Master of Science (M.Sc.) in Mathematics

Course Descriptions Year Wise

First Year

Ordinary Differential Equations (19M21MA111)

Course Code	**19M21MA111**	**Semester Odd**		**Semester I Session-** 2024- 2025 **Month from** July-Dec 2024	
Course Name	Ordinary Differential Equations				
Credits	4		**Contact Hours**	3-1-0	
Faculty (Names)	**Coordinator(s)**				
	Teacher(s) (Alphabetically)				

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C110.1	explain the basic theory of ordinary differential equations, existence and uniqueness theorem of initial value problems and phase plane analysis for nonlinear systems.	Understanding Level (C2)
C110.2	utilize Frobenius method to solve differential equations and discuss Bessel's functions.	Applying Level (C3)
C110.3	apply matrix method to solve a system of homogeneous linear ordinary differential equations.	Applying Level (C3)
C110.4	make use of orthogonality of functions in solving Sturm-Liouville boundary value problems.	Applying Level (C3)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Basic theory of linear differential equations	Initial value problems, boundary-value problems and existence of solutions, the homogeneous linear equation with constant coefficients, variation of parameters, the Cauchy-Euler equation, applications to ordinary differential equations in LCR and mass spring problem.	**8**
2.	Series solution	Power series solutions about an ordinary point, solutions about singular points; the method of Frobenius, Bessel's equation and Bessel functions.	**5**
3.	System of linear differential equations	The matrix method for homogeneous linear systems with constant coefficients: two equations in two unknown functions.	**5**

4.	Existence and uniqueness theory	The fundamental existence and uniqueness theorem, dependence of solutions on initial conditions and on the function.	**6**
5.	Sturm-Liouville boundary value problems	Theory of the homogeneous linear system, the non-homogeneous linear system, Strum Theory, Strum-Liouville problems, orthogonality of characteristic functions, the expansion of a function in a series of orthonormal functions, trigonometric Fourier series, Green's function.	**14**
6.	Nonlinear differential equations	Phase plane, paths and critical points, critical points and path of linear systems, critical points and path of non-linear systems.	**4**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Each student in a group of 3-4 will apply the concepts of homogeneous and non-homogeneous linear systems and BVPs to solve practical problems.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**S. L. Ross,** Differential Equations, 3rd Ed., John Wiley & Sons, Singapore, 2007.
2.	**G. F. Simmons,** Differential Equations with Applications and Historical Notes, 3rd Ed., CRC Press, Boca Raton, 2016.
3.	**P. L. Sachdev,** A Compendium on Nonlinear Ordinary Differential Equations, Wiley-Blackwell, 1996.
4.	**E. A. Coddington,** An Introduction to Ordinary Differential Equations, Dover Publications, 2012.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
C110.1	**3**	**2**	**-**	**2**
C110.2	**3**	**2**	**-**	**2**
C110.3	**3**	**2**	**1**	**2**
C110.4	**2**	**2**	**1**	**2**
AVG	**2.75**	**2.00**	**1.00**	**2.00**

Real Analysis (19M21MA112)

Course Code	**19M21MA112**	**Semester Odd**	**Semester I Session-** 2024- 2025 **Month from** July-Dec 2024
Course Name	Real Analysis		
Credits	4	**Contact Hours**	3-1-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C111.1	explain metric space, sequence and series, continuity, measures and integrals with their properties.	Understanding Level (C2)
C111.2	apply the concepts of sequence and series of functions, uniform convergence and its properties on various problems.	Applying Level (C3)
C111.3	make use of the properties of metric space, Riemann-Stieltjes integrals in solving related problems.	Applying Level (C3)
C111.4	examine the continuity, measurability, integrability and uniform convergence of functions.	Analyzing Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Review of sets	Finite, countable and uncountable sets, metric spaces, compact sets, perfect sets, connected sets.	**4**
2.	Sequences and series	Convergent sequences, sub sequences, Cauchy sequences, power series, absolute convergence, algebra of series, rearrangements of elements in a series	**5**
3.	Continuity	Limits of functions, continuous functions, compactness, connectedness, monotonic functions, infinite limits and limits at infinity.	**6**
4.	The Riemann-Stieltjes integral	Definition and existence of the Riemann-Stieltjes integral, properties of the integral, integration and differentiation, integration of vector-valued functions, rectifiable curves.	**9**
5.	Sequence and series of functions	Sequences and series of functions: interchanging order of limits for sequences of functions, uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, equi-continuous families of functions, Stone Weierstrass theorem.	**10**

6.	Lebesgue theory	Measurable sets and their properties, Lebesgue measure, measurable functions, Lebesgue integral of functions of arbitrary sign, integrable functions.	**8**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Students will be divided in the group of 2-3 students to collect the literature and to explore the applications of series, sequences and Lebesgue integral.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**W. Rudin,** Principles of Mathematical Analysis, 3rd Ed., New Delhi, McGraw-Hill Inc., 2013.
2.	**H. L. Royden, and P. M. Fitzpatrick,** Real Analysis, 4rd Ed., New Delhi, Pearson, 2010.
3.	**N. L. Carothers,** Real Analysis, Cambridge University Press, 2000.
4.	**T. M. Apostol,** Mathematical Analysis –A modern approach to Advanced Calculus, New Delhi, Addison-Wesley, 1974.
5.	**R. G. Bartle, and D. R. Sherbert,** Introduction to Real Analysis, 4th Ed., Wiley, 2011.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
C111.1	**2**	**1**	**-**	**1**
C111.2	**3**	**2**	**-**	**2**
C111.3	**3**	**2**	**-**	**2**
C111.4	**3**	**2**	**1**	**2**
AVG	**2.75**	**1.75**	**1.00**	**1.75**

Abstract Algebra (19M21MA113)

Course Code	**19M21MA113**	**Semester Odd**	**Semester I Session-** 2024-2025 **Month from** Jul -Dec 2024

Course Name	Abstract Algebra			
Credits	4		**Contact Hours**	3-1-0
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing this course, the students will be able to:		
C112.1	recall the basics of group and ring theory.	Remembering (C1)
C112.2	explain Cayley, Cauchy, Sylow theorems, rings, ideals, modules, fields and their properties.	Understanding (C2)
C112.3	apply the theory of integral domain, principal ideal domain, irreducibility of polynomials and modules in solving related problems.	Applying (C3)
C112.4	examine Euclidian domain, Unique factorization domain, fields extensions and its properties.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Groups	Review of basic group theory, isomorphism theorems, group actions, Cayley's theorem, class equation of a group, Cauchy's theorem, p-groups, Sylow's theorems and their applications.	**10**
2.	Rings	Rings, ideals and homomorphisms, quotient rings, isomorphism theorems, prime and maximal ideals, rings of fractions, integral domain, Euclidean domains, principal ideal domains and unique factorization domains (UFD), polynomial rings over UFDs, criteria for irreducibility of polynomials over UFD's.	**12**
3.	Modules	Basic definitions and examples, submodules and direct sums, quotient modules, homomorphism and isomorphism theorems, cyclic modules, free modules.	**10**
4.	Fields	Fields and their extensions, algebraic and finitely generated field extensions, splitting fields and normal extensions, algebraic closures, finite fields, separable and inseparable extensions, Galois groups, fundamental theorem of Galois theory. Applications of fields.	**10**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, PBL etc.)
Total	**100**

Project based learning: Students in small groups will opt a topic form the concerned CO. Students must explore those areas where the theory of fields are used. For example, finite fields are used in number theory, Galois theory, coding theory and combinatorics; and again the notion of algebraic extension is an important tool. Such type of activity enhances student's knowledge in this domain.	
Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	**D. S. Dummit and R. M. Foote,** Abstract Algebra, 2nd Ed., John Wiley & Sons, 2008.
2.	**S. K. Jain, P. B. Bhattacharya and S. R. Nagpaul,** Basic Abstract Algebra, 2nd Ed., Cambridge University Press, 2014.
3.	**I. N. Herstein,** Topics in Algebra, 2nd Ed., John Wiley & Sons, 2006.
4.	J**. B. Fraleigh,** A First Course in Abstract Algebra, 7th Ed., Pearson Education, 2013.
5.	**C. Carstensen, B. Fine, B. and G. Rosenberger,** Abstract Algebra: Applications to Galois Theory, Algebraic Geometry and Cryptography, Heldermann Verlag, 2011.

CO-PO and CO-PSO Mapping:

CO	PO1	PO2	PO3	PSO1
C112.1	**2**	**1**		**1**
C112.2	**2**	**2**		**2**
C112.3	**3**	**2**		**2**
C112.4	**3**	**2**	**1**	**2**
Avg.	**2.5**	**1.75**	**1.00**	**1.75**

General Topology (19M21MA114)

Course Code	**19M21MA114**	**Semester Odd**	**Semester I Session-** 2024- 2025 **Month from** July - Dec 2024	
Course Name	General Topology			
Credits	4	**Contact Hours**	3-1-0	
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			
COURSE OUTCOMES				**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:				
C113.1	recall metric spaces and related concepts.			Remembering (C1)

C113.2	understand the elementary properties of metric space, topological spaces and structures defined on them.		Understanding (C2)
C113.3	construct maps on topological spaces and solve problems on different types of topologies.		Applying (C3)
C113.4	make use of the concepts of various topological spaces and their properties in solving related problems.		Applying (C3)
Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Metric Space	Metric space, open sets, closed sets, Convergence, completeness, continuity in metric space, Cantor intersection theorem	**6**
2.	Topological space	Topological space, elementary concept, basis for a topology, Open and closed sets, interior and closure of sets, neighbourhood of a point, limit points, boundary of a set, Subspace topology, weak topology, Product topology, quotient topology	**9**
3.	Continuous Function	Continuous maps, continuity theorems for open and closed sets, homeomorphism	**4**
4.	Compactness and Connectedness	Connected spaces, continuity and connectedness, components, totally disconnected space, locally connected space, Compact space, limit point compact, sequentially compact space, local compactness, Continuity and compactness, Tychonoff theorem	**11**
5.	Countability and Separation	First and second countable spaces, T_1 spaces, Hausdorff spaces, Regular spaces, normal spaces, completely normal space, completely regular space, Tietz extension theorem, Metrizability, Uryshon lemma, Uryshonmetrization theorem	**12**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, PBL etc.)
Total	**100**

Project based learning: Each student in a group of 3-4 will apply the concepts of countability and separation axioms of topological spaces in mathematical applications

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**G. F. Simmons,** Introduction to Topology and Modern Analysis, Tata Mc-Graw Hill Education, New Delhi, 2016.

2.	**J. R. Munkres,** Topology: A First Course, 2nd Ed., PHI, 2010.
3.	**Y. Min,** Introduction to Topology: Theory & Applications, Higher Education Press, 2010.
4.	**S. Lipschutz,** General Topology, Schaum's Outline Series, Mc-Graw-Hill, 1985.
5.	**C. A. R. Franzosa,** Introduction to Topology, Narosa Publishers, New Delhi, 2007.
6.	**K. D. Joshi,** Introduction to General Topology, New Age Publishers, New Delhi, 1983.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
C113.1	**1**	**1**	**-**	**1**
C113.2	**1**	**2**	**1**	**2**
C113.3	**2**	**1**	**-**	**2**
C113.4	**3**	**2**	**1**	**2**
Avg	**1.75**	**1.50**	**1.00**	**1.75**

Mathematical Methods (19M21MA115)

Course Code	**19M21MA115**	**Semester Odd**		**Semester I** **Session-** 2024-2025 **Month from** July-Dec 2024	
Course Name	Mathematical Methods				
Credits	4		**Contact Hours**	3-1-0	
Faculty (Names)	**Coordinator(s)**				
	Teacher(s) (Alphabetically)				
COURSE OUTCOMES					**COGNITIVE LEVELS**
After pursuing this course, the students will be able to:					
C114.1	understand the concept of functional and its variations, integral equations and integral transformations.				Understanding (C2)
C114.2	solve Fredholm and Volterra type integral equations and use it in solving initial value problems.				Applying (C3)
C114.3	apply the concept of integral transformations to solve integral and differential equations.				Applying (C3)
C114.4	analyze the variational and boundary value problems and its solutions.				Analyzing (C4)

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	Functional and its Variation	Introduction, variation and its properties, comparison between the notion of extrema of a function and a functional, construction of functional, problem of brachistochrone, geodesics and isoperimetric problem.	**6**
2.	Variational Problems with fixed and moving Boundaries	The system of Euler's equations, the fundamental lemma of the calculus of variations, examples, functionals in the form of integrals, special cases containing only some of the variables, functionals depending on the higher derivatives of the dependent variables, Euler-Poisson equation, Ostrogradsky equation, moving end problems, Rayleigh-Ritz method, Galerkin's method and Kantorovich method of solving differential equations.	**10**
3.	Integral equations	Integral equations of Fredholm and Volterra type, Conversion from IVP and BVP. Solution by successive substitution and successive approximation, integral equations with degenerate kernels. Fredholm's theorems, integral equations with symmetric kernel, eigenvalues and eigenfunctions of integral equations and their simple properties.	**10**
4.	Applications of integral equations	Longitudinal vibrations of the rod, deformation of a rod, Green's function, influence function, construction of Green's function when the boundary value problem contains a parameter, Abel integral equation, weakly singular kernel, iteration of the singular equation.	**8**
5.	Integral transform methods	Introduction, Laplace transform, properties of the Laplace transform, application to Volterra integral equation, Fourier transform, application of Fourier transform, introduction to Hankel and Mellin transform, Fox's integral equation.	**8**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Students will be divided in the group of 2-3 students to collect the literature and explore the application of variational problems with fixed and moving boundaries and integral equations.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	**L. Elsegolc,** Calculus of Variation, Dover Publications, 2010.
2.	**I. M. Gelf and, S.V. Fomin,** Calculus of Variations, Prentice Hall, 2012.
3.	**R. P. Kenwal,** Linear Integral Equation; Theory and Techniques, Academic Press, 1971.
4.	**F. B. Hildebrand,** Methods of Applied Mathematics, Dover Publications, 1992.
5.	**S. Pal and S. C. Bhunia,** Engineering Mathematics, Oxford University Press, 2015.
6.	**I. G. Petrovsky,** Lectures on the Theory of Integral Equations, Mir Publishers, Moscow, 1971.
7.	**L. Debnath and D. Bhatta,** Integral Transforms and Their Applications, Chapman and Hall/ CRC, 2006.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
C114.1	1	-	-	1
C114.2	2	2	-	2
C114.3	2	2	1	2
C114.4	3	3	1	2
Avg	2.00	1.75	1.00	1.75

Linear Algebra (19M21MA116)

Course Code	19M21MA116	**Semester: Even**	**Semester** II **Session** 2024-25 **Month from** Jan - May 2025
Course Name	Linear Algebra		
Credits	4	**Contact Hours**	3-1-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		
COURSE OUTCOMES			**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:			

C120.1	explain the basics of vector spaces, linear transformation, canonical forms, and inner product spaces.		Understanding (C2)
C120.2	apply the concept of vector spaces and linear transformation in solving related problems		Applying (C3)
C120.3	solve the problems based on invariant subspaces, matrix exponential, and inner product spaces		Applying (C3)
C120.4	examine canonical forms, orthogonality and operators		Analyzing (C4)
Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Vector spaces	Vector space, subspace, elementary properties of vector spaces, sum of subspaces, linear combination, linear dependence and independence, basis and dimension, ordered bases and coordinates	10
2.	Linear transformation	Basic definitions, null space and range space, rank-nullity theorem, matrix of linear transformation, change of basis, linear functional, dual spaces, dual basis.	10
3.	Canonical forms	Eigenvalues and eigenvectors, eigen space, minimal polynomial, The Cayley-Hamilton theorem, diagonalisation, invariant subspaces, Jordan canonical representation, norm of a matrix, computation of a matrix exponential.	10
4.	Inner product spaces	Inner product spaces, orthogonal and orthonormal vectors, normed space, Gram-Schmidt process for orthogonalisation, projection theorem, quadratic forms, positive definite forms, adjoint operator, unitary operator, normal operator.	12
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Each student in a group of 2-3 will collect literature on canonical forms and inner product space to solve some practical problems. To make the subject application based, the students analyze to deal with afore mentioned topics.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**K. Hoffman and R. Kunze,** Linear Algebra 2nd Ed., Prentice Hall of India, 2015.

2.	**V. Krishnamurty, V. P. Mainra and J. L. Arora,** An introduction to Linear Algebra, Affilated East-West, 1976.
3.	**G. Strang,** Linear Algebra and its applications, 6th Ed., Cambridge Press, 2023.
4.	**H. Anton and C. Rorres,** Elementary linear algebra, 11th Ed., Wiley, 2016**.**
5.	**G. H. Golub and C. F. V Loan,** Matrix Computations, 3rd Ed., Hindustan Book Agency, 2007.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
C120.1	2	1	-	1
C120.2	3	2	-	2
C120.3	3	2	-	2
C120.4	3	2	1	3
Avg	2.75	1.75	1.00	2.00

Mathematical Statistics (19M21MA211)

Course Code	**19M21MA211**	**Semester Odd**		**Semester III Session 2024-25** **Month from** Jan 2025- June 2025	
Course Name	Mathematical Statistics				
Credits	4		**Contact Hours**	3-1-0	
Faculty (Names)	**Coordinator(s)**	XXXX			
	Teacher(s) (Alphabetically)	XXXX			

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	recall basic concepts of random variables, sampling and parameter estimation	Remembering (C1)
CO2	explain theory of parameter estimation, hypothesis testing and regression analysis.	Understanding (C2)
CO3	apply concepts of random variables and sampling in parameter estimation, hypothesis testing and regression analysis.	Applying (C3)
CO4	examine population parameters using the techniques of parameter estimation and hypothesis testing.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Probability Theory and 1D random variable	Probability Space, discrete and continuous random variables, expectation, mean, variance, moment generating function (MGF), Characteristic function.	**4**
2.	Bivariate random variable	Discrete and continuous random variables, joint, marginal and conditional distributions, independent random variables, expectation, correlation.	**5**
3.	Probability distributions	Binomial, Poisson, uniform, normal, F, student's-t, and Chi-square distributions.	**6**
4.	Theory of sampling	Sampling theory, random sampling, Sample moments, distribution of sample mean, variance, Central limit theorem.	**5**
5.	Point estimation	Properties of good estimators, unbiasedness, consistency, efficiency, maximum likelihood estimator, method of moments, Cramer-Rao inequality, Uniformly minimum variance unbiased estimator.	**6**

6.	Interval estimation	Confidence interval, pivotal quantity, interval estimators for population parameters.	**4**
7.	Hypothesis testing	Null and alternative hypothesis, type I and type –II error, analysis of discrete data and Chi-square test of goodness of fit, large sample tests.	**5**
8.	Analysis of variance	One way of analysis with equal and unequal sample size, tests for the homogeneity of variances.	**4**
9.	Linear Regression	Regression curve and scedastic curves, simple linear regression, least square method, likelihood method.	**3**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials, PBL)
Total	**100**

Project based learning: Students in small groups will collect sample data set and make regression models. They will validate and analyze the model by hypothesis testing and ANOVA. By this students will be able to make regression models.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc.
(Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**A. M. Mood, F. A. Graybill and D. C. Boes,** Introduction to the theory of statistics, 3rd Indian Ed., Mc Graw Hill, 2001.
2.	**R. V. Hogg and A. T. Craig,** Introduction to mathematical Statistics, Mc-Millan, 1995.
3.	**V. K. Rohatgi,** An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern, 1984.
4.	**S. M. Ross,** A First Course in Probability, 6th edition, Pearson Education Asia, 2002.
5.	**S. Palaniammal,** Probability and Random Processes, PHI Learning Private Limited, 2012.
6.	**P. L. Mayer,** Introductory Probability and Statistical Applications, Addison-Wesley, Second Edition, 1972.
7.	**R. E. Walpole, R H. Myers, S. L. Myers, and K. Ye,** Probability & Statistics for Engineers & Scientists, 9th edition, Pearson Education Limited, 2016.
8.	**I. Miller and M. Miller, John E. Freund's** Mathematical Statistics with Applications, 8th Edition, Pearson Education Limited 2014.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
CO1	**3**	**2**	**1**	**2**

CO2	**3**	**2**	**1**	**2**
CO3	**3**	**2**	**3**	**2**
CO4	**3**	**2**	**3**	**2**
Avg	**3.00**	**2.00**	**2.00**	**2.00**

Functional Analysis (19M21MA119)

Course Code	19M21MA119	**Semester** Even	**Semester II** **Session** 2024-25 **Month from** Jan - Jun 2025
Course Name	Functional Analysis		
Credits	4	**Contact Hours**	3-1-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C123.1	explain metric space, Banach spaces, Hilbert spaces, orthonormal basis and their properties.	Understanding (C2)
C123.2	make use of the concepts of Banach and Hilbert spaces to prove the fundamental theorems of functional analysis.	Applying (C3)
C123.3	apply basic theoretical techniques to explore linear functionals and operators on normed spaces and develop the orthonormal systems in solving the related problems.	Applying (C3)
C123.4	examine the fundamental theorems of functional analysis for their simple applications.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Normed spaces and Banach space I	Review of Holder inequality, Minkowski inequality and vector spaces with examples to l_p and L_p spaces, normed space, Banach space, subspace of Banach space.	5
2.	Normed spaces and Banach space II	Finite dimensional normed space and subspaces. Linear operators, bounded and continuous linear operators, their properties and related results.	7
3.	Some fundamental theorems of normed spaces	Principle of uniform boundedness, boundedness and continuity of linear transformations, Hahn-Banach theorem, open mapping theorem, closed graph theorem.	6
4.	Inner Product Spaces and Hilbert spaces 1	Inner product spaces, Schwarz and Minkowski inequalities, Hilbert spaces, relation between Banach and Hilbert spaces, projections, orthonormal basis, Reisz-representation theorem.	8
5.	Inner Product Spaces and Hilbert spaces II	Convex sets, existence and uniqueness of a vector of minimum length, projection theorem, orthogonal and orthonormal systems in Hilbert spaces with examples.	8

6.	Inner product spaces and Hilbert spaces III	Bessel's inequality, Parseval's identity, characterization of complete orthonormal systems.	4
7.	Banach fixed point theorem	Contraction mapping, Banach fixed point theorem and its applications.	4
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, PBL, Tutorials)
Total	**100**

Project based learning: Students will be divided in groups of 3-4 students to explore the applications of the fundamental theorems of functional analysis such as uniform boundedness theorem, Hahn-Banach theorem, fixed point theorem etc in solving various related problems .

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc.
(Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**E. Kreyszig**, Introductory Functional Analysis with Applications, John Wiley and Sons, Inc., 2011.
2.	**W. Rudin,** Functional Analysis, 2nd Edition, Mc-Graw Hill, 2018.
3.	**G. F. Simmons,** Introduction to Topology and Modern Analysis, 2nd revised and updated edition, Affiliated Est-West Press New Delhi, 2024.
4.	**A. H. Siddiqi, K. Ahmad and P. Manchanda**, Introduction to Functional Analysis with Applications, Anamaya Publication, New Delhi, 2006.
5.	**L. Debnath and P. Mikusinski**, Introduction to Hilbert spaces with Applications, 3rd Edition, Elsevier, 2010.
6.	**G. Bachman and L. Narici,** Functional Analysis, Dover Publication, 2012
7.	**M. T. Nair,** Functional Analysis: A First Course, 2nd Edition PHI India, 2021.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
C111.1	**2**	**1**	**-**	**1**
C111.2	**3**	**2**	**-**	**2**
C111.3	**3**	**2**	**-**	**2**
C111.4	**3**	**2**	**1**	**3**
Avg	**2.75**	**1.75**	**1.00**	**2.00**

Partial Differential Equations (19M21MA120)

Course Code	19M21MA120	**Semester Even**	**Semester** II **Session** 2024-25 **Month from** Jan - Jun 2025
Course Name	Partial Differential Equations		
Credits	4	**Contact Hours**	3- 1- 0
Faculty (Names)	**Coordinator(s)**	Dr. Pato Kumari	
	Teacher(s) (Alphabetically)	Dr. Pato Kumari	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C124.1	explain first order partial differential equations (PDE), classification of second order PDE and Fourier series.	Understanding (C2)
C124.2	identify boundary value problems and solve Laplace equation.	Applying (C3)
C124.3	make use of Fourier transforms to solve PDE.	Applying (C3)
C124.4	analyze problems related to heat equation and wave equation in cylindrical and spherical polar coordinates.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1	First-order Partial Differential Equations (PDEs)	Formation and classification of first-order PDEs, linear semi-linear and quasi-linear equations, Cauchy problem, method of characteristics, nonlinear first order PDEs, complete integrals, compatible systems, Lagrange method for first order PDEs, Charpit's method.	10
2	Fourier Series	Introduction to Fourier series, convergence of Fourier series for continuous and piecewise continuous functions, Fourier cosine and sine series, Fourier transform, Fourier sine and cosine transform.	5
3	Second-Order PDEs	Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, reduction to canonical forms.	3

4	Laplace's Equation	Basic concepts, types of boundary value problems, the maximum and minimum principle, the method of separation of variables, the Dirichlet problem for the rectangle, the Dirichlet problem for annuli and disk, solution of Laplace equation in cylindrical and spherical polar coordinates.	8
5	Heat Equation	Derivation of the heat equation, maximum and minimum principles, uniqueness, continuous dependence, method of separation of variables, solution of heat equation in cylindrical and spherical polar coordinates.	6
6	Wave Equation	Derivation of the wave equation, infinite string problem, D'Alembert solution of the wave equation, semi-infinite string problem, finite vibrating string problem, method of separation of variables, inhomogeneous wave equation, Duhamel's principle.	7
7	Fourier transform methods for PDEs	Fourier transform methods for heat flow problem in an infinite and semi-infinite rod, Infinite string problem, Laplace equation in a half-plane.	3
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials, PBL)
Total	**100**

Project based learning: Each student in a group of 3-4 will apply the concepts of Laplace's equation, Heat equation, Wave equation to solve some field problems.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc.
(Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**Sneddon, I. N.,** Elements of Partial Differential Equations, Hassell Street Press, 2021.
2.	**John, F.,** Partial Differential Equations, Springer New York, 2013.
3.	**Strauss, W. A.,** Partial Differential Equations: An Introduction, 2nd ed, Wiley, 2012.
4.	**Willams, W. E.,** Partial Differential Equations, Clarendon Press, 2010.
5.	**Evans, L. C.,** Partial Differential Equations, AMS, 1998.
6.	**McOwen, R.,** Partial Differential Equations, Pearson, 2002.

7.	**Powers, D. L.,** Boundary Value Problems and Partial Differential Equations, 5th Ed., Academic Press, 2006.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
C124.1	3	1	-	1
C124.2	3	2	-	2
C124.3	3	2	-	2
C124.4	3	2	1	3
Avg.	3.00	1.75	1.00	2.00

Computer Programming (19M21MA118)

Course Code	**19M21MA118**	**Semester Even**	**Semester II Session 2024-25 Month from Jan - May 2025**
Course Name	Computer Programming		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C122.1	explain fundamentals of programming.	Understanding (C2)
C122.2	apply structures and functions in programming.	Applying (C3)
C122.3	make use of function overloading and pointers in programming.	Applying (C3)
C122.4	analyze the problems using the concepts of object-oriented programming.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the Module**
1.	Basic Computer Fundamentals	Introduction to computer systems; number system, integer, signed integer, fixed and floating-point representations; integer and floating-point arithmetic, expression and operators.	5

2.	Basics of Programming	Input/output; Constants, variables, expressions and operators; Naming conventions and styles; Conditions and selection statements; Looping and control structures (while, for, do-while, break and continue); Arrays; File I/O, header files, string processing; Pre-processor directives.	10
3.	Programming through functional decomposition	Structures; design of functions, void and value returning functions, parameters, scope and lifetime of variables, passing by value, passing by reference, passing arguments by constant reference, recursive functions; Function overloading and default arguments; Library functions.	10
4.	Pointers	Pointers; Dynamic data and pointers, dynamic arrays.	5
5.	Object Oriented Programming Concepts	Data hiding, abstract data types, classes, access control; Class implementation-default constructor, constructors, copy constructor, destructor, operator overloading, friend functions; Object oriented design (an alternative to functional decomposition) inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.	12
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, PBL)
Total	**100**

Project based learning: A group of 2 to 3 students will be formed. Each group will have a group leader to develop coordination among the group members. Each group will be assigned a project based on programming skills. The group leader of each group will submit a report of 6-7 pages and then finally each member of the group will be evaluated through a viva voce.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**Lafore R.,** Object-Oriented Programming in C++. Sams Publishing, 4th edition, 2017.
2.	**Stroustrup, B.,** The C++ Programming Language. Addison-Wesley, 4th edition, 2013.
3.	**Deitel, H.M. and Deitel, P.J.,** C++ How to Program. Prentice Hall, 8th edition, 2011.
4.	**Schildt, H.,** C++: The Complete Reference. McGraw-Hill, 4th Ed., 2002.
5.	**Lippman, S. B. and Lajoie, J. and Moo, B.E.,** The C++ Primer. Addison-Wesley Professional, 5th Ed., 2012.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
C122.1	**2**	**1**	**-**	**1**

C122.2	**2**	**2**	**-**	**2**
C122.3	**3**	**2**	**-**	**2**
C122.4	**3**	**3**	**1**	**2**
AVG	**2.50**	**2.00**	**1.00**	**1.75**

Computer Programming Lab (19M25MA111)

Course Code	**19M25MA111**	**Semester Even**	**Semester II Session 2024-25 Month from Jan - May 2025**	
Course Name	Computer Programming Lab			
Credits	1	**Contact Hours**	0-0-2	
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C170.1	demonstrate the use of the concepts of fundamentals of programming.	Understanding (C2)
C170.2	develop programs using arrays, structures and functions.	Applying (C3)
C170.3	examine function overloading, recursive function and pointers for dynamic memory allocation.	Analyzing (C4)
C170.4	analyse the programs using various concepts of object oriented programming	Analyzing (C4)

Module No.	**Title of the Module**	**List of Experiments**	
1.	Basic Computer Fundamentals	Write programs in C++ to understand the arithmetic operators, logical and relational operators.	
2.	Basic Programming and Statements	Write programs in C++ for I/O functions and conditional statements like if … else etc.	
3.	Basic Programming and loops	Write programs in C++ for controlling execution through loops e.g. for, while and do … while etc.	

4.	Use of loops and statements	Write C++ programs for n!, e^x, sin$x$, log(1+x).	
5.	Arrays and strings	Write C++ programs using 1D and 2D arrays like Sorting of arrays, Matrix multiplication. Strings.	
6.	Structures	Write C++ programs of time and distance structures	
7.	Functions	Write C++ programs using functions for Matrix multiplication, HCF of two numbers, factorial, etc.	
8.	Functions	Write programs in C++ using call by value, reference, recursive functions, function overloading.	
9.	Pointers	Write programs in C++ for handling addressing through pointers.	
10.	Object oriented programming Concepts	Write programs in C++ using OOPs concepts like Object and classes, Constructor, Destructors.	
11.	Object oriented programming Concepts	Write program of Complex class. Use of Operator overloading, Friend functions.	
12.	Object oriented programming Concepts	Write programs in C++ showing the application of Inheritance.	

Evaluation Criteria

Components	**Maximum Marks**
Lab Test 1	20
Lab Test 2	20
TA	60 (Quiz, Assignments, Tests, Viva)
Total	**100**

Project based learning: A group of 2 to 3 students will be formed. Each group will have a group leader to develop coordination among the group members. Each group will be assigned a project based on its commercial and general applications illustrating the programming skills. The group leader of each group will submit a report of 5-6 pages and then finally each member of the group will be evaluated through a viva voce.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**Lafore R.,** Object-Oriented Programming in C++. Sams Publishing, 4th edition, 2017.
2.	**Stroustrup, B.,** The C++ Programming Language. Addison-Wesley, 4th edition, 2013.
3.	**Deitel, H.M. and Deitel, P.J.,** C++ How to Program. Prentice Hall, 8th edition, 2011.
4.	**Schildt, H.,** C++: The Complete Reference. McGraw-Hill, 4th Ed., 2002.
5.	**Lippman, S. B. and Lajoie, J. and Moo, B.E.,** The C++ Primer. Addison-Wesley Professional, 5th Ed., 2012.

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PSO1
C170.1	**2**	**2**	**-**	**2**
C170.2	**3**	**3**	**-**	**2**
C170.3	**3**	**2**	**1**	**2**
C170.4	**3**	**2**	**1**	**2**
AVG	**2.75**	**2.25**	**1.00**	**2.00**

Advanced Matrix Theory (20M22MA211)

Course Code	20M22MA211	**Semester Even**	**Semester II Session 2024-25** **Month from** Jan 2025- June 2025
Course Name	Advanced Matrix Theory		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C230.1	explain vector spaces, inner product spaces and matrix norms.	Understanding (C2)
C230.2	apply the process of orthonormalization in QR decomposition and expansion of functions.	Applying (C3)
C230.3	solve the system of linear equations and eigenvalue problems using direct and iterative methods.	Applying (C3)
C230.4	analyze systems of differential and difference equations arising in dynamical systems using matrix calculus.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Linear System of equations**	Existence and uniqueness of solution for a system of linear equations, LU- decomposition methods, Crout's and DooLittle's methods, Cholesky method, conjugate gradient method.	**7**
2.	**Normed and Inner Product Spaces**	*p*-norms of a vector, norms of a matrix, condition number, Orthogonal matrices, QR factorization, expansion in terms of orthonormal basis–Fourier series, orthogonal complement, Pythagoras theorem.	**10**

3.	**Eigen value Problems**	Eigen values and Eigenvectors, spectral radius, Greshgorin's theorem, Power and Inverse power methods eigen system of a Hermitian matrix, Singular Values and Singular Value Decomposition.	**12**
4.	**Matrix Calculus**	Powers and functions of matrices, approximation methods of function of matrices, application to solve discrete dynamical systems $x(t+1) = Ax(t)$, $x(0) = \alpha$ and a system of differential equations of the form $dx/dt = Ax$, $x(0) = \alpha$.	**13**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments)
Total	**100**

Project based learning: Each student in a group of 3-4 will apply the concepts of matrix calculus to solve system of differential equations related to some practical problems.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**R. Bronson and G. B. Costa,** Matrix Methods: Applied Linear Algebra and Sabermetrics**,** 4th Edition, Academic Press, 2020.
	R. Bronson, Matrix Methods an Introduction, Academic Press, 1991.
2.	**G. H. Golub,** Matrix Computations, 4th Edition, Johns Hopkins University Press, 2013.
3.	**K. B. Datta,** Matrix and Linear Algebra, 3rd Edition, Prentice Hall of India, 2016.
4.	**W. L. David,** Matrix Theory, World Scientific, 1991.
5.	**R. A. Horn and C. R. Johnson,** Topics in Matrix Analysis, Cambridge University Press, 2013.
6.	**G. Strang,** Linear Algebra and its Applications, Thomson, Brooks/Cole, 2006.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
CO1	**3**	**2**	**-**	**1**
CO2	**3**	**2**	**-**	**2**
CO3	**3**	**2**	**-**	**2**

CO4	**3**	**2**	**1**	**3**
Avg	**3.00**	**2.00**	**1.00**	**2.00**

Second Year

Complex Analysis (19M21MA117)

Course Code	19M21MA117	**Semester** Odd		**Semester III Session 2024-2025** **Month from** Jul- Dec 2024	
Course Name	Complex Analysis				
Credits	4		**Contact Hours**	3-1-0	
Faculty (Names)	**Coordinator(s)**				
	Teacher(s) (Alphabetically)				

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C121.1	explain the basic concepts of calculus of functions of complex variables.	Understanding (C2)
C121.2	apply the results of complex differentiation and integration in solving the related problems.	Applying (C3)
C121.3	solve the problems concerning, singularities, expansion of functions and residues.	Applying (C3)
C121.4	examine the problems of conformal mapping and contour integration.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Complex Differentiation	Limit, continuity and differentiability, analytic functions, Cauchy Riemann equation,. harmonic functions, harmonic conjugate, construction of analytic functions, exponential function, trigonometric and inverse trigonometric functions, logarithmic function, complex powers, branches of multi valued functions	12
2.	Complex Integration	complex line integral, Cauchy-Goursat theorem, independence and deformation of path; Cauchy's integral formulas and their consequences, Cauchy inequality, Liouville's theorem, fundamental theorem of algebra, Morera's theorem, maximum modulus principle, Schwarz lemma, analytic continuation.	10
3.	Power Series and Singularities	Taylor and Laurent series and their convergence. zeros and singularities of complex functions, classification of singularities: removable singularity, poles, essential singularities, residue at a pole and at infinity, Cauchy's residue theorem and	12

		its applications in evaluation of real integrals: integration around unit circle, integration over semi-circular contours (with and without real poles), integration around rectangular contours. Argument principle, Rouche's theorem.	
4.	Conformal Transformations	Conformal transformations, bilinear transformations, critical points, fixed points, problems on cross-ratio and bilinear transformation	8
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc.
(Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**Churchill, R. V. and Brown, J.W.,** Complex Variables and Applications, McGraw-Hill, 9th edition, 2021.
2.	**Spiegel, M.R., Lipschutz, S, John J. S, Spellman, D**. Complex Variables, Schaum's Outline, 2nd edition, 2009.
3.	**Ponnusam, S.**, Foundations of Complex Analysis, Narosa Publishing House, Second Edition, Reprint, 2022.
4.	**Lang, S.,** Complex Analysis, Springer-Verlag, 1999.
5.	**Gamelin ,T.W.,** Complex Analysis, Springer-Verlag, 2001.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
C121.1	**3**	**2**	**-**	**1**
C121.2	**3**	**2**	**-**	**2**
C121.3	**3**	**3**	**-**	**2**
C121.4	**3**	**3**	**1**	**2**
Avg	**3.00**	**2.50**	**1.00**	**1.75**

Numerical Analysis (19M21MA212)

Course Code	**19M21MA212**	**Semester Odd**	**Semester III Session 2024-2025** **Month from** Jul- Dec 2024

Course Name	Numerical Analysis		
Credits	3	**Contact Hours**	3
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
CO1	explain the methods for roots of non-linear equations, interpolation and system of linear equations	Understanding (C2)
CO2	apply numerical methods for system of linear and non-linear equations, interpolation, differentiation, integration and differential equations.	Applying (C3)
CO3	analyse computational techniques for finding approximate solutions of related problems.	Analyzing (C4)
CO4	estimate eigen values and solution of the initial and boundary value problems.	Evaluating (C5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Concept of Errors**	Truncation, round-off and maximum absolute errors, relative error, accuracy of the numbers.	**2**
2.	**Algebraic and transcendental equations**	Iterative method, Newton-Raphson's method. successive iteration method, rate of convergence, roots of a polynomial: Horner's method, Birge Vita method, Lin's method, Bairstow and Muller's method, Roots of a system of nonlinear equations.	10
3.	**System of linear algebraic equations**	Gauss elimination method, Gauss-Jordon method, LU-decomposition method, inverse of matrices, Jacobi and Gauss-Seidal iterative methods, convergence of iteration methods.	**6**
4.	**Eigen values and eigen vectors**	Power's method to find dominant eigen value and eigen vector, Rayleigh method, eigen values and eigen vectors of a symmetric matrix by Jacobi's, Given's and Householder's method.	**6**
5.	**Interpolation**	Newton's divided difference, Gauss forward and backward interpolation, Lagrange's interpolation, spline interpolation.	**3**
6.	**Numerical differentiation and integration**	Approximation of derivatives, Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle' rules of integration with errors, Romberg integration, Gaussian two and three point quadrature rules, double integration by Trapezoidal and Simpson's rules.	**6**
7.	**Differential equations**	Picard's method, Euler's and modified Euler methods, Taylor's series method, Runge-Kutta 2^{nd} and fourth order methods, multistep methods, solution of simultaneous and higher order equations, boundary value problems: finite difference and shooting methods.	**9**
		Total number of lectures	**42**

Evaluation Criteria Components	**Maximum Marks**

T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project Based Learning: Each student in a group of 4-6 will apply the concepts of numerical methods for the solution of ODE and PDE.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**M. K. Jain, S. R. K. Iyengar and R. K. Jain,** Numerical Methods for Scientific and Engineering Computation, 6th Ed., New Age International, New Delhi, 2014.
2.	**R. S. Gupta,** Elements of Numerical Analysis, 2nd Ed., (2015) Macmillan.
3.	**C. F. Gerald and P.O. Wheatley,** Applied Numerical Analysis, 7th Ed., Pearson Education, 2007.
4.	**Bradie B., A** Friendly Introduction to Numerical Analysis, 1st Ed., Pearson Prentice Hall, 2006
5.	**Pal, M.** Numerical Analysis for Scientists and Engineers: Theory and C Programs, Narosa, Reprint 2020

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
CO1	**2**	**1**	**-**	**2**
CO2	**3**	**2**	**-**	**2**
CO3	**2**	**1**	**-**	**2**
CO4	**3**	**2**	**1**	**2**
Avg	**2.50**	**1.50**	**1.00**	**2.00**

Operations Research (19M21MA213)

Course Code	**19M21MA213**	**Semester Odd**	**Semester III Session 2024-2025** **Month from** Jul- Dec 2024
Course Name	Operations Research		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C213.1	explain the basics of linear programming problems and duality.	Understanding (C2)
C213.2	apply different methods for solving linear programming problems.	Applying (C3)
C213.3	solve various transportation, assignment, queueing and inventory models.	Applying (C3)

C213.4	examine optimality conditions and perform sensitivity analysis for linear programming problems.		Analyzing (C4)
Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Linear Programming Problems (LPP)**	Introduction, definition of operations research, its scope and Application in different areas, Convex sets, formulation of LPP, graphical solutions, Simplex method, big-M method, two phase method, special cases in simplex method.	**10**
2.	**Duality and Sensitivity Analysis**	Primal-Dual relationship, duality, dual simplex method, sensitivity analysis.	**7**
3.	**Transportation Problems**	Mathematical formulation of transportation problem, basic feasible solution-north west corner rule, least cost method, Vogel's approximation method, degeneracy, resolution on degeneracy, optimal solution, maximization case in transportation problem, unbalanced transportation problem.	**7**
4.	**Assignment Problems**	Mathematical formulation of assignment problem, optimality condition, Hungarian method, maximization case in assignment problem, unbalanced assignment problem, travelling salesman problem.	**4**
5	**Elementary Queuing Models**	Markov process, steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1 model.	**7**
6	**Elementary Inventory Models**	Inventory control models: economic order quantity (EOQ), deterministic inventory problems with and without shortage.	**7**
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Each student in a group of 2-3 will collect literature on queueing and inventory models to solve some applicational problem. To make the subject application based, the students analyze the optimized way to deal with aforementioned topics.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**H. A. Taha,** Operations Research- An Introduction, 11th Edition, Pearson Education, 2022.
2.	**G. Hadley,** Linear Programming, Massachusetts, Addition Wesley, 1962.
3.	**F. S. Hiller and G. J. Lieberman,** Introduction to Operations Research, 11th Edition, McGraw-Hill Education, 2021.
4.	**H. M. Wagner,** Principles of Operations Research with Applications to Managerial Decisions, Prentice Hall of India Pvt. Ltd., 1975.

5.	**N. D. Vohra,** Quantitative Techniques in Management, 6th Edition, McGraw-Hill Education, 2021.

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PSO1
C213.1	3	2		2
C213.2	3	3		3
C213.3	3	3	2	3
C213.4	3	3		3
Avg.	**3.00**	**2.75**	**2.00**	**2.75**

Fluid Dynamics (22M22MA211)

Course Code	**22M22MA211**	**Semester Odd**	**Semester III Session-** 2024- 2025 **Month from** July -Dec 2024	
Course Name	Fluid Dynamics			
Credits	3	**Contact Hours**	3-0-0	
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C237.1	explain the basics of fluids, its motions and boundary layer theory.	Understanding (C2)
C237.2	apply the principles of fluid mechanics in solving related problems.	Applying (C3)
C237.3	make use of laminar and potential flows based theorems to solve related problems.	Applying (C3)
C237.4	analyse the concepts of laminar and boundary layer flows.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures**

1.	**Kinematics**	Lagrangian and Eulerian descriptions, equation of continuity, stream lines, path lines and streak lines, vorticity, velocity potential and stream function, compressible and incompressible flows, circulation, rotational and irrotational motions.	8
2.	**Dynamics**	Equations of motion, inviscid case, Bernoulli's theorem, Kelvin's theorem, constancy of circulation, equations referred to moving axes, impulsive actions, vortex motion and its elementary properties, motions due to circular and rectilinear vortices.	8
3.	**Potential Flow**	Irrotational motion in two-dimensions, complex-velocity potential sources, stream function, source, sink and doublets, circle theorem, method of images, conformal mapping, theorem of Blasius, Strokes stream function, motion of a sphere.	8
4.	**Laminar Flow**	Stress components in a real fluid, Navier-Stokes equations, plane Poiseiuille and Couette flows between two parallel plates, flow through a pipe of uniform cross section in the form of circle, flow between two coaxial cylinders, energy equation, dynamical similarity.	9
5.	**Boundary Layer Flows**	Boundary layer thickness, displacement thickness, Prandlt's boundary layer, laminar boundary layer equations, Blasius solution, solution by Karman-Pohlhausen methods, separation of boundary layer flow, dimensional analysis, large Reynold's numbers, similar solutions, flow past a flat plate, temperature distribution in Couette flow and in flow past a flat plate.	9
		Total number of lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Project based learning: Students in small groups will be assigned the problem of boundary layer flows and its applications.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**S. W. Yuan,** Foundation of Fluid Mechanics, 3rd Ed., Prentice Hall, 1976.
2	**F. Chorlton,** Textbook of Fluid Dynamics, C.B.S. Publishers, 2005.

3.	**P. K. Kundu and I. M. Cohen,** Fluid Mechanics, Academic Press, 2005.
4.	**Frank M. White,** Fluid Mechanics, 6th Ed., Tata McGraw-Hill, New Delhi, 2008.
5.	**H. Schlichting and K. Gersten,** Boundary Layer Theory, 9th Ed., Springer, 2017.
6.	**R. W. Fox and A.T. McDonald,** Introduction to Fluid Mechanics, 10th Ed., Wiley, 2020.

CO-PO and CO-PSO Mapping:

CO	PO1	PO2	PO3	PSO1
C237.1	2	2	-	2
C237.2	3	2	-	2
C237.3	3	3	-	3
C237.4	3	3	2	3
Avg	**2.75**	**2.50**	**2.00**	**2.50**

Fuzzy Sets and Applications (20M22MA213)

Course Code	20M22MA213	**Semester Odd**	**Semester III Session 2024-2025** **Month from** Jul- Dec 2024	
Course Name	Fuzzy Sets and Applications			
Credits	3	**Contact Hours**	3-0-0	
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			
COURSE OUTCOMES				**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:				
C232.1	explain the basics of fuzzy set theory and related operations.			Understanding (C2)
C232.2	apply fuzzy mapping and fuzzy rules to solve function approximation models.			Applying (C3)

C232.3	make use of fuzzy set theory in multi criteria decision making problems.		Applying (C3)
C232.4	analyze multi criteria decision making, fuzzy relational data bases and fuzzy queries in crisp databases.		Analyzing (C4)
Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Basic Concepts of Fuzzy Sets**	Motivation, fuzzy sets and their representations, membership functions and their designing, types of fuzzy sets, operations on fuzzy sets, convex fuzzy sets, alpha level cuts, Zadeh's extension principle, geometric interpretation of fuzzy sets.	**4**
2.	**Fuzzy Relations**	Fuzzy relations, projections and cylindrical extensions, fuzzy equivalence relations, fuzzy compatibility relations, fuzzy ordering relations, composition of fuzzy relations.	**4**
3.	**Fuzzy Arithmetic**	Fuzzy numbers, arithmetic operations on fuzzy numbers.	**3**
4.	**Fuzzy Logic**	Fuzzy propositions, fuzzy quantifiers, linguistic variables, fuzzy inference.	**3**
5.	**Possibility Theory**	Fuzzy measures, possibility theory, fuzzy sets and possibility theory, possibility theory versus probability theory.	**5**
6.	**Probability of a fuzzy event**	Baye's theorem for fuzzy events, probabilistic interpretation of fuzzy sets.	**4**
7.	**Fuzzy Implications and Approximate Reasoning**	Fuzzy mapping rules and fuzzy implication rules. fuzzy rule-based models for function approximation, types of fuzzy rule-based models (the Mamdani, TSK, and standard additive models).	**7**
8.	**Decision making in Fuzzy environment**	Fuzzy decisions, fuzzy linear programming, fuzzy multi criteria analysis, multi-objective decision making.	**7**
9.	**Fuzzy databases and queries**	Introduction, fuzzy relational databases, fuzzy queries in crisp databases.	**5**
		Total number of lectures	**42**

Evaluation Criteria

Components Maximum Marks
T1 20
T2 20
End Semester Examination 35
TA 25 (Quiz, Assignments, Tutorials)
Total 100

Project based learning: Students will be divided in the group of 2-3 students to collect the literature report and submit a report on applications of multi-criteria fuzzy decision making.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**J. Yen and R. Langari,** Fuzzy Logic: Intelligence, Control, and Information, Pearson Education, 2003.
2.	**G. J. Klir, and B. Yuan,** Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall of India, 2015.
3.	**H. J. Zimmermann,** Fuzzy Set theory and its Applications, Kluwer Academic Publ, 2020.
4.	**A. K. Bhargava,** Fuzzy Set Theory Fuzzy Logic and Their Applications, S. Chand Publ., First Edition, 2013.
5.	**M. Ganesh,** Introduction to Fuzzy Sets and Fuzzy Logic, PHI Learning Private Limited, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
C232.1	**2**	**2**	**-**	**2**
C232.2	**3**	**2**	**-**	**2**
C232.3	**3**	**2**	**-**	**2**
C232.4	**3**	**3**	**1**	**3**
Avg.	**2.75**	**2.25**	**1**	**2.25**

Graph Theory (21M22MA215)

Course Code	**21M22MA215**	**Semester Even**	**Semester III Session 2024-2025** **Month from** Jul- Dec 2024
Course Name	**Graph Theory**		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
C214.1	explain basics concepts of graphs and trees.	Understanding (C2)
C214.2	solve problems related to trees, cut sets, planarity of graphs, vector spaces and enumeration.	Applying (C3)
C214.3	construct matrix representations and chromatic polynomials for the graphs.	Applying (C3)
C214.4	examine Galois field and graph theoretic algorithms for solving related problems in graph theory.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Basic graph terminology	Graphs and related definitions, directed and undirected graph, Konigsberg bridge problem, utility problem, paths and circuits, subgraphs, isomorphism, Euler graph, operations on graph, Hamiltonian graph, travelling salesman problem, labelled and weighted graphs.	7
2.	Trees and cut sets	Definition, distance, centre in a tree, rooted and binary tree, counting trees, fundamental circuit, spanning tree, connectivity, separability. Fundamental cut set and network flows.	8
3.	Planarity	Planar graph, detection of planarity, geometric and combinatorial dual, thickness and crossings	5
4.	Vector spaces of a graph	Vector and vector spaces, basis, orthogonal vectors and spaces. Modular arithmetic and Galois field.	6
5.	Matrix representation and graph coloring	Various matrix representations of the graph. Graph coloring, four color and five color theorem, chromatic number, chromatic polynomial	7
6.	Enumeration and graph theoretic algorithms	Types of enumeration, counting labeled trees, Polya's counting theorem, algorithms: connectedness and components.	9

		Shortest path algorithm, depth first and breadth first search.	
		Total number of lectures	**42**

PBL: A group of 2 to 3 students will explore more applications in the said area of employability and will use these to solve the real problems. Their findings will be evaluated on the basis of their report as well as viva voce.

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**N. Deo,** Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India, 2004.
2.	**R. Balakrishnan and K. Ranganathan,** A Textbook of Graph Theory, Springer, 2012.
3.	**V. K. Balakrishnan,** Graph Theory, Discrete Mathematics with Applications, Tata McGraw Hill Publishing Co. Ltd. 2004.
4.	**C. Vasudev,** Graph Theory with Applications, New Age International, 2006.
5.	**R. J. Wilson,** Introduction to Graph Theory, 5th Ed., Longman, 2010.
6.	**D.B. West,** Introduction to Graph Theory, 2nd Ed., Pearson Education, New Delhi, 2016.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**
C214.1	3	1		1
C214.2	3	2		2
C214.3	3	3	1	2
C214.4	3	3	1	3
Avg	**3.00**	**2.25**	**1.00**	**2.00**

Theory of Computation (24M22MA211)

Course Code	**24M22MA211**	**Semester** Odd	**Semester III Session** 2024-25 **Month from** July- Dec 2024
Course Name	Theory of Computation		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**	Prof. Alka Tripathi
	Teacher(s) (Alphabetically)	

COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above mentioned course, the students will be able to:		
C238.1	recall the concepts of set theory, graphs and strings.	Remembering (C1)
C238.2	explain basic concepts of automata, languages, Turing machines and limitations of computers in unsolvable problems.	Understanding (C2)
C238.3	identify regular grammar, context free grammar, pushdown automata and apply Myhill-Nerode theorem to minimize automata.	Applying (C3)
C238.4	apply complexity theory and concepts of NP-Completeness to identify problems that do not admit efficient algorithm.	Applying (C3)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures**
1.	Introduction	Sets, relations, functions, recursive function, generating function, graphs and trees, alphabets, strings, languages and grammars .	2
2.	Finite Automata	Finite automata, transition systems, determinism and non determinism, properties of finite automata.	6
3.	Myhill-Nerode theorem, regular grammar and context free grammar	Finite automata regular grammar and regular expressions, pumping lemma for regular sets. The Myhill-Nerode theorem and minimization of finite automata. Context free grammar, and Push-down automata.	6
4.	Computability-Turing Machine	The standard Turing machine model, multi-tape Turing machines, nondeterministic Turing machines.	5
5.	Computability	Representing restricted models of computation, Universal Turing machines, encoding of strings and Turing machines, limits on language acceptance, reducibility and unsolvability, functions computed by Turing machines.	8
6.	Complexity Theory	Languages and problems, serial computational models, classification of decision problems (space and time hierarchies, time-bounded complexity classes, space-bounded complexity classes), complements of complexity classes, hard and complete problems.	11
7.	NP-completeness	NP-complete problems, the boundary between P and NP.	4
		Total number of lectures	**42**

Project based learning: Students in small groups will identify real life problems which are polynomial time solvable or unsolvable. Find complexity of solvable problems.	
Evaluation Criteria **Components** **Maximum Marks** T1 20 T2 20 End Semester Examination 35 TA 25 (Quiz, Assignments, PBL etc.) **Total** **100**	
Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	**P. Linz,** An Introduction to Formal Languages and Automata, 6th edition, Jones & Bartlett, 2016.
2.	**J. E. Hoperoft, R. Motwani, and J. D. Ullman,** Introduction to Automata Theory, Languages and Computation, 3rd edition, Pearson Education, 2016.
3.	**J. C. Martin,** Introduction to Languages and the Theory of Computation, 3rd edition, McGraw-Hill, Inc., New York, NY, 2007.
4.	**S. Homer and A.L. Selman,** Computability and Complexity Theory, Springer-Verlag, Inc., New York, NY, 2nd Edition, 2011.
5.	**H.R. Lewis, C.H. Padadumtriou, and C. Papadimitriou,** Elements of the Theory of Computation, 2nd edition PHI Publ, 2015.
6.	**G.P.S. Varma and B.T. Rao,** Theory of Computation, Scitech Publ. 2011.

CO-PO and CO-PSO Mapping:

COs	PO1	PO2	PO3	PSO1
CO1	2	2	-	2
CO2	3	3	-	2
CO3	3	3	-	2
CO4	3	3	1	2
Avg	2.75	2.75	1.00	2.00

Numerical Analysis Lab (19M25MA211)

Course Code	**19M25MA211**	**Semester Odd**	**Semester III Session 2024-2025** **Month from** Jul- Dec 2024
Course Name	Numerical Analysis Lab		
Credits	01	**Contact Hours**	0-0-2
	Coordinator(s)		

Faculty (Names)	Teacher(s) (Alphabetically)	

COURSE OUTCOMES		COGNITIVE LEVELS
After pursuing the above mentioned course, the students will be able to:		
C270.1	explain the basics of MATLAB to find real roots of algebraic/ transcendental equations.	understanding (C2)
C270.2	develop the program to solve system of linear algebraic equations and interpolation problems using MATLAB.	Applying (C3)
C270.3	compare the MATLAB programs for finding derivatives and integrals using numerical methods.	Analyzing (C4)
C270.4	estimate solutions of ordinary differential equations by developing programs in MATLAB.	Evaluating (C5)

Module No.	Title of the Module	List of Experiments	
1.	Algebraic/ transcendental equations	1. To find a real root of an algebraic/ transcendental equation by using Newton-Raphson method. 2. To find a real root of an algebraic/ transcendental equation by using Successive iteration method. 3. To find a root of an equation by using Muller's method.	
2.	System of linear algebraic equations	4. Implementation of Gauss-Elimination method to solve a system of linear algebraic equations. 5. Implementation of Gauss-Jordon method to solve a system of linear algebraic equations. 6. Implementation of Gauss-Seidel method to solve a system of linear algebraic equations.	
3.	Interpolation	7. Implementation of Lagrange's formula for interpolation. 8. Implementation of Newton's divided difference formula for interpolation.	
4.	Numerical differentiation and integration	9. To find differential coefficients of 1st and 2nd orders using interpolation formulae. 10. To evaluate integrals by using Trapezoidal rule. 11. To evaluate integrals by using Simpson method.	
5.	Differential equations	12. To compute the solution of ordinary differential equations by using Euler's method. 13. To compute the solutions of ordinary differential equations by using Runge-Kutta methods. 14. To solve two point boundary value problem by shooting and finite difference method.	

Evaluation Criteria

Components	Maximum Marks
Lab Test 1	20
Lab Test 2	20

TA	60 (Quiz, Assignments, Tests, Viva)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**R. Pratap,** Getting started with MATLAB: A quick introduction for scientists and engineers, Oxford university press, 2016.
2.	**B. S. Grewal**, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, 11th Ed., Khanna, 2014.
3.	**S. Nomura**, C Programming and Numerical Analysis: An Introduction, 1st Ed, Morgan & Claypool Publishers, 2018.
4.	**S. S. Otto**, Introduction to Programming and Numerical Methods in MATLAB, 1st Ed. Springer, 2005.
5.	**D. Vaughan Griffiths and I. M. Smith,** Numerical Methods for Engineers, 2nd Ed., CRC Press, 2006.
6.	**S. C. Chapra**, Applied Numerical Methods with Matlab for Engineers and Scientists, 2nd Ed. Tata McGraw Hill, New Delhi, 2008.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1
CO1	**3**	**2**	**-**	**2**
CO2	**3**	**2**	**-**	**2**
CO3	**3**	**2**	**-**	**2**
CO4	**3**	**2**	**-**	**2**
Avg	**3.00**	**2.00**	**-**	**2.00**

Operations Research Lab (19M25MA212)

Course Code	**19M25MA212**	**Semester Odd**	**Semester III Session 2024-2025** **Month from** Jul- Dec 2024	
Course Name	Operations Research Lab			
Credits	01	**Contact Hours**	0-0-2	
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			
COURSE OUTCOMES				**COGNITIVE LEVELS**

After pursuing the above mentioned course, the students will be able to:			
C271.1	explain the basics of MATLAB to solve linear programming problems using graphical method.		Understanding (C2)
C271.2	construct the programs to solve linear programming problems using MATLAB.		Applying (C3)
C271.3	develop the program to solve transportation, assignment and travelling salesman problems with the help of MATLAB.		Applying (C3)
C271.4	perform sensitivity analysis by developing programs for linear programming problems in MATLAB.		Analyzing (C4)
Module No.	**Title of the Module**	**List of Experiments**	
1.	Linear programming problems	1. Construct code to solve linear programming problem (LPP) using Graphical method. 2. Construct code to solve linear programming problem (LPP) using Simplex method. 3. Construct code to solve LPP using Big-M method. 4. Construct code to solve LPP using two phase method.	
2.	Duality and sensitivity analysis	5. Construct code to write the dual of a primal problem. 6. Construct code to solve LPP using dual simplex method. 7. Construct code to analyze the sensitivity of optimal solution if cost coefficients are changed. 8. Construct code to analyze the sensitivity of optimal solution if resource vector components are changed. 9. Construct code to analyze the sensitivity of optimal solution if a constraint is added.	
3.	Transportation problem	10. Construct code to solve transportation problem as a LPP.	
4.	Assignment problem	11. Construct code to solve an assignment problem as a LPP.	
5.	Travelling salesman problem	12. Construct code to solve travelling salesman problem.	

Evaluation Criteria

Components	**Maximum Marks**
Lab Test 1	20
Lab Test 2	20
TA	60 (Quiz, Assignments, Tests, Viva)
Total	**100**

Project based learning: Each student in a group of 2-3 will collect literature on travelling salesman problem to code some applicational problem using MATLAB. To make the subject application based, the students analyze the optimized way to deal with aforementioned topics.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**R. Pratap,** Getting started with MATLAB: A quick introduction for scientists and engineers, Oxford university press, 2016.

2.	**H. A. Taha,** Operations Research - An Introduction, Eleventh Edition, Pearson Education, 2022.
3.	**N. Ploskas and N. Samaras,** Linear programming using MATLAB, Springer Optimization and Its Applications 127, Springer, 2017.
4.	**S. K. Mishra and B. Ram,** Introduction to linear programming with MATLAB, CRC Press, 2018.
5.	**R. H. Kwon,** Introduction to linear optimization and extensions with MATLAB, CRC Press, 2014.
6.	**P. Venkataraman,** Applied Optimization with MATLAB programming, Second Edition, John Wiley & Sons, 2009.

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PSO1
C271.1	3	2		2
C271.2	3	3		3
C271.3	3	3	2	3
C271.4	3	3		3
Avg.	**3.00**	**2.75**	**2.00**	**2.75**

Theory of Data Science (21M22MA213)

Course Code	**21M22MA213**	**Semester** Even **(specify Odd/Even)**	**Semester I**V **Session** 2024-25 **Month from** Jan - Jun 2025
Course Name	**Theory of Data Science**		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES: After the successful completion of this course, the student will be able to		**COGNITIVE LEVELS**
C235.1	explain various concepts related to the data science	Understanding (C2)
C235.2	make use of various supervised and unsupervised techniques for data modeling	Applying(C3)
C235.3	compare different data modeling techniques using model selection and assessment methods	Analyzing(C4)
C235.4	evaluate related models using various datasets.	Evaluating(C5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	The art of data Science	Volume, velocity, variety, machine learning, supervised and unsupervised learning, predictions and forecasts, innovation and experimentation, the dark side, big errors, privacy, example, polynomial curve fitting, probability theory, model selection, the curse of dimensionality, decision theory, information theory, regularization and stability, VC dimension.	6
2.	Methods for function approximation:	linear models for regression, parameter estimation methods - maximum likelihood method and maximum a posteriori method, regularization, ridge regression, lasso, bias-variance decomposition, bayesian linear regression	7
3	Classification based on Bayesian decision theory	Bayesian decision theory, Bayes classifier, minimum error-rate classification, normal (Gaussian) density discriminant functions, decision surfaces, maximum-likelihood estimation, maximum a posteriori estimation, Gaussian mixture models expectation-maximization method for parameter estimation, naive Bayes classifier.	6
4	Classification based on non parametric techniques	Non-parametric techniques for density estimation, Parzen-window method, k-nearest neighbors method, logistic regression, perceptron,	5
5	Sequential pattern classification	Hidden Markov models (HMMS) for sequential pattern classification discrete HMMS and continuous density HMMS	5
6	Boosting of classifiers	Support vector machine, decision trees, bagging, boosting, gradient boosting	5
7.	Dimensionality reduction	Principal component analysis, partial least squares, factor analysis, fisher discriminant analysis, linear and multiple discriminant analysis.	4
8.	Extracting information from news	Algorithms, extracting data from web sources using APIs, text classification, metrics, grading text, text summarization.	4

Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, Tutorials, Project)
Total	**100**

Recommended Reading material:

Project based learning: Students in a small group will collect sample data set and make classification models. They will validate the model by various selection and assessment methods. By this student will be able to make classification models and validate it

1.	**E. Alpaydin,** *Introduction to Machine Learning*, 4th Ed., PHI Learning 2020.
2.	**C. M. Bishop,** *Pattern Recognition and Machine Learning*, Springer 2013.
3.	**T. Hastie, R. Tibshirani and J. Friedman,** *The Elements of Statistical Learning*, 2nd Ed., Springer 2009
4.	**S. R. Das,** *Data Science Theories, Models, Algorithms, and Analytics*, Apache License, 2016
5.	**S. S. Shwartz and S. B.David,** *Understanding Machine Learning: from Theory to Algorithms*, Cambridge University Press, 2014
6.	**R.O.Duda, P.E.Hart and D.G.Stork,** Pattern Classification, 2nd Ed.John Wiley, 2007

CO-PO and CO-PSO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PSO1**
C235.1	2	2	1	2
C235.2	3	3	1	3
C235.3	3	3	3	3
C235.4	3	3	3	3
Avg	**2.75**	**2.75**	**2.00**	**2.75**

Dissertation (19M27MA211)

Course Code	19M27MA211	**Semester** Even **(specify Odd/Even)**	**Semester IV Session** 2024 -2025 **Month from:** January to June
Course Name	Dissertation		
Credits	10	**Contact Hours**	
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES: After completion of the dissertation, student will be able to		**COGNITIVE LEVELS**
C250.1	understand the research-oriented problems and related areas.	Understanding Level (C2)
C250.2	organize the literature to form a problem in said area of study.	Applying Level (C3)
C250.3	develop the solution of the problem.	Applying Level (C3)
C250.4	analyze findings in terms of a report.	Analyzing Level (C4)

Employability: In this course, the students will be working on research problems in various fields of pure and applied Mathematics as per their specialization. The students will be able to learn to use the latest methods/techniques/tools/softwares to achieve the defined objectives of their dissertation. This will help the students to develop mathematical and scientific research temperament which will be beneficial for their future academics and research endeavors.

Module No.	**Topics in module**
1	Identification of the dissertation problem and literature review in the related field and explore experimental and theoretical tools/ techniques/software/hardware.
2	Acquire knowledge and analyze various methods/techniques to be used in solving the defined problem and find a suitable methodology.
3	Utilize latest techniques/software/hardware tools to achieve the proposed objectives and obtain results. Evaluation/analysis of the obtained results and their interpretation.

Evaluation Criteria

Components	**Maximum Marks**
Day to Day Evaluation	40 (To be awarded by supervisor)
End Term Evaluation	50 (To be awarded by a panel of 3 examiners)
Special Contribution	10 (To be awarded by a panel of 3 examiners)
Total	**100**

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PSO1**

CO1	**2**	**2**	**-**	**2**
CO2	**2**	**3**	**-**	**3**
CO3	**2**	**3**	**-**	**3**
CO4	**2**	**2**	**2**	**3**

Certificate Course in Data Analytics for M.Sc. Programme

Objective

The primary objective of this certificate course is to equip students with the knowledge and skills necessary to analyze and interpret complex data sets, allowing them to make informed decisions and contribute to the advancement of their respective fields.

Eligibility: This certificate course in Data Analytics (additional 9 credits) will be given to those students who are pursuing M.Sc in Mathematics, Physics, Economics, Microbiology and Environmental Biotechnology from JIIT.

Prerequisite: Proficiency in mathematics, including calculus, linear algebra, and probability/statistics, is essential. Some special lectures may be provided before 3rd semester to those students who don't have exposure of linear algebra and calculus, so that they can understand the subjects required for certificate course.

Curriculum Structure

S. N.	Course Code	Course Title	Semester	Contact Hours				Credit
				L	T	P	Total	
1	24M22MA112	Techniques of Data Handling and Visualization	2nd	3	-	-	3	3
2	24M22MA212	Regression Models for Data Inference and Prediction	3rd	3	-	-	3	3
3	24C11MA211	Pattern Recognition Models for Learning from Data	4th	3	-	-	3	3
		Total		**9**	**-**	**-**	**9**	**9**

Course Description

Techniques of Data Handling and Visualization (24M22MA112)

Course Code	24M22MA112	**Semester** Even **(specify Odd/Even)**	**Semester** II **Session** 2024-25 **Month from** Jan-May 2025
Course Name	Techniques of Data Handling and Visualization		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

COURSE OUTCOMES: After the successful completion of this course, the student will be able to		**COGNITIVE LEVELS**
CO 1	define important terms related to the data handling.	Remembering (C1)
CO 2	explain the theory of data visualization, management and analytics.	Understanding (C2)
CO 3	organize data using visualization, cleaning and management techniques.	Applying (C3)
CO 4	compare different techniques of data analysis and presentation.	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Data Characteristics	Quantitative, Qualitative, Ordered Categorical, Structured, Unstructured, Dimension, Size, Big Data.	5
2.	Database and its functionalities	Database Languages and Design, Data Storage, System Architecture, Data Security and Analytics, Database users and administrators.	6
3	Data Visualization and Data Cleaning Techniques	Histogram, Box plot, scatter plot, pixel-based techniques, quality metrics for data presentation, data filtering, missing data, duplicates and outliers, scaling, normalization.	6
4	Statistical Decision Theory	Regression, classification and clustering tasks, curve fitting using least square method, training and testing errors, regularization, stability	6
5	Dimension and Size issues in Data	Curse of dimensionality, Principal component analysis, bagging, boosting.	5
6	Hands on Data Handling using MATLAB	Starting with MATLAB, basic mathematical operations using MATLAB on scalars, vectors, matrices, multidimensional array,	5

		control structures, user defined functions and function files	
7.	Hands on Data Visualization and Linear Algebra using MATLAB	two dimensional plots, three dimensional plots, image rendering, graphic object handles, Inverse, Rank, eigenvalue, eigenvector, solution of system of linear equations.	5
8.	Hands on Regression Analysis using MATLAB	curve fitting, regression, training and testing errors, function handle.	4
Total number of Lectures			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, PBL)
Total	**100**

Recommended Reading material:

Project based learning: Students in a small group will collect sample data set. The data presentation techniques will be applied to explain all the data in use and the data management techniques will be explored for efficient data storage. In this way, students will be able to learn presentation of data and its management effectively.

Text Books

1.	**Hastie, R. Tibshirani and J. Friedman,** The Elements of Statistical Learning, 2nd Ed., Springer, 2008.
2.	**W. Stallings and L. Brown**, Computer Security: Principles and Practice, 2nd edition, Pearson/Prentice Hall, 2012. ISBN-10: 0136004245, ISBN-13: 9780136004240.
3.	**C. O. Wilke**, Fundamentals of Data Visualization A Primer on Making Informative and Compelling Figures, O'Reilly Media, 2019.ISBN-13: 978-1-492-03108-6.
4.	**A. Silberschatz and H. F. Korth and S. Sudarshan**, Database System Concepts, Seventh Edition, Mcgraw Hill Education, 2019.
5.	**A. A. Faisal and C. S. Ong and M. P. Deisenroth**, Mathematics for Machine Learning, Cambridge University Press, 2020.
6.	**A. Gilat**, MATLAB An Introduction with Applications, Fourth Edition, John Wiley & Sons, 2011.

Regression Models for Data Inference and Prediction (24M22MA212)

Course Code	24M22MA212	**Semester Odd**	**Semester III** **Session** 2024-25, **Month from July- Dec 2024**
Course Name	Regression Models for Data Inference and Prediction		
Credits	3	**Contact Hours**	3-0-0

Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		
COURSE OUTCOMES			**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:			
CO1	interpret the basic concepts of regression models, multicollinearity and model building.		Understanding (C2)
CO2	apply parameter estimation techniques on given data set.		Applying (C3)
CO3	analyze data and make predictions and inferences using appropriate regression models		Analyzing (C4)
CO4	evaluate important variables to be included in order to make a regression model expressive.		Evaluating (C5)
Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures**
1.	Introduction	Regression and model building, Data collection and uses of regression	2
2.	Simple Linear Regression	Simple linear regression model, Least-Squares Estimation of the model parameters, Inference about the slope and the intercept and the slope parameters, Prediction of new observations, Estimation by maximum likelihood method.	6
3.	Multiple Linear Regression	Multiple linear regression models, Least-Squares Estimation of the model parameters, Inference in multiple linear regression	8
4.	Model Adequacy Checking	Residual analysis, Detection and treatment of outliers, Lack of fit of the regression model	6
5.	Multicollinearity	Source of multicollinearity, Consequences of multicollinearity, Multicollinearity diagnostics, Remedies for multicollinearity	5
6.	Logistic regression Model	Logistic Regression Models its linear Predictions, Prediction of new observations, Maximum likelihood estimation of parameters, Interpretation of parameters	6
7.	Variable Selection and Model Building	Introduction: the model building problem, Model misspecification, Criteria for evaluating subset regression, Computational techniques for variable selection: all possible regressions, Stepwise regression methods	9
Total number of Lectures			**42**

Evaluation Criteria	
Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Quiz, Assignments, PBL etc.)
Total	**100**

Project based learning: Each student in a group of 4-5 will collect data and apply appropriate regression models using software for prediction purpose. The students will be able to use various regression models to achieve the defined objectives in different fields.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Montgomery, D.C., Peck, E.A. and Vining, G.G. (2012). Introduction to Linear Regression Analysis (3rd Edition). John Wiley & Sons, Inc., New York.
2.	Binghom, N. H. and Fry, J. M. (2010). Regression: Linear Models in Statistics. Springer, USA
3.	Myrers, R.H. (1990). Classical and Modern Regression with Applications (2nd Edition). PWS-Kent Publishers, Boston.
4.	Draper, N.R. and Smith, H. (1998). Applied Regression Analysis (3rd Edition). John Wiley & Sons, Inc., New York.
5.	Golberg, M. A. and Cho, H. A. (2010) : Introduction to Regression Analysis, WIT press, USA

Pattern Recognition Models for Learning from Data (24C11MA211)

Course Code	24C11MA211	**Semester Odd**	**Semester IV Session** 2024-25, **Month from** Jan- May 2025
Course Name	Pattern Recognition Models for Learning from Data		
Credits	3	**Contact Hours**	3-0-0
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		

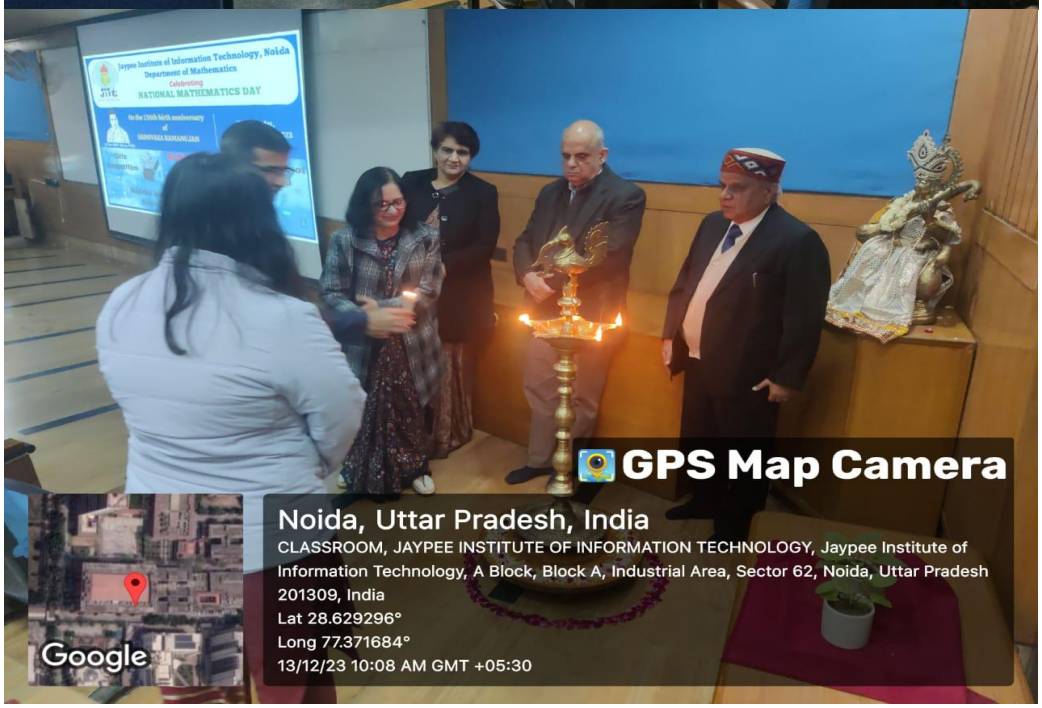
COURSE OUTCOMES		**COGNITIVE LEVELS**
After pursuing the above-mentioned course, the students will be able to:		
CO1	outline basic concepts of pattern recognition	Understanding (C2)
CO2	apply classification and clustering models in pattern recognition	Applying (C3)
CO3	examine various models of pattern recognition	Analyzing (C4)
CO4	evaluate the performance of various techniques for pattern recognition.	Evaluating (C5)

Module No.	Title of the Module	Topics in the Module	No. of Lectures
1.	Introduction	Pattern Recognition; Applications and Examples, Clustering and Classification; Supervised and Unsupervised Learning from Data.	4
2	Theory of Classification	Problem of Classification, Binary Classification, Multiclass Classification, Discriminant Function, Linear and Non-Linear Separable Classes, Types of Errors, Training and Testing Errors, Accuracy, 0-1 Loss Function, Squared Error Loss Function (SELF), General Entropy Loss Function (GELF), Cross Validation.	7
3.	Bayesian Decision Theory	Bayes Theorem, Prior Distribution, Posterior Distribution, Loss Function, Naïve Bayes Classifier; Discriminant Function, Decision Surface.	6
4.	Classification and Clustering Models	Minimum Distance Classifier, Linear Regression Models for binary and multiclasses, K-Nearest Neighbours, K-mean, Decision Tree, Model Assessment.	6
5.	Neural Network	Perceptron, Transfer Function, Multilayer Feed Forward Neural Network, Some Deep Learning Models.	5
6.	Hands on classification concepts using R	Introduction to R for Data Science, Operations, functions and packages in R, Bayesian Classifiers, Visualization of Data, Graphical Analysis of Data	5
7.	Hands on Classification and Clustering Models using R	Linear and Non-Linear separable classes, Linear Regression Models, Decision Tree, Clustering, Graphical Analysis of Data	5
8.	Hands on Neural Network Models using R	Perceptron, Neural Network, training, testing, prediction, deep learning models.	4
Total number of Lectures		**42**	

Evaluation Criteria **Components Maximum Marks** T1 20 T2 20 End Semester Examination 35 TA 25 (Quiz, Assignments, PBL etc.) **Total 100**	
Project based learning: Each student in a group of 4-5 will collect data and apply appropriate classification models using statistical software. The students will be able to use various classifiers to classify the data in different fields of application.	
Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	**Beyerer, J., Hagmanns, R., & Stadler**, D. *Pattern Recognition: Introduction, Features, Classifiers and Principles*. Walter de Gruyter GmbH & Co KG, (2024).
2.	**Braga-Neto**, U. *Fundamentals of Pattern Recognition and Machine Learning*. Berlin/Heidelberg, Germany: Springer. 2020.
3.	**C.M.Bishop,** *Pattern Recognition and Machine Learning*, Springer, 2006
4.	**K. Fukunaga**, *Introduction to Statistical Pattern Recognition, 2nd Ed.* Academic Press, New York, 1990.
5.	**Hastie, T., Tibshirani, R., & Friedman, J. H.** *The elements of statistical learning: data mining, inference, and prediction*. 2nd ed. New York, Springer, 2009.
6.	**R.O. Duda, P.E. Hart, and D.G. Stork**, *Pattern Classification*, New York: John Wiley & Sons, 2001.
7.	**M. H. Beale, O. D. Jesús**, *Neural Network and Design*, 2nd Ed. 2014.
8.	**Gareth, J., Daniela, W., Trevor, H., & Robert, T.** *An introduction to statistical learning: with applications in R*. Spinger, 2013.
9.	Crawley, M. J. *The R book*. John Wiley & Sons, 2012.
10.	**Wickham, H., Çetinkaya-Rundel, M., & Grolemund, G**. *R for data science*. O'Reilly Media, Inc.". (2023).

Annual event (which are held every year): Event, Photo,Title,Weblink if any

National Mathematics Day



International Conference RAMSA


Prof. Alka Tripathi
Prof. S.C. Saxena
Prof. Satya Deo
Prof. Jichun Li


6th International Conference on
Recent Advances in Mathematical Sciences and its Applications
(RAMSA-2022)
December 08-10, 2022
Organized by
Department of Mathematics
Jaypee Institute of Information Technology
A-10, Sector-62,
Noida (U.P.)-201309, India
Partially funded by
SERB