

# **Pt. Ravishankar Shukla University, Raipur**

Scheme of Examination

M.A./M.Sc. (MATHEMATICS) (Semester-I)

**2021 - 22 (Examination – Dec. 2021) onwards**

There shall be five papers. Each paper shall have 100 marks. **Overall tally of marks will be 500.**

| Paper | Code | Description                       | Theory | Sessional | Practical | Total Marks |
|-------|------|-----------------------------------|--------|-----------|-----------|-------------|
| I     | 101  | Advanced Abstract Algebra (I)     | 80     | 20        | -         | 100         |
| II    | 102  | Real Analysis (I)                 | 80     | 20        | --        | 100         |
| III   | 103  | Topology                          | 80     | 20        | --        | 100         |
| IV    | 104  | Advanced Complex Analysis (I)     | 80     | 20        | --        | 100         |
| V     | 105  | Advanced Discrete Mathematics (I) | 80     | 20        | --        | 100         |

**M.Sc./M.A. Course (First Semester)**  
**PAPER -I**

**Advanced Abstract Algebra (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Demonstrate capacity for mathematical reasoning through analyzing, Proving and explaining concepts from advanced algebra.
2. Understand the concept of Normal and subnormal series, solvable group, state and prove Jordan-Holder theorem.
3. Understand the concepts of fields, extension of fields and splitting fields of polynomials.
4. Identify and analyze different types of algebraic structures such as Algebraically closed fields, Splitting fields, Finite field extensions to understand and use the fundamental results in Algebra. Design, analyze and implement the concepts of Gauss Lemma, Einstein's irreducibility criterion, separable extensions etc.
5. Create, select and apply appropriate algebraic structures such as Galois extensions, Automorphisms of groups and fixed fields, Fundamental theorem of Galois theory to understand and use the Fundamental theorem of Algebra, solvability of polynomials.

**Contents:**

- Unit-I** Groups - Normal and Subnormal series. Composition series. Jordan-Holder theorem. Solvable groups. Nilpotent groups.
- Unit-II** Field theory- Extension fields. Algebraic and transcendental extensions. Separable and inseparable extensions. Normal extensions.
- Unit-III** Perfect fields. Finite fields. Primitive elements. Algebraically closed fields.
- Unit-IV** Automorphisms of extensions. Galois extensions. Fundamental theorem of Galois theory.
- Unit-V** Solution of polynomial equations by radicals. Insolvability of the general equation of degree 5 by radicals.

**Books Recommended:**

1. P.B.Bhattacharya, S.K.Jain, S.R.Nagpaul: Basic Abstract Algebra, Cambridge University press
2. I.N.Herstein: Topics in Algebra, Wiley Eastern Ltd.
3. Quazi Zameeruddin and Surjeet Singh : Modern Algebra

**References**

1. M.Artin, Algebra, Prentice -Hall of India, 1991.
2. P.M. Cohn, Algebra, Vols. I,II &III, John Wiley & Sons, 1982,1989,1991.
3. N.Jacobson, Basic Algebra, Vols. I , W.H. Freeman, 1980 (also published by Hindustan Publishing Company).
4. S.Lang, Algebra, 3rd edition, Addison-Wesley, 1993.
5. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol.II-Rings, Narosa Publishing House (Vol.I-1996,Vol. II-1999)
6. D.S.Malik, J.N.Mordeson, and M.K.Sen, Fundamentals of Abstract Algebra, Mc Graw-Hill, International Edition,1997.
7. Vivek Sahai and Vikas Bist: Algebra, Narosa Publishing House, 1999.
8. I. Stewart, Galois theory, 2nd edition, chapman and Hall, 1989.
9. J.P. Escofier, Galois theory, GTM Vol.204, Springer, 2001..
10. Fraleigh , A first course in Algebra Algebra, Narosa,1982.

**M.Sc./M.A. Course (First Semester)**  
**PAPER-II**

**Real Analysis (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of sequences and series of functions and apply the test for their convergence.
2. Understand the concept of convergence and divergence of power series and apply Abel's and Tauber's theorems.
3. Understand the concept of functions of several variables and properties of sets of vectors in  $\mathbb{R}^n$ .
4. Understand the concept of maxima and minima of real valued functions from  $\mathbb{R}$  to  $\mathbb{R}$  and from  $\mathbb{R}^n$  to  $\mathbb{R}$ .
5. Understand the concept of Integration theory that is closely related to the theory of Euclidean spaces and derivatives of functions of several variables.

**Contents:**

**Unit-I** Sequences and series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and differentiation, Weierstrass approximation theorem.

**Unit-II** Power series, uniqueness theorem for power series, Abel's and Tauber's theorems. Rearrangements of terms of a series, Riemann's theorem.

**Unit-III** Functions of several variables, linear transformations, Derivatives in an open subset of  $\mathbb{R}^n$ , Chain rule, Partial derivatives, interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem, Inverse function theorem, Implicit function theorem.

**Unit-IV** Jacobians, extremum problems with constraints, Lagrange's multiplier method, Differentiation of integrals.

**Unit-V** Partitions of unity, Differential forms, Stoke's theorem.

**Recommended Books:**

1. Principle of Mathematical Analysis By Walter Rudin (3rd edition) McGraw-Hill, Kogakusha, 1976, International student edition.
2. Real Analysis By H.L.Roydon, Macmillan Pub.Co.Inc.4th Edition, New York.1962.

**References**

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi,1985.
2. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar,Inc. New York,1975.
3. A.J. White, Real Analysis; an introduction, Addison-Wesley Publishing Co.,Inc.,1968.
4. G.de Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
5. E. Hewitt and K. Stromberg. Real and Abstract Analysis, Berlin, Springer, 1969.
6. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986 Reprint 2000).
7. I.P. Natanson, Theory of Functions of a Real Variable. Vol. I, Frederick Ungar Publishing Co., 1961.
8. Richard L. Wheeden and Antoni Zygmund, Measure and Integral: An Introduction to Real Analysis, Marcel Dekker Inc.1977.
9. J.H. Williamson, Lebesgue Integration, Holt Rinehart and Winston, Inc. New York. 1962.
10. A. Friedman, Foundations of Modern Analysis, Holt, Rinehart and Winston, Inc., New York, 1970.
11. P.R. Halmos, Measure Theory, Van Nostrand, Princeton, 1950.
12. T.G. Hawkins, Lebesgue's Theory, of Integration: Its Origins and Development, Chelsea, New York, 1979.
13. K.R. Parthasarathy, Introduction to Probability and Measure, Macmillan Company of India Ltd., Delhi, 1977.
14. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, 1966.
15. Serge Lang, Analysis I & II, Addison-Wesley Publishing Company, Inc. 1969.
16. Inder K. Rana, An Introduction to Measure and Integration, Norosa Publishing House, Delhi, 1997.
17. Walter Rudin, Real & Complex Analysis, Tata McGraw-Hill Publishing Co.Ltd. New Delhi, 1966.

**M.Sc./M.A. Course (First Semester)**  
**PAPER-III**

**Topology**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of countable and uncountable sets and its properties.
2. Understand the concept of topological spaces and its examples, bases, sub-bases, subspaces and relative topology.
3. Understand the concept of countable, separable spaces and separation axioms with their characterizations and basic properties.
4. Understand the concept and properties of compactness, continuous functions.
5. Understand the concept and properties of countable compactness in metric spaces.

**Contents:**

**Unit-I** Countable and uncountable sets. Infinite sets and the Axiom of Choice. Cardinal numbers and its arithmetic. Schroeder-Bernstein theorem. Cantor's theorem and the continuum hypothesis. Zorn's lemma, well-ordering theorem.

**Unit-II** Definition and examples of topological spaces. Bases and sub-bases. Subspaces and relative topology. Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighbourhood Systems. Continuous functions and homeomorphism.

**Unit-III** First and Second Countable spaces. Lindelof's theorems. Separable spaces. Second countability and separability. Separation axioms; their Characterizations and basic properties. Urysohn's lemma, Tietze extension theorem.

**Unit-IV** Compactness. Continuous functions and compact sets. Basic properties of Compactness. Compactness and finite intersection property. Sequentially and countably compact sets. Local compactness and one point compactification. Stone-Cech compactification.

**Unit-V** Compactness in metric spaces. Equivalence of compactness, countable compactness and sequential compactness in metric space.

Connected spaces. Connectedness on the real line. Components.  
Locally connected spaces.

**Recommended Books:**

1. James R.Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi,2000.
2. K.D.Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.

**References**

1. J. Dugundji, Topology, Allyn and Bacon, 1966 (reprinted in India by Prentice Hall of India Pvt. Ltd.).
2. George F.Simmons, Introduction to Topology and modern Analysis, McGraw-Hill Book Company, 1963.
3. J.Hocking and G Young, Topology, Addison-Wiley Reading, 1961.
4. J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York,1995.
5. L. Steen and J. Seebach, Counter examples in Topology, Holt, Rinehart and Winston, New York, 1970.
6. W.Thron, Topologically Structures, Holt, Rinehart and Winston, New York,1966.
7. N. Bourbaki, General Topology Part I (Transl.),Addison Wesley, Reading, 1966.
8. R. Engelking, General Topology, Polish Scientific Publishers, Warszawa, 1977.
9. W. J. Pervin, Foundations of General Topology, Academic Press Inc. New York,1964.
10. E.H.Spanier, Algebraic Topology, McGraw-Hill, New York,1966.
11. S. Willard, General Topology, Addison-Wesley, Reading, 1970.
12. Crump W.Baker, Introduction to Topology, Wm C. Brown Publisher, 1991.
13. Sze-Tsen Hu, Elements of General Topology, Holden-Day,Inc.1965.
14. D. Bushaw, Elements of General Topology, John Wiley & Sons, New York, 1963.
15. M.J. Mansfield, Introduction to Topology, D.Van Nostrand Co. Inc.Princeton,N.J.,1963.
16. B. Mendelson, Introduction to Topology, Allyn & Bacon, Inc., Boston,1962.
17. C. Berge, Topological Spaces, Macmillan Company, New York,1963.
18. S.S. Coirns, Introductory Topology, Ronald Press, New York, 1961.
19. Z.P. Mamuzic, Introduction to General Topology, P. Noordhoff Ltd.,Groningen, 1963.
20. K. K. Jha, Advanced General Topology, Nav Bharat Prakashan, Delhi.

**M.Sc./M.A. Course (First Semester)**  
**PAPER-IV**

**Complex Analysis (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the fundamental concept of complex analysis. Evaluate Complex integrals with the help of theorems mentioned in the contents. Identify singularities.
2. Understand the concept of maximum modulus principle, and Inverse function theorem.
3. Understand the concept of residues and apply Cauchy's residue theorem to evaluate integrals.
4. Understand the concept of conformal mappings, bilinear transformations, their properties and classifications.
5. Understand the concept about the spaces of analytic functions.

**Contents:**

**Unit-I** Complex integration, Cauchy-Goursat. Theorem. Cauchy's integral formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem. Laurent's series. Isolated singularities. Meromorphic functions.

**Unit-II** Maximum modulus principle. Schwarz lemma. The argument principle. Rouché's theorem Inverse function theorem.

**Unit-III** Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to  $\arg z$ ,  $\log z$  and  $z^a$ .

**Unit-IV** Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings.

**Unit-V** Spaces of analytic functions. Hurwitz's theorem. Montel's theorem Riemann mapping theorem.

**Recommended Books:**

1. Complex Analysis By L.V.Ahlfors, McGraw - Hill, 1979.



2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House,1980.

### **References**

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford 1990.
2. Complex Function Theory By D.Sarason
3. Liang-shin Hahn & Bernard Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. S. Lang, Complex Analysis, Addison Wesley, 1977.
5. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
6. Mark J.Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University press, South Asian Edition, 1998.
7. E. Hille, Analytic Function Theory (2 Vols.) Gonn & Co., 1959.
8. W.H.J. Fuchs, Topics in the Theory of Functions of one Complex Variable, D.Van Nostrand Co., 1967.
9. C.Caratheodory, Theory of Functions (2 Vols.) Chelsea Publishing Company, 1964.
10. M.Heins, Complex Function Theory, Academic Press, 1968.
11. Walter Rudin, Real and Complex Analysis, McGraw-Hill Book Co., 1966.
12. S.Saks and A.Zygmund, Analytic Functions, Monografic Matematyczne, 1952.
13. E.C Titchmarsh, The Theory of Functions, Oxford University Press, London.
14. W.A. Veech, A Second Course in Complex Analysis, W.A. Benjamin, 1967.
15. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

**M.Sc./M.A. Course (First Semester)**  
**PAPER-V**

**Advanced Discrete Mathematics (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of formal Logic, quantifiers, predicates and their uses in truth tables.
2. Understand the concept of homomorphism of semi groups and monoids.
3. Understand the concept of lattices as algebraic systems, Boolean algebras as lattices.
4. Apply Boolean Algebra to switching theory (using AND, OR & NOT gates).
5. Understand grammars and languages.

**Contents:**

**Unit-I** Formal Logic-Statements. Symbolic Representation and Tautologies. Quantifiers, Predicates and Validity. Propositional Logic. Semigroups & Monoids-Definitions and Examples of Semigroups and monoids (including those pertaining to concatenation operation).

**Unit-II** Homomorphism of semigroups and monoids. Congruence relation and Quotient Semigroups. Subsemigroup and submonoids. Direct Products. Basic Homomorphism Theorem.

**Unit-III** Lattices-Lattices as partially ordered sets. Their properties. Lattices as Algebraic Systems. sublattices, Direct products, and Homomorphisms. Some Special Lattices e.g., Complete, Complemented and Distributive Lattices. Boolean Algebras-Boolean Algebras as Lattices. Various Boolean Identities. The Switching Algebra example. Subalgebras,

**Unit-IV** Direct Products and Homomorphisms. Join-Irreducible elements, Atoms and Minterms. Boolean Forms and Their Equivalence. Minterm Boolean Forms, Sum of Products Canonical Forms. Minimization of Boolean Functions. Applications of Boolean Algebra to Switching Theory (using AND,OR & NOT gates). The Karnaugh Map Method.

**Unit-V** Grammars and Languages-Phrase-Structure Grammars. Rewriting Rules. Derivations. Sentential Forms. Language generated by a Grammar. Regular, Context-Free, and Context Sensitive Grammars and Languages. Regular sets, Regular Expressions. Notions of Syntax Analysis, Polish Notations. Conversion of Infix Expressions to Polish Notations. The Reverse Polish Notation.

**Recommended Books:**

1. Elements of Discrete Mathematics By C.L.Liu
2. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.

**References**

1. J.L. Gersting, Mathematical Structures for Computer Science, (3<sup>rd</sup> edition), Computer Science Press, New York.
2. Seymour Lipschutz, Finite Mathematics (International) edition (1983), McGraw-Hill Book Company, New York.
3. S.Wiitala, Discrete Mathematics-A Unified Approach, McGraw-Hill Book Co.
4. J.E. Hopcroft and J.D Ullman, Introduction to Automata Theory, Languages & Computation, Narosa Publishing House.
5. C.L Liu, Elements of Discrete Mathematics, McGraw-Hill Book Co.
6. N. Deo. Graph Theory with Application to Engineering and Computer Sciences. Prentice Hall of India
7. K.L.P.Mishra and N.Chandrashekar, Theory of Computer Science PHI(2002)

**Pt. Ravishankar Shukla University, Raipur**  
Scheme of Examination

**M.A./M.Sc. (MATHEMATICS) (Semester-II)**

**2021 - 22 (Examination - May-June 2022) onwards**

There shall be five theory papers. Each paper shall have 100 marks.

**Overall tally of marks will be 500.**

| Paper | Code | Description                        | Theory | Sessional | Practical | Total Marks |
|-------|------|------------------------------------|--------|-----------|-----------|-------------|
| I     | 201  | Advanced Abstract Algebra (II)     | 80     | 20        | -         | 100         |
| II    | 202  | Real Analysis (II)                 | 80     | 20        | --        | 100         |
| III   | 203  | General and Algebraic Topology     | 80     | 20        | --        | 100         |
| IV    | 204  | Advanced Complex Analysis (II)     | 80     | 20        | --        | 100         |
| V     | 205  | Advanced Discrete Mathematics (II) | 80     | 20        | --        | 100         |

**Pt. Ravishankar Shukla University, Raipur**

**Scheme of Examination**

**M.A./M.Sc. (MATHEMATICS) (Semester-III)**

**2021- 22 (Examination – Dec. 2021) onwards**

There shall be five theory papers. Two compulsory and three optional. Each paper shall have 100 marks. Out of these five papers, the paper which has theory and practical both, the theory part shall have 70 marks and practical part shall have 30 marks. **Overall tally of marks in theory and practical will be 500.**

| Paper                    | Code | Description  | Theory | Sessi<br>-onal | Practi<br>cal | Remark                    |
|--------------------------|------|--|--------|----------------|---------------|---------------------------|
| <b>Compulsory Papers</b> |      |  |        |                |               |                           |
| I                        | 301  | Integration Theory and Functional Analysis (I)                                       | 80     | 20             | --            | --                        |
| II                       | 302  | Partial Differential Equations & Mechanics (I)                                       | 80     | 20             | --            | --                        |
| <b>Optional Papers</b>   |      |  |        |                |               |                           |
| III                      | 303  | A Fundamentals of Computer Science ( Object Oriented Programming and Data Structure) | 70     | --             | 30            | For regular students only |
|                          | 304  | B Fuzzy Set Theory & Its Applications (I)  | 80     | 20             | --            | --                        |
|                          | 305  | C Mathematical Biology (I)   | 80     | 20             | --            | --                        |
| IV                       | 306  | A Operations Research (I)  | 80     | 20             | --            | --                        |
|                          | 307  | B Wavelets (I)   | 80     | 20             | --            | --                        |
| V                        | 308  | A Programming in C (with ANSI Features) (I)  | 70     | --             | 30            | For regular students only |
|                          | 309  | B Graph Theory (I)   | 80     | 20             | --            | --                        |

**M.Sc./M.A. Course (Third Semester)**  
**PAPER -I**  
**Integration Theory and Functional Analysis (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of Signed measure and its properties, Caratheodory's extension measure theory.
2. Understand modern theory of measure and integration.
3. Understand measure theory with respect to continuous functions, regularity of measures on locally compact spaces.
4. Understand finite dimensional normed linear and its basic properties.
5. Understand the concept of weak convergence and dual spaces.

**Contents:**

**Integration Theory:**

**Unit-I** Signed measure. Hahn decomposition theorem, mutually singular measures. Radon-Nikodym theorem. Lebesgue decomposition. Riesz representation theorem. Extension theorem (Caratheodory).

**Unit-II** Lebesgue-Stieltjes integral, product measures, Fubini's theorem. Differentiation and Integration. Decomposition into absolutely continuous and singular parts.

**Unit-III** Baire sets. Baire measure, continuous functions with compact support. Regularity of measures on locally compact spaces. Integration of continuous functions with compact support, Riesz-Markoff theorem.

**Functional Analysis :**

**Unit-IV** Normed linear spaces. Banach spaces and examples. Quotient space of normed linear spaces and its completeness, equivalent norms. Riesz Lemma, basic properties of finite dimensional normed linear spaces and compactness.

**Unit-V** Weak convergence and bounded linear transformations, normed linear spaces of bounded linear transformations, dual spaces with examples.

### **Books Recommended :**

1. P.R. Halmos, Measure Theory, Van Nostrand, Princeton, 1950.
2. B.Choudhary and S.Nanda, Functional Analysis with Applications. Wiley Eastern Ltd. 1989.
3. H.L. Royden, Real Analysis, Macmillan Publishing Co. Inc., New York, 4<sup>th</sup> Edition, 1993.

### **References**

1. S.K. Berberian, Measure and integration, Chelsea Publishing Company, New York, 1965.
2. G. de Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
3. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited, New Delhi, 2000.
4. Richard L. Wheeden and Antoni Zygmund, Measure and Integral : An Introduction to Real Analysis, Marcel Dekker Inc. 1977.
5. J.H. Williamson, Lebesgue Integration, Holt Rinehart and Winston, Inc. New York. 1962.
6. T.G. Hawkins, Lebesgue's Theory of Integration: Its Origins and Development, Chelsea, New York, 1979.
7. K.R. Parthasarathy, Introduction to Probability and Measure, Macmillan Company of India Ltd., Delhi, 1977.
8. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, 1966.
9. Serge Lang, Analysis I & II, Addison-Wesley Publishing Company, Inc. 1967.
10. Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
11. Walter Rudin, Real & Complex Analysis, Tata McGraw-Hill Publishing.
12. Edwin Hewitt and Korl Stromberg, Real and Abstract Analysis, Springer-Verlag, New York.
13. Edwin Hewitt and Kenneth A. Ross, Abstract Harmonic Analysis, Vol. 1, Springer-Verlag, 1993.
14. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
15. N. Dunford and J.T. Schwartz, Linear Operators, Part I, Interscience, New York, 1958.
16. R.E. Edwards, Functional Analysis, Holt Rinehart and Winston, New York, 1965.
17. C. Goffman and G. Pedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.

18. P.K. Jain, O.P. Ahuja and Khalil Ahmad, Functional Analysis, New Age International (P) Ltd. & Wiley Eastern Ltd., New Delhi, 1997.
19. R.B. Holmes, Geometric Functional Analysis and its Applications, Springer-Verlag, 1975.
20. K.K. Jha, Functional Analysis, Students' Friends, 1986.
21. L.V. Kantorovich and G.P. Akilov, Functional Analysis, Pergamon Press, 1982.
22. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
23. B.K. Lahiri, Elements of Functional Analysis, The World Press Pvt. Ltd., Calcutta, 1994.
24. A.H.Siddiqui, Functional Analysis with Applications, Tata McGraw-Hill Publishing Company Ltd. New Delhi
25. B.V. Limaye, Functional Analysis, Wiley Eastern Ltd.
26. L.A. Lustenik and V.J. Sobolev, Elements of Functional Analysis, Hindustan Publishing Corporation, New Delhi, 1971.
27. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, New York, 1963.
28. A.E. Taylor, Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
29. K.Yosida, Functional Analysis, 3<sup>rd</sup> edition Springer-Verlag, New York, 1971.
30. J.B. Conway, A Course in Functional Analysis, Springer-Verlag, New York, 1990.
31. Walter Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1973.
32. A. Wilansky, Functional Analysis, Blaisdell Publishing Co., 1964.
33. J. Tinsley Oden & Leszek F. Dernkowicz, Applied Functional Analysis, CRC Press Inc., 1996.



**M.Sc./M.A. Course (Third Semester)**  
**PAPER -II**  
**Partial Differential Equations and Mechanics (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand classification of partial differential equations in higher dimension.
2. Formulate and solve of PDEs like heat equation, initial value problem etc.
3. Understand basic concept related to discrete and continuous mechanical system.
4. Describe and understand the motion of a mechanical system using Poisson formalism.
5. Understand and evaluate attraction and potential in the problem related to rod, disc, spherical shells and sphere.

**Contents:**

**Partial Differential Equations**

**Unit-I** Examples of PDE. Classification. Transport Equation-Initial value Problem. Non-homogeneous Equation. Laplace's Equation-Fundamental Solution, Mean Value Formulas, Properties of Harmonic Functions, Green's Function, Energy Methods.

**Unit-II** Heat Equation-Fundamental Solution, Mean Value Formula, Properties of Solutions, Energy Methods. Wave Equation-Solution by Spherical Means, Non-homogeneous Equations, Energy Methods.

**Analytical Dynamics:**

**Unit-III** Generalized coordinates. Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Uniqueness of solution. Energy equation for conservative

fields. Hamilton's variables. Donkin's theorem. Hamilton canonical equations. Cyclic coordinates. Routh's equations.

**Unit-IV** Poisson's Bracket. Poisson's Identity. Jacobi-Poisson Theorem. Motivating problems of calculus of variations, Shortest distance. Minimum surface of revolution. Brachistochrone problem. Isoperimetric problem. Geodesic. Fundamental lemma of calculus of variations. Euler's equation for one dependent function and its generalization to (i) 'n' dependent functions, (ii) higher order derivatives. Conditional extremum under geometric constraints and under integral constraints.

### **Gravitation:**

**Unit-V** Attraction and potential of rod, disc, spherical shells and sphere. Surface integral of normal attraction (application & Gauss' theorem). Laplace and Poisson equations. Work done by selfattracting systems. Distributions for a given potential. Equipotential surfaces. Surface and solid harmonics. Surface density in terms of surface harmonics.

### **Books Recommended :**

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998.
2. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
3. R.C.Mondal, Classical Mechanics, Prentice Hall of India
4. S.L. Loney, An Elementary Treatise on Statics, Kalyani Publishers, New Delhi, 1979.

### **References**

1. Books on Partial differential equation by I.N. Sneddon, F. John, P. Prasad and R. Ravindran, Amarnath etc.

2. A.S. Ramsey, Dynamics Part II, The English Language Book Society and Cambridge University Press, 1972.
3. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
4. I.M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice Hall.
5. Narayan Chandra Rana & Pramod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.
6. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press, 1998.
7. A.S. Ramsey, Newtonian Gravitation, The English Language Book Society and the Cambridge University Press.

**M.Sc./M.A. Course (Third Semester)**  
**PAPER-III (A)**  
**Fundamentals of Computer Science-Theory and Practical**  
**(Object Oriented Programming and Data Structure)**

Max. Marks. 100

(Theory-70 +Practical-30)

**Learning Outcomes:** At the end of the course, the students will be able to :

6. Understand fundamentals of OOPs using C++ programming language.
7. Evaluate and apply the concepts of inheritance and virtual functions
8. Understand data structure, analysis of algorithms, list, stacks and queues.
9. Understand trees, binary trees, search tree implementations.
10. Apply various sorting techniques such as insertion sort, Shell sort, quick-sort, heap sort and their analysis.

**Contents:**

**Unit-I** Object Oriented Programming-Classes and Scope, nested classes, pointer class members; Class initialization, assignment and destruction.

**Unit-II** Overloaded functions and operators; Templates including class templates; class inheritance and virtual functions.

**Unit-III** Data Structures-Analysis of algorithms, q, W, 0, o, w notations ; Sequential and linked representations, Lists, Stacks, and queues;

**Unit-IV** Trees: Binary tree- search tree implementation, B-tree (concept only);

**Unit-V** Sorting: Insertion sort, shell sort, quick-sort, heap sort and their analysis; Hashing-open and closed.

**Books Recommended :**

1. S.B. Lipman, J. Lajoi: C++ Primer, Addison Wesley.
2. B. Stroustrup; The C++ Programming Language, Addison Wesley.
3. C.J. Date : Introduction to Database Systems, Addison Wesley.
4. C. Ritehie: Operating Systems-Incorporating UNIX and Windows, BPB Publications.

5. M.A. Weiss, Data Structures and Algorithm Analysis in C++, Addison Wesley.

**Practical Examination Scheme**

Max. Marks – 30

Time Duration – 3 Hrs.

Practical (two)

20 Marks( 10 marks each)

Viva

05 Marks

Sessional

05 Marks

**M.Sc./M.A. Course (Third Semester)**  
**PAPER-III (B)**  
**Fuzzy Set Theory and Its Applications (I)**

Max Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the various concept in fuzzy sets.
2. Understand the extension principle and operations on fuzzy sets.
3. Understand the fuzzy relations on Fuzzy sets.
4. Understand the fuzzy equivalence relations and relational equations.
5. Explain fuzzy measure and possibility theory.

**Contents:**

**UNIT-I** Fuzzy sets-Basic definitions,  $\alpha$ -level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products, Algebraic products. Bounded sum and difference, t-norms and t-conorms.

**UNIT-II** The Extension Principle- The Zadeh's extension principle. Image and inverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy arithmetic.

**UNIT-III** Fuzzy Relations on Fuzzy sets, Composition of Fuzzy relations. Min-Max composition and its properties.

**UNIT-IV** Fuzzy equivalence relations. Fuzzy compatibility relations. Fuzzy relation equations. Fuzzy graphs, Similarity relation.

**UNIT-V** Possibility Theory-Fuzzy measures. Evidence theory. Necessity measure. Possibility measure. Possibility distribution. Possibility theory and fuzzy sets. Possibility theory versus probability theory.

**REFERENCES :**

1. H.J. Zmmemann, Fuzzy set theory and its Applications, Allied Publishers Ltd. New Delhi, 1991.
2. G.J. Klir and B. Yuan- Fuzzy sets and fuzzy logic, Prentice-Hall ol India, New Delhi, 1995.

**M.Sc./M.A. Course (Third Semester)**  
**PAPER-III (C)**  
**Mathematical Biology (I)**

Max. Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Finding the equilibria of a single-population model and their stability in continuous and discrete environment.
2. Find the fixed points and their stability in nonlinear dynamical systems.
3. Analysis and stability of equilibria of nonlinear systems in more than two variables
4. Make the mathematical model of different situations in population dynamics, ecology etc.
5. Relate mathematical notions with biological phenomena.

**Contents:**

**Part-A: Simple Single Species Models**

**UNIT-I**

**Continuous Population Models:** Phase plane analysis of ODE. Exponential Growth model, the Logistic Population Model, qualitative analysis, Harvesting in Population Models, Constant-yield harvesting, constant-effort harvesting, a case study of eutrophication of a lake.

**UNIT-II**

**Discrete Population Models:** Linear Models, graphical solution of difference equations, equilibrium analysis, period-doubling and chaotic behavior, discrete-time metered models, two-age group model and delayed recruitment, a case study of oscillation in flour beetle populations.

**Part-B : Models for interacting species**

**UNIT-III**

**Introduction and Mathematical preliminaries:** The Lotka-Volterra equations, the chemostat, equilibria and linearization, qualitative solutions of linear systems, periodic solutions and limit cycles, models for giving up smoking and retaining of workers by their peers.

**UNIT-IV**

**Continuous Models for Two Interacting Populations:** Species in competitions, Predator-Prey system, Kolmogorov Models, Mutualism, The community matrix, the nature of interactions between species, invading species and coexistence, a predator and two competing prey, two predators competing for prey.

**UNIT-V**

**Harvesting in Two-Species Models:** Harvesting of species in competition, Harvesting of predator-prey systems, some economic aspects of harvesting, optimization of harvesting returns.

**Text Book:**

1. Fred Brauer, Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Biology, Springer (2010)

**Reference Books:**

1. Nicholas F. Britton, Essential Mathematical Biology, Springer-Verlag (2003)
2. J.D.Murray, Mathematical Biology I. An Introduction, Springer-Verlag (2002) 3<sup>rd</sup> Edition.
3. J.D.Murray, Mathematical Biology II. Spatial Models and Biomedical Application, Springer-Verlag (2003) 3<sup>rd</sup> Edition.



**M.Sc./M.A. Course (Third Semester)**  
**PAPER -IV (A)**  
**Operations Research (I)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of operations research and its scope. Formulate real life problems into linear programming problem and understand the simplex method.
2. Analyze duality, sensitivity in linear programming problem.
3. Understand theoretical foundation and implementation of optimization techniques available in the scientific literature.
4. Find the optimal solutions of transportation and assignment problems.
5. Understand the construction of networks of project and optimal scheduling using CPM and PERT. Find the optimal solution for networking problems.

**Contents:**

**Unit-I** Operations Research and its Scope. Necessity of Operations Research in Industry. Linear Programming-Simplex Method. Theory of the Simplex Method.

**Unit-II** Duality and Sensitivity Analysis. Other Algorithms for Linear Programming-Dual Simplex Method.

**Unit-III** Parametric Linear Programming. Upper Bound Technique. Interior Point Algorithm. Linear Goal Programming.

**Unit-IV** Transportation and Assignment Problems.

**Unit-V** Network Analysis-Shortest Path Problem. Minimum Spanning Tree Problem. Maximum Flow I Problem. Minimum Cost Flow Problem. Network Simplex Method. Project Planning and Control I with PERT-CPM.

**Books Recommended :**

1. F.S. Hillier and G.J. Ueberman. Introduction to Operations Research (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995. (This book comes with a CD containing tutorial software).

2. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
3. G. Hadly, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
4. H.A. Taha, Operations Research -An introduction, Macmillan Publishing Co., Inc., New York.
5. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi
6. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network flows, John Wiley & Sons, New York, 1990.

## References

1. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
2. Prem Kumar Gupla and D.S. Hira, Operations Research-An Introduction. S. Cliand & Company Ltd., New Delhi.
3. N.S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, Madras
4. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
5. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.
6. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
7. UNDOSystems Products (Visit websHe <http://www.Hndo.com/productsf.html>)
  - (i) UNDO (the linear programming solver)
  - (ii) UNDO Callable Library (the premier optimisation engine)
  - (iii) LINGO (the linear, non-linear, and integer programming solver with mathematical modelling language)
    - (i) What's Best I (the spreadsheet add-in that solves linear, non-linear, and integer problems).

All the above four products are bundled into one package to form the Solver Suite. For more details about any of the four products one has to click on its name.

- (i) Optimisation Modelling with UNDO (8" edition) by Linus Schrage.
  - (ii) Optimisation Modelling with LINGO by Unus Schrage.
- More details available on the Related Book page York, 1979.

**M.Sc./M.A. Course (Third Semester)**  
**PAPER-IV (B)**  
**Wavelets (I)**

Max Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the basic concept of wavelet theory and ways of constructing wavelets.
2. Understand and apply unitary folding operators and the smooth projections.
3. Understand the concept of multi-resolution analysis and construction of compactly supported wavelets.
4. Understand the characterization of Lemarie-Meyer wavelets, Franklin wavelets and spline wavelets on the real line.
5. Understand and apply decomposition and reconstruction algorithms for wavelets.

**Contents:**

- Unit-I.** Preliminaries-Different ways of constructing wavelets- Orthonormal bases generated by a single function: the Balian-Low theorem. Smooth projections on  $L^2(\mathbb{R})$ .
- Unit-II.** Local sine and cosine bases and the construction of some wavelets. The unitary folding operators and the smooth projections.
- Unit-III.** Multiresolution analysis and construction of wavelets. Construction of compactly supported wavelets and estimates for its smoothness. Band limited wavelets.
- Unit-IV.** Orthonormality. Completeness. Characterization of Lemarie-Meyer wavelets and some other characterizations. Franklin wavelets and Spline wavelets on the real line.
- Unit-V.** Orthonormal bases of piecewise linear continuous functions for  $L^2(\mathbb{T})$ . Orthonormal bases of periodic splines. Periodization of wavelets defined on the real line.

## **REFERENCES:**

1. Eugenic Hernandez and Guido Weiss, A First Course on Wavelets, CRC Press, New York, 1996.
2. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
3. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, I 1992.
4. Y. Meyer, Wavelets, algorithms and applications (Tran. by R.D. Ryan, SIAM, 1993).
5. M.V. Wickerhauser, Adapted wavelet analysis from theory to software, Wellesley, MA, A.K. Peters, 1994.

**M.Sc./M.A. Course (Third Semester)**  
**PAPER -V (A)**  
**Programming in C (with ANSI features) Theory and Practical (I)**

Max. Marks. 100

(Theory-70 +Practical-30)

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understanding the basic structure, operators and statements of C language.
2. Implementing simple C program, data types, operators and console I/O functions.
3. Understand the decision control statements, loop control statements and case control statements.
4. Understand the concept of operator and expression in C.
5. Understand the declaration, implementation of array, pointers, function and structures.

**Contents:**

**Unit-I** An overview of programming. Programming language, Classification. C Essentials-Program Development. Functions. Anatomy of a C Function. Variables and Constants. Expressions. Assignment Statements. Formatting Source Files. Continuation Character. The Preprocessor.

**Unit-II** Scalar Data Types-Declarations, Different Types of Integers. Different kinds of Integer Constants. Floating-Point Types. Initialization. Mixing Types. Explicit Conversions-Casts. Enumeration Types. The Void Data Type. Typedefs. Finding the Address of an object. Pointers.

**Unit-III** Control Flow-Conditional Branching. The Switch Statement. Looping. Nested Loops. The break and continue Statements. The goto statement. Infinite Loops.

**Unit-IV** Operators and Expressions-Precedence and Associativity. Unary Plus and Minus operators. Binary Arithmetic Operators. Arithmetic

Assignment Operators. Increment and Decrement Operators. Comma Operator. Relational Operators. Logical Operators. Bit - Manipulation Operators. Bitwise Assignment Operators. Cast Operator. Size of Operators. Conditional Operator. Memory Operators.

**Unit-V** Arrays -Declaring an Array. Arrays and Memory. Initializing Arrays. Encryption and Decryption.

### **Books Recommended :**

1. Peter A. Darnell and Philip E. Margolis, C: A Software Engineering Approach, Narosa Publishing House (Springer International Student Edition) 1993.
2. Samuel P. Harkison and Gly L. Steele Jr., C : A Reference Manual, 2nd Edition, Prentice Hall, 1984.
3. Brian W. Kernighan & Dennis M. Ritchie, The C Programme Language, 2nd Edition (ANSI Features), Prentice Hall 1989.

### **Practical Examination Scheme**

|                 |                          |
|-----------------|--------------------------|
| Max. Marks - 30 | Time Duration - 3 Hrs.   |
| Practical (two) | 20 Marks( 10 marks each) |
| Viva            | 05 Marks                 |
| Sessional       | 05 Marks                 |

**M.Sc./M.A. Course (Third Semester)**  
**PAPER-V (B)**  
**Graph theory (I)**

Max. Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of topological operations on graphs.
2. Understand the concept of matrices and vector spaces in graph theory.
3. Understand the concept of coloring packing and covering in graph theory.
4. Understand the concept of combinational formulations in graph theory.
5. Understand the concept of perfect graphs, SPGC in graph theory.

**Contents:**

Unit-I: Operations on graphs, matrices and vector spaces: Topological operations, Homeomorphism, homomorphism, contractions, derived graphs, Binary operations.

Unit-II: Matrices and vector spaces: Matrices and vector spaces : The adjacency matrix, The determinant and the spectrum, Spectrum properties, The incidence matrix, cycle space and Bond space, Cycle bases and cycle graphs.

Unit-III: Colouring packing and covering: Vertex coverings, critical graphs, Girth and chromatic number, uniquely colourable graphs, edge-colourings, Face colourings and Beyond, The achromatic and the Adjoint Numbers.

Unit-IV: Combinational formulations: Setting up of combinational formulations, the classic pair of duals, Gallai, Norman-Rabin Theorems, Clique parameters, The Rosenfeld Numbers.

Unit-V: Perfect Graphs: Introduction to the "SPGC", Triangulated (Chordal) graphs, Comparability graphs, Interval graphs, permutation graphs, circular arc graphs, split graphs, weakly triangulated graphs.

## **REFERENCES :**

1. K.R.Parthasarathy, Basic graph theory, Tata Mc graw Hill publishing company limited , 1994.
2. R.J.Wilson, Introduction to graph theory, Longman Harlow, 1985.
3. John Clark, Derek Allon Holton, A first look at graph Theory, World Scientific Singapore, 1991.
4. Frank Hararary, Graph Theory Narosa, New Delhi, 1995.
5. Ronald Gould and Benjamin Cummins, Graph Theory, California.
6. Narsingh Deo, Graph Theory with applications to Engineering and Computer Science, Prentice-Hall of India Private Limited, New Delhi, 2002.



**Pt. Ravishankar Shukla University, Raipur**

**Scheme of Examination**

**M.A./M.Sc. (MATHEMATICS) (Semester-IV)**

**2021 - 22 (Examination – May-June 2022) onwards**

There shall be five papers. Two compulsory and three optional papers.

Each paper shall have 100 marks. The paper which has theory and practical both, the theory part shall have 70 marks and practical part

shall have 30 marks. **Overall tally of marks in theory and practical will be 500.**

| Paper                    | Code | Description                                       | Theory | Sessional | Practical | Remark                    |
|--------------------------|------|---|--------|-----------|-----------|---------------------------|
| <b>Compulsory Papers</b> |      |   |        |           |           |                           |
| I                        | 401  | Functional Analysis (II)                          | 80     | 20        | --        | --                        |
| II                       | 402  | Partial Differential Equations & Mechanics (II)   | 80     | 20        | --        | --                        |
| <b>Optional Papers</b>   |      |   |        |           |           |                           |
| III                      | 403  | A Operating System and Database Management System | 70     | --        | 30        | For regular students only |
|                          | 404  | B Fuzzy Set Theory & Its Applications (II)        | 80     | 20        | --        | --                        |
|                          | 405  | C Mathematical Biology(II)                        | 80     | 20        | --        | --                        |
| IV                       | 406  | A Operations Research (II)                        | 80     | 20        | -         | --                        |
|                          | 407  | B Wavelets (II)                                   | 80     | 20        | -         | --                        |
| V                        | 408  | A Programming in C (with ANSI Features) (II)      | 70     | --        | 30        | For regular students only |
|                          | 409  | B Graph Theory (II)                               | 80     | 20        | --        |                           |

## M.Sc./M.A. Course (Fourth Semester)

### PAPER -I

### Functional Analysis (II)

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of uniform boundedness in normed linear spaces and Banach spaces.
2. Understand and apply fundamental theorems in normed linear spaces.
3. Understand the concept of Inner product spaces, Hilbert spaces, orthonormality and its properties.
4. Explain the concept of projection and reflexivity of Hilbert spaces.
5. Understand and apply general properties of linear operators in Hilbert space.

#### Contents:

**Unit-I** Uniform boundedness theorem and some of its consequences. Open mapping and closed graph theorems.

**Unit-II** Hahn-Banach theorem for real linear spaces, complex linear spaces and normed linear spaces. Reflexive spaces. Weak Sequential Compactness. Compact Operators. Solvability of linear equations in Banach spaces. The closed Range Theorem.

**Unit-III** Inner product spaces. Hilbert spaces. Orthonormal Sets. Bessel's inequality. Complete orthonormal sets and Parseval's identity.

**Unit-IV** Structure of Hilbert spaces. Projection theorem. Riesz representation theorem. Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces.

**Unit-V** Self-adjoint operators, Positive, projection, normal and unitary operators. Abstract variational boundary-value problem. The generalized Lax-Milgram theorem.

## Books Recommended :

1. B.Choudhary and S.Nanda, Functional Analysis with Applications. Wiley Eastern Ltd. 1989.
2. H.L. Royden, Real Analysis, Macmillan Publishing Co. Inc., New York, 4<sup>th</sup> Edition, 1993.

## References

1. Serge Lang, Analysis I & II, Addison-Wesley Publishing Company, Inc. 1967.
2. Walter Rudin, Real & Complex Analysis, Tata McGraw-Hill Publishing.
3. Edwin Hewitt and Korl Stromberg, Real and Abstract Analysis, Springer-Verlag, New York.
4. Edwin Hewitt and Kenneth A. Ross, Abstract Harmonic Analysis, Vol. 1, Springer-Verlag, 1993.
5. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
6. N. Dunford and J.T. Schwartz, Linear Operators, Part I, Interscience, New York, 1958.
7. R.E. Edwards, Functional Analysis, Holt Rinehart and Winston, New York, 1965.
8. C. Goffman and G. Pedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
9. P.K. Jain, O.P. Ahuja and Khalil Ahmad, Functional Analysis, New Age International (P) Ltd. & Wiley Eastern Ltd., New Delhi, 1997.
10. R.B. Holmes, Geometric Functional Analysis and its Applications, Springer-Verlag, 1975.
11. K.K. Jha, Functional Analysis, Students' Friends, 1986.
12. L.V. Kantorovich and G.P. Akilov, Functional Analysis, Pergamon Press, 1982.
13. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
14. B.K. Lahiri, Elements of Functional Analysis, The World Press Pvt. Ltd., Calcutta, 1994.
15. A.H.Siddiqui, Functional Analysis with Applications, Tata McGraw-Hill Publishing Company Ltd. New Delhi
16. B.V. Limaye, Functional Analysis, Wiley Eastern Ltd.
17. L.A. Lustenik and V.J. Sobolev, Elements of Functional Analysis, Hindustan Publishing Corporation, New Delhi, 1971.
18. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, New York, 1963.
19. A.E. Taylor, Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
20. K.Yosida, Functional Analysis, 3<sup>rd</sup> edition Springer-Verlag, New York, 1971.
21. J.B. Conway, A Course in Functional Analysis, Springer-Verlag, New York, 1990.
22. Walter Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1973.

23. A. Wilansky, Functional Analysis, Blaisdell Publishing Co., 1964.
24. J. Tinsley Oden & Leszek F. Dernkowicz, Applied Functional Analysis, CRC Press Inc., 1996.

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER -II**  
**Partial Differential Equations and Mechanics (II)**

Max. Marks 80

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**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand nonlinear first order partial differential equation and its classification.
2. Understand representation of solution, transforms, and potential function.
3. Understand asymptotic and power series.
4. Understand the concept of Hamiltonian's principle and canonical transformations.
5. Understand and apply methods for Lagrange and Poisson brackets.

**Contents:**

**Partial Differential Equations**

**Unit-I** Nonlinear First Order PDE-Complete Integrals, Envelopes, Characteristics, HamiltonJacobi Equations (Calculus of Variations, Hamilton's ODE, Legendre Transform, Hopf-Lax Formula, Weak Solutions, Uniqueness), Conservation Laws (Shocks, Entropy Condition, LaxOleinik formula, Weak Solutions, Uniqueness, Riemann's Problem, Long Time Behaviour)

**Unit-II** Representation of Solutions-Separation of Variables, Similarity Solutions (Plane and Travelling Waves, Solitons, Similarity under Scaling), Fourier and Laplace Transform, Hopf-Cole Transform, Hodograph and Legendre Transforms, Potential Functions.

**Unit-III** Asymptotics (Singular Perturbations, Laplace's Method, Geometric Optics, Stationary Phase, Homogenization), Power Series (Non-characteristic Surfaces, Real Analytic Functions, Cauchy-Kovalevskaya Theorem).

## **Analytical Dynamics:**

**Unit-IV** Hamilton's Principle. Principle of least action. Poincare Cartan Integral invariant. Whittaker's equations. Jacobi's equations. Lee Hwa Chung's theorem, canonical transformations and properties of generating functions.

**Unit-V** Hamilton-Jacobi equation. Jacobi theorem. Method of separation of variables. Lagrange Brackets. Condition of canonical character of a transformation in terms of Lagrange brackets and Poisson brackets, invariance of Lagrange brackets and Poisson brackets under canonical transformations.

## **Books Recommended :**

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998.
2. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
3. R.C.Mondal, Classical Mechanics, Prentice Hall of India

## **References**

1. Books on Partial differential equation by I.N. Sneddon, F. John, P. Prasad and R. Ravindran, Amarnath etc.
2. A.S. Ramsey, Dynamics Part II, The English Language Book Society and Cambridge University Press, 1972.
3. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
4. I.M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice Hall.
5. Narayan Chandra Rana & Pramod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.
6. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press, 1998.

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER-III (A)**  
**Operating System and Database Management System**  
**- Theory and Practical**

Max. Marks. 100

(Theory-70 +Practical-30)

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the role of database system, its architecture and data modeling
2. Understand the concept of relational algebra and relational calculus.
3. Use SQL DML/DDL commands.
4. Understand operating systems.
5. Learn I/O management.

**Contents:**

**Unit-I** Database Systems-Role of database systems, database system architecture and data modeling.

**Unit-II** Introduction to relational algebra and relational calculus.

**Unit-III** Introduction to SQL: Basic features including views; Integrity constraints; Database design-normalization up to BCNF.

**Unit-IV** Operating Systems- Overview of operating system, user interface, processor management, memory management.

**Unit-V** I/O management, concurrency and Security, network and distributed systems.

**Books Recommended :**

1. S.B. Lipman, J. Lajoi: C++ Primer, Addison Wesley.
2. B. Stroustrup; The C++ Programming Language, Addison Wesley.
3. C.J. Date : Introduction to Database Systems, Addison Wesley.
4. C. Ritehie: Operating Systems-Incorporating UNIX and Windows, BPB Publications.
5. M.A. Weiss, Data Structures and Algorithm Analysis in C++, Addison Wesley.

**Practical Examination Scheme**

Max. Marks - 30

Practical (two)

Viva

Sessional

Time Duration - 3 Hrs.

20 Marks( 10 marks each)

05 Marks

05 Marks



**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER-III (B)**  
**Fuzzy Set Theory & Its Applications (II)**

Max Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand fuzzy logic and fuzzy quantifiers.
2. Understand the approximate reasoning.
3. Understand the fuzzy control and fuzzification..
4. Understand the concept of decision making in fuzzy environment.
5. Understand and solve fuzzy linear programming problems.

**Contents:**

**Unit-I** Fuzzy Logic-An overview of classical logic, Multivalued logics, Fuzzy propositions. Fuzzy quantifiers. Linguistic variables and hedges. Inference from conditional fuzzy propositions, the compositional rule of inference.

**Unit-II** Approximate Reasoning-An overview of Fuzzy expert system. Fuzzy implications and their selection. Multiconditional approximate reasoning. The role of fuzzy relation equation.

**Unit-III** An introduction to Fuzzy Control-Fuzzy controllers. Fuzzification. Defuzzification and the various defuzzitication methods.

**Unit-IV** Decision Making in Fuzzy Environment-Individual decision making. Multiperson decision making. Multicriteria decision making. Multistage decision making.

**Unit-V** Fuzzy ranking methods. Fuzzy linear programming.

**REFERENCES :**

1. H.J. Zmmemann, Fuzzy set theory and its Applications, Allied Publishers Ltd. New Delhi, 1991.
2. G.J. Klir and B. Yuan- Fuzzy sets and fuzzy logic, Prentice-Hall ol India, New Delhi, 1995.

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER-III (C)**  
**Mathematical Biology (II)**

Max. Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the key concepts of population models with age structure.
2. Understand population models with spatial structure, make models using diffusion equation and analysis their stability.
3. Understand the key concepts of infectious -disease transmission and control. Define the basic reproduction number, derive its expression using several methods
4. Explore models of different types of infectious disease, including influenza, TB, SARS, and vector-borne diseases.
5. Develop ad-hoc compartmental models (like the susceptible-infectious-recovered (SIR) model) to match epidemiologic surveillance data. Identify the limitations of the presented models, and conditions that may limit their use.

**Contents:**

**Part-A: Population Models**

**UNIT-I**

**Models for population with age structure:** Linear discrete models, linear continuous models, the method of characteristics, nonlinear continuous models.

**UNIT-II**

**Models for population with spatial structure:** A general metapopulation model, a metapopulation model with residence and travel, the diffusion equation, solution by separation of variables. Linear reaction-diffusion equations, nonlinear reaction-diffusion equations, two-species interactions, diffusion in two dimensions.

**Part-B: Disease Transmission Models**

**UNIT-II**

**Epidemic models:** Introduction to epidemic models, The logistic equation in epidemiology (1.3), simple Kermack-McKendrick epidemic model, network and compartmental epidemic models.

**UNIT-IV**

**More complicated epidemic models:** models with exposed period, treatments models, an influenza model, quarantine-isolation models.

An SIR model with a general infectious period, the age of infection epidemic model, models with disease deaths, a vaccination model, the next generation matrix.

**UNIT-V**

**Models for endemic diseases:** A model for diseases with no immunity, the SIR model with births and deaths, some applications: Herd immunity, age of infection, the inter-epidemic period, epidemic approach to endemic equilibrium, the SIS model with births and deaths, temporary immunity, diseases population control.

**Text Book:**

1. Fred Brauer, Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Biology, Springer (2010)

**Reference Books:**

1. Nicholas F. Britton, Essential Mathematical Biology, Springer-Verlag (2003)
2. J.D.Murray, Mathematical Biology I. An Introduction, Springer-Verlag (2002) 3<sup>rd</sup> Edition.
3. J.D.Murray, Mathematical Biology II. Spatial Models and Biomedical Application, Springer-Verlag (2003) 3<sup>rd</sup> Edition.

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER -IV (A)**  
**Operations Research (II)**

Max. Marks 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Investigate the concept of dynamic programming problems.
2. Formulate and solve of linear programming model of game theory.
3. Understand integer programming problem and solve using optimization techniques.
4. Understand the queuing system. Formulate and solve the queuing theory models.
5. Extend the knowledge of programming problem from linear to nonlinear.

**Contents:**

**Unit-I** Dynamic Programming-Deterministic and Probabilistic Dynamic programming.

**Unit-II** Game Theory-Two-Person, Zero-Sum Games. Games with Mixed Strategies. Graphical . Solution. Solution by Linear Programming.

**Unit-III** Integer Programming-Pure and Mixed Integer Programming Problem, Gomory's All-I P.P. Method, Construction of Gomory's Constraints, Fractional Cut Method-All Integer LPP, Fractional Cut Method- Mixed Integer LPP, Branch and Bound Technique.

**Unit-IV** Queueing system: Deterministic Queueing system, probability distribution in Queueing, classification of Queueing models, Poission Queueing system.

**Unit-V** Nonlinear Programming-One/and Multi-Variable Unconstrained Optimization. Kuhn-Tucker Conditions for Constrained Optimization. Quadratic Programming. Separable Programming. I Convex Programming. Non-convex Programming.

## Books Recommended :

1. F.S. Hillier and G.J. Ueberman. Introduction to Operations ResBareft (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995. (This book comes with a CD containing tutorial software).
2. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
3. G. Hadly, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
4. H.A. Taha, Operations Research -An introduction, Macmillan Publishing Co., Inc., New York.
5. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi
6. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network flows, John Wiley & Sons, New York, 1990.

## References

1. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
2. Prem Kumar Gupla and D.S. Hira, Operations Research-An Introduction. S. Cliand & Company Ltd., New Delhi.
3. N.S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, Madras
4. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
5. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.
6. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
7. UNDOSystems Products (Visit websHe [htlp://www.Hndo.com/productsf.html](http://www.Hndo.com/productsf.html))
  - (i) UNDO (the linear programming solver)
  - (ii) UNDO Callable Library (the premier optimisation engine)
  - (iii) LINGO (the linear, non-linear, and integer programming solver with mathematical modelling language)
    - (i) What's Best I (the spreadsheet add-in that solves linear, non-linear, and integer problems).

All the above four products are bundled into one package to form the Solver Suite. For more details about any of the four products one has to click on its name.

- (i) Optimisation Modelling with UNDO (8" edition) by Linus Schrage.
  - (ii) Optimisation Modelling with LINGO by Unus Schrage.
- More details available on the Related Book page York, 1979.

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER-IV (B)**  
**Wavelets (II)**

Max Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the characterizations of wavelets.
2. Characterize MRA wavelets
3. Understand and apply reconstruction formula and the Balian-Low theorem for frames.
4. Understand and apply discrete transforms and algorithms.
5. Understand and apply recomposition and reconstruction algorithms for wavelets.

**Contents:**

**Unit-I** Characterizations in the theory of wavelets-The basic equations and some of its applications.

**Unit-II** Characterizations of MRA wavelets, low-pass filters and scaling functions. Non-existence of smooth wavelets in  $H^2(\mathbb{R})$ .

**Unit-III** Frames - The reconstruction formula and the Balian-Low theorem for frames. Frames from translations and dilations. Smooth frames for  $H^2(\mathbb{R})$ .

**Unit-IV** Discrete transforms and algorithms-The discrete and the fast Fourier transforms. The discrete and the fast cosine transforms.

**Unit-IV** The discrete version of the local sine and cosine bases. Decomposition and reconstruction algorithms for wavelets.

**REFERENCES:**

1. Eugenic Hernandez and Guido Weiss, A First Course on Wavelets, CRC Press, New York, 1996.
2. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
3. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, I 1992.
4. Y. Meyer, Wavelets, algorithms and applications (Trans. by R.D. Rayan, SIAM, 1993).

5. M.V. Wickerhauser, *Adapted wavelet analysis from theory to software*, Wellesley, MA, A.K. Peters, 1994.

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER -V (A)**  
**Programming in C (with ANSI features) (II)**  
**Theory and Practical**

Max. Marks. 100

(Theory-70 +Practical-30)

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand data storage classes and ANSI rules for the syntax and semantics of the storage-class.
2. Understand pointer arithmetic and various sorting algorithms.
3. Declare and call functions and the C processor.
4. Understand structure and union and dynamic memory allocation
5. Understand the I/O file operators, standard library for I/O.

**Contents:**

**Unit-I** Storage Classes-Fixed vs. Automatic Duration. Scope. Global variables.

The register Specifier. ANSI rules for the syntax and Semantics of the storage-class keywords.

**Unit-II** Pointers Pointer Arithmetic. Passing Pointers as Function Arguments. Accessing Array Elements through Pointers. Passing Arrays as Function Arguments. Sorting Algorithms. Strings. Multidimensional Arrays. Arrays of Pointers. Pointers to Pointers.

**Unit-III** Functions-Passing Arguments. Declarations and Calls. Pointers to Functions. Recursion. The main Function. Complex Declarations.The C Preprocessor-Macro Substitution. Conditional Compilation. Include Facility. Line Control.

**Unit-IV** Structures and Unions-Structures. Dynamic Memory Allocation. Linked Lists. Unions, enum Declarations.

**Unit-V** Input and Output-Streams, Buffering. The <Stdio.h> Header File. Error Handling. Opening and Closing a File. Reading and Writing



Data. Selecting an I/O Method. Unbuffered I/O Random Access. The standard library for Input/Output.

**Books Recommended :**

1. Peter A. Darnell and Philip E. Margolis, C: A Software Engineering Approach, Narosa Publishing House (Springer International Student Edition) 1993.
2. Samuel P. Harkison and Gly L. Steele Jr., C : A Reference Manual, 2nd Edition, Prentice Hall, 1984.
3. Brian W. Kernighan & Dennis M. Ritchie, The C Programme Language, 2nd Edition (ANSI Features), Prentice Hall 1989.

**Practical Examination Scheme**

|                 |                          |
|-----------------|--------------------------|
| Max. Marks - 30 | Time Duration - 3 Hrs.   |
| Practical (two) | 20 Marks( 10 marks each) |
| Viva            | 05 Marks                 |
| Sessional       | 05 Marks                 |

**M.Sc./M.A. Course (Fourth Semester)**  
**PAPER-V (B)**  
**Graph theory-II**

Max. Marks – 80

**Learning Outcomes:** At the end of the course, the students will be able to :

1. Understand the concept of perfectness, Ramsey numbers and graphs.
2. Understand the concept of graphs with groups.
3. Understand the concept of polynomials: colour, chromatic, bivariatic etc.
4. Extend the concept of graph enumeration its properties.
5. Understand the concept of digraphs and networks in graph theory.

**Contents:**

Unit-I: Ramsey Theory: Perfectness-preserving operations, Forbidden Subgraph orientations, Ramsey numbers and Ramsey graphs.

Unit-II: Groups: Permutation groups, The automorphism group, graphs with given group, symmetry concepts, pseudo-similarity and stability, spectral studies of the Automorphism group.

Unit-III: Polynomials and Graph Enumeration: The colour polynomials, The chromatic polynomial, The bivariate colouring polynomials.

Unit-IV: Graph Enumeration: Co-chromatic (co-dichromatic) graphs and chromatically unique graphs, Graph Enumeration.

Unit-V: Digraphs & Networks: Digraphs, Types of connectedness, Flows in Networks, Menger's and Konig's Theorem, Degree sequences.

**REFERENCES :**

1. K.R.Parthasarathy, Basic graph theory, Tata Mc graw Hill publishing company limited , 1994.
2. R.J.Wilson, Introduction to graph theory, Longman Harlow, 1985.
3. John Clark, Derek Allon Holton, A first look at graph Theory, World Scientific Singapore, 1991.
4. Frank Hararary, Graph Theory Narosa, New Delhi, 1995.
5. Ronald Gould and Benjamin Cummins, Graph Theory, California.
6. Narsingh Deo, Graph Theory with applications to Engineering and Computer Science, Prentice-Hall of India Private Limited, New Delhi, 2002.