

**Details of Revised/New Course Structure and Syllabus for
4-Year B.Sc. (Mathematics) and 1-Year M.Sc. Mathematics (Programme)
(with effect from July 2025)**

Central University of Rajasthan



Department of Mathematics

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305817

1. The NEP 2020 based Four-Year UG Programme is an 8-semester (4-year) Programme of 160 credits with multiple exit and entry options at the successful completion of courses assigned at the end of each year.
 - Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
 - Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
 - Students who wish to undergo a 3-year UG programme will be awarded UG degree in the Major discipline after successful completion of three years securing 120 credits.
 - Students who wish to undergo a 4-year UG programme will be awarded UG Honours degree in the major discipline after successful completion of four years degree programme with 160 credits.
 - Students who meet minimum requirement of CGPA of 7.5, shall be eligible for a UG Honours with Research degree in respective discipline/field of study after successful completion of 160 Credit, including 12/16 Credits from a research project.

Outline of Courses:

1. **Major and Minor Courses:** Major and minor courses are 4 credits courses. An additional one to two credits may be for tutorials or practices.
 2. **Other Courses:** The Other courses are 3 Credits courses which included multi-disciplinary, Ability enhancement (language) and skill enhancement courses.
 3. **Value Added Courses (Common):** Courses under value-added, summer internship/ apprenticeship/ community outreach activities of 2 credits.
 4. **Final year research project/ dissertation:** Final year research project or dissertation will of 12 credits.
2. Students qualifying and taking one-year Master's degree programme and have secured 200 credits will be awarded the Master's degree in Mathematics.

Structure of the 4-Year UG + 1-Year PG Programme

Minimum Credit requirements to Award Certificate/ Diploma/ Degree under each category

S. No.	Broad category of Course	Minimum Credit requirement					
		UG Certificate (1-year)	UG Diploma (2-year)	UG Degree (3-year)	UG Honours Degree (4-year)	UG Honours with Research Degree (4-year)	PG degree (1year)
1	MAJOR	8	30	60	80	80	100
2	MINOR	8	16	24	44	32	48
3	MULTI/INTER DISCIPLINARY COURSES (IDC)	6	9	9	9	9	9
4	ABILITY ENHANCEMENT COURSES (AEC)	4	8	8	8	8	8
5	SKILL ENHANCEMENT COURSES (SEC)	6	9	9	9	9	9
	VALUE-ADDED COURSES (VAC)	8	8	8	8	8	8
6	SUMER INTERNSHIP	4*	4*	2	2	2	2
7	RESEARCH PROJECT/ DISSERTATION	-	-		-	12	16
	Total	40+4*	80+4*	120	160	160	200

CORE: MAJOR AND MINOR

IDC: INTER DISCIPLINARY COURSES

AEC: ABILITY ENHANCEMENT COURSES (LANGUAGE)

SEC: SKILL ENHANCEMENT COURSES

VAC: COMMON VALUE-ADDED COURSES

INT: INTERNSHIP, DISS: DISSERTATION

Course Structure:

Semester-I: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	4.5MAT01	Differential Calculus	Major	4
2		From another department	Minor	4
3		IDC 1: From Table of IDC	IDC	3
4		SEC 1: From Table of SEC	SEC	3
5		AEC 1: English/Hindi Language	AEC	2
6		VAC 1: Given by University	VAC	4
			Total	20

Semester-II: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	4.5MAT02	Integral Calculus	Major	4
2		From another department	Minor	4
3		IDC 2: From Table of IDC	IDC	3
4		SEC 2: From Table of SEC	SEC	3
5		AEC 2: English/Hindi Language	AEC	2
6		VAC 2: Given by University	VAC	4
			Total	20

Semester-III: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	5.0MAT01	Mathematical Programming	Major	4
2	5.0MAT02	Ordinary Differential Equations	Major	4
3		From another department	Minor	4
4		IDC 3: From Table of IDC	IDC	3
5		SEC 3: From Table of SEC	SEC	3
6		AEC 3: From Table of AEC	AEC	2
			Total	20

Semester-IV: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	5.0MAT03	Numerical Methods	Major	4
2	5.0MAT04	Discrete Mathematics	Major	4
3	5.0MAT05	Solid Geometry	Major	4
4		From another department	Minor	4
5		MOOC Course	Major	2
6		AEC 4: From Table of AEC	AEC	2
			Total	20

Semester-V: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	5.5MAT01	Foundation of Linear Algebra	Major	4
2	5.5MAT02	Elementary Analysis	Major	4
3	5.5MAT03	Foundation of Complex Analysis	Major	4
4		From another department	Minor	4
5		MOOC Course	Minor	2
6	5.5MAT81	Internship	SEC	2
			Total	20

Semester VI: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	5.5MAT04	Foundation of Abstract Algebra	Major	4
2	5.5MAT05	Partial Differential Equations-I	Major	4
3	5.5MAT06	Linear and Non-linear Programming	Major	4
4	5.5MAT07	Calculus of Variations and Integral Equation	Major	4
5		From another department/ MOOC Course	Minor	4
			Total	20

Semester-VII: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	6.0MAT01	Linear Algebra	Major	4
2	6.0MAT02	Real Analysis	Major	4
3	6.0MAT03	Qualitative Theory of ODEs	Major	4
4	6.0MAT--	Departmental Elective	Minor	4
5	6.0MAT81	Basic Programming in MATLAB	SEC	2
6		Generic Elective/MOOC course	Minor	2
			Total	20

Semester-VIII: UG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	6.0MAT04	Abstract Algebra	Major	4
2	6.0MAT05	Complex Analysis	Major	4
3	6.0MAT--	Departmental Elective	Minor	4
4	6.0MAT--	Departmental Elective	Minor	4
5		Generic Elective/MOOC course	Minor	2
6	6.0MAT82	Scientific Writing by Latex	SEC	2
7	6.0MAT83	Project-Dissertation (In place of S. No. 3, 4, 5, 6)	AEC	12*
			Total	20

Semester-I: PG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	6.5MAT01	Functional Analysis	Major	4
2	6.5MAT02	Topology	Major	4
3	6.5MAT03	Partial Differential Equations-II	Major	4
4	6.5MAT--	Departmental Elective	Minor	4
5		Generic Elective/MOOC course	Minor	4
			Total	20

Semester-II: PG

S. No.	Course Code	Title of Courses	Type of Course	Credits
1	6.5MAT81	Project-Dissertation	AEC	16
2		Departmental / Generic Elective/MOOC course	Minor	4
			Total	20

* Project of 12 Credits in place of Minor courses for the 4-year UG Honors with Research degree programme.

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LIST OF CORE MAJORS

DIFFERENTIAL CALCULUS (4.5MAT01)

Course Title:	Differential Calculus	
Course Code:	4.5MAT01	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1.		
2.		
Course Objectives: To prepare the students with		
1.	the basic concepts of limit, continuity, differentiability.	
2.	the basic concepts of mathematical theorems and applications.	
3.	the basic concepts of curvature and different forms.	
Course Outcomes: The students will be able to		
1.	find derivative and limits of various functions and use them for further study	
2.	draw graph of various functions in Cartesian and Polar coordinates	
3.	use the concepts of calculus in higher learning.	
Course Content:		
Unit	Content	Hours
I	Limit of a function, Algebra of Limit, Continuous functions, Classifications of discontinuities, Differentiability of a function, Algebra of derivatives, Increasing and decreasing functions, Extreme values of functions.	15
II	Tangent and normal, Rolle's theorem, Mean value theorems and their geometrical interpretations, Taylor's and Maclaurin's series expansions, Taylor's theorem with Lagrange form of remainder.	15
III	Indeterminate forms, L' Hospital Rule, Successive differentiation and Leibnitz theorem, Asymptotes, Convexity, concavity and point of inflexion.	15
IV	Curvature of plane curves, radius of curvature in Cartesian, parametric and polar forms, center of curvature. Evolutes and involutes, envelopes. Tracing of standard Cartesian and polar curves.	15
Internal Assessment:		
CIA-I	Unit-I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", 9 th Edition, Pearson Education India, 2010 E. Kreyszig, "Advanced Engineering Mathematics", 10 th Edition, John & Wiley Sons, U.K., 2016. R. K. Jain, & S. R. K. Iyenger, "Advanced Engineering Mathematics", 4 th Edition, Narosa Publishing House, New Delhi, India, 2014. 		
Reference Books:		
<ol style="list-style-type: none"> Gorakh Prasad, "Integral Calculus", Pothishala Private Limited, 2015 		
E-resources:		

INTEGRAL CALCULUS (4.5MAT02)

Course Title:	Integral Calculus	
Course Code:	4.5MAT02	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1.		
Course Objectives: To prepare the students with		
1.	the concepts of integration of functions and their applications.	
2.	the concepts of Vector Calculus, Vector Geometry, Vector Integration,	
3.	the concepts of Line and Surface Integrals and relations to double and triple integrals.	
Course Outcomes: The students will be able to		
1.	calculate surface integral and volume integral.	
2.	use the concepts of calculus in higher learning.	
3.	analyze the vector calculus and its applications	
Course Content:		
Unit	Content	Hours
I	Integration-reduction formulae for rational and irrational functions, trigonometric functions. Exponential functions, Polynomial functions, and their composite forms.	15
II	Definite integrals and its application to find area under simple curve and area between two curves, Area of a curve using multiple integral, Change of order of integration.	15
III	Vector Differentiation and their properties, velocity, acceleration, and their radial and transversal components, directional derivative, gradient, divergence and curl and their properties.	15
IV	Vector integration- line, surface and volume integration, Green's theorem, Gauss divergence theorem, Stoke's theorems.	15
Internal Assessment:		
CIA-I	Unit-I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. E. Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John & Wiley Sons, U.K., 2016. 2. MD. Ali Ashraf, and MD. Abdul Khaleq Hazra, "Vector Analysis with Application", 3 rd Edition, New Age International (P) Ltd, 2006. 3. R. K. Jain, & S. R. K. Iyenger, "Advanced Engineering Mathematics", 4 th Edition, Narosa Publishing House, New Delhi, India, 2014. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Seymour Lipschutz, Dennis Spellman, and Murray, Spiegel, "Vector Analysis", 2nd Edition, McGraw Hill Education (India) Private Ltd., 2000 		
E-resources:		

MATHEMATICAL PROGRAMMING (5.0MAT01)

Course Title:	Mathematical Programming		
Course Code:	5.0MAT01		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks		Tutorial: 1
	Total:		4
Course Prerequisite: The student should know			
1	basic concepts in Linear Algebra and Matrices: System of linear equations, Matrices.		
Course Objectives: To prepare the students with			
1	To teach the students the skills to formulate real-world problems as linear and nonlinear programs		
2	To teach the students the theoretical principles of linear programming problems.		
3	To introduce different types of methodologies to solve linear programming problems, e.g., simplex method, dual simplex method, revised simplex method.		
4	To teach how to handle transportation and assignment problems using concept of linear programming.		
Course Outcomes: The students will be able to			
1	Understand the theoretical foundations of simplex and revised simplex method.		
2	Perform sensitivity analysis to identify the direction and magnitude of change of a linear programming model's optimal solution as the input data changes		
3	Formulate specialized linear programming problems, namely transportation and assignment problems and describe theoretical workings of the solution methods for transportation and assignment problems, demonstrate solution process by hand and solver.		
Course Content:			
Unit	Content	Hours	
I	Linear Programming Problems Formulation and Solution by Graphical Method and Simplex Method, Theoretical Foundation of Simplex Method, Revised Simplex Method.	15	
II	Duality in linear programming problem, Primal-dual method, Duality theorems, Dual simplex method; Sensitivity Analysis: Post Optimality Analysis (change in resource vector, change in cost vector, addition and deletion of a constraint, addition and deletion of a decision variable	15	
III	Transportation Problem (TP) and its formulation, finding initial basic feasible solution of TP using North-West Corner rule, Least Cost method and Vogel's Approximation method, MODI method for finding optimal solution, Special cases in TP.	15	
IV	Assignment Problem (AP) and its formulation, Hungarian method for solving AP, Special cases in AP, Transshipment and Travelling salesmen problem.	15	
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
<ol style="list-style-type: none"> 1. Chandra S., Jayadeva and Mehra A., 2009, <i>Numerical Optimization with Applications</i>, Narosa Publishing House Pvt. Ltd. 2. Hadley G., 1987, <i>Linear Programming</i>, Narosa Publishing House Pvt. Ltd. 3. Taha H. A., 2007, <i>Operations Research-An Introduction</i>, Prentice Hall of India Pvt. Ltd. 4. Hillier F. S., Lieberman G. J., Nag B. and Basu P., 2012, <i>Introduction to Operations Research</i>, Tata McGraw Hill Education Pvt. Ltd. 5. Bazaraa M.S., Sherali H.D. and Shetty C.M., 2006, <i>Nonlinear Programming Theory and Algorithms</i>, Wiley. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Bertsimas D. and Tsitsiklis J.N., 1997, <i>Introduction to Linear Optimization</i>, Athena Scientific, Belmont, Massachusetts. 2. Bradley, H., Magnanti, 1977, <i>Applied Mathematical Programming</i>, Addison-Wesley 			
E-resources:			
<ol style="list-style-type: none"> 1. https://onlinecourses.swayam2.ac.in/cec22_ma17/ 2. https://archive.nptel.ac.in/courses/111/107/111107128/ 			

ORDINARY DIFFERENTIAL EQUATIONS (5.0MAT02)

Course Title:	Ordinary Differential Equations		
Course-Code:	5.0MAT202		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite:			
1	Basics of calculus.		
Course Objectives: To prepare the students with			
1	various methods to solve Ordinary Differential Equations analytically.		
2	generate a certain kind of interest in the subject by observing some simple mathematical formulation of real-life problems.		
3	differential equation and what they mean by a solution.		
Course Outcomes: The students will be able to			
1	use which method of solution is applicable for a specific ordinary differential equation.		
2	to get solutions of Ordinary Differential Equations using some known methods.		
3	the existence of a solution to a particular ordinary differential equation.		
Course Content:			
Unit	Content		Hours
I	Order and degree of a differential equation, first order ordinary differential Equations: Solution, Geometrical significance, Initial Value Problems, Boundary Value Problems, Solution methods for solving ordinary differential equations of first order (linear and non-linear): Exact, Integrating factors, Separable, Homogeneous, Linear, Reducible to linear, Special Integrating Factors and Transformations.		15
II	Orthogonal trajectories, Ordinary Simultaneous linear differential equations, Basic theory of linear differential equations, Basic theorem on linear homogeneous differential equations, Linear dependence and independence of solutions, Wronskian.		15
III	First order with higher degree differential equations, Clairaut's form and singular solutions with Extraneous loci, Homogeneous linear differential equations with constant coefficients and its general solution, complementary function and particular integral.		15
IV	Nonhomogeneous linear differential equations and their general solution, Cauchy-Euler equation, Methods for solving higher order linear differential equations: Reduction of order, Reduction to normal form, Methods of undetermined coefficients, Change of independent variable, Variation of parameters, Applications of second order differential equations with constant coefficients.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
<ol style="list-style-type: none"> 1. Ross S. L., 2007, Differential Equations, Wiley. 2. Simmons G. F., 2017, Differential Equations with Applications and Historical Notes, McGraw Hill Education. 3. Deo S. G., Raghavendra V., Kar R., and Laksmikantham V., 2017, Textbook of Ordinary Differential Equations, McGraw Hill Education. 4. Pinchover Y. and Rubjinstein J., 2005, An Introduction to Partial Differential Equation, Cambridge University Press. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Coddington E. A., 1989, An Introduction to Ordinary Differential Equations, Dover Publications. 			
E-resources:			

NUMERICAL METHODS (5.0MAT03)

Course Title:	Numerical Methods		
Course-Code:	5.0MAT03		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite:			
Course Objectives:			
1	To develop the understanding of several methods for interpolation, methods to solve algebraic and transcendental equations.		
2	To develop direct and iterative methods to solve a system of linear equations, different methods to solve ODE and methods to find numerical derivative and integration of a function.		
Course Outcomes: Students will be able to			
1	find the interpolating polynomial and its values		
2	solve an algebraic and transcendental equation		
3	evaluate derivative and integration of a function, numerically		
4	solve ordinary differential equations, numerically.		
Course Content:			
Unit	Content		Hours
I	Finite difference operators, difference tables, Interpolation, Interpolation with equal intervals, Methods of interpolation: Newton-Gregory interpolation method, Interpolation with unequal intervals: Divided difference, Newton's formula for unequal intervals, Lagrange's interpolation formula, Central difference interpolation formulae: Central difference operators. Gauss forward, backward and modified formulae, Stirling and Bessel's central difference formulae.		15
II	Numerical differentiation and integration: method of differentiation based on interpolation, methods based on finite difference operators. Integration by Trapezoidal rule, Simpson's 1/3 rd rule, Simpson's 3/8 th rule, Weddle's rule, Newton Cotes Quadrature formula.		15
III	Numerical Solution of Algebraic and Transcendental equations: Bisection method, Regula-Falsi method, iteration method and Newton-Raphson method along with the rate of convergence.		15
IV	Numerical solution of Ordinary Differential Equations: Euler method, Modified Euler method, Picard's method, Runge-Kutta method.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
<ol style="list-style-type: none"> 1. Atkinson K. E., 1989, An Introduction to Numerical Analysis (2nd Ed.), Wiley-India. 2. Buchaman J. I. and Turner P. R., 1992, Numerical Methods and Analysis, McGraw-Hill. 3. Jain M. K., Iyengar S. R. K. and Jain R. K., 2012, Numerical Methods for Scientific and Engineering Computation (6th Ed.), New Age International Publishers. 4. Sastry S. S. 2019, Introductory Methods of Numerical Analysis, PHI. 			
E-resources:			
https://archive.nptel.ac.in/courses/111/107/111107105/			

DISCRETE MATHEMATICS (5.0MAT04)

Course Title:	Discrete Mathematics	
Course Code:	5.0MAT04	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
	Total:	4
Course Prerequisite: The student should have knowledge of		
1.		
2.		
Course Objectives: To prepare the students with		
1.	mathematical reasoning and problem solving.	
2.	permutation, combinations and pigeon-hole principle.	
3.	graphical algorithms to solve problems.	
4.	different types of graphs and their properties.	
Course Outcomes: The students will be able to		
1.	express a logic sentence in terms of predicates, quantifier and logical connectives.	
2.	three graphical algorithms to solve problems.	
3.	determining the shortest route from one city to another city using graphs	
Course Content:		
Unit	Content	Hours
I	Set, function and logic, Types of functions, Relations, Equivalence relations, Partial Orderings, Principle of mathematical induction, Propositions and predicates, Logic and Proofs: Proposition, Quantifiers, Rules of Inference, Proof Methods and Strategy,	15
II	Combinatorics: Principles of counting, Arrangements, Permutation and Combinations, Partitions and allocations, Pigeon-hole principle. Graphs and Planar Graphs: Graph, Multi Graph, Bipartite Graph, Weighted Graphs, Directed graphs. Paths and circuits. Matrix representation of graphs.	15
III	Eulerian Paths and Circuits, Walks, Paths, Cycles, Hamiltonian cycles and travelling salesman problems, Trees, Distances and Shortest Paths, Minimum spanning trees.	15
IV	Group Theory: Definition and examples of various types of groups, Subgroups, Subgroup Tests, Cyclic group, Classification of subgroups of Cyclic groups, Permutation group, Isomorphism, Properties of Isomorphisms, Cosets and Lagrange's Theorem	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/Viva-Voce	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
1. C.L. Liu, <i>Elements of Discrete Mathematics</i> , 2nd Ed., McGraw Hill, International Edition.		
2. J.P. Tremblay and R. P. Manohar, <i>Discrete Mathematical Structures with Applications to Computer Science</i> , McGraw-Hill, 1989.		
3. S. Wiitala, <i>Discrete Mathematics: A Unified Approach</i> , McGraw-Hill Book Co.		
4. N. Deo, <i>Graph Theory with Applications to Computer Science</i> , Prentice-Hall of India.		
Reference Books:		
1. J. H. Van Lint and R. M. Wilson, <i>A course in combinatorics</i> , 2nd Ed. Cambridge Univ. Press.		
E-resources:		

SOLID GEOMETRY (5.0MAT05)

Course Title:	Solid Geometry	
Course-Code:	5.0MAT05	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 Hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	Basic Concepts of basic geometry.	
Course Objective: This course aims to learn		
1	The properties of conics in two and three dimensions.	
2	The geometry of conics in two and three dimensions and their intersections.	
3	The nature of the second-degree equation.	
Course Outcomes: The students will be able to understand		
1	To write mathematical representations of conics in 2 and 3 dimensions.	
2	The sketches of conic sections in 2 and 3 dimensions.	
3	The properties and intersections of the conic sections.	
4	To identify and classify the nature of quadratic equations.	
Course Content:		
Unit	Content	Hours
I	Straight lines in space (Symmetric & Parametric form), Direction ratio and direction cosines, Canonical equation of the line of intersection of two intersecting planes, Angle between two lines, Distance of a point from a line, Condition of coplanarity of two lines, Equation of skew-lines, shortest distance between two lines.	15
II	Sphere: General equation, Sphere through the intersection of two spheres, radical plane, tangent, normal.	15
	Cone: Right circular cone, general homogeneous second-degree equation, section of cone by a plane as a conic and as a pair of lines, condition for three perpendicular generators, reciprocal cone.	
III	Cylinder: Generator parallel to either of axes, general form of equation, right-circular cylinder.	15
	Conicoid: Ellipsoid, hyperboloid, paraboloid, tangent planes, normal, enveloping cone, enveloping cylinder.	
IV	Surface of revolution (about axes of reference only), ruled surface, reduction of the general equation of second degree, canonical equations only.	15
Internal Assessment:		
CIA-I	Unit-I	
CIA-II	Written Exams/ Quizzes/ Assignment/ Presentations/ Viva-Voce based on Unit II & III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. Loney S. L., 2012, <i>The Elements of Coordinates Geometry</i> , General Books.		
2. Bell J. T., 2010, <i>An Elementary Treatise on Coordinate Geometry of Three Dimensions</i> , General Books.		
3. Smith C., 1911, <i>An Elementary Treatise on Conic Sections by the Methods of Coordinate Geometry</i> , Macmillan and Co. Ltd.		
4. Wentworth G. and Smith D. E., 2007, <i>Plane and Solid Geometry</i> , Merchant Books.		
Reference Books:		
1. Adrian, A. A., 2016, <i>Solid Analytical Geometry</i> , Dover Publications, New York.		
2. Vittal, P. R., 2013, <i>Analytical Geometry 2D and 3D</i> , Pearson		

FOUNDATION OF LINEAR ALGEBRA (5.5MAT01)

Course Title:	Foundation of Linear Algebra	
Course Code:	5.5MAT01	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	Sets, Functions, Matrices, Field	
Course Objective:		
1	To introduce the system of linear equations, equivalence of two systems, solutions of system of linear equations	
2	To teach vector spaces, basis, dimension	
3	To introduce linear transformations between any two vector spaces, eigenvalues, and eigenvectors.	
4	To introduce inner product spaces and associated concepts e.g., norm, orthogonal sets.	
Course Outcomes: The students will be able to learn		
1	how to analyze and solve systems of linear equations	
2	that whether a given a set of vectors is a vector space, a subspace, or a basis for a vector space	
3	how to compute eigenvalues and eigenvectors, algebraic and geometric multiplicities belonging to an eigenvalue	
4	different concepts about linear transformations and inner product spaces	
5	how to use and take help of different concepts associated with system of linear equations, vector spaces, linear transformations, and inner product spaces in advanced course on Linear Algebra	
Course Content:		
Unit	Content	Hours
I	System of linear equations: Equivalent systems, Matrices, Elementary row operations, Row-reduced echelon matrices, Block matrices, Vector spaces: Definition, Subspaces, Linear span, Linear dependence and linear independence, Direct sums.	15
II	Basis, Dimension, Ordered bases and coordinates, Linear transformations: Definition and examples, Null spaces, Range spaces, Rank-nullity dimension theorem, Matrix of a linear transformation, Isomorphism, Change of basis	15
III	Eigenvalues and eigenvectors of linear operators, Computing eigenvalues and eigenvectors of different types of matrices, Diagonalization, Symmetric matrices, Inner product spaces: Definition and examples	15
IV	Cauchy-Schwarz inequality, Triangle inequality, Orthogonal sets and bases, Gram-Schmidt process, Induced Norm, Normed vector spaces, quadratic forms.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Hoffmann K. and Kunze R., 1992, Linear Algebra, Prentice Hall of India. 2. Friedberg S. H., Insel A.J., Spence L.E., 2019, Linear Algebra, Pearson Education. 3. Kumaresan S., 2000, Linear Algebra: A Geometric Approach, Prentice Hall of India. 4. Strang, G. Linear Algebra and its Applications, Thomson. 5. Sahai V., Bist V., 2013, Linear Algebra, Alpha Science International 		
Reference Books:		
<ol style="list-style-type: none"> 1. Halmos, P.R., 2011, Finite Dimensional Vector Spaces, Springer 2. Axler S., 1997, Lineär Algebra, Springer. 		
E-resources:		
https://web.mit.edu/18.06/www/videos.shtml		

ELEMENTARY ANALYSIS (5.5MAT02)

Course Title:	Elementary Analysis	
Course Code:	5.5MAT02	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1.	Basics of numbers, calculus and set theory.	
Course Objectives: To develop the concept of		
1.	number systems and their properties, completeness in the set of real numbers, open and closed sets and their properties.	
2.	convergence of sequence and series with their properties and different kinds of comparison tests	
3.	open and closed sets in a metric space and their properties, continuity and completeness properties in a metric space, compactness in a metric space.	
4.	Riemann-integration and their properties and methods of calculus for functions of two variables.	
Course Outcomes: The students will be able to		
1.	test the convergence of sequence and series and apply the different kinds of test and verify the properties.	
2.	identify different kinds of metric spaces, verify the different properties of metric spaces, and recognise complete and compact metric spaces.	
3.	check the integrability condition and different properties of Riemann-integration	
Course Content:		
Unit	Content	Hours
I	Introduction of Number Systems- Natural numbers (N), Integers (Z), Rational(Q)/Irrational numbers and Real numbers (R), Field structure and order structure, Intervals, Bounded and unbounded sets, Completeness in R, Archemedian property in R, Dedekind's form of completeness property, R as complete ordered field, Representation of real numbers on a straight line, Dedekind-Cantor axiom, Absolute value in R and its properties, Open sets, Closed sets, Countable and uncountable sets.	10
II	Sequence, Limit points of sequence, convergence of sequence, Cauchy's general principle of convergence, Cauchy sequence, Algebra of sequences, sandwich theorem, Cauchy's theorems on limits, monotonic sequences. Series, necessary condition for convergence, Cauchy's general principle of convergence of series, Series of positive terms and necessary condition for its convergence, Geometric series, Comparison of series, Comparison tests, Cauchy's root test, D'Alembert ratio test, Raabe's test, Logarithmic test, Alternating series, Absolute convergence, Abel's test, Dirichlet's test.	20
III	Definition and examples of metric spaces, Interior points, Open ball, Open and closed sets with properties, Adherent points, Limit points, Subspaces of a metric space. Continuous functions on a metric space and its properties, Homeomorphism, Isometry, Cauchy sequence in metric space, Complete metric space and its properties, Compact metric spaces, Finite intersection property.	15
IV	Riemann integration, Darboux's theorem, Conditions of Riemann integrability, Properties of Riemann integrable function, Fundamental theorem of integral calculus. First and second mean value theorem of integral calculus. Functions of two variables: continuity, differential and differentiability, Jacobians.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Somasundaram, D. and Chaudhary, B., 2018, <i>A First Course in Mathematical Analysis</i> (A Corrected Edition), Narosa Publishing House, New Delhi. 2. Malik S. C. and Arora S, 2017, <i>Mathematical Analysis</i>, New Age Int. Ltd. Publishers, New Delhi. 3. Mapa, S.K., 2019, <i>Introduction to Real Analysis</i>, Levant Books, Kolkata. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Rudin W., 2016, <i>Principles of Mathematical Analysis</i> (3rd Ed.), McGraw Hill International Edition. 2. Apostol T. M., 1996, <i>Mathematical Analysis</i> (2nd Ed.), Narosa Publishing House, New Delhi. 		
E-resources:		
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/111106053, 2. https://nptel.ac.in/courses/111101134 		

FOUNDATION OF COMPLEX ANALYSIS (5.5MAT03)

Course Title:	Foundation of Complex Analysis	
Course-Code:	5.5MAT03	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	complex numbers, properties of complex numbers and foundation of real analysis.	
Course Objective:		
1	This course aims to provide an introduction of functions of a complex variable.	
2	Students will be equipped with the understanding of the fundamental concepts of complex variable theory.	
3	To make students understand the functions of complex variable	
Course Outcomes: Students will be able to		
1.	evaluate limit, continuity and differentiability of function of complex variables.	
2.	learn nature of basic functions of complex variable like exponential, logarithmic, trigonometric and hyperbolic.	
3.	find complex line integration and proof of fundamental theorems like necessary and sufficient conditions for differentiability, Cauchy Goursat theorem, Cauchy's theorem, Cauchy's integral theorem etc.	
4.	learn many results and concepts both analytically and geometrically.	
Course Content:		
Unit	Content	Hours
I	Complex Numbers, Conjugation, Modulus and Argument, Geometric Interpretation of complex numbers, Extended complex plane, Square roots, Rational powers, Topology of complex plane, Sequence and series, Stereographic projection. Functions of a complex variable, Univalent functions, Mappings, Limit, Theorems on limit, Limit at infinity.	15
II	Sequence and series of functions and convergence, Continuity, Differentiation, Differentiation of composite functions, Necessary and sufficient conditions for differentiability, Complex form of Cauchy Riemann equations, Polar form of Cauchy Riemann equations and Laplacian, Consequences of C-R equations, Analytic functions, Harmonic functions, Harmonic Conjugate, Milne-Thomson method.	15
III	Antiderivative theorem, Power series, Uniqueness theorem for power series, Exponential function, Mappings by exponential function, Logarithmic function, Mappings by Logarithmic function, Multivalued functions and its branches, Branches and derivatives of logarithms, Identities involving logarithms, Complex exponents, Trigonometric functions, Hyperbolic functions, Inverses of trigonometric and hyperbolic functions.	15
IV	Curves in complex plane, Complex line integration, ML-inequality, Interchange of limit and integration, Interchange of summation and integration, Weierstrass form of Cauchy theorem, Cauchy Goursat theorem for triangle, open convex domains and open connected domains, Cauchy's theorem, Simply and multiply connected domains, Cauchy's integral theorem, Cauchy integral formula.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Brown J.W. and Churchill R.V., 2009, <i>Complex Variables and Applications</i>, Tata McGraw Hill. 2. Ponnusamy S., 2005, <i>Foundations of Complex Analysis</i>, Narosa Publication House. 3. Kasana H.S., 2005, <i>Complex Variables: Theory and Applications</i>, PHI. 4. Rudin W., 2006, <i>Real and Complex Analysis (3rd Edition)</i>, Tata McGraw Hill. 		

FOUNDATION OF ABSTRACT ALGEBRA (5.5MAT04)

Course Title:	Foundation of Abstract Algebra	
Course Code:	5.5MAT04	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	basic concepts of set theory	
Course Objectives:		
1	To teach the students the basics of groups,	
2	To teach the students the properties of group homomorphisms.	
3	To teach the students the basics of rings	
4	To introduce the concepts of irreducible polynomials.	
Course Outcomes: Students will be able to learn		
1	the construction of few groups	
2	the coset decomposition and properties of homomorphisms	
3	the structure of finite abelian groups	
4	fields and their properties	
Course Content:		
Unit	Content	Hours
I	Introduction to Groups: examples and properties, Cyclic and Abelian group, Dihedral Groups, Order of an element of a group, Symmetric Group, Even and Odd Permutation, Alternating Group and its generators, Sub-groups	15
II	Center, Coset Decomposition of a Group, Index of a subgroup, Lagrange's Theorem, Normal subgroups, Quotient groups, Homomorphism and Isomorphism of groups, Group of Automorphisms, Inner Automorphisms, Automorphisms of cyclic groups,.	15
III	Kernel of a Homomorphism, Fundamental Theorem of Homomorphism, Cayley's Theorem, Direct Product (External and Internal) of Groups. Fundamental Theorem of Finite Abelian groups, Introduction to Rings: examples and properties, Integral Domains, Division Rings	15
IV	Fields and its Characteristics, Subrings, Ideals, Quotient Ring, Homomorphism and Isomorphism of Rings, Fundamental Theorem of Ring Homomorphism, The Field of Quotients, Polynomial Rings, Division Algorithm, Eisenstein's Criterion of irreducibility.	15
Internal Assessment:		
CIA-I	Unit -I, II	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Fraleigh J., 2013, <i>A First Course in Abstract Algebra (3rd Ed.)</i>, Narosa Publishing House. 2. Gallian J. A., 1999, <i>Contemporary Abstract Algebra</i>, Narosa Publication House, New Delhi. 3. Artin M., 2011, <i>Algebra</i>, Prentice Hall India, New Delhi. 4. Dummit D. S. and Foote R. M., 2008, <i>Abstract Algebra</i>, Wiley India Pvt. Ltd. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Robinson, D. J. S., 1996, <i>A Course in the Theory of Groups</i>, Springer New York, New York 		
E-resources:		
https://archive.nptel.ac.in/courses/		

PARTIAL DIFFERENTIAL EQUATIONS-I (5.5MAT05)

Course Title:	Partial Differential Equations-I	
Course Code:	5.5MAT05	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite:		
1.	Basics of calculus and ODEs	
Course Objectives:		
1	To learn various methods to solve Partial Differential Equations.	
2	To get solutions of Partial Differential Equations using some known methods.	
3	They will get good motivation and they will be able to generate a certain kind of interest in the subject by observing some simple mathematical formulation of real-life problems.	
Course Outcomes: The students will be able to		
1	Identify the different types of PDE and their nature.	
2	Identify, which method of solution is applicable for a specific partial differential equation.	
3	Find a solution to a particular partial differential equation.	
Course Content:		
Unit	Content	Hours
I	Order and degree of a partial differential equation (PDE), Concept of linear and non-linear PDE, Classification of first order PDE, Formation of PDE by the elimination of arbitrary constants and arbitrary functions, Cauchy's problem for first order equations, Linear PDE of first order, Lagrange's method.	15
II	Non-linear PDE of order one: Complete integral, particular integral, singular integral and general integral, Compatible system of first-order equations, Charpit's method, Special methods of solutions applicable to certain standard forms.	15
III	Homogeneous and non-homogeneous linear partial differential equations with constant coefficients: Method of finding the complementary function (C.F.) of linear homogeneous and non-homogeneous PDE with constant coefficients, Alternative working rule for finding C.F., Particular integral (P.I.) of homogeneous and non-homogeneous PDE, shortcut methods of finding P.I. in certain cases, general method of finding the P.I. of linear homogeneous and non-homogeneous PDE with constant coefficients, method for finding C.F. and P.I. of reducible and irreducible non-homogeneous linear PDE with constant coefficients.	15
IV	General method of finding P.I. for only reducible non-homogeneous linear PDE with constant coefficients, method for finding P.I. of any reducible linear PDE (homogeneous or non-homogeneous), Method of reducible Euler-Cauchy type equation to linear PDE with constant coefficients, PDE of order two with variable coefficients.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967. 2. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984. 3. T Amarnath: An Elementary Course in Partial Differential Equations, Narosa Publications. 4. Robert C. McOwen: Partial Differential Equations, Pearson Education Inc. 5. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Birkhauser, Indian reprint, 2014. 		

LINEAR AND NON-LINEAR PROGRAMMING (5.5MAT06)

Course Title:	Linear and Non-Linear Programming	
Course Code:	5.5MAT06	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should know		
1	basic concepts in linear programming problems, their formulation and solution methods.	
Course Objectives:		
1	To impart knowledge about the formulations of integer linear and multi-objective goal programming problems, and	
2	To teach the students the theoretical principles of linear and non-linear programming problems.	
3	To introduce different types of methodologies to solve linear and nonlinear programming problems.	
Course Outcomes: On successful completion of the course, students will be able to:		
1	Identify different types of optimization problems which occur in real life and their characteristics.	
2	Explain the theoretical concepts related to unconstrained optimization problems and demonstrate optimality conditions and solution approaches for them.	
3	Develop the concepts of a multi-objective programming problem and demonstrate its solution using goal programming.	
4	Understand solution methodologies of nonlinear programming problems, specifically convex programming problems and quadratic programming problems.	
Course Content:		
Unit	Content	Hours
I	Review of linear programming problem and solution methods, Goal Programming: Basics of goal programming, Weighted and pre-emptive goal programming, Formulation of a goal programming problem, Graphical solution method, Modified Simplex method. Integer Linear programming, Gomory's Cutting Plane Method, Branch & Bound Method, Integer Programming Duality,	15
II	Single and multiple variable problems, Necessary and sufficient conditions for finding extrema, Solution methods: Bisection, Newton, Golden section, Gradient search. Local and global maxima/minima for functions of one and two variables, inflection point, positive/negative definite and semi-definite matrices, convex/concave functions, and their properties, Verifying convexity/concavity through a Hessian matrix.	15
III	Dynamic Programming, Bellman's principle of optimality, Applications of dynamic programming, Multi-objective optimization problem, Goal Programming. Nonlinear programming, Solution of nonlinear programming problems with equality constraints and with not all equality constraints.	15
IV	Convex Programming Problem, Constraint qualification, Lagrange Multiplier method, Kuhn-Tucker necessary and sufficient conditions for optimality of the objective function in NLPP. Quadratic programming, Wolfe's method and Beale's Method, Separable Programming.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. Chandra S., Jayadeva and Mehra A., 2009, <i>Numerical Optimization with Applications</i> , Narosa Publishing House Pvt. Ltd.		
2. Hadley G., 1987, <i>Linear Programming</i> , Narosa Publishing House Pvt. Ltd.		
3. Taha H. A., 2007, <i>Operations Research-An Introduction</i> , Prentice Hall of India Pvt. Ltd.		
4. Hillier F. S., Lieberman G. J., Nag B. and Basu P., 2012, <i>Introduction to Operations Research</i> , Tata McGraw Hill Education Pvt. Ltd.		
5. Bazaraa M.S., Sherali H.D. and Shetty C.M., 2006, <i>Nonlinear Programming Theory and Algorithms</i> , Wiley.		
Reference Books:		
1. Bertsimas D. and Tsitsiklis J.N., 1997, <i>Introduction to Linear Optimization</i> , Athena Scientific, Belmont, Massachusetts.		
2. Bradley, H., Magnanti, 1977, <i>Applied Mathematical Programming</i> , Addison-Wesley		
E-resources:		
https://onlinecourses.swayam2.ac.in/cec22_ma17/		
https://archive.nptel.ac.in/courses/111/107/111107128/		

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS (5.5MAT07)

Course Title:	Calculus of Variations and Integral Equations		
Course Code:	5.5MAT07		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	Basic concepts of differential equations.		
2	Basic concepts of calculus.		
Course Objective: This course aims to learn			
1	The necessary and sufficient condition for extremum.		
2	The technique to solve the extremum problem under fixed and moving boundaries.		
3	The different types of kernel and their properties.		
4	The solution approaches Volterra and Fredholm integral equations under different types of kernels.		
Course Outcomes: The students will be able to learn			
1	The variational functional, extremum, maxima, minima, Euler's equation and their properties.		
2	The different solution methodologies of variational problems under free and moving boundary conditions.		
3	The linear integral equation and their properties, conversion of integral equations to IVP and BVP.		
4	The different types of kernels and their properties.		
5	The number of fundamental mathematical ideas and techniques that lie at the core of the integral equation approach.		
Course Content:			
Unit	Content	Hours	
I	Motivation problems of calculus of variations, Variation of a functionals and its properties, Euler's equations and application, Extremals, Geodesics, Variational problems for functional involving several dependent variables and their first order derivatives.	15	
II	Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable, Variational problems in parametric form, Hamilton principle, variational problems with moving (or free) boundaries.	15	
III	Linear integral equation and classification of conditions, Volterra integral equation, Relationship between linear differential equation and Volterra integral equation, Resolvent kernel of Volterra integral equation, method of successive substitution and successive approximation, solution of integral equation by Resolvent kernel.	15	
IV	Fredholm integral equation, boundary value problems reduced to Fredholm equations, Fredholm equation of the second kind, method of successive approximation, Fundamentals-iterated kernels, constructing the resolvent kernel with the aid of iterated kernels, Integral equation with degenerate kernels, solutions of homogeneous integral equation with degenerate kernel.	15	
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/Viva-Voce		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
1. Pipe L. A., 1970, <i>Applied Mathematics for Engineers and Physicists</i> , McGraw Hill.			
2. Harper C., 2004, <i>Introduction to Mathematical Physics</i> , PHI New Delhi.			
3. Kanwal R. P., 1997, <i>Linear Integral Equations</i> , Academic Press, New York			
4. Bansal J.L. and Dhami H. S., <i>Differential Equations Vol.II</i> , JPH, 2004.			
E-resources:			
https://archive.nptel.ac.in/courses/111/107/111107105/			

LINEAR ALGEBRA (6.0MAT01)

Course Title:	Linear Algebra	
Course Code:	6.0MAT01	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	basic concepts in Linear Algebra and Matrices: System of linear equations, Matrices, Rank, Vector Spaces, Basis and Dimension	
Course Objectives:		
1	To introduce the fundamental notions of algebra of linear transformations, diagonalizability, and different canonical forms.	
2	To teach the students different characterization of diagonalization of a linear operator	
3	To introduce the concept of orthonormal basis and their existence.	
4	To create orthogonal and orthonormal bases: Gram-Schmidt process and use bases and orthonormal bases to solve application problems.	
5	To introduce adjoints of linear operators, unitary and normal operators.	
Course Outcomes: The students will be able to		
1	Learn algebra of linear transformations, significance and use of eigenvalue and eigenvectors.	
2	explain different concepts about linear transformations and inner product spaces.	
3	learn different characterization of diagonalization and canonical forms of a given linear transformation.	
4	use different concepts associated with vector spaces, linear transformations, diagonalization and inner product spaces in other courses like functional analysis, differential equations.	
Course Content:		
Unit	Content	Hours
I	Review of vector spaces, The algebra of linear transformations, Isomorphism, Linear functionals, Annihilator, Double dual, Transpose of a linear transformation, Eigenvalues and Eigenvectors, and Eigenvectors.	15
II	Diagonalizability, Minimal Polynomial, Cayley Hamilton theorem. Invariant subspaces, Triangulability and Diagonalization in terms of the minimal polynomial, Direct-sum decompositions, Invariant direct sums.	15
III	The primary decomposition theorem, Cyclic Subspaces And annihilators, Cyclic decomposition, Rational and Jordan forms. Symmetric and Skew-symmetric Bilinear Forms, Diagonalization of symmetric bilinear forms.	15
IV	Inner product spaces: Best approximation, The adjoint of linear transformation, Unitary operators, Self-adjoint, Normal operators, Spectral theorem for self-adjoint operators.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Hoffmann K. and Kunze R., 1992, <i>Linear Algebra</i>, Prentice Hall of India. 2. Friedberg S. H., Insel A.J., Spence L.E., 2019, <i>Linear Algebra</i>, Pearson Education. 3. Kumaresan S., 2000, <i>Linear Algebra: A Geometric Approach</i>, Prentice Hall of India. 4. Halmos, P.R., 2011, <i>Finite Dimensional Vector Spaces</i>, Springer. 5. Lang, S., 2005, <i>Introduction to Linear Algebra</i>, Springer. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Artin M., 2010, <i>Algebra</i>, Pearson Education. 2. Cooperstein B., 2015, <i>Advanced Linear Algebra</i>, CRC Press. 		
E-resources:		
https://archive.nptel.ac.in/courses/111/106/111106051/		

REAL ANALYSIS (6.0MAT02)

Course Title:	Real Analysis		
Course Code:	6.0MAT02		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite:			
1	Basics of real analysis, metric space and integral and differential calculus.		
Course Objectives: To develop the concept of			
1	understanding and applications of different aspects of the real number system \mathbb{R} , in the Euclidean space \mathbb{R}^n		
2	Riemann-Stieltjes integrability, properties of R-S integration and its applications.		
3	uniform convergence of sequence and series of functions, solving problems and their applications.		
4	bounded variation functions and their basic properties, development of derivatives as a linear transformation and understanding of important associated results.		
Course Outcomes: Students will be able to			
1	understand and analyze the different aspects of \mathbb{R} , in \mathbb{R}^n along with their applications.		
2	solve the problems of Riemann-Stieltjes integration and will be able to apply/verify its properties.		
3	understand and apply the tests of uniform convergence of sequence and series of functions along with solving problems.		
4	verify the conditions of bounded variation functions along with applications, understand the concept of derivatives as linear transformation in \mathbb{R}^n and know about the important associated results.		
Course Content:			
Unit	Content		Hours
I	Introduction to Euclidean space, Open ball, Open and closed sets, Adherent points, accumulation points and isolated points, Closure and derived sets, Bolzano Weierstrass theorem, Cantor intersection theorem, Lindeloff covering theorem, Heine-Borel theorem, Compactness in \mathbb{R}^n , Compact subsets of a metric space.		15
II	Basics of Riemann-Stieltjes (R-S) integration, Existence of R-S integration, Conditions of R-S integrability, Properties of R-S integrals, First and second mean value theorems, Some important results on R-S integrability.		15
III	Introduction to sequence and series of functions, Concept of pointwise and uniform convergence, Important tests for uniform convergence of a sequence and series of functions, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Uniform convergence and R-S integration. Term by term differentiability and term by term integrability of series.		15
IV	Functions of bounded variations and its properties, total variations. Continuity, partial derivatives, differentiability, derivatives of functions in an open set of \mathbb{R}^n into \mathbb{R}^n as a linear transformation, chain rule, Jacobians and its properties. Introduction to important theorems such as Inverse function theorem, Implicit function theorem etc.		15
Internal Assessment:			
CIA-I	Unit-I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III		
ESE	Written Exam. for Unit-I, II, III, & IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
1. Somasundaram, D. and Chaudhary, B., 2018, <i>A First Course in Mathematical Analysis (A Corrected Edition)</i> , Narosa Publishing House, New Delhi.			
2. Malik S. C. and Arora S, 2017, <i>Mathematical Analysis</i> , New Age Int. Ltd. Publishers, New Delhi.			
3. Mapa, S.K., 2019, <i>Introduction to Real Analysis</i> , Levant Books, Kolkata.			
Reference Books:			
1. Rudin W., 2016, <i>Principles of Mathematical Analysis (3rd Ed.)</i> , McGraw Hill International Edition.			
2. Apostol T. M., 1996, <i>Mathematical Analysis (2nd Ed.)</i> , Narosa Publishing House, New Delhi.			
E-resources:			
https://nptel.ac.in/courses/111106053			

QUALITATIVE THEORY OF ODES (6.0MAT03)

Course Title:	Qualitative Theory of ODEs	
Course Code:	6.0MAT03	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	basic concepts in Linear Algebra and Real Analysis e.g., continuity, uniform continuity, uniform convergence, system of linear equations, matrices, diagonalization	
2	elementary theory of ordinary differential equations	
Course Objectives:		
1	To introduce the theory of existence and uniqueness theory of IVPs and system of differential equations.	
2	To teach different types of boundary conditions and boundary value problems	
3	To introduce stability theory of linear and nonlinear differential equations.	
4	To develop some of the methods used to explore qualitative information about the behaviour of solutions of differential equations	
Course Outcomes: The students will be able to		
1	explain different existence and uniqueness theorems for initial value problems	
2	Learn how to solve a given boundary value problem	
3	To use different analytical and geometrical methods to analyze the stability of solutions of a given differential equation	
4	use qualitative theory for modeling different real-life problems via differential equations	
Course Content:		
Unit	Content	Hours
I	General existence and uniqueness theory: Well-posedness and examples of Initial Value Problems (IVPs), Gronwall's lemma, Basic lemma and uniqueness theorem, Picard's existence and uniqueness theorem, Cauchy Peano existence theorem, Continuation of solutions.	15
II	System of linear differential equations: existence and uniqueness theorem, homogeneous linear systems, non-homogeneous linear system, Linear systems with constant coefficients, General system and diagonalization.	15
III	Boundary-value problems (BVPs): Different types of Boundary conditions and examples of BVPs, Green's functions, Sturm-Liouville BVPs: Characteristic values and characteristic functions, Orthogonality of characteristic functions, Expansion of a function in a series of orthonormal functions. System of nonlinear differential equations	15
IV	Autonomous system, equilibrium points and their stability, Paths of autonomous linear systems, Paths of nonlinear systems, Lyapunov functions and their construction, Limit cycles and Periodic solutions, Poincare-Bendixson theory.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment , ESE: End Semester Examination		
Textbooks:		
1. Ross S.L., 2007, Differential Equations, Wiley.		
2. Nandakumaran A.K., Dutti P.S. and George R.K., 2017, Ordinary Differential Equations: Principles and Applications, Cambridge University Press.		
3. Brauer F. and Nohel J.A., 2005, Qualitative Theory of Differential Equations, Dover Publications.		
4. Coddington E.R. and Levinson N., 2010, Theory of Ordinary Differential Equations, McGraw Hill Education.		
Reference Books:		
1. Nemytskii V.V., 2005, <i>Qualitative Theory of Differential Equations</i> , Princeton University Press		

ABSTRACT ALGEBRA (6.0MAT04)

Course Title:	Abstract Algebra	
Course-Code:	6.0MAT04	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	Basic Concepts of groups and rings	
Course Objectives:		
1	To teach the students isomorphism theorems	
2	To teach the students the Sylow theorems	
3	To teach the students the properties of rings	
4	To teach the students Chinese remainder theorem	
Course Outcomes: The students will be able to understand		
1	the concepts of group action	
2	The class equation of groups	
3	The properties of solvable groups	
4	The arithmetic in rings	
Course Content:		
Unit	Content	Hours
I	Review of groups and properties, First and second Isomorphism theorems, Conjugacy relation, Group Action, Equivalent formulation of action as a homomorphism of G to Symmetric group, Stabilizer (Isotropy) subgroups	15
II	Orbit decomposition, Class equation of an action, Conjugacy class equation, Transitive actions, core of a subgroup, Sylow subgroups, Sylow's Theorem I, II and III, p-groups and applications, Direct and inverse images of Sylow subgroups, Commutator subgroup, Normal and subnormal series, composition series, Jordan-Holder theorem.	15
III	Solvable groups, Properties of solvable groups, Simple groups, simplicity of A_n , Review of Rings and properties, Left and right ideal, prime ideals, maximal ideals, Prime and irreducible elements, Divisibility in an Integral Domain, Units and Associates, Irreducible elements	15
IV	Greatest Common divisor, Least Common Multiple, Euclidean domains, Maximal and prime ideals, Principal ideal domains, Divisor chain condition, Unique factorization domains, Examples and counterexamples, Chinese remainder theorem for rings and PID's, Polynomial rings over domains, Unique factorization in polynomial rings over UFD's.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III	
ESE	Unit-I, II, III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Bhattacharya P. B., Jain S. K. and Nagpal S. R., <i>Basic Abstract Algebra (2nd Ed.)</i>, Cambridge University Press. 2. Gallian J. A., 1999, <i>Contemporary Abstract Algebra</i>, Narosa Publication House, New Delhi. 3. Artin M., 2011, <i>Algebra</i>, Prentice Hall India, New Delhi. 4. Dummit D. S. and Foote R. M., 2008, <i>Abstract Algebra</i>, Wiley India Pvt. Ltd. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Robinson, D. J. S., 1996, <i>A Course in the Theory of Groups</i>, Springer New York, New York 		
E-resources:		
https://archive.nptel.ac.in/courses/		

COMPLEX ANALYSIS (6.0MAT05)

Course Title:	Complex Analysis	
Course-Code:	6.0MAT05	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	EoSE: 60 Marks	Tutorial: 1
		Total: 4
Course Prerequisite:		
1	The student should have knowledge of complex numbers and their properties, basic foundation of real analysis and concepts of limit, continuity and differentiability for functions of complex variables.	
Course Objectives:		
1	To introduce some topics of contemporary complex analysis.	
2	To provide a solid, classical foundation for the subject while exposing trails leading off in interesting directions.	
3	To prepare the student to work independently in these topics and especially to use the methods of complex analysis in other areas of mathematics.	
Course Outcomes: Students will be able to		
1	learn the basic techniques of contemporary complex analysis as well as applications of these techniques in harmonic analysis, univalent functions theory and special functions.	
2	evaluate integrals along a path, compute the Taylor and Laurent expansions, determine the nature of the singularities and calculating residues.	
3	use of residue theorem to evaluate integrals.	
Course Content:		
Unit	Content	Hours
I	Functions of a complex variable, Differentiability and Analyticity, Harmonic Functions, Contour integrals, Antiderivative, Cauchy theorem, Cauchy-Goursat theorem, Simply and multiply connected domains, Cauchy integral formula, Higher order derivatives, Morera's theorem.	15
II	Cauchy's inequality, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle, Minimum modulus principle, Taylor's series, Laurent series, Absolute and uniform convergence of power series, Weierstrass theorem for sequence of functions. Removable singularities, poles, order and singular part of a pole, Laurent expansions, essential singularities.	15
III	Cauchy residue theorem, Residue at infinity, Evaluation of integrals, Definite integrals involving sines and cosines, Zeros of analytic functions, Uniqueness theorem, Zeros of polynomials, Argument principle, Rouché's theorem, Schwarz lemma, Schwarz-Pick lemma, Open mapping theorem.	15
IV	Conformal mappings, Scale factor, Local inverses, Mappings by elementary functions, Bilinear transformation, Basic properties of Bilinear transformation, Fixed points, Cross-ratio, Mappings of half planes onto disks, Automorphisms of unit disk, Automorphism of half planes, Mappings by $w=e^z$, Mappings by $w=\log z$, Mappings by $w=\sin z$, Mappings by z^2 and branches of $z^{1/2}$.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. Brown J.W. and Churchill R.V., 2009, <i>Complex Variables and Applications</i> , Tata McGraw Hill.		
2. Ponnusamy S., 2005, <i>Foundations of Complex Analysis</i> , Narosa Publication House.		
3. Kasana H.S., 2005, <i>Complex Variables: Theory and Applications</i> , PHI.		
Reference Books:		
1. Rudin W., 2006, <i>Real and Complex Analysis (3rd Addition)</i> , Tata McGraw Hill.		
E-resources:		
https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-ma39		

FUNCTIONAL ANALYSIS (6.5MAT01)

Course Title:	Functional Analysis	
Course Code:	6.5MAT01	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	EoSE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite:		
1	Basics of linear algebra, metric space and real analysis.	
Course Objectives: To develop the concept of		
1	the normed linear space and its completeness property.	
2	linear transformation and operator in normed linear spaces and its properties along with elaboration of open mapping theorem, closed graph theorem, uniform boundedness principle, Hahn Banach theorem, and natural Embedding of normed linear spaces.	
3	Hilbert spaces and its different properties, orthogonality and elaboration of Projection theorem, Bessel's inequality and Riesz's theorem.	
4	different operators in a Hilbert space and elaboration of spectral theorem on a finite dimensional Hilbert space.	
Course Outcomes: Students will be able to		
1	verify the conditions of normed linear space and test the completeness property	
2	verify the different properties of linear transformation and operators and understand the open mapping theorem, closed graph theorem, uniform boundedness principle, Hahn Banach theorem, and natural Embedding of normed linear spaces.	
3	recognize the different properties of Hilbert space and orthogonal sets and understand the Projection theorem, Bessel's inequality and Riesz's theorem.	
4	learn about different operators and understand the spectral theorem on a finite dimensional Hilbert space.	
Course Content:		
Unit	Content	Hours
I	Normed linear spaces, Examples and properties, Equivalent norms, Convexity and completeness, Banach spaces, Examples and properties, l^p spaces, L^p spaces, Function space, Quotient Space	15
II	Operators on normed linear space, Continuous linear transformations, Bounded linear transformations, The open mapping Theorem, The closed graph theorem, The conjugate of an operator, The uniform boundedness principle, Hahn Banach Theorem, Embedding of normed spaces.	15
III	Inner product spaces, Examples and properties, Hilbert spaces, Examples and properties, Polarization identity, Orthogonality, Orthogonal complements, Orthogonal Projection on Hilbert spaces, Projection theorem, Bessel's inequality, Riesz's theorem, Existence of orthogonal basis in Hilbert spaces.	15
IV	The adjoint of an operator, Self-adjoint operators, Normal and unitary operators, projections, Eigenvalues and eigenvectors of an operator on a Hilbert space, The spectral theorem on a finite dimensional Hilbert space.	15
Internal Assessment:		
CIA-I	Unit I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Written Exam. for Unit-I, II, III, & IV	
*: Continuous Internal Assessment, **: End of Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Bachman G. and Narici, 1964, <i>Functional Analysis</i>, Academic Press. 2. Taylor A. E., 1958, <i>Introduction to Functional Analysis</i>, John Wiley and Sons. 3. M.T. Nair, <i>Functional Analysis: A first Course</i>, Prentice Hall of India, New Delhi, 2002 (Second Printing: 2008) 		
Reference Books:		
<ol style="list-style-type: none"> 1. Simmons G. F., 1963, <i>Topology and Modern Analysis</i>, McGraw Hill. 2. Erwin Kreyszig E., 1978, <i>Introductory Functional Analysis with Application</i>, Wiley 		
E-resources:		
https://nptel.ac.in/courses/111106047 https://nptel.ac.in/courses/111106147		

TOPOLOGY (6.5MAT02)

Course Title:	Topology	
Course Code:	6.5MAT02	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	Basic concepts of sets, relations	
2	Basic concepts of functions and congruences	
Course Objectives:		
1	To provide motivation for topology through geometry.	
2	To develop understanding of geometric and topological properties.	
3	To develop understanding of the concepts of general topology as simply as possible.	
Course Outcomes: The students will be able to understand		
1	what are objects of study in topology and geometry?	
2	the concepts and topics in hand without haste;	
3	the significance of the concepts defined and the theorems proved here;	
4	how this course is useful in other courses e.g., analysis, geometry and algebraic topology.	
Course Content:		
Unit	Content	Hours
I	Topological spaces. Open sets, closed sets. Interior points, Closure points. Limit points, Boundary points, Exterior points of a set, Closure of a set, Derived set, Dense subsets. Basis, sub base, Relative topology.	15
II	Product space, Quotient space. Continuous functions, open & closed functions, homeomorphism, Lindelof space, Separable spaces, Connected Spaces, locally connectedness, Connectedness on the real line, Components, Path connected space	15
III	Complete space, Compact Spaces, one point compactification, compact sets, properties of Compactness and Connectedness under a continuous function, Compactness, Equivalence of Compactness.	15
IV	Separation Axioms: T_0 , T_1 , and T_2 spaces, examples and basic properties, First and Second Countable Spaces, Regular, normal, T_3 & T_4 spaces, Tychonoff spaces, Urysohn's Lemma, Tietze Extension Theorem, Tychonoff Theorem.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> 1. Simmons G.F., 1963, <i>Topology and Modern Analysis</i>, McGraw Hill. 2. Vicker, 1996, <i>Topology via Logic</i>, Cambridge University Press. 3. Munkers, J.R., 2015, <i>Topology- A First Course</i>, Pearson Education India. 4. Joshi, K.D., 2017, <i>Introduction To General Topology</i>, New Age International Private Limited. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Kell, J.L., 2017, <i>General Topology</i>, Dover Publications. 		
E-resources:		
https://archive.nptel.ac.in/courses/111/106/111106159/		

PARTIAL DIFFERENTIAL EQUATIONS-II (6.5MAT03)

Course Title:	Partial Differential Equations-II		
Course-Code:	6.5MAT03		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: Students should have knowledge of			
1	solution methods of ODE		
2	differential calculus		
Course Objectives: To teach			
1	theory of partial differential equations and solution methods.		
2	the nature of PDEs like parabolic, elliptic, hyperbolic.		
3	Green's Function method to find the solution of Non-homogeneous PDE		
4	variational formulation of boundary value problems.		
Course Outcomes: Students will be able to			
1	solve the PDEs independently		
2	convert partial differential equations to canonical form.		
3	use Green's function method to solve non-homogeneous PDE		
4	apply to Variational formulation of boundary value problems		
Course Content:			
Unit	Content	Hours	
I	Formation of PDEs: First order PDE in two and more independent variables, Derivation of PDE by elimination method of arbitrary constants and arbitrary functions. Lagrange's first order linear PDEs, Charpit's method for non-linear PDE of first order, Jacobi's method and Cauchy problem for first order PDEs.	15	
II	PDEs of second order with variable coefficients: classification of second order linear PDEs, Canonical forms of Parabolic, Elliptic and Hyperbolic PDEs, Monge's methods for nonlinear second order PDEs, Method of separation of variables for Laplace, Heat and Wave equations.	15	
III	Eigenvalues and Eigenfunctions of BVP, Orthogonality of Eigen function, D-Almbert's solutions to wave equations, Fundamental solution of Laplace Equation, Green's function for Laplace Equation, Wave equation, Diffusion Equation.	15	
IV	General solution of higher order PDEs, Variational formulation of boundary value problem.	15	
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
<ol style="list-style-type: none"> 1. Rao S. K, <i>Introduction to Partial Differential Equations</i>, Phi Learning. 2. Sneddon I. N., <i>Elements of Partial Differential Equations</i>, Dover Publications. 3. Birkhoff G., Rota G. C., <i>Ordinary Differential Equations</i>, Wiley. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Amaranath T., <i>An Elementary Course in Partial Differential Equations</i>, Narosa Publication. 2. Bhamra, K. S., <i>Partial Differential Equations: An Introductory Treatment with Applications</i>, PHI. 			
E-resources:			
https://archive.nptel.ac.in/courses/111/105/111105093			

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List of Minor/Elective

BIOMATHEMATICS (6.0MAT31)

Course Title:	Biomathematics		
Course Code:	6.0MAT31		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1.	basic concepts in elementary Calculus and Linear Algebra		
Course Objectives:			
1.	To introduce basic principles, assumptions and hypotheses for mathematical formulations of different biological systems		
2.	To teach the students the mathematical modeling of growth of single species and interacting populations		
3.	To introduce the compartmental epidemic models e.g., SIR, SEIR and SIS		
4.	To discuss the dynamical analysis of different models using linearization, stability analysis and bifurcation theory		
5.	To introduce the modeling of chemical kinetics		
Course Outcomes: The students will be able to			
1.	use results from differential equations, dynamical systems, bifurcation and stability theory to analyze a given biological system		
2.	model a particular biological system and to predict its different dynamical behaviour		
3.	learn modeling and analysis of single species and interacting population models		
4.	do modeling and analysis of different compartmental epidemic models		
5.	to predict the disease burden and prevalence of a particular disease, long term persistence of a species		
Course Content:			
Unit	Content		Hours
I	Introduction: Goals and Challenges of mathematical modeling in biology. Idealization and general principles of model building, Different types of mathematical models in biology, Bacterial growth, Relevant mathematical techniques: Non-dimensionalization, Steady states and linearization		15
II	Review of linear systems, Stability analysis, Phase diagrams, Single Species population models (discrete and continuous): Exponential, Logistic, and Gompertz growth, Allee effect, Harvesting models and bifurcations, Delay models		15
III	Models with interacting populations: Different types of interactions and examples, Lotka Volterra Competition, Predator-prey model, Chemostat models, Structured (spatial, age and sex) population models, Population biology of infectious diseases: Classification of infectious diseases, SIR, SIRS and SIS epidemic models,		15
IV	Basic reproduction number, Models for molecular events: Michaelis-Menten enzyme example, Timescale decomposition, Quasi steady state analysis, sigmoidal functions, multisite systems, Chemical kinetics: Mass action law, Hopf-bifurcations, Subcritical Hopf, Poincare-Bendixson-I, Poincare-Bendixson-II, Index Theory.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
1. Brauer F. and Chavez C. C., 2000, <i>Mathematical Models in Population Biology and Epidemiology</i> , Springer.			
2. Kot M., 2001, <i>Elements of Mathematical Ecology</i> , Cambridge University Press			
3. Keshet L. E., 2005, <i>Mathematical Models in Biology</i> , SIAM.			
4. Keeling M. J. and Rohani P., 2008, <i>Modeling Infectious Diseases in Humans and Animals</i> , Princeton Uni. Press.			
5. Martcheva M., 2010, <i>An Introduction to Mathematical Epidemiology</i> , Springer.			
Reference Books:			
1. Murray J. D., 2007, <i>Mathematical Biology: An Introduction</i> , Springer.			
2. Smith H., 2010, <i>An Introduction to Delay Differential Equations with Applications to Life Sciences</i> , Springer.			
E-resources:			
https://open.uci.edu/courses/math_113b_intro_to_mathematical_modeling_in_biology.html			
https://www.youtube.com/playlist?list=PL5zWDs2j0YF3kPPvs4L5FGILc7x13Uwjin			

PROBABILITY AND MATHEMATICAL STATISTICS (6.0MAT32)

Course Title:	Probability and Mathematical Statistics	
Course Code:	6.0MAT32	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
	Total:	4
Course Prerequisite: The student should have knowledge of		
1. basic concepts of linear algebra and calculus		
Course Objectives:		
1.	To present the type of the data and tabulate statistical information given in descriptive form and to use graphical techniques to interpret.	
2.	To discuss probability, probability distributions, joint probability distributions and concepts associated with a random variable.	
3.	To explain essential tools for statistical analyses.	
4.	To discuss central limit theorem and order statistics.	
Course Outcomes: The students will be able to		
1.	learn descriptive statistics and to calculate probability for various types of problems.	
2.	work out various probability distributions and statistical tools.	
3.	explain order statistics and central limit theorem	
Course Content:		
Unit	Content	Hours
I	Exploratory data analysis: summary statistics, box and whisker plots, histogram, P-P and Q-Q plots. Random Experiment and its sample space, probability as a set function on a collection of events, stating basic axioms, random variables, c.d.f., p.d.f., p.m.f.	15
II	absolutely continuous and discrete distributions, Some common distributions (Negative Binomial, Pareto, lognormal, beta, etc). Transformations, moments, m.g.f., p.g.f., quantiles and symmetry. Random vectors, Joint distributions, copula, joint m.g.f. mixed moments, variance covariance matrix.	15
III	Independence, sums of independent random variables, conditional expectation and variances, compound distributions, prior and posterior distribution, best predictors. Sampling distributions of statistics from univariate normal random samples, chi-square, t and F distributions.	15
IV	Order statistics and the distribution of rth order statistics, joint distribution of rth and sth order statistics. Statement and application of central limit theorem for a sequence of independent and identically distributed random variables.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. Sheldon R.M., 2010, <i>Introductory Statistics</i> , Academic Press.		
2. Rohatgi V.K. and Md. Ehsanes Saleh A.K., 2015, <i>An Introduction to Probability and Statistics (3rd Ed.)</i> , John Wiley & Sons.		
3. Rao C. R., 1965, <i>Linear Statistical Inference and its Applications (2nd Ed.)</i> , John Wiley & Sons, INC.		
4. Dharmaraja S. and Das D., 2018, <i>Introduction to Statistical Methods, Design of Experiments and Statistical Quality Control</i> , Springer.		
5. Mayer P. L., 1970, <i>Introductory Probability and Statistical Applications</i> , Addison-Wesley.		
Reference Books:		
1. Feller W., 2000, <i>An Introduction to Probability Theory and its Applications (3rd Ed.)</i> , Wiley Eastern.		
E-resources:		
1. https://archive.nptel.ac.in/courses/111/105/111105090/		
2. https://archive.nptel.ac.in/courses/111/102/111102160/		

NUMERICAL ANALYSIS (6.0MAT33)

Course Title:	Numerical Analysis	
Course Code:	6.0MAT33	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1.	differential calculus	
2.	difference operator, ODE	
Course Objectives:		
1.	To introduce different numerical methods and their error to solve systems of linear equations, nonlinear equations, initial value problems and eigenvalue problems.	
2.	to analyze the notion of interpolation and approximation.	
3.	To provide the numerical treatment for the BVP governed by ODE	
Course Outcomes: The students will be able to		
1.	apply a finite difference method to find the interpolation, differentiation and integration for the given discrete data values.	
2.	analyze and choose the best suitable numerical method for the given mathematical problem.	
3.	apply the numerical techniques to solve research problems of fluid dynamics, mathematical modeling.	
Course Content:		
Unit	Content	Hours
I	Introduction to significant digits and errors, Solution of system of linear Equations (direct methods, Iterative methods, Ill-conditioned systems), Eigenvalue problem: Gershgorin circle theorem, power method, Jacobi method, Householder method.	15
II	Finite difference operators, difference tables, Lagrange interpolation, Newton's divided difference interpolation, Hermite interpolation, Cubic spline interpolation.	15
III	Numerical solution of ordinary differential equations: initial value problems, existence and uniqueness of the solution of initial value problem, Single step methods- Taylor series, Picard's method, Euler's method, modified Euler method, Runge-Kutta method, Multi-step methods: Predictor-corrector method, Stability Analysis.	15
IV	Boundary value problems (BVPs), Methods to solve BVPs: Finite-difference method, The Shooting method, The Cubic Spline method.	15
Internal Assessment:		
CIA-I	Unit-I, II	
CIA-II	Written Exams/ Quizzes/Assignment/Presentation/Viva-Voce	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
<ol style="list-style-type: none"> Atkinson K. E., 1989, <i>An Introduction to Numerical Analysis</i> (2nd Ed.), Wiley-India. Jain M. K., Iyengar S. R. K. and Jain R. K., 2012, <i>Numerical Methods for Scientific and Engineering Computation</i> (6th Ed.), New Age International Publishers. Sastry S. S. 2019, <i>Introductory Methods of Numerical Analysis</i>, PHI. 		
Reference Books:		
<ol style="list-style-type: none"> Buchaman J. I. and Turner P. R., 1992, <i>Numerical Methods and Analysis</i>, McGraw-Hill. 		
E-resources:		
https://archive.nptel.ac.in/courses/111/107/111107105/		

INTEGRAL TRANSFORMS (6.0MAT34)

Course Title:	Integral Transforms	
Course Code:	6.0MAT34	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1.	basic concepts of Differential Calculus	
2.	basic concepts of Integral Calculus	
Course Objectives:		
1.	To describe the ideas of Laplace transform, Fourier transform, Z-transform and Wavelet Transform	
2.	To familiarize the students with the applications of the Laplace and Fourier transforms in the fields such as application of PDE, Digital Signal Processing, Theory of wave equations.	
3.	To familiarize the students with the applications of the Z-transform to solve the difference equations.	
Course Outcomes: The students will be able to		
1.	gain the idea that by applying the theory of Integral transform the problem from its original domain can be mapped into a new domain where solving problems becomes easier.	
2.	apply these techniques to solve research problems of signal processing, data analysis and processing, image processing, in scientific simulation algorithms etc.	
3.	apply these transform techniques to solve the physical problem governed by ODE, PDE and difference equations.	
Course Content:		
Unit	Content	Hours
I	Laplace Transform-Definition and its properties, Laplace transform of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties.	15
II	Laplace Transform—Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs and PDEs.	15
III	Fourier transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Applications of Fourier transforms to Boundary Value Problems.	15
IV	Z-Transform: Z-transform and inverse Z-transform of elementary functions, shifting theorems, Convolution theorem, Initial and final value theorem, Application of Z-transforms to solve difference equations.	15
Internal Assessment:		
CIA-I	Unit-I, II	
CIA-II	Written Exams/ Quizzes/Assignment/Presentation/Viva-Voce	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
1. Debnath, L. and Bhatta B., <i>Integral Transforms and Their Applications</i> , Taylor and Francis, 2014		
2. John M. Wills, <i>Integral Transforms in Applied Mathematics</i> , Cambridge University Press, 2008.		
3. Murrey R Spiegel, <i>Laplace Transforms</i> (SCHAUM Outline Series), McGraw Hill, 1965		
Reference Books:		
1. Hildebrand F. B., " <i>Methods of Applied Mathematics</i> ", Courier Dover Publications, 1992.		
E-resources:		
https://nptel.ac.in/courses/111106111		

ELEMENTARY NUMBER THEORY (6.0MAT35)

Course Name	Elementary Number Theory	
Course Code:	6.0MAT35	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
	Total:	4
Course Prerequisite: The student should have knowledge of		
1.	basic concepts of sets	
Course Objectives:		
1.	To teach the students integers and their properties	
2.	To teach the students the congruences	
3.	To teach the students the arithmetic functions	
4.	To teach the students binary quadratic forms	
Course Outcomes: The students will be able to		
1.	Learn the concepts of linear Diophantine equation	
2.	use the modular arithmetic	
3.	learn the primitive root theorem	
4.	discuss the binary quadratic forms	
Course Content:		
Unit	Content	Hours
I	Division in integers, Greatest common divisor, Euclid's Algorithm, Linear Diophantine equations, Prime numbers, Fundamental Theorem of arithmetic, Distribution of primes, Greatest integer functions	15
II	Congruence relation, Properties of Congruence relation, Linear Congruences, Solvability of Linear congruence, modular arithmetic, Residue classes and reduced residue classes, Fermat's little theorem, Wilson's theorem, Euler's theorem Chinese remainder theorem, Higher degree polynomial congruence, Polynomial congruence mod p^r	15
III	Quadratic residues, Legendre Symbol, Primitive root theorem, Arithmetic functions $\phi(n)$, $\mu(n)$, $r(n)$, $\sigma(n)$, Ring of Arithmetic functions, Multiplicative arithmetic functions, Möbius inversion formula, Perfect numbers	15
IV	Representation of an integer as a sum of two and four squares, Diophantine equations $ax+by=c$, $x^2+y^2=z^2$ and $x^4+y^4=z^4$. Binary quadratic forms and Equivalence of quadratic forms, Farey sequences	15
Internal Assessment:		
CIA-I	Unit -I, II	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. Burton D. M., 1989, <i>Elementary Number Theory</i> , Wm. C. Brown Publishers, Dubuque, Iowa.		
2. Jones G.A. and J.M. Jones, 1998, <i>Elementary Number Theory</i> , Springer-Verlag, New York		
3. Sierpinski W., 1998, <i>Elementary Theory of Numbers</i> , North-Holland, Ireland.		
Reference Books:		
1. Zuckerman N.S.H. and Montgomery L.H., 1991, <i>An Introduction to the Theory of Numbers</i> , John Wiley.		

INTRODUCTION TO SPACE DYNAMICS (6.0MAT36)

Course Name	Introduction to Space Dynamics	
Course Code:	6.0MAT36	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
	Total:	4
Course Prerequisite: The student should have knowledge of		
1.	Basics of linear algebra, analytical geometry, differential equations, and vector calculus	
Course Objectives:		
1.	kinematics of particles, understanding of different orbital paths and elaboration of conservation laws.	
2.	two body problems and its application in space and visualization of Kepler's laws of planetary motion.	
3.	existence of integrals in three-body problem, applications of stable equilibrium points of the restricted problem of three bodies and importance of the Jacobi integral.	
4.	rocket dynamics, performance measuring parameters and needs multi-stages rockets.	
Course Outcomes: The students will be able to		
1.	know about the kinematics of particles, understand about different orbital paths of particles and verify the conservation laws.	
2.	solve the two-body problem, verify Kepler's laws of planetary motion and visualize the application of two body problems in space.	
3.	verify the existence of integrals in a three-body problem, determine and examine the stability of equilibrium points in the restricted problem of three bodies and know the importance of the Jacobi integral.	
4.	know about rocket dynamics, estimate the performance parameters and understand about the needs of optimized multi-stages rockets.	
Course Content:		
Unit	Content	Hours
I	Some basic definitions, Conservation laws, Newton's laws of motion, Kinematics of particles, Conic-section, Central force motion, Differential equation of orbit and its solution, Geometry of different kinds of orbits.	15
II	Formulation of problem of two-body and equations of motion, relative equation of motion of two body problem, Solution of two body problem and its application. Kepler's law of planetary motion, Kepler's equation and its solution, Uniform rotating frame.	15
III	Introduction of three body problem, ten known integrals, Stationary solutions of three body problem and applications, Restricted problem of three body, Jacobi integral, prohibited regions of motion, collinear and noncollinear equilibrium points, Stability analysis of equilibrium points, Applications of restricted problem of three body in space.	15
IV	Equation of variable mass, introduction of rocket theory, governing equation of a rocket, Single-stage rocket and its performance, Effect of gravity on the dynamics of a rocket, two-stage rocket and its performance, multi-stage rocket, Optimization of multi-stage rocket.	15
Internal Assessment:		
CIA-I	Written Exam.	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Written Exam. for Unit-I, II, III, & IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. McCuskey S. W., 1963, <i>Introduction to Celestial Mechanics</i> , Addison-Wesley Publishing Company.		
2. Murray C. D., Dermott S.F., 2000, <i>Solar System Dynamics</i> , Cambridge University Press.		
3. Rao K.S., 2009, <i>Classical Mechanics</i> , PHI Learning, Pvt. Ltd.		
4. Goldstein H., Poole C.P. and Safko J.L., 2019, <i>Classical Mechanics</i> (Third edition), Pearson India Education Pvt. Ltd.		
5. Battin, Richard H., 1999, <i>An Introduction to The Mathematics and Methods of Astrodynamics</i> , AIAA Education Series.		
Reference Books:		
1. Szebehely V., 1967, <i>Theory of orbits</i> . The restricted problem of three bodies, New York Acad. Press.		
2. Thomson, William T., 1986, <i>Introduction to Space Dynamics</i> , Dover Publication, Inc. New York		
E-resources:		
https://nptel.ac.in/courses/101105029		
https://nptel.ac.in/courses/101104078		

FLUID DYNAMICS (6.0MAT37)

Course Name	Fluid Dynamics		
Course Code:	6.0MAT37		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1.	basic concepts of differential equations.		
2.	basic concepts of calculus		
Course Objectives:			
1.	the basics characteristics of fluid, continuum hypothesis, kinematics of fluids.		
2.	the Eulerian and Lagrangian methods for fluid motion.		
3.	the Conservation Laws in different coordinate systems and boundary conditions.		
4.	the irrotational and rotational flows		
5.	the solution process of simplified examples.		
Course Outcomes: The students will be able to			
1.	the fluid properties, continuum hypothesis, strain rate tensor, streamline, path line, streak lines, stream function and vortex lines.		
2.	the stress tensor, symmetry of stress tensor, transformation of stress		
3.	the Eulerian and Lagrangian hypothesis and their differences.		
4.	the conservation law and their equations.		
5.	the methods of implementing fluid dynamics laws.		
6.	a number of fundamental mathematical ideas and techniques for the solution of related problems.		
Course Content:			
Unit	Content		Hours
I	Physical Properties of fluids. Concept of fluids, continuum hypothesis, density, specific weight, specific volume, kinematics of fluids; Eulerian and Lagrangian methods of description of fluids, equivalence of Eulerian and Lagrangian method, general motion of fluid element, integrability and compatibility conditions,		15
II	Strain rate tensor, streamline, path line, streak lines, stream function, vortex lines, circulation. Stresses in Fluids: Stress tensor, symmetry of stress tensor, transformation of stress components from one coordinate system to another, principal axes and principal values of stress tensor, conservation of mass,		15
III	Conservation of momentum, Navier Stokes equation, conservation of moments of momentum, equation of energy, basic equations in different coordinate systems, boundary conditions.		15
IV	Irrotational and Rotational Flows: Bernoulli's equation, Bernoulli's equation for irrotational flows, two dimensional irrotational incompressible flows, Blasius theorem, circle theorem, sources and sinks, sources sinks and doublets in two dimensional flows.		15
Internal Assessment:			
CIA-I	Unit-I		
CIA-II	Written Exams/ Quizzes/ Assignment/ Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Textbooks:			
1. Rathy R.K., 1976, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Co.			
2. Thomson L. N. M., 1962, Theoretical Hydrodynamics, Macmillan and Co. Ltd.			
3. Chorlton F., 1985, Textbook of Fluid Dynamics, CBS Publishers.			
4. Landau L. D., Lipschitz E.N., 1985, Fluid Mechanics, Pergamon Press.			
Reference Books:			
1. Emanuel, G. 2000, Analytical Fluid Dynamics, CRC Press.			
2. Nakayama, Y. and Boucher, R. F., 2000, Introduction to Fluid Mechanics, Butterworth-Heinemann			
E-resources:			
https://onlinecourses.nptel.ac.in/noc19_ce28/preview			

GRAPH THEORY (6.0MAT38)

Course Title:	Graph Theory	
Course Code:	6.0MAT38	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	basic concepts of sets	
Course Objectives:		
1	To teach the students basics of graphs	
2	To teach the students the connectivity	
3	To teach the students the planar graph	
4	To teach the students incidence matrix	
Course Outcomes: The students will be able to		
1	the concepts of operation on graphs	
2	the Eulerian graphs	
3	the Kuratowski's theorem	
4	the automorphism of graphs	
Course Content:		
Unit	Content	Hours
I	Graphs, Isomorphism of graphs, subgraph, walk, connectedness, degree, bipartite graph, Intersection graph, Operations on graphs, graph products, cut point, bridges, blocks	15
II	Tree, Center, Centroid, Connectivity, Line connectivity, Partition, Graphical partition, Eulerian graphs, Hamiltonian graphs, Line graph, Characterization of line graph	15
III	Covering, Independence, Planar graphs, Kuratowski's theorem, Chromatic Number, Chromatic polynomial	15
IV	Adjacency matrix, Incidence matrix, automorphism groups of graphs, group of composite graph	15
Internal Assessment:		
CIA-I	Unit -I, II	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Harary F., 1969, Graph Theory, Narosa Publication House, New Delhi. 2. Balakrishnan R., Ranganathan K., 2012, A Textbook of Graph Theory, Springer, New York. 3. Deo N., 1974, <i>Graph Theory with Applications to Engineering and Computer Science</i>, Prentice-Hall of India, New Delhi. 		
Reference Books:		
1. Diestel R., 2000, <i>Graph Theory</i> , Springer, New York		
E-resources:		
https://archive.nptel.ac.in/courses/		

FOUNDATIONS OF SET THEORY (6.0MAT39)

Course Title:	Foundations of Set Theory		
Course Code:	6.0MAT39		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basic concepts of sets		
Course Objectives:			
1	To teach the students the mathematical statements		
2	To teach the students the relation and map		
3	To teach the students the construction of number systems		
4	To teach the students ordinal numbers		
Course Outcomes: The students will be able to			
1	the Zermelo-Fraenkel axioms of set theory		
2	the Peano's axioms		
3	the dedekind cut approach		
4	the cardinal arithmetic		
Course Content:			
Unit	Content		Hours
I	Mathematical statements, connectives, simple sentence and compound sentence, universal quantifiers, Functional Rule and Truth Table, Conjunction, Disjunction, Implication, Tautology and Contradiction, Rules of Inference and Replacement, method of contradiction, Zermelo-Fraenkel axioms of set theory, Class of sets, Russel's Paradox		15
II	Successor set and natural numbers, Ordered pair, Cartesian product, Relations and Maps on sets, Indexing set, Arbitrary intersection and union, Extension of Maps, Fundamental Theorem of Maps, Number Systems, Natural Numbers, Peano's Axioms, Pigeonhole Principle,		15
III	Construction of other number systems, Integers and Rational Numbers, Their arithmetic and ordering, Dedekind cut, Real number system as complete ordered field		15
IV	\in -transitive sets, Ordinals, class of ordinals, Trichotomy law between ordinals, characterization of an ordinal in terms of \in -transitive sets, successor and limit ordinals, Principle of Transfinite Induction, Ordinal Arithmetic, Ordinals and well ordered set, Axiom of Choice and its equivalence, The Banach-Tarski Paradox, Cardinals and its arithmetic, ordering of cardinals, countable and uncountable sets, continuum hypothesis		15
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Levy A., 1979, Basic Set Theory, Springer-Verlag, New York. 2. Copi M., 1979, Symbolic Logic, Macmillan Publishing Co. Inc., New York. 3. Kakkar V., 2016, Set Theory: Read it, Absorb it and Forget it, Narosa Publication House, New. 4. Enderton H. B., 1977, Elements of Set Theory, Academic Press Inc., New York. 			
Reference Books:			
1. Halmos P. R., 1960, <i>Naive Set Theory</i> , Von Nostrand Reinhold Company, New York.			
E-resources:			
https://archive.nptel.ac.in/courses/			

PROGRAMMING IN C (6.0MAT40)

Course Title:		Programming In C	
Course Code:		6.0MAT40	
Teaching Scheme		Examination Scheme	
Theory: 3 hours/week		Internal Assessment: 40 Marks	
Practical: 1 hour/week		ESE: 60 Marks	
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basics of set and functions		
Course Objectives:			
1	To introduce the basic concepts of computer programming languages.		
2	To develop the logics for create programs.		
3	To introduce basic programming constructs		
Course Outcomes: The students will be able to			
1	the concepts of computer programming languages		
2	the codes the programmes in C language		
3	the developing of the applications		
Course Content:			
Unit	Content		Hours
I	Basic concepts of programming languages: Programming domains, language evaluation criterion and language categories, Describing Syntax and Semantics, formal methods of describing syntax, recursive descent parsing, Dynamic semantics (operational semantics, denotational semantics, axiomatic semantics).		11 Hours Theory and 7 Hours Lab
II	Names, Variables, Binding, Type checking, Scope and lifetime data types, array types, record types, union types, set types and pointer types, arithmetic expressions, type conversions, relational and Boolean expressions, assignment statements, mixed mode assignment.		11 Hours Theory and 8 Hours Lab
III	Statement level control structures, compound statements, selection statements, iterative statements, unconditional branching, Character set, variables and constants, keywords, Instructions, assignment statements, arithmetic expression, comment statements, simple input and output.		11 Hours Theory and 7 Hours Lab
IV	Relational operators, logical operators, control structures, decision control structure, loop control structure, case control structure, functions, subroutines, scope and lifetime of identifiers, parameter passing mechanism, arrays and strings.		12 Hours Theory and 8 Hours Lab
Internal Assessment:			
CIA-I	Unit-I		
CIA-II	Written Exams/ Quizzes/ Assignment/ Presentations/ Viva-Voce/ based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> Sebesta R. W., 1999, Concepts of Programming Language, Addison Wesley, Pearson Education. Deitel P., Deitel H., 2010, How to Program C (6th Ed.), Addison Wesley, Pearson Education. Toledo R. A. M. and Cushman P. K., 2003, Introduction to Computer Science, Mc Graw Hill International Edition. Appleby D., Kopple J. J V., 1997, Programming Languages (2nd Ed.), Tata McGraw Hill, India. King K. N., 2008, C Programming a Modern Approach (2nd Ed.), W. W. Norton & Company. 			
Reference Books:			
<ol style="list-style-type: none"> Kanetkar Y., 2018, <i>Let Us C (16th Ed.)</i>, B.P.B Publications. 			
E-resources:			

AN INTRODUCTION TO FUZZY SET THEORY AND FUZZY LOGIC (6.0MAT41)

Course Title:	An Introduction to Fuzzy Set Theory and Fuzzy Logic	
Course Code:	6.0MAT41	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	classical set theory, and two-valued logic.	
Course Objectives:		
1	To provide the basic knowledge of the fuzzy sets, operations and their properties.	
2	To teach them the fundamental concepts of fuzzy functions and fuzzy relational calculus.	
3	To teach them fuzzy logic in detail.	
4	To teach them fuzzy numbers and evidence theory.	
Course Outcomes: The students will be able to		
1	the significance, need and applications of concepts of fuzziness.	
2	the fundamental concepts of Fuzzy functions and Fuzzy logic	
3	the fuzzy numbers and its types.	
4	how to apply evidence theory.	
Course Content:		
Unit	Content	Hours
I	Crisp sets vs fuzzy sets: Membership function types and properties, Chance versus fuzziness, Level sets, Cardinality and fuzzy cardinality, Set theoretic operations on fuzzy sets, Inclusion and Difference, Fuzzy compliments, Fuzzy intersections: t-Norms, Fuzzy unions: t-Conorms, Algebraic operations, Averaging operators. Alpha-cut decomposition principle,	15
II	Extension principle. Crisp versus fuzzy relations, Projections, Composition of fuzzy relations, Fuzzy binary relations, Fuzzy n-ary relation, transitive closure, Fuzzy equivalence relations. Classical logic an overview, : Introduction to propositional Logic, Boolean Algebra, Multi valued logic,	15
III	Fuzzy logic, Linguistic hedges, Fuzzy propositions (conditional and unconditional), Approximate reasoning, Implication operations, Natural language, Fuzzy qualifiers, Inference from conditional and qualified fuzzy propositions, Fuzzy Quantifiers, Inference from quantified fuzzy propositions.	15
IV	Fuzzy numbers, Types of fuzzy numbers, Linguistic variables, Fuzzy arithmetic: Extension principle and Interval arithmetic, Fuzzification, Defuzzification, Methods of Defuzzification. Fuzzy measures, Evidence theory, Necessity and belief measures, Probability measures vs possibility measures.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Klir, G. J., Yuan B., 1997, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall. 2. Ross T. J., 1995, Fuzzy Logic with Engineering Applications, McGraw Hill. 3. Zimmermann H. J., 1990, Fuzzy Set Theory and Its Application (2nd Ed.), Kluwer, Boston. 4. Lee. K. H., 2005, First Course on Fuzzy Theory and Applications, Springer-Verlag. 		
Reference Books:		
E-resources:		
1. https://archive.nptel.ac.in/courses/108/104/108104157/		

COMPUTATIONAL ODE (6.0MAT42)

Course Title:	Computational ODE		
Course Code:	6.0MAT42		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basics of Linear Algebra		
2	basics of Differential Equations		
3	basics of Numerical Methods		
Course Objectives:			
1	the numerical techniques for IVP and BVP		
2	the convergence and stability of finite difference schemes		
3	the finite difference method for differential equations.		
4	the finite element methods for differential equations.		
5	the application of numerical techniques in real life problems.		
Course Outcomes: The students will be able to			
1	obtain numerical solutions and the concepts of consistency, stability, convergence and error analysis.		
2	check the stability and convergence of numerical methods.		
3	solve numerically linear and nonlinear ordinary differential equations.		
4	find the numerical solution to ODEs by using a computer program.		
5	apply various numerical methods in real life problems.		
Course Content:			
Unit	Content		Hours
I	Numerical solutions of systems of simultaneous first order differential equations and second order initial value problems (IVP) by Euler and Runge-Kutta explicit methods, numerical solutions of second order boundary value problems (BVP) of first, second and third types by shooting method.		15
II	Types of finite difference schemes of second order BVP based on difference operators (solutions of tridiagonal system of equations), solutions of such BVP by Newton-Cotes and Gaussian integration rules, convergence and stability of finite difference schemes.		15
III	Variational principle, approximate solutions of second order BVP of first kind by Rayleigh-Ritz, Galerkin, collocation and finite difference methods,		15
IV	Finite Element methods for BVP-line segment, triangular and rectangular elements, Ritz and Galerkin approximation over an element, assembly of element equations and imposition of boundary conditions.		15
Internal Assessment:			
CIA-I	Unit-I		
CIA-II	Written Exams/ Quizzes/ Assignment/ Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Jain M. K., Iyengar S. R. K. and Jain R. K., 2003, Numerical Methods for Scientific and Engineering Computations, New Age Publications. 2. Jain M. K., 1984, Numerical Solution of Differential Equations (2nd Ed.), Wiley-Eastern. 3. Sastry S. S., 2002, Introductory Methods of Numerical Analysis, Prentice-Hall of India. 4. Griffiths D.V. and Smith I. M., 1993, Numerical Methods for Engineers, Oxford University Press. 5. Gerald C. F. and Wheatley P. O., 1998, Applied Numerical Analysis, Addison- Wesley. 			
Reference Books:			
1. Singh, A. K. and Singh, A. K., 2018, <i>Numerical Methods for Differential Equations with Programs</i> , Narosa Publications.			
E-resources:			
https://nptel.ac.in/courses/111107063			

FUNCTIONAL OF SEVERAL REAL VARIABLES (6.0MAT43)

Course Title:	Functional of Several Real Variables		
Course Code:	6.0MAT43		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basic concepts of calculus of one variables		
Course Objectives:			
1	To explain how some concepts of calculus can be generalized in higher dimensions.		
2	To introduce multivariable calculus: different types of derivatives, chain rule, mean value theorem, maxima and minima, implicit and inverse function theorems.		
3	To explain how these generalized concepts impact inventions in science, technology and daily life.		
Course Outcomes: The students will be able to			
1	how existing concepts of calculus of one variable or two variable can be generalized in higher dimensions		
2	the significance of the concepts defined and the theorems proved here;		
3	the importance of these generalized concepts impacts science, technology and our daily life.		
Course Content:			
Unit	Content		Hours
I	\mathbb{R}^n as inner product and as normed space, convergence of sequences, compactness, equivalence of norms, connected and convex sets, Functions from \mathbb{R}^n to \mathbb{R}^m , limit and continuity, Directional derivatives, partial derivatives of a function of several real variables.		15
II	Differentiability of a function of several real variables, sufficient conditions for continuity and differentiability of a function of several real variables in terms of partial derivatives, algebra of differentiable functions, Chain rule of differentiation, Total differentials.		15
III	Mean value Theorem for real valued functions, homogeneous functions and Euler's Theorem, Equality of mixed derivatives, Young's and Schwarz Theorems, higher differentials, Taylor's Theorem.		15
IV	Maxima and minima for real valued functions of several real variables, (necessary and sufficient conditions), saddle points, Lagrange's multipliers, Hessian matrix, Jacobian matrix and determinants, Implicit and Inverse function Theorems, Functional dependence.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> Lang S, 1987, Calculus of Several Variables, Springer-Verlag, New York. Fleming W. H., 1977, Functions of Several Variables, Springer-Verlag, New York. Ghorpade S. R., Limaye B. V., 2010, A Course in Multivariable Calculus and Analysis, Springer. 			
Reference Books:			
<ol style="list-style-type: none"> Giaquinta M., Modica G. 2009, Mathematical Analysis: An Introduction to Functions of Several Variables, Birkhauser, Boston. Spivak M., 1965, Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus, CRC Press. 			
E-resources:			
https://onlinecourses.nptel.ac.in/noc20_ma27/preview			

MATHEMATICAL MODELING (6.0MAT44)

Course Title:	Mathematical Modeling	
Course Code:	6.0MAT44	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	basic concepts in Linear Algebra and Real Analysis and Differential Equations	
Course Objectives:		
1	To introduce students to the elements of the mathematical modeling process	
2	To learn different types of mathematical models and their nature.	
3	To exemplify the value of mathematics in problem solving	
4	To develop students' capacity to solve problems through the use of mathematical models as a transferable process that will equip them to address novel problems in future.	
Course Outcomes: The students will be able to		
1	the unique system characterization approach for a given system	
2	identify assumptions which are consistent with the context of the problem and which in turn shape and define the mathematical characterization of the problem	
3	how to analyze a given model system using mathematical analysis results.	
4	different types of mathematical models in ecology, epidemiology, chemistry, Physics, Life Sciences, Engineering etc.	
Course Content:		
Unit	Content	Hours
I	Introduction to modeling. Definition of System, classification of systems, classification and limitations of mathematical models, Methodology of model building, modeling through ordinary differential equations.	15
II	Linear growth and decay models, non-linear growth and decay models, Compartment models, Checking model validity, verification of models, Stability analysis, Basic model relevant to population dynamics, Epidemics modeling.	15
III	Ecology, Environment Biology through ordinary differential equation, Partial differential equation, Basic theory of linear difference equations with constant coefficients.	15
IV	Mathematical modeling through difference equations in population dynamics, genetics, Markov chains model, Gambler's ruin model, Stochastic models, Monte Carlo methods.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Murthy D. N. P., Page N. W. and Rodin E. Y., 1990, <i>Mathematical Modelling: A Tool for Problem Solving in Engineering, Physics, Biological and Social Sciences</i>, Pergamon Press. 2. Kapur J. N., 2008, <i>Mathematical Modelling</i>, New Age Int. Pub. 3. Law A. M. and Kelton W. D., 1991, <i>Simulation Modeling and Analysis</i>, McGraw-Hill. 4. Meerscheart M.M., 2007, <i>Mathematical Modeling</i>, Academic Press. 		
Reference Books:		
1. Nemytskii V.V., 2005, <i>A Course in Mathematical Modeling</i> , Mathematical Association of America.		
E-resources:		
https://nptel.ac.in/courses/111108081		

GAME THEORY (6.5MAT31)

Course Title:	Game Theory	
Course Code:	6.5MAT31	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	knowledge of linear programming and simplex methods.	
Course Objectives:		
1	To provide a rigorous treatment of solution concepts for games with perfect and imperfect information including Nash and subgame perfect Nash equilibria.	
2	To cover topics such as auction, VNM utility function, bargaining game, etc.	
3	To provide detailed knowledge about cooperative games.	
4	To teach about games with imperfect information.	
Course Outcomes: The students will be able to		
1	model competitive real world phenomena using concepts from game theory and identify optimal strategy and equilibrium solutions for such models.	
2	learn the two person zero-sum game and its equilibrium solution.	
3	discuss dynamic games and cooperative games.	
4	work on strategic and dynamic games with imperfect information.	
Course Content:		
Unit	Content	Hours
I	A General Introduction to Game Theory-its Origin, Representation of Games, Type of Game, Games with Perfect Information-Strategic Form Game, Solution Concept- Pure and Mixed Strategies, Dominance and Best Response, Pareto Optimality, Maxmin and Minmax Strategies,	15
II	Pure and Mixed Strategies Nash Equilibrium, Existence of a Nash Equilibrium, Two-person Zero-Sum Games-its Solution, Market Equilibrium and Pricing: Cournot and Bertrand Game, Auctions.	15
III	Decision Making and Utility Theory, Von Neumann and Morgenstern Utility Function, Theory of Risk Aversion, Equilibrium Theory. Dynamic Games of Perfect Information- Extensive Form Game, Subgame Perfect Nash Equilibrium, Backward Induction, Stackelberg Model of Duopoly. Coalition Games, Core and Shapley Value, Bargaining Game, Illustrations.	15
IV	Strategic Games with Imperfect Information -Bayesian Games, Cournot's Duopoly with Imperfect Information. Dynamic Games with Imperfect Information. Finitely and Infinitely Repeated Games, The Folk Theorem, Illustrations.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> Osborne M.J., 2003, An Introduction in Game Theory, Oxford University Press. Osborne M. J. and Rubinstein A., 1994, A Course in Game Theory, MIT Press. Fudenberg D. and Tirole J., 1991, Game Theory, MIT Press. Von Neumann J. and Morgenstern O., 1944, Theory of Games and Economic Behaviour, New York: John Wiley and Sons. 		
Reference Books:		
1. Watson J., 2013, <i>Strategy: An Introduction to Game Theory (3rd Ed.)</i> , W.W. Norton & Company, London.		
E-resources:		
https://archive.nptel.ac.in/courses/110/104/110104063/		

AUTOMATA THEORY AND FORMAL LANGUAGES (6.5MAT32)

Course Title:	Automata Theory and Formal Languages		
Course Code:	6.5MAT32		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basic concepts of sets, relations, functions		
2	basic concepts of propositional logics		
Course Objectives:			
1	To explain why the study of automata is an important part of the core of computer science.		
2	To explain how finite automata are useful models in science and technology.		
3	To develop understanding of the concepts of automata theory and formal languages.		
Course Outcomes: The students will be able to			
1	how automata and formal languages impact our life.		
2	the concepts and topics in hand without haste;		
3	the significance of the concepts defined and the theorems proved here;		
4	the concepts in more generalized form to capture uncertainty and vagueness of complex systems.		
Course Content:			
Unit	Content		Hours
I	Theory of Computation: Finite automata, Deterministic and non-deterministic finite automata, equivalence of deterministic and non-deterministic automata, Moore and Mealy machines, Minimization of Automata, Regular expressions.		15
II	Conversion of finite automata to Regular expression. Grammars and Languages, Derivations, Language generated by a grammar, Regular language and regular grammar, Context free grammar and context-free language.		15
III	Context sensitive grammars and Languages. Context-free grammar in Chomsky normal form, Regular expressions, Formal definition of regular expression, Equivalence of regular expression and finite automata, Kleene's theorem.		15
IV	Formal definition of a Turing Machine, Representation of a Turing Machine, Turing machines as language acceptors, Universal Turing machines, decidability, undecidability, Turing Machine halting problem, Rice Theorem.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Kelly D., 1995, Automata and Formal Languages: An Introduction, Prentice-Hall.			
2. Hopcroft J. E., Motwani R. and Ullman J. D., 2001, Introduction to Automata, Languages, and Computation (2nd Ed.), Pearson Edition.			
3. Linz P., 2010, An Introduction to Formal Languages and Automata, Narosa.			
Reference Books:			
1. Sipser M., 2012, <i>Introduction to the Theory of Computation (3rd Ed.)</i> , Cengage Learning.			
E-resources:			
1. https://archive.nptel.ac.in/courses/111/103/111103016/			
2. https://nptel.ac.in/courses/106105196			

ALGEBRAIC NUMBER THEORY (6.5MAT33)

Course Title:	Algebraic Number Theory	
Course Code:	6.5MAT33	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	basic concepts of ring and elementary number theory	
Course Objectives:		
1	To teach the students properties of number fields	
2	To teach the students the quadratic fields	
3	To teach the students the class group	
Course Outcomes: The students will be able to		
1	the arithmetic of algebraic number fields	
2	Minkowski's theorem	
3	Dirichlet unit theorem	
4	the diophantine equation	
Course Content:		
Unit	Content	Hours
I	Number fields, the ring of algebraic integers, calculation for quadratic, cubic and cyclotomic cases, norms and traces, integral bases and discriminants,	15
II	Dedekind domains, unique factorization of ideals, norm of ideals, factorization of prime ideals in extensions, The ideal class group, lattices in \mathbb{R}^n , Minkowski's theorem,	15
III	Finiteness of the class number and its consequences, some class number computations, Dirichlet unit theorem, units in real quadratic fields	15
IV	Some Diophantine equations, Cubic residue symbol, Jacobi sums, Cubic reciprocity law, biquadratic reciprocity law and Eisenstein reciprocity law	15
Internal Assessment:		
CIA-I	Unit -I, II	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Esmonde J., Murty M. R., 1999, Problems in Algebraic Number Theory, GTM, Springer-Verlag. 2. Mollin R.A., 2001, Algebraic Number Theory, CRC Press. 3. Alaca S., Williams K. S., 2004, Introductory Algebraic Number theory, Cambridge University Press. 4. Zuckerman N.S.H., Montgomery L.H., 1991, An Introduction to the Theory of Numbers, John Wiley. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Marcus D. A., 1977, <i>Number Fields</i>, Springer-Verlag. 		
E-resources:		
https://archive.nptel.ac.in/courses/		

ALGEBRAIC TOPOLOGY (6.5MAT34)

Course Title:	Algebraic Topology	
Course Code:	6.5MAT34	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	concepts of general topology	
Course Objectives:		
1	To teach the students one point compactification	
2	To teach the students the fundamental groups	
3	To teach the students the lifting problems and its uniqueness	
4	To teach the students Van Kampen Theorem	
Course Outcomes: The students will be able to		
1	the concepts of pushout and adjunct spaces	
2	The calculation of some fundamental groups	
3	The Deck transformation	
4	The homology groups	
Course Content:		
Unit	Content	Hours
I	Review of General Topology, Continuous maps, compactness, one point compactification, Locally compact spaces, Proper maps, Quotient space, Real Projective space, Mobius band, Klein's bottle, torus, Wedge product, Co-product of groups, pushout, adjunct spaces, Cone	15
II	Path, Homotopy, Reparametrization, First fundamental groups, Simply connected spaces, Category and functors between categories, Category of pointed topological space, Functorial property of fundamental group, Retraction map, Brower's fixed point theorem, fundamental group of product spaces,	15
III	Deformation Retract, Covering projections, the lifting problems and its uniqueness, lifting of path and homotopy, Action of fundamental groups on fibers, regular covering, Deck transformation, group of Deck transformations, its action on fibres	15
IV	Van Kampen Theorem, fundamental group of some adjunct spaces, n-simplex, face maps, chain, boundary operator, Chain complexes, homology groups, Convex sets and barycentric coordinates, Homotopy invariance of homology, Mayer Vitory sequence and its applications, Maps on sphere and degree	15
Internal Assessment:		
CIA-I	Unit -I, II	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Munkres J. R., 2000, <i>Topology</i>, Prentice-Hall of India. 2. Greenberg M. J. and Harper J. R., 1997, <i>Algebraic Topology: A First Course</i>, Addison-Wesley Publishing company. 3. Deo S., 2006, <i>Algebraic Topology: A Primer</i>, Hindustan Book Agency. 4. Vick J. W., 1994, <i>Homology Theory, An Introduction to Algebraic Topology</i>, Springer Verlag. 		
Reference Books:		
1. Hatcher A., 2002, <i>Algebraic Topology</i> , Cambridge University Press.		
E-resources:		
https://archive.nptel.ac.in/courses/		

COMPUTATIONAL PDE (6.5MAT35)

Course Title:		Computational PDE	
Course Code:		6.5MAT35	
Teaching Scheme		Examination Scheme	
Theory: 3 hours/week		Internal Assessment: 40 Marks	
Tutorial: 1 hour/week		ESE: 60 Marks	
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basic of Linear Algebra		
2	basic of Differential Equations		
3	basic of Numerical Methods		
Course Objectives:			
1	the numerical techniques for partial differential equations		
2	the convergence, truncation errors and stability of finite difference schemes		
3	the explicit methods for partial differential equations.		
4	the implicit methods for partial differential equations		
5	the finite element methods for partial differential equations.		
6	the application of numerical techniques in real life problems.		
Course Outcomes: The students will be able to			
1	obtain numerical solutions and the concepts of truncation errors, stability, convergence.		
2	check the stability and convergence of numerical methods.		
3	solve numerically parabolic, elliptic and hyperbolic equations.		
4	find the numerical solution to PDEs by using a computer program.		
5	apply various numerical methods in real life problems.		
Course Content:			
Unit	Content		Hours
I	Numerical solutions of parabolic equations of second order in one space variable with constant coefficients:- two and three levels explicit and implicit difference schemes, truncation errors and stability, Difference schemes for diffusion convection equation,		15
II	Numerical solution of parabolic equations of second order in two space variables with constant coefficients-improved explicit schemes, implicit methods, alternating direction implicit (ADI) methods.		15
III	Numerical solution of hyperbolic equations of second order in one and two space variables with constant and variable coefficients-explicit and implicit methods, alternating direction implicit (ADI) methods.		15
IV	Numerical solutions of elliptic equations, Solutions of Dirichlet, Neumann and mixed type problems with Laplace and Poisson equations in rectangular, circular and triangular regions, Finite element methods for Laplace, Poisson, heat flow and wave equations		15
Internal Assessment:			
CIA-I	Unit-I		
CIA-II	Written Exams/ Quizzes/ Assignment/ Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Jain M. K., Iyengar S. R. K., Jain R. K., 1994, Computational Methods for Partial Differential Equations.			
2. Jain M. K., 1984, Numerical Solution of Differential Equations (2nd Ed.), Wiley Eastern.			
3. Sastry S. S., 2002, Introductory Methods of Numerical Analysis, Prentice-Hall of India.			
4. Griffiths D. V., Smith I. M., 1993, Numerical Methods of Engineers, Oxford University Press.			
5. General C. F., Wheatley P. O., 1998, Applied Numerical Analysis, Addison- Wesley.			
6. Bathe K. J. , Wilson E. L., 1987, Numerical Methods in Finite Element Analysis, Prentice-Hall.			
Reference Books:			
1. Mazumder, S., 2016, Numerical Methods for Partial Differential Equations: Finite Difference and Finite Volume Methods, Academic Press.			
2. Sewell, G., 2015, THE Numerical Solution of Ordinary and Partial Differential Equations, 3rd Ed., World Scientific Publications.			
E-resources:			
https://ocw.mit.edu/courses/18-336-numerical-methods-for-partial-differential-equations-spring-2009/			

DIFFERENTIAL GEOMETRY (6.5MAT36)

Course Title:		Differential Geometry	
Course Code:		6.5MAT36	
Teaching Scheme		Examination Scheme	Credits Allotted
Theory: 3 hours/week		Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week		ESE: 60 Marks	Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1	To introduce the basic concept of smooth manifolds with a variety of examples		
2	To elaborate the basic notions of smooth maps between manifolds and tangent spaces.		
3	To convey applications of manifolds		
Course Outcomes: The students will be able to			
1	the concepts of smooth manifold, smooth map, and tangent space.		
2	the inverse function theorem to describe the local structure of immersions and submersions;		
3	the applications and significances of topic in hands.		
Course Content:			
Unit	Content		Hours
I	Smooth manifold, chart and atlas, Compatible charts, Smooth maps between manifolds, Diffeomorphisms, Partial derivatives on manifolds, the inverse function theorems, Quotient manifolds		15
II	Real projective spaces, Standard smooth atlas for real projective space, Tangent spaces, Differential of a map, local expressions for differentials, Immersions and submersions, Rank, critical and regular points,		15
III	Submanifolds and level sets, the rank of a smooth maps, Whitney's embedding theorem; Tangent bundle, Smooth sections and smooth frames, Vector fields and local flows.		15
IV	Differential 1-Forms, Cotangent bundle, Characterization of smooth 1-Forms, Pullback of 1-forms, Differential k-Forms, local expression for k-Form, Pullback of k-Forms, the Wedge Product, Differential forms on a circle.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Tu W. L., 2010, An Introduction to Manifolds (2nd Ed.), Springer-Verlag, New York.			
2. O'Neill B., 1966, Elementary Differential Geometry, Academic Press, New York.			
3. Thorpe J. A., 1979, Elementary Topics in Differential Geometry, Springer Verlag.			
4. Somasundaram D., 2010, Differential Geometry: A First Course, Narosa Pub. House.			
Reference Books:			
1. Willmore T. J., 1965, <i>An Introduction to Differential Geometry</i> , Oxford University Press			
E-resources:			
1. https://ocw.mit.edu/courses/18-950-differential-geometry-fall-2008/			

DIFFERENTIAL EQUATION AND DYNAMICAL SYSTEMS (6.5MAT37)

Course Title:	Differential Equation and Dynamical Systems		
Course Code:	6.5MAT37		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	differential Equations, calculus and linear algebra		
Course Objectives:			
1	To introduce the theory, properties and applications of various dynamical systems		
2	To make the students familiar with stable and unstable subspaces and manifolds		
3	To teach an important theorems: Hartman-Grobman, stable manifold		
4	To introduce center manifold theory and normal form theory		
5	To discuss global existence theorem and Poincare-Bendixon theory		
Course Outcomes: The students will be able to			
1	to analyze and solve system of linear differential equations		
2	learn theory of nonlinear system: existence, maximal interval of existence and linearization		
3	to apply different important theorem and theories e.g., Hartman-Grobman, stable manifold theorems, centre and normal form theory		
4	to learn global existence theorem		
5	to discuss about limit sets, limit cycles and periodic orbits for a given dynamical system		
Course Content:			
Unit	Content		Hours
I	Linear Systems: Exponentials of operators, Planar linear systems and their phase portraits, complex eigenvalues, multiple eigenvalues, Jordon forms, Stability theory		15
II	Generalized eigenvectors and invariant subspaces, Non-homogeneous linear systems, Nonlinear Systems: The fundamental existence-uniqueness theorem, The maximal interval of existence, The flow defined by a differential equation, Linearization, The stable manifold theorem, The Hartman-Grobman theorem		15
III	Stability and Lyapunov functions, Saddles, Nodes, Foci and Centers, Center manifold and Normal form theory, Dynamical systems and global existence theorems, Limit sets and Attractors, Periodic orbits		15
IV	Limit Cycles, and Seperatrix cycles, Poincare map, Stable manifold theorem for periodic orbits, Poincare-Bendixon theory in xy-plane, Lineard Systems, Bendixson's Criteria.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I, II, III, IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Perko L., 2006, Differential Equations and Dynamical Systems, Springer-Verlag. 2. Hirsch M. W., Smale S. and Robert L.D., 2013, Differential Equations, Dynamical Systems and An Introduction to Chaos, Academic Press. 3. Stuart A. M. and Humphries A. R., 1998, Dynamical Systems and Numerical Analysis, Cambridge University Press. 4. Lynch S., 2004, Dynamical Systems with Applications using MATLAB, Birkhause Press. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Strogatz, S. H., 2000, <i>Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering</i>, Westview Press. 			
E-resources:			
https://www.youtube.com/playlist?list=PLbN57C5Zdl6j_qJA-pARJnKsmROzPnO9V https://www.youtube.com/watch?v=BRaliLNUvNg&list=PL6hB9Fh0Z1ELbHIAL22dCk173qykDgeoz			

FINANCIAL MATHEMATICS (6.5MAT38)

Course Title:	Financial Mathematics	
Course Code:	6.5MAT38	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	elementary Mathematics and Probability	
Course Objectives:		
1	To provide the theoretical foundations required to understand the financial mathematics	
2	To make the students familiar with the concepts life insurance contracts.	
3	To teach Black Scholes model and Black Scholes equation	
4	To introduce Binomial methods and Monte Carlo simulation	
5	To discuss finite difference methods	
Course Outcomes: The students will be able to		
1	theoretical foundations required to understand the financial mathematics	
2	binomial methods	
3	how to do Monte Carlo simulation	
4	finite difference methods	
Course Content:		
Unit	Content	Hours
I	Introduction to options and markets: types of options, interest rates and present values, Black Scholes model : arbitrage, option values, pay offs and strategies, put call parity, Black Scholes equation	15
II	Similarity solution and exact formulae for European options, American option, call and put options, free boundary problem, Binomial methods: option valuation, dividend paying stock, general formulation and implementation	15
III	Monte Carlo simulation : valuation by simulation, Lab component: implementation of the option pricing algorithms and evaluations for Indian companies, different concepts associated with Finite difference methods	15
IV	Finite difference methods: explicit and implicit methods with stability and conversions analysis methods for American options- constrained matrix problem, projected SOR, time stepping algorithms with convergence and numerical examples	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
1. Luenberger D. G., 1998, Investment Science, Oxford University Press.		
2. Hull J. C., 2000, Options, Futures and Other Derivatives (4th Ed.), Prentice-Hall New York.		
3. Cox J. C. and Rubinstein M., 1985, Option Market, Englewood Cliffs, N. J. Prentice-Hall.		
4. Jones C.P., 1996, Investments, Analysis and Measurement (5th Ed.), John Wiley and Sons.		
5. Capinski M., Zastawniak T., Mathematics for Finance, Springer		
Reference Books:		
1. Wahidudin A.N., , 2000, <i>Financial Mathematics and Its Applications</i> , Ventus Publishing ApS		
E-resources:		
https://nptel.ac.in/courses/11110312		

LIE ALGEBRAS (6.5MAT39)

Course Title:	Lie Algebras		
Course Code:	6.5MAT39		
Teaching Scheme	Examination Scheme	Credits Allotted	
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3	
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1	
Total:			4
Course Prerequisite: The student should have knowledge of			
1	concepts of linear algebra		
Course Objectives:			
1	To teach the students how to utilize various techniques for working with Lie algebras		
2	To teach the students the parts of a major classification result		
3	To teach the students the representations of $sl(2, \mathbb{C})$		
4	To teach the students root Space Decomposition		
Course Outcomes: The students will be able to			
1	the construction of Lie algebra		
2	The low-dimensional Lie algebras		
3	The semisimple Lie Algebras		
4	The root system		
Course Content:			
Unit	Content	Hours	
I	Definition of Lie Algebras, Some Examples, classical Lie Algebras, Subalgebras and Ideals, Homomorphisms, Derivations, Structure Constants, Ideals and Homomorphisms, Constructions with Ideals, Quotient Algebras, Correspondence between Ideals,	15	
II	Low-Dimensional Lie Algebras, Dimensions 1,2and3, Solvable Lie Algebras, Nilpotent Lie Algebras, Subalgebras of $gl(V)$, Weights, The Invariance Lemma, Engel's Theorem, Lie's Theorem, Some Representation Theory, Definitions, Examples of Representations, Modules for Lie Algebras, Irreducible and Indecomposable Modules, Schur's Lemma	15	
III	Representations of $sl(2, \mathbb{C})$, Classifying the Irreducible $sl(2, \mathbb{C})$ -Modules, Weyl's Theorem, Cartan's Criteria, Jordan Decomposition, Testing for Solvability, The Killing Form, Testing for Semisimplicity, Derivations of Semisimple Lie Algebras	15	
IV	The Root Space Decomposition, Cartan Subalgebras, Subalgebras Isomorphic to $sl(2, \mathbb{C})$, Root Strings and Eigenvalues, Cartan Subalgebras as Inner-Product Spaces, Root Systems, Bases for Root Systems, Cartan Matrices and Dynkin Diagrams	15	
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Humphreys J. E., 1972, Introduction to Lie Algebras and Representation Theory, Springer-Verlag New York.			
2. Jacobson N., 1962, Lie Algebras, Wiley-Interscience, New York.			
3. Erdmann K. and Wilson M.J., 2006, Introduction to Lie Algebras, Springer-Verlag, New York.			
Reference Books:			
1. Serre J. P., 1965, <i>Lie Algebras and Lie Groups</i> , Benjamin, New York.			
E-resources:			
https://archive.nptel.ac.in/courses/			

MODULE THEORY (6.5MAT40)

Course Title:	Module Theory		
Course Code:	6.5MAT40		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
			Total: 4
Course Prerequisite: The student should have knowledge of			
1	concepts of rings and linear algebra		
Course Objectives:			
1	To teach the students linear algebra over certain rings		
2	To teach the students the basic definitions and elementary results		
3	To teach the students the classification of finitely generated abelian groups		
4	To teach the students Jordan Canonical form		
Course Outcomes: The students will be able to			
1	the concepts of isomorphism theorems		
2	the projective and injective modules		
3	the torsion and torsion-free modules		
4	the Jordan canonical form		
Course Content:			
Unit	Content		Hours
I	Modules over a ring, Endomorphism ring of an abelian group, R-Module structure on an abelian group M as a ring homomorphism from R to $\text{End}_Z(M)$, submodules, Direct summands, Annihilators, Faithful modules, Homomorphism, Factor modules, Isomorphism theorems		15
II	Free Module, Noetherian and Artinian Module, Hilbert basis theorem, Wedderburn Artin Theorem, Split exact sequences and their characterizations, Left exactness of Hom sequences and counterexamples for non-right exactness, Projective modules, Injective modules, Baer's characterization, Divisible groups, Examples of injective modules. (M, M) as a ring, Exact sequences, Five lemma,		15
III	External and internal direct sums and their universal property, Submodules of finitely generated free modules over a PID, Torsion submodule, Torsion and torsion-free modules, Direct decomposition into $T(M)$ and a free module, primary components, Decomposition of p-primary finitely generated torsion modules		15
IV	Elementary divisors and their uniqueness, Decomposition into invariant factors and uniqueness, Reduction of matrices over polynomial rings over a field, Similarity of matrices and $F[x]$ -module structure, Rational canonical form of matrices, Elementary Jordan matrices, Reduction to Jordan canonical form, Diagonalizable and nilpotent parts of a linear operator, Smith normal form over PID, Uniqueness of Smith normal form		15
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Dummit D. S. and Foote R. M., 2003, Abstract Algebra, John Wiley NY.			
2. Gopalakrishnan N. S., 1986, University Algebra, Wiley Eastern Ltd., New Delhi.			
3. Lam T. Y., 2007, <i>Exercises in Module and Rings</i> , Springer.			
Reference Books:			
1. Anderson F. W. and Fuller K. R., 1974, <i>Rings and Categories of Modules</i> , Springer, N.Y.			
E-resources:			
https://archive.nptel.ac.in/courses/			

NONLINEAR DYNAMICS AND CHAOS (6.5MAT41)

Course Title:	Nonlinear Dynamics and Chaos		
Course Code:	6.5MAT41		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	differential equations and calculus		
Course Objectives:			
1	To provide knowledge of different topics in Nonlinear dynamics and chaos		
2	To teach one dimensional systems and different types of bifurcations		
3	To introduce some real model systems and applications of one dimensional bifurcations and stability theory		
4	To introduce two dimensional systems and associated bifurcations		
5	To discuss one dimensional maps and different topics in chaos		
Course Outcomes: The students will be able to			
1	different topics in nonlinear dynamics and chaos		
2	bifurcations for one dimensional system and associated applications		
3	bifurcation theory for two dimensional systems and application		
4	different aspects associated with chaos and applications		
Course Content:			
Unit	Content		Hours
I	The importance of being nonlinear, A dynamical view of the world, One dimensional flows: Flows on the lines: a geometric way of thinking, Fixed points, Local stability analysis, Overdamped beam on a rotating hoop, Existence and Uniqueness, Impossibility of oscillations, Potentials, Bifurcations: Saddle-node bifurcations, Transcritical and Pitchfork bifurcations, Supercritical and Subcritical Pitchfork bifurcations, Laser threshold, Imperfect bifurcations and Catastrophes		15
II	Insect outbreak: Model, Dimensionless formulation, Analysis of fixed points, Two dimensional flows: Linear systems, Definitions and examples, Classification of linear systems, Dynamics of love affairs, Rabbit Versus Sheep, Conservative Systems, Limit cycles, Ruling out closed orbits, Poincare-Bendixson theorem, Lienard systems, Weakly nonlinear oscillators,		15
III	Bifurcations in case of two dimensional systems, Hopf-bifurcations in aeroelastic stabilities and chemical oscillators, Global bifurcations of cycles, chaotic waterwheels, waterwheel equations and Lorentz equations, Chaos in the Lorentz equations, Strange attractor of Lorentz equations		15
IV	One dimensional map, Universal aspects of periodic doubling, Feigenbaum's renormalization analysis and periodic doubling, Renormalization: Function space and hands-on calculation, Fractals and the geometry of strange attractors, Henon map, Using chaos to send secret messages		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Strogatz S., 2001, Nonlinear Dynamics and Chaos, Springer. 2. Ermentrout B., 2005, Simulating Analyzing and Animating Dynamical Systems, SIAM. 3. Hirsch M. W., Smale S. and Devaney R. L., 2002, Differential Equations, Dynamical Systems and an Introduction to Chaos, Academic Press. 4. Guckenheimer J. and Holmes P., 2000, Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields, Springer, New York. 			
Reference Books:			
E-resources:			

FIELDS AND GALOIS THEORY (6.5MAT42)

Course Title:	Fields and Galois Theory		
Course Code:	6.5MAT42		
Teaching Scheme	Examination Scheme	Credits Allotted	
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3	
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1	
		Total:	4
Course Prerequisite: The student should have knowledge of			
1	groups and rings		
Course Objectives:			
1	To teach the students symmetries of roots of a polynomial		
2	To teach the students the solubility in terms of simple algebraic formulae		
3	To teach the students the algebraic properties of field extensions		
4	To teach the students geometric problems such as doubling the cube		
Course Outcomes: The students will be able to			
1	the algebraic extension		
2	the splitting field		
3	the Finite field		
4	the construction of regular polygon		
Course Content:			
Unit	Content		Hours
I	Eisenstein's irreducibility criterion, Characteristic of a field, Prime subfields, Field extensions, Finite extensions, Simple extensions, Algebraic and transcendental extensions. Factorization of polynomials in extension fields. Splitting fields and their uniqueness.		15
II	Separable field extensions, Perfect fields, Separability over fields of prime characteristic, Transitivity of separability, Automorphisms of fields, Dedekind's theorem, Fixed fields, Normal extensions, Splitting fields and normality, normal closures,		15
III	Galois extensions, Fundamental theorem of Galois theory, Computation of Galois groups of polynomials., Primitive element theorem, Finite fields, Existence and uniqueness, Subfields of finite fields, Characterization of cyclic Galois groups of finite extensions of finite fields, fundamental theorem of algebra		15
IV	Cyclotomic extensions and polynomials, cyclic extensions, Solvability by radicals, Galois' characterization of such solvability, Generic polynomials, Abel-Ruffini theorem, geometrical constructions, construction of real number by ruler and compass, Impossibility of trisection of angle, Construction of regular polygon		15
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Dummit D. S. and Foote R. M., 2003, Abstract Algebra, John Wiley & Sons, New York. 2. Hungerford T. W., 2004, Algebra, Springer (India), Pvt. Ltd. 3. Roman S., 2007, Field Theory, Springer, New York. 4. Stewart I. N., 2004, Galois Theory, Chapman & Hall, New York. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Artin E., 1997, <i>Galois Theory</i>, Dover Publications. 			
E-resources:			
https://archive.nptel.ac.in/courses/			

OPERATIONS RESEARCH (6.5MAT43)

Course Title:	Operations Research		
Course Code:	6.5MAT43		
Teaching Scheme	Examination Scheme	Credits Allotted	
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3	
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1	
Total:			4
Course Prerequisite: The student should have knowledge of			
1	mathematical programming		
2	probability theory		
Course Objectives:			
1	To teach how to determine an optimal sequence out of a series of jobs.		
2	To teach the PERT/CPM techniques to plan, schedule, and control project activities.		
3	To teach solution methodologies for deterministic and probabilistic inventory models.		
4	To introduce the basic concepts of stochastic processes.		
5	To teach what is a queueing model and how to analyze some specific queueing models.		
Course Outcomes: The students will be able to			
1	to find the optimal job sequencing.		
2	to get a deep understanding of the PERT/CPM techniques to plan, schedule, and control project activities.		
3	to learn deterministic and probabilistic inventory models.		
4	to learn the basic concepts of stochastic processes.		
5	to learn the theory behind queueing models and to characterize a queue & its key performance indicators.		
Course Content:			
Unit	Content		Hours
I	Job sequencing: Principal assumptions, processing n jobs through m machines. Project management by PERT-CPM technique: Network representation, critical path computations, construction of the time schedule, project evaluation and report technique.		15
II	Deterministic inventory models: General Inventory models, static economic order quantity (EOQ) model, dynamic EOQ models, deterministic models with price breaks. Review of Probability theory, Probabilistic Inventory models, Probabilistic EOQ model, Single period model.		15
III	Stochastic processes, Classification and its properties, Markov process, types of Markov processes, infinitesimal generator matrix, transition probability matrix, steady state distributions, transient distributions.		15
IV	Queueing models: Elements of Queueing models, Kendall notations, Poisson process, pure birth model, pure death model, birth-death model, Chapman-Kolmogorov equations, Little's Law, distribution of waiting time and response time, Burke's Theorem, M/M/1 model, M/M/1/N models.		15
Internal Assessment:			
CIA-I	Unit -I,		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Castaneda L. B., Arunachalam V. and Dharmaraja S., 2012 Introduction to Probability and Stochastic Processes with Applications, Wiley, Hoboken, NJ, USA. 2. Hillier F. S., Lieberman G. J., Nag B. and Basu P., 2012, Introduction to Operations Research, Tata McGraw Hill Education Pvt. Ltd. 3. Taha H. A., 2007, Operations Research-An Introduction, Prentice Hall of India Pvt. Ltd. 4. Trivedi K.S., 2016, Probability and Statistics with Reliability, Queueing and Computer Science Applications, John Wiley & Sons, Inc., Hoboken, NJ, USA. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Trivedi K.S., 2016, Probability and Statistics with Reliability, Queueing and Computer Science Applications, John Wiley & Sons, Inc., Hoboken, NJ, USA. 2. Medhi J., 2009, Stochastic Processes (3rd Ed.), New Age International Publishers. 			
E-resources:			
https://archive.nptel.ac.in/courses/111/107/111107128/			

REPRESENTATION THEORY OF FINITE GROUPS (6.5MAT44)

Course Title:	Representation Theory of Finite Groups		
Course Code:	6.5MAT44		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	concepts of groups and module		
Course Objectives:			
1	To teach the students the representation theory of finite groups		
2	To teach the students the finite dimensional algebras		
3	To teach the students Maschke's Theorem		
4	To teach the students the character of the representation		
Course Outcomes: The students will be able to			
1	the concepts of Faithful Representation		
2	the group algebra		
3	the Schur's lemma		
4	the character of the representation		
Course Content:			
Unit	Content		Hours
I	Representation of into group of Matrices, Examples, Faithful Representation, Equivalent Representation, FG-module, Equivalent formulation of Representation as FG module		15
II	Permutation module, FG-submodule, Irreducible Representation, Group algebra, Regular FG-module, Action of FG on FG-module, FG-homomorphism, FG-isomorphism, Direct sum of FG-submodule.		15
III	Maschke's Theorem, Completely reducible FG-submodule, Schur's Lemma and its application, Representation of abelian groups, Irreducible submodules of CG-module, Composition factor,		15
IV	Character of the representation, class function, Character table, irreducible characters, degree of character, regular and permutation character, Orthogonality relation between characters.		15
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Burrow M., 1965, Representation Theory of Finite Groups, Academic Press.			
2. Jacobson N., 1983, Basic Algebra-II, Hindustan Publishing Corporation, New Delhi.			
3. Lang S., 2004, Algebra (3rd Ed.), Springer.			
4. Serre J. P., 1977, <i>Linear Representation of Groups</i> , Springer-Verlag.			
Reference Books:			
1. Dornhoff L., 1971, <i>Group Representation Theory-Part A</i> , Marcel Dekker, Inc., New York.			
E-resources:			
https://archive.nptel.ac.in/courses			

SPECIAL FUNCTIONS (6.5MAT45)

Course Title:	Special Functions		
Course Code:	6.5MAT45		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1	the fundamentals of special functions including Gamma functions,		
2	Riemann Zeta functions, Hypergeometric functions, Generalized Hypergeometric functions		
3	Bessel functions, Legendre polynomials, Hermite Polynomials and Laguerre Polynomials.		
Course Outcomes: The students will be able to			
1	Gamma functions		
2	Hypergeometric functions		
3	Basic theory, property and applications of special functions		
Course Content:			
Unit	Content		Hours
I	Infinite product of complex numbers, Factorization of entire functions, Gamma functions, Order symbols o and O , Beta functions, Euler reflection formula, Factorial function, Legendre's duplication formula, Gauss's multiplication formula, Integral representations for Gamma function and Beta functions, Walli's products, Stirling formula.		15
II	Asymptotic expansion, Riemann Zeta functions, Euler product formula, Riemann Functional equations, Riemann hypothesis, Gauss Hypergeometric Function, Elementary Properties, Conditions of convergence, Contiguous function relations, Integral Representation, Simple transformation, Quadratic transformation.		15
III	Generalized Hypergeometric Functions, Integral representation, Elementary Properties, Integral Representation, Legendre polynomials and functions, Solution of Legendre's differential equations, Generating Functions, Rodrigue's Formula, Orthogonality of Legendre polynomials, Recurrence relations.		15
IV	Bessel functions, Bessel differential equation and its solution, Recurrence relation, Generating functions, Integral representation, Hermite Polynomials, Laguerre Polynomials		15
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Rainville E. D., 1960, Special Functions, The MacMillan Comp. 2. Bell W.W., 1968, Special Functions for Scientists and Engineers, D. Van Nostrand Comp. Ltd. 3. Andrews G.E., Askey R. and Roy R., 1999, Special Functions, Encyclopedia of Mathematics and Its Applications, Cambridge University Press. 			
Reference Books:			
E-resources:			

CLASSICAL MECHANICS (6.5MAT46)

Course Title:	Classical Mechanics	
Course Code:	6.5MAT46	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks	Tutorial: 1
Total:		4
Course Prerequisite: The student should have knowledge of		
1	Basics of linear algebra, differential equations, and vector calculus.	
Course Objectives: To develop the concept of		
1	kinematics of particles, frame of references and relative changes in equation of motion and MI.	
2	of expressing kinetic energy and angular momentum about a fixed axis in terms of MI and in terms of Eulerian angle along with application of these.	
3	of generalized coordinates and degree of freedom and understanding the differences between Lagrangian dynamics and Hamiltonian dynamics.	
4	Hamilton's principle and its uses, applications of canonical transformations along with uses of Lagrange and Poisson brackets.	
Course Outcomes: The students will be able to		
1	know about the kinematics of particles, describe the relative changes in the equation of motion in different frames, and calculate moment of inertia of a given mass about a line.	
2	express kinetic energy and angular momentum of a mass about a fixed axis in terms of moment of inertia and in terms of Eulerian angle and use these expressions to describe the motion of Earth.	
3	recognize the degree of freedom of a mass in motion and formulate the motion of a rigid body using Lagrangian function and Hamiltonian function.	
4	use the Hamilton's principle, apply the canonical transformations and the Lagrange and Poisson brackets.	
Course Content:		
Unit	Content	Hours
I	Introduction of conservation laws, equation of motion of a particle, Simple pendulum, Harmonic oscillator, Motion of system of particles, Principle of angular momentum, Motion of a rigid body about a fixed axis, Moving frames of reference, Moments and products of inertia, moment of inertia of a body about a line through the origin, Momental ellipsoid, rotation of coordinate axes, principal axes and principal moments.	15
II	K.E. of rigid body rotating about a fixed point, angular momentum of a rigid body, Eulerian angle, angular velocity, K.E. and angular momentum in terms of Eulerian angle. Euler's equations of motion for a rigid body rotating about a fixed point, torque free motion, symmetrical rigid body, rotational motion of Earth. Attitudinal stability of Earth's satellite.	15
III	Classification of dynamical systems, Generalized coordinates systems, geometrical equations, Lagrange's equation for a simple system using D'Alembert principle, Deduction of equation of energy, deduction of Euler's dynamical equations from Lagrange's equations, Hamilton's equations, Ignorable coordinates, Routhian Function.	15
IV	Hamiltonian principle for a conservative system, principle of least action, Hamilton- Jacobi equation, Phase space and Liouville's Theorem, Canonical transformation and its properties, Lagrange brackets, and Poisson brackets, Poisson-Jacobi identity.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Milne E. A., 1965, <i>Vectorial Mechanics</i>, Methuen & Co. Ltd. London. 2. Kumar N., 2004, <i>Generalized Motion of Rigid Body</i>, Narosa Pub. House, New Delhi. 3. Rao K. S., 2009, <i>Classical Mechanics</i>, PHI learning Private Ltd., New Delhi. 4. Satya D. and Rahaman R., 2023, <i>Classical Mechanics: An Introduction</i>, Narosa Pub. House, New Delhi. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Ramsey A. S., 2017, <i>Dynamics (Part II)</i>, (2nd Ed.), CBS Publishers & Distributors, Delhi. 2. Goldstein H., 1990, <i>Classical Mechanics</i>, Narosa Publishing House, New Delhi. 		
E-resources:		
https://www.classcentral.com/course/rigid-body-dynamics-20108		

NUMERICAL LINEAR ALGEBRA (6.5MAT47)

Course Title:	Numerical Linear Algebra		
Course Code:	6.5MAT47		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	basic concepts in Linear Algebra, Matrices and Calculus		
Course Objectives:			
1	To introduce the fundamental notions of algebra of matrices and diagonalizability		
2	To teach the students different characterization of matrix decomposition		
3	To introduce computer arithmetic and numerical algorithms		
4	To learn singular value decomposition and use it to analyze the several properties of matrices.		
Course Outcomes: The students will be able to			
1	learn algebra of Matrices, significance and use of eigenvalue and eigenvectors		
2	explain different concepts about matrix decomposition		
3	learn computer arithmetic and numerical algorithms		
4	use different concepts associated with vector spaces, linear transformations, diagonalization		
Course Content:			
Unit	Content		Hours
I	Matrix operations and type of matrices, Determinant of a Matrix, Rank of a matrix, Vector Space, Linear dependence and independence, Bases and Dimensions, Linear, Transformation, Orthogonal subspaces, Row space, column space and null Space, Eigenvalues and Eigenvectors, Diagonalizable Matrices, Orthogonal Sets, Gram Schmidt orthogonalization and orthonormal bases		15
II	Vector Norm, Matrix Norms, Convergent Matrices, Stability of non-linear system, Condition number of a matrix: Elementary properties, Sensitivity analysis, Residual theorem, Nearness to singularity, Estimation of the condition number, Singular value decomposition of a matrix, Orthogonal Projections, Algebraic and geometric properties of matrices using SVD		15
III	SVD and their applications, Perturbation theorem for singular values, Outer product expansion of a matrix, Least square solutions, Pseudo-inverse and least square solution, Householder matrices and their applications, Householder QR factorization, Basic theorems on eigenvalues and QR method, Power method, Rate of convergence of Power method, Applications of Power method with shift, Jacobi method		15
IV	Introduction to Matlab, Sign integer representation, Computer representation of numbers, Floating point representation, Round-off error, Error propagation in computer arithmetic, Addition and multiplication of floating point numbers, Numerical algorithms for numerical methods for matrix eigenstructure, Stability of numerical algorithms.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. V. Sundarapandian, Numerical Linear Algebra, PHI, 2008. 2. Biswa Nath Dutta, Numerical Linear Algebra and Applications, SIAM, 2010. 3. Roger A. Horn and Charles R. Johnson, Matrix Analysis, Cambridge University Press, 1994 4. William Ford, Numerical Linear Algebra with Applications, Academic Press, 2014. 			
Reference Books:			
1.			
E-resources:			

SOBOLEV SPACES AND PDEs (6.5MAT48)

Course Title:	Sobolev Spaces and PDEs		
Course Code:	6.5MAT48		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	Basic knowledge of Functional Analysis (e.g. Banach and Hilbert spaces, linear operators, Lebesgue spaces etc).		
2	Undergraduate Calculus, Real Analysis and Partial Differential Equations etc.		
Course Objectives:			
1	Understand the theory of distributions.		
2	Understand the definition, properties and structure of Sobolev spaces.		
3	Explore the abstract variational problems and applications of Sobolev spaces in elliptic boundary value problems.		
4	Apply the Galerkin method and finite element method to approximate solutions to elliptic boundary value problems (BVPs).		
Course Outcomes: The students will be able to			
1	define and explain the concept of distributions.		
2	define Sobolev spaces, understand their basic properties, and explain their relevance in the context of boundary value problems.		
3	formulate elliptic boundary value problems as abstract variational problems and solve them using the Lax-Milgram Lemma, ensuring well-posedness.		
4	implement the Galerkin method, Finite element method and Variational method to find the weak solutions of elliptic BVPs.		
Course Content:			
Unit	Content		Hours
I	Theory of distributions: Motivation and applications of distributions (generalized functions), Distribution definition, Examples, test functions, distributional derivatives, support of distribution and properties, fundamental solutions, Shwartz spaces		15
II	Sobolev Spaces: Definition and basic properties, approximation by smooth functions, dual spaces, Poincare Inequality, trace and imbedding results		15
III	Elliptic Boundary value problems: Abstract variational problems, Lax-Milgram Lemma, weak solutions and well-posedness with examples, regularity result, maximum principles, eigenvalue problems		15
IV	Solution Methods: Galerkin method, finite element method and their applications in boundary value problems, Variational methods, Mountain Pass Lemma		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. S. Kesavan, Topics in functional analysis and applications, New Age International Private Limited, 2nd ed. 2015.			
2. H. Brezis, Functional Analysis, Sobolev Spaces and Partial Differential Equations, Springer, 2011.			
Reference Books:			
1. L.C. Evans, Partial Differential Equations, American Mathematical Society, Providence, 1998.			
2. R. C. McOwen, Partial Differential Equations: Methods and Applications, 2nd ed. Pearson, 2002.			
E-resources:			
https://archive.nptel.ac.in/courses/111/106/111106154/			

MEASURE THEORY AND INTEGRATION (6.5MAT49)

Course Title: Measure Theory and Integration	
Course Code: 6.5MAT49	
Teaching Scheme	Examination Scheme
Theory: 3 hours/ week	Internal Assessment: 40 Marks
Tutorial: 1 Hour/Week	ESE: 60 Marks
Total:	
Credits Allotted: 4	
Course Prerequisite: The student should have knowledge of	
1	Basic concepts of sets, functions and relations
Course Objectives:	
1	To provide motivation for topology through geometry.
2	To develop understanding of geometric and topological properties.
3	To develop understanding of the concepts of general topology as simply as possible.
Course Outcomes: The students will be able to understand	
1	what are objects of study in topology and geometry?
2	the concepts and topics in hand without haste;
3	the significance of the concepts defined, and the theorems proved here;
4	how this course is useful in other courses e.g., analysis, geometry and algebraic topology.
Course Content:	
Unit	Content
I	Countable and uncountable sets, cardinality and cardinal arithmetic, Schroder–Bernstein theorem, the Cantor’s ternary set, Semi-algebras, Algebras, Monotone class, Measure and outer measures, Carathe dory extension process of extending a measure on a semi-algebra to generated algebras.
II	Borel sets and their measurability, Lebesgue outer measure and Lebesgue measure on R, Translation invariance of Lebesgue measure, Existence of a non-measurable set, Characterizations of Lebesgue measurable sets
III	The Cantor-Lebesgue function, Measurable functions on a measure space and their properties, Borel and Lebesgue measurable functions, Characteristic function, Simple functions and their integrals, Continuous function, Sequence of functions, Convergence in measure. Littlewood’s three principles (statement only).
IV	Lebesgue integral on R and its properties, Bounded convergence theorem, Fatou’s lemma, Lebesgue monotone convergence theorem, Lebesgue dominated convergence theorem, L^p -spaces, Holder-Minkowski inequalities, parseval’s identity, Riesz Fisher’s theorem.
	Hours
	15
	15
	15
	15
Internal Assessment:	
CIA-I	Unit -I
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III
ESE	Unit-I, II, III, IV
CIA: Continuous Internal Assessment, ESE: End Semester Examination	
Textbooks:	
<ol style="list-style-type: none"> 1. Royden H. L. and Fitzpatrick P. M., 2010, Real Analysis (4th Ed.), PHI. 2. Halmos P. R., 1994, Measure theory, Springer. 3. Hewit E. and Stromberg K., 1975, Real and abstract analysis, Springer. 4. Parthasarathy K. R., 2005, Introduction to probability and measure, Hindustan Book Agency. 5. Rana I. K., 2005, An introduction to measure and integration (2nd Ed.), Narosa Publishing House. 	
Reference Books:	
E-resources:	

ADVANCED REAL ANALYSIS (7.0MAT31)

Course Title:		ADVANCED REAL ANALYSIS	
Course Code:		7.0MAT31	
Teaching Scheme		Examination Scheme	
Theory: 3 hours/ week		Internal Assessment: 40 Marks	
Tutorial: 1 Hour/Week		ESE: 60 Marks	
		Credits Allotted	
		Theory: 3	
		Tutorial: 1	
		Total: 4	
Course Prerequisite:			
1 Basic knowledge of Mathematical Analysis			
Course Objectives:			
1.	The course covers advanced metric space properties		
2.	The course covers advanced Riemann integrability		
3.	The course covers Cesaro's Method of Summability and Fourier Series		
Course Outcomes: Students will be able to			
1.	define the advanced properties in metric space		
2.	find the Riemann integrals using Lebesgue's criterion		
3.	find the bounded variations		
4.	classify the Cesaro's Method of Summability and Fourier Series.		
Course Content:			
Unit	Content	Hours	
I	Metric spaces revisited; Baire Category theorem, completion of Metric spaces, Banach contraction principle and some of its applications. Compactness, Total boundedness, characterization of compactness for arbitrary Metric spaces; Arzella-Ascoli theorem, Stone Weierstrass theorem.	15	
II	Integrations : Lebesgue's criterion of Riemann integrability over a bounded closed interval [a, b] and its consequence, length of a rectifiable curve in a plane, Riemann-Stieltjes integral over [a, b] and its properties.	15	
III	Integrators of bounded variation, Integration by parts, Stieltjes integral as a Riemann integral, Step function as integrator, Riesz theorem.	15	
IV	Cesaro's Method of Summability and Fourier Series: Cesaro's method of summability of order 1 and order 2, Some specific examples, Regularity of Cesaro's method, Definition of Fourier series and some examples, Dirichlet's Kernel, Fejer's Kernel, Fejer's theorem, Dini's and Jordan's tests for point wise convergence of Fourier series.	15	
Internal Assessment:			
CIA*-1	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit-II and III		
EoSE**	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Bruckner, A. M., Bruckner J., Thomson B., 1997, <i>Real Analysis</i> , Prentice-Hall, N.Y.			
2. Goldberg, R. R., 1970, <i>Methods of Real Analysis</i> , Oxford-IBH, New Delhi.			
3. Natanson, I. P., 1955, <i>Theory of Functions of a Real Variable</i> , Vol-I, F.Ungar, N.Y.			
4. Hewitt, E., Stromberg, K., 1965, <i>Real and Abstract Analysis</i> , John-Willey, N.Y.			
Reference Books:			
1. Randolph J. F., 1968, <i>Basic Real and Abstract Analysis</i> . Academic Press, N.Y.			
2. Jain P. K., Ahmad K., 1996, <i>Metric Spaces</i> , Narosa Publishing House.			
3. Tolstov G., 1962, <i>Fourier Series</i> , Dover Publication, N.Y.			
E-resources:			
https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-ma63			

ADVANCED NUMERICAL METHODS (7.0MAT32)

Course Title:	ADVANCED NUMERICAL METHODS	
Course-Code:	7.0MAT32	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
		Total: 4
Course Prerequisite:		
1.	Basic knowledge of numerical analysis	
Course Objectives:		
1.	The course covers advanced methods for solving the system of equations,	
2	The course covers advanced methods to solve eigenvalue problems, numerically.	
3	The course covers advanced methods to solve IVP and BVP, numerically.	
Course Outcomes: Students will be able to		
1.	find the zeros of nonlinear equations	
2.	find the solution of system of equations	
3.	find the solutions of BVP governed by ODE, numerically	
4.	find the solutions of IVP and BVP governed by PDE, numerically.	
Course Content:		
Unit	Content	Hours
I	Numerical solution of algebraic and transcendental equations: Introduction- iteration method, Newton-Raphson method, Graeffe's root square method, acceleration of convergence. Numerical Solution of systems of nonlinear equations: iteration method, Newton-Raphson method.	15
II	Linear Systems of equations: Introduction- Gauss elimination method, LU decomposition, Solution of tridiagonal system, Ill-conditioned linear systems and method for Ill-conditioned matrix. EigenValue problem: Power method, Jacobi Method, Householder method.	15
III	Introduction- finite difference formulas. Boundary value problem: Introduction, BVP governed by second order ordinary differential equations, Finite difference method, shooting method, cubic splines method.	15
IV	IVP and BVP in partial differential equations: classification of linear second order partial differential equations, Finite difference methods for Laplace and Poisson equations - Jacobi method, Gauss-Seidel method and ADI (alternating direction implicit) method , Finite difference method for heat conduction equation - Bender- Schmidt recurrence relation, Crank-Nicolson formula, and Jacobi Iteration formula, Finite difference method for wave equation.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Atkinson K. E., 1989, <i>An Introduction to Numerical Analysis (2nd Ed.)</i>, Wiley-India. 2. Sastry S. S., 2012, <i>Introductory Methods of Numerical Analysis (5th Ed.)</i>, Eastern Economy Edition. 3. Jain M. K., Iyengar S. R. K., Jain R. K., 2012, <i>Numerical Methods for Scientific and Engineering Computation (6th Ed.)</i>, New Age International Publishers. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Buchaman J. I., Turner P. R., 1992, <i>Numerical Methods and Analysis</i>, McGraw-Hill. 		
E-resources:		
https://archive.nptel.ac.in/courses/111/107/111107105/		

COMPLEX DYNAMICS (7.0MAT33)

Course Title:	COMPLEX DYNAMICS	
Course Code:	7.0MAT33	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
		Total: 4
Course Prerequisite: The student should have knowledge of		
1.	Complex analysis	
Course Objectives:		
1.	To teach students bilinear transformation of complex functions	
2.	To teach students Fatou sets and Julia sets	
3.	To teach students the Euler characteristic, Riemann Hurwitz formula for covering maps	
Course Outcomes: Students will be able to		
1.	classify the bilinear transformation of complex functions	
2.	explain Fatou sets and Julia sets	
3.	explain the Euler characteristic, Riemann Hurwitz formula for covering maps.	
Course Content:		
Unit	Content	Hours
I	Iteration of a Mobius transformation, attracting, repelling and indifferent fixed points. Iterations of $R(z) = z^2, z^2+c, z + \cdot$. The extended complex plane, chordal metric, spherical metric, rational maps, Lipschitz condition, conjugacy classes of rational maps, valency of a function, fixed points, Critical points, Riemann Hurwitz relation.	15
II	Equicontinuous functions, normality sets, Fatou sets and Julia sets, completely invariant sets, Normal families and equicontinuity, Properties of Julia sets, exceptional points Backward orbit, minimal property of Julia sets.	15
III	Julia sets of commuting rational functions, structure of Fatou set, Topology of the Sphere, Completely invariant components of the Fatou set.	15
IV	The Euler characteristic, Riemann Hurwitz formula for covering maps, maps between components of the Fatou sets, the number of components of Fatou sets, components of Julia sets.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Beardon, A.F. 1991, <i>Iteration of rational functions</i>, Springer Verlag, New York. 2. Carleson, L., Gamelin, T. W. 1993, <i>Complex dynamics</i>, Springer Verlag. 3. Morosawa, S., Nishimura, Y., Taniguchi, M., Ueda, T., 2000, <i>Holomorphic dynamics</i>, Cambridge University Press. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Hua, H.X., Yang, C. C., 1998, <i>Dynamics of transcendental functions</i>, Gordon and Breach Science Pub. 		
E-resources:		
https://archive.nptel.ac.in/courses/111/106/111106141		

NUMBER THEORY (7.0MAT34)

Course Title:	NUMBER THEORY	
Course Code:	7.0MAT34	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
		Total: 4
Course Prerequisite: The student should have knowledge of		
1.	Elementary Number Theory	
Course Objectives:		
1	To teach the students approximation of real numbers	
2	To teach the students the Diophantine equations	
3	To teach the students the arithmetic functions	
4	To teach the students Chebychev's theorems	
Course Outcomes: Students will be able to learn		
1.	the concepts of continued fractions	
2	the Waring's problem	
3	the Fibonacci series	
4	the Prime number theorem	
Course Content:		
Unit	Content	Hours
I	Jacobi's Symbol, Kronecker Symbol, Approximation of real number, Farey Sequence, Approximation by rational numbers, Continued fractions	15
II	Diophantine equation $ax^2 + by^2 + cz^2 = 0$, sum of three squares, Pell's equation, Fundamental solutions, General (Diophantine) equation of second degree, Waring's problem	15
III	Review of arithmetic functions, Character modulo k, Principal character, Additive arithmetic functions, Linear recurrence, Fibonacci series, Bonnet formula	15
IV	Bertrand's postulate, Chebychev's theorems, The function $\pi(x)$, Von Mangoldt function, Merten's theorems, Prime number theorem (statement only)	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
1. Redmond D., 1996, <i>Number Theory An Introduction</i> , Marcel Dekker, New York.		
2. Shockley J. E., 1967, <i>Introduction to Number Theory</i> , Holt, Rinehart and Winston Inc., New York.		
Reference Books:		
1. Nathanson M. B., 2000, <i>Elementary Methods in Number Theory</i> , Springer, New York		
E-resources:		
https://archive.nptel.ac.in/courses/		

NONLINEAR SYSTEMS & CONTROLS (7.0MAT35)

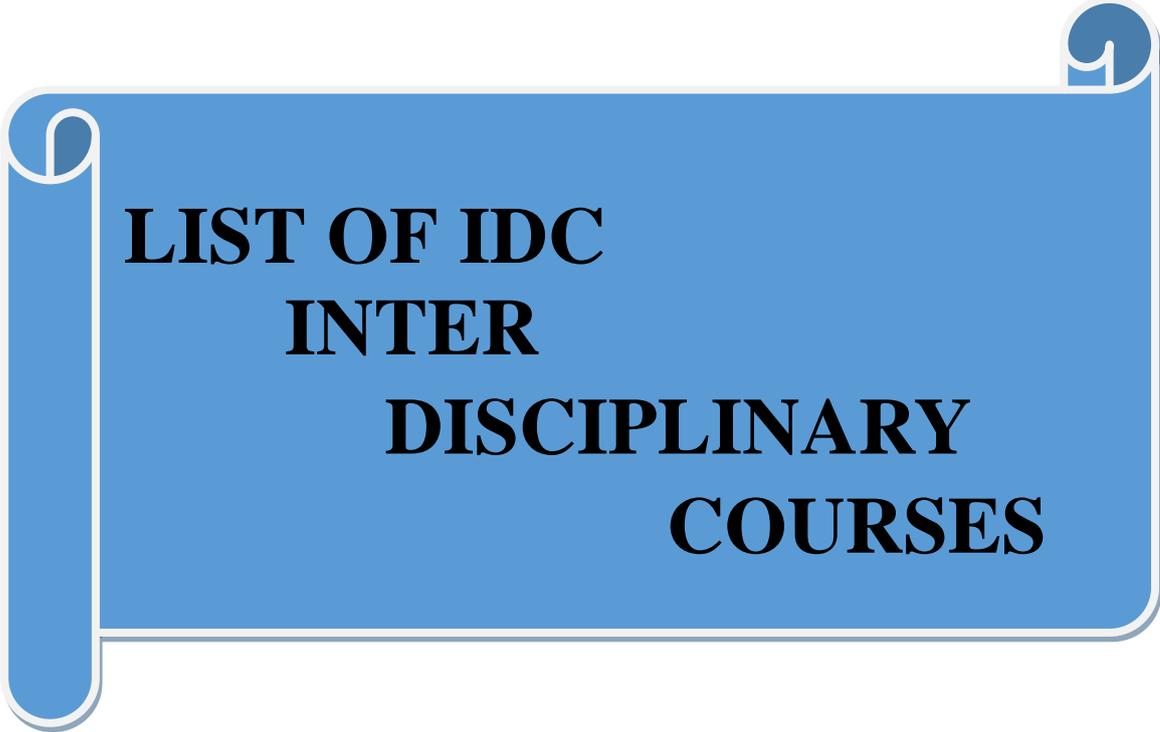
Course Title:	NONLINEAR SYSTEMS & CONTROLS	
Course-Code:	7.0MAT35	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/ week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 1 Hour/Week	ESE: 60 Marks	Tutorial: 1
		Total: 4
Course Prerequisite: Students should have knowledge of		
1.	Differential Equations and Calculus	
Course Objectives:		
1.	To introduce control theory followed by dynamical system theory	
2.	To teach different concepts in dynamical system theory	
3.	To teach Lyapunov functions and Poincare-Bendixon's theorem	
4.	To introduce two dimensional systems and associated bifurcations	
5.	To discuss different topics in control theory	
Course Outcomes: Students will be able to learn		
1.	different topics in dynamical systems and control theory	
2.	stability theory associated with dynamical systems	
3.	Lyapunov stability-I and Lyapunov stability-II.	
4.	several important aspects related to control systems	
5.	different applications of control theory in computing, communications, and sensing technologies that present unprecedented opportunities to impact the economic and scientific development of a particular nation and the world.	
Course Content:		
Unit	Content	Hours
I	Formulation of physical systems, Existence and Uniqueness theorems, Linear systems, Solution of linear systems, Fundamental matrix, autonomous systems, solution of non-homogeneous systems, Fundamental matrices for Non- autonomous systems, solution of non-homogeneous systems.	15
II	Stability of systems: equilibrium points, stability of linear autonomous systems, Stability of linear systems, Stability of weakly non-linear systems, Linearization, Properties of phase portrait, Properties of Orbits, Phase portrait: Types of critical points, Phase portrait of linear differential equations, Poincare Bandixon's theorem, Limit cycle, Lyapunov stability-I, Lyapunov stability-II.	15
III	Introduction of control systems, Controllability of autonomous systems, Controllability of non-autonomous systems, Observability, Results on controllability and observability, Companion form, Feedback Control, State Observer, Stabilizability, Introduction to discrete systems, Lyapunov stability-I, Lyapunov stability-II, Lyapunov stability-III.	15
IV	Optimal Control, Optimal Controls for Discrete systems, Controllability of discrete systems, Observability of discrete systems-I, Stability for discrete systems, Relation between continuous and discrete systems-II.	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III	
ESE	Unit-I, II, III, IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Barun M. 2011, <i>Differential Equations and Their Applications</i>, Springer. 2. Barnett S., 1990, <i>Introduction to Mathematical Control Theory</i>, Oxford University Press. 3. Naidu R.D.S., 2010, <i>Optimal Control Systems</i>, CRC Press. 4. Lakshmikantham, V., Raghvendra, V., 2005, <i>Text Book of Ordinary Differential Equations</i>, TMH. 5. Gopal, M., 1994, <i>Modern Control Systems</i>, John Wiley and Sons. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Simmons G.F., 203, <i>Ordinary Differential Equations</i>, Tata McGraw Hill. 2. Deo, S.G., Lakshminkantahm, V.,, Raghbendra, V., 2020, <i>Text Book of of Ordinary Differential Equations</i>. 		
E-resources:		
https://onlinecourses.nptel.ac.in/noc20_ma46/preview		

CELESTIAL MECHANICS (7.0MAT36)

Course Title:	Celestial Mechanics		
Course Code:	7.0MAT36		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 1 hour/week	ESE: 60 Marks		Tutorial: 1
Total:			4
Course Prerequisite: The student should have knowledge of			
1	Basics of linear algebra, analytical geometry, differential equations, and vector calculus.		
Course Objectives:			
1	motion of space objects via Kepler's laws of planetary motion and Newton's laws of motion and visualization of different paths/orbits of moving mass.		
2	moving frame of reference and its relation to fixed frame along with formulation and special solutions and applications of three body problems.		
3	stable/unstable equilibrium points and their applications along with formulation and applications of different kinds of restricted three body problems.		
4	different kinds of perturbations in space and their impacts on small space objects (e.g. asteroid, satellite, space craft etc.) along with normal form and its application.		
Course Outcomes: The students will be able to			
1	learn about planetary motion of space objects and visualize their orbits/paths.		
2	know the need of different kinds of frames of reference and understand the formulation and importance of special solutions of three body problems.		
3	verify the stable/unstable equilibrium points and understand the applications of stable points along in addition with applications of different kinds of restricted three body problems.		
4	understand about the different kinds of perturbations in space and their impacts on small space objects (e.g. asteroid, satellite, space craft etc.) along with application of normal form for stable motion.		
Course Content:			
Unit	Content		Hours
I	Introduction, Kepler's Laws of Planetary Motion, Central force motion, Differential equation of orbit, Inverse square force and Geometry of orbits, Relative motion in two body problem, Earthbound satellite circular orbit, Classical orbital elements, Kepler's equation and its applications.		15
II	Moving frame of reference, Derivative of a vector in a rotating frame, motion of a mass relative to rotating frame, Uniform rotating frame, General three body problem, Integrals of motion, Lagrange's special solutions.		15
III	Circular RTBP, Lagrangian points and their stability, Zero velocity curves, Elliptic RTBP, Equilibrium points, Existence of ZVC, Introduction of Robe's RTBP, Hill's problem, Sitnikov problem and their applications.		15
IV	Introduction of perturbations factors, potential of oblate body, effective force of radiating body, potential due to disc or belt like structure. Introduction of normal form, Hamiltonian function, Normalization of Hamiltonian function of Circular RTBP and its applications.		15
Internal Assessment:			
CIA-I	Unit I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit II and III		
ESE	Written Exam. for Unit-I, II, III, & IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. McCuskey S. W., 1963, Introduction to Celestial Mechanics, Addison-Wesley Publishing Company. 2. Murray C. D. and Dermott S.F., 2000, Solar System Dynamics, Cambridge University Press. 3. Strogatz S.H., 1994, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering, Addison-Wesley. 4. Rao K.S., 2009, Classical Mechanics, PHI Learning, Pvt. Ltd. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Moulton F.R., 1914, An Introduction to Celestial Mechanics, the MacMillan Company. 2. Szebehely V., 1967, Theory of orbits. The restricted problem of three bodies, New York Acad. Press. 			
E-resources			
https://mitpress.mit.edu/9780262080484/celestial-mechanics/			

ADVANCED COMPLEX ANALYSIS (7.0MAT37)

Course Title:		Advanced Complex Analysis	
Course Code:		7.0MAT37	
Teaching Scheme		Examination Scheme	
Theory: 3 hours/week		Internal Assessment: 40 Marks	
Tutorial: 1 hour/week		ESE: 60 Marks	
		Total:	4
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1 To teach some topics of contemporary complex analysis.			
2 To prepare the student to independent work in these topics			
3 To teach the methods of complex analysis in other areas of mathematics.			
Course Outcomes: The students will be able to			
1 basic techniques of contemporary complex analysis			
2 applications of these techniques in harmonic analysis			
3 univalent functions theory and special functions			
Course Content:			
Unit	Content		Hours
I	Liouville's theorem and its different proofs, Picard's little theorem, Picard's great theorem, Weierstrass form of Picard's great theorem, Casorati-Weierstrass theorem, Harmonic conjugate, Transformation of harmonic functions, Transformations of boundary conditions.		15
II	Applications of conformal mappings, Steady temperatures, Steady temperature in a half plane and related problems, Electrostatic Potentials, Potential in cylindrical space, Open mapping theorem, Hurwitz' theorem, Analytic continuation, Direct analytic continuation Poisson integral formula, Dirichlet problem.		15
III	Infinite sums, Mittag-Leffler theorem, Infinite product of complex numbers, Convergence of infinite products, Infinite product of analytic functions, Factorization of entire functions, Gamma functions, Riemann Zeta functions, Euler product formula, Riemann Functional equations, Riemann hypothesis.		15
IV	Univalent functions, Basic results of univalent functions, Class S , Area theorem, Biberbach theorem and conjecture, Koebe $1/4$ theorem, Riemann mapping theorem.		15
Internal Assessment:			
CIA-I	Unit -I, II		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce based on Unit III		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Brown J.W., and Churchill R.V., 2009, Complex Variables and Applications, McGraw Hill.			
2. Ponnusamy S., 2005, Foundations of Complex Analysis, Narosa Publication House.			
3. Kasana H.S., 2005, Complex Variables: Theory and Applications, PHI.			
Reference Books:			
1. Theodore G., 2003, <i>Complex Analysis</i> , Springer			
E-resources:			
https://archive.nptel.ac.in/courses/111/106/111106084/			



**LIST OF IDC
INTER
DISCIPLINARY
COURSES**

MATHEMATICS-I FOR LIFE SCIENCE (4.5MAT81)

Course Title:	MATHEMATICS-I FOR LIFE SCIENCE	
Course Code:	4.5MAT81	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks	Theory: 3
Tutorial: 0 hour/week	ESE: 60 Marks	Tutorial: 0
Total:		3
Course Prerequisite: The student should have knowledge of		
1		
Course Objectives: To prepare the students with		
1	knowledge of set theory calculus such as functions, limit, continuity, differentiability, integration and differential equations.	
Course Outcomes: The students will be able to		
1	reasonable knowledge of set theory calculus such as functions, limit, continuity, differentiability, integration and differential equations.	
Course Content:		
Unit	Content	Hours
I	Sets and relations, functions and their graphical representations, trigonometric functions, exponential and logarithmic functions, permutations and combinations, principle of mathematical induction, binomial theorem, arithmetic and geometric progression, complex numbers and algebra of complex numbers.	10 Hours
II	Limit, continuity, differentiability, derivative of functions in parametric forms, increasing and decreasing functions, maxima and minima, Rolle's theorem, Lagranges mean value theorem	12 Hours
III	Integration as inverse process of differentiation, methods of integration, integral of some standard functions	12 Hours
IV	definite integrals, fundamental theorem of calculus, some properties of definite integrals, simple applications of integrals such as finding area under a curve.	11 Hours
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
1. Mathematics text book for class XI, NCERT. 2. Mathematics text book for class XII, Part I, NCERT. 3. Mathematics text book for class XII, Part II, NCERT.		
Reference Books:		
1. Shanti Narayan, Differential calculus.		
E-resources:		

MATHEMATICS-II FOR LIFE SCIENCE (4.5MAT82)

Course Title:	MATHEMATICS-II FOR LIFE SCIENCE		
Course Code:	4.5MAT82		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 0 hour/week	ESE: 60 Marks		Tutorial: 0
Total:			3
Course Prerequisite: The student should have knowledge of			
1	Mathematics-II for Life Science		
Course Objectives:			
1	knowledge on matrices, determinant, coordinate geometry of two and three dimension and a feel on probability and statistics.		
Course Outcomes: The students will be able to			
1	reasonable knowledge on matrices, determinant, coordinate geometry of two and three dimension and a feel on probability and statistics.		
Course Content:			
Unit	Content		Hours
I	Matrices, different types of matrices, operations of matrices, invertible matrices, transpose of a matrix. Determinants, properties of determinants, minors and cofactors, adjoint and inverse of a matrix, applications of determinants and matrices.		10 Hours
II	Slope of a line, various forms of equation of a line, general equation of a line, distance of a point from a line, conic sections, circle, and parabola.		11 Hours
III	Probability and statistics, range, mean, median, mode, variance and standard deviation, analysis of frequency distributions, conditional probability		12 Hours
IV	multiplication theory on probability, independent events, Baye's theorem, random variables and its probability distribution, Bernoulli trials and binomial distributions.		12 Hours
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Mathematics text book for class XI, NCERT. 2. Mathematics text book for class XII, Part I, NCERT. 3. Mathematics text book for class XII, Part II, NCERT.			
Reference Books:			
1. Shanti Narayan, Differential calculus.			
E-resources:			

INVITATION TO MATHEMATICS, CURVES AND SURFACES (5.0MAT81)

Course Title:	Invitation to Mathematics, Curves and Surfaces		
Course Code:	5.0MAT81		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 0 hour/week	ESE: 60 Marks		Tutorial: 0
Total:			3
Course Prerequisite: The student should have knowledge of			
1	Calculus and elementary mathematics		
Course Objectives:			
1	To introduce fundamental concepts in Mathematics with more precise and advanced way		
2	To make the students learn about polynomials in several variables and counting of monomials		
3	To introduce different concepts in matrices and linear transformations		
4	To introduce curve and surfaces in 2-dimensional and 3-dimensional spaces		
5	To discuss the use of different concepts from differential geometry in the study of curves and surfaces		
Course Outcomes: The students will be able to			
1	different topics in Mathematics including polynomials in several variables		
2	different concepts associated with a linear transformation, Transformations in Euclidean Geometry.		
3	curves, surfaces and different associated concepts		
4	curves and surfaces in R^3		
Course Content:			
Unit	Content		Hours
I	Polynomials: Interpolation, Taylor's formula, Polynomials with integer values, Polynomials in several variables, Counting monomials, Counting Principles: Basic methods, the Pigeonhole principle, the Binomial theorem, Permutations, Graphs, Recurrence relations, Bijective proofs, Functions: Continuous functions, the Intermediate value property and its applications, Fixed points, Linear transformations of the plane.		15
II	The Derivative and dilations, Higher order derivatives and the binomial theorem, Polynomial approximation to functions, Matrices: Matrices and transformations, Multiplication vs composition, Determinants as dilation factors, Polynomials applied to matrices, Matrices in probability theory. Matrices in Polynomial interpolation, the Vandermonde determinant, Conservation laws: Invariants of transformations, Discrete transformations, and applications, Transformations in Euclidean Geometry- circle inversions.		15
III	Curves in R^2 and R^3 : : Level curves and locus, definition of parametric curves, tangent, arc length, arc length parameterization, How much a curve is 'curved', signed unit normal and signed curvature, rigid motions, constant curvature. Curves in R^3 , principal normal and bi normal, torsion, Curves in R^3 , principal normal and bi-normal, torsion. Frenet Serret formula, simple closed curve and isoperimetric inequality, Smooth surfaces, Surfaces and parametric surfaces, examples, regular surface and non-example of regular surface, transition maps, Transition maps of smooth surfaces, smooth function between surfaces, diffeomorphism.		15
IV	First Fundamental Form, Surfaces of revolution, quadratic surfaces, First Fundamental Form, isometry, Conformal maps, Examples, : Curvature, normal curvature. Principal curvatures, Euler's Theorem. Geometry of principal curvatures, Geodesics, Clairaut's Theorem.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Montiel S., Ross A., 2009, Curves and Surfaces, American Mathematical Society			
2. Schleicher D., Luckmann, 2011, An invitation to Mathematics: From Competition to Research, Springer.			
3. Raussne M., 2008, Elementary Differential Geometry: Curves and Surfaces, Springer			
4. Dresden A., 1882, An invitation to Mathematics, New York, H. Holt and Company.			
Reference Books:			
1. Abate A., Tovenia F., , 2012, Curves and surfaces, Springer			
E-resources:			

MATHEMATICS IN INDIA FROM VADIC PERIOD TO MODERN TIME (5.0MAT82)

Course Title:	Mathematics in India From Vadic Period to Modern Time		
Course Code:	5.0MAT82		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 3 hours/week	Internal Assessment: 40 Marks		Theory: 3
Tutorial: 0 hour/week	ESE: 60 Marks		Tutorial: 0
Total:			3
Course Prerequisite: The student should have knowledge of			
1	Prior exposure is not required		
Course Objectives:			
1	To provide a glimpse of how various important mathematical ideas got evolved in India over several millennia		
2	To the study of some of the finest intellectual achievements of humanity		
3	To introduce in a balanced manner the primary source material (Sanskrit text) in which the technical ideas have been expressed		
4	To discuss numbers in the Vedas, details of construction of geometrical figures		
5	To discuss the development of mathematics in modern India , especially highlighting the work of Srinivasa Ramanujan		
Course Outcomes: The students will be able to			
1	how some of the most fundamental concepts and ideas in mathematics--- starting from the decimal-place-value system to expressing a finite quantity in terms of an infinite series, as well as the foundations of calculus---got originated in India.		
2	the details of arithmetic, algebra, geometry, trigonometry and combinatorics, as discussed in the works of Aryabhata, Brahmagupta, Mahavira, Bhaskaracharya and Narayana Pandita.		
3	the development of ideas and techniques of calculus and spherical trigonometry.		
4	how mathematics and its practice are deeply connected with culture.		
Course Content:			
Unit	Content		Hours
I	Introductory Overview (MDS), Vedas and Sulbasutras, Panini's Astadhyayi, Pingala's Chandahsastra, Decimal place value system, Aryabhata of Aryabhata		15
II	Aryabhata of Aryabhata and Introduction to Jaina Mathematics, Brahmasphutasiddhanta of Brahmagupta, Brahmasphutasiddhanta of Brahmagupta and The Bakhshali Manuscript, Mahavira's Ganitasarasangraha, Development of Combinatorics		15
III	Lilavati of Bhaskaracharya, Bijaganita of Bhaskaracharya, Ganitakaumudi of Narayana Pandita, Magic Squares, Development of Calculus in India.		15
IV	Jyanayanam: Computation of Rsines, Trigonometry and Spherical Trigonometry, Proofs in Indian Mathematics, Mathematics in Modern India.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
<ol style="list-style-type: none"> 1. Iyengar, C.N.S., 1967, History of Indian Mathematics, World Press, Calcutta. 2. Bag, A.K., <i>Mathematics in Ancient and Medieval India</i>, Choukhambha, Varanasi. 3. Datta, B., Singh, A.N., 2004, <i>History of Hindu Mathematics</i>, Bharatiya Kala Prakashan, New Delhi. 4. Emch, G.G., Srinivas M.D., Sridharan, R., 2005, <i>Contributions to the History of Mathematics in India</i>, Hindustan Book Agency, New Delhi. 			
Reference Books:			
<ol style="list-style-type: none"> 1. Seshadri, C.S., 2011, Studies in History of Indian Mathematics, Hindustan Book Agency, New Delhi. 			
E-resources:			
https://nptel.ac.in/courses/111101080			

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**LIST OF SEC
SKILL
ENHANCEMENT
COURSES**

SOFTWARE TOOLS BASED ON 4.5MAT01 (4.5MAT83)

Course Title:	Software Tools Based on 4.5MAT01		
Course Code:	4.5MAT83		
Teaching Scheme		Examination Scheme	Credits Allotted
Theory: 2 hours/week		Internal Assessment: 40 Marks	Theory: 2
Practical: 2 hour/week		ESE: 60 Marks	Practical: 1
Total:			3
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1 knowledge and techniques of professional practices in software processes and activities.			
2 how to use software for analytical programming.			
3 how to implement data structure in software.			
4 how to use software for mathematics course.			
Course Outcomes: The students will be able to			
1 Implement various algorithms in mathematical course.			
2 Analyze the performance of various algorithms.			
3 Identify, formulate, and solve complex engineering problems			
Course Content:			
Unit	Content		Hours
I	Introduction to software user interface, creating variables, analyzing vectors and matrices, visualizing vector and matrix data, working with data files and data types.		15
II	Introduction to mathematical function library contains elementary functions like sum, multiple, trigonometry, matrix, eigenvalues and others.		15
III	This unit demonstrate the application of the software for unit-I and II of course MAT101		15
IV	This unit demonstrate the application of the software for unit-III and IV of course MAT101		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
Reference Books:			
E-resources:			

SOFTWARE TOOLS BASED ON 4.5MAT02 (4.5MAT84)		
Course Title:	Software Tools Based On 4.5MAT02	
Course Code:	4.5MAT84	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 2 hours/week	Internal Assessment: 40 Marks	Theory: 2
Practical: 2 hour/week	ESE: 60 Marks	Practical: 1
Total:		3
Course Prerequisite: The student should have knowledge of		
1		
Course Objectives:		
1	knowledge and techniques of professional practices in software processes and activities.	
2	how to use software for analytical programming.	
3	how to implement data structure in software.	
4	how to use software for mathematics course.	
Course Outcomes: The students will be able to		
1	Implement various algorithms in mathematical course.	
2	Analyze the performance of various algorithms.	
3	Identify, formulate, and solve complex engineering problems	
Course Content:		
Unit	Content	Hours
I	Introduction to software user interface, creating variables, analyzing vectors and matrices, visualizing vector and matrix data, working with data files and data types.	15
II	Introduction to mathematical function library contains elementary functions like sum, multiple, trigonometry, matrix, eigenvalues and others.	15
III	This unit demonstrate the application of the software for unit-I and II of course MAT102	15
IV	This unit demonstrate the application of the software for unit-III and IV of course MAT102	15
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I,II,III,IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
Reference Books:		
E-resources:		

SOFTWARE TOOLS BASED ON 5.0MAT02 (5.0MAT83)

Course Title:	Software Tools Based on 5.0MAT02		
Course Code:	5.0MAT83		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 2 hours/week	Internal Assessment: 40 Marks		Theory: 2
Practical: 2 hour/week	ESE: 60 Marks		Practical: 1
Total:			3
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1	knowledge and techniques of professional practices in software processes and activities.		
2	how to use software for analytical programming.		
3	how to implement data structure in software.		
4	how to use software for mathematics course.		
Course Outcomes: The students will be able to			
1	Implement various algorithms in mathematical course.		
2	Analyze the performance of various algorithms.		
3	Identify, formulate, and solve complex engineering problems		
Course Content:			
Unit	Content		Hours
I	Introduction to software user interface, creating variables, analyzing vectors and matrices, visualizing vector and matrix data, working with data files and data types.		15
II	Introduction to mathematical function library contains elementary functions like sum, multiple, trigonometry, matrix, eigenvalues and others.		15
III	This unit demonstrate the application of the software for unit-I and II of course MAT104		15
IV	This unit demonstrate the application of the software for unit-III and IV of course MAT104		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
Reference Books:			
E-resources:			

INTRODUCTION TO SCILAB (5.0MAT84)

Course Title:	Introduction To SciLab		
Course Code:	5.0MAT84		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 2 hours/week	Internal Assessment: 40 Marks		Theory: 2
Practical: 2 hour/week	ESE: 60 Marks		Practical: 1
Total:			3
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1	To introduce SciLab as software tool.		
2	To learn different types of plots.		
3	To learn programming in SciLab.		
Course Outcomes: The students will be able to			
1	understand various SciLab commands		
2	plot different 2D and 3D graphs		
3	Develop SciLab programmes		
Course Content:			
Unit	Content		Hours
I	Introduction to Scilab, installation, SciNotes, files formatting, local and global variables, predefined constants, constants, common mathematical functions, variable assignment operator, data types, floating points, number formats, Boolean data strings.		15
II	Introduction of loops, while loop, infinite loops, for loop, if-else, arrays, vectors, operations, vector element wise operations.		15
III	Matrix multiplication, inverse of matrices, vector random matrix, row and columns addition and deletion, vector matrix manipulations, matrix reshaping, upper and lower triangular matrices.		15
IV	Introduction to 2D plotting, 3D plotting, multiple plots in same graph, multiple plots, formatting, editing of graphs.		15
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Mathieu, P., and Roux, P., <i>Scilab: I. Fundamentals</i> , Scilab Enterprises, 2016.			
2. Affouf, M., <i>Scilab by Example</i> , Create Space Independent Pub. Platform, 2012.			
Reference Books:			
E-resources:			

INTERNSHIP (5.5MAT81)

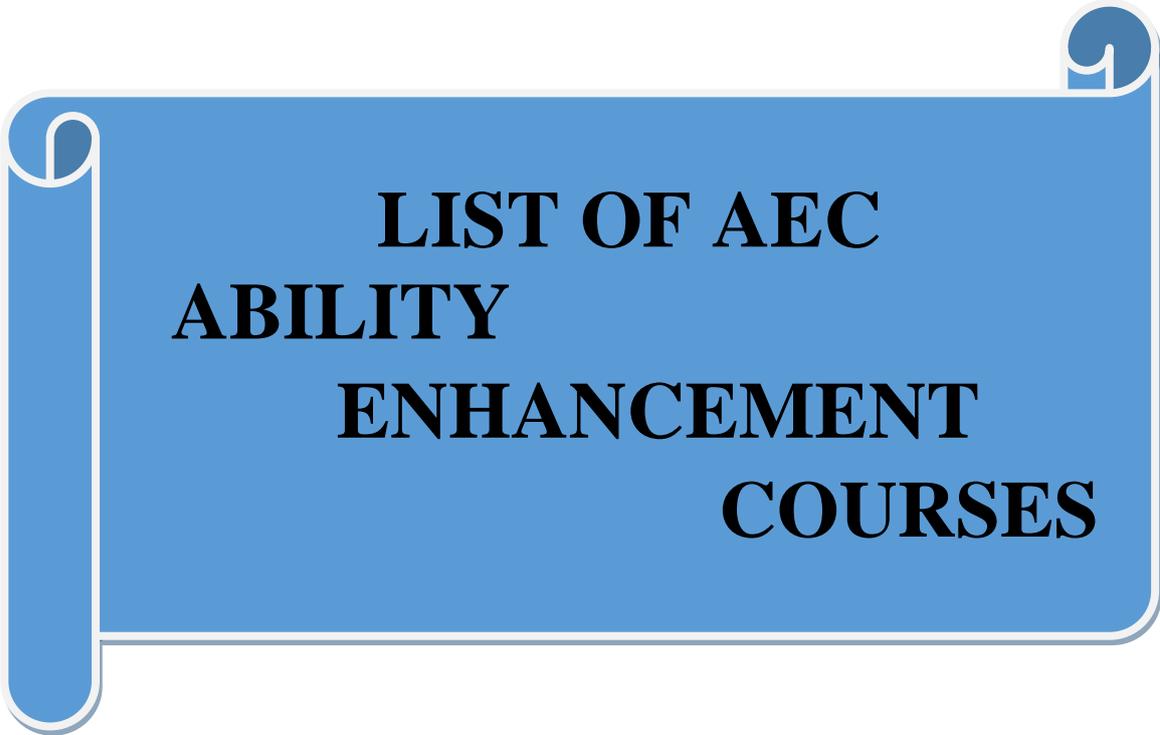
Course Title:	Internship	
Course Code:	5.5MAT81	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory:	Internal Assessment: 00 Marks	Theory:
Tutorial:	ESE: 100 Marks	Tutorial:
	Total:	2

BASIC PROGRAMMING IN MATLAB (6.0MAT81)

Course Title:	Basic Programming in MATLAB	
Course Code:	6.0MAT81	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 1 hours/week	Internal Assessment: 40 Marks	Theory: 1
Practical: 2 hour/week	ESE: 60 Marks	Practical: 1
Total:		2
Course Prerequisite: The student should have knowledge of		
1.	Basic computer skills to download the required files and programmes needed for the course	
Course Objectives:		
1.	To introduce students to computational methods using MATLAB	
2.	To teach the basis of computational techniques for solving ordinary differential equations	
3.	To introduce the use of MATLAB for numerical integration and interpolations	
4.	To discuss different types of plotting (2D, 3D, contour etc.) using MATLAB	
Course Outcomes: The students will be able to		
1.	Learn different environment of MATLAB	
2.	do symbolic computations using MATLAB	
3.	solve a system of differential equations via MATLAB	
4.	Learn different types of plotting namely, 2D, 3D, contour etc.	
5.	do numerical integration and interpolation with unequal intervals	
Course Content:		
Unit	Content	Hours
I	The MATLAB Environment, MATLAB Basics: Variables, Numbers, Operators, Expressions, Input and output, Vectors, Arrays: Matrices. Built-in Functions and User defined Functions, Files and File Management: Import/Export,	10
II	Basic 2D, 3D plots, Graphic handling, Use of MATLAB in Matrix Addition, multiplication, subtraction. Symbolic Calculation-symbols, differentiation, integration, etc. Conditional Statements, Loops.	12
III	MATLAB Programs: Programming and debugging, Mathematical Computing with MATLAB-Algebraic equations. Basic Symbolic Calculus and Differential equations	12
IV	Ordinary Differential Equations: A first order and first-degree ODE. Interpolation with equal Interval: Newton –Gregory forward and backward interpolation formula. Numerical Integration: Trapezoidal method, Numerical Integration: Simpson method (1/3 and 3/8).	11
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I, II	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Text Books:		
<ol style="list-style-type: none"> 1. Prataap R., <i>Getting started with MATLAB</i>, Oxford University Press. 2. S. Lynch, 2014, <i>Dynamical Systems with Applications using MATLAB</i>, Birkhäuser. 3. Fouseff, L.V., 2007, <i>Applied Numerical Analysis using MATLAB</i>, Pearson Education 4. Chapara S.C., Canale, R.P., 2006, <i>Numerical Methods for Engineers</i>, McGraw Hill 		
Reference Books:		
<ol style="list-style-type: none"> 1. Gilat A, 2012, <i>MATLAB: An Introduction with Applications</i>, Wiley 		
E-resources:		
https://onlinecourses.nptel.ac.in/noc20_ge05/preview		

SCIENTIFIC WRITING BY LATEX (6.0MAT82)

Course Title:	Scientific Writing by LaTeX	
Course Code:	6.0MAT82	
Teaching Scheme	Examination Scheme	Credits Allotted
Theory: 1 hours/week	Internal Assessment: 40 Marks	Theory: 1
Practical: 2 hour/week	ESE: 60 Marks	Practical: 1
Total:		2
Course Prerequisite: The student should have knowledge of		
1.	Basic computer skills to downloads the required files and programmes needed for the course	
Course Objectives:		
1.	Installation of scientific typing tools and writing environment to create documents	
2.	To introduce typing tools e.g., LaTeX, Open office	
3.	To introduce different commands and mathematical symbols	
4.	To discuss the use of template to create impressive documents for Master and PhD thesis	
5.	To make students learn how to write equations, plot graphs, and prepare presentations.	
Course Outcomes: The students will be able to		
1.	learn how to create a scientific document	
2.	write equations, letters and do different types of mathematical calculations	
3.	include Tables, Figures and Plots in a document	
4.	create professional presentations	
5.	cite a paper and build Bibliography	
Course Content:		
Unit	Content	Hours
I	Installing LaTeX and Class files, creating first LaTeX document, creating documents in overleaf, Basic document spacing, Basic typesetting	10 Hours (3 Hours Theory and 07 Hours Practical)
II	mathematical Symbols and Commands, writing of simple article, letters and applications, Mathematical symbols and commands, arrays, formulas and equations, Spacing, Borders and Colors	12 Hours (4 Hours Theory and 08 Hours Practical)
III	Figure environments, Subfigures, Tables, LaTeX presentations using Beamer, Creating different templates, Preparation of template of thesis and books	12 Hours (4 Hours Theory and 08 Hours Practical)
IV	Poster and CV templates, Pictures and Graphics, Bibliography, writing of research articles and reports etc.	11 Hours (3 Hours Theory and 08 Hours Practical)
Internal Assessment:		
CIA-I	Unit -I	
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce	
ESE	Unit-I, II, III and IV	
CIA: Continuous Internal Assessment, ESE: End Semester Examination		
Textbooks:		
1. Lammport, L.W., 1994, <i>LaTeX: A document Preparation Systems</i> , Addison-Wesley Publishing Company.		
2. Kopka, H., Daly, P.W., 2004, <i>Guide to LaTeX</i> , Fourth Edition, Addison Wesley.		
Reference Books:		
1. Shirore C., <i>A Beginner guide to LaTeX</i> , Lullu.com		
E-resources:		
2. https://www.udemy.com/course/become-a-good-latex-user-to-create-professional-documents/		
3. https://www.overleaf.com/learn		

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**LIST OF AEC
ABILITY
ENHANCEMENT
COURSES**

QUANTITATIVE APTITUDE (5.0MAT85)

Course Title:	Quantitative Aptitude		
Course Code:	5.0MAT85		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 2 hours/week	Internal Assessment: 40 Marks		Theory: 2
Tutorial: 0 hour/week	ESE: 60 Marks		Tutorial: 0
Total:			2
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1	Improving mathematical and analytical abilities		
2	Improving problem-solving skills		
3	Helping students prepare for competitive exams		
4	Developing skills to meet competitive exams for better job opportunities		
Course Outcomes: The students will be able to			
1	understand basic concepts and arithmetic techniques.		
2	solve problems easily using shortcut methods and time management.		
3	use their logical thinking and analytical abilities to solve aptitude questions from competitive tests.		
Course Content:			
Unit	Content		Hours
I	Numbers, H.C.F and L.C.M of Numbers, Square Root and Cube Root, Logarithms, Simplification.		8 Hours
II	Percentage, Average, Ratio and Proportion.		8 Hours
III	Interest: Simple and Compound, Profit and Loss.		8 Hours
IV	Time and Work, Time and Distance.		6 Hours
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Quantitative Aptitude by Dinesh Khattar			
2. Quantitative Aptitude by R.S. Aggarwal			
Reference Books:			
E-resources:			

MATHEMATICAL AND LOGICAL REASONING (5.0MAT86)

Course Title:	MATHEMATICAL AND LOGICAL REASONING		
Course Code:	5.0MAT86		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 2 hours/week	Internal Assessment: 40 Marks		Theory: 2
Tutorial: 0 hour/week	ESE: 60 Marks		Tutorial: 0
Total:			2
Course Prerequisite: The student should have knowledge of			
1			
Course Objectives:			
1	Improving mathematical and analytical abilities		
2	Improving problem-solving skills		
3	Helping students prepare for competitive exams		
4	Developing skills to meet competitive exams for better job opportunities		
Course Outcomes: The students will be able to			
1	understand basic concepts and arithmetic techniques.		
2	solve problems easily using shortcut methods and time management.		
3	use their logical thinking and analytical abilities to solve aptitude questions from competitive tests.		
Course Content:			
Unit	Content		Hours
I	Analogy, Classification, Coding-Decoding, Blood Relation, Completion of incomplete Figure\Pattern.		8 Hours
II	Puzzle Test: Sitting Arrangement, Ranking Arrangement, Mirror Image, Water Image, Alphabet Test.		8 Hours
III	Number Series, Missing Character, Arithmetic Reasoning.		8 Hours
IV	Direction Test, Calendar, Venn Diagram, Counting Figures, Dice and Cubes.		6 Hours
Internal Assessment:			
CIA-I	Unit -I		
CIA-II	Written Exams/ Quizzes /Assignment /Presentations/ Viva-Voce		
ESE	Unit-I,II,III,IV		
CIA: Continuous Internal Assessment, ESE: End Semester Examination			
Text Books:			
1. Quantitative Aptitude by Dinesh Khattar			
2. Quantitative Aptitude by R. S. Aggarwal			
Reference Books:			
E-resources:			

RESEARCH PROJECT/DISSERTATION (6.0MAT83)

Course Title:	Research Project/Dissertation		
Course Code:	6.0MAT83		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 0 hours/week	Internal Assessment: 00 Marks		Theory:
Tutorial: 0 hour/week	ESE: 100 Marks		Tutorial:
Total:			12

RESEARCH PROJECT/DISSERTATION (6.5MAT81)

Course Title:	Research Project/Dissertation		
Course Code:	6.5MAT81		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: 0 hours/week	Internal Assessment: 00 Marks		Theory: 0
Tutorial: 0 hour/week	ESE: 100 Marks		Tutorial: 0
Total:			16