Shaheed Bhagat Singh State University, Ferozepur

Proposed Scheme of M.Sc. (Mathematics)

Syllabus M.Sc. Mathematics Ist year

Scheme of the Program:

First Semester **Contact Hours: 25 Hrs.**

Course Code	Course Title	Load Allocation			Marks Distribution			Credits
		L	T	P	Internal	External	Total	
MSMM 101C	Abstract Algebra	4	1	0	40	60	100	5
MSMM 102C	Real Analysis	4	1	0	40	60	100	5
MSMM 103C	Complex Analysis	4	1	0	40	60	100	5
MSMM 104C	Ordinary Differential Equations	4	1	0	40	60	100	5
MSMM 105C	Linear Algebra	4	1	0	40	60	100	5
Total		20	05	00	200	300	500	25

Dr. Kiranjeet Kaur

Dr Arvind Gupta

Dr.Karanvir Singh

Dr. Kulbhushan Agnihotri

Dr. Rakesh Kumar

Dr. Gaurav Dhuria

Dr Chanchal Jindal

Mr. K Sunil Behal

Shaheed Bhagat Singh State University, Ferozepur

Proposed Scheme of M.Sc. (Mathematics)

Second Semester

Contact Hours: 25 Hrs.

Course Code	Course Title	Load Allocation			Marks Distribution			Credits
		L	T	P	Internal	External	Total	
MSMM 201C	Advanced Algebra	4	1	0	40	60	100	5
MSMM 202C	Measure Theory	4	1	0	40	60	100	5
MSMM 203C	Mathematical Methods	4	1	0	40	60	100	5
MSMM 204C	Partial Differential Equations	4	1	0	40	60	100	5
MSMM 205C	Numerical Analysis	4	1	0	40	60	100	5
MSMM 206C	Numerical Analysis (Lab)	0	0	4	50	25	75	2
Total		20	05	03	250	325	575	27

Dr Arvind Gupta | Dr. Karanvir Singh | Dr Gaurav Dhuria | Mr Chanchal Jindal

Dr. Kulbhushan Agnihotri | Dr. Rakesh Kumar | Mr K Sunil Behal | Dr. Kiranjeet Kaur

Syllabus M.Sc. Mathematics 2nd year (Scheme of the Program)

Third Semester **Contact Hours: 25 Hrs.**

Course Code	Course Title	Load Allocation			Marks Distribution			Credits
		L	T	P	Internal	External	Total	
MSMM-301C	Advanced Real Analysis	4	1	0	40	60	100	5
MSMM-302C	Operations Research	4	1	0	40	60	100	5
MSMM-303C	Topology	4	1	0	40	60	100	5
MSMM-304C	Mathematical Statistics	4	1	0	40	60	100	5
MSMM-305C	Functional Analysis	4	1	0	40	60	100	5
SBS-101C	Introduction to Shaheed Bhagat Singh & his Co-Patriots	1	0	0	25	--	S/US	S/US
Total		21	05	00	225	300	525	25

Dr Arvind Gupta Dr. Karanvir Singh Dr. Chanchal Jindal Dr. Gaurav Dhuria

Dr. Kulbhushan Agnihotri Dr. Rakesh Kumar Mr K Sunil Behal Dr. Kiranjeet Kaur

Fourth Semester **Contact Hours: 25 Hrs.**

Course Code	Course Title	Load Allocation			Marks Distribution			Credits
		L	T	P	Internal	External	Total	
MSMM-401C	Differential Geometry	4	1	0	40	60	100	5
MSMM-402C	Number Theory	4	1	0	40	60	100	5
MSMM-403C	Discrete Mathematics	4	1	0	40	60	100	5
MSMM-404C	Advanced Numerical Methods	4	1	0	40	60	100	5
MSMM-405C	Project	0	0	0	100	0	100	5
Total		16	04	00	260	240	500	25

Dr. Kiranjeet Kaur

Dr Arvind Gupta

Dr. Karanvir Singh

Dr. Kulbhushan Agnihotri

Dr. Rakesh Kumar

Dr. Gaurav Dhuria

Dr. Chanchal Jindal

Mr K Sunil Behal

MSMM-301C	**Advanced Real Analysis**	**L-4,T-1,P-0**	**5 Credits**

Pre-requisite: Calculus of several variables and Real Analysis

Course Objectives: This course is designed to consider theoretical foundations of concepts of mathematical analysis, viz. derivative, MVTs, functions of several variables, measure theory and integration that have many important applications in different branches of pure and applied mathematics. Further, the objective is enable students familiar with these concepts and their fruitful applications.

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

CO1	Apply the knowledge of concepts of functions of several variables and measure theory in order to study theoretical development of different mathematical concepts and their applications.
CO2	Understand the nature of abstract mathematics and explore the concepts in further details
CO3	Utilize the concepts of derivative, MVTS for vector-valued functions in applications different fields for example management, industry and economics etc.
CO4	Recognize the need of concept of measure from a practical view point.
CO5	Understand measure theory and integration from theoretical point of view and apply its tools in different fields of applications.
CO6	Extend their knowledge of Lebesgue theory of integration by selecting and applying its tools for further research in this and other related areas

Advanced Real Analysis (MSMM-301C)

UNIT-I

Differentiation of Real functions, Mean value theorems, Taylor's theorem, Differentiation of vector-valued functions, Functions of several variables: Linear transformations, Differentiation, Contraction principle, The Inverse function theorem, The implicit function theorem.

UNIT-II

Lebesgue Measure: Introduction, Lebesgue outer measure, Measurable sets and Lebesgue measure, non-measurable set, Measurable functions, Borel and Lebesgue measurability, Littlewood's three principles.

UNIT-III

Lebesgue Integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of a nonnegative function, The general Lebesgue integral, Convergence in measure.

UNIT-IV

Differentiation and Integration: Differentiation of monotone functions, The Four derivatives, Functions of bounded variation, differentiation of an integral, Lebesgue Differentiation Theorem. Absolute continuity.

RECOMMENDED BOOKS:

1. Royden, H.L. and Fitzpatrick, P.M., Real Analysis, 4th Edition. New Delhi: Pearson, 2010.
2. Barra, G. de., Measure Theory and Integration, New Delhi: Woodhead Publishing, 2011.
3. Rudin, W., Principles of Mathematical Analysis, 3rd Edition. New Delhi: McGraw-Hill Inc., 2013.
4. Carothers, N. L., Real Analysis, Cambridge University Press, 2000.
5. Apostol, T.M., Mathematical Analysis –A modern approach to Advanced Calculus. New Delhi: Narosa Publishing House, 1957.

MSMM-302C	**Operations Research**	**L-4,T-1,P-0**	**5 Credits**

Pre-requisite: Basic Calculus, analysis and linear algebra

Course Objectives: This course is designed to introduce basic optimization techniques in order to get best results from a set of several possible solutions of different problems viz. linear programming problems, transportation problem, assignment problem and unconstrained and constrained problems etc. The major focus will be on formulation of real world phenomena from its physical considerations and implementation of optimization algorithms for solving these problems.

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

CO1	Apply the knowledge of basic optimization techniques in order to get best possible results from a set of several possible solution of different problems viz. linear programming problems, transportation problem, assignment problem and unconstrained and constrained problems etc.
CO2	Formulate an optimization problem from its physical consideration.
CO3	Select and implement an appropriate optimization technique keeping in mind its limitations in order to solve a particular optimization problem.
CO4	Understand theoretical foundation and implementation of similar type optimization techniques available in the scientific literature.
CO5	Continue to acquire knowledge and skills of optimization techniques that are appropriate to professional activities
CO6	Extend their knowledge of basic optimization techniques to do interesting research work on these types of optimization techniques.

Operations Research (MSMM-302C)

UNIT-I

Formulation of linear programming problem (LPP) -graphical method, Basic Feasible Solution, Extreme Points, Convex set, Convex linear combination, optimal solution of LPP using Simplex, Big-M and two-phase methods, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.

UNIT-II

General Primal-Dual pair, Formulating a dual problem, Weak and strong duality theorems, Complementary slackness theorem, Dual simplex method, Economic interpretation of primal-Dual problems. Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.

UNIT-III

Initial basic Feasible solution of transportation problem, Balanced and unbalanced transportation problems, Optimal solutions of transportation problem using U-V /MODI methods, Assignment problems; Mathematical formulation of assignment problem, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Project management with critical path method.

UNIT-IV

Concept of convexity and concavity, Maxima and minima of convex functions, Single and multivariate unconstrained problems, constrained programming problems, Kuhn-Tucker conditions for constrained programming problems, Quadratic programming, Wolfe's method.

BOOKS RECOMMENDED

1. Taha, H.A., Operations Research-An Introduction, PHI, 2007.
2. Kanti Swarup, Gupta, P.K. and Man Mohan, Operations Research, Sultan Chand & Sons, Ninth Edition, 2002.
3. Hillier, F.S. and Lieberman, G.J., Operations Research, Second Edition, Holden-Day Inc, USA, 1974.
4. Bazaraa, M.S., Sherali, H.D., Shetty, C.M., Nonlinear Programming: Theory and Algorithms, John Wiley and Sons, 1993.
5. Chandra, S., Jayadeva, and Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, 2013

MSMM-303C	Topology	L-4,T-1,P-0	5 Credits

Pre-requisite: Real Analysis

Course Objectives: The objective of the course on **Topology** is to provide the knowledge of Topological Spaces and their importance. To acquaint students with the concept of Homeomorphism and the topological properties and important mathematical concepts which can be generalized in topological spaces, so that students may learn and appreciate the nature of abstract Mathematics.

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

CO1	Understand the concepts of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space.
CO2	Understand the concept of Bases and Subbases, create new topological spaces by using subspace.
CO3	Understand continuity, compactness, connectedness, homeomorphism and topological properties.
CO4	Understand how points of space are separated by open sets, Housdroff spaces and their importance.
CO5	Understand regular and normal spaces and some important theorems in these spaces.

Topology (MSMM-303C)

UNIT-I

Introduction topological spaces, closed sets, Closure, Dense subsets, neighborhoods, interior, exterior and boundary, Accumulation points and derived sets.
Bases and subbases, Subspaces and relative Topology, Alternative methods of defining a Topology in terms of Kuratowski closure operator and neighborhood systems.

UNIT-II

Open mappings and closed mappings, Continues functions and homomorphism's, Compactness and local Compactness. One-point compactification, connected and arc-wise connected spaces, Components and Locally connected spaces.

UNIT-III

T0 and T1 spaces, T2 spaces and sequences. Hausdorffness of one-point compactification, Axioms of Countability and Separability, Equivalence of Separable, second Axiom and Lindel of properties in a metricspaces. Equivalence of compact and countably compact sets in metric spaces.

UNIT-IV

Regular and completely regular, Normal and completely normal spaces. Metric spaces as T2, completely normal and first axiom spaces, Urysohn's Lemma, Tietze Extension Theorem.

BOOKS RECOMMENDED

1. Munkres, J. R., Topology, a first course, Prentice-Hall of India Ltd., New Delhi, 2000.
2. Joshi, K. D., An introduction to general topology, 2nd edition, Wiley Eastern Ltd., New Delhi, 2002.
3. Simmons, G.F., Introduction to topology and Modern Analysis, McGraw Hill Publications, 2017.
4. Kelley, J. L., General Topology, Springer Verlag, New York, 1990.
5. Armstrong, M.A., Basic Topology, Springer International Ed., 2005.

MSMM-304C	**Mathematical Statistics**	**L-4,T-1,P-0**	**5 Credits**

Pre-requisite: Basic Statistics and Calculus of several variables

Course Objectives: The aim of the course is to enable the students with understanding of various types of probability distributions and testing of hypothesis problems. It aims to equip the students with standard concepts of statistical techniques and their utilization.

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

CO1	Tackle big data and draw inferences form it by applying appropriate statistical techniques.
CO2	Explore the basic ideas about measures of central tendency, dispersion and their applications in other statistical problems.
CO3	Explain the different types of discrete and continuous distributions and their utilization.
CO4	Deal with formulation of hypotheses as per situations and their testing.
CO5	Apply the knowledge of statistical techniques in various experimental and industrial requirments.

Mathematical Statistics (MSMM-304C)

Unit I

Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Bayes theorem.Random variable, function of random variable, and their distributions, probability mass function, probability density function, cumulative distribution function.

Unit II

Study of various discrete and continuous distributions, Binomial, Poisson, Geometric, Hyper geometric, Multinomial. Uniform, Exponential, Normal distributions, Gamma distribution, Cauchy, exponential, Beta and gamma distributions, Bivariate normal distribution

Unit III

Two dimensional random variables, joint, marginal and conditional distributions, independence of random variables, expectation, conditional expectation, moments, product moments, probability generating functions, moment generating function and its properties. Chebyshev's, Markov, Jenson, Techebyshey's, inequalities, stochastic convergence, central limit theorem.

Unit IV

Concept of sampling distribution and its standard error, Derivation of sampling distributions of χ^2, t and F distribution of sample mean and sample variance Testing of hypotheses, fundamental notions important tests based on normal distributions, Tests of significance: tests based on normal distribution, χ^2, t and F statistic. Estimation: Point estimation, Interval estimation, Maximum Likelihood estimation.

BOOKS RECOMMENDED:

1. Hogg R. V., McKean J. W. and Craig A. T., Introduction to Mathematical Statistics, Pearson, 2005, Sixth Edition.
2. Gupta S. C. and Kapoor V. K., Fundamentals of Mathematical Statistics, 11th Edition. Sultan Chand & Sons, 2014.
3. Fisz M., Probability Theory and Mathematical Statistics, 3rd Edition. John Wiley & Sons, 1967.
4. Gun A.M., Gupta, M.K. and Dasgupta B., Fundamentals of Statistics (Vol-I), World Press, 2013.
5. Feller W., An Introduction to Probability Theory and Its Applications (Vol-I), 3rd Edition. John Wiley & Sons, 2003.

MSMM-305C	**Functional** Analysis	L-4,T-1,P-0	5 Credits
Pre-requisite: Real analysis and Linear Algebra			
Course Objectives: This course will develop a deeper and rigorous understanding of fundamental concepts of functional analysis, their properties and related theorems.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Explain the fundamental concepts of functional analysis and their role in modern mathematics.		
CO2	Utilize the concepts of functional analysis, for example continuous and bounded operators, normed spaces, Hilbert spaces and to study the behavior of different mathematical expressions arising in science and engineering.		
CO3	Understand and apply fundamental theorems from the theory of normed and Banach spaces including the Hahn-Banach theorem, the open mapping theorem, the closed graph theorem and uniform boundedness theorem.		
CO4	Understand the nature of abstract mathematics and explore the concepts in further details.		
CO5	Explain the concept of projection on Hilbert and Banach spaces.		

Functional Analysis (MSMM-305C)

UNIT-I

Normed linear spaces, Banach spaces, properties of normed spaces, finite dimensional normed spaces and subspaces, linear operators, bounded and continuous linear operators, linear functionals, normed spaces of operators

UNIT-II

Equivalent norms, conjugate spaces, Reflexivity. Hahn-Banach theorems for real/complex vector spaces and normed spaces, Applications to bounded linear functionals on C [a,b].

UNIT-III

Uniform boundedness theorem, open mapping theorem, closed graph theorem, Projections on Banach spaces.

UNIT-IV

Inner product spaces, Hilbert spaces, properties of inner product spaces, orthogonal complements, orthonormal sets, Hilbert – adjoint operator, self-adjoint, unitary and normal operators, projections on Hilbert spaces.

RECOMMENDED BOOKS:

1. Simmons, G.F., Introduction to Topology and Modern Analysis, 2008.
2. Rudin, W., Functional Analysis, International Series in Pure and Applied Mathematics, McGraw-Hill inc.,1991.
3. Kreyszig, E., Introductory Functional Analysis with Applications, John Wiley and Sons (Asia) Pvt. Ltd., 2006.
4. Bachman, G. and Narici, L., Functional Analysis, Dover, 2000.
5. Conway, J.B., A Course in Functional Analysis, 2nd Edition. Springer-Verlag, 2006.

MSMM-401C	**Differential Geometry**	**L-4,T-1,P-0**	**5 Credits**
Pre-requisite: Basic calculus and vector calculus			
Course Objectives: The objective of this course is to make students familiar with basic concepts of differential geometry so as to deal with geometry of curves and spaces using the methods of differential calculus.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Understand the basic concepts and results related to space curves, tangents, normals and surfaces.		
CO2	Explain the geometry of different types of curves and spaces.		
CO3	Explain the physical properties of different curves and spaces.		
CO4	Understand principal directions and curvatures, asymptotic lines and then apply their important theorems and results to study various properties of curves and surfaces.		
CO5	Utilize Geodesics, it's all related terms, properties and theorems.		

Differential Geometry (MSMM-401C)

Unit I

Theory of Space Curves: Tangent, principal normal, bi-normal, curvature and torsion. Serretfrenet formulae, Contact between curves and surfaces. Locus of centre of curvature, spherical curvature, Helices.

Unit II

Spherical indicatrix, Bertrand curves, surfaces, envelopes, edge of regression, developable surfaces, two fundamental forms.

Unit III

Curves on a surface, Conjugate Direction, Principle Directions, Lines of Curvature, Principal Curvatures, Asymptotic Lines. Theorem of Beltrami and Enneper, Mainardi- Codazzi equations.

Unit IV

Geodesics, Differential Equation of Geodesic, torsion of Geodesic, Geodesic Curvature, Clairaut's theorem, Gauss- Bonnet theorem, Joachimsthal's theorem, Geodesic Mapping, Tissot's theorem.

BOOKS RECOMMENDED:

1. Weatherburn, C.E., Differential Geometry of Three Dimensions, Cambridge University Press, 2016.
2. Willmore, T.J., Introduction to Differential Geometry, Dover Publications Inc., United States, 2012.
3. Bansi Lal, Differential Geometry, 4th Edition. Atma Ram & Sons, India, 1976.
4. Victor Andreevich Toponogov, Differential Geometry of Curves and Surfaces: A Concise Guide 2006th Edition.

MSMM-402C	Number Theory	L-4,T-1,P-0	5 Credits
Pre-requisite: Congruences, Number System			
Course Objectives: This course is designed to provide students an introduction to classical number theory and enable them to study higher courses in number theory, and to apply the learnt concepts of number theory.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Apply the knowledge of Number theory to attain a good mathematical maturity and enables to build mathematical thinking and skill.		
CO2	Utilize the congruences, Chinese remainder theorem, indices, residue classes, Legendre symbols to solve different related problems.		
CO3	Identify and analyze different types of divisibility tests, Euler's theorem, Wilson theorem, Mobius inversion formula to formulate and solve various related problems.		
CO4	Design, analyze and implement the concepts of Diophantine equations for solving different types of problems, for example, sum of two and four squares.		
CO5	Create, select and apply appropriate number theoretic techniques such as primes, greatest integer functions.		
CO6	Identify the challenging problems in modern mathematics and find their appropriate solutions.		

Number Theory (MSMM-402C)

UNIT-I

Divisibility, Greatest common divisor, Euclidean Algorithm, The Fundamental Theorem of arithmetic, congruence's, Special divisibility tests, Chinese remainder theorem, residue classes and reduced residue classes, Fermat's little theorem, Wilson's theorem, Euler's theorem.

UNIT-II

Arithmetic functions $\phi(n)$, $d(n)$, $\sigma(n)$, $\mu(n)$, Mobius inversion Formula, the greatest integer function, perfect numbers, Mersenne primes and Fermat numbers.

UNIT-III

Primitive roots and indices, Quadratic residues, Legendre symbol, Gauss's Lemma, Quadratic reciprocity law, Jacobi symbol, Diophantine equations: $ax+by=c$, $x^2+y^2=z^2$, $x^4+y^4=z^2$, sums of two and four squares.

UNIT-IV

Representation of an integer as a sum of two squares and sum of four squares, finite and infinite simple continued fractions, Convergent, The fundamental solution of Pell's Equations, Applications to Pell's equations.

RECOMMENDED BOOKS:

1. Burton, D.M., Elementary Number Theory, 7th Edition. McGraw-Hill Education, 2010.
2. Hardy, G.H. and Wright, E.M., An introduction to the Theory of Numbers, 4th Edition. Oxford University Press, 1975.
3. Niven, I., Zuckerman, H.S. and Montgomery, H.L., Introduction to Theory of Numbers, 5th Edition. John Wiley & Sons, 1991.
4. Koblitz N., A Course in Number Theory and Cryptography, Graduate Texts in Mathematics, No.114. New-York: Springer-Verlag, 1987.
5. Stallings, W., Cryptography and Network Security, 5th Edition. Pearson, 2010.

MSMM-403C	**Discrete Mathematics**	**L-4,T-1,P-0**	**5 Credits**

Pre-requisite: Set Theory, Relations, functions.

Course Objectives: Prepare students to develop mathematical foundations to understand and create mathematical arguments require in learning many mathematics and computer sciences courses. To motivate students how to solve practical problems using discrete mathematics. Also, in this course basic concepts of Graph theory such as Trees, Eulerian Graphs, Matching, Vertex colourings, Edge colourings, Planarity, are introduced.

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

CO1	construct mathematical arguments using logical connectives and quantifiers.
CO2	understand how lattices and Boolean algebra are used as tools and mathematical models in the study of networks.
CO3	validate the correctness of an argument using statement and predicate calculus.
CO4	learn how to work with some of the discrete structures which include sets, relations, functions, graphs and recurrence relation.
CO5	understand the concepts Planarity including Euler identity.
CO6	discuss and understand the importance of the concepts Matching's and Colourings'.

Discrete Mathematics (MSMM-403C)

Unit-I

Mathematical Logic: Basic logical operations, conditional and bi-conditional statements, tautologies, contradiction, Proposition and predicate logic.

Basic counting techniques: Basic counting techniques-inclusion and exclusion, pigeon-hole principle.

Unit-II

Recursion and Recurrence Relations: Polynomial expressions, telescopic form, recursion theorem, closed form expression, generating function, solution of recurrence relation using generating Function and recursion.

Unit-III

Lattices and Boolean Algebra: Introduction to Binary relations, equivalence relations and partitions, Partial order relations, Hasse diagram. Lattices as partially ordered sets, properties, lattices as algebraic systems, sub lattices. Boolean algebra as lattices, Boolean identities, sub-algebra, Boolean forms and their equivalence, Applications of Boolean algebra to circuit theory.

Unit-IV

Graph Theory: Directed graphs, undirected graphs, paths, circuits, cycles, sub-graphs, induced Sub graphs, degree of vertex, connectivity, planner graph, complete, Eulerian paths and circuits, Trees and Coloring of the graph, Rooted tree, spanning trees, minimal spanning trees, Kruskal's algorithm. Chromatic number, four-color problem (statement only).

BOOKS RECOMMENDED:

1. Tremblay, J.P. and Manohar, R.P., Discrete Mathematics with Applications to Computer Science, Tata McGraw Hill, 2008.
2. Ram, Babu, Discrete Mathematics, Pearson Education, 2007.
3. Harary, F., Graph Theory, Narosa, 1995
4. Anami, B.S and Madalli, V.S., Discrete Mathematics, University Press, 2016.
5. Liu, C.L, Elements of Discrete Mathematics, 3rd Edition, Tata McGraw Hill, 2008.
6. Grimaldi, R.P and Ramana, B.V., Discrete and Combinatorial Mathematics-An Applied Introduction, Pearson education, 5th Edition, 2004.

MSMM-404C	**Advanced Numerical Methods**	**L-4,T-1,P-0**	**5 Credits**

Pre-requisite: Basic Calculus and analysis. Basic numerical analysis

Course Objectives: This course is designed to provide a theoretical introduction and application of advanced numerical methods for solving different types of problems viz. linear systems, ordinary and partial differential equation arising in various field of applications, for example in science, engineering and economics etc. The major focus will be on development, analysis and implementation of numerical methods keeping in mind advantages & limitations of these methods.

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

CO1	Apply the knowledge of advanced numerical methods in order to solve different types of problems viz. linear systems, ordinary and partial differential equation arising in various field of applications for example in science, engineering and economics etc.
CO2	Understand advantages and limitations of advanced numerical methods.
CO3	Select and implement an appropriate numerical method for solving a given problem keeping in mind nature of the problem.
CO4	Use theoretical basis of these methods in order to study their counterparts existing in the scientific literature.
CO5	Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically) and find their appropriate solutions accurately and efficiently.
CO6	Extend their knowledge to do research work on these methods and similar type of other methods.

Advanced Numerical Methods (MSMM-404C)

Unit-I

Iterative Methods for Linear Systems: The classical iterative methods (Jacobi, Gauss-Seidel and Successive Over Relaxation (SOR) methods), Conjugate gradient, Bi-conjugate-gradient (BiCG), Preconditioning techniques.

Unit-II

Finite Difference Methods: Explicit and implicit schemes, consistency, stability and convergence, Lax equivalence theorem (statement only), numerical solutions to elliptic, parabolic and hyperbolic partial differential equations.

Unit-III

Approximate methods of solution: Rayleigh-Ritz, collocation and Galerkin methods, properties of Galerkin approximations, Petrov-Galerkin method, Generalized Galerkin method.

Unit-IV

Finite Element Method (FEM): FEM for second order problems, One dimensional problems, The finite elements (elements with a triangular mesh and a rectangular mesh and three-dimensional finite elements), Fourth-order problems, Hermite families of elements, iso-parametric elements.

BOOKS RECOMMENDED:

1. Jain, M.K, Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, 5th Edition, New Age international, 2008.
2. Hoffman Joe D., Numerical methods for Engineers and Scientists, McGrow-Hill, 1993.
3. Atkinson, K.E, An Introduction to Numerical Analysis, 2nd Edition, John Wiley, 2004.
4. Gupta R.S., Elements of Numerical Analysis, McMillan India, 2009
5. Seshu P., Textbook of Finite Element Analysis, Prentice Hall India, 2003.