THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

Royal School of Applied & Pure Sciences
(RSAPS)

Department of Mathematics

COURSE STRUCTURE & SYLLABUS
(BASED ON NATIONAL EDUCATION POLICY 2020)

FOR

B.Sc. IN MATHEMATICS

W.E.F

AY- 2023 – 24

STRUCTURE OF THE SYLLABUS FOR 4 YEAR UG PROGRAMME

SCHOOL NAME – ROYAL SCHOOL OF APPLIED AND PURE SCIENCES
DEPARTMENT NAME - MATHEMATICS
PROGRAMME NAME - B.Sc. in MATHEMATICS

	1ST SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M101	Calculus	100	3	3-0-0
	MAT012M102	Classical Algebra and Trigonometry	100	3	3-0-0
Minor	MAT012N101	Fundamental Mathematics-I	100	3	3-0-0
Interdisciplinary (IDC)	IKS-1	Introduction to Indian Knowledge System – I	100	3	3-0-0
Ability Enhancement course (AEC)	CEN982A101	Communicative English-I	100	1	1-0-0
	BHS982A102	Behavioural Science-I	100	1	1-0-0
Skill Enhancement Course (SEC)	MAT012S111	Mathematical programming tools-I	100	3	0-0-6
Value Added Course (VAC)	VAC-1	VAC- (Basket Course)	100	3	3-0-0
SWAYAM 1	SWAYAM CODE 1	Swayam 1	100	3/4/5	
	TOTAL CREDIT FOR 1ST SEMESTER			**20+3/4/5**	
	2ND SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M201	Vector analysis and Linear Algebra	100	3	3-0-0
	MAT012M202	Analytical Geometry (2D & 3D)	100	3	3-0-0
Minor	MAT012N201	Fundamental Mathematics-II	100	3	3-0-0
IDC	IKS-II	Introduction to Indian Knowledge System – II	100	3	3-0-0
AEC	CEN982A201	Communicative English-I	100	1	1-0-0
SEC	BHS982A202	Behavioural Science-I	100	1	1-0-0
SEC	MAT012S211	Mathematical programming tools-II	100	3	0-0-6
VAC	VAC-2	VAC- (Basket Course)	100	3	3-0-0
SWAYAM 2	SWAYAM CODE 2	Swayam 2	100	3/4/5	
	TOTAL CREDIT FOR 2ND SEMESTER			**20**+3/4/5	
	3RD SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M301	Ordinary Differential Equations	200	4	4-0-0
	MAT012M302	Real Analysis	200	4	4-0-0
Minor	MAT012N301	Matrix algebra and Vector calculus	200	4	4-0-0
IDC	IDC-3	Basket Course	200	3	3-0-0
AEC	CEN982A301	Communicative English-I	200	1	1-0-0
	BHS982A302	Behavioural Science-I	200	1	1-0-0
SEC	MAT012S311	Introduction to data science	200	3	2-0-2
SWAYAM 3	SWAYAM CODE 3	Swayam 3	100	3/4/5	
	TOTAL CREDIT FOR 3RD SEMESTER			**20**+3/4/5	

	4TH SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M401	Complex Analysis	200	4	4-0-0
	MAT012M402	Abstract Algebra	200	4	4-0-0
	MAT012M403	Partial Differential Equations	200	4	4-0-0
Minor	MAT012N401	Coordinate Geometry	200	3	3-0-0
	MAT012N402	Differential Equations	200	3	3-0-0
AEC	CEN982A401	Communicative English-I	200	1	1-0-0
	BHS982A402	Behavioural Science-I	200	1	1-0-0
Swayam 4	SWAYAM CODE 4	Swayam 4	200	3/4/5	
	TOTAL CREDIT FOR 4TH SEMESTER			**20**+3/4/5	
	5TH SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M501	Numerical Methods	300	4	4-0-0
	MAT012M502	Number Theory and Graph Theory	300	4	4-0-0
	MAT012M503	Mechanics-I	300	4	4-0-0
Minor	MAT012N501	Real Analysis	300	4	4-0-0
Internship	MAT012M521	Internship	300	4	
	TOTAL CREDIT FOR 5TH SEMESTER			**20**	
	6TH SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M601	Transform Calculus (Laplace & Fourier)	300	4	4-0-0
	MAT012M602	Metric Space and Topology	300	4	4-0-0
	MAT012M603	Linear Programming	300	4	4-0-0
	MAT012M604	Mechanics-II	300	4	4-0-0
Minor	MAT012N601	Modern Algebra	300	4	4-0-0
	TOTAL CREDIT FOR 6TH SEMESTER			**20**	
	7TH SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M701	Advanced Calculus	400	4	4-0-0
	MAT012M702	Spherical Trigonometry and Tensor Calculus	400	4	4-0-0
	MAT012M703	Mathematical Logic & Combinatorics	400	4	4-0-0
	MAT012M704	Python Programming	400	4	3-0-2
Minor	MAT012N701	Numerical Methods	400	4	4-0-0
	TOTAL CREDIT FOR 7TH SEMESTER			**20**	
	8TH SEMESTER				
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MAT012M801	Guide specific paper	400	4	4-0-0
	MAT012M802	Research Methodology	400	4	4-0-0
	MAT012M823	Dissertation/Research Project	400	12	
For the students who are not eligible for the Research Project*					
Or 400 level advanced course Core (in lieu of Project / Dissertation)	MAT012M803	Advanced Real Analysis	400	4	4-0-0
	MAT012M804	Fuzzy set theory	400	4	4-0-0
	MAT012M805	Mathematical Modelling	400	4	4-0-0
	TOTAL CREDIT FOR 8TH SEMESTER			**20**	

SYLLABUS (1ST SEMESTER)

Subject Name: Calculus	**Level: 100**	**Subject Code: MAT012M101**
L-T-P-C: 3-0-0-3	**Credit: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Calculus (MAT02M101)** is to impart the fundamental concepts of calculus and to explain various real-life problems which can be solved by using calculus.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different methods of finding higher order differential and integral calculus of various functions.	BT1
CO2	**Illustrate** various methods to find higher order differentiation and integration of various functions.	BT2
CO3	**Apply** differentiation to find extreme values of functions, Jacobian, physical properties of various transformations.	BT3
CO4	**Analyze** concepts of differential calculus and integral calculus theories and their applications to scientific problems.	BT4

Prerequisite:

- Basic concepts of function, limit, continuity, differentiability of single variable functions
- Basic differentiation of important functions (from 10+2 level).
- Basic integration of important functions (from 10+2 level).

Detailed Syllabus:

Modules	Topics / Course Contents	Periods
I	**Differentiation:** Successive differentiation, nth derivative of some standard functions and Leibnitz's theorem, function of several variables, limit and continuity of function of several variables, partial differentiation, partial derivatives of first and higher orders for functions of two and three variables, Euler's theorem on homogeneous functions, total derivatives.	15
II	**Application of differentiation:** Jacobian, maxima and minima of function of several variables (two and three variables only), Leibnitz's rule (differentiation under integral sign). Tangents and normal-angle of intersection of two curves, length of tangent, normal, derivative of arc-length, pedal equations, angle between radius vector and tangent, Asymptotes-definition and working rules for finding asymptotes (in case of Cartesian equations).	15

III	**Curvature and curve tracing:** Curvature-definition of curvature and radius of curvature (Cartesian and polar), formulae for radius of curvature, circle of curvature. Singular points, double points, cusp, node, conjugate point, multiple point, determination of multiple points of the curve $f(x, y) = 0$. Curve tracing—tracing of catenary, cissoid, asteroid, cycloid, folium of Descartes, cardioide, lemniscate.	15
IV	**Integration and its applications:** Integrals of the form $\int \frac{px+q}{\sqrt{ax^2+bx+c}}dx$, $\int (px+q)\sqrt{ax^2+bx+c}\,dx$, $\int \frac{dx}{(px+q)\sqrt{ax^2+bx+c}}$ Integration of rational functions of sin x and cos x.(review only) Reduction formulae for integration of some functions, Multiple integral (double, triple integral and application), Change of variables, change of order of integration.	15
TOTAL		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	–	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Differential and Integral calculus;* Piskunov N.; Paperback edition; 2018; Aargon Press.

Reference Books:

1. Apostol Tom M.; *Calculus* Volume-1; Second edition; 1975; John Wiley and Sons.
2. Apostol Tom M.; *Calculus*, Volume-2; Second edition; 1975; John Wiley and Sons.
3. Ayres Frank , Jr., Mendalson Elliott; *Calculus*; 2013; (Schaum's Outlines), McGraw -Hill.

SYLLABUS (1ST SEMESTER)

Subject Name: Classical Algebra and Trigonometry Level: 100 Subject Code: MAT012M102

L-T-P-C: 3-0-0-3 **Credit: 3** **Scheme of Evaluation: T**

Objective: The objective of **Classical Algebra and Trigonometry** (**MAT012M102)** is to impart the fundamental concepts of classical algebra and trigonometry and to apply the results of classical algebra and trigonometry to any other field of mathematics for higher study.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** concept of classical and trigonometry.	BT1
CO2	**Understand** inequalities and different inequality theorems.	BT2
CO3	**Solve** different types of algebraic equations.	BT3
CO4	**Analyze** various aspects of trigonometric and logarithm functions.	BT4

Prerequisites:

- Concept of Classical Set theory.

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	**Relations:** Review (Relations, Functions, Composition of functions, Invertible functions), Binary relation, Well ordering principle, Equivalence relation, congruence relation in integers, Equivalence class, Relation induced by a partition of a set, Fundamental theorem on Equivalence relation, Partial order relation, Chain, Hasse diagram of partially ordered set, Maximal, Minimal element, infimum, supremum.	15
II	**Inequalities:** Inequalities $AM \geq GM \geq HM$ and their generalizations, the theorem of weighted means, Cauchy Schwarz Inequality, Weirstrass' Inequalities, Extreme values of sum & product.	15
III	**Theory of equations:** Relation between the roots and coefficients of a general polynomial equation in one variable, Transformation of equations, Descarte's rule of signs, Strum's theorem (statement only), Symmetric functions of roots, Solution of cubic equation by Cardon's method, Solution of biquadratic equation by Ferrari's method.	15

IV	**De'Moivre's theorem and its applications:** De'Moivre's theorem, Expansion of cosx and sinx in positive integral powers of x, Logarithm of a complex number, Exponential and Trigonometric functions of a complex variable, Euler's expansion for cosine and sine, Inverse functions, Gregory's series and its variants.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	–	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Higher Algebra (classical)**;*** Mapa S.K.; 2014; Sarat Book House; Calcutta.
2. *Part II- Plane Trigonometry*; Loney S. L.; Paperba edition; 2016; G.K. Publication Private limited.

Reference Books:

1. *Higher Algebra*; Hall H.S. and Knight S. R.; Paperback edition; 2016; Arihant Publications.
2. Das and Mukherjee; *Higher Trigonometry*; 33rd edition; 1933, Dhur and Sons; Kolkata.
3. Das B. & Maiti S. R.; *Higher Algebra*; 16th edition; 2010; Asoke Prakasan; Calcutta.
4. Bernard, S. & Child, J.M.; *Higher Algebra*; 2000; Macmillan India Ltd; Delhi.

SYLLABUS (1ST SEMESTER)

Subject Name: Fundamental Mathematics-I Level: 100 Subject Code: MAT012N101
L-T-P-C: 3-0-0-3 Credit: 3 Scheme of Evaluation: T

Objective: The objective of **Fundamental Mathematics-I (MAT02N101)** is to impart the fundamental concepts of calculus and to explain various real-life problems which can be solved by using calculus.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different methods of finding derivative and integration of various functions.	BT1
CO2	**Illustrate** different methods to find differentiation and integration of various functions.	BT2
CO3	**Apply** differentiation to find extreme values of functions, Jacobian and tangent and normal.	BT3
CO4	**Analyze** concepts of differential calculus and integral calculus theories and their applications to scientific problems.	BT4

Prerequisite:

- Basic concepts of function, limit, continuity, differentiability of single variable functions
- Basic differentiation and integration of important functions (from 10+2 level).

Detailed Syllabus:

Modules	Topics / Course Contents	Periods
I	**Differentiation:** Limit and continuity of a function, Derivative of a function, Geometrical meaning of derivative, Product rule, Quotient rule and chain rule of differentiation, Successive Differentiation, Leibnitz's theorem, Partial derivative and total derivative.	15
II	**Application of differentiation:** Rolle's theorem, Mean value theorem, Jacobian, Maxima or minima of a function of two variables, Tangent and normal. Leibnitz's rule for differentiation under integral sign.	15
III	**Integration:** Definition, Standard formulae, Rules of integration, Method of substitution, Integration by parts, Method of Partial fractions, Standard integrals, Definite integrals, Properties of definite integrals.	15

IV	**Application of integration:** Reduction formulae for some standard functions, Multiple integral (double and triple integral), Area, volume and surface area by integration.	15
TOTAL		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	–	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Differential and Integral calculus;* Piskunov N.; Paperback edition; 2018; Aargon Press.

Reference Books:

1. Apostol Tom M.; *Calculus* Volume-1; Second edition; 1975; John Wiley and Sons.
2. Apostol Tom M.; *Calculus*, Volume-2; Second edition; 1975; John Wiley and Sons.
3. Ayres Frank , Jr., Mendalson Elliott; *Calculus*; 2013; (Schaum's Outlines), McGraw -Hill.

SYLLABUS (1st SEMESTER)		
Subject Name: Mathematical programming tools-I	**Level: 100**	**Subject Code: MAT012S11**
L-T-P-C: 0-0-6-3	**Credit Units: 3**	**Scheme of Evaluation: P**

Course Objectives:

The objective of Mathematical programming tools-I is to familiarize students with the usage of mathematical software (Mathematica/MATLAB/Maxima/Maple).

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

Sl No	Course outcome	Bloom's Taxonomy Level
CO1	Define basic terms relating to Mathematica	BT1
CO2	Demonstrate different functions using codes of Mathematica	BT2
CO3	Apply different codes of Mathematica to find outputs.	BT3
CO4	Compare and conclude the output obtained by using Mathematica	BT4

Prerequisites:

- Knowledge of fundamentals of algebra, calculus and linear algebra.

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	**Functions of single variable and their Graphs:** Use of Mathematica as a calculator, Defining Function of single variable, Computing and plotting functions in 2D, Plot Options.	15
II	**Functions of two variables and their Graphs:** Plotting functions of two variables using Plot3D function, Contour Plot using "**ContourPlot"**, Plotting para metric curves surfaces using 'ParametricPlot3D' function, Customizing plots.	15
III	**Algebra:** Factoring, Expanding and plot polynomials, Finding Roots of Polynomials with 'Solve' and 'NSolve', Partial fractions using 'Apart', Simplification, Solving Systems of Equations.	15

IV	**Calculus:** Computing Limits, Derivative of a given function, Partial Derivative of a function, Finding higher Order Derivatives.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
-	60	30 (Problem solving, Project, Internship, Seminar, Workshop)

Text Books:

1. Bruce F. Torrence, Eve A. Torrence, *The Student's Introduction to Mathematica ® A Handbook for Precalculus, Calculus, and Linear Algebra,* CUP

Referencet Book:

1. Bindner, Donald & Erickson, Martin. (2011): *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.

SYLLABUS (2nd SEMESTER)

Subject Name: Vector Analysis and Linear Algebra Level: 100 Subject Code: MAT012M201

L-T-P-C: 3-0-0-3 Credit: 3 Scheme of Evaluation: T

Objectives: The objective of **Vector Analysis and Linear Algebra (MAT012C201)** is to provide the fundamentals & concept of vector algebra, vector calculus and matrix algebra.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Remember** the definitions and formulae of vector calculus and linear algebra.,	BT1
CO2	**Understand** the theories of vector analysis and linear algebra.	BT2
CO3	**Apply** the theories of vector analysis and linear algebra to solve related problems.	BT3
CO4	**Analyze** the theories of vector analysis and linear algebra with examples.	BT4

Prerequisites:

- Position vector, collinear vectors, parallel vectors, coplanar vectors, unit vectors, modulus of a vector, rectangular resolution of a vector, vector addition, scalar product and vector product of two and three vectors
- Matrix addition and multiplication.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Vector Algebra: Scalar and vector product of four vectors, Conditions for collinearity and coplanarity, Vector equations of line and Plane, Distance of a point from a line, length of perpendicular from a point to a plane, distance of a point from a plane, Equation of the line of intersection of two planes. Shortest distance between two skew lines.	15
II	Vector Calculus: Ordinary differentiation of vector functions, Partial derivatives, Vector differential operator, Properties & significance of gradient, divergence & curl, Laplacian, Level surface, Directional derivative. Line, Surface and volume integrals. Green's theorem (with proof) and applications. Stokes theorem, Gauss divergence theorem (without proof) and their applications.	15

III	Matrix Algebra and Determinants: Algebra of matrices/Identity, scalar, diagonal matrix and Trace/Transpose of a Matrix, Power Matrices, Invertible Matrices/ Special Matrices: Symmetric, Skew-symmetric Matrices, Idempotent, nilpotent and orthogonal Matrices / Complex Matrices, Hermitian and Skew-Hermitian Matrices, Unitary Matrices / Normal Matrices and Properties / square block matrices. Basic properties of determinants, Cofactors, minors, principal minors / Singular and non-singular matrices/Evaluation of determinants: Laplace expansion / Adjoint and its properties / Volume as a determinant.	15
IV	System of linear equations: System of linear equations / Elementary row operations; pivots / Inverse of a matrix (Gauss-Jordan reduction), Cramer's rule, Rank of a matrix, Echelon matrices, Normal form/ consistency and inconsistency of the system (homogeneous and non-homogeneous) / solution using Gauss elimination and Gauss-Jordan elimination / LU Decomposition method.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Vector Analysis*; Spiegal Murrary, 2nd Edition, 2017; Tata McGraw Hill Education.
2. *Linear Algebra*, Hoffman Kenneth and Kunze Ray, 2015, PHI learning private limited.

Reference Books:

1. Narayana Shanti; *A Text Book of Vector Calculus;* 2003; S. Chand & Co., New Delhi.
2. Lipschutz Seymour, *Linear Algebra*, 2017, Tata McGraw-Hill publishing Co Ltd.
3. Friedberg, Insel, Spence, "*Linear Algebra",* 4th edition 2015, Pearson Education India.
4. Raisinghania M. D.; *Vector Analysis*; 2nd Edition; 2015; S. Chand And Co.

SYLLABUS (2nd SEMESTER)

Subject Name: Analytical Geometry **Level: 100** **Subject Code: MAT012M202**

L-T-P-C: 3-0-0-3 **Credit: 3** **Scheme of Evaluation: T**

Objective: The objective of **Analytical Geometry (MAT012M202)** is to impart fundamental laws and formulas of coordinate geometry and to demonstrate the algebraic methods to study geometry and to make graphical representations of algebraic equations.

Prerequisites:

- Basic concepts (absolute value, graphing, distance formula), inclination and slope of a line, division of a line segment, analytic proofs of geometric theorems, relations, and functions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of two- and three-dimensional geometry.	BT1
CO2	**Understand** the equation and geometry of two- and three-dimensional coordinate system.	BT2
CO3	**Apply** the theories of two- and three-dimensional coordinate geometry to solve related problems.	BT3
CO4	**Analyze** two- and three-dimensional coordinate geometry to sketch different geometrical shapes.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Transformation and Pair of Straight Lines: Transformation of Rectangular axes, Invariants, Removal of the xy-term, Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines, Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$, and Angle bisector between pair of lines.	15
II	General Equation of Second Degree: General Equation of Second degree of two variables for conic section, Parabola, Standard form of the equation of a Parabola, Different forms of Parabola, Parametric Equation of a Parabola, Ellipse, Standard form of the equation of a Ellipse, Different forms of Ellipse, Parametric Equation of a Ellipse, Hyperbola, Standard form of the equation of Hyperbola, Conjugate Hyperbola, Parametric Equation of a Hyperbola, Pole, and Pair of tangents.	15
III	**Three-dimensional Geometry-I:**	15

	Rectangular Cartesian Co-ordinates in space, Direction cosines and angle between two lines, Equation of Plane in General form, Intercept and Normal form, Plane passing through three points, and Angle between two Planes. Straight line in symmetrical form, Angle between two lines, Coplanar lines, and Skew lines.	
IV	**Three-dimensional Geometry-II:** Sphere: Plane section of a sphere, Sphere through a given circle. Intersection of two spheres, Condition for orthogonality of two spheres, Cone, Equation of the Cone with the origin as vertex and a given curve as a base, Equation of the Right Circular Cone and Cylinder, Equation of a Cylinder, Equation of a Right Circular Cylinder.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip)

Text Books:

1. *The Elements of Coordinate Geometry*; Loney S. L.; 6th Edition, 2016, Arihant Publication.

Reference Books

1. Bell R. J. T., *An Elementary Treatise on Co-ordinate Geometry*; 2018; Franklin Classics.
2. Askwith E. H.; *A Course of Pure Geometry*, 2018; Franklin Classics.
3. Vittal P. R.; *Analytical Geometry 2D and 3D*; 2013; Pearson Education.

SYLLABUS (2ND SEMESTER)

Subject Name: Fundamental Mathematics-II Level: 100 Subject Code: MAT012N201
L-T-P-C: 3-0-0-3 Credit: 3 Scheme of Evaluation: T

Objective: The objective of **Fundamental Mathematics-II (MAT02N201)** is to impart the fundamental concepts of classical algebra and trigonometry and to apply the results of classical algebra and trigonometry to any other field of mathematics for higher study.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** concept of classical and trigonometry.	BT1
CO2	**Understand** inequalities and different inequality theorems.	BT2
CO3	**Solve** different types of algebraic equations.	BT3
CO4	**Analyze** various aspects of trigonometric and logarithm functions.	BT4

Prerequisites:

- Concept of Classical Set theory.

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	**Relations:** Set, Relations, Functions, Composition of functions, Invertible function, Binary relation, Equivalence relation, Equivalence class, Relation induced by a partition of a set.	15
II	**Inequalities:** Inequalities $AM \geq GM \geq HM$ and their generalizations, Cauchy Schwarz Inequality, Weirstrass' Inequalities, Extreme values of sum & product.	15
III	**Theory of equations:** Relation between the roots and coefficients of a general polynomial equation in one variable, Symmetric functions of roots, Transformation of equations, Descarte's rule of signs, Solution of cubic equation by Cardon's method.	15

IV	**De'Moivre's theorem and its applications:** De'Moivre's theorem, Expansion of cosx and sinx in positive integral powers of x, Logarithm of a complex number, Exponential and Trigonometric functions of a complex variable, Euler's expansion for cosine and sine, Inverse functions, Gregory's series.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Higher Algebra (classical)**;*** Mapa S.K.; 2014; Sarat Book House; Calcutta.
2. *Part II- Plane Trigonometry*; Loney S. L.; Paperba edition; 2016; G.K. Publication Private limited.

Reference Books:

1. *Higher Algebra*; Hall H.S. and Knight S. R.; Paperback edition; 2016; Arihant Publications.
2. Das and Mukherjee; *Higher Trigonometry*; 33rd edition; 1933, Dhur and Sons; Kolkata.
3. Das B. & Maiti S. R.; *Higher Algebra*; 16th edition; 2010; Asoke Prakasan; Calcutta.
4. Bernard, S. & Child, J.M.; *Higher Algebra*; 2000; Macmillan India Ltd; Delhi.

SYLLABUS (2nd SEMESTER)

Subject Name: Mathematical programming tools-II Level: 100 Subject Code: MAT012S211

L-T-P-C: 0-0-6-3 Credit Units: 3 Scheme of Evaluation: P

Course Objectives:

The objective of Mathematical programming tools-II is to familiarize students with the usage of mathematical software (Mathematica/MATLAB/Maxima/Maple).

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

Sl No	Course outcome	Bloom's Taxonomy Level
CO1	Define basic terms relating to Mathematica	BT1
CO2	Demonstrate different functions using codes of Mathematica	BT2
CO3	Apply different codes of Mathematica	BT3
CO4	Compare and conclude the output obtained by using Mathematica	BT4

Prerequisites:

- Knowledge of fundamentals of algebra, calculus and linear algebra.

Detailed Syllabus:

Modules	Topic /Course content	Periods
I	**Working with Matrices I:** Write Matrices and use of 'MatrixForm', Check dimensions of a given matrix, Matrix addition and multiplication, Transpose, Determinant, Inverse of a matrix.	15
II	**Working with Matrices II:** Minors and cofactors, Working with large matrices**,** Performing Gauss elimination, Solving system of linear equations, Eigenvalue and Eigenvectors of a matrix, Rank and nullity of a matrix**.**	15
III	**Lines and Line Segments**: Parallel and Perpendicular Lines, Angle between Lines, Two–Point Form, Point–Slope Form, Slope–Intercept Form, Intercept Form, Normal Form.	15

IV	**Circles and Conic:** Plotting of circle, Circle Through Three Points, Plotting of parabola, Parabola from Focus and Directrix, Plotting of ellipse, Ellipse from Vertices and Eccentricity, Ellipse from Foci and Eccentricity	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
-	60	30 (Problem solving, Project, Internship, Seminar, Workshop)

Text Books:

1. Bruce F. Torrence, Eve A. Torrence, *The Student's Introduction to Mathematica ® A Handbook for Precalculus, Calculus, and Linear Algebra*, CUP
2. Exploring Analytic Geometry with Mathematica, Donald L. Vossler, Anaheim, California USA, 1999.

Referencet Book:

1. Bindner, Donald & Erickson, Martin. (2011): *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.

SYLLABUS (3rd SEMESTER)

Subject Name: Ordinary Differential Equations **Subject Code: MAT012M301**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objectives: The objective of **Ordinary Differential Equations** (**MAT012M301)** is to understand different forms of first ordinary differential equations, their solution methods and application to physical problems.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different terms and definitions related to ordinary differential equations and identify different solution methods for ODE.	BT1
CO2	**Understand** the different methos of first and higher order differential equations.	BT2
CO3	**Apply** different methods to solve related problems of ordinary differential equations.	BT3
CO4	**Analyze** the solution of differential equations relating to physical or real-life problems.	BT4

Prerequisites:

- Concept of Differential Calculus and Integral Calculus from HS (10+2) level.
- Concept of Ordinary Differential Equation from HS (10+2) level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Equations of first order** Introduction to differential equations, Separation of variables, Homogeneous Equation and equation reducible to homogeneous form, Exact differential equation and equation reducible to exact differential equation, Linear differential equations and equations reducible to linear form, Bernoulli's equation, Equation solvable for x, y and p, Clairaut's equation.	18
II	**Higher order homogeneous and non-homogeneous linear differential equations** Linear equations with constant coefficients, Homogeneous (Cauchy-Euler) Equation, Equations reducible to homogeneous form, Method of variation of parameters, Method of undetermined coefficients, Method of operators, Wronskian and its properties.	18

III	**Simultaneous and total differential equations** Ordinary simultaneous differential equations, working rules for solving simultaneous equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, total differential equations, condition for integrability, condition for exactness and methods of solution.	18
IV	**Application of ODE** Trajectory, orthogonal trajectories in cartesian and polar coordinates, population dynamics, chemical reaction, equation of motion.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Differential Equations*, Ross S. L., 3rd Edition, 2007, Wiley India.

Reference Books:

1. Raisinghania M.D., *Ordinary and Partial Differential Equations*, 19th edition, 2017, S. Chand and Co., New Delhi.
2. Coddington E. A. and Levinson N., *Theory of Ordinary Differential Equations*, Indian Edition., 2017 , Tata McGraw-Hill, New Delhi.
3. Ayers Jr Frank, *Schaum's Outline Series of Theory and problems of differential equations* , Reprint, 1989, Tata McGraw-Hill, New Delhi.
4. F. Brauer F. and Nohel J. A., *The Qualitative Theory of Ordinary Differential Equations: An Introduction*, New edition, 1999, Dover Publications Inc.

SYLLABUS (3rd SEMESTER)		
Subject Name: Real Analysis		**Subject Code: MAT012M302**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Real Analysis (MAT012M302)** is to develop independent thinking and problem-solving skills in various analytical properties of the real number system.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of Real analysis.	BT1
CO2	**Understand** the theories of Real analysis.	BT2
CO3	**Apply** the theories of Real analysis to solve related problems.	BT3
CO4	**Analyze** the theories of Real analysis with examples.	BT4

Prerequisite:

- Concept of Set theory and Calculus from HS level.

Modules	Topics / Course Contents	Periods
I	**Real Number System** Algebraic properties of $\mathbb{R}$, Absolute value and the real line, bounded and unbounded sets, Supremum and infimum of subsets of $\mathbb{R}$, Completeness property of $\mathbb{R}$, Archimedean property, Dense property of rational numbers, Neighborhood of a point in $\mathbb{R}$, Open and closed sets in $\mathbb{R}$.	18
II	**Sequences and Series** Sequences and their limits, convergent sequence, limit theorem, monotone sequence, subsequences, Limit superior and limit inferior for bounded sequence, series, convergence of series, Cauchy criterion for series, comparison tests, d'Alembert's Ratio Test, Cauchy's Root Test, Leibnitz's test for alternating series.	18

III	**Limits and continuity of functions** Cluster/Limit point, Limit of functions ($\epsilon - \delta$ approach), sequential criterion for limits, Divergence criterion, limit theorems, infinite limits, limits at infinity, Continuity, Algebra of continuous functions, the maximum-minimum theorem.	18
IV	**Uniform continuity of functions and Differentiation** Uniform continuity, Lipschitz function, Differentiability of functions, Algebra of differentiable functions, Rolle's theorem, Mean value theorem, intermediate value property of derivatives, L'Hospital's rules.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Introduction to Real Analysis*; Bartle, Robert G., Sherbert Donald R.; Fourth Edition; 2018; Wiley India Pvt. Ltd.
2. *A Basic Course in Real Analysis*; Kumar, A. and Kumaresan, S.; Reprint 2016; CRC Press.

Reference Book:

1. *Mathematical Analysis*; Malik, S.C. and Arora Savita; Fifth edition; 2017; New Age Science Ltd.
2. *Introduction to Analysis*, Mattuck, Arthur. ;1999; Prentice Hall.
3. *A Course in Calculus and Real Analysis*; Ghorpade, Sudhir R. & Limaye, B. V.; 2006; Undergraduate Texts in Mathematics, Springer (SIE).
4. *Principles of Mathematical Analysis*; Rudin Walter; Third Edition; 2017; McGraw Hill Education.
5. *Basic Real Analysis*; Sohrab, Houshang H.; Second Edition; 2014; Birkhauser.
6. *Elementary Analysis: The Theory of Calculus*; Ross, Kenneth A.; Second Edition; 2013; Springer.

SYLLABUS (3rd SEMESTER)

Subject Name: Matrix algebra and Vector calculus		**Subject Code: MAT012N301**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objectives: The objective of **Matrix algebra and Vector calculus (MAT012N301)** is to provide the fundamentals & concept of matrix algebra, vector algebra and vector calculus.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Remember** the definitions and formulae of vector calculus and matrix algebra.,	BT1
CO2	**Understand** the theories of vector analysis and matrix algebra.	BT2
CO3	**Apply** the theories of vector analysis and matrix algebra to solve related problems.	BT3
CO4	**Analyze** the theories of vector analysis and matrix algebra with examples.	BT4

Prerequisites:

- Position vector, collinear vectors, parallel vectors, coplanar vectors, unit vectors, modulus of a vector, rectangular resolution of a vector, vector addition, scalar product and vector product of two and three vectors.
- Matrix addition and multiplication.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Matrix Algebra and Determinants:** Algebra of matrices/Identity, scalar, diagonal matrix and Trace/Transpose of a Matrix, Power Matrices, Invertible Matrices/ Special Matrices: Symmetric, Skew-symmetric Matrices, Idempotent, nilpotent and orthogonal Matrices / Complex Matrices, Hermitian and Skew-Hermitian Matrices, Unitary Matrices / Normal Matrices and Properties / square block matrices. Basic properties of determinants, Cofactors, minors, principal minors / Singular and non-singular matrices/Evaluation of determinants: Laplace expansion / Adjoint and its properties.	15

II	**System of linear equations:** System of linear equations / Elementary row operations; pivots / Inverse of a matrix (Gauss-Jordan reduction), Cramer's rule, Rank of a matrix, Echelon matrices, Normal form/ consistency and inconsistency of the system (homogeneous and non-homogeneous) / solution using Gauss elimination and Gauss-Jordan elimination / LU Decomposition method.	15
III	**Vector Algebra:** Conditions for collinearity and coplanarity, Vector equations of line and Plane, Distance of a point from a line, length of perpendicular from a point to a plane, distance of a point from a plane, Equation of the line of intersection of two planes. Shortest distance between two skew lines.	15
IV	**Vector Calculus:** Ordinary differentiation of vector functions, Partial derivatives, Vector differential operator, Properties & significance of gradient, divergence & curl, Laplacian, Level surface, Directional derivative. Line and Surface integral, Statement of Green's and Stoke's Theorem and their simple applications.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Vector Analysis*; Spiegal Murrary, 2nd Edition, 2017; Tata McGraw Hill Education.
2. *Linear Algebra*, Hoffman Kenneth and Kunze Ray, 2015, PHI learning private limited.

Reference Books:

1. Narayana Shanti; *A Text Book of Vector Calculus;* 2003; S. Chand & Co., New Delhi.
2. Lipschutz Seymour, *Linear Algebra*, 2017, Tata McGraw-Hill publishing Co Ltd.
3. Friedberg, Insel, Spence, "*Linear Algebra",* 4th edition 2015, Pearson Education India.
4. Raisinghania M. D.; *Vector Analysis*; 2nd Edition; 2015; S. Chand And Co.
5. Tallack J.C; *Introduction to Vector Analysis*; 1st Edition; 2009; Cambridge University Press.

SYLLABUS (3rd SEMESTER)		
Subject Name: Introduction to Data Science		**Subject Code: MAT012S311**
L-T-P-C: 2-0-2-3	**Credit Units: 3**	**Scheme of Evaluation: TP (T-40%, P-30%, CE-30%)**

Objective: The objectives of the course **Introduction to Data Science (MAT01S311)** are to impart the knowledge of data handling with R.

Course Outcome:

After successful completion of the course, students will be able to		
Sl. No.	Course outcome	Bloom's Taxonomy Level
CO1	**State** various methods of assembling, storing and cleaning of data	BT1
CO2	**Discuss** univariate and bivariate data	BT2
CO3	**Apply** various techniques of data handling	BT3
CO4	**Examine** the nature and shape of the data	BT4

Prerequisite:

- Basic concepts of averages.
- Basic knowledge of MS-Excel.

Detailed Syllabus:

Modules	Topics / Course Content	Periods
I	**Data Collection:** Concept of a statistical population and sample from a population; qualitative and quantitative data. Primary data, secondary data, questionnaire and schedule. Construction of tables with one or more factors of classification. Diagrammatic and Graphical representation of non-frequency data. Frequency distribution, cumulative frequency distribution and their graphical representation - histogram, frequency polygon and Ogive, Syntax of R.	**15**
II.	**Data Handling-1:** Univariate data: Concepts of Central tendency or location, Mean, Median and Mode. Concept of Dispersion, range, Mean Deviation and Standard Deviation and their relative measures, Skewness, Kurtosis, Syntax of R.	**15**
III.	**Data Handling-2:** Bivariate Data: Introduction to Correlation, Diagrammatic method and Mathematical methods of simple correlation, probable error, rank correlation for untied and tied ranks. Introduction to simple regression	**15**

	and prediction, Syntax of R.	
IV	**Hands-on Programme with R:** Construction of Frequency distribution and drawing of charts, Mean Deviation and Standard Deviation, Data Cleaning, Summary statistics, Correlation and Regression.	**15**
TOTAL		**60**

Credit distribution		
Theory	Practicum	Experiential Learning
60	30	30 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. *Fundamentals of Mathematical Statistics*; Gupta S. C., Kapoor V. K.; 10th revised edition, 2014, Sultan Chand and Sons, New Delhi
   Sultan Chand & Sons Publishers.
2. *Basics of R and Data Analysis in Research"*; Kalita. B; 2023; Himalaya Publishing House, Mumbai.

Reference Books:

1. *Statistical Methods: An Introductory Text*; Medhi. J; 2006; New Age International Publishers.
2. Choudhury L; "*Introduction to Statistics*"; Vol 1 & 2, 2002, Kitap Ghar, Guwahati.
3. Saxena H C; "*Calculus of Finite Difference & Numerical Analysis*"; 2010; S. Chand.
4. Spiegel Murray R, Schiller John J, Srinivasan R. Alu; "*Schaum's outline: Probability and Statistics*"; 4th Edition; 2012; Mc Graw –Hill Education.
5. Hooda R P; "*Statistics for Business and Economics*"; 3rd Edition, Macmillan India Ltd.
6. Goon A.M., Gupta M.K. and Dasgupta B.; "*Fundamentals of Statistics* (Vol.2)"; 2001; World Press.

SYLLABUS (4th SEMESTER)

Subject Name: Complex Analysis		**Subject Code: MAT012M401**
L-T-P-C: 3-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Complex Analysis** (**MAT012M401)** is **t**o provide the fundamental concepts of complex analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the different terms of complex number system.	BT1
CO2	**Understand** the theories of complex analysis.	BT2
CO3	**Apply** the theories of complex analysis to solve related problems.	BT3
CO4	**Analyze** different theories of complex analysis.	BT4

Prerequisites:

- Concept of real number system and calculus in the set of real numbers.

Detailed Syllabus:

Modules	Topics /Course content	Periods
I	**Complex Numbers:** Introduction to Complex number system (Fundamental operations with complex numbers, Vector representation of complex coordinates, Absolute value and conjugate coordinates with properties), Graphical representation of complex numbers (e.g. straight line, triangle, circle) and related problems, Polar form of complex numbers, De Moivre's Theorem, Roots of Complex numbers, Stereographic Projection, Dot and Cross product, Point sets and regions in complex plane, Extended complex plane.	18
II	**Functions, Limits and Continuity:** Variables and functions, Single and multiple valued functions, Inverse functions, Transformations, Curvilinear coordinates, Branch points and branch lines, Riemann surfaces, limits, Theorems on limits, Infinity, Continuity, Theorems on continuity, Uniform continuity, Sequences, Limit of a sequence, Infinite series.	18

III	**Complex Differentiation:** Differentiability, Analytic function, Cauchy Riemann Equations, Polar form of Cauchy Riemann Equations, Harmonic Functions, Harmonic conjugates, Geometric representation of derivative, Higher order derivatives, L'Hospital's Rule, Singularities, Construction of Analytic function, Orthogonal system	18
IV	**Elementary functions and definite integrals:** Elementary functions, Periodic functions, Zero of a function, Exponential Function, Trigonometric functions, Hyperbolic functions, Logarithimic function, Complex exponents, inverse trigonometric functions, Inverse hyperbolic functions, Definite integrals of functions, Contours, Contour integrals and its examples, Moduli of contour integrals.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. *Complex Variables and Applications;* Churchill R.V. and Brown J.W.; 8th edition; 2017; McGraw Hill Education.
2. *Schaum's Outline of Complex Variables*; Spiegel M.R.; 2edition; 2017; McGraw-Hill.

Reference Books:

1. Ahlfors L. V.; *Complex Analysis*; 3nd Edition; 2000; McGraw-Hill.
2. D. Sarason; *Complex Function Theory*; 2008; Hindustan Book Agency, Delhi.
3. Rudin, W.; *Real and Complex Analysis*; 3rd edition; 2017; McGraw-Hill.
4. Conway J. B.; *Functions of one complex variable;* Springer International Student edition; 2012; Narosa Publishing House, New Delhi.
5. ITL ESL Research and Development wing; *Complex analysis; 2012;* Pearson Education, New Delhi

SYLLABUS (4th SEMESTER)

Subject Name: Abstract Algebra **Subject Code: MAT012M402**
L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objective of **Abstract Algebra** (**MAT012M402)** is to provide the concept of algebraic structures and their applications.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of Abstract Algebra.	BT1
CO2	**Understand** the theories of Abstract Algebra.	BT2
CO3	**Apply** the theories of Abstract Algebra.to solve related problems.	BT3
CO4	**Examine** the theories of Abstract Algebra with examples.	BT4

Prerequisites:

- Knowledge of set theory

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	Binary relation, Equivalence relation, Equivalence class, Mappings, Composition of mappings, Binary operations, Concept of algebraic structure, Semigroup, Group.	18
II	Abelian Group, Order of a group, Subgroups, Cosets, Lagrange's theorem, Index of a subgroup, Order of an element of a group, Cyclic groups, Permutation, Cycle, Transposition, Product of disjoint cycles, Even and odd permutations, Permutation Group, Symmetric group, Alternating Group.	18
III	Normal sub-groups of a Group, Quotient Group, Homomorphism, Fundamental theorem of Homomorphism, Isomorphism of Groups. First, Second and Third isomorphism theorems, Cayley's theorem, Centralizer, Normalizer, Center of a group.	18

IV	Rings, Unitary and commutative rings. Sub-ring Divisors of zero, Integral domain, Field, sub-field, Characteristic of a ring, Ideals, Ideal generated by a subset of a ring, Operations on ideals, Prime and Maximal ideals.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Contemporary Abstract Algebra*; Gallian J. A.; 8th edition; 2013; Cengage Publication.

2. I. N. *Herstein*; *Topics in Algebra*; 2nd edition; 2006; John *Wiley* & Sons; New York.

Reference Books:

1. Malik D. S., Mordeson J.N., Sen M. K. ; *Fundamentals of Abstract Algebra* ; 1996; McGraw Hill Company.
2. *A course in Abstract Algebra*, V.K. Khanna, S.K. Bhamri, Vikash Publishing House Pvt Ltd.
3. *Modern Algebra*; Singh Surajeet and Zameeruddin Qazi; Eighth Edition; 2006; Vikash Publishing House Pvt Ltd.
4. Fraleigh John B.; *A First Course in Abstract Algebra*; 7th edition; 2013; Pearson Education India.
5. Dummit D. and Foote R.; *Abstract Algebra*; 3rd edition; 2011; *Wiley*; New York.
6. Jacobson, N.*; I & II Basic Algebra*; Second edition; 2009; Hindusthan Publishing Corporation, India.

SYLLABUS (4th SEMESTER)

Subject Name: Partial Differential Equations		**Subject Code: MAT012M403**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Partial Differential Equations** (**MAT012M403**) is to develop the concepts of different forms of partial differential equations, their solution methods and application to physical problems.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different terms and definitions related to partial differential equations and identify different solution methods for PDE.	BT1
CO2	**Understand** the different methos of first and higher order partial differential equations.	BT2
CO3	**Apply** tdifferent methods to solve related problems of partial differential equations.	BT3
CO4	**Analyse** the solution of partial differential equations relating to physical or real-life problems.	BT4

Prerequisites:

- Concept of Differential Calculus and Integral Calculus.
- Concept of Ordinary differential equations.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Linear partial differential equations of first order** Introduction to first order PDE, solution by direct integration, Lagrange's method of solving First order linear PDE, Integral surfaces passing through a given curve, surfaces orthogonal to a given system of curves.	**18**
II	**Non-linear partial differential equations of first order** Charpit's methods of solving first order but of any degree PDE, Standard forms of solution, Complete integral, particular integral, singular integral and general integral for solution of non-linear PDE, Jocobi's method of solving PDE with three independent variables.	**18**

III	**Linear partial differential equations with constant coefficients** Homogeneous and non-homogeneous linear PDE with constant coefficients, equations reducible to linear equations with constant coefficients, solution under given geometrical conditions	**18**
IV	**Second order partial differential equations** Solution of PDE of order two with variable coefficients, Laplace's transformation (Canonical forms), Monge's method, Method of separation of variables for Laplace equations, Heat equations, Wave equations	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Elements of partial differential equations,* Snedden Ian Naismith, Reprint, 2006, Dover Publications Inc.
2. *Ordinary and Partial Differential Equations,* Raisinghania M.D., 19th Edition, 2017, S. Chand & Company Ltd.

Reference Books:

1. Logan J. David, *Applied Partial Differential Equations*, 3rd Edition, 2014, Springer Nature.
2. Tveito Aslak, Winther Ragnar., *Introduction to partial differential equations: a computational approach*, Vol. 25, 2005, Springer-Verlag Berlin Heidelberg.

SYLLABUS (4th SEMESTER)

Subject Name: Coordinate Geometry Level: 100 Subject Code: MAT012N401

L-T-P-C: 3-0-0-3 Credit: 3 Scheme of Evaluation: T

Objective: The objective of **Coordinate Geometry (MAT012N401)** is to impart fundamental laws and formulas of coordinate geometry and to demonstrate the algebraic methods to study geometry and to make graphical representations of algebraic equations.

Prerequisites:

- Basic concepts (absolute value, graphing, distance formula), inclination and slope of a line, division of a line segment, analytic proofs of geometric theorems, relations, and functions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of two- and three-dimensional geometry.	BT1
CO2	**Understand** the equation and geometry of two- and three-dimensional coordinate system.	BT2
CO3	**Apply** the theories of two- and three-dimensional coordinate geometry to solve related problems.	BT3
CO4	**Analyze** two- and three-dimensional coordinate geometry to sketch different geometrical shapes.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Transformation and Pair of Straight Lines:** Transformation of Rectangular axes, Invariants, Removal of the xy-term, Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines, Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$.	15
II	**General Equation of Second Degree:** General Equation of Second degree of two variables for conic section, Parabola, Standard forms of the equation of a Parabola Ellipse, Standard forms of the equation of an Ellipse, Hyperbola, Standard forms of the equation of Hyperbola.	15

III	**Three-dimensional Geometry-I:** Rectangular Cartesian Co-ordinates in space, Direction cosines and angle between two lines, Equation of Plane in General form, Intercept and Normal form, Plane passing through three points, and angle between two Planes. Straight line in symmetrical form, angle between two lines.	15
IV	**Three-dimensional Geometry-II:** Sphere: Plane section of a sphere, Sphere through a given circle. Intersection of two spheres, Condition for orthogonality of two spheres, Cone, Equation of the Cone with the origin as vertex and a given curve as a base, equation of right circular cone, Cylinder, Equation of a Cylinder, and equation of Right Circular Cylinder.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

2. *The Elements of Coordinate Geometry*; Loney S. L.; 6th Edition, 2016, Arihant Publication.

Reference Books

4. Bell R. J. T., *An Elementary Treatise on Co-ordinate Geometry*; 2018; Franklin Classics.
5. Askwith E. H.; *A Course of Pure Geometry*, 2018; Franklin Classics.
6. Vittal P. R.; *Analytical Geometry 2D and 3D*; 2013; Pearson Education.

SYLLABUS (4th SEMESTER)		
Subject Name: Differential Equations		**Subject Code: MAT012N402**
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objectives: The objective of **Differential Equations (MAT012N402)** is to introduce the fundamental concepts of ordinary and partial differential equations and to explain the methods to solve such equations.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the first order differential equations and learn to solve first order differential equations by using different standard methods.	BT1
CO2	**Understand** the second order linear differential equations and able to apply the methods to solve such equations.	BT2
CO3	**Apply** different standard methods to solve first order linear and non-linear partial differential equations.	BT3
CO4	**Analyze** second order partial differential equations and find it's solution by standard methods.	BT4

Prerequisites:

- Concept of Differential Calculus and Integral Calculus from HS (10+2) level.
- Concept of Ordinary Differential Equation from HS (10+2) level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Equations of first order** Introduction to differential equations (origin, order and degree, formation, types of solution), Separation of variables, Homogeneous Equation and equation reducible to homogeneous form, Exact differential equation, Linear differential equations, Bernoulli's equation, Application of first order differential equations.	**15**
II	**Higher order linear differential equations** Linear equations with constant coefficients, Homogeneous (Cauchy-Euler) Equation, Equations reducible to homogeneous form, Method of variation of parameters.	**15**
III	**Linear and Non-linear partial differential equations of first order** Definition, order, degree and formation of PDE, solve by direct integration, Lagrange's method of solving First order linear PDE, Classification of first order PDE, Non-linear PDE, Charpit's method of solution, Standard forms of solution.	**15**

IV	**Linear partial differential equations with constant coefficients and Second order PDE** Homogeneous and non-homogeneous linear PDE with constant coefficients, Classification of second order PDE, Solution of second order PDE by Monge's method and Method of separation of variables.	**15**
Total		**60**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Differential Equations*, Ross S. L., 3rd Edition, 2017, Reprint, Wiley India.
2. *Applied Partial Differential Equations*, Logan J. David, 3rd Edition, 2014, Springer Nature.

Reference Books:

1. Raisinghania M.D., *Ordinary and Partial Differential Equations*, 2017, S. Chand and Co., New Delhi.
2. Coddington E. A. and Levinson N., *Theory of Ordinary Differential Equations*, 1st Edn., 2017, Tata McGraw-Hill, New Delhi.
3. *Elements of partial differential equations*, Snedden Ian Naismith, Reprint, 2006, Dover Publications Inc.
4. **Tveito** Aslak**, Winther** Ragnar., *Introduction to partial differential equations: a computational approach*, Vol. 25, 2005, Springer-Verlag Berlin Heidelberg.

SYLLABUS (5th SEMESTER)		
Subject Name: Numerical Methods		**Subject Code:** MAT012M501
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The general objectives of the course **Numerical Methods (**MAT012M501**)** are to enable students solving algebraic, transcendental equations, numerical solutions of differential equation and Optimization Techniques.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**List** different types of error occurred in numerical analysis.	BT1
CO2	**Understand** the different methos of first and higher order partial differential equations.	BT2
CO3	**Apply** appropriate numerical method to solve algebraic or transcendental equation.	BT3
CO4	**Analyze** the solution of first order differential equation obtained by numerical integration.	BT4

Prerequisites:

- Concepts of Matrices, Inequality and idea of Differential and Integral calculus.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Errors and Interpolation** Errors in arithmetic operations, different types of errors. Finite Difference operators and their operations on functions of a single variable, Relation between operators. Interpolation with equal intervals, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae.	**18**
II	**Solution of polynomial and transcendental equations** Iteration method, Secant method, Bisection method, NewtonRaphson method and Regula-Falsi method. (Programming code of the methods)	**18**
III	**Numerical Differentiation and Integration** Numerical Differentiation, Numerical integration: General quadrature formula, Trapezoidal rule and Simpson's 1/3rd and 3/8 rules, Weddle's rule. (Programming code of the methods).	**18**

IV	**Numerical solution of ordinary differential equations** Taylor's series, Picard's method, Euler's methods, modified Euler methods, Runge-Kutta method, Finite Difference method. (Programming code of the methods).	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Introductory Methods of Numerical Analysis*, Sastry S. S., 5th edition, 2012, PHI Learning Private Limited.
2. *Numerical Mathematical Analysis*, Scarborough J. B., 6th Edition, Pb 2020, Oxford University Press, London.

Reference Books:

1. H. C Saxena, *Finite difference and Numerical Analysis*., 2010, S Chand and Sons.
2. Jain M. K, Jain R. K. and Iyenger S.R.K, *Numerical Methods* (problem and solutions), 2004, New age Publishers.
3. Bali N. P. and Narayan Iyenger N, *A text book of Engineering Mathematics*, 9th edition, 2016, Laxmi Publication.

SYLLABUS (5th SEMESTER)		
Subject Name: Number Theory and Graph Theory		**Subject Code: MAT012M502**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Number Theory and Graph Theory (MAT012M502)** is to develop the basic understanding and problem-solving skills in Number Theory and Graph theory.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and properties of Well-ordering principle, Archimedean property, division algorithm, GCD and LCM, Euclidean algorithm, and prime numbers.	BT1
CO2	**Understand** the theory of Congruence	BT2
CO3	**Apply** the theories and properties of various Graphs to solve related problems.	BT3
CO4	**Analyse** the theories of Trees and connectivity with examples.	BT4

Prerequisites: Basic concepts of number system and matrices.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Divisibility theory in the integers:** Well-ordering principle, Archimedean property, mathematical induction, division algorithm, greatest common divisor, relatively prime integers, least common multiple, Euclidean algorithm, prime numbers, properties of prime numbers, factorization in prime numbers, fundamental theorem of arithmetic.	**18**
II	**The theory of congruences:** Congruences, basic properties of congruence, residue classes, addition and multiplication of residue classes, linear congruences, the Chinese Remainder theorem, Fermat's theorem, Wilson's theorem.	**18**
III	**Introduction:** Definition of graph, undirected and directed graph, degrees and incidence of a vertex, handshaking theorem, isomorphism of graphs, Euler graphs, Hamiltonian paths and circuits, Weighted graph, Directed graphs- definition, types, directed paths and connectedness.	**18**

IV	**Trees and connectivity:** Definition and Properties of trees, rooted and binary trees, spanning trees, Kruskal's algorithm, Prim's algorithm, Connectivity, cut vertices, cut edges and blocks, Matrix representation of graphs- adjacency matrix and incidence matrix.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Elementary Number Theory,* Burton, D. M., 7th edition, 2011 (Reprint), McGraw-Hill Education
2. *Graph Theory*, Harary F., 1st Edition, 1994, West View Press.

Reference Books:

1. Hardy, G.H. and Wright, E. M., *An Introduction to the Theory of Numbers*; 6th edition, 2008, Oxford University Press.
2. *An introduction to number theory,* Ivan Nivam& H.S. Zuckerman, 5th Revised edition edition, 2008, John Wiley & Sons.
3. Telang, S. G., *Number Theory*, 2003, Tata McGraw-Hill, New Delhi.
4. *Basic Graph Theory*, Parthasarathy H. R., 1998, McGraw Hill Publishing.
5. Diestel. R., *Graph Theory (Graduate Texts in Mathematics),* 5th edition, 2017, Springer.
6. Deo N., *Graph Theory with Applications to Engineering and Computer Science*, 1st Edition Reprint, 2016, Dover Publication.

SYLLABUS (5th SEMESTER)

Subject Name: Mechanics-I **Subject Code: MAT012M503**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Mechanics-I** (**MAT012M503**) is to impart the principles of static equilibrium to particles and rigid bodies.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** terms related to statics and dynamics.	BT1
CO2	**Understand** the laws different laws of statics and dynamics.	BT2
CO3	**Apply** different laws of statics and dynamics to solve related problems	BT3
CO4	**Examine** theories of statics and dynamics to solve real field problems.	BT4

Prerequisites:

- Concept of Vector Analysis, Differential Calculus and Integral Calculus.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Forces and Centre of gravity** Composition and Resolution of forces, Equilibrium of con- current forces, Parallel forces, Moment of a force, Couple, System of coplanar forces and conditions of equilibrium, Centre of gravity of plane curves and areas.	**18**
II	**Friction and Machines** Friction, laws of friction, Cone of friction, Angle of friction, Limiting friction, Equilibrium of a particle on a rough inclined plane, Machines, Mechanical advantage, Velocity ratio, System of Pulleys.	**18**
III	**Velocity, Acceleration and Motion** Components of velocity and acceleration along radial and transverse direction and along tangential and normal directions, Angular velocity and its relation with linear velocity, rectilinear motion, Simple harmonic motion.	**18**

IV	**Projectile and Impulsive forces** Motion of a Projectile, range on an inclined plane, work and energy, Central force, Resisting medium, conservation of linear momentum and conservation of energy, Impact of elastic bodies (direct impact only).	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. *Statics*, Das B.C. and Mukherjee B.N., 27th Edition, Reprint 2017, U N Dhar and Sons Private Ltd., Kolkata.
2. *Analytical Dynamics*, Das B.C. and Mukherjee B.N., 27th Edition, Reprint 2017, U N Dhar and Sons Private Ltd., Kolkata.

Reference Books:

1. Loney S. L., *The elements of Statics and Dynamics*, Part 1, Statics, 2016, Arihant Publication.
2. Loney S. L., *The elements of Statics and Dynamics*, Part 2, Dynamics, 2016, Arihant Publication.
3. Ray M. and Sharma G. C., *A text book on Dynamics*, Reprint, 2005, S Chand and Company.

SYLLABUS (5th SEMESTER)

Subject Name: Real Analysis		**Subject Code: MAT012N501**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Real Analysis (MAT012N501)** is to develop independentthinking and problem-solving skills in various analytical properties of the real number system.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of Real analysis.	BT1
CO2	**Understand** the theories of Real analysis.	BT2
CO3	**Apply** the theories of Real analysis to solve related problems.	BT3
CO4	**Analyze** the theories of Real analysis with examples.	BT4

Prerequisite:

- Concept of Set theory and Calculus from HS level.

Modules	Topics / Course Contents	Periods
I	**Real Number System** Algebraic properties of $\mathbb{R}$, Absolute value and the real line, bounded and unbounded sets, Supremum and infimum of subsets of $\mathbb{R}$, Completeness property of $\mathbb{R}$, Archimedean property, Dense property of rational numbers.	18
II	**Sequences and Series** Sequences and their limits, convergent sequence, limit theorem, bounded sequence, monotone sequence, subsequences, series, convergence of series, comparison tests, d'Alembert's Ratio Test, Cauchy's Root Test, Leibnitz's test for alternating series.	18

III	**Limits and continuity of functions** Cluster/Limit point, Limit of functions ($\epsilon - \delta$ approach), sequential criterion for limits, Divergence criterion, limit theorems, infinite limits, limits at infinity, Continuity, Algebra of continuous functions, the maximum-minimum theorem.	18
IV	**Uniform continuity of functions and Differentiation** Uniform continuity, Lipschitz function, Differentiability of functions, Algebra of differentiable functions, Rolle's theorem, Mean value theorem, intermediate value property of derivatives, L'Hospital's rules.	18
	Total	72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Introduction to Real Analysis*; Bartle, Robert G., Sherbert Donald R.; Fourth Edition; 2018; Wiley India Pvt. Ltd.
2. *A Basic Course in Real Analysis*; Kumar, A. and Kumaresan, S.; Reprint 2016; CRC Press.

Reference Book:

1. *Mathematical Analysis*; Malik, S.C. and Arora Savita; Fifth edition; 2017; New Age Science Ltd.
2. *Introduction to Analysis*, Mattuck, Arthur. ; 1999; Prentice Hall.
3. *A Course in Calculus and Real Analysis*; Ghorpade, Sudhir R. & Limaye, B. V.;2006; Undergraduate Texts in Mathematics, Springer (SIE).
4. *Principles of Mathematical Analysis*; Rudin Walter; Third Edition; 2017; McGraw Hill Education.
5. *Basic Real Analysis*; Sohrab, Houshang H.; Second Edition; 2014; Birkhauser.
6. *Elementary Analysis: The Theory of Calculus*; Ross, Kenneth A.; Second Edition; 2013; Springer.

SYLLABUS (6th SEMESTER)

Subject Name: Transform Calculus (Laplace & Fourier Series)		**Subject Code: MAT012M601**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Transform Calculus (Laplace & Fourier Series)** (**MAT012M601)** are to enable solving the ordinary and partial differential equations by using Laplace and Fourier Transforms and to provide exposure to solve initial and boundary value problems.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the Laplace transform with formulae	BT1
CO2	**Understand** the Fourier transform method	BT2
CO3	**Solve** the Fourier series problems.	BT3
CO4	**Analyse** the solution of ordinary differential equations using Laplace technique	BT4

Prerequisite: Concept of calculus, ordinary and partial differential equations.

Detailed Syllabus:

Modules	Topics /Course content	Periods
I	Laplace Transform: Laplace Transform of some elementary functions, Properties, Initial and Final Value Theorem, Laplace transforms of derivatives, Multiplication by positive integral powers of t and division by t. Inverse Laplace Transform: Inverse Laplace transforms of some elementary functions, Properties, Inverse Laplace transforms of derivatives, Multiplication by powers of s, Convolution property, Partial fraction method.	18
II	Fourier Transform: Fourier Integral Transform, Properties of Fourier Transform, Infinite Fourier sine and cosine transforms, Fourier Transform of Derivative of a function, Convolution Theorem, Perseval's Identity for Fourier transforms, Finite Fourier Transforms.	18

III	Fourier Series: Periodic functions, Euler's formulae, Convergence of the Fourier Series (Dirichlet's condition), the Main Theorem, Fourier Series for even and odd functions, Half Range Series, Fourier series for Discontinuous functions, Change of interval.	18
IV	Application to differential equation: Solution of ordinary and partial differential equations of initial and boundary value problems by Laplace and Fourier transform methods.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. *Laplace and Fourier Transforms*, Goyal J. K. & Gupta K. P, Pragati Edition, 2016, Pragati Prakashan.
2. *FourerTransformsi*, Sneddon I. N., 2008, S. Chand and Co., New Delhi
3. *Theory and Problem of Laplace Transform,* Spiegel M. R., Paperback edition, 2018, McGraw-Hill Book Company.
4. *Integral Transforms and Fourier Series*, Srivastava A.N and Ahmad M., 2011 , Alpha Science Intl Ltd.

Reference Books:

1. Raisinghannia M.D., *Advanced Differential Equations*, 19th Edition, 2018, S. Chand and Co., New Delhi.
2. Brown J. W. and Churchill R.*, Fourier Series and Boundary Value Problems*, 8th Edition, 2015, McGraw Hill.
3. Dyke, P., *An introduction to Laplace Transforms and Forier Series*, 2001, Springer London.

SYLLABUS (6th SEMESTER)		
Subject Name: Metric Space and Topology		**Subject Code: MAT012M602**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The aim of the course **Metric Space and Topology (MAT012M602)** is to introduce the concepts and to explain the fundamental theory of metric and topological spaces, to enable learning the basic notions of metric and topological spaces and to impart the properties of continuous mappings.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** and understand the concept of metric spaces.	BT1
CO2	**Understand** the concept of sequences in metric spaces.	BT2
CO3	**Apply** the concept of continuity, compactness and connectedness in metric spaces to solve related problems.	BT3
CO4	**Analyze** the concept of topological spaces.	BT4

Prerequisites: Basic knowledge on calculus and set theory.

Detailed Syllabus:

Modules	Topics / Course Contents	Periods
I.	**Metric spaces:** Definition and examples, diameter of a set, bounded and unbounded metric spaces, open and closed balls, neighborhood, open set, interior of a set, Limit point of a set, closed set, closure, exterior, boundary of a set, dense and non-dense sets.	18
II.	**Sequences in metric space:** Cauchy sequences, complete metric spaces, cantor's intersection theorem, Baire Category theorem, completeness and contracting mappings, Banach's fixed point theorem.	18

III	**Continuity in metric spaces:** Continuity and uniform continuity in metric spaces, homeomorphism in metric spaces, Compactness and connectedness in metric spaces.	18
IV	**Topological Spaces:** Definition and examples of topological spaces, indiscrete topology, discrete topology, usual topology, cofinite topology, open and closed sets, neighborhoods, limit points, adherent points, derived sets, closure, interior and exterior of a set.	18
	TOTAL	72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. Simmons G.F., *Introduction to topology and modern analysis*, Indian Edition, 2017, McGraw Hill Education.
2. Sharma J. N., Mathematical Analysis-I 2014, Krishna Prakashan Mandir, Meerut.

Reference Books:

1. Malik S. C. and, Arora S, *Mathematical Analysis*, 2017, New Age International Private Limited.
2. Lipschutz S., *General topology*, Schaum outline series, 2011, McGraw-Hill Education.
3. Kumaresan S., *Topology of Metric Spaces*, 2005, Alpha Science International Ltd, Harrow, UK.

SYLLABUS (6th SEMESTER)		
Subject Name: Linear Programming		**Subject Code: MAT012M603**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Linear Programming** (**MAT012M603**) is to impart the fundamental concepts and application of Linear Programming Problem in real-life problems.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different types of Linear Programming Problem.	BT1
CO2	**Explain** the methods of solution of different types of LPP	BT2
CO3	**Apply** the methods of solution to solve using simplex method, transportation, and Assignment problems.	BT3
CO4	**Analyse** the different cases that can arise during solution process such as concept of degeneracy, alternate Optima, infeasibility and boundedness of the solution.	BT4

Prerequisites:

- Basic Concepts of Calculus and Linear Algebra.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Introduction to Linear Programming** Linear Programming problems (LPP): Definition of L.P.P., Mathematical Formulation of L.P.P. Graphical solution of L.P.P., Matrix formulation of L.P.P., Basic solutions and Basic Feasible Solution (BFS), Degenerate and Non-degenerate B.F.S.	**18**
II	**Optimality Theory of Linear Programming Problem** Simplex algorithm and its tableau format: Optimal solution by Simplex Method, Termination criteria for optimal solution of the linear programming problem, Unique and alternate optimal solutions.	**18**
III	**Optimality and Duality Theory of Linear Programming Problem** Artificial variables, Two-phase method, Big-M method. Duality Theory: Motivation and formulation of dual problem, Primal-Dual relationships, Fundamental theorem of duality;	**18**

IV	**Transportation Problem and Assignment Problem.** Transportation Problem: Definition and formulation, Northwest-corner, Least-cost, and Vogel's approximation methods of finding initial basic feasible solutions; Algorithm for solving transportation problem. Assignment Problem: Mathematical formulation and Hungarian method of solving.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

3. G. Hadley. *Linear Programming*, , 2002, Narosa publication house.
4. R.K. Gupta, "*Linear programming*." 2011, Krishna Prakashan Media (p) Ltd.
5. Gupta P.K. and Hira D.S., *Problems in Operations research (Principles and Solutions)*, Revised Edition, 2015, Sultan Chand and Sons New Delhi.

Reference Books:

3. Hamdy A. Taha, "*Operations Research: An Introduction*", 8th Edition, 2008, Pearson Education.
4. Rao S. S., *Optimization Theory and Applications*, 1979, Wiley Eastern Limited, New Delhi.
5. Bronson Richard and Naadimuthu Govindasami, Schaum's Outline of Operations Research, 2nd Edition, 2017,
6. Swarup Kanti, Gupta P.K. and Mohan M., *Operations Research*, 2014, Sultan Chand and Sons New Delhi.

SYLLABUS (6th SEMESTER)

Subject Name: Mechanics-II		**Subject Code: MAT012M604**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Mechanics-II** (**MAT012M604**) is to impart the principles of static equilibrium to particles and rigid bodies.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the terms related to rigid dynamics.	BT1
CO2	**Understand** the motion of the centre of inertia.	BT2
CO3	**Apply** different laws of rigid dynamics to solve related problems	BT3
CO4	**Examine** theories of rigid dynamics to solve real field problems.	BT4

Prerequisites:

- Concept of Vector Analysis, Differential Calculus and Integral Calculus.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Moment of inertia and radius of gyration, Perpendicular axis theorem on moment of inertia, Moment of inertia of few simple bodies, Parallel axis theorem on moment of inertia, Product of inertia, theorem of six constants.	**18**
II	D'Alembert's principle, the general equation of motion of a rigid body, motion of the centre of inertia and motion relative to the centre of inertia.	**18**
III	Motion about a fixed axis, the compound pendulum, centre of percussion, Impulse and Impulsive force, Motion of a body in two dimensions under finite and impulsive forces.	**18**

IV	Conservation of momentum and energy, generalized coordinates, Lagrange's equations, initial motions, Hamilton's principle and related equations.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. Loney, S. L., An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, (AITBS Publishers, 2016).

Reference Books:

1. Ray M. and Sharma G. C., *A text book on Dynamics*, Reprint, 2005, S Chand and Company.
2. Spiegel, M. R., Schaum's Outline of Theory and Problems of Theoretical Mechanics: with an Introduction to Lagrange's Equations and Hamiltonian Theory (McGraw-Hill, 2007).
3. Ramsey, A. T., Dynamics, 2nd Edition (The University Press, 2007).

SYLLABUS (6th SEMESTER)

Subject Name: Modern Algebra **Subject Code: MAT012N601**
L-T-P-C: 3-0-0-3 **Credit Units: 3** **Scheme of Evaluation: T**

Objective: The objectives of **Modern Algebra (MAT012N601)** are:

- The course intends to introduce to the learners the abstract structure called group theory and ring theory with various examples.
- To provide the continuous approach to the subject of algebra, which is one of the basic pillars of modern mathematics and to inculcate in students the power of accurate analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and basics concept related to group theory and ring theory.	BT1
CO2	**Understand** the theories related to group theory and ring theory.	BT2
CO3	**Apply** the theories to solve related problems.	BT3
CO4	**Analyse** the basic concepts and theories of algebra.	BT4

Prerequisites:

- Set theory and basic knowledge of Arithmetic.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Relations and Mappings:** Binary relation, Equivalence relation, Equivalence class, Partial order relation, Poset, Lattice, Mappings, Inverse mappings, Composition of mappings, Binary operations.	**15**
II	**Group theory I:** Concept of algebraic structure, Semigroup, Group, Abelian Group, Order of a group, Subgroups, Cosets, Lagrange's theorem, Index of a subgroup, Order of an element of a group, Cyclic groups. Permutation, Even and odd permutations, Permutation Group.	**15**

III	**Group theory II:** Normal sub-groups of a Group, Prefect of a normal sub-group and a subgroup. Quotient Group, Homomorphism Kernel of a Homomorphism and Fundamental theorem of Homomorphism, Isomorphism of Groups.	**15**
IV	**Ring theory:** Rings, Unitary and commutative rings. Sub-ring Divisors of zero, Integral domain, Field, sub-field, Characteristic of a ring, Ordered integral Domain, Ideals.	**15**
Total		**60**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Modern Algebra*; Singh Surajeet and Zameeruddin Qazi; Eighth Edition; 2006; Vikash Publishing House Pvt Ltd.
2. *Contemporary Abstract Algebra* ; Gallian J. A.; 8th edition; 2013; Cengage Publication.

Reference Books:

1. Malik D. S., Mordeson J.N., Sen M. K. ; *Fundamentals of Abstract Algebra* ; 1996; McGraw Hill Company.
2. I. N. *Herstein*; *Topics in Algebra*; 2nd edition; 2006; John *Wiley* & Sons; New York.
3. Fraleigh John B.; *A First Course in Abstract Algebra*; 7th edition; 2013; Pearson Education India.
4. Dummit D. and Foote R.; *Abstract Algebra*; 3rd edition; 2011; *Wiley*; New York.
5. Jacobson, N.*; I & II Basic Algebra*; Second edition; 2009; Hindusthan Publishing Corporation, India.

SYLLABUS (7th SEMESTER)

Subject Name: Advanced Calculus		**Subject Code: MAT012M701**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Advanced Calculus** (**MAT012M701)** to develop independent thinking in various analytical properties of the advance real number system.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** sequence and different comparison tests.	BT1
CO2	**Understand** the theory of Continuity and Differentiability.	BT2
CO3	**Apply** the theories to find out maxima and minima of functions of two variables.	BT3
CO4	**Analyse** Change of order of integration in double integrals.	BT4

Prerequisites:

- Concept of Set Theory and Calculus.

Detailed Syllabus:

Modules	Topics /Course content	Periods
I	Advanced Sequence: Definition of a sequence, Series of non-negative terms. Comparison tests, Cauchy's integral test, Ratio tests, Raabe's, Logarithmic, De Morgan and Bertrand's tests. Alternating series, Leibnitz's theorem. Absolute and conditional convergence.	18
II	Continuity and Differentiability: Continuity, Sequential continuity, Chain rule of differentiability, Mean value theorems and their geometrical interpretations. Darboux's intermediate value theorem for derivatives, Taylor's theorem with various forms of remainders.	18

III	Maxima and Minima: Envelopes, evolutes. Maxima, minima and saddle points of functions of two variables. Lagrange's multiplier method.	18
IV	Double and Triple Integration: Beta and Gamma functions, Double and triple integrals, Dirichlet's integrals, Change of order of integration in double integrals.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Introduction to Real Analysis*; Bartle, Robert G., Sherbert Donald R.; Fourth Edition; 2014; Wiley India Pvt. Ltd.

Reference Book:

1. *A Basic Course in Real Analysis*; Kumar, A. and Kumaresan, S.; Reprint 2016; CRC Press.
2. *Mathematical Analysis*; Malik, S.C. and Arora Savita; Fifth edition; 2017; New Age ScienceLtd.
3. *Principles of Mathematical Analysis*; Rudin Walter; Third Edition; 2017; McGraw HillEducation.
4. *Basic Real Analysis*; Sohrab, Houshang H.; Second Edition; 2014; Birkhauser.
5. *Elementary Analysis: The Theory of Calculus*; Ross, Kenneth A.; Second Edition; 2013; Springer.
6. *A Course in Calculus and Real Analysis*; Ghorpade, Sudhir R. & Limaye, B. V.; 2006; Undergraduate Texts in Mathematics, Springer (SIE).

SYLLABUS (7th SEMESTER)

Subject Name: Spherical Trigonometry and Tensor Calculus Level: 400 Subject Code: MAT012M702

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objective of the course *Spherical Trigonometry and Tensor Calculus (***MAT012M702***)* is to develop analytical skills in solving spherical geometry problems and understanding tensor concepts for advanced applications in physics and mathematics.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** fundamental concepts of spherical trigonometry and basic tensor operations.	BT1
CO2	**Explain** spherical triangles, tensor notations, and their significance in mathematical and physical applications.	BT2
CO3	**Solve** real-world problems involving spherical triangles and tensor equations in physics and engineering contexts.	BT3
CO4	**Differentiate** between various tensor types and **analyze** their properties in curved spaces and complex systems.	BT4

Prerequisites:

- Concept of Trigonometry on Euclidean Spaces.
- Concept Vector Calculus and Differential Calculus

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Spherical Trigonometry:** Section of a sphere by a plane, spherical triangles, properties of spherical and polar triangles, fundamental formulae of spherical triangles, sine formula, cosine formula, sine cosine formula, cot formula, Napier's rule of circular parts.	**18**

II	**Celestial Sphere:** The standard (or geometric) celestial sphere, system of coordinates, conversion of one coordinate system to the another system, diurnal motion of heavenly bodies, sidereal time, solar time(mean), rising and setting of stars, circumpolar star, dip of the horizon, rate of change of zenith distance and azimuth, examples.	**18**
III	**Curvilinear Coordinates:** Curvilinear coordinates, unit vectors in curvilinear system, representation of as vector F in terms of unit base vectors, contravariant and covariant components of F, arc length and volume element in orthogonal curvilinear coordinates. Transformations of coordinates.	**18**
IV	**Tensors:** Definition of tensors, fundamental operations with tensors, Symmetric and skew-Symmetric tensors, Riemannian space and metric tensor, Conjugate tensor, Christoffel symbols.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Text Book on Spherical Astronomy*, Smart W. M., 6th edition, 1977, Cambridge University Press.
2. *Tensor Calculus*, David C. Kay, 1st edition, 2011, McGraw Hill.

Reference Books:

1. Prasad G., *Text Book on Astronomy*; 8th edition 2014, Pothishala Pvt. Ltd.
2. Nayak P. K., *Textbook of Tensor Calculus and Differential Geometry*, 2012, PHI.
3. Sharma S. K. and Gupta R.K., *Spherical Astronomy*, 2014, Krishna Pakashan Media (P) Ltd.
4. Malik G.S., *Spherical Astronomy*, 2005, Kedar Nath Ram Nath, Meerut.

SYLLABUS (7th SEMESTER)

Subject Name: Mathematical Logic & Combinatorics **Subject Code: MAT012M703**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Mathematical Logic & Combinatorics** (**MAT012M703**) is to formulate problems in the language of formal system, to use concept of mathematical logic in inference theory and to study basic idea of counting principle.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** basic connectives and formal system of statement calculus	BT1
CO2	**Understand** the basic concept of mathematical logic and combinatorics	BT2
CO3	**Apply** idea of mathematical logic and combinatorics to solve problems.	BT3
CO4	**Examine** theories of mathematical logic and combinatorics to solve problems of other branches.	BT4

Prerequisites: Set theory, permutation and combination.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Combinatorics** Pigeonhole Principle, Basic and Bijective counting, Compositions and Partitions, Advanced Counting, Inclusion Exclusion, Mobius Inversion, Generating Functions.	18
II	**Informal statement calculus** Propositional Connectives, Truth Tables, Tautologies, rules for manipulation and substitution, Normal forms, adequate sets of connectives, arguments and validity	18

III	**Formal Statement Calculus** Formal system L of statement calculus, Formal definitions of Proof, Theorem and Deduction, Deduction theorem and its converse, Hypothetical Syllogism, Theory of Inference, Truth table technique, rule of inference, Indirect method of proof.	18
IV	**Adequacy theorem for Logic** Valuation in Logic, tautology, the Soundness theorem, extensions of Logic, consistency of an extension, Informal Predicate Calculus, Predicates and Quantifiers, Inference theory of predicate calculus.	18
Total		72

Text Book:

1. *Logic for Mathematicians*; Hamilton A.G, 7th edition, 1991, Cambridge University Press.

Reference Books:

1. Elliot Mendelson, *Introduction to mathematical Logic*, Revised 6th Edition, 2015, Chapman and Hall.
2. Veerarajan T., *Discrete Mathematics with Graph Theory and Combinatorics,* 2007, McGraw Hill Education (India) Private Limited.
3. Enderton H.B., *A Mathematical Introduction to Logic*, 2nd edition, 2001, A Harcourt Science and Technology Company.

SYLLABUS (7th SEMESTER)

Subject Name: Python Programming **Subject Code: MAT012M704**

L-T-P-C: 3-0-2-4 **Credit Units: 4** **Scheme of Evaluation: TP**

Objective: The general objectives of the course **Python Programming (MAT012M704)** are to enable learning basics and advance concept of Python, handling various data structure, write Python script to solve different problem.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Memorize** Python Basics, Data types and variables, Operators and operator precedence, Data type conversions, Control statements	BT1
CO2	**Discuss** about Functions, Local and global variables	BT2
CO3	**Apply** Python for writing script for mathematical problems.	BT3
CO4	**Analyze** and visualize the data creating various plots.	BT4

Prerequisites:

- Basic of Matrix Theory
- Basic knowledge of function

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Introduction to Python:** History and evolution of Python, Application areas and real-world use cases, Installation and setup (Downloading, Installing, Running scripts from Command Prompt and IDLE), Writing and saving Python programs, Understanding Algorithms and Flowcharts. **Python Basics:**	9+9

	Print statements and comments, Variables and keywords, Data types (Numeric, Dictionary, Boolean, Set, List, Tuple, String – Creation, Access, Modification, Deletion), Operators (Arithmetic, Relational, Assignment, Logical), Input and output functions.	
II	**Control Structures:** Conditional statements (if, elif, else, nested if), Looping constructs (for, while, nested loops), Control statements (break, continue). **Functions:** Defining functions, Function parameters and return statements, Keyword arguments, Local and global variables, The global statement, Exception handling (try-except blocks).	9+9
III	**Matrix in Python:** Using NumPy for matrix operations, Matrix creation, access, and manipulation, Types of matrices, Matrix operations (Determinant, Minor, Inverse, Rank, Eigenvalues, Eigenvectors), Solving systems of linear equations. **Plotting in Python:** Using Matplotlib for data visualization, Creating various plots (Line plots, Bar graphs, Pie charts, Histograms, Scatter plots, Contour plots).	9+9
IV	**File Handling:** Opening and closing files, Reading from files and writing to files, File modes and basic operations. **Data Structures:** Lists, Tuples, and Dictionaries, Accessing and modifying elements, List comprehensions for efficient data manipulation.	9+9
Total		72

Text Book:

1. **Matthes, E. (2023).** *Python Crash Course: A Hands-On, Project-Based Introduction to Programming.* 3rd ed., No Starch Press, 2023.
2. Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.

Reference Books :

1. Zelle, J. (2016). *Python programming: An introduction to computer science* (3rd ed.). Franklin, Beedle & Associates.
2. Python Tutorial, W3school, https://www.w3schools.com/python

SYLLABUS (7th SEMESTER)		
Subject Name: Numerical Methods		**Subject Code: MAT012N701**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The main objective of the course **Numerical Methods (**MAT012N701**)** is to study numerical methods to solve algebraic and transcendental equations, systems of linear algebraic equations and differential equations. This course will also help to find derivatives and integrals numerically.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**List** different types of error occurred in numerical analysis.	BT1
CO2	**Understand** the different methos of first and higher order partial differential equations.	BT2
CO3	**Apply** appropriate numerical method to solve algebraic or transcendental equation.	BT3
CO4	**Analyze** the solution of first order differential equation obtained by numerical integration.	BT4

Prerequisites:

- Concepts of Matrices, Inequality and idea of Differential and Integral calculus.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Errors and Roots of Transcendental and Polynomial Equations** Errors: Round-off error, Local truncation error, Global truncation error; Order of a method, Convergence, and terminal conditions; Bisection method, Secant method, Regula–Falsi method, Fixed point iteration method and Newton–Raphson method.	**18**
II	**Interpolation Techniques and Difference Methods** Finite difference and shift operators; Difference tables: forward difference, backward difference, Divided difference; Newton's forward	**18**

	and backward interpolation formulae; Newton's divided differences formula for interpolation; Lagrange's interpolation polynomials.	
III	**Numerical Methods in Linear Algebraic Systems** System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods, LU decomposition method, Gauss -Jacobi method, Gauss-Seidel method and their convergence analysis.	**18**
IV	**Numerical Integration and Differentiation** Numerical Integration: Newton Cotes' formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Weddle's rule. Numerical Differentiation: The method of successive approximations (Picard's method), Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four, Milne's predictor-corrector method.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. Sastry, S. S. (2012). *Introductory Methods of Numerical Analysis*. PHI Learning Pvt. Ltd.
2. Bradie, Brian. (2006). *A Friendly Introduction to Numerical Analysis.* Pearson Education India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.
3. Jain, M. K., Iyengar, S. R., & Jain, R. K. (2007). *Numerical Methods: Problems and Solutions*. New Age International.
4. Kandasamy, P., Thilagavathy, K., and Gunavathy, K. (2003). *Numerical Methods.* S. Chand & Co. Ltd., New Delhi, 2003 Edition.

Reference Books:

1. Zwillinger, D., & Dobrushkin, V. (2021). *Handbook of Differential Equations*. Chapman and Hall/CRC.

2. Fausett, Laurene V. (2009). *Applied Numerical Analysis Using MATLAB*. Pearson. India.
3. Gerald, Curtis F., & Wheatley, Patrick O. (2007). *Applied Numerical Analysis* (7th ed.). Pearson Education. India.

SYLLABUS (8th SEMESTER)

Subject Name: Finite Element Methods (FEM) **Subject Code: MAT012M801**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The general objectives of the course **Finite Element Methods (FEM) (MAT012M801)** are to enable learning basics finite element methods for one dimensional elliptic and parabolic problem. By the end of this study, students will have a strong theoretical foundation and practical understanding of the Finite Element Method. They will be able to apply FEM techniques to solve one-dimensional and time-dependent problems, analyze errors, and improve the accuracy of solutions.

Course Outcomes:

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

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**Memorize** the fundamental concepts of Finite Element Method, including historical background, boundary value problems, functionals, weak formulation, and Sobolev spaces.	BT1
CO2	**Discuss** the formulation and application of FEM for one-dimensional problems, including discretization, element connectivity, matrix formulation, boundary conditions, and solution approximation.	BT2
CO3	**Apply** the Finite Element Method to solve second-order boundary value problems and time-dependent problems using semidiscrete, and fully discrete formulations.	BT3
CO4	**Analyze** the accuracy and error convergence of FEM solutions using various error approximation techniques.	BT4

Prerequisites:

Partial Differential Equation

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**The basic concept of Finite element Method:** Historical Background, Initial value problem, Boundary value problem, Functional, Weak formulation of boundary valued problem, Sobolev spaces, Finite element method (Definition, Examples)	18
II	**Finite Element Analysis for One Dimensional Problem:** Second order boundary value problem, Discretization of the domain, Derivation of finite element, Connectivity of the elements, Matix calculation, Imposing boundary condition, Approximate solution of the equation, Applications.	18
III	**Finite Element Error Analysis:** Approximation of the error, Various measures of errors, Convergence of solution, Accuracy of the solution. Implementation.	18
IV	**Finite Element Analysis for Time dependent problem:** Time dependent boundary values problem, Weak formulation, Semidiscrete formulation, Fully discrete formulation, Error analysis. Implementation. Basic idea of two-dimensional extension.	18
Total		72

Text Book:

1. S.C. Brenner and L.R. Scott, The Mathematical Theory of Finite Element Methods, (Springer-Verlag, 1994).
2. J. N. Reddy, An Introduction to the Finite Element Method (McGraw-Hill, Inc., 1993).
3. S. Larsson and V. Thomée, Partial Differential Equations with Numerical Methods, (Springer, 2005).

Reference Books:

1. P. G. Ciarlet, The Finite Element Method for Elliptic Problems (North Holland, Amsterdam, 2002).
2. V. Thomee, Galerkin Finite Element Method for Parabolic Problems, (Springer- Verlag, 1997).
3. C. Johnson, Numerical Solution of Partial Differential Equations by Finite Element Method (Dover Publications, 2008).

SYLLABUS (8th SEMESTER)		
Subject Name: Linear Algebra and Functional Analysis		**Subject Code: MAT012M801**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of the course *Linear Algebra and Functional Analysis (MAT012M801)* is to develop foundational knowledge of vector spaces, linear transformations, and functional spaces for advanced problem-solving in mathematics and applied sciences.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** fundamental concepts of vector spaces, linear transformations, and normed spaces.	BT1
CO2	**Explain** the principles of linear independence, basis, and functional mappings in various contexts.	BT2
CO3	**Solve** problems involving eigenvalues, eigenvectors, and linear operators in different mathematical systems.	BT3
CO4	**Analyze** functional spaces and linear operators to interpret their properties and applications in real-world problems.	BT4

Prerequisites:

- Understanding of fundamental algebraic operations, equations, and matrix theory.
- Familiarity with sequences, limits, continuity, and basic concepts of metric spaces.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Normed linear spaces:** Normed linear space/Cauchy Sequence/Convergent Sequence/ Inner product space, properties of inner product and norms/ Cauchy-Schwarz Inequality and applications/ orthogonality, orthogonal complements/ orthogonal sets and bases / projections, Gram-Schmidth algorithm, applications.	**18**
II	**Linear Mappings:** Linear Mappings, Properties of Linear Mappings / kernel and image of linear mapping, computing the kernel and image of linear mappings /	**18**

	singular and non-singular linear mappings, isomorphism. Vector space of linear mappings / Invertible operators / Matrix representation of a linear operator, matrices and linear operator on R^3 / matrices and linear mappings. Change of basis (transition) matrix / change of basis and linear operators / similarity transformations /change of basis and linear mappings.	
III	**Bounded Linear Functionals:** Bounded and continuous operator/compact operator / normed linear spaces of linear operators/ bounded linear functionals/ dual space. Riesz's theorem (functional on Hilbert spaces) / Riesz's representation (sesquilinear form) / Hilbert adjoint operator and its properties /self adjoint, unitary and normal operators.	**18**
IV	**Fundamental Theorems for Banach Spaces:** Zorn's lemma / Hahn-Banach theorem (vector space version), Hahn-Banach theorem (normed linear space version) / reflexive space / Baire's category theorem/Zabreiko's lemma /Uniform boundedness theorem / strong and weak convergence / convergence of sequences of operators and functionals / Open mapping theorem / closed graph theorem.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Introductory Functional Analysis with Applications*, Kreyszig Erwin, 2007, Wiley India Pvt. Ltd.
2. *Linear Algebra*, Hoffman Kenneth and Kunze Ray , 2nd edition, 2015, PHI learning private limited.

Reference Books:

1. Conway John B., *A Course in Functional Analysis*, 1st edition, 2010, Springer Verlag.
2. Rudin Walter, *Functional Analysis*, 2nd edition, 2017, McGraw-Hill Education (ISE Editions)
3. Balmohan V. Limaye , *Functional Analysis*, 2014, New Age International Private Limited.
4. Nair M. Thamban , *Functional Analysis: A First Course*, 2001, PHI Learning Pvt. Ltd.
5. Lipschutz Seymour , *Linear Algebra*, 2004,Tata McGraw-Hill publishing Co Ltd.
6. Sharma A. K. , "*Linear Algebra" ,* 2007, Discovery Publishing House.

SYLLABUS (8th SEMESTER)		
Subject Name: Number Theory		**Subject Code: MAT012M801**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The main objective of the course **Number Theory (**MAT012M801**)** is to introduce the basic concept of Theory of Partitions and Continued fractions.

Course Outcomes:

After successful completion of the course, students will be able to understand Partition theory and Continued fraction

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**List** the basic concepts of Number Theory.	BT1
CO2	**Understand** the different terms describing general theta function and q-series, Partition theory and Continued fractions.	BT2
CO3	**Apply** these concepts to understand the Partition theory and Continued fractions.	BT3
CO4	**Analyze** Ramanujan's Congruences for partition functions and finding congruences for other partition function with restriction.	BT4

Prerequisites:

- Concept of number theory from B.Sc. level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Divisibility theory in the integers** Divisibility, division algorithm, greatest common divisor, least common multiple, Euclidean algorithm, prime numbers, factorization in prime numbers, fundamental theorem of arithmetic.	18
II	**The theory of congruences** Congruences, basic properties of congruence, linear congruences, the Chinese Remainder theorem, Fermat's theorem, Wilson's theorem, the Diophantine equation, linear Diophantine equations.	18

III	**Number-theoretic functions** Number-theoretic functions, divisor functions, multiplicative function, the mobius inversion formula, Euler's phi-function, Primitive roots and indices, primitive roots for primes, composite numbers and primitive roots, quadratic residue, Legender's symbol and its properties, quadratic reciprocity law.	**18**
IV	**Theory of Partitions and Continued fractions** Ramanujan's general theta functions, q-series and infinite product, Jacobi triple product identity, Ramanujan's continued fractions and explicit values, partition function, Ramanujan's famous congruences for partition, application of theta function to the theory of partitions.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Elementary Number Theory,* Burton, D. M., 7th edition, McGraw-Hill Education, 2010.
2. *Number theory in the spirit of Ramanujan,* Berndt B.C, AMS, 2006.
3. *The theory of partitions, Andrews G.E, Addition-Wesely, Reading, MA,1976.*

Reference Books:

1. Ramanujan's Notebook, Part III, IV and V, Berndt, B.C, Springer, 1991,1994,1998.
2. Ramanujan, Hardy, G. H, AMS- Chelsea, New York 1999.

SYLLABUS (8th SEMESTER)		
Subject Name: Fluid Dynamics	**Level: 400**	**Subject Code: MAT012M801**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The main objective of the course **Fluid Dynamics (**MAT012M801**)** is to introduce the basic concept of continuum mechanics and fluid dynamics to enable the students to solve problems of fluid dynamics.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**List** the basic concepts of Continuum mechanics.	BT1
CO2	**Understand** the different terms describing fluid motion and continuity equation.	BT2
CO3	**Apply** these concepts to understand the viscous fluid motion and Navier-Stokes equation of motion.	BT3
CO4	**Analyze** the Boundary layer flow with some special energy equations and concepts.	BT4

Prerequisites:

- Concept of dynamics and vectors from B.Sc. level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Fundamentals of Continuum Mechanics** Continuum Concept: Homogeneity, isotropy, mass density Stress Analysis: Cauchy's stress principle, stress tensor, equilibrium equations, principal stress, stress invariants, deviator and spherical stress tensors. Strain Analysis: Deformation tensors, small deformation theory, linear strain tensor, principal strains, strain invariants.	**18**
II	**Kinematics of Fluid Dynamics** Kinematics of fluids in motion and Equations of motion of inviscid fluids: Methods of describing fluid motion, Material, local and convective derivatives, Different kinds of flow, Path lines, streamlines, Velocity	**18**

	Potential, Vorticity Vector, Vortex lines, Equations of continuity; Equations of motion and their integrals. Bernoulli's equation.	
III	**Viscous fluid motion** Navier-Stokes equation of motion, rate of change of vorticity and circulation, rate of dissipation of energy, flow between plates, flow through a circular pipe, flow through concentric cylinders.	**18**
IV	**Laminar Boundary Layer Theory** General outline of Boundary layer flow, Boundary layer thickness, Displacement thickness, Energy thickness, Flow along a flat plate at zero incidence, Similarity solution and Blasius flow about a flat plate, Karman's momentum integral equation, Energy integral equation, Pohlhausen solution of momentum integral equation, phenomenon of separation.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 1985.
2. H. Schlichting, *Boundary Layer Theory*, McGraw Hill Book Company Inc., 2016.
3. R. Chatterjee, *Mathematical Theory of Continuum Mechanics*, Narosa Publishing House, 2015.

Reference Books:

1. Horace Lamb, *Hydrodynamics*, Cambridge University Press, 1953.
2. S. Goldstein, *Modern development of Fluid Dynamics*, Vol. 1, 1965, Dover Publication, New York.
3. G. K. Batchelor, *An Introduction to Fluid Dynamics*, 2007, Foundation Books, New Delhi.

4. M. D. Raisinghania, *Fluid Dynamics*, 2010, S. Chand and Co., New Delhi.
5. W. H. Besant and A.S. Ramsay, A *Treatise on Hydromechanics*, Part II, CBS Publishers & Distributors, 2006.
6. P. K. Kundu, I. M. Cohen, D. R. Dowling & J. Capecelatro, *Fluid Mechanics*. Elsevier, 2024.
7. L. M. Milne Thomson, *Theoretical Hydrodynamics*, Dover Publications Inc.; New edition, 2011.

SYLLABUS (8th SEMESTER)

Subject Name: Topology	**Level: 400**	**Subject Code: MAT012M801**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Guide Specific Paper - Topology** (**MAT012M801**) are:

1. To establish clear comprehension of different types of topological spaces.
2. To impart proper knowledge of the characteristics, properties and operations of topological spaces.
3. To introduce preliminary concepts of Algebraic Topology.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the terms related to Topology.	BT1
CO2	**Understand** the structure of various topologies, and diffeomorphism of topological structures.	BT2
CO3	**Apply** different results to construct topological spaces and to solve related problems.	BT3
CO4	**Examine** and **differentiate** the different types of topologies and solve related problems.	BT4

Prerequisites:

- Concepts of Real Analysis
- Basic concepts of Abstract Algebra.

Detailed Syllabus:

Modules	Topics / Course content	Hours
I	Topological spaces and basis of a topology; Order topology, Product topology, Subspace topology; Closed sets and limit points; Continuous functions, Homeomorphisms; Metric topology, Quotient topology.	**18**
II	Connected spaces, Connected subspaces of $\mathbb{R}$; Components and local connectedness; Compact Spaces, Compact subspaces of $\mathbb{R}$; Limit point compactness, Local compactness.	**18**
III	Countability axiom, Separation axiom; Normal Spaces; Urysohn Lemma, the Urysohn Metrization Theorem, Tietze Extension Theorem.	**18**
IV	Homotopy and Homotopy type, Cell complexes, Operation on spaces; Criteria for Homotopy Equivalence: Collapsing spaces and attaching spaces; The Homotopy Extension Property; Paths and Homotopy; The Fundamental Group; The Fundamental Group of the Circle; Induced Homomorphisms.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72		48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop)

Text Books:

1. Munkres, J. R., *Topology,* (Pearson Education, 2000).
2. Hatcher, A., *Algebraic Topology*, (Cambridge University Press, 2002).

Reference Books:

1. Morris, S. A., *Topology Without Tears*, (University of New England, 1989).
2. Kosniowski, C., *A first course in algebraic topology*, (Cambridge University Press, 1980).

SYLLABUS (8th SEMESTER)

Subject Name: Mathematical Modeling of Epidemiology
Level: 400 Subject Code: MAT012M801
L-T-P-C: 4-0-0-4 Credit Units: 4 Scheme of Evaluation: T

Objective: The objective of **Mathematical Modeling of Epidemiology** (**MAT012M801**) is to impart the fundamental of Mathematical modeling and understand the techniques of mathematical modeling of both infectious and non-infectious diseases.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Remember** basic infectious disease modelling.	BT1
CO2	**Understand** real life problem with stochastic modelling.	BT2
CO3	**Apply** different mathematical and machine learning methods to solve mathematical model.	BT3
CO4	**Analyze** real life problems with the help of mathematical and stochastic methods.	BT4

Prerequisites:

- Differential and Integral calculus
- Linear Algebra (linear systems of equations, Eigenvalues of a matrix)
- Computer programming.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Mathematical Modelling of Infectious Diseases I – Compartmental Models: Introduction to Epidemiological Modelling, SIR, SIS, SIRS Models, SEIR, Basic Reproduction Number, Stability Analysis and Equilibria, Vaccination and Herd Immunity, Case Studies: Influenza, Measles (Tools: Differential Equations, Phase Plane Analysis, Simulation (coding in Python:scipy, numpy/R/MATLAB)	12

II	Mathematical Modelling of Infectious Diseases II – Advanced and Stochastic Models: Stochastic Modelling in Epidemiology, Time-delay and Seasonality in Disease Spread, Case Studies: COVID-19, HIV/AIDS, Ebola, (Tools: Monte Carlo Simulations, Use of EpiModel or NetworkX in Python / R/ MATLAB, Real Data Fitting (curve fitting, parameter estimation)	12
III	Modelling of Non-Infectious Diseases: Chronic Diseases: Cancer, Diabetes, Cardiovascular Disease, Risk Factor Modelling, Population-Level Modelling and Screening Strategies, Markov Models and Life Tables, Case Studies: Diabetes Progression, Cancer Screening (Tools: Discrete-time Models, Markov Chains, Decision Trees)	12
IV	Computational Tools and Machine Learning in Epidemiology: Data Sources and Preprocessing (e.g., CDC, WHO, Kaggle datasets), Predictive Modelling: Regression, Time Series Forecasting, Classification and Clustering of Disease Patterns, Introduction to ML Models: SVM, Random Forests, Neural Networks and Deep Learning in Disease Prediction, Model Validation (Tools: Python Libraries: pandas, scikit-learn, matplotlib, TensorFlow or PyTorch/R/MATLAB Hands-on Projects using Jupyter Notebooks, Integration with earlier modules e.g., Predicting basic reproduction number, Outbreak Detection)	12
Total		48

Text Books:

1. *Mathematical Modeling*, J.N. Kapur, 2015, New Age International Publication.
2. ***An Introduction to Infectious Disease Modelling***, Emilia Vynnycky & Richard White Great, 2010, Oxford, New York: Oxford University Press.

Reference Books:

1. Hethcote, H.W., 2000, *The Mathematics of Infectious Diseases*. SIAM Review.
2. Brauer, F., Castillo-Chavez, C., 2012, *Mathematical Models in Population Biology and Epidemiology,* Springer.
3. Andersson, H., Britton, T., 2010, *Stochastic Epidemic Models and Their Statistical Analysis,* Springer.
4. Allen, L.J.S., 2003, *An Introduction to Stochastic Processes with Applications to Biology,* Prantice Hall, New Jersy

SYLLABUS (8th SEMESTER)

Subject Name: Research Methodology		**Subject Code: MAT012M802**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Research Methodology** (**MAT012M802**) are

- To develop students' ability to conduct individual major research
- To inculcate critical understanding of a topic relevant research interest
- To instill the ability of writing research report
- To develop the ability to communicate through presentation

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the terms related to Research.	BT1
CO2	**Understand** the motivation, rules and methods of research.	BT2
CO3	**Apply** research methods, paper and report writing, and tools to conduct research.	BT3
CO4	**Examine/Analyse** the research work.	BT4

Prerequisites:

- Basic knowledge of MS-Word
- Basic knowledge of MS-Excel
- Basic knowledge of Computing software

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Introduction to Research: Overview of Research - Meaning, Types, Objectives of Research, Research Process. Research problem identification, Literature survey.	**18**
II	Research Design: Exploratory Research Design- Using Secondary Data, Qualitative Research, Descriptive Research Design - Survey and Observation methods, Causal Research Design - Experimentation and conditions for causality.	**18**
III	Sampling & Scaling: Sampling Concepts, Probability and Non-Probability Sampling Designs, Sample Size Determination. Data Analysis and Hypothesis Testing: Descriptive Statistics, Inferential Statistics, Hypothesis formulation and Testing, Z-test for proportion and mean. Basic concepts of MS-Excel, LaTeX and computing software.	**18**
IV	Report Writing, Research Presentation, Referencing & Citation; Referencing style: APA, Chicago, IEEE; Surfing of journals, Submission of articles; Mathematical Subject Classification.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Seminar, Workshop)

Text Books:

3. Kothari C R & Garg G (2019): *Research Methodology (Methods and Techniques)*, 4th Edition, New Age International Publishers.

Reference Books:

3. Kalita B (2023): *Basics of R and Data Analysis for Research,* 1st Edition, Himalaya Publishing House, Mumbai.
4. Concise Rules of APA Style. (2010). American Psychological Association. Language, Arts and Disciplines.
5. The Chicago Manual of Style. (2003). University of Chicago Press

SYLLABUS (8th SEMESTER)		
Subject Name: Advanced Real Analysis		**Subject Code: MAT012M803**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Advanced Real Analysis (MAT012M803)** are

- To understand the concept of differentiability and Taylor's theorem.
- To understand the idea of Riemann integration and its applications.
- To learn the concepts of sequence and series of functions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** concepts of differentiability and its applications.	BT1
CO2	**Illustrate** various methods to understand mean value theorem, Taylor's theorem, Riemann integration and sequence and series of functions.	BT2
CO3	**Apply** these ideas to solve problems and its applications.	BT3
CO4	**Analyze** these concepts to understand and develop critical thinking.	BT4

Prerequisite:

- Concept of Real Analysis studied in 3rd Semester.

Detailed Syllabus

Modules	Topics / Course Contents	Periods
I	**Mean Value Theorems and its Applications** Definition and types of intervals, Nested intervals property; Open and closed sets in $\mathbb{R}$; Neighborhood of a point in $\mathbb{R}$, adherent point, limit point, condensation point, isolated point, derived set; Interior point, exterior point, boundary point; Differentiability, Rolle's Theorem, Mean Value Theorems and its applications.	18
II	**Taylor's Theorem and its Applications** Taylor polynomial, Taylor's theorem with Lagrange form of remainder, Application of Taylor's theorem in error estimation; Relative extrema, and to establish a criterion for convexity; Taylor's series expansions of e^x , $\sin x$ and $cos\ x$.	18
III	**Riemann Integration** Definition of Riemann integration, Inequalities for upper and lower Darboux sums, Necessary and sufficient conditions for the Riemann integrability, Properties of Riemann integrable functions, intermediate value theorem for integrals, Fundamental theorems of calculus, and the integration by parts.	18
IV	**Sequence and Series of Functions** Pointwise and uniform convergence of sequence of functions, Theorem on the continuity of the limit function of a sequence of functions, Cauchy criterion sequence of functions, interchange of the limit and integrability of a sequence of functions. Pointwise and uniform convergence of series of functions, Derivability and integrability of the sum function of a series of functions, Cauchy criterion and the Weierstrass M-Test for uniform convergence.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	–	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

2. *Introduction to Real Analysis*; Bartle, Robert G., Sherbert Donald R.; Fourth Edition; 2014; Wiley India Pvt. Ltd.
3. *A Basic Course in Real Analysis*; Kumar, A. and Kumaresan, S.; Reprint 2016; CRC Press.
4. Introduction to Analysis; Mattuck, Arthur; 1999; Prentice Hall.
5. A Course in Calculus and Real Analysis; Ghorpade, Sudhir R. & Limaye, B. V.; 2006; Undergraduate Texts in Mathematics, Springer (SIE).

Reference Book:

7. *Mathematical Analysis*; Malik, S.C. and Arora Savita; Fifth edition; 2017; New Age ScienceLtd.
8. *Principles of Mathematical Analysis*; Rudin Walter; Third Edition; 2017; McGraw HillEducation.
9. *Basic Real Analysis*; Sohrab, Houshang H.; Second Edition; 2014; Birkhauser.
10. *Elementary Analysis: The Theory of Calculus*; Ross, Kenneth A.; Second Edition; 2013; Springer.

SYLLABUS (8th SEMESTER)		
Subject Name: Fuzzy Set Theory		**Subject Code: MAT012M804**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The main objective of **Fuzzy Set theory (MAT012M804)** is

- To impart understanding the basic mathematical elements of the theory of fuzzy sets that are widely used in science and engineering.
- To provides the idea on the differences and similarities between fuzzy sets and classical sets theories.
- To make the student understand the fuzzy logic inference with emphasis on their use in the design of intelligent or humanistic systems.
- To introduce the fuzzy arithmetic concepts and provide an insight into fuzzy inference applications

Prerequisites

Concept of Algebra, Mathematical Logic (Discrete Mathematics).

Course Outcomes:

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

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**Recall** the definitions and formulae of the classical set theory.	BT1
CO2	**Understand** the equation of fuzzy set theory.	BT2
CO3	**Apply** the theories of fuzzy set theory to solve related problems.	BT3

CO4	**Analyze** fuzzy sets to make fuzzy equivalence relations.	BT4

Detailed Syllabus

Modules	Topics/Course content	Periods
I	**Fuzzy Sets and Operations on Fuzzy Sets:** Classical sets vs Fuzzy Sets, Need for fuzzy sets, Definition and Mathematical representations, Level Sets, Fuzzy functions, Zadeh's Extension Principle, Operations on [0,1], Fuzzy negation, Fuzzy Numbers.	**18**
II	**Fuzzy Relations and Fuzzy Graphs** Fuzzy Binary and n-ary relations, composition of fuzzy relations, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations, Fuzzy Relational Equations.	**18**
III	**Fuzzy Logic and Approximate Reasoning** Fuzzy Logic, Linguistic hedges, Fuzzy propositions (conditional and unconditional), Inference from conditional and qualified fuzzy propositions, Fuzzy Quantifiers, Inference from quantified fuzzy propositions	**18**

IV	**Possibility Theory** Introduction to possibility theory Possibility vs probability Belief and Plausibility, Dempsters rule, Fuzzy sets in Decision making.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip)

Text Book:

1. *Fuzzy Sets and Fuzzy Logic: Theory and Applications* , George J Klir and Bo Yuan, Prentice Hall NJ,1995.

Reference Books:

1. Zimmermann H.J., *Fuzzy Set Theory and its Applications*, 3rd Edition, 2014, Springer.
2. John N. Mordeson and Premchand S.Nair , *Fuzzy Mathematics-An Introduction for engineers and Scientists*, 2010, Springer Books.
3. Anastassiou George *A, Fuzzy Mathematics-Approximation Theory.* 2010 Springer Publication.

SYLLABUS (8th SEMESTER)

Subject Name: Mathematical Modeling **Level: 400** **Subject Code: MAT012M805**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objective of Mathematical Modeling (**MAT012M805**) is to impart the fundamental of Mathematical modeling and understand the techniques of mathematical modelling.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Remember** solution method of differential equations	BT1
CO2	**Understand** real life problem	BT2
CO3	**Apply** different mathematical methods to solve mathematical model .	BT3
CO4	**Analyze** real life problem mathematically	BT4

Prerequisites:

- Differential and Integral calculus
- Linear Algebra (linear systems of equations, Eigenvalues of a matrix)
- Differential equations.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Introduction, basic concepts of Mathematical Modeling, its needs, types of models, limitations. Elementary ideas of dynamical systems, Mathematical modeling through ordinary and partial differential equation. Equilibrium point, node, saddle point, focus, centre and limit-cycle ideas with simple illustrations and figures. Linearization of non-linear plane autonomous systems. Mathematical Modeling Through Graphs. Differential-difference equations. Mathematical modeling through calculus of variations ,.	18
II	Mathematical Modeling in the biological environment: Blood flow and oxygen transfer. Modeling blood flow, viscousity, Poiseuille law, mathematical formulation of the problem, solution and interpretation. Oxygen transfer in red cells, diffusion, mathematical formulation, solution, interpretation, and limitations.	18

III	Population Models: Single species population models. Basic concepts. Exponential growth model, Compensation and depensation. Logistic growth model, Gompertz growth model, formulation, solution, interpretation, and limitations. Two species population models. Types of interaction between two species. Lotka-Volterra prey-predator model, formulation, solution, interpretation, arid limitations. Lotka-Volterra model of two competing species, formulation, solution, interpretation, and limitations.	18
IV	Mathematical modeling of epidemics. Basic concepts. Simple epidemic model, formulation, solution, interpretation, and limitations. General epidemic model, formulation, solution, interpretation, and limitations.	18
Total		72

Text Books:

3. *Mathematical Modeling*, J.N. Kapur , 2015, New Age International Publication.

Reference Books:

1. Edward A. Bender: *An introduction to mathematical Modeling*, 2002, CRC Press.
2. Walter J. Meyer, *Concepts of Mathematical Modeling*, 2004, Dover Publ.
3. Mark M. Meerschaert, *Mathematical Modeling*, 2013, Academic Press,.