M. Sc. Mathematics

Syllabus

UNIVERSITY DEPARTMENT

Program Code: MATA

2020 – 2021 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking : Times - 801-1000, Shanghai - 901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

Programme Educational Objectives (PEOs)	
The **M. Sc. Mathematics** programme describes accomplishments that graduates are expected to attain within five to seven years after graduation.	
PEO1	Have professional and ethical responsibility and able to adopt new skills and techniques.
PEO2	Be able to plan, organize, lead and work in team to carry out tasks to the success of the team.
PEO3	Understand the need for continuous learning and prepare himself/ herself with relevant inter–personal skills as an individual, as a member or as a leader throughout the professional career.
PEO4	Be motivated to prepare himself/ herself to pursue higher studies and research to meet out academic demands of the country.
PEO5	Communicate mathematical ideas with clarity and able to identify, formulate and solve mathematical problems.
PEO6	Have knowledge in wide range of mathematical techniques and application of mathematical methods/tools in scientific and engineering domains.
PEO7	Have both analytical and computational skills in mathematical sciences.

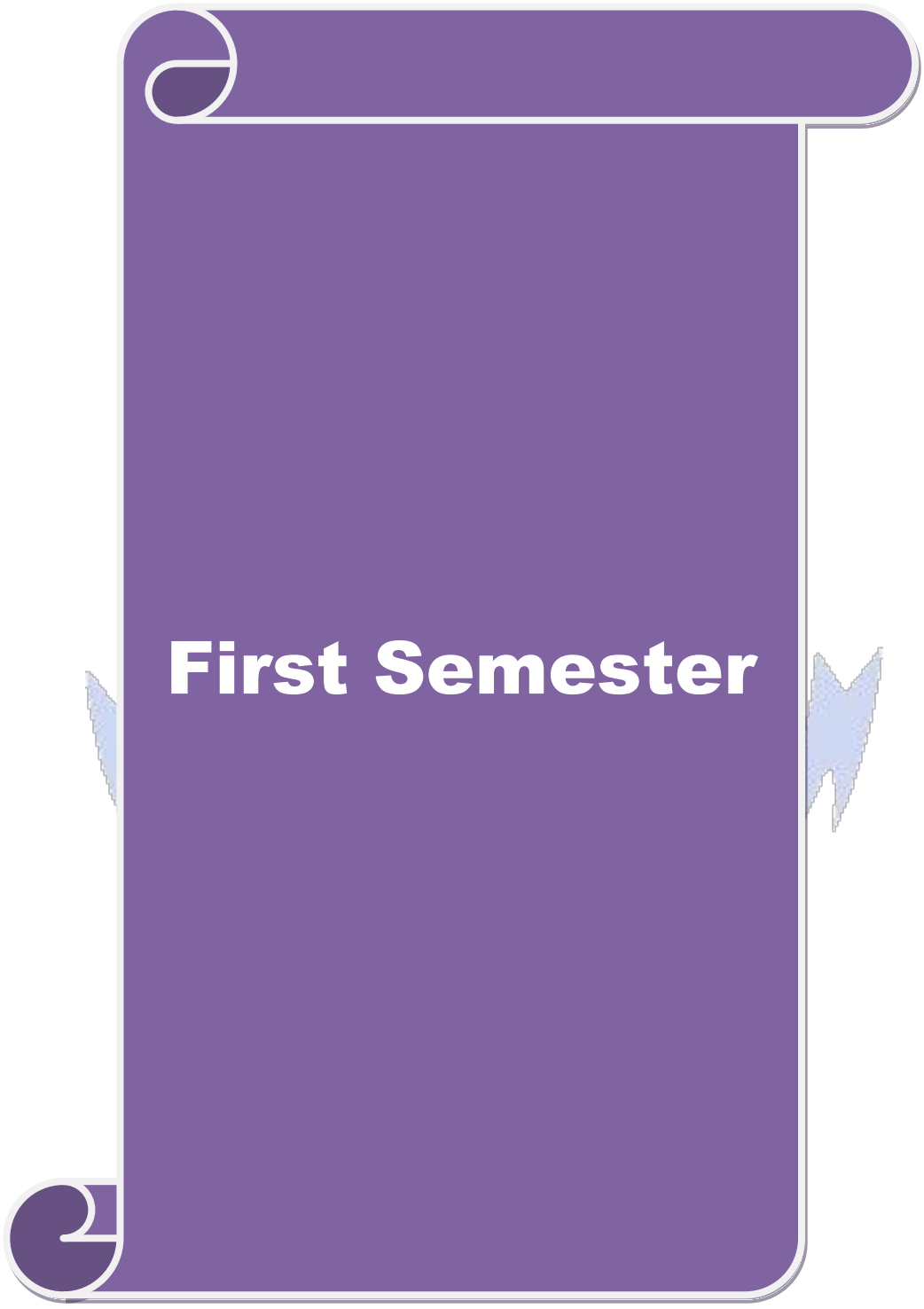
Programme Specific Outcomes (PSOs)	
After the successful completion of **M.Sc. Mathematics** programme, the students are expected to	
PSO1	Solve diverse mathematical problems and capable of analysing the obtained results.
PSO2	Analyze and interpret the outcomes and develop new ideas based on the issues in broader social context.
PSO3	Apply the knowledge and design the methodology to the real world problems.
PSO4	Use the learned techniques, skills and modern mathematical tools suitable to the problem encountered.
PSO5	Acquire problem solving skills, analytical thinking, creativity and mathematical reasoning.
PSO6	Write effective reports and documents, prepare effective presentations and communicate the findings efficiently.
PSO7	Develop confidence to crack the competitive exams like NET, GATE, SET, etc.

Programme Outcomes (POs)	
Successful completion of the **M. Sc. Mathematics** programme	
PO1	Inculcates mathematical reasoning among students
PO2	Makes students understand fundamental axioms and develop ideas based on them
PO3	Equips students analyze and write logical arguments to prove mathematical concepts
PO4	Equips students with advanced knowledge and insight in mathematics
PO5	Equips students with different types of problem solving methods
PO6	Moulds students communicate mathematical ideas precisely
PO7	Enhances professional skills in mathematics and some specialized areas of applied mathematics
PO8	Equips students with mathematical and computational skills so that they can later get involved in independent research
PO9	Produces professionals who can work on real life and challenging problems
PO10	Moulds students prepare a written report on technical mathematical content with clarity and coherence

BHARATHIAR UNIVERSITY : : COIMBATORE 641 046
M. Sc. Mathematics Curriculum (University Department)
(For the students admitted during the academic year 2020 – 21 onwards)

Course Code	Title of the Course	Credits	Hours per week (30 hours)		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
19MATA13A	Algebra I	4	5	0	25	75	100
19MATA13B	Real Analysis	4	5	0	25	75	100
19MATA13C	Ordinary Differential Equations	4	5	0	25	75	100
19MATA13D	Optimization Techniques	4	5	0	25	75	100
19MATA1E-	Elective I	4	5/3	0/4	25	75	100
191GS--	Supportive I	2	2	0	12	38	50
Total		22	27/25	0/4	137	413	550
SECOND SEMESTER							
19MATA23A	Algebra II	4	5	0	25	75	100
19MATA23B	Measure and Integration	4	5	0	25	75	100
19MATA23C	Partial Differential Equations	4	5	0	25	75	100
19MATA23D	Mechanics	4	5	0	25	75	100
19MATA2E-	Elective II	4	5/3	0/4	25	75	100
192GS--	Supportive II	2	2	0	12	38	50
Total		22	27/25	0/4	137	413	550
THIRD SEMESTER							
19MATA33A	Complex Analysis	4	5	0	25	75	100
19MATA33B	Topology	4	5	0	25	75	100
19MATA33C	Fluid Dynamics	4	5	0	25	75	100
19MATA33D	Mathematical Methods	4	5	0	25	75	100
19MATA3E-	Elective III	4	5/3	0/4	25	75	100
192GS--	Supportive III	2	2	0	12	38	50
Total		22	27/25	0/4	137	413	550
FOURTH SEMESTER							
19MATA43A	Functional Analysis	4	5	0	25	75	100
19MATA43B	Number Theory and Cryptography	4	5	0	25	75	100
19MATA43C	Nonlinear Differential Equations	4	5	0	25	75	100
19MATA4E-	Elective IV	4	5/3	0/4	25	75	100
19MATA4LP	Project	8	7	0	-	200	200
Total		24	27/25	0/4	100	500	600
Grand Total		90	108/100	0/16	511	1739	2250

CO-SCHOLASTIC COURSES							
ONLINE COURSES							
	Swayam, MOOC Course etc.,	2	-	-	-	-	-
VALUE ADDED COURSES							
	Value Added Course - I	2	30	-	50	-	50
	Value Added Course - II	2	30	-	50	-	50
CERTIFICATE COURSES							
	Certificate Course - I	4	30-40	-	100	-	100
	Certificate Course - II	4	30-40	-	100	-	100
The scholastic courses are only counted for the final grading and ranking. However, for the award of the degree, the completion of co-scholastic courses is also mandatory.							


First Semester

Course code	19MATA13A	Algebra-I	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in definitions and preliminaries of Group Theory	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Learn the elementary concepts and basic ideas involved in homomorphism and isomorphism.
2. Develop the ability to form and evaluate group theory and its actions.
3. Understand the fundamental concepts of abstract algebra which include sylow theorems and relative this concept to the direct products and abelian groups.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Demonstrate ability to think group actions critically by Cayley's theorem.	K2
CO2	Use the logical connectives on abstract algebra to decide whether an argument is a tautology or contradiction.	K4
CO3	Effectively write abstract mathematical proofs in a clear and logical manner.	K5
CO4	Apply the sylow theorems to describe the structure of certain finite groups.	K3
CO5	Achieve enrich knowledge of problem solving	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to groups	15 hours

Dihedral groups-Symmetric groups - Matrix groups -Homomorphisms and Isomorphisms - Group actions.

Subgroups: Definition and Examples -Centralizers and Normalizer, Stabilizers and Kernels.

Unit:2	Subgroups	15 hours

Cyclic groups and Cyclic subgroups of a group.

Quotient Groups and Homomorphisms: Definitions and Examples - More on cosets and Lagrange's Theorem – The isomorphism theorems - Transpositions and the Alternating group.

Unit:3	Group Actions	15 hours

Group actions and permutation representations - Groups acting on themselves by left multiplication - Cayley's theorem - Groups acting on themselves by conjugation - The class equation - Automorphisms.

Unit:4	Group Actions	15 hours

Sylow's theorems - The simplicity of A_n.

Unit:5	Direct and semi-direct products and Abelian groups	13 hours
Direct Products – The fundamental theorem of finitely generated abelian groups - Table of groups of small order – semi direct products.		
Unit:6	**Contemporary Issues**	**2 hours**
Nilpotent groups-Solvable groups		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Abstract Algebra" by **David S. Dummit** and **Richard M. Foote**, Third Edition, Wiley (2018) Unit I : Chapter 1: (Sections 1.2, 1.3. 1.4, 1.6, 1.7); Chapter 2: (Sections 2.1, 2.2) Unit II : Chapter 2: (Sections 2.3); Chapter 3: (Sections 3.1, 3.2, 3.3, 3.5) Unit III: Chapter 4: (Sections 4.1, 4.2, 4.3, 4.4) Unit IV: Chapter 4: (Sections 4.5, 4.6) Unit V : Chapter 5: (Sections 5.1, 5.2, 5.3, 5.5)

Reference Books

1	Topics in Algebra by I.N. Herstein, John Wiley & Sons (Second Ed), New Delhi, 1975
2	Lectures in Abstract Algebra Vol. I by N. Jacobson, D. Van Nostrand Co., New York, 1976.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=PN-cro0J_v8&list=PLEAYkSg4uSQ1Yhxu2U-BxtRjZElrfVVcO https://nptel.ac.in/courses/111/106/111106113/

Course Designed By: **Dr. R. Rakkiyappan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	S	S	S
CO2	M	S	S	S	S	S	M	S	S	S
CO3	S	S	M	S	S	M	S	S	S	S
CO4	M	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	M	S

*S-Strong; M-Medium; L-Low

Course code	19MATA 13B	REAL ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in Real Analysis	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. The main objective of this course is to introduce students to the theory and methods of Real Analysis.
2. Students should be able to implement the theorems taught in the course to work associated problems, including proving results of suitable accessibility.
3. This course will focus on the proofs of basic theorems of analysis.
4. The way to establish the proofs, many new concepts will be introduced.
5. Understanding the basic concepts and their properties are important for the development of the present and further courses.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Determine the Riemann integrability and the Riemann- Stieltjes integrability of a bounded function and proved a selection of theorems concerning integration.	K1
CO2	Recognize the difference between pointwise and uniform convergence of a sequence of functions.	K3
CO3	Determine the continuity, differentiability, and integrability of functions defined on subsets of the real line.	K4
CO4	Able to learn advanced the Lebesgue measure and Lebesgue integral with related problems	K5
CO5	Illustrate the derivatives of higher order and differentiation of integral.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Continuity	12 hours

Limits of functions-Continuous functions-Continuity and Compactness- Continuity and Connectedness- Discontinuities- Monotonic functions- Infinite limits and Limits at Infinity.

Unit:2	Differentiation	12 hours

The Derivative of a Real function- Mean Value Theorems- The Continuity of Derivatives- L'Hospital's Rule- Derivatives of Higher Order- Taylor's Theorem- Differentiation of Vector-valued Functions.

Unit:3	Riemann Stieltjes Integral	14 hours

Definition and existence of the integral – Properties of the integral – Integration and differentiation – Integration of vector-valued functions – Rectifiable curves.

Unit:4	Sequences and Series of Functions	15 hours

Uniform convergence-Uniform convergence and continuity – Uniform convergence and integration – Uniform convergence and differentiation – Equicontinuous families of functions – The Stone - Weierstrass theorem.

Unit:5	Functions of Several Variables	20 hours
Linear transformations –Differentiation - The contraction principle – The inverse function theorem – The implicit function theorem –Determinants – Derivatives of higher order – Differentiation of integrals.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"Principles of Mathematical Analysis" by **W. Rudin,** McGraw-Hill, New York, 1976 Unit-I : Chapter 4. Unit-II : Chapter 5.Unit-III : Chapter 6.Unit-IV : Chapter 7. Unit-V : Chapter 9 (Except Rank Theorem)
Reference Books	
1	Mathematical Analysis" by Tom. M. Apostol, Second Edition, Addison Wesley Publishing House.
2	' Mathematical Analysis' by V. Ganapathy Iyer, , Tata McGraw Hill Publishing House
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/106/111106053/
2	https://ocw.mit.edu/courses/mathematics/18-100c-real-analysis-fall-2012/
3	https://cosmolearning.org/courses/real-analysis-with-prof-sh-kulkarni/
Course Designed By: **Dr. S. Narayanamoorthy**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	M	S	S	S
CO2	M	S	S	M	S	M	S	S	M	S
CO3	M	M	S	M	M	M	M	S	M	M
CO4	S	M	S	S	S	S	M	S	S	S
CO5	M	S	L	M	L	M	S	M	M	M

*S-Strong; M-Medium; L-Low

Course code	19MATA13C	ORDINARY DIFFERENTIAL EQUATIONS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in differential equations	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. The main purpose of the course is to introduce students to the theory and methods of ordinary differential equations
2. Students should be able to implement the methods taught in the course to work associated problems, including proving results of suitable accessibility.
3. Understand the Existence and Uniqueness Theorem and its ramifications.
4. This course is designed to prepare students to solve problems arising from many applications such as mathematical models of physical or engineering processes.
5. Apply the methods of undetermined coefficients and variation of parameters.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explore some of the basic theory of linear ODEs, recognize basic types of linear ODEs for which exact solutions may be obtained and to apply the corresponding methods of solution.	K1
CO2	Recognize ODEs and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved in order to solve the problems using multiple approaches.	K3
CO3	Interpret the obtained solutions in terms of the physical quantities involved in the original problem under reference.	K4
CO4	Determine particular solutions to differential equations with given boundary conditions or initial conditions.	K5
CO5	Students are introduced to modern concepts and methodologies in differential equations, with particular emphasis on the methods that can be used to solve large-scale problems.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Second Order Linear Equations With Constant Coefficients	14 hours

The second order homogeneous equations – Initial value problems – Linear dependence and independence - A formula for the Wronskian – The non- homogeneous equation of order two.

Unit:2	n^{th} Order Linear Equations With Constant Coefficients	12 hours

Homogeneous and non–homogeneous equations of order n – Initial value problems – Annihilator method to solve a non–homogeneous equation – Algebra of constant coefficient operators.

Unit:3	Linear Equations With Variable Coefficients	12 hours

Initial value problems for the homogeneous equation- Solutions of the homogeneous equation – The Wronskian and linear independence –Reduction of the order of a homogeneous equation - Homogeneous equation with analytic coefficients – The Legendre equation.

Unit:4	**Linear Equation With Regular Singular Points**	**15 hours**
Euler equation - Second order equations with regular singular points – Exceptional cases – Bessel equation.		
Unit:5	**Existence and Uniqueness of Solutions to First Order Equations**	**20 hours**
Equation with variables separated– Exact equations – The method of successive approximations – The Lipschitz condition –Convergence of the successive approximations.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"An Introduction to Ordinary Differential Equations" by E.A. Coddington, Prentice Hall of India Ltd., New Delhi, 2009 Unit I : Chapter 2: Sections: 1 - 6. Unit II : Chapter 2: Sections: 7, 8, 10, 11, 12. Unit III : Chapter 3: Sections: 1 – 5, 7, 8. Unit IV : Chapter 4: Sections: 1 - 4, 6 - 8. Unit V : Chapter 5: Sections: 1 - 6.
Reference Books	
1	"Ordinary Differential Equation" by S.C. Deo, Y. Lakshminathan and V. Raghavendra: Text Book of Tata McGraw Hill, New Delhi (Chapters IV, VII and VIII). 1997 (Second edition)
2	"Ordinary Differential Equations" by P. Haitman:, Wiley, New York, 1964
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/107/111107111/
2	https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/
3	https://www.youtube.com/watch?v=CogfMjKUGc0
Course Designed By: **Dr. M. Muthtamilselvan**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	M	S	S	M	M
CO2	S	S	S	M	L	S	S	S	S	M
CO3	M	S	S	M	M	M	M	M	L	M
CO4	M	S	S	S	S	L	M	S	S	S
CO5	M	S	S	M	L	S	M	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATA13D	OPTIMIZATION TECHNIQUES	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in Operations Research	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. The student is expected to be able to understand basic theoretical principles in optimization.
2. Define and use optimization terminology and concepts and understand how to classify an optimization problem.
3. Be able to implement basic optimization algorithms in a computational setting
4. To apply existing optimization software packages to solve engineering problems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand and apply constrained and unconstrained optimization theory including the necessary and sufficient optimality conditions and algorithms.	K2
CO2	Explain the fundamental knowledge of Geometric programming and Dynamic programming problems including different methods in order to solve various optimization problems arising from engineering areas.	K3
CO3	The ability to analyze optimization methods to engineering problems, including developing a model, defining an optimization problem, applying optimization methods, exploring the solution, and interpreting results.	K4
CO4	Apply and evaluate optimization techniques to find a robust design.	K5
CO5	To Create the acquired knowledge to select the most appropriate method to solve the practical applications.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	One dimensional minimization methods	12 hours

Unrestricted search –Exhaustive search Dichotomous search – Fibonacci method – Golden section method – Quadratic interpolation method.

Unit:2	Unconstrained Optimization	14 hours

Random search method – Grid Search method- Univariate method — The simplex method.

Unit:3	Constrained Optimization techniques	14 hours

The Complex method – Sequential linear programming– Basic approach in the method of feasible directions. Transformation techniques – Interior penalty function method.

Unit:4	**Geometric Programming**	**15 hours**
Unconstrained Minimization problem-Solution of an unconstrained geometric programming-Primal dual relationship and sufficient conditions in the unconstrained case-Constrained Minimization-Solution of a constrained geometric programming problem. Primal and dual programs in the case of less than inequalities.		
Unit:5	**Computational procedure in Dynamic Programming**	**18 hours**
Example illustrating the Calculus method of solution – Example illustrating the Tabular method of solution – Conversion of a final value problem into initial value problem- Linear programming as a case of Dynamic programming- Continuous dynamic programming.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Engineering Optimization Theory and Practice" by **Singiresu S. Rao,** Third Ed., 2013 Unit I : Chapter 5 : Sections:5.3-5.5,5.7,5.8,5.10; Unit II : Chapter 6 : Sections:6.2-6.4, 6.9, Unit III: Chapter 7 : Sections:7.4-7.6,7.11,7.13; Unit IV: Chapter 8 : Sections:8.3-8.9 Unit V : Chapter 9 : Sections:9.4-9.9

Reference Books

1	Hamdy A. Taha , " Operations Research ", Seventh Edition, Pearson Education Asia Editions

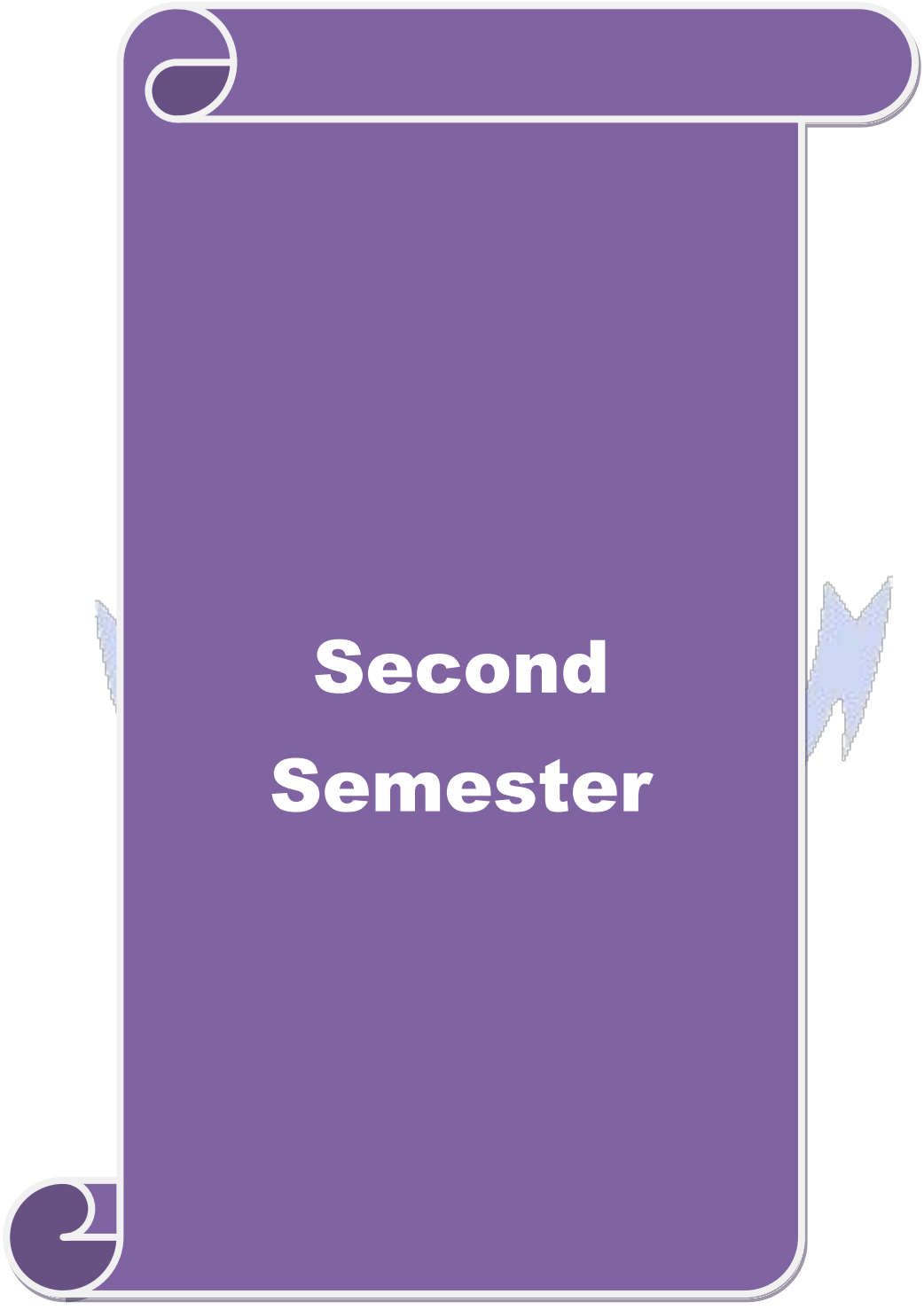
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/105/111105100/
2	https://nptel.ac.in/courses/111/104/111104071/
3	http://apmonitor.com/me575/

Course Designed By: **Dr. S. Narayanamoorthy**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	S	S	S	M	S	S	S
CO2	M	M	S	S	M	M	M	S	S	M
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	M	M	S	L	M	M	M	S	S
CO5	S	S	S	M	S	S	S	S	M	S

*S-Strong; M-Medium; L-Low


Second
Semester

Course code	19MATA23A	ALGEBRA-II	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in definitions and preliminaries of Ring Theory	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To learn the basic ideas and notions of abstract algebra which includes ring and field theory.
2. To develop student's mathematical maturity and enables to build mathematical thinking and use results from ring and field theory to solve contemporary problems.
3. Discuss the separable and inseparable extensions over the splitting fields.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the notion and use the notion of ring theory.	K1
CO2	Demonstrate the relationship between ring, field and module theory.	K2
CO3	Locate and use Chinese remainder theorem to solve problems in number theory for various real life applications.	K4
CO4	Demonstrate understanding of algebraic extensions and algebraic closures.	K4
CO5	Achieve enrich knowledge of problem solving	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Rings	15 hours

Examples: Polynomial rings - Matrix rings and group rings – Ring Homomorphisms and quotient rings - Properties of Ideals - Rings of fractions - The Chinese remainder theorem.

Unit:2	Euclidean domains, principal ideal domains and unique factorization domains	15 hours

Euclidean domain - Principal ideal domains - Unique factorization domains.
Polynomial rings: Definitions and basic properties – Polynomial rings over fields.

Unit:3	Polynomial rings	15 hours

Polynomial rings that are unique factorization domains-Irreducibility criteria – Polynomial ring over fields.
Introduction to Module Theory: Basics definitions and examples – Quotient modules and Module homomorphism.

Unit:4	Field theory	13 hours

Basic Theory of field extensions - Algebraic Extensions.

Unit:5	Field theory	15 hours
Splitting fields and Algebraic closures - Separable and inseparable extensions - Cyclotomic polynomials and extensions.		
Unit:6	**Contemporary Issues**	**2 hours**
Finite fields-Galois Theory		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"Abstract Algebra" by **David S. Dummit** and **Richard M. Foote**, Third Edition, Wiley (2018) Unit I : Chapter 7: (Sections 7.2,7.3,7.4,7.5,7.6) Unit II : Chapter 8: (Sections 8.1,8.2,8.3); Chapter 9: (Sections 9.1,9.2) Unit III: Chapter 9: (Sections 9.3,9.4,9.5); Chapter 10: (Sections 10.1,10.2,10.3) Unit IV: Chapter 13: (Sections 13.1,13.2) Unit V : Chapter 13: (Sections 13.4,13.5,13.6)
Reference Books	
1	Topics in Algebra by I.N. Herstein, John Wiley & Sons (Second Edition), New Delhi, 1975.
2	Lectures in Abstract Algebra Vol. I by N. Jacobson, D. Van Nostrand Co., New York, 1976.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=yKRbG9Y5pYY&list=PLEAYkSg4uSQ3AaON5oCbS6ecwKsoopBN3 https://nptel.ac.in/courses/111/106/111106131/
2	https://www.youtube.com/watch?v=cDCFS68W7ZA
Course Designed By: **Dr. R. Rakkiappan**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	S	S	S	S
CO2	M	S	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	M	S	S	S
CO4	M	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATA23B	MEASURE AND INTEGRATION	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Knowledge in Analysis	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Gain understanding of the abstract measure theory, definition and main properties of the integral.
2. Construct Lebesgue's measure on the real line and in n-dimensional Euclidean Space.
3. Explain the basic advanced directions of the theory.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Demonstrate understanding of the basic concepts underlying the definition of the general Lebesque integral.	K2
CO2	Prove basic results of measure theory and integration theory.	K3
CO3	Demonstrate understanding of the statement and proof of the fundamental integral convergence theorems, and their applications.	K4
CO4	Demonstrate understanding of the statements of the main results on integration on product spaces and an ability to apply these in examples.	K4
CO5	Apply the theory of the course to solve a variety of problems at an appropriate level of difficulty.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Measure on the Real line	12 hours

Measure on the Real line – Lebesgue Outer measure – Measurable sets – Regularity – Abstract Measure Spaces – Measures and Outer Measures - Extension of a Measure

Unit:2	Measurable Functions	14 hours

Measure on the Real Line – Measurable functions – Borel and Lebesgue Measurability

Unit:3	Integration of Functions of a Real Variable	14 hours

Integration of Functions of a Real Variable – Integration of Non–negative Functions – The General Integral – Integration of series -Riemann and Lebesgue integrals

Unit:4	Signed Measures and their Derivatives	15 hours

Signed Measures and their Derivatives – Signed Measures and the Hahn Decomposition – The Jordan Decomposition – the Radon – Nikodym Theorem.

Unit:5	**Measure and Integration in a Product Space**	**18 hours**
Measure and Integration in a Product Space – Measurability in a Product Space – The Product Measure and Fubini's Theorem.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"Measure Theory and Integration" by **G. De Barra**, Wiley Eastern, New Delhi, 1981. Unit I : Chapters 2 &5: Sections 2.1, 2.2, 2.3, 5.1, 5.2 Unit II : Chapter 2: Sections 2.4, 2.5 Unit III : Chapter 3: Sections 3.1, 3.2, 3.3, 3.4 Unit IV: Chapter 8: Sections 8.1, 8.2, 8.3 Unit V :Chapter 10: Sections 10.1, 10.2
Reference Books	
1	"Real Analysis" by H.L. Royden, , McMillian Publ. Co, New York, 1993.
2	"Lebesgue Measure and Integration" by P.K. Jain and V.P. Gupta, , New Age Int. (P) Ltd., New Delhi, 2000.
3	"Real and Complex Analysis" by Walter Rudin, , Tata McGraw Hill Publ. Co. Ltd., New Delhi, 1966.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/101/111101005/
2	https://nptel.ac.in/courses/111/101/111101100/#
3	https://www.youtube.com/playlist?list=PLo4jXE-LdDTQq8ZyA8F8reSQHej3F6RFX
Course Designed By: **Dr. S. Narayanamoorthy**	

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	M
CO2	S	M	M	S	S	S	M	M	S	S
CO3	S	S	S	S	M	S	S	M	S	M
CO4	M	M	S	S	S	M	M	S	S	S
CO5	S	S	S	M	M	M	S	S	M	S

*S-Strong; M-Medium; L-Low

Course code	19MATA23C	PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Knowledge in Ordinary Differential Equations	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Learn the elementary concepts and basic ideas involved in partial differential equations.
2. Develop the mathematical skills to solve problems involving partial differential equations rather than general theory.
3. Solve linear second order PDEs using canonical variables for initial-value problems, separation of variables and boundary value problems.
4. Understand the partial differential equations as models of various physical processes such as mechanical vibrations, transport phenomena and electrostatics.
5. This course focuses on partial differential equation (PDE) models, which will be developed in the context of modeling heat and mass transport and, in particular, wave phenomena, such as sound and water waves.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Know the various types of methods and their limitations to solve the pdes.	K2
CO2	Extract information from partial differential equations to interpret the reality.	K3
CO3	Identify the physical situations formulate mathematical models using pdes.	K4
CO4	Solve practical PDE problems with finite difference methods, implemented in code, and analyze the consistency, stability and convergence properties of such numerical methods.	K4
CO5	Apply the acquired knowledge to select the most appropriate method to solve the particular partial differential equations.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Nonlinear Partial Differential Equations of the First Order	12 hours

Cauchy's method of characteristics-Compatible systems of first order equations – Charpit's method-Special types of first order equations – Jacobi's method.

Unit:2	Partial Differential Equations of Second Order	14 hours

The origin of second-order equations – Linear partial differential equations with constant coefficients – Equations with variable coefficients –Characteristic curves of second–order equations-Characteristics of equations in three variables.

Unit:3	Partial Differential Equations of Second Order	14 hours

The solution of linear hyperbolic equations - Separation of variables – The method of integral transforms – Nonlinear equations of the second order.

Unit:4	Laplace's Equation	15 hours
The occurrence of Laplace's equation in physics- elementary solution of Laplace's equation – Families of equipotential surfaces - boundary value problems Separation of variables- Problems with axial symmetry.		
Unit:5	**The Wave Equation**	**18 hours**
The occurrence of wave equation in physics – Elementary solutions of the one-dimensional wave equation – vibrating membranes: Applications of the calculus of variations – Three dimensional problems. The diffusion equation: Elementary solutions of the diffusion equation – Separation variables- The use of integral transforms		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)

1	Elements of Partial Differential Equations" by I. N. Sneddon, McGraw-Hill Book Company, Singapore, 1957. Unit-I : Chapter 2: Sections: 7, 8, 9, 10, 11, 13. Unit-II : Chapter 3: Sections: 1, 4, 5, 6, 7. Unit-III: Chapter 3: Sections: 8, 9, 10, 11. Unit-IV: Chapter 4: Sections: 1, 2, 3, 4, 5, 6. Unit-V : Chapter 5: Sections: 1, 2, 4, 5; Chapter 6: Sections: 3, 4, 5.

Reference Books

1	"Differential Equations, Graduate Studies in Mathematics" by L.C. Evans Partial Vol. 19, American Mathematical Society, 1998.
2	"Partial Differential Equations", by F. John, 3rd Edition, Narosa, 1979.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/107/111107111/
2	https://nptel.ac.in/courses/122/107/122107037/
3	https://ocw.mit.edu/courses/mathematics/18-152-introduction-to-partial-differential-equations-fall-2011/lecture-notes/

Course Designed By: **Dr. M. Muthtamilselvan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	M	S	S
CO2	S	M	M	S	S	S	M	S	S	S
CO3	S	S	S	S	M	S	M	S	S	M
CO4	M	M	S	S	S	S	S	M	M	M
CO5	S	S	S	M	M	S	M	S	L	M

*S-Strong; M-Medium; L-Low

Course code	19MATA23D	MECHANICS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		A basic course on partial differential equations	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are:

1. To create a solid foundation for understanding basic principles of mechanics and some classical problems
2. To learn Lagrangian and Hamiltonian formulations of classical mechanics
3. To learn the importance and consequences of canonical transformations

Expected Course Outcomes:

On the successful completion of the course, the student will be able to:

CO1	Derive Lagrange's equation using elementary calculus	K2
CO2	Use Hamilton-Jacobi theory in identifying conserved quantities for a mechanical system, even when the problem is not solvable.	K4
CO3	Define different sets of generalized coordinates for a given mechanical system and use the canonical transformations.	K3
CO4	Apply techniques like least action principles and calculus of variations on to understand the motion of objects.	K3, K4
CO5	Use analytical treatments in checking the numerical models.	K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introductory Concepts	16 hours

The mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and momentum.

Unit:2	Lagrange's Equations	14 hours

Derivations of Lagrange's equations- Examples –Integrals of the motion.

Unit:3	Hamilton's Equations	13 hours

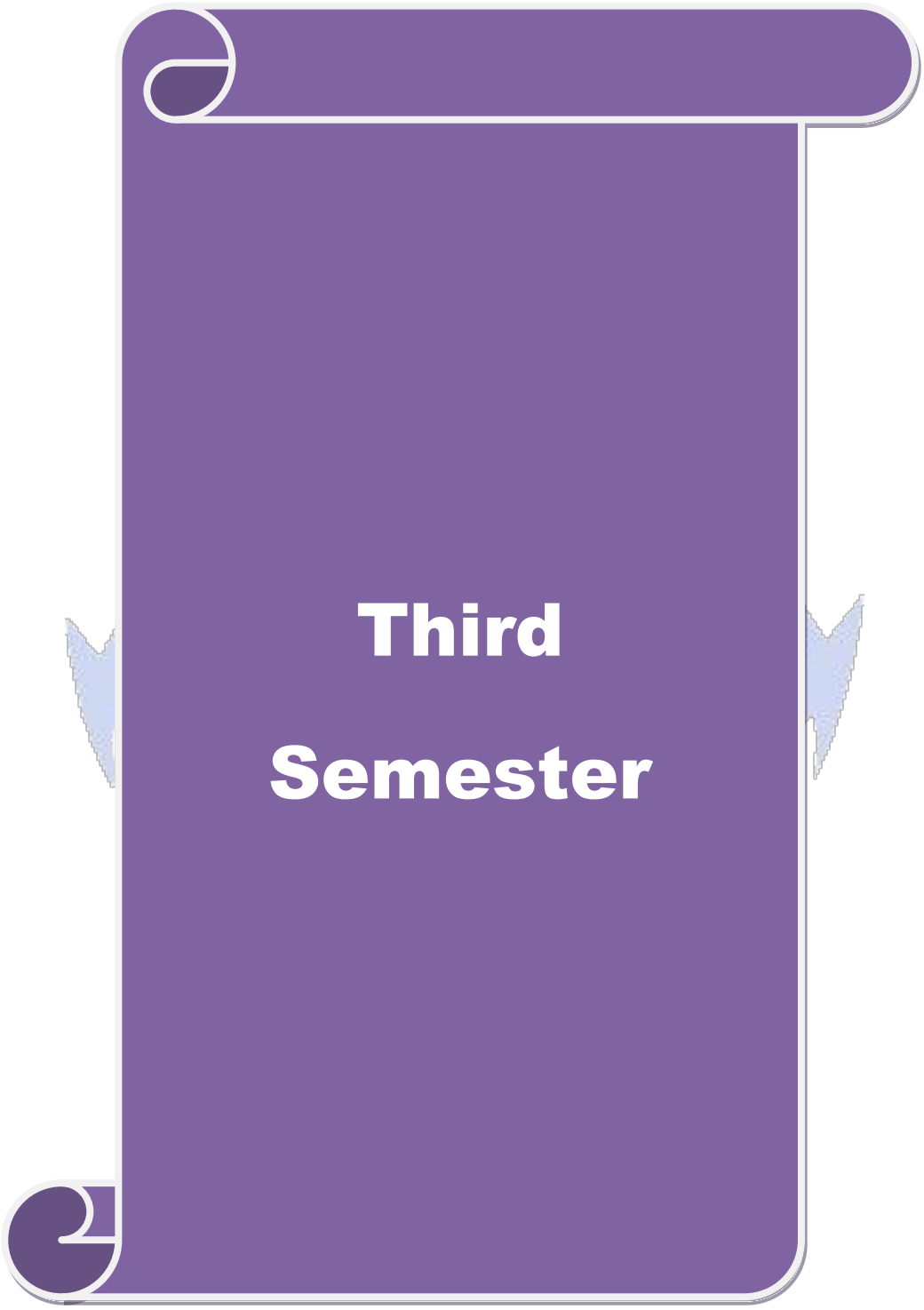
Hamilton's principle – Hamilton's equations.

Unit:4	**Hamilton-Jacobi Theory**	**16 hours**
Hamilton's principal function –The Hamilton - Jacobi equation – Separability.		
Unit:5	**Canonical Transformations**	**14 hours**
Differential forms and generating functions – Lagrange and Poisson brackets**.**		
Unit:6	**Contemporary Issues**	**2 hours**
Industry 4.0: Introduction to Cyber Physical Systems and Manufacturing		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"Classical Dynamics" by **D.T. Greenwood,** Dover, 1997. Unit-I : Chapter 1. Unit-II : Chapter 2: Sections: 2.1 - 2.3 Unit-III: Chapter 4: Sections: 4.1 - 4.2 Unit-IV: Chapter 5 Unit-V : Chapter 6: Sections: 6.1.6.3
Reference Books	
1	Classical Mechanics by H. Goldstein, C. Poole & J. Safko, Pearson Education, Inc., New Delhi, 2002.
2	Classical Mechanics by R. Douglas Gregory, Cambridge University Press, 2006.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.edx.org/course/introduction-to-mechanics-part-1 (Prof. Jason Hafner, Rice University)
2	https://swayam.gov.in/nd1_noc20_ph18/preview (Prof. Charudatt Kadolkar, IIT Guwahati)
Course Designed By: **Dr. S. Saravanan**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	L	M	M	L	S	S	M	M
CO2	M	L	L	S	M	L	M	M	M	L
CO3	L	L	L	M	L	L	S	M	S	L
CO4	M	L	L	M	M	L	S	S	S	L
CO5	M	M	M	S	M	L	M	M	M	M

*S-Strong; M-Medium; L-Low


Third
Semester

Course code	19MATA33A	COMPLEX ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in definitions and preliminaries of Complex numbers, Analytic functions and Conformal Mappings	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To lay the foundation for this subject, to develop clear thinking and analyzing capacity for further study.
2. Cauchy's Theorem guaranteeing that certain integrals along closed paths are zero. This striking result leads to useful techniques for evaluating real integrals based on the 'calculus of residues'
3. Important results are the Mean Value Theorem, leading to the representation of some functions as power series (the Taylor series), and the Fundamental Theorem of Calculus which establishes the relationship between differentiation and integration.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Analyze limits and continuity for complex functions as well as consequences of continuity.	K1
CO2	Apply the concept and consequences of analyticity and the Cauchy- Riemann equations and of results on harmonic and entire functions including fundamental theorem of algebra.	K1& K2
CO3	Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem	K3& K5
CO4	Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.	K4 & K5
CO5	Find residues and evaluate complex integrals using the residue theorem.	K4& K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Fundamental theorems	18 hours

Line integrals rectifiable arcs – Line integrals as functions of arcs- Cauchy's theorem for a rectangle - Cauchy's theorem in a disk, Cauchy's integral formula: The index of a point with respect to a closed curve – The integral formula – Higher derivatives - Local properties of analytical functions: Removable singularities, Taylor's theorem – Zeros and poles – The local mapping – The maximum principle –The general form of Cauchy's theorem: Chains and cycles.

Unit:2	The calculus of residues	12 hours

The residue theorem – The argument principle – Evaluation of definite integrals-Harmonic functions: Definition and basic properties – The mean-value property – Poisson's formula.

Unit:3	Power series Expansions	12 hours

Weierstrass theorem – The Taylor series – The Laurent series- Partial fractions and factorization: Partial fractions – Infinite products – Canonical products-The Gamma functions-Stirling's formula-Jensen's formula- Hadamard's Theorem.

Unit:4	The Riemann mapping theorem	13 hours
Statement and proof – Boundary behavior – Use of the reflection principle – Analytic arcs – Conformal mapping of polygons: The behavior at an angle – The Schwarz – Christoffel formula – Mapping on a rectangle. A close look at Harmonic functions: Functions with mean-value property, Harnack's Principle.		
Unit:5	**Elliptic functions**	**18 hours**
Simply periodic functions: Representation by Exponentials-The Fourier development-Functions of Finite Order. Doubly Periodic Functions: The Period Module Unimodular Transformations- The Canonical Basis- General Properties of Elliptic Functions. The Weierstrass Theory: The Weierstrassρ-function, The functions $\varsigma(z)$ and $\sigma(z)$-The Differential Equation- The Modular Function $\lambda(\tau)$.		
Unit:6	**Contemporary Issues**	**2 hours**
Elliptic Equations-Applications to Fluid Flow problems		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Complex Analysis" by **L.V. Ahlfors,** Third Edition, McGraw-Hill, New York, 1979. Unit I : Chapter 4: Sections: 1.1 – 1.5, 2.1 - 2.3, 3.1 - 3.4, 4.1. Unit II: Chapter 4: Sections: 5.1 - 5.3, 6.1 – 6.3. Unit III: Chapter 5: Sections: 1.1 – 1.3, 2.1 – 2.5, 3.1-3.2. Unit IV : Chapter 6: Sections: 1.1 - 1.4, 2.1 – 2.3, 3.1-3.2. Unit V: Chapter 7: Sections: 1.1-1.3, 2.1-2.4, 3.1-3.5.

Reference Books

1	"Complex Analysis" by T. W. Gamlelin, Springer-Verlag, New York, 2001
2	"Complex Analysis" by V. Karunakaran, Narosa Publishing House, New Delhi, 2002.
3	"Complex Variables & Applications" by R.V. Churchill & J. W. Brown, Mc.Graw Hill, 1990.
4	"Complex Variables with Applications"by S. Ponnusamy& Herb Silverman, ,Birkhauser, Boston, 2006

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=b5VUnapu-qs
2	https://www.youtube.com/watch?v=gFjlBKW8aZU&list=PLbMVogVj5nJS_i8vfVWJG16mPcoEKMuWT&index=2
3	https://www.youtube.com/watch?v=QQ4xY0TS6wY&list=PLbMVogVj5nJTLfYTwvct_SlLaxv1b50Vk

Course Designed By: **Dr. R. Rakkiappan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	S	S	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	M	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATA33B	TOPOLOGY	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in definitions and preliminaries of Real Analysis	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To introduce the fundamental concepts of topology
2. To study the properties oftopological spaces.
3. To enrich much knowledge in Metric topology, connected, compact and normal spaces

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Acquire knowledge about several constructions of topological spaces	K2
CO2	Understand various properties of topological spaces	K2 & K4
CO3	Recognize the properties of continuous functions on topological spaces	K2 & K4
CO4	Understand connected, compact and normal topological spaces and their properties	K4
CO5	Understand normal topological spaces and their properties.	K2 & K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**15 hours**

Topological spaces -Basis for a topology - The order topology - The producttopology on $X \times Y$ – The subspace topology - Closed sets and limit.

Unit:2	**15 hours**

Continuous functions - The product topology - The metric topology.

Unit:3	**15 hours**

Connected spaces - Connected subspaces of the real line - Compact spaces -Compact subspaces of the real line.

Unit:4	**15 hours**

Limit point compactness - The countability and separation axioms: The countability axioms - The separation axioms.

Unit:5	**13 hours**

Normal spaces - The Urysohn's lemma - The Urysohn's metrization theorem –Tietz extension theorem - The Tychonoff theorem.

Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**-- hours**

Text Book(s)	
1	"Topology" by James R. Munkres, 2nd Edition, Pearson Education, Delhi, 2006. Unit 1: Chapter 2: Sections 2.1- 2.6 ; Unit 2: Chapter 2: Sections 2.7-2.10 Unit 3: Chapter 3: Sections 3.1, 3.2, 3.4, 3.5; Unit 4: Chapter 4: Sections 3.6, 4.1-4.2 Unit 5: Chapters 4: Sections 4.3, 4.4, 4.5, 4.6, Chapter 5: 5.1.
Reference Books	
1	"Introduction to Topology" by B. Mendelson, CBS Publishers, Delhi, 1985.
2	"Introduction to General Topology" by Sze- Tsen Hu, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1966
3	"General Topology" by S. Lipschutz, Schaum's Series, McGraw-Hill New Delhi, 1965
4	"Introduction to General Topology" by K. D. Joshi, New Age International Pvt. Ltd, 1983
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=XHKcrs8YaSo&list=PLbMVogVj5nJRR7zYZifYopb52zjoScx1d
2	https://www.youtube.com/watch?v=-CWFpdPQqFI
Course Designed By: **Dr. R. Rakkiappan**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	S	S	S	S
CO4	M	S	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATA33C	FLUID DYNAMICS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		A basic course on mechanics and analysis	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are:

1. To establish an understanding of the fundamental concepts of fluid dynamics
2. To make students understand the importance of fluid dynamics in diverse real life applications
3. To build the necessary theoretical background for solving a variety of problems

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Apply laws of discrete mechanics to continuous systems	K3, K4
CO2	Apply basic principles of multi-variable calculus, differential equations and complex variables to fluid dynamic problems	K3, K4
CO3	Analyze fluid flow problems with the application of the momentum and energy	K4
CO4	Understand modeling approximations in finding exact solutions	K2
CO5	Derive boundary layer equations by logical reasoning	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Inviscid Theory	15 hours

Introductory notions - velocity: streamlines and paths of the particles-stream tubes and filaments- fluid body –density –pressure- Bernoulli's theorem. Differentiation with respect to time- equation of continuity- boundary conditions: kinematical and physical- rate of change of linear momentum- equation of motion

Unit:2	Inviscid Theory Continued	13 hours

Euler's momentum theorem- conservative forces- Lagrangian form of the equation of motion- steady motion- energy equation- rate of change of circulation- vortex motion- permanence of vorticity.

Unit:3	Two Dimentional Motion	18 hours

Two dimensional functions : stream function, velocity potential- complex potential- indirect approach- inverse function basic singularities : source, doublet, vortex- mixed flow- method of images: circle theorem- flow past circular cylinder with circulation - aerofoil: Blasius's theorem- lift force.

Unit:4	Viscous Theory	14 hours

Equations of motion for viscous flow: stress - Navier-Stokes equations- vorticity and circulation in a viscous fluid. Flow between parallel flat plates: Couette flow - plane Poiseuille flow. Steady flow in pipes: Hagen-Poiseuille flow.

Unit:5	**Boundary Layer Theory**	**13 hours**
Boundary layer concept- boundary layer equations in two dimensional flow- boundary layer along a flat plate: Blasius solution- shearing stress and boundary layer thickness- momentum integral theorem for the boundary layer: Von Karman integral relation- Von Karman integral relation by momentum law.		
Unit:6	**Contemporary Issues**	**2 hours**
Industry 4.0 and 5.0: Internet of Things in the field of Fluid Power, FDMS, etc. – Impact of Augmented Reality on CFD.		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Theoretical Hydrodynamics" by **L.M. Milne Thomson**, Dover, 1996. Unit-I : Chapter 1:Sections: 1.0-1.4, Chapter 3: Sections: 3.10-3.31, 3.40, 3.41. Unit-II : Chapter 3:Sections: 3.42-3.45, 3.50-3.53.
2	"Modern Fluid Dynamics Vol-I" by **N. Curle and H.J. Davies,** D Van Nostrand, London, 1968. Unit-III: Chapter 3: Sections: 3.2, 3.3, 3.5 - 3.5.1, 3.5.2, 3.7.4, 3.7.5. Unit-IV: Chapter 5: Sections: 5.2.1- 5.2.3
3	"Foundations of Fluid Mechanics" by **S.W. Yuan** Prentice- Hall of India, New Delhi, 1988. Unit-IV: Chapter 8: Sections: 8.3 - a,b, 8.4 – a. Unit-V : Chapter 9: Sections: 9.1, 9.2, 9.3 – a,b, 9.5 – a,b.

Reference Books

1	"Textbook of Fluid Dynamics" by Chorlton, CBS Publishers, New Delhi, 2004.
2	"A Mathematical Introduction to Fluid Dynamics" A.J. Chorin and A. Marsden, Springer-Verlag, New York, 1993.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.edx.org/course/flight-vehicle-aerodynamics (Prof. Mark Drela, MIT)
2	https://swayam.gov.in/nd1_noc20_me54/preview (Prof. Suman Chakraborty, IIT Kharagpur)

Course Designed By: **Dr. S. Saravanan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	L	L	M	L	L	S	M	S	L
CO2	S	L	L	M	S	M	S	M	S	M
CO3	L	M	L	M	M	L	S	M	S	L
CO4	L	M	M	L	L	L	S	L	M	L
CO5	S	L	L	M	L	M	M	M	M	M

*S-Strong; M-Medium; L-Low

Course code	19MATA33D	MATHEMATICAL METHODS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		A basic course on mechanics and analysis	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course is to:

1. Introduce fundamentals of integral transforms, integral equations and calculus of variations
2. Use integral transforms, integral equations and calculus of variations as tools for problem solving

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the basic properties of Fourier and Hankel transforms	K1,K2
CO2	Understand the classical Fredholm theory	K2,K4
CO3	Solve differential and integral equations	K3,K4
CO4	Evaluate the extremals of functionals	K3,K5
CO5	Apply the acquired knowledge in solving applied problems	K4,K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Fourier Transforms	15 hours

Fourier Transforms – Definition. Inversion theorem – Fourier cosine transforms - Fourier sine transforms – Fourier transforms of derivatives - Fourier transforms of some simple functions - Fourier transforms of rational functions – The convolution integral – convolution theorem – Parseval's relation for Fourier transforms – solution of PDE by Fourier transform. Laplace's Equation in Half plane Laplace's Equation in an infinite strip The Linear diffusion equation on a semi-infinite line The two-dimensional diffusion equation.

Unit:2	Hankel Transforms	15 hours

Definition – Elementary properties of Hankel Transforms - Hankel Transforms of Derivatives of functions - Hankel Transforms of some elementary functions - The Parseval relation for Hankel transforms – Relation between Fourier and Hankel transforms – Application to PDE. Axisymmetric Dirichlet problem for a half – space. Axisymmetric Dirichlet problem for a thick plate

Unit:3	Integral Equations	17 hours

Types of Integral equations – Equation with separable kernel - Fredholm Alternative Approximate method – Volterra integral equations – Classical Fredholm theory – Fredholm's First, Second, Third theorems.

Unit:4	**Applications of Integral equations to ordinary differential equations**	**13 hours**
initial value problems – Boundary value problems – singular integral equations – Abel Integral equation		
Unit:5	**Calculus of Variations**	**13 hours**
Variation and its properties – Euler's equation – Functionals of the integral forms Functional dependent on higher order derivatives – functionals dependent on the functions of several independent variables – variational problems in parametric form.		
Unit:6	**Contemporary Issues**	**2 hours**
Industry 4.0 and 5.0: Internet of Things in the field of Fluid Power, FDMS, etc. – Impact of Augmented Reality on CFD.		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"The Use of Integral Transforms" by **I.N.Sneddon**, Tata Mc Graw Hill, New Delhi, 1974. For Units I & II
2	"Linear Integral Equations Theory and Technique" by **R.P.Kanwal**, Academic Press, New York, 1971. For Units III & IV
3	"Differential Equations and Calculus of Variations" by **L.Elsgolts**, Mir Publishers, Moscow, 1970. For Unit V

Reference Books

1	Integral Transforms and their Applications by Lokenath Debnath, Dambaru Bhatta, Taylor & Francis, London, 2007.
2	Integral Equations and Applications by C. Corduneanu, Cambridge University Press, 1991
3	Calculus of Variations, with Applications to Physics and Engineering by R. Weinstock, McGraw-Hill, New York, 1952.

Course Designed By: **Dr. S. Saravanan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	L	M	M	L	M	M	S	L
CO2	M	L	L	M	M	M	S	M	M	M
CO3	L	L	L	M	S	L	S	S	S	L
CO4	L	L	L	M	S	L	S	M	S	L
CO5	M	M	L	M	S	M	S	S	S	M

*S-Strong; M-Medium; L-Low


Fourth
Semester

Course code	19MATA43A	FUNCTIONAL ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in definitions and preliminaries of Real Analysis and Linear Algebra	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

This course introduces functional analysis and operator theoretic concepts. This area combines ideas from linear algebra and analysis in order to handle infinite-dimensional vector spaces and linear mappings thereof

1. To impart analytic knowledge on infinite-dimensional vector spaces, of which the most important cases are Banach spaces and Hilbert spaces.
2. This course provides an introduction to the basic concepts which are crucial in the modern study of partial differential equations, Fourier analysis, quantum mechanics, applied probability and many other fields.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Appreciate how ideas from different areas of mathematics combine to produce new tools that are more powerful than would otherwise be possible.	K1 & K2
CO2	Understand how functional analysis underpins modern analysis.	K2
CO3	Develop their mathematical intuition and problem-solving capabilities, especially in predicting the space in which the solution of a partial differential equation belongs to.	K3 & K4
CO4	Understand the Sobolev, Besov, Orlicz spaces and their properties.	K2
CO5	Learn advanced analysis in terms of Sobolev spaces, Besov spaces, Orlicz spaces and other distributional spaces.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Banach spaces	15 hours

Definition and examples – Continuous linear transformations – The Hahn Banach theorem.

Unit:2	Banach spaces	15 hours

The natural imbedding – Open mapping theorem – The conjugate of an operator.

Unit:3	Hilbert spaces	15 hours

Definition and simple properties – Orthogonal complements –Orthonormal sets– Conjugate space

Unit:4	Hilbert spaces	15 hours

The adjoint of an operator-Self –adjoint operators-Normal and unitary operators-Projections.

Unit:5	**Algebras of Operators**	**13 hours**
General Preliminaries on Banach Algebras: The definitions and some examples-Regular and singular elements-Topological divisors of zero-The spectrum-The formula for the spectral radius.		
Unit:6	**Contemporary Issues**	**2 hours**
Frechet Spaces		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Introduction to Topology and Modern Analysis" by **G.F. Simmons,** McGraw-Hill, New York, 1963

Reference Books

1	"A Course in Functional Analysis" by **J. B. Conway,** Springer, New York, 1990
2	"First Course in Functional Analysis" by **C. Goffman& G. Pedrick**, Prentice-Hall of India, New Delhi, 2002.
3	"Elements of Functional Analysis" by **L. A. Lusternik& V. J. Sobolev,** Hindustan Publishing Co, New Delhi, 1985.
4	"Introduction to Functional Analysis" by **A. E. Taylor,** John Wiley, New York, 1958.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=lD3d7ZxoTe4&list=PL5022A32B9BCFE3E4
2	https://www.youtube.com/watch?v=QzcazcGZUFQ&list=PLmx4utxjUQD4xJkiHY4pp720LyeCZyEKW

Course Designed By: **Dr. R. Rakkiappan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	S	S	S	S	S	S	S
CO2	S	M	S	S	S	S	S	S	S	M
CO3	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATA43B	NUMBER THEORY & CRYPTOGRAPHY	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in definitions and preliminaries of Number Theory	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To introduce students to some of the basic ideas of number theory, and to use this as a context in which to discuss the development of mathematics through examples, conjectures, theorems, proofs and applications.
2. Illustrate different methods of proof in the context of elementary number theory, and will apply some basic techniques of number theory to cryptography.
3. To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms.
4. To introduce classical encryption techniques and concepts of modular arithmetic and number theory.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Identify and apply various properties of and relating to the integers including the Well Ordering Principle, primes, unique factorization, the division algorithm, and greatest common divisors.	K1 & K2
CO2	Understand the concept of congruence and use various results related to congruencies including the Chinese Remainder Theorem.	K2 & K3
CO3	Identify and Understand how number theory is related to and used in cryptography	K2 & K4
CO4	Acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.	K4
CO5	Understand how to deploy encryption techniques to secure data in transit across data networks	K5 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**15 hours**

Divisibility and Euclidean algorithm – Congruence, Euler's Theorem, Wilson's Theorem, Chinese Remainder Theorem, Primitive roots - Applications to Factoring..

Unit:2	**15 hours**

Finite Fields – Quadratic Residues – Quadratic Reciprocity – The Jacobi symbol.

Unit:3	**15 hours**

Cryptosystems – Enciphering Matrices – Public Key Cryptography – Concepts of Public Key Cryptography – Modular Arithmetic – RSA.

Unit:4		**15 hours**
Pseudo primes and Strong Pseudo primes – The rho method – Fermat factorization and factor bases and Algorithm – The Continued fraction method and Algorithm.		
Unit:5		**13 hours**
Elliptic Curves – Basic Facts, Elliptic curves Cryptosystems, Elliptic curve Factorization.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"A Course in Number Theory and Cryptography" by Neal Koblitz, , Springer – Verlag, New York, 1987. Unit I: Chapter 1, Sections 1.1-1.4; Unit II: Chapter 2, Sections 2.1-2.2 Unit III: Chapters 3&4, Sections 3.1-3.2, 4.1-4.2;Unit IV: Chapter 5, Sections 5.1-5.4 Unit V: Chapter 6, Sections 6.1-6.2,6.4
Reference Books	
1	"An Introduction to Theory of Numbers" by Ivan Nivan and HerbertsZucherman, Third Edition, 1972, Wiley Eastern Limited, New Delhi
2	"Introduction to Analytic Number Theory" by Tom Apostol, Narosa Publications, New Delhi
3	"Elementary Number Theory" by David M. Burton, Wm. C. Brown Publishers, Dubuque, Lowa, 1989.
4	"Cryptography and Network Security Principles and Practice" by William Stallings, Prentice Hall, Fifth Edition, New Delhi, 2011.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=SCvtxjpVQms
2	https://www.youtube.com/watch?v=pBELpoglnvQ&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2
Course Designed By: **Dr. R. Rakkiappan**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	S	S	S	S	S	S
CO4	M	S	S	S	S	S	S	M	S	S
CO5	S	S	M	S	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATA43C	NONLINEAR DIFFERENTIAL EQUATIONS	L	T	P	C
Core/Elective/Supportive		Core	4	1	0	4
Pre-requisite		Basic knowledge in differential equations	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Introduce oscillations or wild chaotic fluctuations produced by a nonlinear system
2. Discuss solution behaviour of nonlinear differential equations without finding the solutions explicitly.
3. Develop clear thinking and analyzing capacity for advanced research.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the dynamics of basic population models	K2
CO2	Find approximate solutions of nonlinear equations using averaging and perturbation methods	K3, K5
CO3	Master the concepts of stability in different perspectives	K2, K4
CO4	Have an idea on qualitative properties of solutions of linear and nonlinear systems	K2
CO5	Improve their problem solving capabilities	K3, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	First order Systems in Two Variables and Linearization	14 hours

The general phase plane – Some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

Unit:2	Averaging Methods	15 hours

An energy balance method for limit cycles – Amplitude and frequency estimates – Slowly varying amplitudes; Nearly periodic solutions - Periodic solutions: Harmonic balance – Equivalent linear equation by harmonic balance – Accuracy of a period estimate.

Unit:3	Perturbation Methods	16 hours

Outline of the direct method – Forced oscillations far from resonance Forced oscillations near resonance with weak excitation – Amplitude equation for undamped pendulum – Amplitude perturbation for the pendulum equation – Lindstedt's method- Forced oscillation of a self – excited equation – The Perturbation method and Fourier series.

Unit:4	Linear Systems	14 hours

Structure of solutions of the general linear system – Constant coefficient system – Periodic coefficients – Floquet theory – Wronskian.		
Unit:5	**Stability**	**13 hours**
Poincare stability – Solutions, paths and norms – Liapunov stability- Stability of linear systems – Comparison theorem for the zero solutions of nearly-linear systems.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)	
1	"Nonlinear Ordinary Differential Equations" by **D.W. Jordan and P. Smith,** Clarendon Press, Oxford, 1977. Unit-I: Chapter 2; Unit-II :Chapter 4; Unit-III: Chapter 5: Sections: 5.1 - 5.4, 5.7 -5.10. Unit-IV: Chapter 8: Sections: 8.1 - 8.4; Unit-V: Chapter 9: Sections: 9.1 - 9.4, 9.6.
Reference Books	
1	"Differential Equations" by **G.F. Simmons,** Tata McGraw-Hill, New Delhi, 1979.
2	"Ordinary Differential Equations and Stability Theory" by **D.A. Sanchez,** Dover, New York, 1968.
3	"Notes on Nonlinear Systems" by **J.K. Aggarwal,** Van Nostrand, 1972.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.edx.org/course/differential-equations-2x2-systems (Prof. David Jerison, MIT)
Course Designed By: **Dr. S. Saravanan**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	S	M	S	M	S	M
CO2	L	L	L	M	S	L	M	M	S	L
CO3	M	M	M	M	L	S	M	M	M	M
CO4	M	L	L	M	M	M	S	S	M	L
CO5	M	L	L	M	S	L	M	S	M	L

*S-Strong; M-Medium; L-Low


Elective
Courses

ELECTIVES COURSES

Course code	19MATAEA	NUMERICAL METHODS	L	T	P	C
Core/Elective/Supportive		Elective	4	1	0	4
Pre-requisite		Basic Knowledge in Algebraic &Differential Equations	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To understand appropriate numerical methods to solve algebraic and transcendental equations
2. To perform an error analysis for various numerical methods and derive appropriate numerical methods to solve definite integrals.
3. To develop appropriate numerical methods to solve a system of linear equations.
4. To learn special kinds of differential equations such as elliptic, parabolic and hyperbolic differential equations

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Solve algebraic and transcendental equations using appropriate numerical methods and approximate a function using appropriate numerical methods.	K2
CO2	Derive numerical methods for various mathematical operations and tasks such as interpolation, differentiation, integration and the solution of linear and nonlinear equations.	K3
CO3	Analyze and evaluate the accuracy of common numerical methods.	K4
CO4	Demonstrate understanding of the numerical methods in real life problems	K4
CO5	To evaluate the numerical methods using software's	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Solving Nonlinear Equations	12 hours

Newton's method – Convergence of Newton's method – Bairstow's method for quadratic factors. **Numerical Differentiation and Integration**: Derivatives from differences tables – Higher-order derivatives – Divided difference, Central difference formulas – The trapezoidal rule-A composite formula – Romberg integration – Simpson's rules.

Unit:2	Solving set of Equations:	14 hours

The elimination method – Gauss and Gauss Jordan methods – LU decomposition method – Matrix inversion by Gauss-Jordan method – Methods of iteration – Jacobi and Gauss Seidal iteration – Relaxation method – Systems of nonlinear equations.

Unit:3	Solution of Ordinary Differential Equations:	14 hours

Taylor series method – Euler and modified Euler methods – Runge- Kutta methods – Multistep methods – Milne's method – Adams-Moulton method.

Unit:4	**Boundary value problems and Characteristic value problems**	**15 hours**
The shooting method – Solution through a set of equations – Derivative boundary conditions – Characteristic-value problems – Eigen values of a matrix by iteration – The power method.		
Unit:5	**Numerical solution of Partial Differential Equations:**	**18 hours**
Representation as a difference equation – Laplace's equation on a rectangular region – Iterative methods for Laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The explicit method (ii) The Crank Nicolson method – Solving the wave equation by finite differences.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Applied Numerical Analysis" by **C.F. Gerald and P.O. Wheatley,** Sixth Edition, Addison-Wesley, Reading, 1998. Unit I: Chapter 1: Sections: 1.4, 1.8, 1.11; Chapter 5: Sections: 5.2, 5.3, 5.6, 5.7. Unit II: Chapter 2: Sections: 2.3 - 2.5, 2.7, 2.10 - 2.12. Unit III: Chapter 6: Sections: 6.2 - 6.7. Unit IV: Chapter 7: Sections: 7.2 – 7.5. Unit V: Chapter 7: Sections: 7.6,7.7; Chapter 8: Sections: 8.1 - 8.4.

Reference Books

1	"Numerical Methods for Scientific and Engineering Computation" by Jain MK, Iyengar SRK, Jain R K., Second Edition, Wiley Eastern Ltd, New Delhi
2	"Introduction to Numerical Analysis" by Froberg C E., Second Edition, Addison-Wesley Publishing Company, 1972.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/107/111107105/
2	https://freevideolectures.com/course/3597/numerical-analysis
3	http://mathforcollege.com/nm/videos/index.html

Course Designed By: **Dr. S. Narayanamoorthy**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	S	S	S
CO2	S	S	M	S	S	S	S	M	S	S
CO3	S	S	S	S	M	S	S	S	S	M
CO4	M	M	S	M	S	M	M	S	M	S
CO5	S	M	S	S	M	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATAEB	MATLAB THEORY & PRACTICAL	L	T	P	C
Core/Elective/Supportive		Elective	2	0	2	4
Pre-requisite		Basic knowledge in Numerical Methods	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. This course provides basic fundamentals on MATLAB, primarily for numerical computing.
2. To learn the characteristics of script files, functions and function files, two-dimensional plots and three-dimensional plots.
3. To enhance the programming skills with the help of MATLAB
4. Its features which allow learning and applying specialized technologies.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	It lays foundation for doing matrix manipulations, plotting of functions and data, implementation of algorithms, and creation of user interfaces.	K1
CO2	It helps to understanding in integrating computation, visualization and programming in an easy to use environment where problems and solutions are expressed in familiar mathematical notations.	K2
CO3	This software is a more flexible programming tool for users in order to create large and complex application programs.	K3
CO4	It consists of set of tools that facilitates for developing, managing, debugging and profiling M-files, and MATLAB's applications.	K4
CO5	It consists of set of tools that facilitates for evaluating and crating the MATLAB's applications.	K5 &K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1		**12 hours**
Starting with Matlab - Creating arrays - Mathematical operations with arrays.		
Unit:2	**Script files**	**14 hours**
Script files - Functions and function files.		
Unit:3		**14 hours**
Two-dimensional plots - Three-dimensional plots.		
Unit:4		**15 hours**

Programming in MATLAB.		
Unit:5		**18 hours**
Polynomials, Curve fitting and interpolation - Applications in numerical analysis.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture and practical hours	**75 hours**

Text Book(s)	
1	"MATLAB An Introduction with Application" by **A. Gilat,** John Wiley & Sons, Singapore, 2004. Unit – I: Chapter 1, Chapter 2, Chapter 3 ;Unit -II: Chapter 4, Chapter 6. Unit -III: Chapter 5, Chapter 9; Unit – IV: Chapter 7; Unit - V: Chapter 8, Chapter 10. ***List of practical programs will be issued by course teacher
Reference Books	
1	*"Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers"* by R. Pratap, Oxford University Press, New Delhi, 2006.
2	"*Introduction to Matlab 7 for Engineers"* by W.J. Palm, McGraw-Hill Education, New York, 2005.
3	*"Introduction to MATLAB 7"* by D. M. Etter, D. C. Kuncicky and H. Moore, Prentice Hall, New Jersy, 2004.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/103/106/103106118/
2	https://freevideolectures.com/course/3186/matlab
3	https://www.classcentral.com/course/swayam-matlab-programming-for-numerical-computation-5303
Course Designed By: **Dr. S. Narayanamoorthy**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	L	S	M	S	S	M
CO2	M	S	M	M	S	M	S	M	M	S
CO3	S	M	S	S	L	S	M	S	S	M
CO4	M	M	S	M	S	M	M	S	M	S
CO5	S	S	M	M	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATAEC	COMPUTER PROGRAMMING (C++ Theory & Practical)	L	T	P	C
Core/Elective/Supportive		Elective	2	0	2	4
Pre-requisite		Basic Knowledge in C	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To perform object oriented programming to develop solution to problems demonstrating.
2. The usage of objects as instances of classes and data members, to implement various member functions and manage I/O operation.
3. To learn the characteristics of the object oriented programming language, data abstraction, dynamic memory allocation and inheritance,
4. To learn about operator overloading and type conversions.
5. To enhance problem solving and programming skills with extensive programming sessions.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Remember to use different data structures and memory allocation method.	K1
CO2	Understand advanced features of C++ such as stream I/O templates and operator overloading.	K2
CO3	Apply and analyze the C++ programme in various mathematical problem	K3
CO4	Apply and analyze the major object oriented concepts to implement object oriented programs in C++, encapsulation and inheritance.	K4 &K5
CO5	Its helps to create the mathematical logical problems in real situation	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	The Big Picture:	12 hours

Overview of object- oriented programming –Characteristics of object- oriented languages –C++ and C. C++ Programming Basics: Basic program construction- Output using cout – Preprocessor directives –Comments –Integer variables –Character variables –Input with cin –Type float – Manipulators –Variable type summary –Type conversion –Arithmetic operators –Library functions.

Unit:2	Loops and Decisions	14 hours

Relational operators –Loops –Decisions –Logical operators- Precedence summary –Other control statements. Structures: Enumerated datatypes. Functions: Simple functions –Passing arguments to functions –Returning values from functions –Reference arguments –Overloaded functions –Inline

functions –Default arguments- Variables and storage classes –Returning by reference.		
Unit:3	**Objects and Classes:**	**14 hours**
A simple class – C++ objects as physical objects –C++ objects as datatypes –Constructors –Objects as function arguments –Returning objects from functions- A card game example –Structures and classes –Classes, objects, and memory –Static class data. Arrays: Array fundamentals –Arrays as class member data –Arrays of objects –Strings.		
Unit:4	**Operator Overloading**	**15 hours**
Overloading unary operators –Overloading binary operators –Data conversion –Pitfalls of operator overloading and conversion. Inheritance: Derived class and base class –Derived class constructors –Overriding member functions –Inheritance in the English distance class –Class hierarchies –Public and private inheritance –Levels of inheritance –Multiple inheritance –Ambiguity in multiple inheritance –Containership: classes within classes –Inheritance and program developing.		
Unit:5	**Pointers:**	**18 hours**
Address and pointers –Pointers and arrays –Pointers and functions –Pointers and string –Memory management: new and delete –Pointers to objects –A linked list example- Pointers to pointers –Debugging pointers. Virtual Functions and Other Subtleties: Virtual functions –Friend functions –Static functions –Assignment and copy-initialization – The this pointer. Files and Streams: Streams –String I/O –Character I/O –Object I/O – I/O with multiple objects –File pointers –Disk I/O with member functions –Error handling Redirection –Command-line arguments –Printer output –Overloading the extraction and insertion operators.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture and practical hours	**75 hours**

PRACTICALS (50 Marks)
SAMPLE LIST OF PRACTICALS

1. DISTANCE CONVERSION PROBLEM

Create two classes DM and DB which store the value of distances. DM stores the value of distances. DM stores distances in meters and centimeters in DB in feet and inches. Write a program that can create the values of the class objects and add one object DM with another object DB. Use a friend function to carry out addition operation. The object that stores the result may be DM object or DB object depending on the units in which results are required. The display should be in the order of meter and centimeter and feet or inches depending on the order of display.

2. OVERLOADING OBJECTS

Create a class FLOAT that contains one float data member overload all the four arithmetic operators

so that operate on the objects of FLOAT.

3. OVERLOADING CONVERSIONS

Design a class polar which describes a part in a plane using polar Co-ordinates radius and angle. A point in polar Co-ordinates is as shown below. Use the over loader + operator to add two objects of polar. Note that we cannot add polar values of two points directly. This requires first the conversion. Points into rectangular co-ordinates and finally converting the result into polar coordinates. You need to use following trigonometric formulas.

X= r * cos(a); Y= r * sin(a); a=tan-1(Y/X) ; r = √(X 2 +Y 2);

4. POLAR CONVERSION

Define two classes polar and rectangular coordinates to represent points in the polar and rectangular systems. Use conversion routines to convert from one system to another.

5. OVRELOADING MATRIX

Create a class MAT of size M*N. Define all possible matrix operations for MAT type objects. Verify the identity.(A-B)^2 = A^2+B^2 – 2*A*B

6. AREA COMPUTATION USING DERIVED CLASS

Area of rectangle = X*Y, Area of triangle = ½ * X * Y

7. VECTOR PROBLEM

Define a class for vector containing scalar values. Apply overloading concepts for vector addition, Multiplication of a vector by a scalar quantity, replace the values in a position vector.

Text Book(s)

1	"Object – Oriented Programming in Microsoft C++" by **R. Lafore,** Galgotia Publications Pvt. Limited, New Delhi, 1999. Unit I: Chapters 1,3 ; Unit II: Chapters 4,5,6; Unit III: Chapter 7, 8; Unit IV: Chapters 9, 10; Unit V: Chapters 12, 14.

Reference Books

1	*"The C Programming Language"* by **B.W. Kernighan & D. M. Ritchie,** Second Edition, Prentice Hall of India Pvt. Limited, New Delhi, 2006.
2	"Object Oriented Programming with C++" by **Balagurusamy E.**, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1996.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/106/105/106105151/
2	https://nptel.ac.in/courses/106/101/106101208/
3	https://www.youtube.com/playlist?list=PL0gIV7t6l2iIsR55zsSgeiOw9Bd_IUTbY
Course Designed By: **Dr. S. Narayanamoorthy**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	S	M	M	S
CO2	M	M	M	M	M	M	S	S	M	S
CO3	S	S	M	S	M	S	S	S	S	M
CO4	M	M	M	M	M	M	M	M	M	S
CO5	S	S	S	M	S	S	S	S	L	S

*S-Strong; M-Medium; L-Low

Course code	19MATAED	PROBABILITY THEORY	L	T	P	C
Core/Elective/Supportive		Elective	4	1		4
Pre-requisite		Basic knowledge in definitions and preliminaries of Mathematical Statistics	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To provide a thorough treatment of probability ideas and techniques necessary for a firm understanding of the subject.
2. Understanding of the ideas in their proofs, and ability to make direct application of those results to related problems.
3. As evidence of that understanding, students should be able to demonstrate mastery of all relevant vocabulary, familiarity with common examples and counterexamples, knowledge of the content of the major theorems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	The ability to use and simulate random variables, distribution functions, probability mass functions, and probability density functions.	K1 & K2
CO2	Through calculus and functional transformations, to answer quantitative questions about the outcomes of probabilistic systems.	K2
CO3	The ability to use and simulate multivariate distributions, independence, conditioning, and functions of random variables.	K2 &K3
CO4	The ability to compute expectations, moments, and correlation functions, to describe relationships between different experimental conditions.	K2 &K3
CO5	The ability to use probabilistic reasoning and the foundations of probability theory to describe probabilistic engineering experiments in terms of sample spaces, event algebras, classical probability, and Kolmogorov's axioms.	K4 & K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Random Events and Random Variables	15 hours

conditional probability - Bayes Theorem Independent events - Random variables - Distribution Function - Joint Distribution – Marginal Distribution - Conditional Distribution - Independent random variables - Functions of random variables.

Unit:2	Parameters of the Distribution	15 hours

Expectation – Moments - The Chebyshev Inequality Absolute moments. **Characteristic functions:** Properties of characteristic functions - Characteristic functions and moments-semi invariants - characteristic function of the sum of the independent random variables - Determination of distribution function by the Characteristic function - Characteristic function of multidimensitional random vectors - Probability generating functions.

Unit:3	Some Probability distributions	15 hours
One point, two point, Binomial - Polya -Hypergeometric - Poisson (discrete) distributions-Uniform-normal gamma-Beta-Cauchy and Laplace (continuous) distributions.		
Unit:4	**Limit Theorems**	**15 hours**
Stochastic convergence - Bernaulli law of large numbers - Convergence of sequence of distribution functions – Levy - Cramer Theorems - de Moivre -Laplace Theorem - Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem - Lapunov Theorem– Borel - Cantelli Lemma -Kolmogorov Inequality and Kolmogorov Strong Law of Large numbers.		
Unit:5	**Markov Chains**	**13 hours**
Preliminaries-Homogeneous Markov chains-The Transition matrix Theergodic theorem- Random variables forming a homogeneous Markov chain.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)

1	**"**Probability theory and Mathematical statistics" by **MarekFisz,** John Wiley and Sons,ThirdEdition,New York, 1963. Unit I: Chapter 1 & 2: 1.5-1.7, 2.1-2.9; Unit II: Chapter 3 & 4: 3.1-3.5, 4.1-4.7 Unit III: Chapter 5: 5.1-5.10; Unit IV: Chapter 6: 6.2-6.4,6.6-6.9,6.11,6.12 Unit V: Chapter 7: 7.1-7.5

Reference Books

1	"Introduction to Mathematical Statistics" by Robert V. Hogg & Allen T. Craig, , 5th Edition, Pearson Education, Singapore, 2002.
2	"Introduction to Probability Models" by S.M. Ross, Academic Press, India, 2000
3	"Mathematical Statistics" by John E. Freund, 5th edition, Prentice Hall India, 1994.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=mrCrjeqJv6U&list=PLbMVogVj5nJQWowhOG0-K-yI-bwRRmm3C
2	https://www.youtube.com/watch?v=VVYLpmKRfQ8&list=PLbMVogVj5nJQrzbAweTVvnH6-vG5A4aN5

Course Designed By: **Dr. R. Rakkiappan**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	M	M	S	S	S	S	S	S	S
CO2	L	S	S	S	S	M	S	S	S	S
CO3	S	M	M	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S
CO5	M	S	S	S	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATAEE	FUZZY SET THEORY	L	T	P	C
Core/Elective/Supportive		Elective	4	1	0	4
Pre-requisite		Basic knowledge in set theory & Analysis	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To understand the basic knowledge of fuzzy set theory.
2. To gain knowledge in fuzzy relations and fuzzy measures
3. To learn the basics of pattern recognition and decision making.
4. To learn about relations between crisp and fuzzy in applications.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	It lays foundation for difference between the concepts of crisp and fuzzy set, principle for fuzzy sets in the real life situations.	K2
CO2	The ability to use and understand the concept of operations on fuzzy sets- Union, intersection, complement properties of α-cuts.	
CO3	This course also provides the several relations according to the fuzzy set theory and possibility theory	K3
CO4	Knowledge and understanding of the applications such as Fuzzy clustering; Fuzzy image processing, fuzzy decision making and fuzzy ranking methods.	K4
CO5	Demonstrate understanding of the Fuzzy Set theory in real applications	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Crisp sets and Fuzzy sets	12 hours

Fuzzy Sets (basic concepts); Representation of fuzzy sets; Decompositions theorems; Extension Principle for fuzzy sets.

Unit:2	Operation on fuzzy sets	14 hours

Operations on Fuzzy sets-Union, intersection and complement; Properties of De-Morgan's Laws: α-cuts of fuzzy operations.

Unit:3	Fuzzy Relations	14 hours

Crisp and fuzzy relations-Projections; Binary fuzzy relations; Binary relations on a single set; Fuzzy equivalence relations; Fuzzy compatibility relations; Fuzzy ordering relations; Fuzzymorphism ; Compositions of fuzzy relations

Unit:4	Possibility theory	15 hours
Fuzzy Measure; Evidence Theory; Possibility theory; fuzzy sets and possibility theory.		
Unit:5	**Pattern Recognition& Fuzzy Decision Making:**	**18 hours**
Fuzzy clustering; Fuzzy image processing. Multi-person decision making; Multicriteria decision making; Multistage decision making; Fuzzy Ranking Methods.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**75 hours**

Text Book(s)

1	"Fuzzy Sets and Fuzzy Logic : Theory and Applications" by George J. Klir and Bo Youn, Prentice Hall of India, 2004.

Reference Books

1	"Fuzzy Set theory and its Applications" by H.J. Zimmerman, Kluwer Academic Publishers,.
2	"Fuzzy Sets and Systems: Theory and Applications" by D. DuBois and H.M. Prade, Academic Press, 1994.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/102/111102130/
2	https://nptel.ac.in/courses/127/105/127105006/
3	https://www.youtube.com/watch?v=oWqXwCEfY78

Course Designed By: **Dr. S. Narayanamoorthy**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	S	M	S	M	M	S
CO2	S	M	S	S	M	S	M	S	S	M
CO3	M	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	M
CO5	S	S	S	M	S	S	S	S	L	S

*S-Strong; M-Medium; L-Low

Course code	19MATAEF	GRAPH THEORY	L	T	P	C
Core/Elective/Supportive		Elective	4	1	0	4
Pre-requisite		Concept of relation, mapping, Discrete Structures	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:
1. Explain basic concepts in graph theory, with an emphasis on applications and modeling.
2. Discuss the key ideas, theorems, and proofs of the important result.
3. To learn to model problems using graphs and to solve these problems algorithmically.
4. To develop rigorous logical thinking and analytical skills by graph theoretic concepts, which helps for solving real time problems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Grasp the type of graphs, features, properties of special graphs	K2
CO2	Use the concept and properties of different types of trees	K3
CO3	Formulate and prove central theorems about trees, matching, connectivity, colouring and planar graphs	K3
CO4	Discuss the concept of graph, tree, Euler graph, cut set and Combinatorics	K4
CO5	Use graph theory as a modelling tool	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Graphs And Subgraphs	13- hours

Elementary Concepts of Graphs and Digraphs , Graphs - Degree sequences - Connected graphs and Distance -Digraphs and Multigraphs - Cut vertices - Bridges - Blocks - Automorphism group of a graph.

Unit:2	Trees and Connectivity	15- hours

Trees and Networks: Trees, cut edges and bonds, cut vertices, Cayley Formula, the maxflow min-cut theorem, connectivity, blocks. The Connector problem, Menger's theorem.

Unit:3	Euler Tours and Hamilton Cycles	15- hours

Euler and Hamiltonian Paths. Necessary and sufficient conditions for Euler circuits and paths in simple, undirected graphs. Hamiltonicity: noting the complexity of hamiltonicity, Traveling Salesman's Problem, Nearest neighbor method.

Unit:4	Planar Graphs	15- hours

Planarity in graphs, Euler's Polyhedron formula. Kuratowski's theorem . Vertex connectivity, Edge connectivity, covering, Independence.

Unit:5	Matching and Colouring	15- hours
Matching in Bipartite graphs, perfect matching. The personnel Assignment problems, The Optimal assignment problems. Colorings: Edge chromatic number, Coloring of Chordal graph, Class-1 graphs, Class-2 graphs, Vizing's theorem, Brook's theorem.		
Unit:6	**Contemporary Issues**	**2 hours**
The Shortest Path Problem, The Chinese Postman Problem, The Personnel Assignment Problem		
	Total Lecture hours	**75- hours**

Text Book(s)

1	"Graph Theory with Applications" by Bondy, J. A. and Murty, U.S.R. North Holland Publication (2000).

Reference Books

1	"Graph Theory with Application to Engineering and Computer Science" by Narasing Deo, Prentice Hall of India, New Delhi. 2003
2	"Graph Theory" by F. Harary: Addition Wesley, 1969

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Graph Theory A NPTEL Course by S.A. Choudum , Department of Mathematics IIT Madras Chennai, India https://nptel.ac.in/courses/111/106/111106050/
2	Graph Theory by Prof. SoumenMaity, IISER, PUNE https://swayam.gov.in/nd1_noc20_ma05
3	Graph Theory by Prof. S.A. Choudum , IIT Madras, https://nptel.ac.in/courses/111/106/111106102/

Course Designed By: **Dr. S. Bharathi (BUPEC, Erode)**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	S	M	M	M	M	S
CO2	S	M	M	S	S	S	M	M	S	S
CO3	S	M	M	S	S	S	M	M	S	M
CO4	S	S	M	S	S	S	M	M	S	S
CO5	S	M	S	S	S	S	M	S	S	S

*S-Strong; M-Medium; L-Low

Course code	19MATAEG	Advancements in Industry 4.0	L	T	P	C
Core/Elective/Supportive		Elective	4	1	0	4
Pre-requisite		Basic knowledge computer science	Syllabus Version		2020-2021	

Unit:1	MACHINE LEARNING	15 hours
Machine learning–Introduction-Definition-Types of Machine Learning-Supervised, Unsupervised, Reinforcement Learning – Algorithms for Machine Leaning – Problems solved by Machine Learning – Tools for Machine Learning – Applications areas of Machine Learning		

Unit:2	Robotic Process Automation (RPA)	15 hours
Robotic Process Automation (RPA): Introduction to RPA – Need for automation Programming constructs in RPA - Robots and Softbots – RPA architecture and process methodologies – Industries best suited for RPA – Risks & Challenges with RPA		

Unit:3	Cloud Computing	15 hours
Cloud Computing: Need – Definition – Types of Cloud – Types of Services – SaaS, PaaS,Iaas		

Unit:4	Cyber Security	15 hours
Cyber Security : Cyber Crime and Information Security – Classification of Cyber Crimes Types of Cyber Attacks – Cyber crime and Indian IT Act 2000 - Security Methods		

Unit:5	Virtual Reality	13 hours
Virtual Reality: Definition – Types of Head Mounted Displays – Tools for Virtual Reality – Applications of VR in Education, Industries – Differences between VR and AR .		

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		
	Total Lecture hours	75 hours

Text Book(s)

1	"Higher Education for Industry 4.0 and Transformation to Education 5.0" by P.Kaliraj and T.Devi, (in Press)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	www.uipath.com

Course Designed By: **University**


Supportive
Course

SUPPORTIVE COURSES

Course code		APPLIED MATHEMATICS-I	L	T	P	C
Core/Elective/Supportive		Supportive	2	0	0	2
Pre-requisite		Any allied mathematics course in under graduation	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. Introduce basic applied mathematics to students from other Departments
2. Understand basic tools of applied mathematics which are essential in problem solving
3. Introduce fundamental concepts in differential equations and vector calculus

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Solve differential equations and their systems arising in other field	K2
2	Formulate differential equations for the given scenario	K3
3	Extend basic calculus to vectors	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Ordinary Differential Equations	7 hours

Second order linear equations: homogeneous linear equations with constant coefficients – case of complex roots – non-homogeneous equations – solutions by variation of parameters.

Unit:2	Systems of Ordinary Differential Equations - Basics	7 hours

Systems of differential equations: introductory ideas on vectors, matrices, eigenvalues and eigenvectors - basic concepts and theory – homogeneous linear systems with constant coefficients.

Unit:3	Systems of Ordinary Differential Equations - Applications	7 hours

Systems of differential equations: phase plane, critical points and stability.

Unit:4	Vector Differentiation	7 hours

Differential calculus: Calculus in several variables – gradient – divergence - curl.

Unit:5	Vector Integration	8 hours

Integral calculus: line integrals – path independence (statements alone) - double integrals.

Unit:6	**Contemporary Issues**	**1 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**37 hours**

Text Book(s)	
1	"*Advanced Engineering Mathematics*" by **E. Kreyszig,** Eighth Edition, John Wiley and Sons, (Asia) Pvt Ltd., Singapore, 2000. Unit I : Chapter 2: Sections 2.2, 2.3, 2.8, 2.10 Unit II : Chapter 4: Sections 4.0, 4.2, 4.3 Unit III: Chapter 4: Section 4.4 Unit IV: Chapter 8: Sections 8.8- 8.11 Unit V : Chapter 9: Sections 9.1, 9.2, 9.3
Reference Books	
1	"Higher Engineering Mathematics" by B.S.Grewal, Khanna Publishers, 43rd Edition 2015
2	"Essential Mathematical Methods for Physicists" by H.J. Weber and G.B. Arfken, Academic Press, 2003.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.edx.org/course/mathtrackx-differential-calculus (Dr Melissa Humphries, University of Adelaide)
2	https://www.edx.org/course/engineering-calculus-and-differential-equations (Prof. Kwok Wing Chow and Prof. Kai Man Tsang, University of Hong Kong)
Course Designed By: **Dr. S. Saravanan**	

Course code	191GS56	APPLIED MATHEMATICS-II	L	T	P	C
Core/Elective/Supportive		Supportive	2	0	0	2
Pre-requisite		Any allied Mathematics subject in Undergraduate studies	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Learn the basic concepts of system dynamics and applications in various disciplines.
2. Understand the methods to analyze the system behavior for linear and nonlinear, homogeneous and non-homogeneous cases.
3. Introduce the Fourier series and its application to the solution of partial differential equations.
4. Solve the simple problems using Fourier transform and Complex Integration.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Formulate simple physical processes as mathematical models.	K1
2	Select the appropriate methods to solve the mathematical problems.	K2
3	Apply the acquired knowledge to identify the different kinds of system behavior.	K3
4	Find the Fourier transform, inverse Fourier transform and Residue of a function.	K5
5	understand and evaluate partial derivatives and integrals of multivariable functions	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Fourier Analysis and Partial Differential Equations**	**8 hours**

Fourier series: functions of period 2π - even and odd functions - half range expansions.

Unit:2	**Fourier Analysis and Partial Differential Equations**	**7 hours**

Fourier Transform.

Unit:3	**Fourier Analysis and Partial Differential Equations**	**7 hours**

Partial differential equations: basic concepts - solution using separation of variables.

Unit:4	**Complex Analysis**	**7 hours**

Complex integration: line integral – two integration methods - Cauchy integral theorem - Cauchy integral formula.

Unit:5	**Residue Theorem**	**7 hours**

Residue integration method: residues - residue theorem - evaluation of real integral.

Unit:6	**Contemporary Issues**	**1 hours**

Expert lectures, online seminars - webinars

	Total Lecture hours	**37 hours**

Text Book(s)	
1	"Advanced Engineering Mathematics" by E. Kreyszig, Eighth Edition, John Wiley and Sons, (Asia) Pvt Ltd., Singapore, 2000. Unit I: Chapter 10.2, 10.4, 10.5 Unit II: Chapter 10.11 Unit III: Chapter 11.1, 11.3 Unit IV: Chapter 13.1, 13.2, 13.3, 13.5 Unit V: Chapter 15.1-15.3
Reference Books	
1	"Higher Engineering Mathematics" by B.S. Grewal, Thirty Eighth Edition, Khanna Publishers, New Delhi, 2004.
2	"Higher Engineering Mathematics" by John Bird, Sixth Edition, Published by Elsevier Ltd. 2010
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/105/111105035/
2	https://nptel.ac.in/courses/111/106/111106046/
3	https://www.youtube.com/watch?v=gZNm7L96pfY
Course Designed By: **Dr. M. Muthtamilselvan**	

Job Oriented Certificate Courses

Job Oriented Certificate Programme (Add on Programme)

Job Oriented Course	Data Analytics using R	Credits: 4	
Pre-requisite	Basic knowledge of programming and statistics	Syllabus Version	2020-2021

Course Objectives:

The main objectives of this course are to:

1. Introduce the programming knowledge in R
2. Inculcate various methods to visualize data
3. Linear Algebra, Numerical Methods
4. Learn machine learning techniques

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Download and install open source software R	K1
2	Visualize and summarize data	K2
3	Recognize Rconcepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved in order to solve the problems using multiple approaches	K3
4	Determine the solutions of Linear Algebra and Numerical Methods using R	K5
5	Students are introduced to modern concepts and methodologies in R	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Essentials of R	08 hours

Introduction to Data Analytics - Introduction to R – download and installation procedure – Data types: vectors, list, matrix, array, data frame, list - data management.

Unit:2	Functions of R	08 hours

Functions: built in functions – user defined function – Control structures: looping and conditional structures – R packages.

Unit:3	Visualization	11 hours

Methods of collection of various data - Visualization of data: bar plot – line plot – pie plot – multiple bar diagram – histogram - boxplot - steam-leaf plot – strip chart — scatter plot –

Unit:4	Linear Algebra	09 hours

Vector Operations, Arrays and Matrices (Matrix addition, Matrix Multiplication)

Unit:5	Numerical Methods	09 hours

Taylor series method – Euler and modified Euler methods – Runge- Kutta methods

	Total Lecture hours	**45 hours**
Books for study and References		
1	Crawley, M.J. (2007). The R Book, John Wiley and Sons Limited.	
2	Purohit, Gore and Deshmukh (2008). Statistics Using R, Narosa Publishing House, New Delhi	
3	Gupta, S.P. (2014). Statistical Methods, 43rd edition, Sultan Chand, New Delhi	
4	"Applied Numerical Analysis" by C.F. Gerald and P.O. Wheatley, Sixth Edition, AddisonWesley, Reading, 1998.	
Related Online Contents		
1	https://cran.r-project.org/	
2	https://nptel.ac.in/courses/110/107/110107095/	
3	http://www.digimat.in/nptel/courses/video/111104100/L01.html	
Course Designed By: **Dr. S. Narayanamoorthy**		

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	S	M	S	S
CO2	S	M	S	S	M	S	M	S	S	S
CO3	S	S	M	M	S	S	S	S	S	L
CO4	S	S	S	S	M	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	M	M

*S-Strong; M-Medium; L-Low

Job Oriented Course	Python for Data Analytics	Credits: 4	
Pre-requisite	Basic knowledge of programming, statistics & mathematics	Syllabus Version	2020-2021

Course Objectives:

The main objectives of this course are to:

1. Introduce the programming knowledge in Python
2. Learn descriptive statistics using Python
3. Learn machine learning Techniques
4. Learn ODE using Python

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Remember to download and install open source software Python	K1
CO2	Recognize Python concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved in order to solve the problems using multiple approaches	K2
CO3	Interpret the Python programming in to the real world problems	K3
CO4	Determine the solutions of ODE using Python	K4
CO5	Create the code structures for real applications	K5
CO6	Students are introduced to modern concepts and methodologies in Python	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Introduction to Python	08 hours

Introduction- History of Python-Python Features-Python Interpreter- Installation and setup: Windows-Linux-macOS-Installing/ Updating Python Packages.

Unit:2	Data Structures	10 hours

Introduction-NumPy package-Python List: Introduction-Accessing values-List Manipulation-List Operations-Python Tuples: Creating Tuples-Operation in Tuples- Accessing and Functions in Tuples.

Unit:3	Descriptive Statistics	08 hours

Descriptive Statistics – Measures of location and Scale – Correlation and regression.

Unit:4	Machine Learning Techniques	10 hours

Machine Learning – Introduction – supervised and unsupervised machine learning - Classification – Discrimination – Clustering techniques

Unit:5	Ordinary Differential Equations	09 hours

Functions , Variables and Derivatives

	Total Lecture hours	**45 hours**
Books for study and References		
1	Fred L.Drake , Guido Van Russomk, " An Introduction to Python", Network Theory Limited.	
2	Magnus Lie Hetland , Beginning Python: From Novice to Professional", 2nd Edition.	
3	Gupta, S.P. (2014). Statistical Methods, 43rd edition, Sultan Chand, New Delhi	
4	Kaliraj P and Devi T, Highere education for Industry 4.0 and Transformation to Education 5.0, 2020	
Related Online Contents		
1	https://www.youtube.com/watch?v=VV3BnroVjZo	
2	https://www.youtube.com/watch?v=Dkifb6nytao	
3	https://nptel.ac.in/courses/111/107/111107137/	
Course Designed By: **Dr. S. Narayanamoorthy**		

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	M	M	S
CO2	S	M	S	S	M	S	M	S	S	S
CO3	M	S	M	M	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	M
CO5	S	S	S	M	S	M	S	L	M	S

*S-Strong; M-Medium; L-Low


Value Added
Courses

Value Added Programme (Add on Programme)

Value added Course	Latex	Credits: 4	
Pre-requisite	**Basic knowledge of programming & mathematics**	**Syllabus Version**	2020-2021

Course Objectives:

The main objectives of this course are to:

1. Introduce the Software knowledge in Latex
2. Learn Mathematics structures using Latex
3. Understanding the basic concepts and their properties are important for the development of the present and further courses.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Remember to Download and install open source software Latex	K1
2	Understanding and formatting Latex	K2
3	Illustrate to learn to create Latex file	K3
4	Apply and Analyze the Latex commands to large files	K3 & K4
5	Able to learn mathematics derivations and structures using LATEX	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	**07 hours**

Text formatting, TEX and its offspring

Unit:2	**09 hours**

What's different in LATEX2ϵ , Distinguishing LATEX2 ϵ, Basic of a LATEX file

Unit:3	**07 hours**

Commands and Environments-Command names and arguments, Declarations Lengths, special Characters.

Unit:4	**09 hours**

Document layout and Organization-Document class, Page style, Parts of the Document

Unit:5	**08 hours**

Table of Contents, Fine tuning text, Footnotes and marginal notes.

Total Lecture hours	**40 hours**

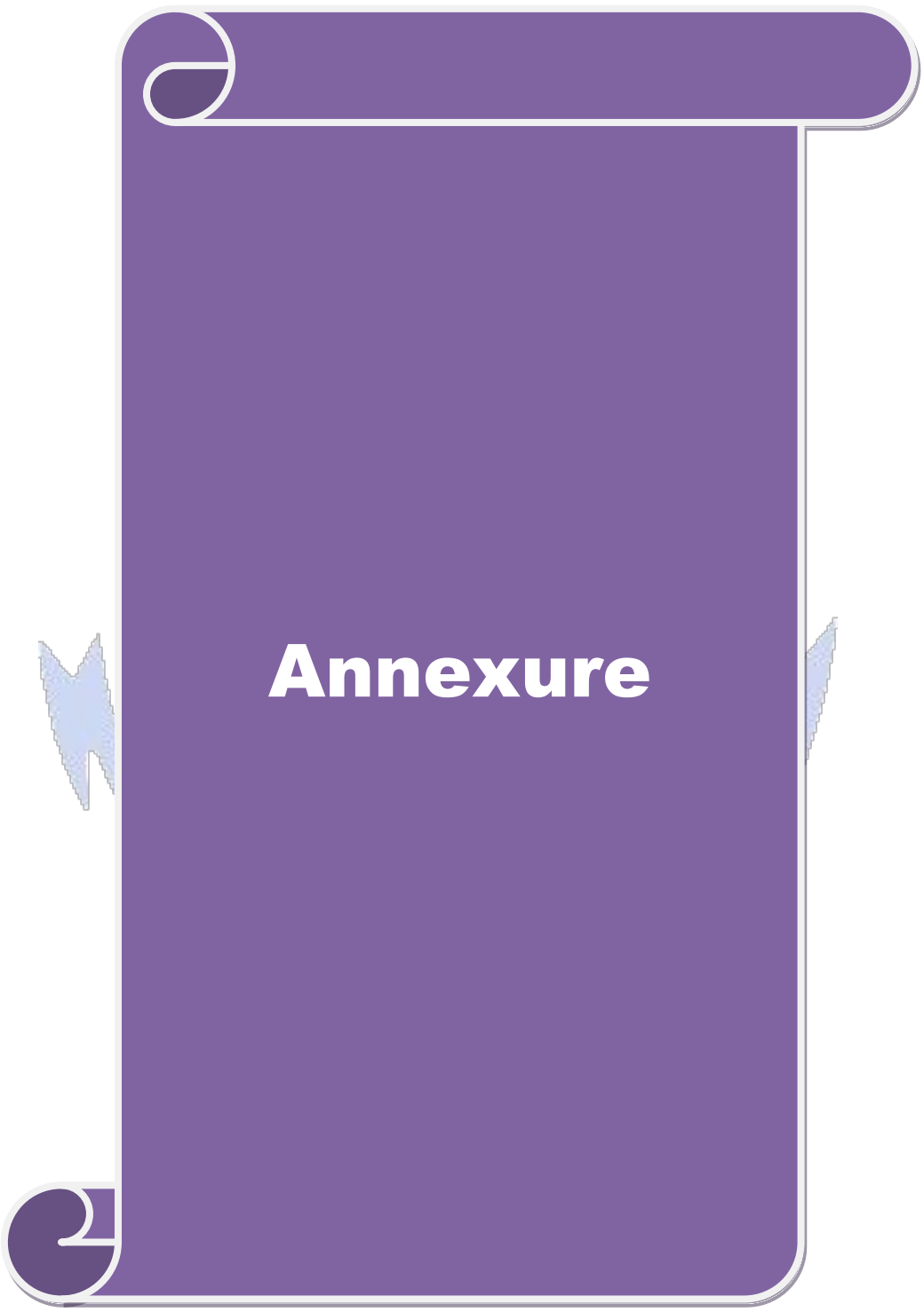
Books for study and References

1 H. Kopka and P.W. Daly , "A guide to LATEX" - third Edition, Addison –Wesley , London

	1999.
2	**Stefan Kottwitz** "LaTeX Beginner's Guide: Create High-quality and Professional-looking Texts, Articles, and Books for Business and Science Using LaTeX" Packt Publishing, 2011
Related Online Contents	
1	https://onlinecourses.swayam2.ac.in/aic20_sp17/preview
2	https://www.classcentral.com/course/edx-latex-for-students-engineers-and-scientists-15201
3	http://home.iitk.ac.in/~dasgupta/teaching/LSSC/TechInScholComm/A%20Brief%20Introduction%20to%20LaTeX-2017-8.pdf
4	http://www.latextemplates.com/
Course Designed By: **Dr. S. Narayanamoorthy**	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	M	S	S	M
CO2	M	S	S	M	S	M	S	S	M	S
CO3	M	S	S	M	M	M	S	M	S	S
CO4	S	M	S	S	S	S	S	S	S	S
CO5	M	S	M	M	M	M	S	S	M	S

*S-Strong; M-Medium; L-Low


Annexure

M. Sc. MATHEMATICS

Syllabus

(With effect from 2020-21)

Programme Code : 111

DEPARTMENT OF MATHEMATICS
Bharathiar University
(A State University, Accredited with ''A'' Grade by NAAC and
13th Rank among Indian Universities by MHRD-NIRF)
Coimbatore 641 046, INDIA

LIST OF ELECTIVES	
19MATAEA	Numerical Methods
19MATAEB	Matlab Theory & Practical
19MATAEC	Computer Programming (C++ Theory & Practical)
19MATAED	Probability Theory
19MATAEE	Fuzzy Set Theory
19MATAEF	Graph Theory
19MATAEG	Advancements in Industry 4.0

ONLINE COURSES
In addition to the above, the students have to earn at least two additional credits at any time during the course of study by taking an online course from Swayam.

SUPPORTIVE COURSES OFFERED TO OTHER DEPARTMENTS	
191GS21	Applied Mathematics I (Odd Semester)
191GS56	Applied Mathematics II (Even Semester)