Rev: 04

SYLLABUS

For

2 YEARS MSC MATHEMATICS PROGRAMME

(Revised Syllabus Approved by Academic Council)

Dept. of

Mathematics

JUNE, 2019

UNIVERSITY OF SCIENCE &TECHNOLOGY, MEGHALAYA

Techno City, 9th Mile, Baridua, Ri-Bhoi, Meghalaya, 793101

Semester I

Course code	Course title	Credit	Total marks		Total
			Internal	External	
MSM 101	Real Analysis	4	30	70	100
MSM 102	Differential Equations I	4	30	70	100
MSM 103	Abstract Algebra	4	30	70	100
MSM 104	Numerical Analysis	4	30	70	100
MSM 105	Linear Algebra	4	30	70	100
	Total	20	150	350	500

Semester II

Course code	Course title	Credit	Total marks		Total
			Internal	External	
MSM 201	Topology	4	30	70	100
MSM 202	Differential equations II	4	30	70	100
MSM 203	Complex analysis	4	30	70	100
MSM 204	Mechanics and Tensor	4	30	70	100
MSM 205	Computer programming With C&Mathematica	4	30	70	100
	Total	20	150	350	500

Semester III

Course code	Course title	Credit	Total marks		Total
			Internal	External	
MSM 301	Number theory	4	30	70	100
MSM 302	Functional Analysis	4	30	70	100
MSM 303	Mathematical methods	4	30	70	100
MSM 304	Continuum Mechanics and Hydrodynamics	4	30	70	100
MSM 305 (optional)	Special Theory of Relativity(A)/ Operation Research(B)	4	30	70	100
	Total	20	150	350	500

Semester IV

Course code	Course title	Credit	Total marks		Total
			Internal	External	
MSM 401	Graph theory	4	30	70	100
MSM 402	Advanced Partial Differential Equation	4	30	70	100
MSM 403	Fluid Dynamics (A)	4	30	70	100
MSM 403	Space Dynamics (B)	4	30	70	100
MSM 404	Dynamical System (A)	4	30	70	100
MSM 404	General Theory of Relativity (B)	4	30	70	100
MSM 404	Advanced Algebra (C)	4	30	70	100
MSM 405	Project	4	30	70	100
	Total	20	150	350	500

Real Analysis (MSM 101)

COURSE OUTCOMES (COs):

CO1. Introduction to the notion of set and functions

CO2. Understand the properties of real number system

CO3. Introduction to the concept of sequence and limit, cantor set, Metric space.

CO4.Understand the concepts of continuous and discontinuous function.

CO5.Introduction and applications of Mean value theorem.

CO5. Understand the properties of Heine-Borel theorem, Cantors theorem.

Unit 1: (Metric spaces)

Theory of metric spaces: limit point, isolated point, Cantor set, connected sets, connected component, totally disconnected set, compact set, finite intersection property, totally bounded set, Bolzano -Weierstrass theorem for metric space, sequential compactness, Heine - Borel theorem. **(Marks 10)**

Unit 2: (Limit and continuity)

Limit and continuity of a function defined on a metric space, uniform continuity, homeomorphism, Lipschitz continuous function, contraction, isometry, Banach's contraction mapping principle, Intermediate Value Theorem, continuous functions on compact sets, types of discontinuity.**(Marks 10)**

Unit 3: (Differentiation& Integration)

Derivative, differentiable function, chain rule, derivative of a composite function, local minimum, local maximum, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, indeterminate forms, L' Hospital's rule, intermediate value property, higher order derivatives, Taylor's theorem, Taylor series, infinitely differentiable function, Maclaurin series, differentiation of vector valued functions, Theorems of vector differentiation.

Riemann integral, properties, fundamental theorem of integral calculus, mean value theorem, improper integral and its convergency and tests.
(Marks 25)

Unit 4:(Sequence and series in metric space)

Convergent sequence, subsequence, Sandwich theorem, monotonic sequence, limsup, liminf, Bolzano-Weierstrass Theorem for sequence, Cauchy sequence.
Infinite series: convergent series, absolute convergence, series of nonnegative real numbers,

comparison test, root test, ratio test, power series, extended real line, conditional convergence, rearrangement of terms.
(Marks 10)

Unit 5: (Sequence and series of functions)

Sequence of functions, pointwise convergence, series of functions, uniform convergence, uniformly bounded sequence, Cauchy's criterion for uniform convergence, uniformly Cauchy sequence, Weierstrass' M test, Dini's theorem, uniform convergence and continuity, uniform convergence and integration of functions, uniform convergence and differentiation of functions, Weierstrass theorem. **(Marks 15)**

Text Books:

1. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill Education, 2017.
2. R. K. Goldberg, Methods of Real Analysis, Oxford &lbh, 2012.

References:

1. R. G. Bartle, D. R. Sherbert, Introduction to real analysis, 3rd Edition, Wiley India, 2010.
2. S. C. Malik, S. Arora, Mathematical Analysis, New Age International Publishers, 2006.
3. T. M. Apostol, Mathematical Analysis, 2nd Edition, Narosa Publication, 2002.

Differential Equations I (MSM 102)

COURSE OUTCOMES (COs):

CO1.Concept of Differential Equation

CO2. Classification of differential equation according to linearity and order.

CO3. Solution of Differential equation interpretation.

CO4. Using integrating factor, Separable and Homogeneous equations can be convert to exact differential Equation.

Unit 1:

Linear Differential Equation of second order, General solution of Homogeneous Equation, Method for non-homogeneous problem, variable coefficient, Variation of Parameter.
(Marks 10)

Unit 2:

Existence Theorem of 1st order equation, Statement of Existence Theorem for a system of 1st order equation and for nth order differential equation.
(Marks 10)

Unit 3:

Series Solution for ODE, Solution about an arbitrary point, Types of Singularity, Solution at a singular point.
Method of series solution of 2nd order differential equation with particular reference to Legendre, Bessel, Hermite and Gauss, Hypergeometric series, Solution of Hypergeometric series, Gauss's Hypergeometric equation, Symmetric property of Hypergeometric equation.

(Marks 20)

Unit 4:

Simultaneous Differential Equation, Total Differential Equation.
(Marks 10)

Unit 5:

Origin of partial differential equation of 1st order linear partial differential equation, Lagrange's method of solving 1st order,Particular solution under various prescribed conditions. Linear homogeneous equations with more than two independent variables. Charpit's method of solving nonlinear 1st order partial differential equation, Complete Integrals, Standard forms of nonlinear 1st order partial differential equation.

(Marks 20)

Text Books:

1. Earl A.Coddington, An introduction to ordinary differential equation, Prentice Hall of India, 1997.
2. I. N. Herstein, Introduction to partial differential equation, Prentice Hall of India.
3. M. D.Raisinghaniya, Advanced Differential Equation,18th Edition, S Chand, 2016.

Abstract Algebra (MSM 103)

COURSE OUTCOMES (COs):

CO1.Understand definition and example of group, some special groups, subgroups, normal subgroup and their properties, center and normalizer of a group, cyclic group,class equation of a group, Sylow's theorems and their applications and classification of groups.

CO2. They will learn about Simple group, separable and non-separable group.

CO3. They will learn Definition and example of Ring, Ideal, prime and maximal ideal, integral domain, Euclidian domain, PID, UFD, reducibility of polynomial ring etc.

CO4. They will learn the basic concept and properties of finite field.

Unit 1 (Introduction to Groups):

Groups,abelian groups,subgroups, cyclic groups.Coset, Dihedral group, permutation groups, Quaternion groups. Homomorphism of groups, isomorphism of groups, cosets and Lagrange's theorem. **(Marks 15)**

Unit 2 (Direct products of Groups):

External direct products, internal direct products, fundamental theorem of finite Abelian groups. **(Marks 10)**

Unit 3 (Group Actions):

Group actions, class equations of finite groups, Sylow's theorem and applications.

(Marks 15)

Unit 4 (Series of Groups):

Normal and subnormal series, composition series, solvable groups, nilpotent groups and Jordan Holder theorems and applications. **(Marks 10)**

Unit 5 (Introduction to Rings):

Rings, integral domains, ideals and factor rings, homomorphism of rings, prime and maximal ideals. Polynomial rings, factorization of polynomials, divisibility in integral domains: PID, UFD, Euclidean domains. (Marks 20)

Text Books:

1. P. B. Bhattacharya, S. K. Jain and S. R, Nagpal, Jain, Basic Abstract Algebra, 2ndEdition, Cambridge University Press, 1994.
2. Joseph A Gallian, Contemporary Abstract Algebra, 4th Edition,Narosa Publishing house, 1999.

References:

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. N. S. Gopalakrishnan, University Algebra, 2nd Edition, New Age International Publisher, 2016.
3. D. S. Dummit and R. M. Foote, Abstract algebra, 3rd Edition, John Wiley & Sons, 2004.

4. J. B. Fraleigh, A First Course in Abstract Algebra, 3rd Edition, Narosa Publishing House, 2003.
5. S. Singh, Q. Zameeruddin, Modern Algebra, Vikas Publishing House Pvt Ltd.

Numerical Analysis (MSM 104)

COURSE OUTCOMES (COs):

CO1. Problem solving using numerical methods

CO2. Graphical representation of complex problems to solve accurately

CO3.Simulation with the help of numerical analysis can be done accurately and easily

CO4. Helps in multidisciplinary fields like electronics and electrical engineering to design complex circuits using finite difference equations.

Unit 1: (Calculus of finite Difference)

Finite Difference: Introduction, Difference, Difference formulae, Fundamental theorem of difference calculus, the difference table, the forward difference operator Δ, the backward difference operator ∇, the operator E, properties of two operator E and Δ, relation between operator E of finite differences and differential coefficient D of differential calculus, factorial notation, recurrence relation.
(Marks 10)

Unit2: (Interpolation)

Interpolation with equal intervals:Newton's interpolation formula, Newton Gregory forward difference interpolation formula, Newton Gregory backward difference interpolation formula.

Interpolation with unequal intervals:Divided Differences, Newton's Divided Difference formula, Langrange's Interpolation Formula.**(Marks 20)**

Unit 3: (Numerical Differentiation and Integration)

Numerical Differentiation and Integration,quadrature formula,Gauss's quadrature formula, Simpson's rule, Weddle's central differenceformula, Euler's formula for summationand quadrature.
(Marks 15)

Unit 4: (Solution of Algebraic and Transcendental Equations)

Numerical Solutions of Algebraic and Transcendental Equations, Solutions by the method of iteration and the Newton-Raphsonmethod, cases of repeated roots,bijection and graphical methods.

(Marks 10)

Unit 5: (Linear Equations)

Direct method for solving systems of linear equations (Gauss Elimination, LU decomposition, Cholesky decomposition), iterative methods (Jacobi, Gauss-Seidel,Relaxation methods).
(Marks 15)

Text Books:

1. K. S. Kuntz, Numerical Analysis, CreateSpace Independent Publishing Platform, 1974.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods, 2nd Edition, New Age International (P) limited Publishers, 2008.

References:

1. F. Scheid, Numerical Analysis, Schaum's Outline series, McGraw-Hill, 1989.
2. J. D. Hoffman, Numerical Methods for Engineers and Scientists, 2nd Edition, CRC Press, 2001.
3. J. B. Scarborough, Numerical Mathematical Analysis, 6th Edition, Oxford &lbh, 2005.

Linear Algebra (MSM 105)

COURSE OUTCOMES (COs):

CO1. Introduction to basic concepts of system of linear Equations.

CO2. Understand the concepts of vector space, basis and dimension.

CO3. Study of linear transformation, representation of linear transformation by matrices.

CO4. Introduction to canonical product, Diagonalization, orthogonality , inner product space etc.

CO5. Increase problem solving technique like finding eigen value, eigen vectors, linear dependence, independence, rank and nullity etc.

Unit 1: (Linear transformations)

Vector Space, Linear Independence, Linear Dependence, base, dimension, Linear transformation, matrix representation of a linear transformation, kernel and image of a linear transformation, singular and non-singular linear transformation, the rank-nullity theorem, dual spaces, transpose of a linear transformation. **(Marks 15)**

Unit 2: (Diagonalization: Eigen values and Eigen vectors)

Polynomials of matrices, characteristic polynomial, Cayley- Hamilton theorem, diagonalization, Eigen values and Eigen vectors, minimal polynomial, characteristic and minimal polynomial of block matrices.**(Marks 15)**

Unit 3: (Canonical & Bilinear forms)

Diagonal form, triangular form, Jordan canonical forms. Bilinear, positive and quadratic forms.
(Marks 15)
Unit 4: (Inner product spaces)

Inner product spaces, Cauchy-Schwarz inequality, orthogonal sets and bases, orthonormal bases, Gram Schmidtorthogonalization process, orthogonal and positive definite matrices.

(Marks 15)

Unit 5: (Linear functional and adjoints)

Linear functional and adjoints of operators, self adjoint, normal and unitary operators; orthogonal projections; spectral theorem for normal operators on a finite dimensional vector space. **(Marks 10)**

Text Books:

1. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall, 2010.
2. P. R. Halmos, Finite dimensional vector spaces, Springer Verlag, New York, 1974.

References:

1. P. R. Halmos, Linear Algebra Problem Book,The Mathematical Association of America(MAA), USA, 1995.
2. P. K. Saikia, Linear algebra, Pearson Education India Publishers, 2001.
3. Michael Artin, Algebra, Person Publishing House, 2015.
4. David C. Lay, Linear Algebra and its applications, Pearson Education, 2009.

Topology (MSM 201)

COURSE OUTCOMES (COs):

CO1.They will learn about countable and uncountable sets, Cantor's theorem and continuum hypothesis, Zorn's lemma and well ordering theorem and definition and examples of topology.

CO2. They will learn about base and sub base of topology, ordered, product and subspace topology and their relation.

CO3. They will learn about the closed set, closure, derive set, limit point and boundary of a set.

CO4. They will learn the countable and separation axioms of topology.

CO5. Understand about the basic properties of compactness.

CO6. Learn about connected space and component.

Unit 1 (Introduction to Topology):

Countable and uncountable sets, Infinite sets and the axiom of choice, Cardinal numbers and its arithmetic, Schroeder-Bernstein theorem, Cantor's theorem and the continuum hypothesis, Zorn's lemma, well ordering theorem, Definition and examples of topological spaces, Bases and sub bases, subspaces and relative topology, Order topology, product topology on $X \times Y$.
(Marks 15)

Unit 2 (Basic concepts in Topological Spaces):

Neighbourhoods, interior, exterior and boundary, Closed sets, closure, dense subsets, Accumulation point and derived sets., Limit points, boundary of a set, Kuratowski closure operator and the generated topology, Continuous functions, open mapping, closed mapping and homeomorphism, Quotient topology, metric topology, Complete metric spaces, Bairecatrgory theorem.
(Marks 15)

Unit 3 (Countable and Separable Axioms):

Countable axioms, Separation axioms T_0, T_1 : their characterization and basic properties, Separation axioms T_2, $T_{31/2}$, T_4 : their characterization and basic properties, Urysohn's Lemma, Tietze extension theorem.
(Marks 15)

Unit 4 (Compactness):

Compactness, basic properties of compactness, Continuous functions and compact sets, Compactness and finite intersection property, sequentially and countably compact sets, Local compactness and one point compactification, Compactness in metric spaces, equivalence of compactness, countable compactness and sequential compactness in metric spaces.
(Marks 15)

Unit 5 (Connectedness):

Connected spaces, disconnected spaces, connectedness on real line, Components, Totally disconnected spaces, locally connected spaces.**(Marks 10)**

Text Books:

1. J. R.Munkres, Topology, Second Edition, Prentice Hall, 2008.
2. K. D. Joshi, Introduction to general topology, New Age International Publisher Ltd. 1984.

References:

1. G. F. Simmons, Introduction to topology and Modern Analysis, Tata McGraw-Hill Publishing company Ltd. 2004.
2. J. L. Kelley, General Topology, Springer India, 1975.
3. J. Dugundji, Topology, McGraw-Hill Inc., 1966.

Differential Equations II (MSM 202)

COURSE OUTCOMES (COs):

CO1. We can solve Boundary value problem. With this study we have discussed about wave problem, Heat problem etc.

CO2. Using Monge's method we will solve special type of non linearpartial differential equation.

CO3. Calculus of variations helps to understand what functional are and their application.

CO4. Study Euler-Lagrange equation to find differential equation for stationary paths.

Unit 1:

Existence and Uniqueness of solutions of initial value problems for first order ordinary differential equations, Clairauts form, singular solutions of first order ODEs, system of first orderODEs. Linear Differential System, Green's Matrix, Equivalent Differential System. **(Marks 15)**

Unit 2:

General theory of homogenous and non-homogeneous linear second order ODEs, Sturm-Liouville boundary value problem. Self Adjoint boundary problems associated with second order linear differential equation. **(Marks 10)**

Unit 3:

Cauchy problem for first order PDEs. Classification of second order PDEs,Calculus of Variation with one independent variable, Euler-Lagrange's equation, Isoperimetric problem, Second variation. **(Marks 15)**

Unit 4:

General solution of higher order PDEs with constant coefficients, Monge's Method, Method of separation of variables for Laplace, Heat and Wave equations, Hamilton-Jacobi Equation, **(Marks 15)**

Unit 5:

Boundary Value problems, Laplace's Equation, Laplace's and Wave equations for plane, Wave equation, Laplace's Equation for plan polar coordinates, Green's function, cylindrical coordinates and spherical coordinates.

(Marks 15)

Text Books:

1. I.N Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
2. S.Kesavan,Topics in Functional Analysis and Application,Wiley Eastern, New Age International, 1989.
3. Phoolan Prasad and RenukaRavindran, Partial Differential Equations, New Age International Publisher, 2005.

References:

1. W.T Reid,Ordinary Differential Equations, John Wiley & Sons, 1971.
2. I. M. Gelfand and S. V. Fomin, Calculus of Variation, Dover Publications, 2000..
3. M. D. Raisinghania, Advanced Differential Equations,18th Edition, S Chand, 2016.

Complex Analysis(MSM 203)

COURSE OUTCOMES (COs):

CO1. Introduction to the basic concept and properties of complex numbers.

CO2. Study of differentiability, limit, continuity of a complex number.

CO3. Introduction to analytic function, C-R equation, harmonic function, harmonic conjugate etc.

CO4. Study of complex Integration, Cauchy Integral theorem,Lioville's theorem power series etc.

CO5. Understand the concept of singularity

CO6. Increase problem solving method.

Unit 1 (Analytic Functions):

Introduction: Analytic functions, Derivative of a Complex function comparison between differentiability in the real and complex Senses, Cauchy-Riemann Equations, Necessary and

Sufficient condition for analyticity of the complex function, Harmonic Function and Harmonic conjugates.

(Marks 15)

Unit 2 (Integration):

The complex Integral. Cauchy's Theorem and Integral Formulae. Morera's theorem, Fundamental theorem of algebra, Lioville's theorem, Maximum Modulus Principle and its Applications, Schwarz's Lemma, Index of a closed Curve, Contour, Index of a Contour, Simply Connected Domains.

(Marks 20)

Unit 3 (Power Series):

Power Series, Taylor's and Laurent's Theorem, Zero and Singularity of an Analytic function, The Argument Principle, Rouche's Theorem, Cauchy's Residue Theorem, Evaluation of Definite Integrals.

(Marks 15)

Unit 4 (Conformal Mapping):

Conformal mappings, Mobius transformations. The Little Picard Theorem. The range of an Analytic function, Bloch's Theorem. **(Marks 15)**

Unit 5 (Canonical Products):

Canonical Products. Jensen Formulae. Poisson-Jensen Formulae, Hadamard's Three Circle's Theorem, Order of an entire function, Exponent of convergnce, Borel's theorem (statement and example), Hadarmard's factorization theorem (statement and example). (Marks 10)

Text Books:

1. John B Conway, Functions of One Complex Variable, Springer, 1978.
2. R. V. Churchill and J. W. Brown, Complex variables and applications, McGraw-Hill Publishing Company,1990.

References:

1. E. G. Philips, Functions of a complex variables with applications, Edinburgh: Oliver and Boyd, 1961.
2. M.R. Spiegel, S. Lipschutz, J. J. Schiller and D. Spellman, Complex variables. Schaum'sOutlines, McGraw Hill, 2010.
3. L. V. Ahlfors, Complex Analysis, 3rd Edition, McGraw-Hill Publishing Company, 2017.

Mechanics and Tensor (MSM 204)

COURSE OUTCOMES (COs):

CO1. Understand motion in three dimension and motion in spherical and conical surface.

CO2. Study of motion of a rigid body in 2-D, compound pendulum, D'Alembert's Principle, motion under impulsive forces.

CO3. Understand the application of principle of virtual work in impulsive forces, Carnot's theorem, Kelvin's theorem and Bertrand's theorem.

CO4. Study of generalized coordinates and Lagrange's equation of motion for finite and impulsive forces in holonomic systems.

CO5. Understand the concepts of Transformation of coordinates, Kronecker delta, outer and inner product of tensors, Christoffel's three-index symbols etc.

Unit 1:

Motion in three dimension, velocity and acceleration in cylindrical polar and spherical coordinates, motion on cylindrical, spherical and conical surfaces, Application.

(**Marks 10)**

Unit 2:

Motion of a rigid body in 2-D, Compound pendulum, D'Alembert's Principle, motion under impulsive forces, Application of principle of virtual work in impulsive forces, Carnot's theorem, Kelvin's theorem and Bertrand's theorem, Motion of a rigid body about a fixed point, Euler's Geometrical & Dynamical equations, Motion under no external forces**.**

(Marks 20)

Unit 3:

Generalized coordinates, Lagrange's equation of motion for finite and impulsive forces in holonomic systems, Case of conservative forces and theory of small oscillation, Hamilton's equation of motion, Variational methods, Hamilton's principle and principle of least action.

(**Marks 15)**

Unit 4:

Transformation of coordinates, summation convention, Kronecker delta, definition of tensors covariant, contra variant and mixed tensor, Cartesian tensors, rank of a tensor, symmetric and antisymmetric tensors, outer and inner product of tensors, contraction, quotient law, Riemannian space, metric tensor, fundamental tensors, associate tensors, magnitude of a vector, angle between two vectors ,Parametric curves, group property of tensor.

(**Marks 10)**

Unit 5:

Christoffel's three-index symbols (or brackets) and properties, covariant differentiation of sum and product of tensors, divergence and curl of a vector and gradient of a scalar. Intrinsic derivatives, curvature of a curve, parallel displacement of vectors. (**Marks 15)**

Text Books:

1. F. Chorlton,Text Books of dynamics, Van Nostrand, 1967.
2. S.L. Loney,Dynamics of a particle and of rigid bodies, CUP, 1889.
3. B. C. Kalita, Tensor Calculus & Application: Simplified tools and Techniques, Tylor & Francis, 2018.

References

1. H. Goldstein, C. P. Poole and J. Safko, Classical mechanics, Addison Wesley, 3rd Edition, 2000.
2. M. R. Speigel, Theritical Mechanics, Schaum's Outline series, McGraw Hill, 2017.
3. J. L. Synge and B. A. Griffith,Principles of mechanics, McGraw Hill, 2015.

Programming with C&Mathematica (MSM 205)

(Theory and Practical, Theory 50 + Practical 20)

COURSE OUTCOMES (COs):

CO1.As a middle level language ,C program combines both high level and low level languages.

CO2.It can be used for scripting for drivers and software applications and kernels.

CO3. Companies like Facebook, Google, etc use C for operating systems, games, embedded technology, etc.

CO4. Mathematica helps in building technical, computing web services, including numerical, symbolic, and graphical applications that solve technical problems quickly and easily

Unit 1:

An overview of Programming : The basic model of computation, Algorithms, flow charts, programming languages, Compilation, Linking and Loading, Testing and Debugging, Documentation, Efficiency and analysis of algorithms.C Essentials :Character set, Variables and Identifiers, Build in data types, variable definition, Operators and Expressions, Constants

and Literals, type conversions, Basic input/output operations, Anatomy of a C program.
(**Marks 10)**

Unit 2:

Control Flow : Conditional Branching, The switch statement, Looping, Nested Lops, The Break and Continue statement, the go to statement, infinite Loops. **(Marks 10)**

Unit 3:

Arrays and Pointers: Declaration, initialization and manipulation of one and two dimensional arrays. Strings, Address operators, pointer type declaration, initialization, pointer arithmetic.
(**Marks10)**

Unit 4:

Functions and Program Structure: Basics of functions, passing arguments, declarations and calls, return values, recursion, the main function. Scope andlifetime of variablesin functions.
(**Marks 10)**

Unit 5:

Basic idea of Structure and Unions: Structure variables, initialization, structure assignment, array within structures . File handling: Opening and closing text file and data file. Commands for Reading and writing data.
(Marks 10)

Sample Program for Practical **(Marks 20)**

To evaluate an arithmetic expression, to find gcd, factorial, Fibonacci sequence, Prime number generation, reversing digits of an integer, finding square root of a number, roots of a quadratic equation, to find the greatest and smallest of a finite set of numbers by sorting, sum of different algebraic and trigometric series. Sum and multiplication of matrices. Solution of ordinary differential equations etc.

Text Books:

1. T. Jeyapoovan, A first course in Programming with C, Vikas Publishing House, 2004.
2. E. Balaguruswamy- ANSI C, McGraw-Hill Education India pvt ltd, 2008.

References:

1. R.G. Dromey, How to solve it by Computer, PHI, 2006.

Number Theory (MSM 301)

COURSE OUTCOMES (COs):

CO1. Will learn about division, division algorithm, Euclidian algorithm, gcd, lcm etc.

CO2. Understand about the congruence and its properties and applications, order of an element, primitive element etc.

CO3. Understand about quadratic residues, Legendre and Jacobi symbols, higher power residues, Fermat's Little theorem, Euler theorem, necessary and sufficient condition for the existence of primitive root.

CO4. They will learn about Fibonacci sequence and its properties, Continued fraction and its properties etc

Unit 1 (Divisibility Theory):

Divisibility and Devisor function, Greatest common divisor, least common multiple, Euclidean algorithm, Prime numbers, factorization in prime numbers, fundamental theorem of arithmetic. Perfect numbers, Mersenne numbers, Fermat numbers.

(**Marks 15)**

Unit 2 (Congruence):

Concept of congruence and properties, residue classes and reduced residue classes, Euler-Fermat's Theorem. Wilson's Theorem, linear congruence, Chinese Remainder Theorem, polynomial congruence. **(Marks 10)**

Unit 3 (Primitive Roots):

Primitive roots, indices, order, necessary and sufficient condition for the existence of primitive roots, primitive roots for prime.**(Marks 15)**

Unit 4 (Quadratic Residues):

Quadratic residues, Legendre's symbol, Euler's Criterion, Gauss' Lemma, Quadratic reciprocity Law, Jacobi symbol, quadratic congruence of second degree with prime modulus

and with composite modulus.

(Marks 15)

Unit 5 (Fibonacci numbers and Continued Fraction):

Fibonacci numbers, the Fibonacci sequences, certain identities involving Fibonacci numbers.Continued fractions, simple continued fractions, approximation of irrational numbers by continued fractions, Pell's equation. **(Marks 15)**

Text Books:

1. D.M. Burton, Elementary Number Theory, McGraw-Hill Education, 2014.
2. Niven& Zuckerman, An Introduction to the Theory of Numbers, Wiley Edition, 1999.

References:

1. W. Sierpinski, Elementary Theory of Numbers, North-Holland PWN- Polish Scientific publisher, 1970.
2. Kenneth H. Rosen, Elementary Number Theory and its Application, Pearson Publisher, 2005.

Functional Analysis (MSM 302)

COURSE OUTCOMES (COs):

Co1.Understand the basic principles of functional analysis

Co2. Understand the concept of Banach spaces, linear operators and continuous linear functional.

Co3. Introduction to Hilbert space, operators on Hilbert space.

Co4. Understand the concept of Representation Theorems and Hahn –Banach extension theorem.

Co5.Understand the principles of Spectral theory.

Unit 1:

Normed linear space and Banach spaces: Definitions and examples, properties of Banach spaces, continuous linear functional. **(Marks 15)**

Unit 2:

Finite dimensional normed linear space, Compact linear operators on normed linear space, basic properties, bounded linear maps. **(Marks 10)**

Unit 3:

Hahn Banach theorem, Open mapping Theorem, Closed Graph Theorem, BanachSteinhaus Theorem. **(Marks 10)**

Unit 4:

Hilbert spaces: Definition and properties, orthogonal complement, orthogonal sets, Conjugate space, Adjoint of an operator, Self-adjoint of an operator, Normal and Unitary operators, Projection. **(Marks 20)**

Unit 5:

Finite dimensional Spectral theory: Spectrum of an operator, Spectral theorem, positive operators, projection operators, spectral representation of bounded self adjoint linear operators. **(Marks 15)**

Text Books:

1. B. V. Limaye,Functional Analysis, 2nd Edition, Wiley Eastern, 1996.
2. W. Rudin, Functional Analysis, McGraw Hills

References:

1. Robert E Megginson,An Introduction to Banach space theory, springer Verlag.

Mathematical Methods (MSM 303)

COURSE OUTCOMES (COs):

CO1. Understand the concepts of convolution theorem, inverse Laplace transform, laplace transform with application to the solution of differential equations

CO2. Understand the concept of Fourier transform and its applications.

CO3. Introduction to integral equation and finding solution.

CO5.Maline Transform and Hankel Transforms and their application

CO4. Increase problem solving technique.

Unit 1: (Laplace Transformation)

Convolution theorem, Inverse Laplace Transform, Laplace Transform with application to the solution of differential equations, Solution of ordinary and partial differential equation. **(Marks 15)**

Unit 2: (Fourier Transformation)

Fourier Transform: Fourier Sine and cosine transform, Fourier Integral Integral Transform, Application of Fourier Transform to ordinary and partial differential equations of initial and boundary value problems. **(Marks 15)**

Unit 3: (Fredholm Integral Equation)

Definition of Integral equation, eigenvalues and eigen functions, Reduction of ordinary differential equation to Integral equation, Solution of Linear Integral Equations, Fredholm's Integral Equations with separable kernels, Method of successive Approximations, Fredholm's Integral equation of second kind.

(Marks 15)

Unit 4: (Voltera Integral Equation)

VolteraIntegral Equations, Voltera Integral equation of second kind, Resolvent kernel of Voltera Integral equation, Solution of Voltera Integral equation. (**Marks 15)**

Unit5: (Maline and Hankel Transformation)

Maline Transform and Hankel Transforms and their application. **(Marks 10)**

Text Books:

1. R. P. Kanwal,Linear integral equations, theory and techniques, academic press, New York.
2. Francis B, Methods of Applied Mathematics,Hilerbrand, Prentice Hall of India.
3. R. Conrant& D. Hilbert, Methods of Mathematical Physics- Vol 1, Wiley Interscience, Newyork, 1953.

References:

1. M R Spiegel, Theory and problems of Laplace transform.
3. A. D. Poularikas ,The Laplace Transforms and Applications-Handbook, CRC Press, 1996.
4. J. W. Brown and R. Churchill, Fourier Series and Boundary Value Problems, McGraw Hill, 1993.
5. M. D. Raisinghania, Integral transform, S Chand.

Continuum Mechanics & Hydrodynamics (MSM 304)

COURSE OUTCOMES (COs):

CO1. The theory of continuum is useful to geometrical deformation analysis obtained from repeated positional survey in geodesy.

CO2. It serves as a technological and scientific communication basis in different areas like geophysics, etc.

CO3. Hydrodynamics help in the smooth running of cooler fans because there is less friction and mainly viscous loss to the oil.

CO4. Helps in the lowering of wear between metal bearings and race components giving them longer life to sustain.

Unit1:

Analysis of Stress: The continuum concept. Homogeneity isotropy mass density. Cauchy's stress principle. Stress tensor. Equations of equilibrium. Stress quadric of Cauchy. Principal stresses. Stress invariants. Deviator and spherical stress tensors.

(Marks 10)

Unit 2:

Analysis of Strain: Lagrangian and Eularian descriptions. Deformation tensors. Finite strain tensor. Small deformation theory. Linear strain tensors and physical interpretation. Stress ratio and finite strain interpretation strain quadric of Cauchy.Principal strains. Strain invariants. Spherical and Deviator strain components. Equation of Compatibility.

(Marks 15)

Unit 3:

Constitutive equations of Continuum Mechanics: Linear elasticity.Generalized Hook's Law. Strain energy function. Elastic constants for isotropic homogeneous materials. Elaststatic and Elastodynamic problems.Fluids: Viscous Stress tensor. Barotropicflow :Stokesian fluids. Newtonian fluids,Navier stokes equations. Irrotational flow. Perfect fluids. Bernoulis equation. Circulation. **(Marks 15)**

(For Hydrodynamics)

Unit 4:

Kinematics of fluid motion: Path lines stream lines equations of continuity equation of motion and their integrals boundary conditions. Impulsive motions. Analysis of fluid motion and general theory of irrotational motion.**(Marks 10)**

Unit 5:

Motion in a plane: Use of Complex potential. Source. Sink doublet. Method of images.The Circle theorem. The theorem of Blasius. Motion past circular cylinder.
(Marks 10)

Unit 6:

Motion in space: Motion past a sphere axisymmetric motion. Stoke's stream function and its use.Vortex motion : Properties of vortex filament motion due to rectilinear vortex and a system of vortices motion of a vortex filament due to the influence of others. Ranking vortex.

(Marks 10)

Text Books:

1. G.E.Mase, Continuum Mechanics, McGraw-Hill.
2. Hydrodynamics, Horace Lamb, Cambridgruniversity Press.
3. M. D. Raisinghania, Hydrodynamics, S Chand.

References:

1. L M Milne Thomson, Theoretical Hydrodynamics, Mc Millan company.
2. W H Besant and A S Ramsey, A treatise on Hydrodynamics, Part II, CBS publishers, Delhi.

Special Theory of Relativity (MSM 305A) (Optional)

COURSE OUTCOMES (COs):

CO1.Study about failure of Galilean Transformation

CO2.Understand Lorentz Transformation

CO3. Understand Space and Time in Relativity

Co4.Study about momentum and energy in Relativity

Unit 1:

Inertial and non-inertial frames, Geometry of Newtonian mechanics, GalileaTransformations, Back-ground of the fundamental postulates of the special theory ofrelativity, Lorentz transformation. Relativistic concept of space and time and relativity ofmotion.

(Marks 20)

Unit 2:

Relativistic addition law of velocities and its interpretation in terms of Robb'srapidity, Invariance of sped of light, consequences of Lorentz transformation eg (I), Lorentz Fitzgerald contraction (ii) Time dilation (iii) Simultaneity of events, Properlength and proper time.

(Marks 20)

Unit 3:

Relativistic mechanics. Variation of mass with velocity, Transformation of mass,force and density Equivalence of mass and energy, Transformation of momentum andenergy, Energy momentum vector.

(Marks 10)

Unit 4:

Minkowaki's space, Geometircal representation of simultaneity, Contraction anddilation, space like and time like intervals, Relativistic equations of motion.

(Marks 10)

Unit 5:

Electrodynamics: Fundamentals of electrodynamics, Transformation ofdifferential operators, D' Alembert operator, Drivation of Maxwell's equation,Electromagnetic potentials and Lorentz condition, Lorentz face, Lorentz transformationsof space and time in four-vector form.

(**Marks 10)**

TextBooks

1. R.Resnick,Introduction to special Relativity, Wiley Eastern Lt. 1990.
2. A S. Eddington, The Mathematical Theory of relativity, Cambridge University Press 1965.

References:

1. Relativistic Mechanics (Theory of Relativity) PragatiPrakashan, 2000-SatyaPrasash
2. K.D Krori,Fundamentals of Special & General Relativity, PHI.

Operations Research (MSM 305B) (Optional)

Unit 1:

History and Development of Operations Research. Operation Research and its Scope Necessity of Operation Research in Industry and Management, General idea of queuing problem-Markovian and non Markovian queues.

(Marks 10)

Unit 2:

Simulation: Theory of simulation. Monte Carlo method application to the problems of replacement and maintenance inventory, queuing and financial problems.**(Marks 10)**

Unit 3:

Linear Programming: Simplex method. Theory of the simplex Method Duality and sensitivity Analysis. Other Algorithms for Linear Programming DualSimplex Method. Integer programming-Branch and Bound technique. Concept of cutting plane. Gomory's all integer cutting plane method. Applications to Industrial Problems: - Optimal product mix and

activity levels. Petroleumrefinery operations blending problems. Economic interpretation of dual linear programming problems. Input-output analysis.

(Marks 20)

Unit 4:

Transportation and Assignment Problems, New York Analysis- Shortest Path Problem. Minimum Spanning Tree Problem. Maximum Flow Problem, Minimum Cost Flow Problem. Network simplex Method. Project Planning and Control with PERT-CPM.**(Marks 20)**

Unit 5:

Nonlinear Programming: One and Multi-Unconstrained Optimization. Kuhn-Tucker Conditions for Constrained Optimization. Quadratic Programming. Separable Programming Convex Programming Non-convex Programming. **(Marks 10)**

Text Books:

1. H. S.Kasana and K. D. Kumar,Introductory operations research, Springer.
2. G Hadely, Linear Programming, Narosa Publishing house
3. H A Taha,Operation Research, an introduction, Macmillan Publishing Co Inc

References:

1. F. S. Hillier and G J Lieberman,Introduction to operation research, McGraw Hill.
2. P. K. Gupta and Monmohan,Operation research, KantiSwarup, S chand and Co.
3. P. K. Gupta and D. S.Hira,Operation research-An introduction, S chand and Co.

Graph theory (MSM 401)

COURSE OUTCOMES (COs):

CO1. Student will learn the definition and example of graphs, various operation on graphs, homomorphism and isomorphism of graphs.

CO2.They will learn about graph connectivity and complete graph.

CO3. They will learn various properties of Tree, types of tree and some algorithms. And also cycle and co-cycle space.

CO4. They will learn basic concept and properties of Eulerian, Hamiltonian and Planer graph.

CO5. They will learn the basic concept of coloring and covering of graphs and their applications.

Unit 1 (Introduction to graph):

Graphs: History, the Konigsberg bridge problem, basic ideas, definition of graphs, sub graph, spanning and induced sub graph, degree and incidence, multi and pseudo graphs, digraphs,

bipartite graph, isomorphism and homeomorphism of graphs, operations on graphs: union, intersection, join, product, composition. **(Marks 10)**

Unit2 (Connectivity):

Connectivity: Connectivity, walk, path, circuit, cut-vertex, fundamental cut set, separable and non-separable graphs, components of a graph, complete graph, edge and vertex connectivity and related theorem. **(Marks 15)**

Unit 3 (Tree):

Tree: Introduction of trees and characterization, theorems on trees, forest, spanning trees, minimum spanning tree and its algorithms, rooted tree, binary tree, cycles, co-cycles, cycle spaces, co-cycle spaces. **(Marks 15)**

Unit 4 (Traversability):

Traversability: Eulerian graphs and its properties, Necessary and sufficient conditions, Hamltonian graphs and its properties, Necessary and sufficient conditions. Planarity: Plane and planer graphs, outer planer graphs, Euler's polyhedron formula, different representations of planer graphs, detection of planarity, Kuratowski's theorems. **(Marks15)**

Unit 5(Covering and Coloring):

Covering and coloring: Covering, independence and domination, matching, coloring: vertex coloring, chromatic number, edge coloring, five coloring theorem, four color conjecture, six colorable graphs, unique colorable graphs, chromatic polynomial. **(Marks 15)**

Text Books:

1. F. Harary, Graph theory, Narosa Publishing House.
2. K R Parthasarathy, Basic graph theory, McGraw-Hill Professional Publishing.

References:

1. NarasinghDeo,Graph theory with applications to engineering and computer science, PHI.
2. ChrisGodsil, Gordon Royle, Algebraic graph theory, Tata McGraw Hill,Springer.

Advanced Partial Differential Equation (MSM-402)

COURSE OUTCOMES (COs):

CO1. Partial differential equations have a remarkable ability to predict the world around us.

CO2. They can describe exponential growth and decay.

CO3. Partial differential equation helps in calculating the population growth of a species or the change in investment return over time.

CO4.They are also used in medicine estimation for modeling cancer cells growth

Unit 1:

Classification of second order PDE,Reduction of linear and quasilinear equations in two independent variables to their canonical form.**(Marks 10)**

Unit 2:

Study of VonderpolEquation,Perturbrative method, Derivation of KdV equation and its solution. **(Marks 20)**

Unit 3:

Euler-Lagrange Equation with two and more independent variable and its Application, Calculus of variation in various forms of isoperimetric problem. **(Marks 10)**

Unit 4:

Wave equation-Solution by spherical means, Non homogeneous equation, Energy Methods.

(Marks 20)

Unit 5:

Distributions**,**Test function and distributions,Examples and Fourier Transforms,Schartz space. **(Marks 10)**

Text Book:

1. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications.
2. L.C.Enans, Partial Differential Equation,Graduate Studies in Mathematics,vol 19,AMS 1998

Fluid Dynamics (MSM 403A) (Optional)

COURSE OUTCOMES (COs):

CO1. Bernoulli's principle in Fluid Dynamics helps in the design of airplane's wings, which helps in maintaining the pressure over the plane.

CO2.Fluid Dynamics is used in turbines for the generation of power from hydroelectric dams.

CO3. Fluid dynamics help in the design of pumps, compressors, and piping used in airconditioning system of homes.

CO4. The fundamental principles of fluid dynamics are used to explain the mechanisms of biological flows and their interrelationships with physiological processes in health and disease disorder

Unit 1:

Waves: Long wave and surface wave stationary wave. Energy of the waves. Waves between different media. Group velocity Dynamical significance of Group velocity. Surface tension and Capillary waves. Effect of Surface tension in water waves.

(Marks 15)

Unit 2:

Viscous fluid motion: Navier-Stokes equation of motion rate of change of vorticity and circulation rate of dissipation of energy. Diffusion of a viscous filament. **(Marks 15)**

Unit 3:

Exact solution of Navier Stokes Equation: Flow between plates. Flow through a pipe (circular elliptic). Suddenly accelerated plane wall. Flow near an Oscillating flat plate. Circular motion through cylinders, Stoke's linearization process. Flow past a sphere. Whitehead paradix and Stoke's paradox. Oseen's approximation. **(Marks 15)**

Unit 4:

Laminar Boundary Layer Theory: General outline of Boundary layer flow. Boundary layer thickness. Displacement thickness. Energy thickness. Flow along aflat plate at zero incidence. Similarity solution and Blasius solution for flow about a flat plate. **(Marks 15)**

Unit 5:

Energy integral equation, Karman's momentum integral equation. Energy integral equation. Pohlhausen solution of momentum integral equation. Two dimensional Boundary layer equations for flow over a curved surface. Blasius solution for flow past a cylindrical surface phenomenon of separation.

(Marks 10)

Text Books:

1. Modern Fluid Dynamics, N. Curle and H. Davies, Van Nostrand Reinhold, 1966.
2. Theoretical Hydrodynamics, L. M. Milne Thomson, Macmillan and Co., 1960.

References:

1. G. K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press,1993.
2. F. Chorlton,A Text Book of Fluid Dynamics, Von Nostrand Reinhold/CBS, 1985.
3. A. R. Patterson,A First Course in Fluid Dynamics, Cambridge University Press, 1992.
4. M. D. Raisinghania, Hydrodynamics, S Cnand.

SpaceDynamics (403B optional)

Unit 1

TheTwobodyproblem.Themotion of the centreof mass, Therelativemotion,Kepler's laws and equation of motion.

(**Marks 10)**

Unit 2

Solution of Kepler's equation byHamilton Jacobi Theory. Thedetermination ofOrbits :Laplace'sGauss Methods, Osculatingorbit, perturbingforces, Secularand Periodicperturbations **(Marks 15)**

Unit 3

General threebodyproblem, solutions restricted threebodyproblem, Jacobi integral, curves of zero velocity, stationarysolutions and theirstability. Then- bodyproblem. Themotion of the centreof mass,Classical integrals.
(Marks 15)

Unit 4

Lagrange's planetaryEquations in terms of perturbingforces, motion ofthe moon- Theperturbing forces, Perturbation ofKeplerianelements of the moon bythe sun.
(**Marks 10)**

Unit 5

Rocket performance in avaccum, verticallyascendingpaths, Gravity twin trajectories, Multi-stage rocket in avacuum. Definitions pertinent to sigle stage rocket, performance, limitations of single stagerockets, Definition pertinentto multi stagerockets including gravity. (**Marks 20)**

TextBooks

1. Fundamentals of Celestial Mechanics, TheMacmillan Company, 1962 JM A Danby
2. Celestial Mechanics, TheMacmillan Company, 1985-E- Finlay,Freundlich.
3. Orbital Dynamics of spacevehicles, PrenticeHallInc, Engle Wood Cliff, News Jersey,1963-Ralph Deutsch

ReferenceBooks

1. AnIntroduction to Celestial Mechanics,IntersciencesPubliers,Inc1960-TheodreE. Stern.
2. Flight Mechanics VolI,Theoryof flight paths, AddissionWileyPublishingCompany, INC, 1962-Angelo Miele
3. SpaceDynamics, J. P. Chauhan, Krishnaprakashan.

Dynamical Systems (MSM-404A) (Optional)

Unit 1:

Dynamical systems and Vector Fields, The fundamental theorem, Existence and uniqueness, Continuity of solution in Initial condition, Orbit of a map, fixed point, equilibrium point, periodic point, circular map, configuration space and phase space.**(Marks 15)**

Unit 2:

Stability of a fixed point, equilibrium point, Concept of limit cycle and tours, Hyperbolicity, Quadric Map Periodic doubling phenomenon, Feigenbaum's Universal constant.

(Marks 15)

Unit 3:

Nonlinear oscillators, Conservative system, Hamiltonian system, Various types of Oscillators in non linear system, Solutions of nonlinear differential equations.**(Marks 15)**

Unit 4:

Phenomenon of losing stability, Quasiperiodic motion, Topological study of nonlinear differential equations, Poincare map.**(Marks 10)**

Unit 5:

Randomness of orbits of a dynamical system, Chaos, Strange attractors, Various routes to chaos, Onset mechanism of turbulence.**(Marks 15)**

Text Book:

1. Robert Devany, An introduction to Chaotic Dynamical system,Addison-Wesley Publishing Co.Inc,1989
2. Morris W. Hirsch &Stephen Smale, Differential Equations,Dynamical System and Linear Algebra,Academic press.

Reference:

1. D.K. Arrowsmith and C.M. Place, "An Introduction To Dynamical Systems" Cambridge University Press, 1994.
2. J. Guckenheimer and P. Holmes, "Nonlinear Oscillations, dynamical Systems and Bifurcation of Vector Fields"Spinger -Verlag, 1983.
3. AnaloteKatok and Boris Hasselblatt, "Introduction to the Modern Theory of Dynamical Systems", Cambridge University Press, 1995.
4. G C Layek, "An Introduction to Dynamical Systems and Chaos", Springer Verlag, 2016

General Theory of Relativity and Cosmology (MSM-404B) (Optional)

COURSE OUTCOMES (COs):

CO1.Study about fundamental principles of the General Theory of Relativity

CO2. How gravity is main cause of a curved space time

CO3. Study about Gravitational Waves

CO4. Understand Cosmological models and cosmological principle

Unit1:

Intrinsic derivatives, First Curvature, Parallel transport, parallel vectors. Geodesics, Derivation of the equation of geodesics, Geodesic co-ordinates, locally constant co-ordinate system

(Marks 10)

Unit 2:

Riemann Christoffel Curvature tensors and their properties, Riciitensor, Bianchiidentities, Einstein tensor Divergence of Einstein tensor, Condition of Flat Space, Riemann Curvature.
(Marks 15)

Unit 3:

Theory of gravitation, principle of covariance and principle of equivalence, Simple consequences of the principle of equivalence (i) the equality of inertial and gravitational masses, (ii) effect of gravitational potential on the rate of a clock, (iii) The clock paradox, the energy momentum tensor, Energy momentum tensor in case of a perfect fluid.
(Marks 15)

Unit 4:

Newtonian equation of motion as an approximation of geodesic equations, Poission'sequation as an approximation of Einstein field equation, Schwarzschid exterior solutionand its

isotropic form, planertary orbits and analogues of Kepler's laws in generalrelativity.The three crucial' tests (i) The advance of perihelion (ii) Bending of light rays in a gravitational field (iii) Gravitational red-shift in spectral lines. Schawarzachid interior solutions, Boundary conditions. **(Marks 15)**

Unit 5:

Cosmology, Mach principle, Einstein modified field equations with cosmologicalterm, Static cosmological models of Einstein and de-sitter, their derivations, Geometries, dynamical consequences, non-static cosmological model, Robertson-Walker metric: derivations, geometry and dynamical significance

(**Marks15)**

Text Books:

1. A.S.Eddington,The Mathematical Theory of Relativity, Cambridge Univesity Press, 1965.
2. B.F. Shutz,A First course in general relativity, Cambridge University Press, 1990.

References:

1. C.Moller, The Theory of Relativity, Oxford University Press.
2. G.,E.Weatherburn,An Introduction to Riemannian Geometry and Tensor Calculus,Cambridge University Press, 1950.
3. K.D Krori,Fundamentals of Special & General Relativity, PHI.

Advanced algebra (MSM 404C) (Optional)

Unit1:

Posets and lattices: Well oredering set, maximal and minimal elements, modular, distributive lattices, direct product and sum of an infinite family of groups. **(Marks 15)**

Unit2:

Free abelian groups, free groups, free product of groups, representation of groups.

(Marks 15)

Unit3:

Modules, elementary properties of modules, submodules, quotient modules, direct sum and product of modules, finitely generated modules, module homomorphisms, free modules.

(Marks 15)

Unit4:

Tensor product of modules and properties, exact sequences, projective and injective modules, modules over PID. **(Marks 10)**

Unit5:

Primitive rings, Radicals, complete reducible module and rings, artinian and noetherian rings and modules and examples. **(Marks 15)**

Text Books:

1. M.Hall, Theory of groups, American Mathematical Society.
2. J. Lambek, Lectures of Rings and Modules, American Mathematical Society.

References:

1. V. K. Sarma, Lattices and Boolean algebra,Vikas Publishing House Pvt Ltd.
2. L. Fuch, Infinite Abelian groups, Academic Press.
3. Pasi, Algebra vol 3 Modulus, Alpha Science international ltd. 2001.

MSM-405 PROJECT

COURSE OUTCOMES (COs):

CO1.The students take up research work applying the knowledge and experience acquired during the course.

CO2. Increase problem solving technique and get the idea to write a research paper or article.

CO3.Will help in their future research work.

CO4. Introduce to new dimension of knowledge with better understanding of the subject.

Relevant Topic **(Mark 100)**