Annexure II

UNIVERSITY OF LADAKH

SYLLABI AND COURSES OF READING IN MA/M.Sc. MATHEMATICS

OFFERED

BY

DEPARTMENT OF MATHEMATICS

CHOICE BASED CREDIT SYSTEM (CBCS) SYSTEM
OUTLINE OF COURSE
(Session 2022-2023, 2023-2024)

OBJECTIVE OF THE COURSE

The MA/M. Sc programme being offered by the department aims to inculcate among the students an overall and in depth understanding of the mathematical concepts, so that they can work as professionals in the subject. The programme will help students to develop research oriented attitude, handle the problems faced by industry and find out solution of real world problems through mathematical knowledge and computational techniques. It will also help them improve their logical and analytical ability. The courses are specially designed to help them build a strong mathematical foundation, so that they can build a successful career in academic institution, research institution, government and non-governmental organizations and industry across the world.

Credit Requirements :

• A one-year/two-semester Master's degree programme builds on a Bachelor's degree with Honours/Research and requires 36-40 credits for individuals who have completed a Bachelor's degree with Honours/Research.

• The two-year/four-semester Master's degree programme builds on a Bachelor's degree and requires a total of 72-80 credits from both years of the programme, with 36-40 credits in the first year and 36-40 credits in the second year of the programme at level 9.

• A one-year/two-semester Post-Graduate Diploma programme builds on a Bachelor's degree and requires 36-40 credits for individuals who have completed a Bachelor's degree.

A student will be allowed to enter/re-enter only at the odd semester and can only exit after the even semester. Re-entry at various levels as lateral entrants in academic programmes should be based on the earned credits and proficiency test records.

The validity of credits earned will be to a maximum period of seven years or as specified by the ABC. The procedure for depositing credits earned, its shelf life, redemption of credits, would be as per UGC (Establishment and Operationalization of Academic Bank of Credits (ABC) scheme in Higher Education) Regulations, 2021.

1. Entry/Exit Policy:

Sl. No.	Course	Entry	Exit	Outcome

1	Semester I (6 months)	B.Sc. (3-year course)	Certificate	To cater basic need of mathematics.
2	Semester II (6 months)	Certificate/Semester I	PG Diploma	Leading to M.Sc. Mathematics
3	Semester III & Semester IV (12 months)	B.Sc. (4-year course)/ PG Diploma	M.Sc. Mathematics	Teaching/ Expertise in Mathematics/ Leading to research.

2. Course Structure:

S. No	Course code	Title	Credit	Marks
SEMSTER-I				
Core Courses				
1	PGMAT-C101	Algebra-I	4	100
2	PGMAT-C102	Topology-I	4	100
3	PGMAT-C103	Complex Analysis I	4	100
4	PGMAT-C104	Ordinary Differential Equation	4	100
5	PGMAT-M105	Real Analysis-I	2	50
6	PGMAT-P106	Skill Based Project Work	2	50
	Total		**20**	**500**

SEMSTER-II				
Core Courses				
1	PGMAT-C201	Algebra-II	4	**100**
2	PGMAT-C202	Real Analysis-II	4	**100**
3	PGMAT-C203	Complex Analysis II	4	**100**
4	PGMAT-C204	Topology-II	4	**100**
5	PGMAT-M205	Theory of Matrices	2	**50**
6	PGMAT-P206	Skill Based Project Work	2	**50**
	Total		**20**	**500**

SEMSTER-III				
Core Courses				
1	PGMAT-C301	Functional Analysis	4	100
2	PGMAT-C302	Theory of Numbers	4	100
3	PGMAT-C303	Fluid Mechanics	4	100
4	PGMAT-C304	Partial Differential Equations	4	100
5	PGMAT-P305	Skill Based Project Work	2	50
Opt. any one of The Following or MOOCS Course or Course from any other sister department of same Credits				
6	PGMAT-M306	Mathematical Aptitude	2	50
7	PGMAT-M307	Mathematical Statistics	2	50
	Total		**20**	**500**

SEMSTER-IV				
Core Courses				
	PGMAT-C401	Classical Mechanics	4	100
	PGMAT-C402	Operations Research	4	100
	PGMAT-C403	Numerical Methods	4	100
	PGMAT-P404	Project/Dissertation	8	200
Total			**20**	**500**
Grand total				**2000**

Note: A student is required to complete 80 credits for the completion of the course and the award of degree. In general, one-hour theory lecture per week equals 01 Credit, 2 hours practical class per Week equals 01 credit. Courses/Papers offered in the M.Sc. are divided into three categories:

(i) **'Core Course'** means a course that is Compulsory for a particular programme and offered by the Department, where the student is admitted.

(ii) **'Multidisciplinary Course'** means a course of 2 credit which can be a selected by the students from an y sister department or from MOOCS or within the department in the 3rd semester.

(iii) **'Skill Based Project Work"** means a minor project to be performed by the students from semester 1ST to 3RD.

3. EVALUATION PATTERN:

There will be internal examinations (Assignments, Tests and Presentations) of 30% marks in each semester. End-semester examination will be for the rest 70% marks in each semester.

Pattern of end-semester question paper

(i) There will be two sections A and B.

(ii) There will be 9 questions in all.

(iii) **Section A** will carry one compulsory question (question no 1) with four sub-parts (consisting of short answer type questions). Each sub-part (short answer type question) will be from each unit and a student will have to attempt all the four sub-parts.

(iv) **Section B** will comprise of four long answer type questions (question number 2 to 5); each question will have an option. Thus, there will be two questions from each unit. In total, there will be eight questions in the section; two from each unit and a candidate will be asked to

attempt four questions.

(v) All short answer type questions will carry 3½ marks each. Thus, question No 1 will carry weightage of 14 marks. Whereas, each question from no 2 to 5 will carry equal marks of 14 marks.

(vi) Students are required to attempt FIVE questions in all, ONE question from each unitand the Compulsory question of Section A

Project work:

Project/Dissertation work will begin in third/forth semester. The weightage will be of 150 marks. At the end of semester, students will submit project work in the form of a report. There will be a presentation before a panel of teachers from the department.

4. Detailed syllabi:

SEMESTER - I

Paper- Core 1: Algebra-I

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

To enable the student to understand the concept of group theory, ring theory and modulus.

UNIT-I **(15 Hrs.)**

Review of basic property of groups, Isomorphism, Automorphism, Conjugacy and G-Sets. Normal Series, Solvable Groups, Nilpotent Groups. Direct Products, Finitely Generated Abelian Groups, Invariants of a Finite abelian Groups, Sylow Theorems, Groups of Orders p^2, pq.

UNIT-II **(15 Hrs.)**

Definition and Examples of Rings, Some Special Classes of Rings, Homomorphisms, Ideals and Quotient Rings, More Ideals and Quotient Rings and The Field of Quotients of an Integral Domain.

UNIT-III **(15 Hrs.)**

Euclidean Rings, A Particular Euclidean Ring(Euclidean ring of Gaussian integers), Polynomial Rings, Polynomials over the Rational Field, Polynomial Rings over Commutative Rings; Unique factorization domain.

UNIT-IV **(15 Hrs.)**

Definition and examples of modules, Submodules and direct sums, homomorphisms and quotient modules, Completely reducible modules, Free modules, Noetherian and Artinian modules

Suggested Books

Essential

1. P.B. Bhattacharya, S.K. Jain & S.R. Nagpal, Basic Abstract Algebra, 2nd Edition, Cambridge University Press (See pg. 107-152 for Unit I, pg. 246-263 and pg. 368 for Unit IV).

2. I.N. Herstein, 'Topics in Algebra', Second Edition), John Wiley & Sons, New York (See pg. 120-161 for Unit II and Unit III)
3. Kenneth Hoffman & Ray Kunze, 'Linear Algebra', Second Edition, Prentice-Hall of India Private Limited, New Delhi (Also see 8.4, 8.5, 9.1 to 9.5).

Further Reading

1. N.S Gopalakrishan : *University Algebra*, Weiley Eastern Ltd. 1986.
2. Vivek Sahai and Vikas Bist, *Algebra*, Narosa Publishing House 1999.
3. D. S. Malik, J. N. Mordeson, and M. K. Sen, *Fundamentals of Abstract Algebra*, McGraw-Hill International Edition, 1997
4. Surjeet Singh and Qazi Zameeruddin, Modern Algebra, Vikas Publishing House Pvt. Limited.
5. Michael Artin, Algebra, Pearson Publication.
6. C. Musili, Introduction to Rings and Modules, Narosa Publishing House New Delhi, 1994.

SEMESTER - I

Paper- Core 2: Topology-I

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

In inculcate the students to study the properties that are preserved through deformations, twisting and stretching of objects without tearing.

Unit-I **(15 Hrs.)**

Cartesian product of a family of sets, partially ordered sets, the axiom of choice and some of its equivalent forms, the Hausdorff maximality principle, fixed point theorem (statement only), Zorn's lemma, applications of Zorn's lemma, the well ordering principle, equivalence of the above three concepts, the principle of transfinite induction. Finite and infinite sets. Equipotence of sets, examples and properties of denumerable sets, non-denumerable sets. Problems and exercises based on these concepts.

Unit-II **(15 Hrs.)**

Cardinal numbers and ordinal numbers: The concept of the cardinal number, ordering of the cardinal numbers. The Schroder- Bernstein Theorem, cardinal number of a power set, Cantor's theorem, addition and multiplication of cardinal numbers, the continuum hypothesis and its generalization. Order isomorphism, the concept of ordinal number with examples, ordering of ordinal numbers. Addition and multiplication of ordinal numbers. Any set of ordinal numbers is well ordered, Problems and exercises based on these concepts.

Unit-III **(15 Hrs.)**

Topological spaces (open sets as primitive notion), closure, interior and boundary of a set. Neighbourhood system, neighbourhood base and base. Alternate methods of defining a topology in

terms of the Kuratowski's closure operator, neighbourhood systems and bases, accumulation points and derived sets, sub-bases, sub-spaces and relative topology, order topology. Problems and exercises based on these concepts.

Unit-IV **(15 Hrs.)**

Continuous maps, open maps, closed maps and their important characterizations. Homeomorphism, product topology and its properties, weak topology induced by a family of maps, evaluation map, quotient topology and its properties, decomposition spaces, upper semi-continuous decomposition spaces, examples of quotient spaces like cylinder, circle, torus and Mobius band, Problems and exercise based on these concepts.

Suggested Books

Essential

1. T Lin and You-Feng Line: Set theory Houghton Mifflin Company Boston, 1974.(for unit –I & II)
2. S. Willard: General topology (1970), Addison Wesley (for unit- III & IV).

Further Reading

1. J. L. Kelley, *General Topology*, Van Nostrand, 1995.
2. K. D. Joshi, *Introduction to General Topology*, Wiley Eastern, 1983.
3. James R. Munkres, *Topology, 2nd Edition*, Pearson International, 2000.
4. J. Dugundji, *Topology*, Prentice-Hall of India, 1966.
5. George F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill, 1963.
6. N. Bourbaki, *General Topology*, Part I, Addison-Wesley, 1966.
7. J. N. Sharma and J. P. Chauhan, Topology, Krishna's Educational Publisher.

SEMESTER - I

Paper- Core 3: Complex Analysis-I

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

To enable the students to understand the extensions of the real analysis problems to the complex domain in order to solve harder problems pertaining to the different disciplines.

Unit I **(15 Hrs.)**

The Complex Plane, Polar Representation , The stereographic Projection , The square and square root function, The Exponential functions, The Logarithmic function The Trigonometric and Hyperbolic functions . Analytic function , the Cauchy-Riemann Equations The inverse mapping theorem and Jacobian, Harmonic functions , Harmonic conjugate, The Mean Value Property , Maximum modulus Principle , Conformal mappings and Mobius Transformations(i.e. Fractional linear).

Unit-II **(15 Hrs.)**

Line Integral and Green's Theorem , Complex line Integral Fundamental theorem of Calculus for

Analytic function, Cauchy's Theorems , Cauchy Integral Formula , Liouville's Theorem , The Fundamental Theorem of Algebra , Morera's Theorem , Goursat's Theorem , The Power series Representation of Analytic Function , The Power series expansion at infinity , The Zero of Analytic Functions and Identity Theorem.

Unit-III **(15 Hrs.)**

The Laurent series and Isolated Singularities of Analytic Function , Laurent expansion, Riemann Theorem on Removable Singularities, Casorati-Weierstrass Theorem, Isolated Singularity at infinity, Partial Fraction Decomposition , The Residue Theorem , The Integrals featuring Rational Functions ,Integral of Trigonometry Functions Integral with Branch point , Fractional Residue s , Principal Values, Jorden Lemma.

Unit-IV **(15 Hrs.)**

The Argument Principle , Rouche's Theorem ,Hurwitz Theorem, Open Mapping Theorem and Inverse Mapping Theorem, Critical Points , Winding Numbers, Simply Connected Domain s , Schwarz Lemma , Conformal Self-maps of the Unit Disk , An Introduction to Hyperbolic Geometry.

Suggested Books

Essential

1. Theodore W. Gamelin: *Complex Analysis*, Springer-Verleg, 2001.

Further Reading

1. E. C. Titchmarsh, *The Theory of Functions*, Oxford University Press.
2. J. B. Conway, *Functions of One Complex Variable*, Narosa Publishing House, 1980
3. E. T. Copson, *Complex Variables*, Oxford University Press.
4. L. V. Ahlfors, *Complex Analysis*, McGraw-Hill, 1977.
5. D. Sarason, *Complex Function Theory*, Hindustan Book Agency, Delhi, 1994.
6. S.Ponnusamy, *Foundation of complex analysis*, Narosa publication, 2003.

SEMESTER - I

Paper- Core 4: Ordinary Differential Equations

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

The subject of differential Equations is the natural goal of elementary calculus and most important part of mathematics for understanding the physical sciences, engineering and technology. Also in the deeper questions it generates, it is the source of most of the ideas and theories which constitute higher analysis. It is indispensable for undertaking the nature mathematically.

Unit-I Existence and Uniqueness Theory (15 Hrs.)

Uniform convergence, Weierstrass M-test, Functions of two real variables; Lipschitz condition, The fundamental existence and uniqueness theorem, Dependence of solutions on the initial conditions, Dependence of solutions on the function f, Existence and uniqueness theorems for systems and higher order equations.

Unit-II The Theory of Linear Differential Equations (15 Hrs.)

Theory of the Homogenous Linear System, Abel-Liouville formula, The Non-homogenous Linear System, Theory of the nth order Homogenous Linear Differential Equation, Properties of the nth order Homogenous Linear Differential Equation, The nth order Non-homogenous Linear Equation, Sturm Theory: Self-Adjoint equations of second order, some basic results on Sturm Theory, Abel's formula, The separation and comparison theorems.

Unit-III Sturm-Liouville Boundary Value Problems and Fourier Series (15 Hrs.)

Sturm- Liouville problems, Characteristic values and Characteristic functions, Orthogonality of Characteristics functions, The Expansion of a function in a series of Orthonormal functions: Orthonormal systems, The Expansion problem, Trigonometric Fourier Series: Fourier Sine and Cosine Series, Convergence of Trigonometric Fourier Series.

Unit-IV Nonlinear Differential Equations (15 Hrs.)

Phase, Plane, Path and Critical points, Critical points and Paths of Linear Systems, Critical points and Paths of Non-linear Systems, Limit Cycles, Existence and non-existence of Limit Cycles, The mothods of Kryloff and Bogoliuboff: The first approximation of Kryloff and Bogoliuboff, Special cases and examples.

Suggested Books

Essential

1. Shepley L. Ross: *Differential Equations, 3rd Edition,* John Wiley and Sons(Asia) Pvt. Ltd. 2004(See, pg. 461 to 707 for Unit I, Unit II, Unit III.)

Further Reading

1. H.T.H. Piaggio: *Differential Equations*, CBS Publishers and Distributors, New Delhi.
2. P. Hartmen: *Ordinary Differential Equations*.
3. G.F. Simmons : *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill 2003.
4. E.A. Coddington: *An introduction to Ordinary Differential Equations*, Prentice Hall of Privative Limited, New Delhi,2005.

SEMESTER - I

Paper- Multidisciplinary: Real Analysis-I

M.Marks: 50 **30Hrs.**

OBJECTIVE OFTHECOURSE

The main objective of this course is to study real analysis in more generalized form i.e., in n dimension and study the uniform continuity, uniform convergence of functions, Riemann Stieltjes integrals and functions of several variables.

UNIT-I **(15Hrs.)**

Euclidean Space, open ball and open sets in, structure of open sets in, closed sets, adherent sets, Bolzano-weistrass theorem, Cantor intersection theorem. Lindeloff covering theorem, Hein-Borel theorem, compactness in $\mathbb{R}^n$ connectedness in $\mathbb{R}^n$

Riemann-Stieltjes integral, linear properties of R-S integrals, integtration by parts, change of variable, reduction to Riemann Stieltjes integral to finite sum, Euler's summation formula, upper and lower R-S integrals, Riemann's condition, comparison theorems. First and second mean value theorems for R-S integrals. Function of bounded variation, total variation, additive property of total variation. Total variation on $[a, x]$ expressed as the difference of increasing functions

Unit-II FUNCTION OF SEVERAL VARIABLES (15 Hrs.)

The Directional derivative, total derivative, matrix of a linear function, Jacobian matrix and the chain rule. The Mean value theorem for differentiable functions, a sufficient condition for differentiability, a sufficient condition for equality of mixed partial derivatives, Taylor's formula for function from $\mathbb{R}^n$ to $\mathbb{R}^n$. Functions with non-zero Jacobian determinant, the inverse function theorem, the implicit function theorem (only statements)

Suggested Books

Essential

1. T.M. Apostol: Mathematical Analysis Narosa Pub. House, New Delhi 1997.

Further Reading

1. W.Rudin : Principles of Mathematical Analysis, McGraw Hill international edition (Third edition) (1976).
2. S.C. Malik : Mathematical Analysis, Wiley Easter, New Delhi 1984.
3. D. Somasundaram, B. Choudhary : A first course in Mathematical Analysis, Narosa Pub. House, New Delhi 1999

SEMESTER - I

Paper- Minor Project: Typesetting in LaTeX

M. Marks: 50

OBJECTIVE OF THE COURSE

To develop the skill of writing mathematical topics and presentations of proofs of fundamental results pertaining to the subject.

Topics:
i. Algebra-I
ii. Real Analysis-I
iii. Topology-I
iv. Complex Analysis-I
v. Ordinary Differential Equations

The student will be put under the guidance of faculty member of the respective areas. At the end of the semester the student will have to submit the minor project to their guide. The minor project will carry 50 marks.

SEMESTER - II

Paper- Core 1: Algebra-II

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

The objective of this course is to introduce the basic ideas of Field Theory and Galois Theory and to see its application to the solvability of polynomial equations by radicals.

UNIT-I Field Theory **(15 Hrs.)**

Basic review of fields, irreducible polynomials and Eisenstein criterion, Adjunction of roots, Algebraic extensions, Algebraically closed fields.

UNIT-II **(15 Hrs.)**

Normal and Separable extensions: Splitting fields, Normal extensions, Multiple roots, Prime Fields, Finite fields, separable extensions.

UNIT-III **(15 Hrs.)**

Irreducible Polynomials, Roots of unity and cyclotomic polynomials, Representation of Elements of Finite Fields, Order of Polynomials and Primitive Polynomials, Irreducible Polynomials.

UNIT-IV Galois Theory and its Applications **(15 Hrs.)**

Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of algebra.

Suggested Books

Essential

1. P.B. Bhattacharya, S.K. Jain & S.R. Nagpaul, 'Basic Abstract Algebra', Second Edition, Cambridge University Press, (See pg. 281 to 295 for Unit I , pg. 300 to 316 for Unit II, pg. 322 to 338 for Unit IV).

2. Rudolf Lidl & Harald Niederreiter, "Finite Fields", Cambridge University Press, (See pg. 48 to 66 and pg. 84- 91 for Unit III)

Further Reading

1. N.S Gopalakrishan : *University Algebra*, Weiley Eastern Ltd. 1986.
2. Vivek Sahai and Vikas Bist, *Algebra*, Narosa Publishing House 1999.
3. D. S. Malik, J. N. Mordeson, and M. K. Sen, *Fundamentals of Abstract Algebra*, McGraw-Hill International Edition, 1997
4. Qazi Zameeruddi and Surjeet Singh, Modern Algebra, Vikas Publication.
5. Michael Artin, Algebra, Pearson Publication.
6. C. Musili, Introduction to Rings and Modules, Narosa Publishing House New Delhi, 1994.

SEMESTER - II

Paper-Core 2: Real Analysis-II

M.Marks: 100 **60Hrs.(4 Hrs./week)**

OBJECTIVE OFTHECOURSE

To provide the students the notions of length, area and volume with respect to different measures viz., Lebesque and Borel measure and theory of measure integration in order to overcome problems arising from Riemann Integration.

Unit-I **(15 Hrs.)**

Pointwise and uniform convergence, uniform convergence and continuity, Cauchy condition for uniform convergence, uniform convergence of infinite series. Weistrass M-test, uniform convergence and R-S integration, uniform convergence and differentiation. Power series, multiplication of power series, the substitution theorem. Reciprocal of a power series, Taylor's series generated by a function. Bernstein's theorem. Abel's limit theorem, Tauber's theorem.

Unit-II **(15 Hrs.)**

σ- Algebra of sets, limits of sequences of sets. Generation of algebras, Borel σ- algebra, G_δ and F_σ-sets. Measure on σ- algebra, Measures of sequences of sets, Measureable spaces and measure space. Outer measures, regular outer measure, metric outer measure, construction of outer measure.
Lebesgue outer measure on R, properties of Lebesgue measure spaces, translation invariances of Lebesgue measure. Existence of non-Lebesgue measureable sets. Regularity of Lebesgue outer measure.

Unit-III **(15 Hrs.)**

Cantor ternary set and cantor function. Relation between Lebesgue and Borel measurability, completion of measure space. Completion of Borel measure space to the Lebesgue measure space.
Measureable functions , Operation with measureable function, equality a.e. , Sequence of measureable functions, continuity and Borel Lebesgue measureability of functions on R, integration of simple functions, Lebesgue integral of non-negative and measureable functions. Properties of Lebesgue integrals.

Unit-IV **(15 Hrs.)**

Convergence a.e., almost uniform convergence, Egroff's theorem, convergence in measure, convergence in mean, Cauchy sequence in measure, relation among various convergence types, Fatou's lemma, Lebesgue monotone convergence theorem. Lebesgue dominated theorem. Examples and exercises based on these concepts.

Suggested Books

Essential

1 .J. Yeh, Real Analysis, Theory of measure and integration, 3rd edition, World Scientific (2000).

Further Reading

1. M.E. Munroe, *An Integration 2nd ed.* Addison Wesley 1971.
2. G.D. Barra, *Measure theory and Integration*, Willey Eastern 1987.
3. H.L. Royden, Real Analysis , 3rd edition, Macmillon, New York 1988.
4. L. Royden, Real Analysis (PHI).
5. R. Goldberg, Methods of Real Analysis
6. G. De. Barra, Measure theory and Integration (Narosa).
7.. I. K. Rana , An Introduction to Measure and Integration.
8. W. Rudin, Principles of Mathematical Analysis.
9. Soo Bong Chae, Lebsgue Integgration, Second Edition, Springer.

SEMESTER - II

Paper-Core 3: Complex Analysis II

M.Marks:100 **60Hrs.(4 Hrs./week)**

OBJECTIVE OFTHECOURSE

The main objective of this course is to study some advance topics in the field of Complex Analysis.

UNIT-I **(15 Hrs.)**

Harmonic Functions and the Reflection Principle: The Poisson Integral Formula, Characterization of Harmonic Functions, The Schwarz Reflection Principle, Analytic Continuation, The Monodromy Theorem.

Unit-II **(15 Hrs.)**

Conformal Mappings: Mappings to the Unit Disk and Upper Half-Plane, Compact Families of Functions, Chordal metric, spherical metric, spherical derivative, The Arzela Ascoli Theorem, Montel Theorem, The Riemann Mapping Theorem

Unit-III **(15 Hrs.)**

Compact Families of Meromorphic Functions: Marty's Theorem, Montel three point theorem, Picard Little Theorem, Picard Big Theorem, Fatou sets, Julia sets, Connectedness of Julia sets, The Mandelbort Set.

Unit-IV **(15 Hrs.)**

Approximation Theorems: Runge's Theorem, The Mittag-Leffler Theorem, Infinite Products, The Weierstrass Product Theorem. The Gamma and Zeta Functions and their important properties.
Abstract Riemann Surface, the idea of Green's Function and an idea of the proof of Uniformation Theorem.

Suggested Books

Essential

1. S. Ponnusamy,*Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, 2005.
2. Theodore W. Gamelin,*Complex Analysis*, Springer-Verlag, 2001.

Further Reading

1. L.V. Ahlfors ,*Complex Analysis*, Mc Graw-Hill International Editions 1979.
2. J.B. Conway, *Functions of One Complex Variable*, Narosa Publishing House, 1997.
3. M.O. Gonzalez, *Complex Analysis- Selected Topics*, Marcel Dekker Inc. New York, 1992
4. R.E. Gonzalez, *Function Theory of One Complex Variable, 3rd Edition*, Graduate Studies and S.G Krantz in Mathematics, Vol. 40, American Math. Soc., 2006.

5. S. Lang, *Complex Analysis,3rd Edition*, Springer- Verlag, New York, 1993.
6. Bruce P. Palka, *An Introduction to Complex Function Theory*, UTM, Springer- Verlag, New York, 1993.

SEMESTER-II

Paper-Core 4: Topology II

M.Marks: 100 **60Hrs.(4 Hrs./week)**

OBJECTIVE OF THE COURSE

The objective of the course is to understand the concepts of connectedness, compactness and countabilities.

Unit-I Connectedness. **(15 Hrs.)**

The definition of the Connected spaces and its important characterization, Components, Products of Connected spaces, Local Connectedness, Path Connectedness, Local Path-Connectedness and relationships amongst various Connectedness ,Path Component , Problems and Exercises based on topics of the unit.

Unit-II Convergence and Compactness. **(15 Hrs.)**

Nets , Subnets, Cluster Point of the net, Convergence of the net, Net and Continuous maps ,Nets in Product spaces , Filters and their Convergence Filter-base, Filter in Product spaces, Ultrafilters. Relationships between Nets and Filters. Definition of compact spaces and its important equivalent statements, T_2-space , Tychonof f Theorem, Compactness and Continuous maps Lebsegue Covering Lemma for Compact Metric spaces, one point and Stone-Cech Compactification. Problems and Exercises based on the topics of the unit.

Unit-III Separation Axioms and Countability. **(15 Hrs.)**

Hausdorff, Regular, completely regular and normal spaces with reference to T_1, T_2, $T_3, T_{3\frac{1}{2}}$ and axioms, Relationships among these spaces, their properties with respect to subspaces, Product spaces and quotient spaces, characterization of the complete regular spaces as subspaces of cube. Examples and exercises based on these concepts.

UNIT-IV **(15 Hrs.)**

Uryshon's Lemma, Tietze's extension theorem , Shrinkable covering theorem for normality, First countable, second countable, Separable and Lindelof spaces, relationships among these spaces and their properties with respect to subspaces, Product spaces and quotient spaces . Examples and exercises based on these concepts.

Suggested Books

Essential

1. S. Willard : General topology (1970), Addison Wesley.

Further Reading

1. S.W.Davis, *Topology*, Tata McGraw Hills.
2. K.D. Joshi, Introduction to General Topology, New Age International, Publisher.
3. J. Munkres, Topology, 2nd Edition, Pearson New International Edition.

SEMESTER - II

Paper-Multidisciplinary: Theory of Matrices

M.Marks:50 **30Hrs.**

OBJECTIVE OFTHECOURSE

To inculcate the students to understand and apply the techniques of matrices like linear transformations from a vector space to itself such as reflection, rotation and sharing to solve multivariate problems arising in different disciplines of science and technology.

UNIT-I. **(15 Hrs.)**

Eigen values and eigenvectors of a matrix and their determination, similarity of matrices, two similar matrices have the same eigen values, algebraic and geometric multiplicity, necessary and sufficient condition for a square matrix of order n to be similar to a diagonal matrix, orthogonal reduction of real matrices, Orthogonality of the eigenvectors of a Hermitian matrix

UNIT-II **(15 Hrs.)**

If A is a real symmetric matrix then there exists an orthogonal matrix P such that $P^{-1}AP=P'AP$ is a diagonal matrix whose diagonal elements are the eigenvalues of A, semi–diagonal or triangular form, Schur's theorem, normal matrices, necessary and sufficient condition for a square matrix to be unitarily similar to a diagonal matrix.

Quadratic forms: theKroneckers and Lagranges reduction, reduction by orthogonal transformation of real quadratic forms, necessary and sufficient condition for a quadratic form to be positive definite, rank, index and signature of a quadratic form.

Suggested Books

Essential

1 Shanti Narayan, A Text Book of Matrices, S.Chand and Company Ltd.
2 Rajendra Bhatia, Matrix Analysis, Springer.

Further Reading

1 Richard Bellman, Introduction to Matrix Analysis, McGraw Hill Book Company.

2 Franz E.Hohn, Elementary Matrix Algebra, American Publishing company Pvt.Ltd.

SEMESTER - II

Paper- Minor Project: Hands on MATLAB

M. Marks: 50

OBJECTIVE OF THE COURSE

To develop the skill of writing mathematical topics and presentations of proofs of fundamental results pertaining to the subject.

Topics:
i. Algebra-II
ii. Real Analysis-II
iii. Complex Analysis-II
iv. Partial Differential Equations
v. Theory of Matrices
vi. Operator Theory

The student will be put under the guidance of faculty member of the respective areas. At the end of the semester the student will have to submit the minor project to their guide. The minor project will carry 50 marks.

SEMESTER - III

Paper- Core 1: Functional Analysis

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

To extend the concepts of real and complex domain to abstract spaces in order to gain insight in the real world phenomenon. The course aims at familiarizing the students with the geometry of metric spaces, Banach Spaces and Hilbert spaces. Some fundamental theorems in functional analysis like Banach contraction principle and Hahn Banach theorems.

Unit-I Metric Spaces, Contraction Principle and Arzela Ascoli Theorem (15 Hrs.)

Definition of metric spaces, convergence complete metric spaces, Banach contraction principle and its applications to differential and integral equations ,completion theorem, category theorem and its applications, compactness , Arzela-Ascoli's Theorem, Problems and examples based on these concepts.

Unit-II Banach Spaces, Bounded linear operators, Dual Spaces. (15 Hrs.)

Normed linear spaces and Banach spaces, examples, finite dimensional normed linear spaces, equivalent norms quotient spaces, F. Riesz's lemma , Bounded linear operators, examples, dual spaces, computation of duals of IR, l^p ,$1 \leq p < \infty$ and C_∞.

Unit-III Fundamental Theorem for normed linear Spaces and Banach Spaces. (15 Hrs.)

Hahn-Banach Theorem in real, Complex and linear spaces and applications, reflexive spaces, uniform boundedness principle, open mapping theorem, Bounded inverse – theorem, closed graph theorem.

Unit-IV Hilbert Spaces (15 Hrs.)

Inner product spaces, the Cauchy-Schwartz inequality, the Phythagorean Theorem, Hilbert spaces, examples of Hilbert spaces. Orthognal complement and direct sum, minimizing vector theorem, projection theorem, orthonormal sets, Bessel's inequality orthonormal basis, the existence of orthonormal basis Riez representation theorem, the dimension of Hilbert spaces. Adjoint of a linear operator, self adjoint , normal and unitary operators.

Suggested Books

Essential

1. C. Goffman & G. Padrick, First course in Functional Hall Analysis, Prentice. 1955.(for unit -I)
2. E. Kreyszig, Introductory Functional Analysis with Application John Wiley & Sons 1978. (For unit- II, III & IV)

Further Reading

1. R. G. Douglas ,Banach Algebra Techniques in operator Theory, Springer-Verlag, New York 1998.
2. J. B. Conway, A course in Functional Analysis, Springer Verlag , 1973.
3. B. V. Limaye, Functional Analysis, Wiley Eastern Ltd. 1981

SEMESTER - III

Paper- Core 2: Theory of Numbers

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

This is a foundation course in number theory. A course in modern algebra (like Groups, Rings and Fields) is pre- requisite for this course.

UNIT-I (15 Hrs.)

Divisibility: the division algorithms and its uniqueness, greatest common divisor, prime number, Euclid,s first theorem, Fundamental Theorem of Arithmetic, standard form of an integer, divisior of n. Linear Diophantine Equation ax+by=c, necessary and sufficient condition for solvability of linear

Diophantine equation, Radix representation, Euclid's second theorem, Infinitude of primes of the form 4n+3 and of the form 6n+5.

UNIT-II **(15 Hrs.)**

Congruences and their properties, Complete residue system, reduced residue system. Multiplicative function, Euler Phi function, Euler Phi function is a Multiplicative function, Fermat's little theorem, Euler theorem. Generalization of Fermat's Theorem, Polynomial congruences, degree of polynomial congruence. Linear Congruence , solution of linear congruence. Chinese Remainder theorem, Wilson's theorem and its application to the solution of $x \equiv -1 \pmod{p}$. Examples and exercises based on these concepts.

UNIT-III **(15 Hrs.)**

Integers belonging to a given exponent mod m, Primitive roots, power residues, congruence of degree two, power modulus. Quadratic residue and quadratic non residue. Quadratic residue of m cannot be a primitive root of m. Quadratic residues of a odd prime are congruent to even powers of a primitive root of p and conversely, quadratic non residue of an odd prime are congruent to odd powers of a primitive root of p and conversely, Euler criterion, Legendre symbols and their properties, lemma of Gauss. Quadratic Reciprocity law, Jacobi symbols. Examples and exercises based on these concepts.

UNIT-IV **(15 Hrs.)**

Greatest integer function, Number theoretic functions or Arithmetic functions, simple properties of $\phi(n), \tau(n), \sigma(n)$. Perfect number, divisors of n. Mobius function, F. Merten's lemma, Mobius Inversion formulae. Theorem of Gauss.

Suggested Books

Essential

1. David M. Burton, Elementary Number Theory 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Ivan Niven, Hilber S. Zuckerman, An introduction to the theory of numbers, fifth edition. John Wil Hugh I. Montgoineryey and Sons . Inc New York, 2001

Further Reading

1. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with Maple, CRC Press, Boca Raton, 2000.
2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.
3. M. G. Nadkarni , Number Theory. Tata Mac. Graw Hill (1988)
4. W.I. Leveque : Topics in Number Theory, Vol. 1 and Vol. 2
5. Hollas J.M., Symmetry in Molecules, Pubs: Chapman and Hall (1972).

SEMESTER - III

Paper-Core 3: Fluid Mechanics

M.Marks:100 **60Hrs.(4 Hrs./week)**

OBJECTIVE OFTHECOURSE

To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.

UNIT-I. **(15 Hrs.)**

Type of fluids, Lagrangian and Eulerian method of describing fluid motion Motion of the fluid element: Translation, rotation and deformation Stream lines path lines and streak lines, Material derivative, Acceleration Components of fluid particle in Cartesian, Cylindrical and Spherical polar coordinates (without proof). Vorticity vector, Vortex Lines, rotational and irrotational motion. Velocity, Potential boundary surface, Boundary condition**.**

UNIT-II. **(15 Hrs.)**

Irrational Motion in two-dimensional, Stream function, Physical significance of stream function, Complex velocity potential, Sources, sinks, doublets, and their images in two dimensional. Continuum hypothesis, Newton's law of viscosity, Some Cartesian tensor notations. General analysis of fluid motion, Thermal conductivity, Generalized law of heat conduction. Fundamental equations of motion of viscous fluid.

UNIT-III. **(15 Hrs.)**

Equation of State, Equation of continuity, Navier-Stokes (N-S) equations of motion. Equation of energy, Vorticity and circulation (Kelvin's circulation theorem). Dynamical similarity (Reynolds law), Inspection analysis, Dimensional analysis, Buckingham π theorem and its application, π product and coefficients, non-dimensional parameter and their physical importance.

UNIT-IV. **(15 Hrs.)**

Exact solution of the N-S Equations, Steady motion between the parallel plates (a) velocity distribution, (b) Temperature distribution, Plane couette flow, Plane Poiseuille flow, Generalized plane Couette flow.Flow in a circular pipe (Hagen-Poiseuille flow), (a) Velocity distribution, (b) temperature distribution**.**

Suggested Books

Essential

1. J.L. Bansal, Viscous fluid dynamics, Oxford and IBH Publishing Company Pvt. Ltd., (1977).

2. F. Chorlton, Text book of fluid dynamics, CBS Publishers and distribution (2000).

Further Reading

1.G.K. Batchelor, An introduction to fluid dynamics, Cambridge University press, (1970).
2.C.S. Yih, Fluid Mechanics, McGraw-Hill Book Company.
3.S.W. Yuan, Foundation of Fluid Mechanics, PHI Pvt Ltd. New Delhi (1969).

SEMESTER - III

Paper- Core 4: Partial Differential Equations

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

To familiarize the students with the fundamental and some advance concepts of PDE's and to understand some basic approach to mathematical oriented PDEs

Unit–I **(15 Hrs.)**

Introduction to partial differential equations in $\mathbb{R}^n$: Examples of Single partial differential equations, System of partial differential equations, Strategies for studying PDE, First order PDE in two independent variables, classification into Semilinear, Quasilinear, Nonlinear PDE and its solution; Characteristics equations and characteristics curves, Monge strip and Charpit equations. Transport equation (in $\mathbb{R}^n$): Initial value problem, Nonhomogeneous problem;

Unit–II **(15 Hrs.)**

Second order PDE: Classification of linear PDE into Elliptic, Hyperbolic and Parabolic equations, reduction to canonical forms. Laplace equation (in $\mathbb{R}^n$): Fundamental solution, Mean value formulas, Properties of Harmonic functions: Strong maximum principle, Regularity, Local estimates on derivatives, Liouville's theorem, Analyticity, Harnack's Inequality, Green's function.

Unit – III **(15 Hrs.)**

Solution of Poisson's equation using Laplace equation. Heat Equation (in $\mathbb{R}^n$): Derivation of Fundamental solution, Solution of homogeneous initial value problem, Solution of nonhomogeneous problem, Duhamel's principle, Mean-value formula, Properties of solutions: strong maximum principle.

Unit – IV **(15 Hrs.)**

Wave equation (in $\mathbb{R}^n$): d'Alembert formula, Reflection method, Spherical means, Euler-Poisson- Darboux equation, Kirchhoff's solution, Poisson's formula, Solution for odd n, Solution for even n, nonhomgeneous problem, Energy methods: Uniqueness and domain of dependence.

Suggested Books

Essential

1. L. C. Ivans: Partial Differential equations, Graduate studies in Mathematics, Volume 19, American Mathematical Society, 2002.

Further Reading

1. P. Prasad and R. Ravindran, Partial Differential equations, New Age International Publishers, 2015.
2. K. Sankara Rao, Introduction to Partial Differential Equations, PHI Learning Private Limited, 2013.
3. F. John, Partial Differential Equations, Fourth Edition, Springer-Verlag New York, 2009.
4. T. Amaranath, An introduction course in Partial Differential Equations, Narosa Publishing House, 2003
5. A. Tveito and R. Winter, Introduction to Partial Differential Equations, A computational Approach, Springer-Verlag Berlin Heidelberg, 2009.

6. A.K. Nandakumaran and P.S. Datti, Partial Differential Equatons: Classical Theory with Modern Touch, Cambridge University Press, 2020 (in Press).

SEMESTER - III

Paper- Minor Project: Literature review

M. Marks: 50

OBJECTIVE OF THE COURSE

To prepare students for the main dissertation/project .

The student will be put under the guidance of faculty member of the respective areas. At the end of the semester the student will have to submit the minor project to their guide. The minor project will carry 50 marks.

SEMESTER - III

Paper-Multidisciplinary: Mathematical Statistics

M.Marks: 50 **30Hrs.**

OBJECTIVE OFTHECOURSE

To enhance basic skills in the area of data collection and know the testing tools and method.

Unit-I. Central Tendency and Variation **(15 Hrs.)**

Measure of Central Tendency, Measure of dispersion, Correlation and Regression introduction - Types of correlation graphical representation of Correlation - Karl Pearson‟s coefficient of correlation – Rank correlation- Coefficient of rank correlation.

Regression: Significance of regression-difference between correlation and regression-RegressionLines - Regression equations.

Unit-IITheoretical distributions **(15Hrs.)**

Theoretical distributions introduction - Binomial distribution –properties of binomial distribution-simple problems in binomial distribution - Poisson distribution- simple problems in Poisson distribution -Normal distributions – properties of Normal distributions - practical problems in Normal distributions.

Suggested Books

Essential

1. R.S.N. Pillai and V.Bagavathi,, "Statistics", Sultan Chand, New Delhi, 2008.

Further Reading

1. Gupta S.P, "Statistical Methods", Sultan Chand, New Delhi, 33rd Edition, 2005
2. S.C.Gupta and V.K.Kapoor, "Fundamentals of Mathematical Statisitics", Sultan Chand and Sons, New Delhi -2, 2011

SEMESTER - III

Paper-Multidisciplinary: Mathematical Aptitude

M.Marks:50 **30Hrs.**

OBJECTIVE OF THE COURSE

To inculcate among student the skill in solving real life problems by using quantitative techniques.

Unit-I **(15 Hrs.)**

Numbers, HCF,LCM, Square Roots, Cube Roots and problems based on this topics. Decimal Fractions, Simplification, Distance and Time, Surds and Indices and problems based on this topics.

Unit-II **(15 Hrs.)**

Percentage, Profit and Loss, Simple Interest , Ration and Proportion and problems based on this topics.

Suggested Books:

Essential

1. Dr. R. S. Aggarwal, "Quantitative Aptitude for Competitive Examinations" , S.Chand & Company Ltd., Ram Nagar, New Delhi -2007.

Further Reading

1. Dr. A. B. Rao, Numerical Ability & Mathematical Aptitude, Jaico Publishing House.

SEMESTER - IV

Paper- Core 1: Classical Mechanics

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

The objective of this paper is to introduce the concept of variation of a functional and variational techniques. The Calculus of variation helps a lot to understand the Lagrangian and Hamiltonian equations for dynamical systems. Variational principles and their applications are introduced at large.

UNIT-I Calculus of variations **(15 Hrs.)**

Functional and their properties, Motivating problems of Calculus of variations, Shortest distance, minimum surface of revolution, Brachistochrone problem, Isoperimetric problems, Geodesics, 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, Variational problems with moving boundaries, Variation under constraints, Variational methods of Rayleigh-Ritz and Galerkin.

UNIT-II Lagrangian Mechanics **(15 Hrs.)**

Generalized coordinates, Constraints, Holonomic and non-holonomic systems, Scleronomic and Rheonomic systems, Generalized velocity, Generalized potential, Generalized force, D'Alembert's principle, Lagrange's equation, Velocity dependent Potentials and Dissipation function, Expression of Kinetic energy using generalized velocity, Non-uniqueness in the choice of Lagrangian.

UNIT-III **(15 Hrs.).**

Lagrangian Mechanics: Hamilton's principle, Principle of Least action, Derivation of Lagrange's equations from Hamilton's principle, Cyclic co-ordinates, Conjugate momentum, Conservation theorems.

Hamiltonian Mechanics: Legendre's transformation, Hamilton's equations, Routhian, Poisson Bracket, Jacobi identity for Poisson bracket, Poission theorem**.**

UNIT-IV **(15 Hrs.)**

Hamilton's equation in Poission bracket, Canonical Transformation. Hamilton-Jacobi equations, Method of Separation of variables, Action – Angle variables, Lagrange Bracket. Invariance of Lagrange Bracket under Canonical Transformations.

Suggested Books

Essential

1. H. Goldstein, C. Poole and J. Safko: Classical Mechanics, 3rd Edition, Addition Wesley (2002)
2. L. Elsgolts, Differential equations and the calculus of variations, Mir Publication

Further Reading

1. John L. Synge and Byron A. Griffith, Principle of Mechanics, McGraw Hill, International Edition.
2. K. Sankara Rao , Classical Mechanics, Prentice-Hall of India, 2005.
3. F. Chorlton, Text book of Dynamics, CBS Publishers, 2nd Edition, Reprint 2002.
4. F. Grantmacher, Lecture in analytical Mechanics, Mir Publication,1975.

SEMESTER - IV

Paper- Core 2: Operations Research

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

To equip the student with methods and trends for taking management decisions and networking.

Unit –I **(15 Hrs.)**

Definition of operation research, main phases of OR study, linear programming problems (LPP), applications to industrial problems –optimal product links and activity levels, convex sets and convex functions, simplex method and extreme point theorems, Big M and Two phase methods of solving LPP.

Unit–II **(15 Hrs.)**

Revised simplex method, assignment problem, Hungarian method, transportation problem, and mathematical formulation of transportation problem, methods of solving (North-West Corner rule, Vogel's method and U.V. method), concept and applications of duality, formulation of dual problem, duality theorems (weak duality and strong duality theorems), dual simplex method, primal- dual relations, complementary slackness theorems and conditions.

Unit -III **(15 Hrs.)**

Sensitivity Analysis: changes in the coefficients of the objective function and right hand side constants of constraints, adding a new constraint and a new variable.

Unit–IV **(15 Hrs.)**

Game theory: Two person zero sum games, games with pure strategies, games with mixed strategies, Min. Max. principle, dominance rule, finding solution of 2 x 2, 2 x m, 2 x m games, equivalence between game theory and linear programming problem(LPP), simplex method for game problem.

Suggested Books

Essential

1.Kanti Swarup, P.K Gupta and Man.Singh, Operation Research; SultanChand & Sons.
2.J.K.Sharma: Operations Research,Theory and applications.

Further Reading

1.C.W.Curchman, R.L. Ackoff and E.L.Arnoff, (1957) Introduction to OperationResearch.
2. F. S Hiller and G.J. Lieberman, Introduction to Operations Research (SixthEdition), McGraw Hill International, Industries Series, 1995.
3. G. Hadley, Linear programming problem, Narosa publishing House, 1995.
4. S.I.Gauss , Linear Programming, Wiley Eastern.

SEMESTER - IV

Paper- Core 3: Numerical Methods

M. Marks: 100 **60 Hrs. (4 Hrs./week)**

OBJECTIVE OF THE COURSE

To provide the student with different techniques in order to find approximate numerical solutions to the problems where exact solutions are not available.

Unit-I **(15 Hrs.)**

Introduction to numerical methods, Bisection method, Method of False position, Secant method, Method of functional iterations, Newton-Raphson method, Ramanujan's method for smallest root, Convergence of iteration methods, Solution of system of linear algebraic equations: Direct and iterative methods, Matrix inverse method, Gaussian elimination method, Gauss Jacobi, Gauss Seidel, Eigen value problem.

Unit-II **(15 Hrs.)**

Finite difference operators: Backward, Forward and Central difference operators, Shift operator, Relation between operators, Interpolations with equal and unequal intervals, Newton's forward interpolation formula, Lagrange's and Hermite interpolation formula.

Unit-III **(15 Hrs.)**

Numerical differentiation, Formulae for derivatives, Derivative using Newton's forward interpolation formula, Difference interpolating formula, Numerical integration, Trapezoidal rule, Simpson's $1/3$ rule, Simpson's $3/8$ rule, Errors in numerical integration formula.

Unit-IV **(15 Hrs.)**

Numerical solution for the initial value problems for ODE'S, Taylor's series method, Euler's

method, Runge-Kutta Method, Boundary value problems in ODE's, Finite difference methods for solution, Finite difference approximations for partial derivatives, Solution of one-dimensional Laplace, Heat and wave equations.

Suggested Books

Essential

1. S.S.Sastry, Introductory methods of numerical analysis, PHI Learning.

Further Reading

1. M.K.Jain, S.R.K.Iyengar, R.K.Jain, Numerical methods for scientific and engineering computation, New Age International Publishers.

2. B.S.Grewal, Numerical methods in engineering & science, KHANN PUBLISHERS.

SEMESTER - IV

Paper- Core 4: Project

M. Marks: 200

OBJECTIVE OF THE COURSE

To develop the skill of writing mathematical topics and presentations of proofs of fundamental results pertaining to the subject.

The projects\dissertation work has been given so that students gets a hands on exposure in Mathematics. Each of the fourth semester student will be given a mentor(faculty) member under whose guidance he/she will complete a project work. In the project\dissertation he will work on problem based on the application of knowledge in solving/analysing/exploring a real life situation or a difficult problem or open problems in mathematics. He can also work on the recent development in the field of Mathematics. At the end of the semester the students will have to submit a project report in the form of the dissertation.

The student opting for project will have to work on the research problem in anyone areas of pure and applied mathematics.