M.Sc MATHEMATICS
(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM (CBCS)

TWO YEARS FULL TIME PROGRAMME
COURSE OF STUDIES R-20

GIET UNIVERSITY, GUNUPUR
ODISHA

All the precautions have been taken to print the course curriculum accurate. However, mistakes if any will be corrected as and when noticed. The university reserves the right to include/exclude any content at any point of time during the progression of the course.

M.Sc MATHEMATICS

Schedule for Instruction and Examination
(Proposed Scheme for Academic year 2020-2021)

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	101	Algebra -1	3	1	0	4
2	MTPC	102	Topology	4	0	0	4
3	MTPC	103	Ordinary Differential Equation	3	1	0	4
4	MTPC	104	Integral Transformations	4	0	0	4
5	MTPC	105	Numerical Analysis	3	1	0	4
6	MTEC	106	Seminar & Project-I	0	0	2	2
TOTAL				**17**	**3**	**2**	**22**

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	201	Algebra-II	3	1	0	4
2	MTPC	202	Advanced Calculus	4	0	0	4
3	MTPC	203	Partial Differential Equations	3	1	0	4
4	MTPC	204	Complex Analysis	4	0	0	4
5	MTPC	205	Mathematical Statistics	3	1	0	4
			PRACTICAL / SESSIONAL				
6	MTPC	206	Statistical Data Analysis	0	0	2	2
7	MTEC	207	Seminar & Project-II	0	0	2	2
TOTAL				**17**	**3**	**4**	**24**

BoS Members: 1. Dr. Biplab Kumar Rath 2. Prof. (Dr.) U. K. Mishra 3. Dr. P.Vijay Kumar 4 Dr. Runu Sahu 5. Mr. V. Ganesh 6. Mr. N Jagannadham 7. Ms. Ranjita Rath 8.Mrs. M. Sivakami Sundari

BOS Approved
Date:05/06/2020

III SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	301	Functional Analysis-I	3	1	0	4
2	MTPC	302	Number Theoretic Cryptography	4	0	0	4
3	MTPE	303	Graph Theory	3	1	0	4
		304	Fuzzy Set Theory	3	1	0	4
		305	Number Theory	3	1	0	4
4	MTCBOE	306	Differential Geometry	3	1	0	4
		307	Finite Element Methods	3	1	0	4
		308	Optimization Techniques	3	1	0	4
5	MTPE	309	Fluid Dynamics	4	0	0	4
		310	Classical Mechanics	4	0	0	4
		311	Mathematical Modeling	4	0	0	4
6	MTEC	312	Summer Internship / Seminar & Project-III	0	0	2	2
TOTAL				**17**	**3**	**2**	**22**

IV SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	401	Functional Analysis-II	3	1	0	4
2	MTPE	402	Automata Theory	3	1	0	4
		403	Design & Analysis of Algorithm	3	1	0	4
		404	Abstract Measure	3	1	0	4
3	MTOE	405	Ethics & IPR	4	0	0	4
PRACTICAL / SESSIONAL							
4	MTPE	406	Documentation Using Latex	0	0	2	2
5	MTEC	407	Major Project/Dissertation	0	0	10	8
TOTAL				**10**	**2**	**12**	**22**

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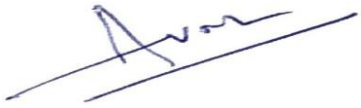

SCHEME OF INSTRUCTION SUMMARY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER				TOTAL CREDITS	%
		I (550 marks)	II (550 marks)	III (550 marks)	IV (600 marks)	Total (2250 marks)	
1	Professional Course (PC)	20	22	8	4	52	58
2	Professional Electives (PE)	-	-	8	4	16	18
3	Choice Based Open Electives (CBOE)/ Open Electives (OE)	-	-	4	4	8	9
4	Project Work, Seminar and/or Internship in Industry or elsewhere(EC)	2	2	2	10	14	15
5	Value added Courses/MOOCS	-	-	-	-	-	-
	TOTAL	**22**	**24**	**22**	**22**	**90**	**100**

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M.Sc. MATHEMATICS SYLLABUS STRUCTURE

(Credits-Hours - Marks System-2020-22)

Semester	Course	Course Title	Hrs per week L-T-P	Credit L-T-P	Exam Hrs L-T-P	Marks		Total
						Mid Sem	End Sem	
I	MTPC101	Algebra -1	4	4	3	30	70	100
	MTPC102	Topology	4	4	3	30	70	100
	MTPC103	Ordinary Differential Equation	4	4	3	30	70	100
	MTPC104	Integral Transformations	4	4	3	30	70	100
	MTPC105	Numerical Analysis	4	4	3	30	70	100
	MTPC106	Seminar & Project-I	2	2	2	0	50	50
			22	**22**				**550**
II	MTPC201	Algebra-II	4	4	3	30	70	100
	MTPC202	Advanced Calculus	4	4	3	30	70	100
	MTPC203	Partial Differential Equations	4	4	3	30	70	100
	MTPC204	Complex Analysis	4	4	3	30	70	100
	MTPC205	Mathematical Statistics	4	4	3	30	70	100
		PRACTICAL						
	MTPC206	Statistical Data Analysis	**2**	**2**	**-**	**0**	**50**	**50**
	MTPC207	Seminar & Project-II	**2**	**2**	**-**	**0**	**50**	**50**
			24	**24**				**600**

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Date:05/06/2020

(Credits-Hours - Marks System-2020-22)

Semester	Course Category	Course Code	Course Title	Hrs per week L-T-P	Credit L-T-P	Exam Hrs L-T-P	Marks		Total
							Mid Sem	End Sem	
III	MTPC	301	Functional Analysis-I	4	4	3	30	70	100
	MTPC	302	Number Theoretic Cryptography	4	4	3	30	70	100
	MTPE	303	Graph Theory	4	4	3	30	70	100
		304	Fuzzy Set Theory						
		305	Number Theory						
	MTCBOE	306	Differential Geometry	4	4	3	30	70	100
		307	Finite Element Methods						
		308	Optimization Techniques						
	MTPE	309	Fluid Dynamics	4	4	3	30	70	100
		310	Classical Mechanics						
		311	Mathematical Modeling						
			PRACTICAL						
	MTPC	312	Seminar Internship/MOOCS	2	0	0	0	0	50
			TOTAL	**22**	**22**				**550**
IV	MTPC	401	Functional Analysis-II	4	4	3	30	70	100
	MTPE	402	Automata Theory and Formal Languages	4	4	4	30	70	100
		403	Design & Analysis of Algorithm						
		404	Abstract Measure						
	MTOE	405	Ethics & IPR	4	4	3	30	70	100
			PRACTICAL						
	MTPE	406	Documentation Using Latex	**4**	**2**	**0**	**0**	**0**	**50**
	MTPC	407	Major Project/Dissertation	**10**	**8**				**200**
			TOTAL	**26**	**22**				**550**
			GRAND TOTAL	**102**	**90**				**2250**

PC---Professional Courses, PE---Professional Elective , CBOE---Choice Based Open Elective, OE--- Open Elective, EC---Elective Courses, VAC —Value Added Course, L---- Lectures, T---Tutorial, P--Practical

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COURSE EDUCATIONAL OBJECTIVES:

Course Code:	**MTPC101**	No. of Credits:	4
Course Name:	**ALGEBRA –I**	**Sem End Exam & Cycle Test:**	**70+30**

CEO-1: To focus on permutation groups and auto Orphisms mapping of group Cayley's theorem. To make them understand ring theory and related definitions and application with Sylow's theorem.

CEO-2: To introduce the basic concept of vector space and test of linear independence of vectors & To calculate the roots of the polynomials and know more about roots.

COURSE OUTCOMES:

After completion of this course, students will be able

CO-1: To classify numbers into number sets.
CO-2: To combine polynomial by addition or subtraction.
CO-3: To solve problems of simple Inequalities & Interpret basic absolute value expression
CO-4: To simplify algebraic expressions, using the commutative, associative and Distributive properties.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[8 Hours]**

Automorphisms, Cayley's Theorem, Permutation, Groups, Another Counting Principle.

Unit-II **[12 Hours]**

Sylow's Theorems. More Ideals and Quotient Rings, The Field of Quotients of an Integra! Domain. Euclidean Rings. A Particular Euclidean Ring.

Unit-III **[10 Hours]**

Polynomial Rings, Polynomial Rings over the Rational Field, Elementary Basic Concepts of Vector Space, Linear Independence and Bases.

Unit-IV **[10 Hours]**

Extension Fields, The Transcendenceofe ,Roots of Polynomials, Construction with Straightedge and Compass, More about Roots.

BOOKS PRESCRIBED: I.. N. Hersfein : Topics in Algebra, John Wiley and Sons, (2nd Edn.,) 2002. **Chapters:** 2(2.8 to 2, l2i) 3(3.5 to 3.10), 4(4.1, 4.2), 5(5.1 to 5.5).

BOOKS FOR REFERENCE:

1. S. Singh end Q, Zameeraddin, Modern Algebra, Vikas Publishing House, 1590.
2. P. B .Bhattacharya. S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press, 1995.

Course Code:	**MTPC102**	No. of Credits:	4
Course Name:	**TOPOLOGY**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO -1: Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics and the concepts of Hilbert spaces and Banach spaces, and their role in mathematics.

CEO-2 : Demonstrate familiarity with a range of examples of these structures and Prove basic results about completeness, compactness, connectedness and convergence within these structures

COURSE OUTCOMES:
After completion of this course, students will be able to:

CO-1: Topology uses to analyze complex networks and applies Differential Topology to probability to identity multivariate interactions
CO-2: This paper discusses using cell phones to actually map out the topology of indoor spaces.
CO-3: Another cool application is in the world of chemistry where one can discuss the shape of molecules by an analysis of the topology of a related graph.
CO-4: There is also an application for medical imaging software and technology.Towards the end of the course the students will be able to :

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[10 Hours]**

Open sets and limit points, closed sets and closure, Bases and relative topologies.

Unit-II **[10 Hours]**

Connected Sets andcomponents, compact and .Countable compact spaces, continuous functions, homeomorphisms.

Unit-III **[10 Hours]**

T_0 -and T_1 -spaces & sequence, Axioms of countability.T_2 Spaces, Axiom of Countability, Regular and Normal Spaces, Completely regular Spaces.

Unit-IV **[10 Hours]**

Urysohn's metrization theorem, Finite products, product invariant properties, metric products, product topology.

BOOK PRESCRIBED:

1. W. J. Pervin, Foundations of General Topology, Academic Press.
   Chapters : 3(3.1, S.2 and 3.4), 4(4.1 to 4.4), 5(1.1 to 5.3, 3.5 and 5.6), 8(8,1 to 8.4), 10(10.1 only)

BOOKS FOR REFERENCE:

J. R. Munkers ,Topology-A First Course, Prentice Hall, 1996.
K. D. Joshi, Introduction to General Topology, Willey Eastern Ltd., 1983.

Course Code:	**MTPC103**	No. of Credits:	4
Course Name:	**ORDINARY DIFFERENTIAL EQATION**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: Evaluate first order differential equations including separable, homogeneous, exact, and linear. . Show existence and uniqueness of solutions.

CEO-2: Solve second order and higher order linear differential equations and Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits.

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO-1: The study of Differential focuses on the existence and uniqueness of solutions and also emphasizes the rigorous justification of methods for approximating solutions in pure and applied mathematics.

CO-2: It plays an important role in modeling virtually every physically technical or biological process from celestial motion to bridge design to interactions between neurons.

CO-3: Theory of differential equations is widely used in formulating many fundamental laws of physics and chemistry.

CO-4: Theory of differential equation is used in economics and biology to model the behaviour of complex systems. Differential equations have a remarkable ability to predicts the world around us. They can describe exponential growth and decay population growth of species or change in investment return over time.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantia

COURSE CONTENT

Unit-I **[10 Hours]**

Basic Concepts and Linear Equations of the First Order, Intial and Boundary value problem, method of variation of parameter, Exact equation , linear Equation with higher order, Equation with variable coefficient, Variation of parameter, Wronskian Method, Abel's Formula.

Unit-II **[10 Hours]**

Systems of Linear Differential Equations; Systems of Firtt Order Equations, Existence and Uniqueness Theorems. Fundamental Matrix Non Homogeneous Linear Systems, Systems cf Linear Differential Equations Continued Linear Systems with Constant Coefficients, Linear System with Periodic Coefficients.

Unit-III **[8 Hours]**

Oscillations of Second Order Equations : Fundamental Results ,Strum's Comparison Theorem, Strum's Separation Theorem, Elementary Linear Oscillation, Comparison Theorem of Hille-Wintner

Unit- IV **[12 Hours]**

Stability of Linear and Nonlinear, Systems: Elementary Critical Points, System of Equations with constant coefficients, linear Equations with constant coefficients, Stability of Linear and Nonlinear Systems (continued) Lyapunov stability, stability of Quasi-linear systems, Second Order Linear Differential Equations.

BOOKS PRESCRIBED: Text Book of Ordinary Differential Equations (Second Edition) S. G. Deo. V. Lakhsmikantham, V. Raghavendra, Tata Mc Graw Hill, Tata-Mc Gran-Hill Publishing Company Limited. New Delhi.

Course Code:	**MTPC104**	No. of Credits:	4
Course Name:	**INTEGRAL TRANSFORMATIONS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: To analyze properties of special functions by their integral representations and symmetries and To determine properties of Fourier Transform which may be solved by application of special functions. CEO-2: To determine properties of Laplace Transform which may be solved by application of special functions and To determine properties of Legendre Polynomial which may be solved by application of special functions.

COURSE OUTCOMES:
Towards the end of the course the students will be able to:

CO-1: understand integral calculus and special functions of various engineering problem and to known the application of some basic mathematical methods via all these special functions.

CO-2: Explain the applications and the usefulness of these special functions and classify and explain the functions of different types of differential equations.

CO-3: Understand purpose and functions of the gamma and beta functions, Fourier series and Transformation.

CO-4: use the gamma function, beta function and special functions to: evaluate different types of integral calculus problems and Fourier series to solve differential equations.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit1 **[10 Hours]**

Laplace Transform: Definition, Transform of some elementary functions, rules of manipulation of Laplace Transform, Transform of Derivatives, relation involving Integrals, the error function, Transform of Bessel functions, Periodic functions, convolution of two functions, Inverse Laplace Transform of simple function, Tauberian Theorems, Solution of Differential Equations- Initial value problems for linear equations with constant coefficients, simultaneous differential equations with constant coefficients

Unit2 **[10 Hours]**

Fourier series and Fourier Transforms: Orthogonal set of functions, Fourier series, Fourier sine and cosine series, Half range expansions, Fourier integral Theorem, Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, Transforms of Derivatives, Fourier transforms of simple Functions, Fourier transforms of Rational Functions, Convolution Integral, Parseval's Theorem for Cosine and Sine Transforms, Inversion Theorem.

Unit3 **[10 Hours]**

Hankel Transform: Elementary properties, Inversion theorem, transform of derivatives of functions, transform of elementary functions, Parseval relation, relation between Fourier and Hankel transform, use of Hankel Transform in the solution of Partial differential equations, Dual integral equations and mixed boundary value problems.

Unit4 **[10 Hours]**

Z-transforms: Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems – Convolution theorem – Formation of difference equations – Solution of difference equations using Z – transform.

BOOKS RECOMMENDED:

1. Ian N. Sneddon , The use of Integral Transforms ,McGraw Hill; Second Printing edition ,1972.
2. Ian N. Sneddon, Fourier Transforms , Dover Publications,2010 .
3. Loknath Debnath, Integral Transforms and their applications ,Chapman and Hall/CRC; 2 edition ,2006.4. Higher Engineering Mathematics by B. S. Grewal, **40th Edition, Khanna Publishers**, 201

Course Code:	**MTPC105**	No. of Credits:	4
Course Name:	**NUMERICAL ANALYSIS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs and The main objective of this course is to provide students with an introduction to the field of numerical analysis.

CEO-2: Derive appropriate numerical methods to solve interpolation based problems and Derive appropriate numerical methods to solve probability based problems.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1: Understand the theoretical and practical aspects of the use of numerical analysis and proficient in implementing numerical methods for a variety of multidisciplinary applications.

CO-2: Establish the limitations, advantages, and disadvantages of numerical analysis.

CO-3: Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

CO-4: Understand of common numerical analysis and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[10 Hours]**

Interpolation & Approximation: Introduction, Lagrange and Newton interpolations, finite difference operators. Interpolating Polynomials using finite differences, Hermite Interpolation, Piecewise and spline interpolation.

Unit-II **[10 Hours]**

Interpolation and Approximation (contd : Bivariate interpolations, Approximation, least square approximation, uniform approximation,Rational approximation,, choice of the method.

Unit-III **[10 Hours]**

Differentiation and Integration : Introduction, Numerical differentiation, Optimum choice of step length, extrapolation method, partial differentiation, Numerical Integration, Methods based on interpolation. Methods based on undeterrmined coefficients, Composite Integration methods, Romberg Integration, Double integration.

Unit- IV **[10 Hours]**

Ordinary Differential Equations, Intial Value Problems : Introduction, Difference Equations, Ordinary Differential Equations, Initial Value Problem (contd.) : Numerical methods, single step methods, stability analysis of single step methods, Multi step methods **.**

BOOK PRESCRIBED :

M. K. Jain, S. R. K. Iyengar and R.K. Jain : Numerical Methods for Science and Engineering Computations (Fourth Edition) New Age International Publishers, 2003., Chapters : 4

Course Code:	MTEC106	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-I	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER-II

Course Code:	MTPC201	No. of Credits:	4
Course Name:	ALGEBRA-II	Sem End Exam & Cycle Test:	70+30

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To introduce the concept of dual space and inner product space with Galois theory. To focus on the algebra of linear transformation and characteristic roots of matrices.

CEO-2: To make them different types of forms like canonical,triangular and jorden forms. To calculate the trace and transpose of matrices and determinants

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1: Explain the fundamental concepts of advanced algebra and their role in modern Mathematics and applied contexts.

CO-2: Explain Demonstrate accurate and efficient use of advanced algebraic techniques.

CO-3: Demonstrate capacity for mathematical reasoning through analyzing, Proving And explaining concepts from advanced algebra.

CO-4: Apply problem-solving using advanced algebraic techniques applied to Diverse situations in physics, engineering and other mathematical

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[10 Hours]**

Dual Spaces, Inner Product Spaces, The Elements of Galois Theory, Solvability by Radicals.

Unit-II **[10 Hours]**

The Algebra of Linear Transformation, Characteristic Roots, matrices.

Unit-III **[10 Hours]**

Canonical Forms 1 Triangular Form, Nilpotent Transformations, Jordan Form.

Unit-IV **[10 Hours]**

Trace and Transpose Determinants, Hermitian, Unitary and normal Transformations.

BOOKS PRESCRIBED:

1. I.. N. Herstein : Topics in Algebra, John Wiley and Sons, (2nd Edn.,) 2002. Chapters : 2(2.8 to 2,l2i, 3(3.5 to 3.10), 4(4.1, 4.2), 5(5.1 to 5.5).

BOOKS FOR REFERENCE:

S. Singh end Q, Zameeraddin, Modern Algebra, Vikas Publishing House, 1590.
P. B.Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press, 1995.

Course Code:	**MTPC202**	No. of Credits:	4
Course Name:	**ADVANCE CALCULUS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: To understand Different indeterminate forms of limit and Calculate functional value in neighbourhood of some point using expensions.

CEO-2 : To understand the behaviour of curve in space and Continuity and Limits - Prove convergence and divergence of limits and Differentiation - Identify and prove basic facts about derivatives and their properties.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1: The student is expected to learn about the basic principles of multi-variable calculus with proofs.

CO-2: To have full knowledge of calculus involving the fundamental tools such as continuity and differentiability and Students are able to reason rigorously in mathematical arguments. They can follow abstract mathematical arguments and write their own proofs.

Co-3: Students are able to effectively communicate mathematics: reading, writing, listening, and speaking. Students make effective use of the library, conduct research and make oral and written presentations of their findings.

Co-4: To know Relationship between the increasing and decreasing behavior of f and the sign of f

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I **[10 Hours]**

Derivatives for Functions on R^n - Differentiation of composite functions, Taylors Theorem.

UNIT-II **[8 Hours]**

Transformations, Linear function and transformations, Differentials of Transformations, Inverse of transformations.

UNIT-III **[12 Hours]**

Implici tfunctiontheorems, functionaldependence, set function transformation of multiple Integrals.

UNIT-IV **[10 Hours]**

Curves and Arc length, surfaces and surface area, Integrals over curves and surface, Differential forms, Theorem of Green, Gauss and stokes, exact form and closed form.

BOOKS RECOMMENDED :

Advanced Calculus (third edition by R. C. Back, Mo Graw Hill). Chapters: 3(3.3 to 3.3), 7(7.2 to 7.7), 8(8.2 to 8.6), 9(9.2, 9.4.9.5)

Course Code:	**MTPC203**	No. of Credits:	4
Course Name:	**PARTIAL DIFFERENTIAL EQUATIONS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CO-1: Introduce students to partial differential equations & Introduce students to how to solve linear Partial Differential with different methods.

CO-2 : To derive heat and wave equations in 2D and 3D and Find the solutions of PDEs are determined by conditions at the boundary of the spatial domain and initial conditions at time zero and Technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions

COURSE OUTCOMES:
Towards the end of the course the students will be able to:

CO-1: classify partial differential equations and transform into canonical form and solve linear partial differential equations of both first and second order.

CO-2: apply partial derivative equation techniques to predict the behavior of certain phenomena.

CO-3: apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.

CO-4 : extract information from partial derivative models in order to interpret reality. 6. Identify real phenomena as models of partial derivative equations

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[10 Hours]**

Partial Differential Equations of First Order: Formation and solution of PDE- Integral surfaces – Cauchy Problem of First order equation- Orthogonal surfaces – First order non-linear – Characteristics – Compatible system – Charpit method. Fundamentals: Classification and canonical forms of PDE. Chapter 0: 0.4 to 0.11 (omit .1,0.2.0.3 and 0.11.1) and Chapter 1: 1.1 to 1.5

UNIT-II **[10 Hours]**

Elliptic Differential Equations: Derivation of Laplace and Poisson equation – BVP – Separation of Variables – Dirichlet's Problem and Newmann Problem for a rectangle – Interior and Exterior Dirichlets's problems for a circle – Interior Newmann problem for a circle – Solution of Laplace equation in Cylindrical and spherical coordinates – Examples. Chapter 2: 2.1, 2 2 ,2.5 to 2.13 (omit 2.3 and 2.4)

UNIT-III **[10 Hours]**

Parabolic Differential Equations: Formation and solution of Diffusion equation – Dirac-Delta function – Separation of variables method – Solution of Diffusion Equation in Cylindrical and spherical coordinates Examples.
Solution of Diffusion and Wave equation by Laplace Transform and Fourier Transform Method. Chapter 3: 3.1 to 3.7 and 3.9 (omit 3.8) 6.13.1, 7.11

UNIT-IV **[10 Hours]**

Hyperbolic Differential Equations: Formation and solution of one-dimensional wave equation – canonical reduction – IVP- D'Alembert's solution – Vibrating string – Forced Vibration – IVP and BVP for two-dimensional wave equation – Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate systems – vibration of circular membrane – Uniqueness of the solution for the wave equation – Duhamel's Principle – Examples
Solution of Wave equation, Laplace's equation by Laplace Transform and Fourier Transform Method. Chapter 4: 4.1 to 4.12(omit 4.13) 6.13.2, 7.12, 7.13.

Text Book:

S, Sankar Rao, Introduction to Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi. 2005

Reference Books1. R.C.McOwen, Partial Differential Equations, 2nd Edn. Pearson Eduction, New Delhi, 2005. 2. I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983. 3. R. Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.

Course Code:	**MTPC204**	No. of Credits:	4
Course Name:	**COMPLEX ANALYSIS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: Understand how complex numbers provide a satisfying extension of the real numbers & Learn techniques of complex analysis that make practical problems easy

CEO-2: Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

COURSE OUTCOMES:
Towards the end of the course the students will be able to

CO-1. Use analytical functions Compute definite integrals using residue calculus.

CO-2. Understand the concept of sequences and series with respect to the complex numbers system and establish whether a given series/ sequences is convergent/ divergent at a specified point or interval

CO-3 Appreciate the existence of special functions and their use in a range of contexts.

CO-4. The students should be able to participate in scientific discussions and conduct researches on high international level in contemporary and classical complex analysis and its applications.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[10 Hours]**

Function of complex variable, continuity and differentiability, Analytic functions, Cauchy Riemann equation (Cartesian and polar form). Harmonic functions, Harmonic conjugate, Construction of analytic functions. Exponential function, Trigonometric and inverse trigonometric functions, Logarithmic function, Complex powers, Branches of multivalued functions with reference to arg(z), log(z), z^c. Stereographic projection and the spherical representation of the extended complex plane.

Unit-II **[10 Hours]**

Complex line integral, Cauchy theorem, independence 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, Poisson's integral formula.

Unit –III **[10 Hours]**

Power series: circle of convergence, radius of convergence. Taylor's series and Taylor's theorem, Laurent'z series and Laurent theorem, 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 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. Casorati- Weirstrauss Theorem

Unit-IV **[10 Hours]**

Conformal transformations, Bilinear transformations, Critical points, Fixed points, Problems on cross-ratio and bilinear transformation. Series and product development continued : Entre .function Riemann .Zeta Function. Elliptic Functions..simple periodic functions and Double periodic functions, Elliptic Functions, Weirstrass Theory

BOOKS PRESCRIBED:

Lars V. Abfors, Complex Analysis, Third Edition, Mc Gr&w Mill Kogakusha Ltd., International Student Edition.

Course Code:	**MTPC205**	No. of Credits:	4
Course Name:	**MATHEMATICAL STATISTICS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: Develop an understanding of the principles of statics & Develop an ability to analyze problems in a systematic and logical manner, including the ability to draw free-body diagrams.

CEO-2 :. Ability to analyze the statics of trusses, frames and machine& Ability to apply laws of statics. And to know the knowledge of equilibrium conditions of a static body.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1 : An ability to construct free-body diagrams and to calculate the reactions necessary to ensure static equilibrium.

CO-2 : An understanding of the analysis of distributed loads.

CO-3 : A knowledge of internal forces and moments in members.

CO- 4 : An ability to calculate centroids and moments of inertia.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit – I Probability and Random Variables [10 Hours]

Probability – Axioms of probability – Conditional probability – Baye‘s theorem - Discrete and continuous random variables – Moments – Moment generating functions Random Variables and Distribution functions. Expectation and their properties, Characteristic function and their properties, Chebychev’s inequality. Chapters: 4 (Sections – 4.5, 4.6, 4.7 and 4.8), Chapter 5 (Sections 5.1, 5.2, 5.3, 5.4) and Chapter 6 (Sections – 6.1, 6.2, 6.3, 6.4, 6.5, 6.12, 6.13).

Unit – II: Theoretical Distributions [10 Hours]

Binomial, Poisson, Geometric, Negative binomial, hyper geometric, uniform, Normal, exponential, gamma, Weibull and Cauchy distributions. Transformation of One dimensional Random variable (Section5.6). Chapter 7 (Sections 7.2 to 7.6), Chapter 8 (Setiond 8.1 to 8.3, 8.6, 8.8, 8.9), Chapters: 8 (Sections: 8.1 to 8.9) and 9 (Sections: 9.1 to 9.3, 9.5 to 9.8, 9.12 and 9.13)

Unit – III TWO - DIMENSIONAL RANDOM VARIABLES [10 Hours]

Joint distributions – Marginal and conditional distributions — Transformation of random variables – Covariance – Correlation and regression - Central limit theorem (for independent and identically distributed random variables). Chapter 5(Sections – 5.5, 5.7), Chapter 10 (Sections – 10.1, 10.3, 10.10.7(except 10.7.7))

Unit – IV TESTING OF HYPOTHESIS [10 Hours]

Sampling distributions – Estimation of parameters – Statistical hypothesis – Large sample tests based on Normal distribution for single mean and difference of means, single and difference of proportions -Tests based on t, Chi-square and F distributions for mean, variance and proportion – Contingency table (test for independent) – Goodness of fit.
Chapter 12 (Sections 12.1 to 12.9), Chapter 13 (Sections 13.1 and 13.7), Chapter 14 (Sections 14.2.9, 14.2.10, 14.5, 14.5.5, 14.5.6)

Text Book:

S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi, 2002.

Books for supplementary reading and Reference:

1. K. L.Chung, A course in Probability, Academic Press, New Tork, 1974.
2. Y.S. Chow and H. Teicher, Probability theory, Springer Verlag. Berlin, 2005 (3rd Edition).
3. R. Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
4. M. Fisz, Probability theory and mathematical statistics, John Wiley and Sons,New York.1963.
5. V. K. Rohatgi, An Introduction to Probability theory and Mathematical Statistics, Wilsey Eastern Ltd, New Delhi, 1988 (3rd Print).
6. S. I. Resnick, A Probability Path, Birhauser, Berlin, 1999.

Course Code:	MTPC206	No. of Credits:	2
Course Name:	STATISTICS LAB	End Exam:	50

Statistical Analysis Using R (PSPP)

CO-1: Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures.

CO-2: Demonstrate understanding of how to design experiments and surveys for efficiency, classical and repeated measures multivariate methods and computational techniques.

Po-1: Identify the population of interest. Determine whether an observational or an experimental study is appropriate and feasible. Explain the difference between, and importance of, random selection and random assignment in study design

PO-2: Verify that the appropriate conditions have been met. Construct one- and two-sample confidence intervals for means and for proportions. Identify appropriate hypotheses. Describe type I and type II errors in context. Interpret the meanings of rejection of the null hypothesis and of failure to reject the null hypothesis, in context.

Lab content

1) Data Screening
   - Missing data, Unengaged responses , Outliers, Normality (Skewness and Curtosis)

(2) Data Transformation

(3) Data Computation

(4) Reliability

(5) Correlation

(6) Hypothesis Testing

(a) Test for association-Cross Tabulation

(b) Test for difference-

- One sample T test
- Independent sample T test
- Paired sample T test
- One way ANOVA

(7) Non Parametric tests

(a) Chi square

(b) Binomial

(c) Runs

- 1 sample K-S
- 2 related samples
- K related samples
- K independent samples

(8) Regression

Course Code:	MTEC207	No. of Credits:	2
Course Name:	Seminar & Project-II	End Exam:	50

Every student will present a seminar on a topic related to theoretical or experimental, advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report.

CRITERIA	Max. Marks
Presentation	10
Communication	15
Seminar contents	25
Total Marks	**50**

SEMESTER III

Course Code:	**MTPC301**	No. of Credits:	4
Course Name:	**FUNCTIONAL ANALYSIS-I**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO1**:** This course will develop a deeper and rigorous understanding of fundamental concepts of functional analysis, their properties and related theorems

CEO-2**:** The student has knowledge of central concepts from functional analysis, including the Hahn-Banach theorem, the open mapping and closed graph theorems, the Banach-Steinhaus theorem, dual spaces, weak convergence, the Banach-Alaoglu theorem, and the spectral theorem for compact self-adjoint operators.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO1:- Explain the fundamental concepts of functional analysis and their role in modern mathematics

CO2:- Utilize the concepts of functional analysis, for example continuous and bounded operators, normed spaces, Hilbert spaces and to study the behavior of different mathematical expressions arising in science and engineering.

CO3:- Understand and apply fundamental theorems from the theory of normed and Banach spaces including the Hahn-Banach theorem, the open mapping theorem, the closed graph theorem and uniform boundedness theorem.

CO4:- Understand the nature of abstract mathematics and explore the concepts in further details

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[10 Hours]**

Normed spaces, continuity of linear maps. Normed spaces. defication and theorem, Unit sphere ,strictly convex and theorem, Definition of stronger ,comparable and equivalent, Theorem of nor med spaces, Continuity of Linear maps ,definition and theorem, Bounded linear maps ,definition and theorem, examples.

UNIT-II **[10 Hours]**

Hahn-banach theorem ,definition and problems, Hahn-banach separation theorem,support hyperplane, support functional, Hahn-banach extension theorem and unique Hahn-banach extension and theorems, Banach spaces ,summable and absolutely summable, Second dual canonical embedding, Completion and exercise problems

UNIT-III **[10 Hours]**

Uniform Boundetfness principle. Closed Graph theorem , Open MappingThe orems, Bounded Inverse Theorem. Bounded inverse theorem, Two- norm theorem. Spectrum of bounded operator.

UNIT-IV **[10 Hours]**

Spectrum of a Bounded operator and its theorems .Duals and Transposes. Eigen value, Eigen spectrum and theorem .spectral radius.

BOOK PRESCRIBED:

Functional Analysis—B. V. Limayee (New Age— International Limited, Publishers, Second Edition

Course Code:	**MTPC302**	No. of Credits:	4
Course Name:	**NUMBER THEORETIC CRYPTOGRAPHY**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO1 : To know the algorithms, properties and theorems of number theory.

CEO2: To know the symmetric cryptography and techniques of symmetric key cryptography

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO:1 The divisibility and Euclidian algorithm, properties of congruence and law of quadratic reciprocity and its use in number system

CO2: The symmetric key cryptography and different methods of symmetric key cryptography and its limitations

CO3: The concept of public key cryptography and different methods like RSA**,** Discrete log, Knapsack and concept of zero knowledge protocol

CO4: The prime factorization of numbers using rho method, Fermat factorization and factor bases**,** the continued fraction method which are useful in public key cryptography

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[12 Hours]**

Some Topics in Elementary Number Theory: Time estimates for doing arithmetic, Divisibility and the Euclidean algorithm, Congruence, Some applications to factoring, Finite Fields and Quadratic Residues :Finite fields, Quadratic residues and reciprocity

Unit-II **[8 Hours]**

Cryptography*: Some* simple cryptosystems, enciphering matrices

Unit-III **[8 Hours]**

Public Key: The idea of public key cryptography, RSA, Discrete log, Knapsack ,Zero-knowledge protocols and oblivious transfer

Unit-IV **[12 Hours]**

Primarily and Factoring: Pseudo primes, the rho method, Fermat factorization and factor bases, the continued fraction method.

TEXT BOOK:

Neal Koblitz: A Course In number theoretic Cryptography, Springer Veriag, GTM No. 114; 1987). **Chapters:** 1, 2, 3, 4, 5.1, 5.2, 5.3 and 5.4

REFERENCE:

A. J. Menezes. P. C. Van Oorchot and Scoff A. Vanstone, Hand Bjok of Applied Cryptography, CRC Press (1997).

Course Code:	**MTPE303**	No. of Credits:	4
Course Name:	**GRAPH THEORY**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO1: Present the relationships between abstract algebraic structures with familiar numbers systems such as the integers and real numbers. And Present concepts of and the relationships between operations satisfying various properties (e.g. commutative property).

CEO-2 : Present concepts and properties of various algebraic structures and Discuss the importance of algebraic properties relative to working within various number systems and Develop the ability to form and evaluate conjectures.

COURSE OUTCOMES:
Towards the end of the course the students will be able to:

CO-1: Understand the language of graphs and trees and the use of graphs as models.

CO-2: Understand various types of trees and methods for traversing trees.

CO-3: Formulate and prove central theorems about trees, connectivity and planar graphs.

CO-4: Describe and apply basic algorithms for graphs and Know application of trees and connectivity

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I **[10 Hours]**

Graphs, Sub-graphs and Trees: Graphs and simple graphs – Graph isomorphism – The incidence and adjacency matrices – subgraphs – Vertex degrees – Paths and connection – Cycles – Trees – Cut edges and bonds – Cut vertices. Chapter 1: Sections 1.1 – 1.7 and Chapter 2: Section 2.1 – 2.3

UNIT II **[10 Hours]**

Connectivity, Euler tours and Hamilton cycles: Connectivity – Blocks – Euler tours – Hamilton Cycles. Chapter 3: Sections 3.1 – 3.2 and Chapter 4: Sections 4.1 – 4.2

Matchings and Edge Colourings: Matchings – Matchings and coverings in bipartite graphs – Edge chromatic number – Vizing's theorem. Chapter 5: Sections 5.1 – 5.2 and Chapter 6: Sections 6.1 – 6.2

UNIT III **[10 Hours]**

Independent sets and Cliques, Vertex Colorings: Independent sets – Ramsey's theorem – Chromatic number – Brook's theorem – Chormatic polynomials. Chapter 7: Sections 7.1 – 7.2 and Chapter 8: Sections 8.1 – 8.2 and 8.4

UNIT IV **[10 Hours]**

Planar graphs: Plane and planar graphs – Duel graphs – Euler's formula – The Fivecolor theorem and the four-Color conjecture. Chapter 9: Sections 9.1 – 9.3 and 9.6

TEXT BOOK:

J.A. Bondy and U.S.R Murthy: Graph Theory and Applications, Macmillan , London, 1976.

REFERENCE:

1. J.Clark and D.A.Holton, A First look at Graph Theory, Allied Publishers, New Delhi, 1995.
2. R.Gould. Graph Theory, Benjamin/Cummings. Mento Park,1989.
3. A.Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge,1989.
4. R.J.Wilson and J.J.Watkins, Graphs : An Intorductory Approach, John Wiley and Sons, New York, 1989.
5. S.A.Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987

Course Code:	**MTPE304**	No. of Credits:	4
Course Name:	**FUZZY SET THEORY**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-2 : Provide an understanding of the basic mathematical elements of the theory of fuzzy sets.

CEO1 Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO_1 : Be able to distinguish between the crisp set and fuzzy set concepts through the learned differences between the crisp set characteristic function and the fuzzy set membership function.

CO-2 : Be able to draw a parallelism between crisp set operations and fuzzy set operations through the use of characteristic and membership functions respectively.

CO-3 : Be able to control operation of the systems ,modeling , Matrix representation.

CO-4 : Become aware of the use of fuzzy inference systems in the design of intelligent or humanistic systems.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[10 Hours]**

Crisp Sets Basic Definitions - Operations on crisp sets – Properties of crisp set – Crisp relations- Operations on crisp relations – Properties of Crisp relations – Composition of Crisp relations - Characteristic Function-Exercises

Fuzzy Sets Definition of Fuzzy sets - examples - Fuzzy Numbers- Characteristics of a Fuzzy Set- Basic Operations on fuzzy Sets- Properties of Fuzzy Sets- Membership functions- Algebraic Product and Sum of Fuzzy Sets – Power and Related Operations on Fuzzy Sets – The Extension Principle- Exercise

Unit-II **[10 Hours]**

Fuzzy Relations Definition of Fuzzy Relation – Basic Operations on Fuzzy Relations – Direct Product – Projections of a Fuzzy Relation – Max-Min and Min-Max Compositions – Fuzzy Relations and Approximate Reasoning – Exercise-Fuzzy Relational Equation-Problem Partitioning – Solution method – Use of Neural Network in Fuzzy Relation.

Unit-III **[12 Hours]**

Fuzzy control systems Introduction – Fuzzy Control Structure - Modelling and Control Parameters – If….and….Then Rules – Rule Evaluation – Conflict Resolution – Defuzzification – Fuzzy Controller with Matrix Representation - Exercises. .

Unit-IV **[8 Hours]**

Applications Fuzzy Control in Washing Machine – Fuzzy Decision Making in Forecasting – Fuzzy Decision Making in Industrial problems – Fuzzy control in Traffic control – Fuzzy Relational Equation in Medicine.

Text Books:

1. George J. Klir/Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, 2000
2. George Bojadziev and Maria Bojadziev, Fuzzy Sets, Fuzzy Logic, Applications, World Scientific Publishing Co.Pte.Ltd, Singapore, 1995

Reference Books:

1. George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice-Hall of India, 1993 .\
2. Pedrycz & Fernando Gomide, An introduction to Fuzzy Set, Prentice-Hall of India, New Delhi, 2005.
3. James J. Buckely, Esfandiar Eslami, An introduction to Fuzzy Logic and Fuzzy Sets, Springer, 2002.

Course Code:	**MTPE305**	No. of Credits:	4
Course Name:	**NUMBER THEORY**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization & Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.

CEO-2: Formulate and prove conjectures about numeric patterns. 4. Produce rigorous arguments (proofs) centered on the material of number theory, most notably in the use of Mathematical Induction and/or the Well Ordering Principal in the proof of theorems.

COURSE OUTCOMES:

Towards the end of the course the students will be able to :

CO-1: Demonstrate knowledge and understanding of topics including, but not limited to divisibility, prime numbers, congruences, quadratic reciprocity, Diophantine equations.

CO-2: Learn methods and techniques used in number theory.

CO-3: Write programs/functions to compute number theoretic functions.

CO-4: Use mathematical induction and other types of proof writing techniques.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I: **[12 Hours]**

Divisibility: Introduction - Divisibility - Primes. Congruences - Solution of Congruences - Congruences of higher degree - Prime power moduli - Prime Modulus - Congruences of degree two, prime modulus - Power residues - Number theory from an algebraic view point Multiplicative groups, rings and fields.

Unit-II **[8 Hours]**

Quadratic Reciprocity: Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol.

Unit-III **[10 Hours]**

Some functions of Number Theory: Greatest Integer function - Arithmetic function s - The Moebius Inversion Formula - Multiplication of arithmetic functions – Recurrence functions.

Unit-IV **[10 Hours]**

Some Diophantine Equations: The equation ax + by = c - Positive Solutions - Other linear equations - The equation $x^2 + y^2 = z^2$ - The Equation $x^4 + y^4 = z^2$ - Sum of fourth powers - Sum of two squares - The equation $4x^2 + y^2 = n$.

Text Book:

Ivan Niven and S.Zuckerman, *An Introduction to the Theory of Numbers,* John Wiley, New York, 2000 Chapter 1 : Sections 1.1 – 1.3 Chapter 2 : Sections 2.1 - 2.11 Chapter 3 : Sections 3.1 – 3.3 Chapter 4 : Sections 4.1 – 4.5 Chapter 5 : Sections 5.1 - 5.6, 5.10 and 5.11

Course Code:	**MTCBOE306**	No. of Credits:	4
Course Name:	**DIFFERENTIAL GEOMETRY**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: define the equivalence of two curves , find the derivative map of an isometry,analyse the equivalence of two curves by applying some theorems,defines surfaces and their properties

CEO-2: express definition and parametrization of surfaces, express tangent spaces of surfaces,explain differential maps between surfaces and find derivatives of such maps,integrate differential forms on surfaces and give examples of manifolds and investigate their properties.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1 : compute quantities of geometric interest such as curvature, as well as develop a facility to compute in various specialized systems, such as semi geodesic coordinates or ones representing asymptotic lines or principal curvatures.

CO-2 : introduced to the method of the moving frame and over determined systems of differential equations as they arise in surface theory.

CO-3 : Develop arguments in the geometric description of curves and surfaces in order to establish basic properties of geodesics, parallel transport, evolutes, minimal surfaces and consequences of the Poincar{\'e} index theory

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I: Space Curves [10 Hours]

Definition of a space curve – Arc length – Tangent – Normal and binormal – Curvature and torson – Contact between curves and surfaces – Tangent surface – Involutes and evolutes – Intrinsic properties. [Chapter 1: Sections 1 - 9]

Intrinsic properties of a surface: Definition of a surface – Curves on a surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties. [Chapter 2: Sections 1 - 9]

UNIT II: Geodesics [10 Hours]

Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesics curvature – Gauss Bonnet theorem – Gaussian curvature – Surface of constant curvature. [Chapter 2: Sections 10 – 18]

UNIT III: Non-intrinsic properties of a surface [10 Hours]

The second fundamental form Principle curvature – Lines of curvature – Developable – Developable associated with space curves and with curves on surface – Minimal surfaces – Rules surfaces. [Chapter 3: Sections 1 – 8]

UNIT IV: Differential geometry of surfaces [10 Hours]

Compact surfaces whose points are umblics – Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's theorem – Conjugate points on geodesics. [Chapter 4: Sections 1 – 8]

TEXT BOOK:

T.J.Wilmore: *An Introduction to Differential Geometry,* Oxford University Press, 17th Impression, New Delhi 2002 (Indian Print)

REFERENCE :

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison – Wesley, Mass. 1950.

2. Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.

3. Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1078.

Course Code:	**MTCBOE307**	No. of Credits:	4
Course Name:	**FINITE ELEMENT METHOD**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1 Implement the basics of FEM to relate stresses and strains.

CEO-2 Formulate the design and heat transfer problems with application of FEM

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO1 Implement numerical methods to solve mechanics of solids problems.

CO2. Formulate and Solve axially loaded bar Problems.

CO3. Formulate and analyze truss and beam problems.

CO4. Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[10 Hours]**

Finite Element Method: Vibrational formulation – Rayleigh-Ritz minimization – weighted residuals – Galerkin method applied to boundary value problems.

UNIT-II **[8 Hours]**

Global and local ¹nite element models in one dimension – derivation of ¹nite element equation.

UNIT-III **[12 Hours]**

Finite element interpolation – polynomial elements in one dimension, two dimensional elements, natural coordinates, triangular elements, rectangular elements, Lagrangian and Hermite elements for rectangular elements – global interpolation functions.

UNIT-IV **[10 Hours]**

Local and global forms of ¹nite element equations – boundary conditions – methods of solution for a steady state problem – Newton-Raphson continuation – one dimensional heat and wave equations.

TEXT BOOKS

1. J.N.Reddy, An introduction to the Finite Element Method, McGraw Hill, NY, 2005.
2. I.J. Chung, Finite element analysis in Fluid Dynamics, McGraw Hill Inc., 1978.

REFERENCE BOOKS

1. O.C. Zienkiewiez and K. Morgan : Finite Elements and approximation, John Wieley, 1983
2. P.E. Lewis and J.P. Ward : The Finite element method- Principles and applications, Addison Weley, 1991.
3. L.J. Segerlind: Applied finite element analysis (2nd Edition), John Wiley, 1984

Course Code:	**MTCBOE308**	No. of Credits:	4
Course Name:	**OPTIMIZATION TECHNIQUES**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too.

CEO-2 : After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO1 To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems

CO2. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology

CO3. To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

CO4 Cast engineering minima/maxima problems into optimization framework.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT - I **[10 Hours]**

Linear Programming Problem – Formulation, graphical solution, simplex method. Artificial Variable Techniques – Big M method, Two phase method, Revised Simplex Method. Dual Simplex Method

UNIT – II **[10 Hours]**

Integer Linear Programming: Introduction – Types of Integer Linear Programming Problems – Enumeration and Cutting Plane Solution Concept – Gomory's All Integer Cutting Plane Method – Gomory's mixed Integer Cutting Plane method – Branch and Bound Method Dynamic Programming: Introduction –Dynamic Programming Terminology – Developing Optimal Decision Policy – Dynamic Programming Under Certainty – Dynamic Programming Approach for Solving Linear Programming Problem.

UNIT – III **[10 Hours]**

Classical Optimization Methods: Introduction – Unconstrained Optimization – Constrained Multi-variable Optimization with Equality Constraints - Constrained Multivariable Optimization with inequality Constraints Non-linear Programming Methods: Introduction – General Non-Linear Programming Problem – Quadratic Programming: Kuhn-Tucker Conditions - Wolf's Modified Simplex Method – Beale's Method

UNIT – IV: **[10 Hours]**

Queuing Theory: Introduction - Essential Features of Queuing System – Performance Measures of a Queuing System – Probabilistic Distribution in Queuing Systems – Classification of Queuing Models and their Solutions – Single Server Queuing Models – Multi Server Queuing Models – Finite Calling Population Queuing Models – Multi-Phase Service Queuing Model.

TEXT BOOK:

J.K. Sharma, Operations Research Theory and Applications, Second Edition, Macmillan (India) New Delhi 2005 Chapters: 7 (Sections: 7.1 to 7.6) and 22 ,Chapters: 23 and 24 (Sections: 24.1, 24.2 and 24.4) Chapter: 16 (Sections: 16.1 to 16.9)

REFERENCE:

1 Kanti Swarup, Manmohan, P.K. Gupta, Operation Research, Sultan & Chand Publications
2 Manmohan, Gupta, Problems in Operation Research, Sultan & Chand Publications
3 Hamdy A. Taha, Operations Research, (seventh edition), Prentice - Hall of India Private Limited, New Delhi, 1997.

Course Code:	**MTPE309**	No. of Credits:	4
Course Name:	**FLUID DYNAMICS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO1 - understanding basic laws, principles and phenomena in the area of fluid mechanics - to solve simplified examples of fluid mechanics -

CEO-2 theoretical and practical preparation enabling students to apply the acquired knowledge and skills in professional and specialist courses

COURSE OUTCOMES:

Towards the end of the course the students will be able to :

CO1 define basic terms, values and laws in the areas of fluids properties, statics, kinematics and dynamics of fluids, and hydraulic design of pipes,

CO2 describe methods of implementing fluid mechanics laws and phenomena while analysing the operational parameters of hydraulic problems, systems and machines

CO3. practically apply tables and diagrams, and equations that define the associated laws

CO4 calculate and optimise operational parameters of hydraulic problems, systems and machines,

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I: Kinematics Of Fluids In Motion [10 Hours]

Real Fluids and Ideal Fluids – Velocity of a Fluid at a point – Streamlines and Pathlines; Steady and Unsteady Flows – The Velocity Potential – The Velocity Vector – Local and Particle Rates of Changes – The Equation of Continuity – Worked Examples – Acceleration of a Fluid – Condition at a Rigid Boundary
Chapter 2: Sections 2.1 to 2.10.

UNIT II: Equations Of Motion of a Fluid [10 Hours]

Pressure at a Point in a Fluid at Rest - Pressure at a Point in a Moving Fluid – Conditions at a Boundary of two Inviscid Immiscible Fluids – Euler's Equations of Motions – Bernoulli's Equation – worked Examples – Discussion of the Case Steady Motion under Conservative Body Force – Some flows involving axial symmetry – Kelvin's Theorem.
Chapter 3: Sections 3.1 to 3.7, 3.9, 3.12.
Some Three Dimensional Flows: Introduction – Sources, Sinks, and Doublets – Images in a Rigid Infinite Plane – Axi-Symmetric Flows; Stroke's Stream Function (Chapter 4: Sections 4.1 to 4.3 and 4.5)

UNIT III: Some Two Dimensional Flows [10 Hours]

Meaning of Two-Dimensional Flow – Use of Cylindrical Polar Coordinates – The Stream Function – The Complex Potential for Two - Dimensional irrotational, Incompressible Flow – Complex Velocity Potential for Standard Two-Dimensional Flows – Some Worked Examples – The Milne-Thomson Circle Theorem – The Theorem of Blasius (Chapter 5: section 5.1 to 5.6, 5.8, 5.9)

UNIT IV: Viscous flows [10 Hours]

Stress Components in a Real Fluid – Relations between Cartesian Components of Stress – Translational Motion of Fluid Element – The Rate of Strain Quadric and Principal Stresses – Some Further Propertie**[10 Hours]**s of the Rate of Strain Quadric – Stress analysis in Fluid Motion – Relations between Stress and Rate of Strain Quadric – The Coefficient of Viscosity and Laminar Flow – The Navier –Stokes Equations of Motion of a Viscous Fluid – Some Solvable Problems in Viscous Flow. (Chapter 8: section 8.1 to 8.10)

Text Book:

F. Charlton, *Text book of Fluid Dynamics*, CBS Publications, New Delhi, 1985.

Course Code:	**MTPE310**	No. of Credits:	4
Course Name:	**CLASSICAL MECHANICS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1 The students will introduce about the forces, angular momentum and knowledge about the Constraint .

CEO-2. The course will give knowledge about the general parameter like velocity, acceleration.

COURSE OUTCOMES:

Towards the end of the course the students will be able to :

CO1 TheLagrangian and Hamiltonian approaches in classical mechanics.

CO2 The classical background of Quantum mechanicsand get familiarized with Poisson brackets and Hamilton -Jacobi equation

C03 Kinematics and Dynamics of rigid body in detail and ideas regarding Euler's equations of motion

CO4 Theory of small oscillations in detail along with basis of Free vibrations.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[12 Hours]**

Mechanical Systems: The Mechanical system- Generalized coordinates – Constraints - Virtual work - Energy and Momentum
Lagrange's Equations: Derivation of Lagrange's equations- Examples- Integrals of motion.

UNIT-II **[8 Hours]**

Hamilton's Equations: Hamilton's Principle - Hamilton's Equation - Other variational principles.

UNIT – III **[8 Hours]**

Hamilton-Jacobi Theory: Hamilton Principle function – Hamilton-Jacobi Equation - Separability

UNIT-IV **[12 Hours]**

Canonical Transformation: Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets.

TEXT BOOK:

T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985. Chapter 1 : Sections 1.1 to 1.5 Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4) Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4) Chapter 5: Sections 5.1 to 5.3 Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)

REFERENCE BOOKS:

1. H. Goldstein, Classical Mechanics, (2nd Edition) Narosa Publishing House, New Delhi.
2. N.C.Rane and P.S.C.Joag, Classical Mechanics, Tata McGraw Hill, 1991.
3. J.L.Synge and B.A.Griffth, Principles of Mechanics (3rd Edition) McGraw Hill Book Co., New York, 1970.

Course Code:	**MTPE311**	No. of Credits:	4
Course Name:	**MATHEMATICAL MODELING**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: create mathematical models of empirical or theoretical phenomena in domains such as the physical, natural, or social science;

CEO-2: create variables and other abstractions to solve college-level mathematical problems in conjunction with previously-learned fundamental mathematical skills such as algebra

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1: create mathematical models of empirical or theoretical phenomena in domains such as the physical, natural, or social science;

CO-2: create variables and other abstractions to solve college-level mathematical problems in conjunction with previously-learned fundamental mathematical skills such as algebra;

CO – 3 : draw inferences from models using college-level mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs;

CO-4: take an analytical approach to problems in their future endeavors.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[8 Hours]**

Meaning of first and second order ordinary derivatives – slope of a tangent and curvature. Connecting these concepts to practical observation.

UNIT-II **[12 Hours]**

Basic concepts. Real world problems, (Physics, Chemistry, Biology, Economics, and others) Approximation of the problem, Steps involved in modeling.

UNIT-III **[10 Hours]**

Microbial population models – Single species nonage-structured population models , age structured population models ,two species population models ,multispecies population models ,optimal exploitation models , epidemic models

UNIT-IV **[10 Hours]**

models in genetics , mathematical models in pharmacokinetics , models for blood flows ,models for other biofluids, diffusion and diffusion reaction models , optimization models in biology and medicine.

TEXT BOOKS

1. J. N. Kapur : Mathematical Moodelling, Wiley Eastern Ltd., 1998.
2. W.J.Meyer, Concepts of Mathematical Modelling, McGraw Hill, Tokyo, 1985.

REFERENCE BOOKS

1. Neil Gerschenfeld : The nature of Mathematical modeling, Cambridge Univeristy Press, 1999.
2. A. C. Fowler : Mathematical Models in Applied Sciences, Cambridge Univeristy Press, 1997

Course Code:	MTEC312	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-III	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER-IV

Course Code:	**MTPC401**	No. of Credits:	4
Course Name:	**FUNCTIONAL ANALYSIS-II**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1 T :he objectives of the course are the study of the main properties of bounded operators between Banach and Hilbert spaces, the basic results associated to different types of convergences in normed spaces and the spectral theorem and some of its applications.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-I Explain the fundamental concepts of functional analysis and their role in modern mathematics and applied contexts

CO-2 . recognize inner product spaces. Identify whether a real valued function defined on Cartesian product of a vector space is inner product or not and an inner product space is Hilbert space or not.

CO-3 Identify orthogonal sets. Understand the notion of orthogonal complement and the decomposition of the space.

CO-4 Apply problem-solving using functional analysis technique applied to diverse situations in physics, engineering and other mathematical context.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[10 Hours]**

Weak and Weak *convergence Reflexivity: W eak and weak* convergent and weak limit. Theorem of weak convergence. Examples of weak convergence, schur's lemma. coordinate functional and weak* convergent of theorem . Bolzano-Weierstrass property and weak* sequentially compact. Banach-Alaoglu theorem ,cumulative distribution function. Helly's selection principle

UNIT-II **[10 Hours]**

Inner product spaces, Orthonormal sets.: Definition and examples of Hilbert Spaces, Cauchy's Schwartz Inequality and Parallelogram Law, Orthogonal Complements, Orthogonal Decomposition of Hilbert Space, Orthonormal Systems, Bessel's Inequality, Gram Schmidth Process, Application of - process to certain Linearly Independent Sequences in , Orthonormal Basis in Seperable Hilbert Spaces.

UNIT-III **[8 Hours]**

Approximation and Optimization and , Projections on a Hilbert space, and their Characterization Riesz Representation Theorems. unique Hanhn-Banach extension theorem. Weak convergence and weak* boundedness.

UNIT-IV **[12 Hours]**

The Conjugate Space, The Adjoint of an Operator on Hilbert Space and its Properties, Self Adjoint Operators, Normal and Unitary Operators, and their Properties, Projections on a Hilbert Space and their Characterization, Reflexivity of Hilbert Space, and Finite Spectral Theorem for Normal Operators.

BOOK PRESCRIBED:

Functional Analysis—B.V.Limaye (New Age—International! Limited, Publishers, Second Edition)

Course Code:	**MTPE402**	No. of Credits:	4
Course Name:	**AUTOMATA THEORY AND FORMAL LANGUAGE**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO1 Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, (non-)deterministic automata, regular expressions, regular languages, context-free grammars, context-free languages, Turing machines;

CEO-2 :Explain the power and the limitations of regular languages and context-free languages.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1 : Be able to construct finite state machines and the equivalent regular expressions.

CO-2 :Be able to prove the equivalence of languages described by finite state machines and regular expressions.

CO-3 :Be able to construct pushdown automata and the equivalent context free grammars and to prove the equivalence of languages described by pushdown automata and context free grammars.

CO-4 Be able to construct Turing machines and Post machines. Be able to prove the equivalence of languages described by Turing machines and Post machines

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I: AUTOMATA FUNDAMENTALS [12 Hours]

Introduction to formal proof – Additional forms of Proof – Inductive Proofs –Finite Automata – Deterministic Finite Automata – Non-deterministic Finite Automata – Finite Automata with Epsilon Transitions

UNIT II: REGULAR EXPRESSIONS AND LANGUAGES [8 Hours]

Regular Expressions – FA and Regular Expressions – Proving Languages not to be regular – Closure Properties of Regular Languages – Equivalence and Minimization of Automata.

UNIT III: CONTEXT FREE GRAMMAR AND LANGUAGES [10 Hours]

CFG – Parse Trees – Ambiguity in Grammars and Languages – Definition of the Pushdown Automata – Languages of a Pushdown Automata – Equivalence of Pushdown Automata and CFG, Deterministic Pushdown Automata.

UNIT IV: PROPERTIES OF CONTEXT FREE LANGUAGES [10 Hours]

Normal Forms for CFG – Pumping Lemma for CFL – Closure Properties of CFL – Turing Machines – Programming Techniques for TM.

TEXT BOOK:

J.E.Hopcroft, R.Motwani and J.D Ullman, ―*Introduction to Automata Theory, Languages and Computations*‖, Second Edition, Pearson Education, 2003. www.rejinpaul.com

REFERENCES:

1. H.R.Lewis and C.H.Papadimitriou, ―Elements of the theory of Computation‖, Second Edition, PHI, 2003.
2. J.Martin, ―Introduction to Languages and the Theory of Computation‖, Third Edition, TMH, 2003.
3. Micheal Sipser, ―Introduction of the Theory and Computation‖, Thomson Brokecole, 1997

Course Code:	**MTPE403**	No. of Credits:	4
Course Name:	**DESIGN & ANALYSIS OF ALGORITHMS**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1: Analyze the asymptotic performance of algorithms and Demonstrate a familiarity with major algorithms and data structures.

CEO-2: Write rigorous correctness proofs for algorithms and Apply important algorithmic design paradigms and methods of analysis

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO-1 : Argue the correctness of algorithms using inductive proofs and invariants.

CO-2 : Analyze worst-case running times of algorithms using asymptotic analysis.

CO-3 : Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms and Derive and solve recurrences describing the performance of divide-and-conquer algorithms.

CO-4 :Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic-programming algorithms, and analyze them.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[10 Hours]**

Introduction : Concepts in algorithms analysis (best case, average case and worst case complexity calculations), asymptotic complexity of the algorithms in Basic search and traversal techniques : General techniques, code optimization, Graphs and trees, Biconnected graphs, DFS, BFS,Kruskal, Prims and Dijkstra algorithms.

UNIT-II **[10 Hours]**

Domain independent algorithms and design techniques : Divide and conquer, greedy method. Dynamic Programming, Back tracking. Branch and Bound Technique. Algebraic simplification and transformation, the general method, evaluation and interpolation, the fast Fourier transform, modular arithmetic.

UNIT-III **[12 Hours]**

Lower bound theory : Comparison trees, Oracles and adversary arguments, techniques for algebraic problems, lower bounds on parallel computation.

NP-hard problems and NP-complete problems: Nondeterministic algorithms, Cook's theorem, NP-hard graph problems, NP-hard scheduling problems, NP-hard code generation problems.

UNIT-IV **[8 Hours]**

Approximation algorithms for NP-hard problems: Absolute approximations, epsilon approximations, polynomial and fully polynomial time approximation schemes, and probabilistically good algorithms.

TEXT BOOKS

1. Horowitz and Sahni, Fundamentals of Computer Algorithms, Computer Science Press, Maryland, 2006.

REFERENCE BOOKS

1. Baase S and Gelder, A.V, computer Algorithms, Addition- Wesle Langman Singapore, Ptv. Ltd. India, 2000.
2. Garey, M.R, and Johnson, D.S, Computers and Intractability: A Guide to the Theory of NP- Completeness, W. H. Freeman, San Francisco,1976.
3. R. Sedgewick, Algorithms in C++, Addison- Wesley, 1992.

Course Code:	**MTPE404**	No. of Credits:	4
Course Name:	**ABSTRACT MEASURE**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1 To provide thorough understanding on ethics, moral values, moral development theories, personal and professional ethics.**&** To provide students with a deep insight about Profession and Professionalism, Professional accountability and ethical theories.

CEO-2 To impart knowledge on intellectual properties, intellectual property rights and their need in research.&To learn about patentable requirements, various IPRs and patent filling procedure.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1: Students will understand the fundamentals of measure theory and be acquainted with the proofs of the fundamental theorems underlying the theory of integration.

CO-2: They will also have an understanding of how these underpin the use of mathematical concepts such as volume, area, and integration and

CO-3 : They will develop a perspective on the broader impact of measure theory in ergodic theory and have the ability to pursue further studies in this and related area.

CO-4: The students will learn about measure theory random variables, independence, expectations and conditional expectations, product measures and discrete parameter matingalus.• Explain the concept of length, area, volume using lebesgue's theory.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[12 Hours]**

Introduction, Outer measure, Measurable sets and Lebesgue measure, Anon measurable set. Measurable functions, Littlehood's hree principle

Unit-II **[8 Hours]**

The Lebesgue Integral. Introduction, lebesgue integral ,Riemann sums Lebesgue integrals ,properties Bounded converges theorem Fatuous lemma and the lebesgue converges theorem

Unit-III **[10 Hours]**

Differentiation and Integration. Introduction, monotone functions, lemma(vitali) Bounded variation, properties Differentiation of an integral theorem Absolute continuity ,theorems

Unit-IV **[10 Hours]**

The classical Banach Spaces. Introduction Linear space ,Minkowsky inequality Holders inequality, theorems Riesz - fischers theorem

BOOK PRESCRIBED:

Real Analysis-H.L.Royden(Macmillan) Chapter: 3,4,5,6.

Course Code:	**MTPE405**	No. of Credits:	4
Course Name:	**ETHICS & IPR**	**Sem End Exam & Cycle Test:**	**70+30**

COURSE EDUCATIONAL OBJECTIVES:

CEO1 To provide thorough understanding on ethics, moral values, moral development theories, personal and professional ethics.**&** To provide students with a deep insight about Profession and Professionalism, Professional accountability and ethical theories.

CEO-2 To impart knowledge on intellectual properties, intellectual property rights and their need in research.&To learn about patentable requirements, various IPRs and patent filling procedure.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO1: Recognize the philosophical assumptions that are embedded in moral ideas and in philosophical works in order to define one's moral responsibility in contemporary society.

CO2: Reflect on and evaluate ethical arguments from diverse sources in order to communicate effectively with others who might have a different opinion from one's own.

CO3: Gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas and devise business strategies by taking account of IPRs.

CO4: Acquire more insights into the regulatory affair and assists in technology up-gradation for enhancing competitiveness.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-1 **[10 Hours]**

Introduction to Ethics: 1.1 Basic terms- Moral, Ethics, Ethical dilemma, Emotional intelligence 1.2 Moral development theories of Kohlberg and Piaget 1.3 View on ethics by Aristotle 1.4 Governing factors of an individual's value system 1.5 Personal and professional ethics

Unit-2 **[10 Hours]**

Profession and Professionalism: 2.1 Clarification of the concepts: Profession, Professional, Professionalism, Professional accountability, Professional risks, Profession and Craftsmanship, Conflict of interest 2.2 Distinguishing features of a professional 2.3 Role and responsibilities of professionals 2.4 Professionals' duties towards the organization and vice-a-versa 3 Ethical Theories: 3.1 Various ethical theories and their application-Consequentialism, Deontology, Virtue theory, Rights Theory, Casuist theory 3.2 Ethical terms: Moral absolutism, Moral Relativism, Moral Pluralism etc. 3.3 Resolving Ethical Dilemma

Unit-3 **[10 Hours]**

Concept of property, rights, duties and their correlation; Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies.

Unit-4 **[10 Hours]**

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art;Patent databases; Searching International Databases; Analysis and report formation; Filing of a patent application; Role of a Country Patent Office; Precautions before patenting-disclosure/non-disclosure; International patenting-requirement; Introduction to History of GATT, WTO, WIPO, TRIPS, PCT and Implications; Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neemetc.

Text Books:

1. R. Subramanian, "Professional Ethics" , Oxford University Press, New Delhi, 2013
2. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics", Oxford University Press, New Delhi, 2012.
3. Stanley SA, Bioethics, Wisdom educational services
4. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Course Code:	**MTPE406**	No. of Credits:	2
Course Name:	**DOCUMENT USING LATEX**	**End Exam:**	**50**

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To know about installation, compilation, syntax of Latex and to write mathematical equations and matrices.

CEO2: To know about Title, Abstract, Keywords, Chapter, Sections and Subsections, References and their citations. Table of contents, List of figures, List of tables, Page numbering.

CEO3: To know about Latex packages and its uses.

CEO4: To know about Article, Report, Book, Letter, Slides, Presentation.

COURSE OUTCOMES:
Towards the end of the course the students will be able to :

CO-1 : Installation of the Latex software, compilation, Basic syntax, Writing mathematical equations, Matrices, Tables

CO-2 : About Writing Title, Abstract, Keywords, Chapter, Sections and Subsections, References and their citations. Table of contents, List of figures, List of tables, Page numbering.

CO-3 : About Packages like amsmath, amssymb, amsfonts, hyperrefer, graphic, color, latexsym, natbib, setspace, multicol, subcaption, tikz, and geometry.

CO-4 : To know about Article, Report, Book, Letter, Slides, Presentation.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[10 Hours]**

Installation of the software LaTeX, Understanding LaTeX compilation and LaTeX editors, Basic syntax, Writing mathematical equations, Matrices, Tables, Inclusion of graphics into LaTeX file.

Unit-II **[10 Hours]**

Page configurations: Title, Abstract, Keywords, Chapter, Sections and Subsections, References and their citations, Labeling of equations, Table of contents, List of figures, List of tables, Page numbering, Generating index.

Unit-III **[10 Hours]**

Packages: amsmath, amssymb, amsthm, amsfonts, hyperrefer, graphic, color, latexsym, natbib, setspace, multicol, subcaption, tikz, and geometry.

Classes: Article, Report, Book, Letter, Slides, Beamer.

Unit-IV **[10 Hours]**

Applications: Writing reports, books, articles/ research papers, thesis, and official letters. Making simple and modern resumes, figures, question papers, and presentations.

TEXT BOOK

L. Lamport. LATEX: A Document Preparation System, User's Guide and Reference Manual. 2nd Edition, Addison Wesley, New York, 1994.

Course Code:	MTEC407	No. of Credits:	8
Course Name:	Major Research Project /Dissertation	End Exam	200

Objectives:

Every student will have to complete one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a project report with details as per the Performa and sample provided.

The project report should be hard bound and the students will have to submit ***fou***r ***copies*** of the project repor*t* for final evaluation of ***200 marks*** based on the following criteria.

CRITERIA	Max. Marks
Literature Survey/Reference	20
Objectives/Plan of the project	20
Experimental/Theoretical Methodology	40
Significance and originality of the study	20
Depth of knowledge in the subject	20
Results and Discussions	20
Presentation/seminar/Viva	60
Total Marks	**200**

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