:

1. H. L. Royden : Real Analysis, Macmillan, 1963

REFERENCES:

1. P.R. Halmos : Measure Theory, East West Press, 1962
2. W. Rudin : Real & Complex Analysis, McGraw Hill , 1966
3. I.K.Rana. An introduction to measure and integration, Narosa publishing House(1997)
4. K.P.Gupta. Measure Theory, Krishna Prakashan Media (P) Ltd, II, Shivaji Road, Meerut (U.P) India.

MSM-HC 4.2 : MATHEMATICAL METHODS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-HC 4.2** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- The main objectives of the course are to familiarize basics of Integral transforms, Integral equations and calculus of variations. Perturbation methods and its applications in engineering problems.
- Calculus of variations and Euler equations are essential in understanding many physical problems and optimization problems.

Unit I:

Integral Transforms: General definition of Integral transforms, Kernels, etc. Development of Fourier integral, Fourier transforms – inversion, illustration on the use of integral transforms, Laplace, Fourier, and Mellin transforms to solve ODEs and PDEs - typical examples. Z-transform, difference equations, definition, standard z-transform, linear property, damping rule, shifting rule, initial value theorem, inverse z-transforms, Application of z-transform to solve difference equations,

Unit II :

Integral Equations: Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series resolvent kernel and transform methods, Convergence for Fredholm and Volterra types.Reduction of IVPs BVPs and eigenvalue problems to integral equations.Theory of Symmetric Kernels.

Unit III:

Calculus of variations: Vaiational of function and a functional extremal of a functional, variational problems, Eulers equation, standard variational problems including geodesis, minimal surface of revolution, hanging chain problems.

Unit IV :

Perturbation method: Regular and singular perturbation methods: Parameter and co-ordinate perturbations. Regular perturbation solution of first and second order differential equations involving constant and variable coefficients.

Outcomes:

- Know different integral equations and methods of solving them.
- Be able to understand Green's function in reducing boundary value problems to integral equations.
- Understanding Hilbert Schmidt theory
- Know functional and the construction of Euler's equation.
- Be able to understand variational methods for solving differential equations.

- Be able to analyze variational problems with moving boundaries.
- Know methods of finding infinite Fourier transforms and Fourier integrals.
- Applications of Fourier, Laplace, Z and Mellin transform to solve the various physical problems.

Text Books:

1. I.N. Sneddon – The use of Integral Transforms, Tata McGraw Hill, Publishing Company Ltd, New Delhi, 1974
2. R.P. Kanwal: Linear integral equations theory and techniques, Academic Press, New York, 1971
3. C.M. Bender and S.A. Orszag – Advanced mathematical methods for scientists and engineers, McGraw Hill, New York, 1978

MSM-SC 4.3(a):FLUID MECHANICS –II

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 4.3(a)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives

- Students will be able to apply the techniques used in deriving a range of important results and in research problems.
- To provide the knowledge of fundamentals of fluid mechanics and an appreciation of their application to real world problems.

Unit I:

Basic concept of real fluid , continuum hypothesis, general motion of a fluid element, Stress & strain components in a real fluid. Relation between stress & strain components. Geometrical interpretation of the components of strain. Thermal conductivity of fluid, Fourier law of hear conduction, equation of continuity in Cartesian, polar and spherical forms and illustrative examples,

Unit II:

Navier-stoke equation- some illustrative examples, energy equation.Vorticity equation in viscous flow, analogy between vorticity equation & heat conduction equation .

Dynamic similarity: Principles of similarity, Buckingham's pi-theorem & its applications/ Physical significances of non- dimensional numbers

Unit III:

Exact Solutions: Poiseuille and Coutte flows between two parallel, flow between two co axial cylinders and their temperation distributions, flow through tubes of uniform cross section in form of an elliptic and equilateral triangles under constant pressure gradients, stroke's first and second problems, flow in convergent and divergent channels.

Unit IV:

Laminar Boundary Layers: Prandtl's boundary layer concept. Derivation of two dimensional boundary layer equation for velocity &temperature by order magnitude approach. Boundary layer thickness, Displacement thickness, Energy thickness, boundary layer flow past a fiat plate- Blasius solution, boundary layer separation ,Von-Mises transformations Von-Karman momentum integral equation.

Outcomes :

- Able to derive equation of continuity in Cartesian, polar and spherical forms
- Able to derive Navier-stoke equation, energy equation and apply them to solve the problems.
- Understand the Principles of similarity, Buckingham's pi-theorem & it Applications.
- Analyze simple fluid flow problems (flow between parallel plates, flow through pipes etc.) with Navier Stokes's equation of motion
- Understand boundary layer theory and the phenomenon of flow separation.

REFERENCES:

1. W.H.Besaint and A.S. Ramsey, A treatise of Hydrodynamics, part II, CBS publishers, Delhi, 1958.
2. G.K. Batchelor, A introduction to Fluid Mechanics, Foundation Books, New Delhi,1994.
3. F.Chorlton, Text book of Fluid Dynamics, CBS publishers, Delhi, 1985.
4. A.J.Chorin and A. Marsden. A mathematical introduction to Fluid Dynamics, Springer- Verlag, New Yark,'1993.
5. L.D.Landau and E.M. Lipschitz, Fluid Mechanics ,Pergamon press, London, 1995.
6. H.Schlichting, Boundary Layer Theory, McGraw Hill Book company, New York,1979.
7. R.K.Rathy, A introduction to Fluid Dynamics, Oxford and IBM Publishing company- New Delhi,1976.
8. A.D.Young, Boundary Layers AJAA Education series, Washington DC 1989.
9. S.W.Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
10. L.Popenhead. Laminar Boundary Layer ,Clearan don press Oxfoed,.
11. S.I.Pai. vipcoup flow theory vol.1; Laminar flow ,D Von Moptrand comp.
12. C.S. Yin. Dynamic of non-homogenous fluid. McMillan, New York,1965.
13. C.C.Lin. Theory of Hydrodynamics stability, Cambridge University Press.

MSM-SC 4.3(b) :GRAPH THEORY

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 4.3(b)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Introduce students with the fundamental concepts of graph theory, with a sense of some of its modern applications.
- Understand the concept of Factorization, Planarity, Colorings and Spectra of Graph.
- Use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.

UNIT 1: Factorization: 1-factorization,2-factorization, decomposition and labeling of graphs,
Coverings: Vertex covering, edge covering, independence number and matchings and matching polynomials.
UNIT II: Planarity: Planar graphs, outer planar graphs, Kuratowaski criterion for planarity and Eulers polyhedron formula.
Graph valued functions: Line graphs, subdivision graph and total graphs.
Unit III: Colourings: Chromatic numbers and chromatic polynomials.
Spectra of Graphs: Adjacency matrix, incidence matrix, characteristic polynomials, Eigen values, graph parameters, strongly regular graphs and Friendship Theorem.
UNIT IV: Groups and Graphs: Automorphism group of a graph, operations on permutation graphs, the group of a composite graph.
Topological indices and Adriatic indices of a various graphs.

Outcomes:

- Cover a variety of different problems in Graph Theory.
- Come across a number of theorems and proofs.
- Prove theorems which will be stated formally using various techniques.
- Learn various graphs algorithms which will also be taught along with its analysis.
- Applications to real life problems
- Introduction to advance topics in graph theory
- Algorithms in graph theory

REFFERENCES

1. M. Behzad, G. Charatrand and L. leniak-Foster : graphs and Digraphs , Wadsworth, Bemont, CALIF (1981)
2. NarasingDeo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, India (1995)
3. J. A. Bondy and V. S. R. Murthy: Graph Theory with Applications, MacMillan, London.

4. F.Buckley and F. Harary: Distance in Graphs, Addison-Wesley (1990)
5. Diestel: Graph Theory, Springer-Verlag, Berlin.
6. R. Gould: Graph Theory, The Benjamin/Cummings Publ. Co. Inc. Calif (1988)
7. F. Harary: Graph Theory, Addison Wesley, Reading mass(1969)
8. O. Ore: Theory of Graphs, Amer-Maths. Soc. Collg. Publ. -38, providence (1962)
9. D. Cvetkovic, M.Doob and H. Sachs, Spectra in Graphs, Academic Press, New York (1980)
10. Tulasiraman and M.N.S.Swamy: Graphs, Networks and Algorithms, John Wiley (1989)
11. BelaBollobas, Modern Graph Theory, Springer (1998)
12. ReinhardDiestel, Graph Theory, 2nd Edition, Springer (2000)

MSM-SC 4.3(C) :WAVELETS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 4.3(C)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- Foundations to introduce the fast Fourier Transform.
- Construction of wavelets on Z_{n}.
- Wavelets on set of integers.
- Wavelets on the real line.

Unit I :

Recaptulation of Complex number and linear algebra: Complex Series, Euler's formula and roots of unity. Vectors Spaces and bases.Linear Transformation, Matrices, diagonalization, Inner product Spaces, Orthonormal basis, Unitary matrices, Discrete Fourier Transform, the F ast Fourier Transform.

Unit II : Wavelets on Z_n

Construction of wavelets on Z_n : The first stage, the iteration step examples and applications.

Unit III : Wavelets on Z

$L^2(z)$, Complete orthonormal sets in Hilbert spaces, L^2 ([-π , □]) and Fourier series, the Fourier Transform and convolution on l^2 (z), first stage wavelets on z, the iteration step for wavelets on Z, implementation and examples.

Unit IV : Wavelets on R

L^2® and Approximate identities, the Fourier Transform on R, Multiresolution Analyses and wavelets, Construction of MultiresolutionAnalsis, wavelets with compact support and their computation.

Outcomes

- Ability to compute the fast Fourier transform of a vector. Detection of frequencies.
- Compute wavelet transform for discrete signals.
- Compute wavelet transform for discrete signals on the set of integers.
- MRA for functions.

REFERENCES:

1. Michael W. Frazier : An Introduction to Wavelets through Linear Algebra, Springer, 1999.
2. Patrick J. Van Fleet : Discrete Wavelet Transformations an Elementary Approach with Applications, A John Wiley & Sons, Inc., 2008.
3.

MSM-SC 4.3 (d): MAGNETOHYDRODYNAMICS

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 4.3(d)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives

- To introduce the various laws of electromagnetism and their representing equations.
- Maxwell's electromagnetic equations and their properties.
- To introduce electromagnetic waves in various types of electrically conducting fluids. Force free magnetic fields and their characteristics.
- To introduce the boundary conditions in electromagnetic field, hydromagnetic flows in various geometries with different conditions.

UNIT-1: Electrodynamics:
Outline of electromagnetic units and Electrostatics, Derivations of Gauss Law, Faraday's Law, Ampere's Law and Solenoidal property, Dielectric material, Conservation of charges, Electromagnetic boundary conditions.

UNIT-2: Basic Equations:
Outline of Basic equations of MHD, Magnetic Induction equation, Lorentz force, MHD approximations, Non-dimensional numbers, Velocity, Temperature and Magnetic field boundary conditions.

UNIT-3: Exact Solutions:
Hartmann flow, isothermal boundary conditions, Temperature distribution in Hartmann flow, Hartmann-Couette flow.

UNIT-4: Applications:
Concepts in Magnetostatics, Classical MHD and Alfven waves, Alfven theorem, Frozen-n-phenomena and equipartition of energy by Alfven waves.

Outcomes:

- Understand the various laws of electromagnetism and their consequences.
- Electromegnetic waves and its effects on the flow system.
- Force field magnetic field and its significances.
- Modeling of hydromagnetic flows in a channel appearing is various biosciences, engineering and technological systems.

REFERENCES:

1. An Introduction to Magnetofluid Mechanics :V.C.A. Ferraro and Plumpton.
2. An Introduction to Magnetohydrodynamics : P.H. Roberts
3. Magnetohydrodynamics : Allen Jeffrey

MSM-SC 4.3 (e) BANACH ALGEBRA

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-SC 4.3(e)** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Objectives:

- To understand the algebra of infinite dimensional function spaces Banach algebras are naturally studied. Analysis is extended to the functional algebras while studying certain external formulas.
- Exposed to many ideas and tools that are useful in other branches of analysis and mathematical physics, including spectrum, commutative Banach algebras, the Gelfand transform, C algebras and their representations.
- This course also includes a few important applications of algebras and spectral to other branches of both pure and applied mathematics.
- To learn to recognize the fundamental properties of algebras and of the transformations between them

Unit 1: Definition of Banach Algebra, Homomorphisms, Spectrum, Basic properties of Spectra, Gelfand- Mazur Theorem, Spectral Mapping Theorem, group of invertible elements.

Unit 2: Ideals, Maximal Ideals and Homomorphisms, SemisimpleBanachAlgerbras

Unit 3: Gelfand Topology, Gelfand Transform, Involutions, Banach-C-*Algebras, GelfandNaimark Theorem, Applications to Non-Commutative Banach Algebras, Positive functions.

Unit 4: Operators on Hilbert Spaces, Commutativity theorem, Resolution of the identity spectral theorem, A Charecterization of Banach C*-Algebras

Out comes:

- Since students attending the course had different background, course had to give full proofs for every statement and explains many details from measure theory and functional analysis as well as the theory of algebras.
- Learn the skills helpful to study spectral analysis.
- It's the formal setting for understanding properties and spectra of operators on a Hilbert space, and therefore for understanding results about differential equation.
- Banach algebras have specific beautiful applications in the theory of Fourier analysis.

REFERENCES

1. Rudin.W, Functional Analysis.
2. Bachman and Narice L, Functional Analysis , Academic Press.
3. B.V.Limaye, Functional Analysis, New Age International Limited
4. S.K.Berbenon, Lectures in Functional Analysis and Operator Theory, Narosa, 1979.

MSM-4.5 :CPW – Project Work

Teaching: 4 hrs/week **Credits: 04**
Max Marks: 100 **Hours : 52**
Code: **MSM-4.4** .

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

Dissertation – 70 + Viva-Voce - 30

Note:

Pattern of Question Paper:

The question paper contains 4 units. Namely Unit-I-IV, each unit contains 2 questions. Five full questions are to be answered by choosing at least one from each unit