MMA23601T	GENERAL TOPLOGY	L	T	P	C
		4	0	0	4

Pre-requisite: Knowledge of Groups and Rings

Course Objectives:

1. To enable students to identify topological spacesand to classify different spaces like first countable, second countable, separable spaces etc.
2. To provide the idea of compactness and connectedness and give their different characterizations.
3. To equip students with the skills necessary to analyze and solve complex problems using topological methods and techniques.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: define and explain the fundamental concepts of topology, including open and closed sets, topological spaces, bases, sub-bases, and continuous functions.

CO 2: study various separation axioms such as T0, T1, T2, etc. and their implications.

CO3: apply key topological properties such as compactness, connectedness, and convergence to solve complex problems in topology and related fields.

CO 4: identify and explore connections between topology and other branches of mathematics and science, such as algebra, geometry, and physics.

Module1: Introduction	**12 Hours**

Definition and examples of topological spaces, closed sets, closure, Dense subsets, Neighbourhood, Interior, Exterior and Boundary, Accumulation Points and Derived sets, Bases and subbases.Subbase and Relative Topology, Continuous Functions and Homeomorphism.

Module2: Countable and Uncountable sets	**10 Hours**

Countable and uncountable sets, First and second Countable spaces, Lindelof's theorem,Separable spaces, Second Countability and Separability.

Module3: Separation Axioms	**12Hours**

Separation Axioms T_0, T_1, T_2, $T_{3 1/2}$,T_4 ; their characterizations and basic properties, Urysohn's lemma, Tietze Extension Theorem.

Module4: Compactness	**16Hours**

Compactness, continuous functions and compact sets. Basic properties of compactness, Compactness and finite intersection property, Sequentially and Countably compact sets, LocalCompactness and one point compactification. Stone-Cech Compactification, Compactness in metricspaces, Equivalence of compactness, Countable compactness and sequential compactness in metricspaces.

Module5: Connectedness	**10 Hours**

Connected spaces, connectedness on the real line, components, totally disconnected spaces, Locally connected spaces.

Total Lecture hours	**60 Hours**

Text Book(s)

1. Munkres, J.R., *Topology*: A first course, Prentice Hall of India, 1974.
2. Simmons, G.R., *Introduction to Topology and Modern Analysis*, McGraw Hill, 2017.

Reference Books

1. Joshi., K.D., *Introduction to General Topology*, New Age International Private Limited, 2017.
2. Dugundji,, J. *Topology*, Allyn and Bacon, 1966 (Reprinted in India By PHI).
3. Hocking., J. and Young., G. *Topology*, Addison Wiley Reading, 1961.
4. Steen, L.A. and Seebach, J.A.*Counter Examples in Topology*, Dover Publications, 1995.

MMA23602T	NUMERICAL ANALYSIS	L	T	P	C
		4	0	0	4

Pre-requisite: Calculus and Differential Equations

Course Objectives:

- To understand the importance of error analysis and their propagation and techniques of interpolation and polynomial fitting.
- To understand methods too numerical differentiation and integration.
- To introduce the basic concepts of solving algebraic, transcendental equations and system of linear and non-linear equations.
- To understand numerical solution of ordinary differential equations.

Course Outcome:

After successful completion of the course, the students will be able to

CO 1: calculate errors induced in the values by truncation of a series expansion.

CO2: fit polynomials to a given set of data points.

CO3: find roots of linear and non-linear system (algebraic and transcendental) of equations

CO4: solve ordinary differential equations numerically.

Module 1: Error Approximation and Interpolation — **15 Hours**

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation, Finite differences, Newton's forward and backward interpolation formulae, Central difference interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Newton's divided difference formula, Inverse interpolation.

Module 2: Numerical Differentiation and Integration — **10 Hours**

Numerical differentiation: Derivatives using Newton's forward interpolation formula, Derivatives using Newton's backward interpolation formula and Derivatives using Stirling's formula, Numerical Integration: Quadrature formula, Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpsons 3/8th rule, Boole's Rule, Errors in Quadrature formulae.

Module 3: Solution of Algebraic and Transcendental Equations — **15 Hours**

Bisection method- Secant Method, Regula Falsi Method, Newton-Raphson method, Muller's method, Direct methods for solving systems of linear equations: Matrix inversion methods, Gauss Elimination method, Gauss-Jordan method, LU decomposition; Iterative methods: Jacobi's method, Gauss-Seidel method, Relaxation Methods

Module 4: Solution of Ordinary Differential Equations — **20 Hours**

Solution of differential equations: Picard's method, Taylor's series method, Euler's method, Modified Euler's method, Runge-kutta method, Predictor-corrector method, Milne's method, Boundary value Problems, Shooting method

Total Lecture hours — **60 Hours**

Text Book(s)

1. K. E. Atkinson, *An Introduction to Numerical Analysis*, John Wiley and Sons, 1989
2. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson, 7th Edition, 2004

3. M.K. Jain, S. R. K. Iyengar, R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New Age International, 2005

Reference Books

1. Niyogi P., *Numerical Analysis and Algorithm*, Tata Mcgraw Hill
2. S. D. Conte and DeBoor C., *Elementary Numerical Analysis: An Algorithmic Approach*, McGraw Hill, N.Y., 1980.

MMA23620T	NUMBER THEORY	L	T	P	C
		4	0	0	4

Pre-requisite: Knowledge of divisibility of numbers, congruences

Course Objectives:

- To enable students to learn about arithmetic functions such as Euler's phi function, Möbius function, and the divisor function
- To understand the concept of primitive roots and quadratic residues
- To study recent advancements and open problems in number theory

Course Outcome:

After successful completion of the course, the students will be able to
CO1: demonstrate a deep understanding of number theoretic concepts and their applications.
CO 2: solve complex number theoretic problems using various techniques
CO3: explain Fibonacci numbers and related identities.
CO 4: demonstrate partition functions, its graphical representations and generative functions.

Module1:Introduction — **15 Hours**

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Module2: Primitive Roots — **10 Hours**

Primitive roots: order of an integer mod m, primitive roots for primes, composite numbers having primitive roots, theory of indices.

Module3: Residues — **10 Hours**

Quadratic residues: Euler's criterion, Legendre's symbol and its properties, Quadratic Reciprocity Law, Quadratic congruences with composite moduli.

Module4: Fibonacci Numbers — **10 Hours**

Fibonacci numbers: certain identities involving Fibonacci numbers, Continued fractions, Pell's equation.

Module5:Partitions — **15 Hours**

Partitions, graphical representation of partitions. Euler's theorem, generating functions, search for partition identities.

Total Lecture hours — **60 Hours**

Text Book(s)

1. Burton, M. D., *Elementary Number Theory*, McGraw Hill Education, 2017.
2. Andrews, G.E., *Number Theory*, Dover Publications, 2012.
3. Molin, R. A., *Algebraic Number Theory*, Chapman and Hall/CRC, 2011.

Reference Books

1. Niven, I., Zuckerman, H. S. and Montgomery, H. L., *Introduction to Theory of Numbers*, Wiley, 2008.

MMA23621T	**MEASURE THEORY**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: Real analysis

Course Objectives:

- To give students idea measure space, measurable functions and their properties.
- To provide a detailed study of convergence of measurable functions.
- To give students idea about variations of measure space viz. signed measure and product measure

Course Outcome:

After successful completion of the course, the students will be able to

CO1: apply the concepts of Lebesgue measure, completeness and regularity in mathematical problems.

CO2: analyze measurable functions and their properties.

CO 3: analyze modes of convergence, properties of Signed and complex measures

CO4: apply product measures in specific mathematical problems.

Module1: Measures	**15 Hours**

Algebras and sigma-algebras, Measures, Outer measures, Lebesgue measures, Completeness and regularity

Module2: Functions and integrals	**15 Hours**

Measurable functions, Properties that hold almost everywhere, The integral, Limit theorems, Measurable functions again, complex valued functions, and image measures.

Module2: Convergence, Signed and complex measures	**15 Hours**

Modes of convergence, Definition of $\mathcal{L}^p$and L^p, Properties of $\mathcal{L}^p$ and L^p , dual spaces, Signed and complex measures, Absolute continuity, Singularity, Functions of bounded variation, The duals of the $\mathcal{L}^p$spaces.

Module4: Product Measures	**15 Hours**

Construction, Fubini's theorem, Applications

Total Lecture hours	**60 Hours**

Text Book(s)

1. Cohn D. L., *Measure Theory*, Birkhäuse, 2013
2. de Barra G., *Measure Theory and Integration*, New Age Publishers, 1st ed., 2013.
3. Halmos P. R., *Measure Theory*, Springer-Verlag, 1974

Reference Books

4. Royden H.L., *Real Analysis*, Pearson Education India, 2015

MMA23622T	HYDRODYNAMICS	L	T	P	C
		4	0	0	4

Pre-requisite: Basic knowledge of physics

Course Objectives:

- To understand the properties of fluids
- To derive the equation of conservation of mass and its application
- To use important concepts of equations of motion and apply the same to various problems

Course Outcome:

After successful completion of the course, the students will be able to

CO1: understand the various properties of fluids and their influence on fluid motion and analyse a variety of problems in fluid statics and dynamics.

CO2: derive Equation of Continuity, Euler's equation of motion

CO3: identify and analyse various types of fluid flow

CO4: evaluate the velocity potential, streamlines, path lines, equi-potential surface, steam function, complex potential for two dimensional, irrotational, incompressible flow

Module 1: Kinematics of fluids in motion — **15 Hours**

Methods of describing fluid motion: Lagrangian method, Eulerian method; Material, local and convective derivatives, Path lines, Stream lines, Vortex lines, Equations of continuity (Cartesian, cylindrical polar and spherical polar)

Module 2: Equations of motion — **15 Hours**

Equations of motion of a fluid: pressure at a point in a fluid at rest, Pressure at a point in a moving fluid, Conditions at a boundary of two inviscid Immiscible fluids, Euler's equations of motion, Bernoulli's equation, worked examples, some flows involving axial symmetry, Some special two-dimensional flows, Impulsive motion

Module 3: Two dimensional flow — **15 Hours**

Some two-dimensional flows: Meaning of two- dimensional flow, use of cylindrical polar coordinates, The stream function, The complex potential for two-dimensional irrotational, incompressible flow, complex velocity potential for standard two dimensional flows, uniform stream, line sources and line sinks, line doublets, line vortices, worked examples.

Module 4: Motion in space, Sources and Sinks — **15 Hours**

Use of complex potential, Source, Sink, doublet , Method of images, statements of Circle and Blasius theorems, Motion past a circular cylinder, Motion past a sphere, Stokes's stream function; Vorticity equation, Properties of vortex filaments, motion due to rectilinear vortex and a system of vortices; Kelvin's circulation theorem and its use, Green's theorem and its deductions, Acyclic and Cyclic motions, Kelvin's minimum energy theorem

Total Lecture — **60 Hours**

Text Book(s)

1. Besant W.H. and Ramsay A.S., A *Treatise on Hydromechanics*, Part II, CBS Publishers & Distributors, 2006

2. Chorlton F., *Text Book of Fluid Dynamics*, CBS Publishers & Distributors, 1985

Reference Books

1. Batchelor G.K., *An Introduction to Fluid Mechanics* (Ebook), New Delhi, 2002

2. Raisinghania M. D., *Fluid Dynamics*, S. Chand and Co. Ltd, 2014

MMA23624T	SPECIAL THEORY OF RELATIVITY	L	T	P	C
		4	0	0	4

Pre-requisite: Classical mechanics and calculus

Course Objectives:

- To study the fundamental concept of special theory of relativity and its applications.
- To conceptualize the implications of the two postulates of Einstein's special theory of relativity.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: apply Galilean transformation and principles of Newtonian mechanics to solve problems involving relative motion and reference frames.

CO2: apply Lorentz transformations to solve problems involving relative motion, time dilation, length contraction, and velocity addition in the context of special relativity.

CO3: apply energy-momentum tensors and the action principle in relativistic systems, and calculate the energy-momentum tensor for special and general cases.

CO4: apply the transformation of differential operators and Maxwell's equations for solving problems in electromagnetic theory and Lorentz condition in four vector form.

Module1: Pre-relativity & Galilean transformation — **10 Hours**

The special theory of relativity: Inertial frames of reference; Galilean transformation, Geometry of Newtonian Mechanics, Fundamentals of Electrodynamics, Background of the Fundamental Postulates of the Special Theory of Relativity

Module2: Lorentz Transformations and Some Consequences — **20 Hours**

Lorentz transformations, relativistic concept of space and time and relativity of motion, Geometrical interpretation of Lorentz transformation as a rotation. Consequences of Lorentz transformations: Length contraction; Time dilation; Variation of mass; Composition of velocities; Proper length and proper time. Relativistic law of addition of velocities and its interpretation, Invariance of speed of light, Lorentz transformation as a group, Applications in problems. Transformation of acceleration.

Module3: Relativistic mechanics — **15 Hours**

Relativistic mechanics; world events, world regions and light cone; Minkowski space-time; equivalence of mass and energy. Energy-momentum tensors: The action principle; The electromagnetic theory; Energy-momentum tensors (general); Energy-momentum tensors (special cases); Conservation laws; Four Vectors

Module4: Relativity and Electromagnetism — **15 Hours**

Transformation of differential operators, D' Alembert's operator, Maxwell's electromagnetic equations, Electromagnetic potentials and Electromagnetic force, Lorentz condition, Lorentz condition in four vector form, Transformations of charge and current density, Transformations of electromagnetic potentials, Invariance of Maxwell's equations, The electromagnetic field tensor, Maxwell's equation in tensor form, Transformation equations of electric field strength and magnetic field induction vector

Total Lecture hours — **60 Hours**

Text Book(s)

1. Katz R., An Introduction to the Special Theory of Relativity, Electronic edition, 2008
2. Robert R., Introduction to Special Relativity, John Wiley & Sons Inc., 1968

Reference Books

1. Rahaman F., The Special Theory of Relativity, A mathematical approach, Springer, 2014
2. Sardesai P. L., A primer of Special Relativity, New Age International (P) Limited, 2004
3. Eddington A.S., The Mathematical Theory of Relativity, Cambridge University Press, 1923

MMA23260T	LaTeX and HTML	L	T	P	C
		2	0	2	3

Pre-requisite: Basic knowledge of computers

Course Objectives:

- To provide students with the equipped knowledge and skills necessary to effectively create, manage, and publish documents using LaTeX and HTML for a variety of purposes.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: apply LaTeX commands to create text documents including figures, tables, lists etc.

CO2: apply mathematical typesetting techniques to write complex equations and formulas.

CO3: apply LaTeX's built-in features to manage bibliographies and citations.

CO4: apply HTML tags and attributes to create well-structured and semantically meaningful web pages.

Module1:	15Hours

Introduction to LaTeX: Overview of LaTeX and its advantages, Basic document structure and compiling; Document Formatting: Text formatting: fonts, styles, and sizes, Paragraph formatting: indentation, spacing, and alignment, Page layout: margins, headers, and footers, Mathematical Typesetting: Math mode: inline and display equations, Mathematical symbols and operators, Equation environments and alignment

Module2:	15Hours

Tables and Figures: Creating tables: structure, alignment, and spanning cells, Including graphics and images, Captions, labels, and cross-referencing. Document Structure: Sections, subsections, and chapters, Lists: itemized, enumerated, and description, Customizing document structure and appearance. Bibliographies and Citations: Managing references with BibTeX, Citation styles and formatting, Creating bibliographies and citing sources; PS Tricks; Beamer presentation.

Module3:	15Hours

HTML, creating simple web pages, Modifying text, Organizing text, Making lists: ordered, unordered, line breaks, Addimages and links, design of web pages.

Total Lecture hours	**45 hours**

Text Book(s)

1. Lamport L., *LATEX: A Document Preparation System, User's Guide and Reference Manual*. Addison-Wesley, New York, second edition, 1994.
2. Robbins, J. N., *Learning web design: A beginner's guide to HTML, CSS, JavaScript, and web graphics*. O'Reilly Media, Inc., 2012.

ReferenceBooks

1. Kottwitz, S., *LaTeX beginner's guide*, Packt Publishing Ltd, 2011.
2. Martin J. Erickson and Donald Bindner, *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*, CRC Press, Boca Raton, FL, 2011.