University of Mysore

SL.NO	Programme Name
1	MSc in Mathematics
2	PhD in Mathematics

Implementation / Revision History (2014-19)

Program Name: MSc in Mathematics

Sl. No.	Scheme	Revised /Implemented/ Adopted	W.E.F the year
1	CBCS	Implemented	2014
2	CBCS	Revised and implemented	2016
3	FCBCS	Adopted	2018

- No. of HC revised: NIL (0%)
- No. of SC revised: 1- Graph Theory (30%)
- No. of OE revised: NIL (0%)

Program Name: PhD in Mathematics

Sl.No	Scheme	Revised /Implemented/ Adopted	W.E.F the year
1	CBCS	Implemented	2014
2	CBCS	Revised and implemented	2016

Course: Research Methodology is revised (70%)

Program Outcomes (MSc & PhD in Mathematics):

The Program Outcomes of PG in Mathematics are:

At the end of the programme, the students will be able to:

1. Apply knowledge of Mathematics, in all the fields of learning including higher research and its extensions.

2. Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.

3. Explain the knowledge of contemporary issues in the field of Mathematics and applied sciences.

4. Adjust themselves completely to the demands of the growing field of Mathematics by life-long learning.

5. Effectively develop good writing and presenting skills for perusing research in Mathematics.

6. Crack lectureship and fellowship exams approved by UGC like CSIR – NET and SET.

7. Prepare with good motivation for research studies in Mathematics and related fields.

8. Develop required communication and computing skills to peruse a career in teaching field or software industry.

Syllabi for M. Sc. in Mathematics:

FIRST SEMESTER:

MATH HC 01	Algebra I

Course Outcome(s):
At the end of the course, the studentswill be able to:

- Apply the knowledge of Algebra to attain a good mathematical maturity and enables to buildMathematical thinking and skill.
- Utilize the class equation and Sylow theorems to solve different related problems.
- Identify and analyze different types of algebraic structures such as Solvable groups,
- Simple groups, Alternate groups to understand and use the fundamental results in Algebra.
- Design, analyze and implement the concepts of homomorphism and isomorphism between groups for solving different types of problems, for example, Isomorphism theorems, quotient groups, conjugacy etc.
- Create, select and apply appropriate algebraic structures such as finitely generated abelian groups, Ideals, Fields to explore the existing results.
- Identify the challenging problems in modern mathematics and find their appropriate solutions.

Unit I

Number theory - Congruences, residue classes, theorems of Fermat, Euler and Wilson, linear congruences, elementary arithmetical functions, primitive roots, quadratic residues and the law of quadratic reciprocity.

Unit II

Groups - Lagrange’s Theorem, homomorphism and isomorphism, normal subgroups and factor groups.

Unit III

The fundamental theorem of homomorphism, two laws of isomorphism.

Unit IV

Permutation groups and Cayley’s theorem, Sylow's theorems.

Books for Reference:

1. D. M. Burton – Elementary Number Theory, Tata McGraw-Hill, New Delhi, 6thEd.,

2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theoryof Numbers, New York, John Wiley and Sons, Inc., 2004, 5thEd.,

3. G. A. Jones and J. M. Jones – Elementary Number Theory, Springer,1998.

4. Thomas W. Hungerford – Algebra, Springer International Edition, NewYork.

5. Michael Artin – Algebra, Prentice-Hall of India, NewDelhi.

6. J. A. Gallian – Contemporary Abstract Algebra, Narosa Publishing House, 4thEd.,

7. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons,1999.

8. I. N. Herstein – Topics in Algebra, Vikas Publishing House, NewDelhi.

9. J. B. Fraleigh – A First course in Abstract Algebra,Addison-Wesley,

10. N. S. Gopalakrishnan – University Algebra, New Age International, 2ndE

MATH HC 02	Real Analysis I

Course Outcome(s):
At the end of the course, the studentswill be able to:

- Describe the real line as a complete, ordered field.
- Identify challenging problems in real variable theory and find their appropriate solutions.
- Deal with axiomatic structure of metric spaces and generalize the concepts of sequences and series, and continuous functions in metric spaces.
- Use theory of Multiplications of series and infinite productsin solving problems arising in different fields of science and engineering.
- Extend their knowledge of real variable theoryfor further exploration of the subject for going into research.

Unit I

The extended real number system, the n-dimensional Euclidean space, the binomial inequality, the inequality of the arithmetic and geometric means, the inequality of the power means, Cauchy's, Holder's inequality and Minkowski's inequality.

Unit II

Numerical sequences, convergent sequences, Cauchy sequences, upper and lower limits.

Unit III

Series of real numbers series of non-negative terms, the number `e', tests of convergence.

Unit IV

Multiplications of series, re-arrangements. Double series, infinite products.

Books for Reference:

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw Hill, 3rdEd.

2. T. M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, New Delhi, 2ndEd.

3. R. R. Goldberg – Methods of real Analysis, Oxford and IBH, NewDelhi.

4. Torence Tao – Analysis I, Hindustan Book Agency, India,2006.

5. Torence Tao – Analysis II, Hindustan Book Agency, India, 2006.

6. Kenneth A. Ross – Elementary Analysis: The Theory of Calculus, Springer International Edition,2004.

MATH HC 03	Real Analysis II

Course Outcome(s):
At the end of the course, the studentswill be able to:

- Apply the knowledge of concepts of functions of real variables in order to study theoretical development of different mathematical concepts and their applications.
- Understand the nature of abstract mathematics and explore the concepts in further details.
- Determinethe continuity, differentiabilityand integrability of functions defined on subsets of the real line.
- Utilize the concepts of derivative, MVTS for real -valued functions applied to different fieldsof science and engineering.
- Use theory of Riemann – Stieltjesintegral in solving definite integrals arising in different fields of science and engineering.

Unit I

Finite, countable and uncountable sets, the topology of the real line.

Unit II

Continuity, uniform continuity, properties of continuous functions, discontinuities, monotonic functions.

Unit III

Differentiability, mean value theorems, L' Hospital rule, Taylor's theorem, maxima and minima, Functions of bounded variation.

Unit IV

The Riemann-Stieltje's integral, criterion for integrability. Properties of the integral, classes of integrable functions. The integral as the limit of a sum. First and second mean value theorems. Integration anddifferentiation.

Books for Reference:

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw-Hill, 3rdEd..

2. Torence Tao – Analysis I, Hindustan Book Agency, India,2006.

3. Torence Tao – Analysis II, Hindustan Book Agency, India, 2006.

4. T. M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, 2ndEd.,

5. R. R. Goldberg – Methods of real Analysis, Oxford and IBH Publishing Company, NewDelhi.

6. Kenneth A. Ross – Elementary Analysis: The Theory of Calculus, Springer International Edition,2004.

MATH HC 04	Complex Analysis I

Course Outcome(s):
At the end of the course, the studentswill be able to:

- Understand how complex numbers provide a satisfying extension of the real numbers.
- Solve real integrals by doing complex integration.
- Work on Taylor series of a complex variable illuminating therelationship between real function.
- Learn techniques of complex analysis that make practical problems easy (e.g. graphical rotation and scalingas an example of complex multiplication).
- Continue to develop proof techniques.

Unit I

Algebra of complex numbers, geometric representation of complex numbers. Riemann sphere and Stereographic projection, Lines, Circles. Limits and Continuity.

Unit II

Analytic functions, Cauchy-Riemann equations, Harmonic functions, Polynomials and Rational functions. Elementary theory of power series - sequences, series, uniform convergence of power series, Abel's limit theorem, The elementary functions.

Unit III

Topology of the complex plane. Linear fractional transformations, Cross-ratio, Symmetry, Elementary conformal mappings. Complex integration – Line integrals, Rectifiable arcs.

Unit IV

Cauchy's theorem for a rectangle. Cauchy's theorem in a Circular disk, Cauchy's integral formula. Local properties of analytic functions.

Books for Reference:

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

2. J. B. Conway – Functions of one complex variable, Narosa, NewDelhi.

3. R. P. Boas – Invitation to Complex Analysis, The Random House,1987

4. B. C. Palka – An Introduction to Complex Function Theory, Springer,1991.

5. S. Ponnusamy – Foundations of Complex Analysis, Narosa,1995.

MATH SC 01	Linear Algebra

Course Outcome(s):
After completing this course, the student will be able to:

- Understand the concepts of Liner independence, bases and Dual spaces.
- Discuss Algebra of Linear Transformations and Characteristics roots.
- Study canonical forms and Nilpotent transformations.
- Analyze rational canonical forms and Determinants.
- Understand the Hermitian, Unitary and Normal Transformations.

Unit I

Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets;

Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation, Composition of Linear Transformations and Matrix Multiplication, Invertibility and Isomorphisms, The Change of Coordinate Matrix, The Dual Space;

Elementary Matrix Operations and Elementary Matrices, The Rank of a Matrix and Matrix Inverses, Systems of Linear Equations.

Unit II

Properties of Determinants, Cofactor Expansions, Elementary Operations and Cramer's Rule;
Eigenvalues and Eigenvectors, Diagonalizability, Invariant Subspaces and the Cayley-HamiltonTheorem;
Inner Products and Norms, The Gram-Schmidt Orthogonalization Process and OrthogonalComplements.

Unit III

The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem;Bilinear and Quadratic Forms;

Unit IV

The Diagonal form, The Triangular form; The Jordan Canonical Form; The Minimal Polynomial;
The Rational Canonical Form.

Books for Reference:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI,2009.

2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint ofElsevier.

3. I. N. Herstein – Topics in Algebra, Vikas Publishing House, NewDelhi.

4. Hoffman and Kunze – Linear Algebra, Prentice-Hall of India, 1978, 2ndEd.,

5. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand,1958.

6. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India,2000.

MATH SC 02	Combinatorics and Graph Theory

Course Outcome(s):
After completing this course, the student will be able to:

- Learn Basic concepts of Lattice theory and Boolean algebra and apply it to switching circuits.
- Develop the skill to apply permutations and combinations in practical problems.
- Understand the definitions namely, cut vertex, bridge, block and block graph.
- Study the properties of trees and connectivity.

Unit I

Partially ordered sets, Lattices, Complete lattices, Distributive lattices, Complements, Boolean Algebra, Boolean expressions, Application to switching circuits.

Unit II

Permutations and Combinations, Pigeon-hole principle, Principle of inclusion and exclusion.

Unit III

Graphs, Vertices of graphs, Walks and connectedness, Degrees, Operations on graphs, Blocks - Cutpoints, bridges Block graphs and Cutpoint graphs.

Unit IV

Trees - Elementary properties of trees, Center, Connectivity, Connectivity and line connectivity, Menger's theorem, Partitions, Coverings, Coverings and independence number.

Books for Reference:

1. C. L. Liu – Elements of Discrete Mathematics, McGraw-Hill,1986.

2. Kenneth H. Rosen – Discrete Mathematics and its Applications, McGraw-Hill, 2002.

3. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.

4. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India,1987.

5. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi,1994.

6. G. Chartand and L. Lesniak – Graphs and Diagraphs, wadsworth and Brooks, 2^{nd}Ed.,

7. Clark and D. A. Holton – A First Look at Graph Theory, Alliedpublishers.

8. D. B. West – Introduction to Graph Theory, Pearson Education Inc.,2001, 2ndEd.,

9. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier,1976.

SECOND SEMESTER

MATH HC 05	Algebra II

Course Outcome(s):
After completing this course, the student will be able to:

- Learn the fundamental theorems of algebraic structures.
- Explore the concepts of Polynomial rings, UFD, ED, PID, Field extensions, Einstein's irreducibility criterion, Galois extensions etc.
- Learn how to apply the concepts in real-life situations.
- Apply the knowledge of Algebra to attain a good mathematical maturity and enables to build mathematical thinking and reasoning.
- 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.
- 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.
- Identify the challenging problems in advanced Algebra to pursue further research.

Unit I

Rings, Integral domains and Fields, Homomorphisms, Ideals and Quotient Rings, Prime and Maximal ideals.

Unit II

Euclidean and principal ideal rings, Polynomials, Zeros of a polynomial, Factorization, Irreducibility criterion.

Unit III

Adjunction of roots, algebraic and transcendental extensions, Finite fields.

Unit IV

Separable and inseparable extensions, Perfect and imperfect fields. Theorem on the primitive element.

Books for Reference:

1. Thomas W. Hungerford – Algebra, Springer International Edition, NewYork.

2. Michael Artin – Algebra, Prentice-Hall of India, NewDelhi.

3. Joseph A. Gallian – Contemporary Abstract Algebra, Narosa, 4thEd.,

4. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons,1999, 2ndEd.,

5. I. N. Herstein – Topics in Algebra, Vikas Publishing House, NewDelhi.

6. J. B. Fraleigh – A First course in Abstract Algebra,Addison-Wesley,

7. N. S. Gopalakrishnan – University Algebra, New Age International, 2nded.,

MATH HC 06	Real Analysis III

Course Outcome(s):
After completing this course, the student will be able to:

- Applythe Mean Value Theorem and the Fundamental Theorem of Calculus to problems in the context of real analysis.
- Writesolutions to problems and proofs of theorems that meet rigorous standards based on content, organization and coherence, argument and support, and style and mechanics.
- Determinethe improper Riemann integrals and prove a selection of theorems concerning improper integrals.
- Recognizethe difference between pointwise and uniform convergence of a sequence of functions.
- Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.
- Recognizethe difference between calculus of one variable and several variables.

Unit I

Sequences and series of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation.

Unit II

Power series, The exponential and logarithmic functions, The trigonometric functions. Improper integrals and their convergence.

Unit III

Functions of several variables, partial derivatives, continuity and differentiability, the chain rule, Jacobians.

Unit IV

The Implicit function theorem, Taylor's theorem, the Maxima and Minima, Lagrange's multipliers.

Books for Reference:

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw-Hill, 3rdEd.,

2. T.M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, 2ndEd.,

3. R.R. Goldberg – Methods of Real Analysis, Oxford and IBH, NewDelhi.

4. D.V. Widder – Advanced Calculus, Prentice Hall of India, New Delhi, 2ndEd.,

5. Torence Tao – Analysis I, Hindustan Book Agency, India, 2006.

6. TorenceTao – Analysis II, Hindustan Book Agency, India, 2006.

7. Kenneth A. Ross – Elementary Analysis: The Theory of Calculus, Springer International Edition,2004.

MATH HC 07	Complex Analysis II

Course Outcome(s):
After completing this course, the student will be able to:

- Apply the concept and consequences of harmonicity and of results on harmonic and entire functions including the fundamental theorem of algebra.
- Analyze sequences and series of analytic functions and types of convergence.
- Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, the Cauchy integral formula.
- Represent functions as Taylor, power and Laurent series and classify singularities and poles.
- Find residues and evaluate complex integrals using the residue theorem.

Unit I

The Calculus of Residues – The residue theorem, argument principle, Evaluation of definite integrals.

Unit II

Harmonic functions – Definition and basic properties, mean value property, Poisson's formula, Schwarz's theorem, reflection principle.

Unit III

Power series expansions – The Weierstrass theorem, The Taylor series, The Laurent series.

Unit IV

Partial fractions and factorization – Partial fractions, Mittag - Leffer's theorem, Infinite products, Canonical products, The Gamma and Beta functions, Sterling's formula.
Entire functions – Jensen's formula, Hadamard's theorem.

Books for Reference:

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

2. J. B. Conway – Functions of one complex variable, Narosa, NewDelhi.

3. R. P. Boas – Invitation to Complex Analysis, The Random House,1987.

4. B. C. Palka – An Introduction to the Complex Function Theory, Springer,1991.

5. S. Ponnusamy – Foundations of Complex Analysis, Narosa,1995.

MATH SC 03	Ordinary and Partial Differential Equations

Course Outcome(s):
After completing this course, the student will be able to:

- Solve problems in ordinary differential equations, dynamical systems, stability theory, and a number of applications to scientific and engineering problems.
- Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.
- Demonstrate their understanding of how physical phenomena are modeled by differential equations and dynamical systems.
- Implement solution methods using appropriate technology.
- Investigate the qualitative behavior of solutions of systems of differential equations and interpret in the context of an underlying model.

Unit I

Linear Second Order Equations - Initial value problem, Existence and Uniqueness by Picard’s Theorem, Wronskian, separation and comparison theorems, Poincare phase plane, variation of parameters.

Unit II

Power series solutions - Solution near ordinary and regular singular point. Convergence of the formal power series, applications to Legendre, Bessel, Hermite, Laguerre and hypergeometric differential equations with their properties.

Unit III

Partial differential equations - Cauchy problems and characteristics, Classification of Second order PDE’s, reduction to canonical forms, derivation of the equations of mathematical physics and their solutions by separation of variables.

UnitIV

Boundary value problems - Transforming Boundary value problem of PDE and ODE, Sturm - Liouvile system, eigen values and eigen functions, simple properties, expansion in eigen functions, Parseval's identity, Green’s function method.

Books for Reference:

1. E. A. Coddington and N. Levinson – Theory of Ordinary Differential equations, Tata McGraw-Hill, NewDelhi.

2. R. Courant and D. Hilbert – Methods of Mathermatical Physics, Vol. I. & II, Tata McGraw-Hill, New Delhi,1975.

3. G. F. Simmons – Differential Equations with applications and Historical Notes, Tata McGraw-Hill, NewDelhi, 1991.

4. I. N. Sneddon – Theory of Partial differential equations, McGraw-Hill, International StudentEdition.

5. S. G. Deo and V. Raghavendra – Ordinary Differential Equations and Stability Theory, Tata McGraw-Hill, NewDelhi.

MATH SC 04	Representation Theory of Finite Groups

Course Outcome(s):
After completing this course, the student will be able to:

- Utilize Classical groups to solve different related problems.
- Identify and analyze different types of algebraic structures such as G – invariant spaces and Group algebra,
- Design, analyze and implement various representation of symmetric groups for solving different types of problems.
- Identify the challenging problems in modern algebra and find their appropriate solutions.

Unit I

Classical Groups: General linear group, Orthogonal group, Symplectic group, Unitary group.

Unit II

Group representation, Conjugate representation, G-invariant spaces – irreducible representations – Schur's lemma.

Unit III

The Group Algebra – Maschke's theorem – characters. Orthogonality relations for characters – Number of irreducible representations.

Unit IV

Permutation representations – Regular representation. Representations of Symmetric groups. Representation of Finite abelian groups – Dihedral groups.

Books for Reference:

1. Alperin, J. L.; Bell R. B., "Groups and Representations", Graduate Texts in Mathematics, 162,Springer-Verlag, New York,1995.

2. Curtis C. W.; Reiner I., "Representation theory of finite groups and associative algebras", Pure andApplied Mathematics, Vol. XI Interscience Publishers, a division of John Wiley & Sons, New York-London1962.

3. Dummit D. S.; Foote R. M. "Abstract algebra", Third edition, John Wiley & Sons, Inc., Hoboken, NJ,2004.

4. Fulton; Harris, "Representation theory: A first course" Graduate Texts in Mathematics, 129, Readingsin Mathematics, Springer-Verlag, New York,1991.

5. James,Gordon;Liebeck,Martin,"Representationsandcharactersofgroups",Secondedition,Cambridge University Press, New York,2001.

6. MusiliC.S.,"Representationsoffinitegroups"TextsandReadingsinMathematics,HindustanBookAgency, Delhi, 1993.

MATH OE 01	Discrete Mathematics

Course Outcome(s):
After completing this course, the student will be able to:

- Describe and apply formal definitions.
- Conduct and explain basic formal proofs.
- Use models of computation and specification.
- Use combinatorial reasoning.
- Understand the definitions namely, cut vertex, bridge, blocks and Automorphism group of a graph.
- Study the properties of trees and connectivity.

Unit I

Mathematical Logic: Connection – Normal Forms – Theory of Inferences –Predicate Calculus.

Unit II

Set Theory: Operations on Sets – Basic Set Identities – Relations and Orderings.

Unit III

Recursion: Functions – Recursive Functions – Partial Recursive Functions.

Unit IV

Graph Theory: Basic Concepts of Graph Theory- Paths – Connectedness – Matrix Representation of Graphs – Trees – List structures and Graphs

Books for Reference:

1. C. L. Liu – Elements of Discrete Mathematics, McGraw-Hill,1986.

2. Kenneth H. Rosen – Discrete Mathematics and its Applications, McGraw-Hill, 2002.

3. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.

4. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India,1987.

5. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi,1994.

6. G. Chartand and L. Lesniak – Graphs and Diagraphs, wadsworth and Brooks, 2^{nd}Ed.,

7. Clark and D. A. Holton – A First Look at Graph Theory, Alliedpublishers.

8. D. B. West – Introduction to Graph Theory, Pearson Education Inc.,2001, 2ndEd.,

9. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier,1976

THIRD SEMESTER

MATH HC 08	Elements of Functional Analysis

Course Outcome(s):
After completing this course, the student will be able to:

- Learn to recognize the fundamental properties ofnormed spaces and of the transformations betweenthem.
- Acquaint with the statement of the Hahn-Banach theorem and its corollaries.
- Understand the notions of dot product and Hilbert space.
- Understand the statements and proofs of important theorems and be able to explain the key steps inproofs, sometimes with variation.

Unit I

Metric completion. Banach's contraction mapping theorem and applications, Baire' category theorem, Ascoli - Arzela theorem.

Unit II

Linear spaces and linear operators, Norm of a bounded operator, The Hahn – Banach extension theorem, Stone - Weirstrass theorem.

Unit III

Open mapping and Closed Graph theorems. The Banach - Steinhaus Principle of Uniform Boundedness.

Unit IV

Hilbert spaces- The orthogonal projection, Nearly orthogonal elements, Riesz's lemma, Riesz's representation theorem.

Books for Reference:

1. G. F. Simmons – Introduction to Topology and Modern Analysis, Tata McGraw-Hill, NewDelhi.

2. A. E. Taylor – Introduction to Functional Analysis, Wiley, New York,1958.

3. A. Page and A. L. Brown – Elements of FunctionalAnalysis.

4. George Bachman and Lawrence Narici – Functional Analysis, Dover Publications, Inc., Mineola, NewYork.

5. J. B. Conway – A Course in Functional Analysis, GTM, Vol. 96., Springer,1985.

MATH HC 09	Topology I (Topology[FCBCS])

Course Outcome(s):
After completing this course, the student will be able to:

- Distinguish among open and closed sets on different topological spaces.
- Know the two fundamental topologies: discrete and indiscrete topologies
- Identify precisely when a collection of subsets of a given set equipped with a topology forms a topological space
- Understand when two topological spaces are homeomorphic.
- Differentiate different concepts of distance between two sets, connectedness, denseness, compactness and separation axiom

Unit I

Set theoretic preliminaries.
Topological spaces and continuous maps - topological spaces, basis for a topology, the order topology, the product topology on X xX, the subspace topology.

Unit II

Closed sets and limit points, continuous functions, the product topology, the metric topology, the quotient topology.

Unit III

Connectedness - connected spaces, connected sets on the real line, path connectedness.

Unit IV

Compactness - compact spaces, compact sets on the line, limit point compactness, local compactness.

Books for Reference:

1. J. R. Munkres – A First Course in Topology, Prentice Hall India, 2000, 2ndEd.,

2. G. F. Simmons – Introduction to Topology and Modern Analysis, McGraw-Hill, Kogakusha,1968.

3. S. Willard – General Topology, Addison Wesley, New York,1968.

4. J. Dugundji – Topology, Allyn and Bacon, Boston,1966.

5. J. L. Kelley – General Topology, Van Nostrand and Reinhold Co., New York,1955.

MATH SC 05	Theory of Numbers

Course Outcome(s):

After completing this course, the student will be able to:

- Understand all the basic concepts of Number Theory.
- Learn different Arithmetical Functions and apply to the distribution of lattice points visible from the origin.
- Study properties of Approximation to Irrational numbers.
- Analyze the complicated structure of continued fractions and their number theoretic properties.

Unit I

Prime numbers, The Fundamental theorem of Arithmetic, The series of Reciprocals of primes, The Euclidean Algorithm.
Fermat and Mersenne numbers.
Farey series, Farey dissection of the continuum,
Irrational numbers-Irrationality of m^{th} root of N, e andπ.

Unit II

Arithmetical Functions – The Mobius function, The Euler' function and Sigma function, The Dirichlet product of Arithmetical functions, Multiplicative functions. Averages of Arithmetical functions – Euler summation formula, Some elementary asymptotic formulas, The average orders of $d(n)$, $\sigma(n)$, $\varphi(n)$, $\mu(n)$. An application to the distribution of lattice points visible from theorigin.

Unit III

Approximation Irrational numbers, Hurwitz's Theorem, Representation of a number by two or four squares, Definition g(k) and G(k), Proof of $g(4)<50$, Perfect numbers. The series of Fibonacci and Lucas.

Unit IV

Continued fractions - Finite continued fractions, Convergent of a continued fraction, Continued fractions with positive quotients. Simple continued fractions, The representation of an irreducible rational fraction by a simple continued fraction. The continued fraction algorithm and Euclid's algorithm. The difference between the fraction and its convergents, Infinite simple continued fractions, the representation of an irrational number by an infinite continued fraction, Equivalent numbers and periodic continued fractions, some special quadratic surds.

Books for Reference:

1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, Oxford University Press, 1979, 5thEd.,

2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York,John Wiley and Sons, Inc., 2004, 5thEd.,

3. Bruce C. Berndt – Ramanujan's Note Books Volume-1 to 5,Springer.

4. G. E. Andrews – Number Theory, Dover Books,1995.

5. T. M. Apostol – Introduction to Analytic Number Theory, Narosa Publishing House, NewDelhi.

MATH SC 06	Graph Theory

Course Outcome(s):

After completing this course, the student will be able to:

- Understand the definitions namely, cut vertex, bridge, block and block graph.
- Study the properties of trees and connectivity.
- Study Spanning trees and Partitions.
- Discuss and understand the importance of the concepts ofCoverings and Independence.

Unit I

Types of Graphs, Walks and connectedness, Degrees, Extremal graphs, Intersection graphs and operations on graphs

Unit II

Cutpoints, Bridges and Blocks, Block graphs and Cutpoint graphs.

Unit III

Characterization of trees, centers and centroids, Spanning trees and Partitions.

Unit IV

Connectivity and line-connectivity, Menger’s theorem, Coverings and Independence, Critical points and lines.

Books for Reference:

1. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.

2. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India,1987.

3. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi,1994.

4. G. Chartand and L. Lesniak – Graphs and Diagraphs, Qwadsworth and Brooks, 2ndEd.,

5. Clark and D. A. Holton – A First Look at Graph Theory, Alliedpublishers.

6. D. B. West – Introduction to Graph Theory, Pearson Education Inc., 2001, 2ndEd.,

7. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier,1976.

MATH SC 07	Theory of Modular Forms

Course Outcome(s):
After completing this course, the student will be able to:

- Get good exposure to highly complicated unimodular functions.
- Learn Mobius transformation and its application to Picard's theorem.
- Work on Dedekind's functional equation and its rich structure.
- Prove deep theorems on Congruences for the coefficients of the modular function j.

Unit 1. Elliptic Functions

Introduction, Doubly periodic functions, Fundamental pairs of periods, Elliptic functions, Construction of elliptic functions, The Weierstrass $\wp$function, The Laurent expansion of$\wp$near the origin, Differential equation satisfied by $\wp$, The Eisenstein series and the invariants g_2 and g_3,The numbers e_1, e_2, e_3 The discriminant Δ, Klein's modular function $J(\tau)$, Invariance of J under unimodular transformations, The Fourier expansions of $g_2(\tau)$ and $g_3(\tau)$, The Fourier expansions of $\Delta(r)$ and $J(\tau)$.

Unit 2. The Modular group and modular functions

Mobius transformations, The modular group Γ, Fundamental regions, Modular functions, Special values of J, Modular functions as rational functions of J, Mapping properties of J, Application to the inversion problem for Eisenstein series, Application to Picard's theorem.

Unit 3. The Dedekind eta function

Introduction, Siegel's proof of Theorem 3.1, Infinite product representation for $\Delta(\tau)$, The general functional equation for $\eta(\tau)$ transformation formula , Deduction of Dedekind's functional equation from Iseki's Formula, Properties of Dedekind sums, The reciprocity law for Dedekind sums, Congruence properties of Dedekind sums , The Eisenstein series $G_2(\tau)$.

Unit 4. Congruences for the coefficients of the modular function j

Introduction, The subgroup $\Gamma_0(q)$, Fundamental region of $\Gamma_0(p)$, Functions automorphic under the subgroup $\Gamma_0(p)$, Construction of functions belonging to $\Gamma_0(p)$, The behavior of f_p under the generators ofΓ, The function $\varphi(\tau) = \Delta(q\tau)/\Delta(\tau)$, The univalent function $\phi(\tau)$, Invariance of $\phi(\tau)$ under transformations of $\Gamma_0(q)$, The function j_p expressed as a polynomial in ϕ.

Books for Reference:

1. Tom M. Apostol, Modular Functions and Dirichlet Series in Number Theory, Springer - Verlag, 1976..
2. Gunning, R. C. Lectures on Modular Forms, Annals of Mathematics Studies, No. 48. Princeton Univ. Press, Princeton, New Jersey, 1962. MR 24 # A2664.

MATH SC 08	Commutative Algebra

Course Outcome(s):
After completing this course, the student will be able to:

- Comprehend the important concepts and results of Rings and Ideals.
- Prove deep theorems on different kinds of Ideals.
- Apply standard theorems on Homomorphisms to algebraic problems.
- Learn advanced concepts such as Artinian and Noetherian modules.

Unit I

Rings and ideals - Rings and ring homomorphisms, Ideals, Quotient rings, zero-divisors, nilpotent elements, units, prime ideals and maximal ideals.

Unit II

The prime spectrum of a ring, the nil radical and Jacobson radical, operation on ideals, extension and contraction.

Unit III

Modules - Modules and modules homomorphisms, submodules and quotient modules, Direct sums, Free modules Finitely generated modules, Nakayama Lemma, Simple modules, Exact sequences of modules.

Unit IV

Modules with chain conditions - Artinian and Noetherian modules, modules of finite length, Artnian rings, Noetherian rings, Hilbert basis theorem.

Books for Reference:

1. M. F. Atiyah and I. G. Macdonald – Introduction to Commutative Algebra, Addison-Wesley.

2. C. Musili – Introduction to Rings and Modules, Narosa PublishingHouse.

3. Miles Reid – Under-graduate Commutative Algebra, Cambridge University Press.

4. N. S. Gopalakrishnan, Commutative Algebra, OxonianPress.

MATH SC 09	Algebraic Number Theory

Course Outcome(s):
After completing this course, the student will be able to:

- Apply Number theory to unique factorization domain.
- Prove Ramanujan - Nagell theorem.
- Learn Dedekind domains in the context of algebraic number theory.
- Differentiate class group and class number for better understanding.

Unit I

Number theoretical applications of unique factorization - Algebraic integers.

Unit II

Quadratic fields, Certain Euclidean rings of algebraic integers, Some Diophantine equations, Ramanujan - Nagell theorem.

UnitIII

Factorization of Ideals - Dedekind domains, Fractional ideals, Invertible ideals, Prime factorization of ideals.

Unit IV

Class group and Class number, Finiteness of the Class group, Class number computations.

Books for Reference:

1. Karlheinz Spindler – Abstract Algebra with Applications, Vol. II, Rings and Fields, Marcel Dekker,Inc.

2. I. N. Stewart and David Tall – Algebraic Number Theory, Chapman andHall.

3. Jody Esmonde and M. Ram Murthy – Problems in Algebraic Number Theory, SpringerVerlag.

4. I. S. Luthar and I. B. S. Passi – Algebra Vol. II: Rings, Narosa PublishingHouse.

MATH SC 10	Galois Theory

Course Outcome(s):
After completing this course, the student will be able to:

- Show familiarity with the concepts of ring and field, and their main algebraic properties;
- Correctly use the terminology and underlying concepts of Galois theory in a problem-solving context
- Reproduce the proofs of its main theorems and apply the key ideas in similar arguments;
- Calculate Galois groups in simple cases and to apply the group-theoretic information to deduce results about fields and polynomials

Unit I

Algebraically closed fields and algebraic closures, The existence of an algebraic closure, The basic isomorphisms of algebraic field theory, Automorphisms and fixed fields, The Frobenius automorphism, The isomorphism extension theorem.

Unit II

The index of a field extension, Splitting fields, Separable extensions, Perfect fields, Normal extensions.

Unit III

Galois theory - the main theorem of Galois theory, Galois groups over finite fields, Symmetric functions, Cyclotomic extensions, Constructible numbers.

Unit IV

The impossibility of certain geometrical constructions, constructible polygons, Subnormal and normal series, the Jordan - Holder theorem, Radical extensions and solution of equation by radicals, The insolvability of thequintic.

Books for Reference:

1. J. B. Fraleigh – A First Course in Abstract Algebra, Narosa PublishingHouse.

2. Ian Steward – Galois Theory, Chapman andHall.

3. Joseph Rotman – Galois Theory, Universitext Springer,1998.

4. Michael Artin – Algebra, Prentice-Hall of India, NewDelhi.

5. Joseph A. Gallian – Contemporary Abstract Algebra, Narosa Publishing House, 4^{th}Ed.,

6. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons,1999.

7. I. N. Herstein – Topics in Algebra, Vikas Publishing House, NewDelhi.

8. N. S. Gopalakrishnan – University Algebra, New Age International, 2ndEd.,

MATH OE 02	Differential equations and its applications

Course Outcome(s):
After completing this course, the student will be able to:

- Analyze real world scenarios to recognize when ordinary differential equations (ODEs) or systems of ODEs are appropriate, formulate problems about the scenarios, creatively model these scenarios (using technology, if appropriate) in order to solve the problems using multiple approaches, judge if the results are reasonable, and then interpret and clearly communicate the results.
- Recognize ODEs and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved to help another person gain insight into the situation.
- Work with ODEs and systems of ODEs in various situations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics involving ODEs and systems of ODEs with colleagues in the field of mathematics, science or engineering.

Unit I

Recap of Elementary Functions of Calculus - Properties of limits, derivatives and integrals of elementary functions of Calculus, Polynomials, Rational functions, exponential and logarithmic functions, trigonometric and inverse trigonometric functions, hyperbolic and inverse hyperbolic functions.

Unit II

Special Functions of Mathematical Physics - Bessel functions, Legendre polynomials, Tchebyshev polynomials, Hermite polynomials and Laguerre polynomials. Power series solutions of Second Order Linear Differential Equations. Their Mathematical properties.

Unit III

Applications of First Order Ordinary Differential Equations - Simple problems of dynamics – falling bodies and other motion problems, Simple problems of Chemical reactions and mixing, Simple problems of growth and decay.

Unit IV

Applications of Second Order Ordinary Differential Equations - Undamped simple harmonic motion, damped vibrations, Forced vibrations, Problems on simple electric circuits – Laplace transforms.

Books for Reference:

1. G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw-Hill, New Delhi,1991.

2. E. D. Rainville and P. Bedient– Elementary course on Ordinary Differential Equations, Macmillan, New York,1972.

3. R. Courant and D. Hilbert, Methods of Mathematical Physics, Vol. I, Tata McGraw- Hill, New Delhi,1975.

FOURTH SEMESTER

MATH HC 10	Measure and Integration

Course Outcome(s):
After completing this course, the student will be able to:

- Define and understand basic notions in abstract integration theory, integration theory on topological spaces and the n-dimensional space.
- Describe and apply the notion of measurable functions and sets and use Lebesgue monotone and dominated convergence theorems and FatousLemma.
- Describe the construction of and apply the Lebesgue integral.
- Describe the construction of product measures and use Fubini's theorem.
- Describe the notion of absolute continuity and singularities of measures and apply Lebesgue decomposition and the Radon-Nikodym theorem.

Unit I

Lebesgue measure - outer measure, measurable sets and Lebesgue measure, a nonmeasurable set, measurable functions.

Unit II

The Lebesgue integral – the Lebesgue Integral of a bounded function over as set of finite measure, the integral of a non-negative function, the general Lebesgue integral.

Unit III

Differentiation and integration - Differentiation of monotonic functions, functions of bounded variation, differentiation of an integral, absolute continuity.

Unit IV

Measure and integration - Measure spaces, Measurable functions, integration, Signed measures, the Radon - Nikodym theorem, Measure and outer measure, outer measure and measurability, the extension theorem, product measures.

Books for Reference:

1. H. L. Royden – Real Analysis, Prentice Hall, 3rdEd.,

2. G. de Barra – Measure Theory and Integration, Wiley EasternLimited.

3. Inder K. Rana – An Introduction to Measure and Integration, Narosa,1997.

MATH HC 11	Topology II (Advanced Topology[FCBCS])

Course Outcome(s):
After completing this course, the student will be able to:

- Distinguish among countability and separation axioms on different topological spaces.
- Understand Urysohn's metrization theorem.
- LearnTychonoff's theorem on the product of compact spaces.
- Apply Fundamental groups in algebraic topology.

UnitI

CountabilityandSeparationaxioms-thecountabilityaxioms,these parathion axioms,normalityofa compactHausdorff space.

Unit II

Urysohn's lemma, Tietze's extension theorem, Urysohn'smetrization theorem, Partitions of unity.

Unit III

Tychonoff's theorem on the product of compact spaces. Local finiteness, Paracompactness, Normality of a paracompact space.

Unit IV

The Fundamental group and the Fundamental group of a circle, The Fundamental group of the punctured plane, Essential and Inessential Maps, The Fundamental Theorem of Algebra.

Books for Reference:

1. James R. Munkres - A First Course in Topology , Prentice Hall India, 2000, 2ndEd.,

2. G. F. Simmons – Introduction to Topology and Modern Analysis, McGraw-Hill, Kogakusha,1968.

3. S. Willard – General Topology, Addison Wesley, New York,1968.

4. J. Dugundji – Topology, Allyn and Bacon, Boston,1966.

5. J. L. Kelley – General Topology, Van Nostrand and Reinhold Co., New York,1955.

MATH SC 11	Differential Geometry

Course Outcome(s):
After completing this course, the student will be able to:

- Explain the concepts and language of differential geometry and its role in modern mathematics.
- Analyze and solve complex problems using appropriate techniques from differential geometry.
- Apply problem-solving with differential geometry to diverse situations in physics, engineering or other mathematical contexts.
- Apply differential geometry techniques to specific research problems in mathematics or other fields.

Unit I

Plane curves and Space curves – Frenet-Serret Formulae.
Global properties of curves – Simple closed curves, The isoperimetric inequality, The Four Vertex theorem.
Surfaces in three dimensions – Smooth surfaces, Tangents, Normals and Orientability, Quadric surfaces.

Unit II

The First Fundamental form – The lengths of curves on surfaces, Isometries of surfaces, Conformal mappings of surfaces, Surface area, Equiareal Maps and a theorem of Archimedes.

Unit III

Curvature of surfaces – The Second Fundamental form, The Curvature of curves on a surface, Normal and Principal Curvatures.

Unit IV

Gaussian Curvature and The Gauss' Map – The Gaussian and The mean Curvatures, The Pseudo sphere, Flat surfaces, Surfaces of Constant Mean Curvature, Gaussian Curvature of Compact surfaces, The Gauss' Map.

Books for Reference:

1. A. Pressley – Elementary Differential Geometry, Under-graduate Mathematics Series,Springer.

2. T. J. Willmore – An Introduction to Differential Geometry, Oxford UniversityPress.

3. D. Somasundaram – Differential Geometry: A First Course, Narosa,2005.

MATH SC 12	Advanced Graph Theory

Course Outcome(s):
After completing this course, the student will be able to:

- Distinguish between Eulerian graphs, Hamiltonian graphs and apply to the problem of traversability.
- Understand Plane, Planar graphs and Euler's beautiful formula.
- Apply theory of matrices to Graph theory.
- Analyze concepts of graphs through Group theory.

Unit I

Traversability - Eulerian graphs, Hamiltonian graphs.
Line Graphs - Some properties of line graphs, Characterization of line graphs, Special line graphs, Line graphs and traversability.

Unit II

Factorization.
Planarity - Plane and planar graphs, Euler's formula, Characterizations of planar graphs, Nonplanar graphs, Outerplanar graphs.

Unit III

Colorability - the chromatic number, Five color theorem.
Matrices – The adjacency matrix, The incidence matrix, The cycle matrix.

Unit IV

Groups – The automorphism group of a graph, Operation on Permutation groups,The group of a composite graph, Graphs with a given group, Symmetric graphs, Highly symmetricgraphs.
Domination Theory - Domination numbers, Some elementaryproperties.

Books for Reference:

1. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.

2. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India,1987.

3. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi,1994.

4. G. Chartand and L. Lesniak – Graphs and Diagraphs, Qwadsworth and Brooks, 2ndEd.,

5. Clark and D. A. Holton – A First Look at Graph Theory, Alliedpublishers.

6. D. B. West – Introduction to Graph Theory, Pearson Education Inc., 2001, 2ndEd.,

7. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier,1976.

MATH SC 13	Theory of Partitions

Course Outcome(s):
After completing this course, the student will be able to:

- Learn Generating functions for various partitions.
- Prove combinatorically Euler's beautiful identity on pentagonal numbers.
- Understand congruence properties of Rogers - Ramanujan Identities.
- Apply elementary series – product identities to various types of partitions.

Unit I

Partitions - partitions of numbers, the generating function of p(n), other generating functions, two theorems of Euler, Jacobi's triple product identity and its applications.

Unit II

${}_1\psi_1$ - summation formula and its applications, combinatorial proofs of Euler's identity, Euler's pentagonal number theorem, Franklin's combinatorial proof.

Unit III

Congruence properties of partition function, the Rogers - Ramanujan Identities.

Unit IV

Elementary series - product identities, Euler's, Gauss', Heine's, Jacobi's identities. Restricted Partitions – Gaussian, Frobinius partitions.

Books for Reference:

1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, Oxford University Press, 1979, 5thEd.,

2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York,John Wiley and Sons, Inc., 2004, 5thEd.,

3. Bruce C. Berndt – Ramanujan's Note Books Volumes-1 to5.

4. G. E. Andrews – The Theory of Partitions, Addison Wesley,1976.

5. A. K. Agarwal, Padmavathamma, M. V. Subbarao – Partition Theory, Atma Ram & Sons, Chandigarh,2005.

MATH SC 14	**Hypergeometric Functions and q - Series**

Course Outcome(s):
After completing this course, the student will be able to:

- Learn the Gauss Function.
- Prove combinatorically Basic Hypergeometric Functions.
- Understand Theta Function identitiesfound in Chapter 16 of Ramanujan's second notebook.
- Analyze complicated Rogers-Ramanujan continued fractions and related theta-function identities.

Unit 1. The Gauss Function

Historical introduction, The Gauss series and its convergence, The Gauss equation, The connection with Riemann's equation, Kummer's twenty-four solutions, Contiguous functions and recurrence relations, Special cases of the Gauss function, Some integral representations, The Gauss summation theorem, Another special summation theorem, Analytic continuation formulae.

Unit 2. Basic Hypergeometric Functions

Convergence of Heine series-Some simple results, Jackson's Theorem, Basic analogue of Saalschutz's Theorem, Application of Bailey's transformation to basic series, Some numerical evaluation of infinite products, Basic bilateral series, Ramanujan's ${}_1\psi_1$ - summation formula.

Unit 3. Theta Functions

Ramanujan's general theta-function and its particular cases, Theta-function identities of Ramanujan found in his Chapter 16 of his second notebook, Quintuple product identity and its applications.

Unit 4. q-Continued fractions

Ramanujan's cubic continued fractions, Rogers-Ramanujan continued fractions and related theta-function identities.

Books for Reference:

1. L. J. Slater, Generalized Hypergeometric Functions, Cambridge University Press, London, 1966.
2. H. Exton, q-Hypergeometric Functions and Applications, Ellis Horwood Series in Mathematics and its Application, Chichester, 1983.
3. B. C. Berndt, Ramanujan's Notebooks, Part III, Springer-Verlag, New York, 1991.
4. G. Gasper and M. Rahman, On Basic Hypergeometric Series, Second Ed., Encycl. Math. Applics., Vol 35, Cambridge University Press, Cambridge, 2004.
5. B. C. Berndt, Number Theory in the Spirit of Ramanujan, American Mathematical Society, Providence, RI 2006.

MATH SC 15	Advanced Functional Analysis

Course Outcome(s):
After completing this course, the student will be able to:

- Explain the fundamental concepts of functional analysis and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of functional analysis techniques.
- Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from functional analysis.
- Apply problem-solving using functional analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts

Unit I

Bounded linear operators on Hilbert spaces, the adjoint of an operator, self adjoint operators, positive operators, properties of normal and unitary operators. One to one correspondence between projections on a Banach space and pairs of closed linear subspaces of the space, properties of orthogonal projections on Hilbert spaces.

Unit II

Spectral resolution of an operator on a finite dimensional Hilbert space H and the spectral theorem of a normal operator on H.

Unit III

The structure of commutative Banach algebras - properties of the Gelfand mapping, the maximal ideal space, multiplicative functional and the maximal ideal.

Unit IV

Applications of
spectral radius formula. Involutions in Banach algebras, the Gelfand - Neumark theorem.

Books for Reference:

1. G. F. Simmons – Introduction to Topology and Modern Analysis, Tata McGraw- Hill, NewDelhi.

2. A. E. Taylor – Introduction to Functional Analysis, Wiley, New York,1958.

3. A. Page and A. L. Brown – Elements of FunctionalAnalysis.

4. George Bachman and Lawrence Narici – Functional Analysis, Dover Publications, Inc., Mineola, NewYork.

5. J. B. Conway – A course in Functional Analysis, GTM, Vol. 96., Springer,1985.

MATH OE 03	Algorithms and computations

Course Outcome(s):
After completing this course, the student will be able to:

- Select a computation problem to work on.
- Analyze a problem and its complexity.
- Analyze several algorithmic solutions to the problem.
- Use one or more appropriate models of computation in the analysis.
- Select and/or generate input data for the algorithmic solutions.
- Analyze empirical results to get a deeper understanding of the algorithmic solutions and/or the problem.

Unit I

Introduction to Computers, Flowcharts, Algorithms and their features, Languages, Types of language and translators. Numerical Algorithms - Solving a simultaneous system of linear equations using iterative and direct methods.

Unit II

Interpolation algorithms - equal, unequal intervals, central difference and inverse interpolation.
Numerical differentiation and integration and their errors calculations.

Unit III

Graph theoretical algorithms - Connectivity, finding shortest path between two vertices, enumeration of all paths, construction of minimum spanning tree, cutest, cut vertex, coding and decoding.

Unit IV

Computation - Algorithms complexities, strategies, Divide and conquer, greedy technique, Introduction to NP hard problems.

Books for Reference:

1. Conte and D'bear – Numerical Algorithms, McGraw-Hill,1985.

2. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India,1987.

3. E. V. Krishnamurthy – Introductory Theory of Computer Science, Prentice Hall of India,1980.

4. Horowitz and Sahni – Fundamentals of Computer Algorithms, Addison Wesley,1987.

5. V. Rajaraman – Computer Oriented Numerical Methods, Prentice Hall of India,1980.

6. G. Shankar Rao – Numerical Analysis, Prentice Hall of India,1985.

UNIVERSITY OF MYSORE
DEPARTMENT OF STUDIES IN MATHEMATICS

LIST OF COURSES under CBCS (Hard Core, Soft Core and Open Elective) withCREDIT PATTERN

Sl. No.	Stream Code	Type of the paper	Title of the Paper	No. of Credits L:T:P	Total Credits
			I SEMESTER		
1	MSMAT13	HC	Algebra I	3: 1 : 0	4
2	MSMAT13	HC	Real Analysis I	3 : 1 : 0	4
3	MSMAT13	HC	Real Analysis II	3 : 1 : 0	4
4	MSMAT13	HC	Complex Analysis I	3 : 1 : 0	4
5	MSMAT13	SC	Linear Algebra	3 : 1 : 0	4
6	MSMAT13	SC	Combinatorics and Graph Theory	3 : 1 : 0	4
			II SEMESTER		
7	MSMAT13	HC	Algebra II	3 : 1 : 0	4
8	MSMAT13	HC	Real Analysis III	3 : 1 : 0	4
9	MSMAT13	HC	Complex Analysis II	3 : 1 : 0	4
10	MSMAT13	SC	Ordinary and Partial Differential Equations	3 : 1 : 0	4
11	MSMAT13	SC	Representation Theory of Finite Groups	3 : 1 : 0	4
12	MSMAT13	OE	Discrete Mathematics	3 : 1 : 0	4
			III SEMESTER		
13	MSMAT13	HC	Elements of Functional Analysis	3 : 1 : 0	4
14	MSMAT13	HC	Topology I [Topology (FCBCS)]	3 : 1 : 0	4
15	MSMAT13	SC	Theory of Numbers	3 : 1 : 0	4
16	MSMAT13	SC	Graph Theory	3 : 1 : 0	4
17	MSMAT13	SC	Theory of Modular Forms	3 : 1 : 0	4
18	MSMAT13	SC	Commutative Algebra	3 : 1 : 0	4
19	MSMAT13	SC	Algebraic Number Theory	3 : 1 : 0	4
20	MSMAT13	SC	Galois Theory	3 : 1 : 0	4
21	MSMAT13	OE	Differential equations and its applications	3 : 1 : 0	4
			IV SEMESTER		
22	MSMAT13	HC	Measure and Integration	3 : 1 : 0	4
23	MSMAT13	HC	Topology II[Advanced Topology (FCBCS)]	3 : 1 : 0	4
24	MSMAT13	SC	Differential Geometry	3 : 1 : 0	4
25	MSMAT13	SC	Advanced Graph Theory	3 : 1 : 0	4
26	MSMAT13	SC	Theory of Partitions	3 : 1 : 0	4
27	MSMAT13	SC	Hypergeometric Functions and q - Series	3 : 1 : 0	4
28	MSMAT13	SC	Advanced Functional Analysis	3 : 1 : 0	4
29	MSMAT13	SC	Algorithms and computations	3 : 1 : 0	4

Syllabus for Ph D Course Work
DOS in Mathematics

Course Title: **Research Methodology** Teaching Hours: 4/week

Course Outcome(s):
After completing this course, the student will be able to:

- Understand some basic concepts of research and its methodologies.
- Identify appropriate research topics.
- Select and define appropriate research problems.
- Prepare a project proposal to undertake a project.
- Write a research report and thesis.
- Write a research proposal for grants.

Unit 1. Introduction

Meaning of research, Objectives of research, Motivation in research, Types of research, Research Approaches, Significance of research, Research methods versus methodology, Research and Scientific method, Importance of knowing how research is done, Research process, criteria of good research.

Unit 2. Mathematical Analysis

Elementary Calculus, Limits and Continuity (Both in Real and Complex number system), Sequence, Series and Products (Both in Real and Complex number system), Differential Calculus, Integral Calculus (in Real number system), Sequences of Functions (Both in Real and Complex number system), Fourier Series, Convex Functions, Conformal Mappings, Functions of the Unit Disc, Growth Conditions, Analytic and Meromorphic Functions, Complex Integrals, Zeros and Singularities, Harmonic Functions, Residue Theory, Integrals along the Real Axis.

Unit 3. Algebra

Examples of Groups and General Theory, Homomorphisms and Subgroups, Cyclic Groups, Normality, Quotients and Homomorphisms, S_n , A_n, D_n, … , Direct Products, Free Groups, Generators and Relations, Finite Groups, Rings and Their Homomorphisms, Ideals, Polynomials, Fields and Their Extensions, Elementary Number Theory, Vector Spaces, Rank and Determinants, System of Equations, Linear Transformations, Eigen values and Eigen vectors, Canonical Forms, Similarity, Bilinear, Quadratic Forms and Product Spaces, General Theory of Matrices.

Unit 4. Metric Spaces

Topology of R^n, General Theory, Fixed Point Theorem.

Books for reference:

1. C. R. Kothari, *Research Methodology*, New Age International Publishers.
2. Paulo Ney de Souza and Jorge-Nuno Silva, *Berkeley Problems in Mathematics*, Third Ed., Springer - Verlag