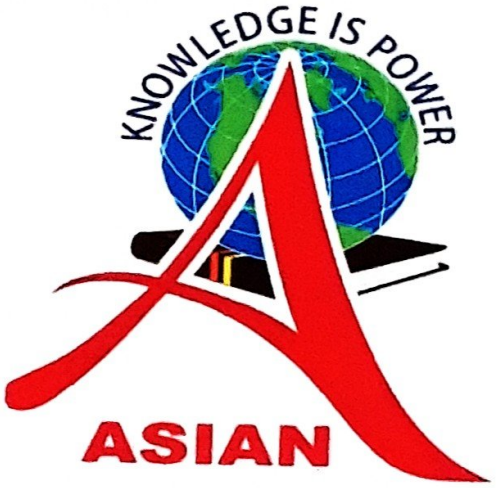
Asian Educational Institute, Patiala (PB)

(An Autonomous College)

School of Science and Mathematics



SYLLABUS

M.Sc. (MATHEMATICS)

(Semester- III & IV)

Session: 2025-2026

Semester-III

Paper Code	Title of paper	Credits	External Examination (Marks)	Internal Assessment (Marks)	Total Marks
MMATH2301T	OPTIMIZATION TECHNIQUES-I	04	70	30	100
MMATH2302T	FIELD THEORY	04	70	30	100
MMATH2303T	DIFFERENTIABLE MANIFOLDS	04	70	30	100
MMATH2304T	FUZZY SETS AND APPLICATIONS	04	70	30	100
MMATH2305T	CLASSICAL MECHANICS-I / NUMERICAL ANALYSIS	04	70	30	100

Semester-IV

Paper Code	Title of paper	Credits	External Examination (Marks)	Internal Assessment (Marks)	Total Marks
MMATH2401T	THEORY OF LINEAR OPERATORS	04	70	30	100
MMATH2402T	MATHEMATICAL METHODS	04	70	30	100
MMATH2403T	OPERATIONS RESEARCH	04	70	30	100
MMATH2404T	COMMUTATIVE ALGEBRA	04	70	30	100
MMATH2405T	STRUCTURES ON MANIFOLDS	04	70	30	100

(Semester III)

OPTIMIZATION TECHNIQUES-I

Paper Code: MMATH2301T

Max. Marks: 100

Credits: 04

External Exam: 70 Marks

Total teaching hours: 50-55

Internal Assessment: 30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Model a problem as a linear programming problem and apply the appropriate method to find an optimal solution.
CO2: Formulate a given simplified description of a suitable real-world problem as a programming models in general, standard and canonical forms.
CO3: Sketch graphical representation of a two- dimensional linear programming model given in general, standard or canonical form.
CO4: Use the simplex method to solve small linear programming models by hand.
CO5: Find optimal solutions for many other problems like assignment, transportation, traveling salesman etc.
CO6: Understand dynamic programming algorithms and its applications in problem solving.
CO7: Solve various problems in game theory.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of Section A and B and compulsory question of Section C. Use of non-programmable scientific calculators is allowed.

SECTION-A

Review of Linear Programming: Simplex method, Big-M method, two phase method and duality.

Sensitivity Analysis: Discrete changes in the cost vector, requirement vector and coefficient matrix, addition of a new variable, deletion of a variable, addition of new constraint, deletion of a constraint.

Integer Programming: Introduction, Gomory's all IPP method, Gomory's mixed-integer method, branch and bound method.

Dynamic programming: Introduction, the recursive equation approach, dynamic programming algorithm, solution of discrete DPP.

SECTION-B

Transportation Problem: Introduction, mathematical formulation of the problem, initial basic feasible solution using North-West corner method, least cost method and Vogel's approximation method, optimal solution using MODI method, degeneracy in transportation problems, some exceptional cases in transportation problems.

Assignment Problems: Introduction, mathematical formulation of an assignment problem, assignment algorithm, unbalanced assignment problems, traveling salesman problem.

Games and Strategies: Definition and characteristics of games, two person zero sum games, maximin and minimax principle, games without saddle points, mixed strategies, graphical method for solving 2 X 2 games, concept of dominance, reducing the game problem to LPP, limitations.

BOOKS RECOMMENDED:

1. K. Swarup, P.K. Gupta, M. Mohan: Operations research, Sultan Chand and Sons, New Delhi, 2010.
2. C.Mohan, K. Deep: Optimization Techniques, New Age international, 2009.
3. H.S. Kasana, K.D. Kumar: Introductory Operations Research: Theory and Applications, Springer, Science and Business Media, 2013.
4. G.Hadley: Linear Algebra, Addison- Willey, 7th Edition 1977.

FIELD THEORY

Paper Code: MMATH2302T

Credits: 04

Max. Marks: 100

Total teaching hours: 50-55

External Exam: 70 Marks

Internal Assessment:30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Ability to test whether a given polynomial is irreducible or not.
CO2: Understanding the basic notions of Field theory like Normal Extensions, Separable Extensions etc.
CO3: Ability to find splitting field of a given polynomial.
CO4: To calculate Galois group of certain polynomials.
CO5: To apply the Galois' correspondence to solve problems of Field theory.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: This course will introduce the basic ideas of field theory, leading to Galois theory and its applications in solving some of the classical problems.

SECTION-A

Fields, examples, algebraic and transcendental elements, irreducible polynomials. Gauss lemma, Eisenstein's criterion, adjunction of roots, Kronecker's theorem, algebraic extensions, algebraically closed fields. Splitting fields, normal extensions, multiple roots, finite fields, separable extensions, perfect fields, primitive elements, Lagrange's theorem on primitive elements.

SECTION-B

Automorphism groups and fixed fields, Galois extensions, fundamental theorem of Galois theory, fundamental theorem of algebra, roots of unity and cyclotomic polynomials. Cyclic extensions, polynomials solvable by radicals, symmetric functions, cyclotomic extensions, quintic equation and solvability by radicals, ruler and compass construction.

Pedagogy: It is expected that the teacher will lay emphasis on how the modern field theoretical methods help us to find relatively easier solutions to the problems of algebraic and geometric constructions.

BOOKS RECOMMENDED:

1. P.B. Bhattacharya, S.K. Jain, S.R.Nagpal: Basic Abstract Algebra, 2nd Edition, Cambridge University Press, 2002 (chapters 15 -18).
2. D.S. Dummit, Richard M Foote: Abstract Algebra, John Wiley and Sons, 2004.
3. M.Artin: Algebra, Prentice Hall of India, New Delhi, 1994.

DIFFERENTIABLE MANIFOLDS

Paper Code: MMATH2303T

Max. Marks: 100 **Credits: 04**

External Exam: 70 Marks **Total teaching hours: 55**

Internal Assessment: 30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: To study complicated structures in terms of relatively well understood properties of Simpler spaces.
CO2: To acquire thorough knowledge of the concept of Riemannian manifolds having wide applications in various fields of mathematics.
CO3: Understanding the theory of various differentials geometric structures on manifolds and arrange the results on sub manifolds of Riemannian manifolds with certain structures.
CO4: To deal with the theory of tensors and to construct differentiable mappings on the tensor product spaces.
CO5: To define various differentiable mappings and connections on the structure of manifold leading to formation of some important differential geometric tools.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: The aim of this paper is to study the theory of differentiable manifolds and the structure of sub-manifolds. It introduces and elaborates the concept of Riemannian manifolds having wide applications in various fields of mathematics.

SECTION-A

Differentiable Manifolds, examples of differentiable manifolds, the local coordinate approach, differentiable maps on manifolds, tangent vectors and tangent space, different approaches to tangent vectors, Cotangent space. Vector Fields, Lie -bracket of vector fields. Jacobian map, pull back map, integral curves. Tensors, exterior product, forms, exterior derivatives, contraction, Lie- derivative. Affine connection, difference tensor, covariant derivative of tensor.

SECTION -B

Torsion tensor and curvature tensor of a connection, properties of torsion and curvature tensor, Bianchi's identities, the Riemannian metric, Riemannian manifolds, fundamental theorem of Riemannian geometry, Riemannian connection, Christoffel symbols, Riemannian curvature tensor and its properties. Sectional curvature, theorem of Schur, sub- manifolds and hyper surfaces, normal, induced connection, Gauss and Weingarten formulae and their applications.

Pedagogy: The teacher should lay emphasis on the extensive study of the basic properties instrumental in developing the theory of Riemannian manifolds having wide applications in further research in this area.

BOOKS RECOMMENDED:

1. Y. Matsushima: Differentiable Manifolds, Marcel Dekker, Inc. New York, 1972.
2. K. Yano, M. Kon: Structures on Manifolds, World. Scientific Publishing Co. Pvt. Ltd., 1984.
3. U.C. De: Differential Geometry of Manifolds, Alpha Science Int. Ltd., Oxford, U.K., 2007.
4. J.M. Lee: Introduction to Riemannian Manifolds, Springer International Publishing 2nd edition, 2018.
5. K. Nomizu, S. Kobayashi: Foundation of Differential Geometry, Vol. I, Inter-science Publishers, John Wiley and Sons, New York, 1963.

FUZZY SETS AND APPLICATIONS

Paper Code: MMATH2304T

Max. Marks: 100

External Exam: 70 Marks

Internal Assessment: 30 Marks

Passing Marks: 35%

Credits: 04

Total teaching hours: 55

Course outcomes:
CO1: To be able to distinguish between the crisp set and fuzzy set concepts through the learned differences between the crisp set characteristic function and the fuzzy set membership function.
CO2: To be able to draw a parallelism between crisp set operations and fuzzy set operations through the use of characteristics and membership functions respectively
CO3: Become aware of the use of fuzzy inference systems in the design of intelligent humanistic systems.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: This course introduces Fuzzy Techniques to the students. The techniques have found many applications in sciences to solve problems with limit and incomplete information.

SECTION-A

Classical Sets and Fuzzy Sets: Overview of Classical Sets, Membership Function, α-cuts, Properties of α-cuts, Decomposition Theorems, Extension Principle.

Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of operations, Aggregation Operations.

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on intervals and Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

Fuzzy Relations: Crisp and Fuzzy Relations, Projections and Cylindrical Extensions, Binary Fuzzy Relations, Binary Relations on single set, Equivalence, Compatibility and Ordering Relations, Morphisms, Fuzzy Relation Equations.

SECTION-B

Possibility Theory: Fuzzy Measures, Evidence and Possibility Theory, Possibility versus Probability Theory.

Fuzzy Logic: Classical Logic, Multi-valued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.

Uncertainty based Information: Information and Uncertainty, Non-specificity of Fuzzy and Crisp sets, Fuzziness of Fuzzy Sets. Applications of Fuzzy Logic.

Pedagogy: The need for fuzzy techniques should be stressed throughout.

BOOKS RECOMMENDED:

1. G. J. Kilrand T. A.Folyger: Fuzzy Sets: Uncertainty and Information, Prentice Hall of India, (1988).
2. G. J. Kilr and B. Yuan: Fuzzy Sets and Fuzzy logic: Theory and Applications, Prentice Hall of India, (1995).
3. H.J. Zimmermann: Fuzzy Set Theory and its Applications, Allied Publishers, (1991).
4. C. Mohan: An Introduction to Fuzzy Set Theory and Fuzzy Logic: M. V. Learning Publishers, New Delhi (INDIA) and London (UK), 2015.

CLASSICAL MECHANICS-I

Paper Code: MMATH2305T

Max. Marks: 100 **Credits: 04**

External Exam: 70 Marks **Total teaching hours: 55**

Internal Assessment: 30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Determine the Lagrangian and Hamiltonian functions for a physical system.
CO2: Derive and solve the equations of motion from these functions.
CO3: Determine the moments of inertia of a rigid body.
CO4: Identify Symmetries and to derive the corresponding conservation laws.
CO5: Perform calculations using relativistic kinematics and conservation laws.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: The subject of classical mechanics is a perfect example of the power of mathematics to solve real physical problems, and this course introduces the students to the Lagrangian version of classical mechanics which is indispensable for any study of quantum mechanical methods.

SECTION-A

Basic Principles: Mechanics of a particle and a system of particles, constraints, generalized Co-ordinates, holonomic and non- holonomic constraints. D'Alembert's principle and Lagrange's equations, velocity dependent potentials and the dissipation function, simple applications of the Lagrangian formulations.

Variational Principles and Lagrange's Equations: Hamilton's principle, derivation of Lagrange's equation from Hamilton's principle, extension of Hamilton's principle to non-holonomic systems.

Conservation Theorems and Symmetry Properties: Cyclic co-ordinates, canonical momentum and its conservation, the generalized force, and angular momentum conservation theorem.

SECTION-B

The Two- Body Central Force Problem: Reduction to the equivalent one-body problem, equation of motion, equivalent one-dimensional problem and classification of orbits. The viral theorem, conditions for closed orbits, Bertrand's theorem.

The Kepler Problem: Inverse square law of force, the motion in time in the Kepler problem, Kepler's laws, Kepler's equation, the Laplace- Runge-Lenz vector.

Scattering in a Central Force Field: Cross section of scattering, Rutherford scattering cross section, total scattering cross section, transformation of the scattering problem to laboratory co-ordinates.

Pedagogy: The instructor should lay emphasis on those techniques which naturally lend themselves to their quantum mechanical interpretations to enable the student to more naturally transform from the classical to the quantum.

BOOKS RECOMMENDED:

1. H. Goldstein: Classical mechanics, Addision-wesley,3rd Edition,2002
2. D. Kleppmer ,R.kolenlpw: An Introduction to Mechanics, Cambridge University press,2014

NUMERICAL ANALYSIS-I

Paper Code-MMATH2305T

Max. Marks: 100 marks

External Exam: 70 marks

Internal Assessment: 30 marks

Passing Marks: 35%

Credits: 04

Total Teaching Hours :55

Course Outcomes:
CO1: Understand and Solve the Initial value problems of ODE's
CO2: Solve System of Linear Equations Using Numerical Techniques.
CO3: Understand and explain the Significance of Numerical Methods.
CO4:Analyze Accuracy and Convergence of Elliptic PDE Solution
CO5: Analyze Different Types of errors in Approximation.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having ten short answer type questions covering the entire syllabus uniformly. Each question in Sections A and B will be of 10 marks and and Section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions from each of the Section A and B and compulsory question of Section C. Use of Calculators is allowed.

SECTION-A

Solution of Differential Equations: Tayler's series, Euler's method, Improved Euler method, Modified Euler method and Runge-kutta method (upto 4^{th} order),Predictor Corrector method. Stability and Convergence of Runge- Kutta method and Predictor corrector methods.

Parabolic Equation: Explicit and Implicit schemes for solution of one dimensional equations, Crank-Nicolson, Du fort and Frankel schemes for one dimension equations. Discussion of their Compatibility , stability and convergence. Peaceman-Rachford A.D.I. scheme for two dimensional equations.

SECTION-B

Elliptic Equation: Finite difference replacement and reduction to block tridiagonal form and its solution; Dirichlet and Neumann boundary conditions. Treatment of curved boundaries; Solution by A.D.I. method.

Hyperbolic equations: Solution by finite difference methods on rectangular and characteristics grids and their stability.

Approximate methods: Methods of weighted residual, collocation,
Least-squares and Galerkin' s methods. Variational formulation of a given boundary value problem, Ritz method. Simple examples from ODE and PDE.

RECOMMENDED BOOKS

1. Smith, G D, Numerical solution of partial differential equations, Oxford Univ. Press (1982).
2. R.S. Gupta, Elements of Numerical Analysis, Macmillan India Ltd., 2009.
3. Mitchell, A. R., Computational methods in partial differential equations, John Wiley (1975).
4. Froberg, C. E., Introduction to Numerical Analysis, Addision-Wesley, Reading, Mass (1969).
5. Gerald, C. F., Applied Numerical Analysis Addision Wesley, Reading, Mass (1970).
6. Jain, M. K., Numerical solutions of Differential equations, John Wiley (1984).
7. Collatz, L., Numerical Treatment of Differential Equations, Springer - Verlag, Berlin (1966)
d Euler method, and Runge-Kutta methods (upto fourth order), Predictor Corrector methods. Stability and convergence of Runge-Kutta and Predictor Corrector Methods.

(Semester IV)

THEORY OF LINEAR OPERATORS

Paper Code: MMATH2401T

Max. Marks: 100 **Credits: 04**

External Exam: 70 Marks **Total teaching hours: 55**

Internal Assessment: 30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Understand spectrum theory in Normed linear spaces, bounded linear operator, spectral mapping theorem for polynomials, elementary theory of Banach algebras.
CO2: Understand spectral properties of compact linear operators on Normed Space bounded self-adjoint linear operators on a Complex Hilbert space.
CO3: Differentiate between Banach Space and Hilbert Space.
CO4: Apply spectral techniques for the study of the theory of linear Operators.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: The aim of this course is to introduce Spectral Techniques for the study of the Theory of Linear Operators.

SECTION-A

Spectral theory in normed linear spaces, resolvent set and spectrum, spectral properties of bounded linear operator, properties of resolvent and spectrum, spectral mapping theorem for polynomials, spectral radius of bounded linear operator on a complex Banach space. Elementary theory of Banach Algebras, resolvent set and spectrum, invertible elements, resolvent equation, general properties of compact linear operators.

SECTION-B

Spectral properties of compact linear operators on normed space, behavior of compact linear operators with respect to solvability of operator equations, Fredholm -type theorems ,Fredholm alternative theorems .Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space, positive operators, monotone sequence theorem for bounded self-adjoint operators on a complex Hilbert Space ,square roots of positive operators, spectral family of a bounded self-adjoint linear operators and its properties, spectral theorem .

BOOKS RECOMMENDED:

1. 1.E. Kreyszic: Introductory Functional Analysis with Applications, Wiley, New York, 1978
2. Balmohan V. Limaye: Linear Functional Analysis for Scientist and Engineers, Springer, Singapore,2016.

MATHEMATICAL METHODS

Paper Code: MMATH2402T

Max. Marks: 100 **Credits: 04**

External Exam: 70 Marks **Total teaching hours: 55**

Internal Assessment:30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Understand the relation between linear differential equations and Volterra's equation and convert one type into another.
CO2: Apply to analyze the safety and stability of the dam during anearthquake.
CO3: Understand the difference between Volterra and Fredholm integral equations, first kind and second kind.
CO4: Understand the fundamental concepts of the space of admissible variations for fixed points.
CO5: Give the solution to the brachistochrone and isoperimetricProblem.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: This course teaches integral equations and variational methods.

SECTION-A

Linear integral equations of first and second kind, Abel's problem, relation between linear differential equation and Volterra's equation, non- linear and singular equations, solution by successive substitutions, Volterra's equation, iterated and reciprocal functions, Volterra's solution of Fredholm's equation. Fredholm's equation as limit of finite system of linear equations, Hadamard's theorem, convergence proof, Fredholm's two fundamental relations,

Fredholm's solution of integral equation when D(x)=0, Fredholm's solution of Dirichlet's problem and Neumann's problem, lemmas on iterations of symmetric kernels, Schwarz's inequality and its applications.

SECTION-B

Simple variational problems, necessary condition for an extremum, Euler's equation, end point problem, variational derivative, invariance of Euler's equation, fixed point problem for unknown functions, variational problem in parametric form, functionals depending on higher order derivatives. Euler- Lagrange equation, first integral of Euler-Lagrange equation, geodesics, the Brachistochrone, minimum surface of revolution, brachistochrone from a given curve to a fixed point, Snell's law, Fermat's principle and calculus of variations.

BOOKS RECOMMENDED:

1. F.B. Hildebrand: Method of Applied Mathematics, Prentice Hall, India, 1965.
2. I.M. Gelfand, S.V. Fomin: Calculus of Variations, Prentice Hall, India, 1961.
3. W.W. Lovitt: Linear Integral Equations, Tata McGraw- Hill, India ,1950.
4. R. Weinstock: Calculus of Variations, McGraw-Hill, London, 1974.
5. L.B. Chambers: Integral Equations, International Textbook C0, 1976.

OPERATIONS RESEARCH

Paper Code: MMATH2403T

Max. Marks: 100 **Credits: 04**

External Exam: 70 Marks **Total teaching hours: 45**

Internal Assessment:30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Understand basic characteristics features of a queueing system and acquire skills in analyzing queuing models.
CO2: Apply models studied in queuing to solve real life problems.
CO3: Comprehend the dynamics of inventory management's principles, concepts, and techniques as they relate to the entire supply chain (customer demand, distribution, and product transformation processes.)
CO4: Study the models for replacement of machines which degenerate the time with/without considering any change in value of money.
CO5: Understand operations research situations that can be conveniently modeled and solved as network problems through a variety of network optimization algorithms.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks. Use of non-programmable calculator is allowed.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: Operations research is an analytical method of problem solving and decision making. The course aims to well-grounded students in mathematical engineering and modeling skills. This very practical and useful subject introduces the students to queuing problems, inventory models, network analysis and project management.

SECTION-A

Queuing Problems: Characteristic of queuing system, distribution in querying systems, Poison arrivals and exponential service time, transient and steady state, probabilistic queuing models (Model I (M/M/1) (∞/FCFS), Model II A (General Erlang queuing model), Model II B (M/M/1):(∞/SIRO),Model III (M/M/1): (N/FCFS),Model IV(M/M/S):(∞/FCFS),Model V(M/M/S): (N/FCFS),Model VI A(M/Ek/1):(∞/FCFS),),Model VI B(M/Ek/1):(1/FCFS), measures and their solutions.

Inventory Models: Introduction, costs involved in inventory problems, variables in inventory problems, classification of inventory models, deterministic inventory models, (DIM), basic economic order quantity,(EOQ) models with no shortages:Model I(a), I(b), I(c). DIM with shortages: Model II(a), II(b), II(c). Multi item deterministic inventory models: Models III(a), III(b), III(c). Introduction to stochastic inventory models.

SECTION-B

Replacement and Maintenance Problems: Replacement policy when money value changes and does not change with time, group replacement of items that fails suddenly, the general renewal process.

Network Analysis: Introduction to networks, minimal spanning tree, problem shortest path problem,Dijkastra's algorithm,Floyd's algorithm, maximum flow problem.

Project Management: Critical path method, critical path computations, optimal scheduling by CPM, project cost analysis, PERT, distinction between CPM and PERT.

BOOKS RECOMMENDED:

1. K. Swarup, P.K. Gupta, Man Mohan: Operations research, Sultan Chand and Sons, New Delhi, 2010.
2. C.Mohan, Kusum Deep: Optimization Techniques, New Age international, 2009.
3. H.S. Kasana, K.D. Kumar: Introductory Operations Research: Theory and Applications, Springer, Science and Business Media, 2013.
4. S.D. Sharma: Operation Research, Kedarnath Ramnath and Co., Meerut., 2002.
5. H.A. Taha: Operations Research: An Introduction, Pearson Parentice Hall, New Delhi 2007.

COMMUTATIVE ALGEBRA

Paper Code: MMATH2404T

Max. Marks: 100

Credits: 04

External Exam: 70 Marks

Total teaching hours: 55

Internal Assessment:30 Marks

Passing Marks: 35%

Course Outcomes:
CO1: Understanding of the basic terminology used to understand commutative algebra.
CO2: Understanding of Localization of rings, modules and will be able to see the correspondence between ideals of rings and localized rings.
CO3: To know exact sequences, construction of Tensor product and exactness of Hom and Tor Functor.
CO4: To know primary ideals and two theorems regarding decomposition of ideals as product of primary ideals.
CO5: To understand Integral Dependence of rings, going up and going down theorems

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. section A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having 10 short answer type questions covering the entire syllabus uniformly. Each question in section A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all, selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: This course introduces basic techniques of commutative algebra and discusses the behavior of prime ideals under localization.

SECTION-A

Nil radical and Jacobson radical of Ring, Operation on ideals, Extension and Contraction of Ideals, The Prime Spectrum of Ring, Zairiski Topology, Exact sequence of Modules, Tensor product of modules, Restriction and Extension of Scalars, Exactness property of Tensor product, Flat Modules, Tensor product of Algebras. Rings and modules of fractions, local properties.

SECTION-B

Extended and Contracted ideals in rigs of Fractions.

Primary decomposition: Primary ideals, Decomposable Ideals, First Uniqueness Theorem, Isolated prime ideals, Second Uniqueness Theorem, behavior of primary ideals under localization, integral dependence, integrally closed integral domains, integral A- algebra, going- up theorem, going- down theorem, valuation rings.

BOOKS RECOMMENDED:

1. M.F. Atiyah, L.G.MacDonald: Introduction to Commutative Algebra, Addison-Wesley Publishing, 1969 (Chapter 1-4).
2. David S. Dummit,M.Foote: Abstract Algebra, Wiley India, 2nd Edition, 2008.
3. B. Singh: Basic Commutative Algebra, Board Scientific Publishing, 2011.

STRUCTURES ON MANIFOLDS
Paper Code: MMATH2405T

Max. Marks: 100

Credits: 04

External Marks: 70 Marks

Total Teaching hours: 55

Internal Assessment: 30 Marks

Pass Marks: 35%

Course Outcomes:	
CO1	To acquire the knowledge of the theory of lie group which is based on the study of differential geometry and differential topology.
CO2	To define connection on the structure of complex manifolds leading to the development of new spaces.
CO3	To implement the metric induced on the submanifolds for the construction of structural equations.
CO4	To understand the concept of complex manifolds and complex differential forms based on unitary space which is instrumental in further research in this field.
CO5	To apply the theory of differential manifolds and lie groups, which is one of the cornerstones of the edifice of modern mathematic, in various sphere of study.

INSTRUCTIONS FOR THE PAPER SETTER

The Question paper will consist of three sections A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having ten short answer type questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions from each of the section A and B and compulsory question of Section C.

Section-A

Almost Complex manifolds, Nijenhuis tensor, Contravariant and Covariant almost analytic vector fields, F-connections, Hermitian metric, Almost Hermitian manifolds. Linear connections in an almost Hermitian manifold, Hermitian manifolds with their characterizations, The fundamental 2-form, Kaehler metric and Kaehler manifolds. Holomorphic Sectional Curvature, Kaehler analogue of Schur's theorem.

Section-B

Almost contact structure on a smooth manifold, Contact manifolds. Torsion tensor of in almost contact manifold. Normal almost contact structure, Killing vector field, K-contact manifolds. Sasakian manifolds, Some curvature properties of Sasakian manifolds. φ -Sectional curvature, Sasakian space form.

Pedagogy: The teacher should lay emphasis on the study of structure of sub-manifolds and of the differentiable manifolds based on C^n which is of great use for further research in this field.

BOOKS RECOMMENDED:

1. K. Yano and M. Kon: Structures on Manifolds, World Scientific Publishing Co., Singapore, 1984.
2. D.E. Blair, Contact manifolds in Riemannian Geometry, Lecture Notes in Mathematics, 509, Springer-Verleg, New York, 1976.
3. D.E. Blair, Riemannian Geometry of Contact and Symplectic Manifolds, Progress in Mathematics, 203, Birkhauser, New York, 2010.
4. U.C. De and A.A. Shaikh, Complex Manifolds and Contact Manifolds, Narosa Publishing House, New Delhi, 2009.
5. K. Nomizu and S. Kobayashi, Foundation of Differential Geometry, Volume II, Interscience Publishers, John Wiley & Sons, New York, 1969.