M.Sc. MATHEMATICS

(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM (CBCS)

TWO YEARS FULL TIME PROGRAMME

COURSE OF STUDIES AR-23

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

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.

DEPT. OF MATHEMATICS

GIET UNIVERSITY, GUNUPUR

PG DEPARTMENT OF MATHEMATICS

ProgramEducationalObjectives (PEOs)	
The **M.Sc. Mathematics** program describe accomplishments that graduates are expected to attainafter graduation	
PEO1	To enable pupils to thrive in the many mathematical vocations and to compete with their peers, give them a solid foundation in a variety of mathematics courses.
PEO2	Encourage and equip the students to pursue further education and research, helping to meet the nation's growing academic needs..
PEO3	Equip students with a comprehensive knowledge base, a grasp of multicultural and global perspectives, and excellent communication and interpersonal skills to work as leaders and team members in interdisciplinary teams.
PEO4	Encourage the full development of the student's personality so that they can handle moral and professional dilemmas and become capable of lifelong, autonomous learners.
Program Specific Outcomes (PSOs)	
After the successful completion of **M.Sc. Mathematics** program, the students are expected to	
PSO1	Explain mathematical ideas and their applications.
PSO2	Learn to think logically and analytically by using a variety of mathematical tools and strategies.
PSO3	Examine real-world issues and discover how to create mathematical models to address them.
PSO4	Obtain the in-depth information and research skills necessary to seek further education. Engage in professional work involving mathematics.
PSO5	Reach goals of passing different tests and interviews to get hired by banks, companies, schools, and other organizations/services.

SCHOOL OF SCIENCES
Ref.No.....
Dt.....
Dt-Rayagada (Odisha)
GIET UNIVERSITY, GUNUPUR

HOD
School of Sciences
GIET University, Gunupur

M.Sc. MATHEMATICS

Schedule for Instruction and Examination
(Proposed Scheme for Academic year 2022-2024)

1st SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	101	Abstract Algebra	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	Programming in C	3	1	0	4
PRACTICAL / SESSIONAL							
6	MTPE	106	Programming in CLab	0	0	4	2
7	MTPC		Project-I			4	2
TOTAL				**17**	**3**	**8**	**24**

2nd SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	201	Linear Algebra	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	Mathematical Statistics	3	1	0	4
5	MTCBOE*	205	Graph Theory	3	1	0	4
		206	Fuzzy Set Theory				
		207	Stochastic Process				
PRACTICAL / SESSIONAL							
6	MTPE	209	Documentation using LATEX	0	0	4	2
7	MTPC	209	Project-II	0	0	4	2
TOTAL				**16**	**4**	**8**	**24**

Type text here

BoS Approved
Date: 07.05.22

3rdSEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	MTPC	301	Measure Theory & Integration	3	1	0	4
2	MTPC	302	Numerical Analysis	4	0	0	4
3	MTPC	303	Complex Analysis	4	0	0	4
4	MTCBPE	304	Differential Geometry	3	1	0	4
		305	Finite Element Methods				
		306	Optimization Techniques				
5	MTPE	307	Fluid Dynamics	4	0	0	4
		308	Classical Mechanics				
		309	Mathematical Modelling				
PRACTICAL / SESSIONAL							
6	PC	310	Minor Project/Dissertation - I	0	0	4	2
TOTAL				**18**	**2**	**6**	**22**

4THSEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	CC	401	Functional Analysis	3	1	0	4
2	PE	402	Number Theoretic Cryptography	4	0		4
3		403	Automata Theory	3	1	0	
		404	Design & Analysis of Algorithm	4	0	0	
4	OE	405	Ethics & IPR	4	0	0	4
PRACTICAL / SESSIONAL							
5	PC	406	Major Project/Dissertation -II	0	0	16	8
TOTAL				**18**	**2**	**16**	**20**

Type text here

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC1001**	**No. of Credits:**	**4**
Course Name:	**LINEAR ALGEBRA**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To introduce the concept of Basis and Dimensions of vector spaces. Also, it will focus on the Matrix transformations and different matrix operations.
CEO-2	**:**	To introduce the concept of norms and inner product spaces in the process of Gram-Schmidt orthonormalization. Next it will give's the idea of various transformations such as Bilinear forms, Symmetric or Skew Symmetric Bilinear forms etc.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	:	To explain the fundamental concepts of vectors and vector spaces to understand the Basis and dimensions.
CO-2	:	To explain the concepts of linear transformations of different vector spaces, with numerous examples.
CO-3	:	To use the concepts of Linear Transformations and basis to create a matrix to easily find the Range Space, Kernel, Rank and Nullity.
CO-4	:	To find the solutions to system of differential equations in various methods such as Gaussian Elimination Method, Gauss Jordan Method etc.
CO-5	:	To know the various matrices and their properties and also to understand the concepts of the eigenvalue and eigen vector problems.
CO-6	:	To understand the concept of inner product space and its use in Gram-Schmidt orthonormalization Process. Also, to find various transformations such as Bilinear forms, Symmetric or Skew Symmetric Bilinear forms etc.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	1	1	3											
CO-2	3	2	3											
CO-3	2	3	3											
CO-4	2	2	3											
CO-5	2	2	3											
CO-6	2	2	3											
Avg.	2	2	3											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Vector Space	12: HOURS
Vector spaces over fields, subspaces, bases and dimension, Linear transformations, rank-nullity theorem, representation of linear transformations by matrices,		
UNIT-II	**Linear Transformations**	**12: HOURS**
Systems of linear equations, matrices, rank, Gaussian elimination, Determinants, Laplace expansions, co-factors, adjoint, Cramer's Rule.		
UNIT-III	**Matrices**	**12: HOURS**
Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonalization, rational canonical form, Jordan canonical form.		
UNIT-IV	**Inner Product**	**12: HOURS**
Inner product spaces, Gram-Schmidt orthonormalization, orthogonal projections, linear functionals and adjoints, duality and transpose.		
UNIT-V	**Bilinear Form**	**12: HOURS**
Rayleigh quotient, Min-Max Principle. Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Hoffman K. and Kunze R. Linear Algebra, Pearson Education.
2	V. K Khanna and S. K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House, 1993.
3.	Strang G. Linear Algebra and its applications, Cengage Learning.
4.	Ramana B.V. Higher Engineering Mathematics, Tata Mcgraw-Hill.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC1002**	**No. of Credits:**	**4**
Course Name:	**REAL ANALYSIS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	The main objective is to familiarize with the Riemann-Stieltjes Integral.
CEO-2	**:**	To understand convergence of sequence and series of real valued function Lebesgue outer, differentiability, continuity.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Evaluate the convergence or divergence of sequences and series**.**
CO-2	**:**	Analyze continuity and uniform continuity of functions.
CO-3	**:**	Develop knowledge of Riemann integral and improper integral.
CO-4	**:**	Incorporate uniform convergence of sequences and series of functions.
CO-5	**:**	Demonstrate the concept of differentiability for functions of several variables.
CO-6	**:**	Define and understand basic notions in abstract integration theory, integration theory on topological spaces and the n-dimensional space.

Mapping of COs with POs and PSOs

PSOs / **COs**	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	**3**	**1**	**3**	**2**	**1**									
CO-2	**3**	**1**	**3**	**2**	**1**									
CO-3	**3**	**1**	**3**	**2**	**1**									
CO-4	**3**	**1**	**3**	**2**	**1**									
CO-5	**3**	**1**	**3**	**2**	**1**									
CO-6	**3**	**1**	**3**	**2**	**1**									
Avg.	**3**	**1**	**3**	**2**	**1**									

1. Slight	**2. Moderate**	**3. Substantial**

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

COURSE CONTENT

UNIT-I	**Sequence & Series**	**12: HOURS**
Sequences: Sequences and their limits, monotone sequences, Bolzano-Weierstrass theorem for sequence, Cauchy Sequence, Cauchy criterion for convergence Series: Introduction to Infinite series, convergence and absolute convergence, tests for absolute convergence, tests for non-absolute convergence.		
UNIT-II	**Continuity & Differentiability**	**12: HOURS**
Continuity: Continuous function and composition, continuous functions on intervals, intermediate value theorem, fixed point theorem, uniform continuity Differentiability: Mean value theorem, Taylor's theorem, convex function.		
UNIT-III	**Riemann Integration**	**12: HOURS**
Riemann integration: Riemann integral, Riemann integrable functions, fundamental theorem, Darboux's theorem. Improper Integral: Basic concept of convergence of improper integrals.		
UNIT-IV	**Convergency of Sequence & Series**	**12: HOURS**
Sequences and series of functions: Point wise and uniform convergence, consequences of uniform convergence, power series, Weierstrass approximation theorem.		
UNIT-V	**Function Of Several Variable**	**12: HOURS**
Function of several variables: differentiability, directional derivative, the matrix of linear function, Jacobian matrix, sufficient condition for differentiability, Taylor's formula.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Apostol T.M, Mathematical Analysis, Narosa Publishing House, Indian.
2.	W. Rudin, Principle of Mathematical Analysis, Tata Mc Graw Hills.
3.	R. G. Bartle, Introduction to Real Analysis, Wiley.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC1003**	**No. of Credits:**	**4**
Course Name:	**NUMERICAL ANALYSIS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	The course will 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:

After completion of this course, students will be able to

CO-1	**:**	Apply various numerical methods to find the approximate solutions for linear and non-linear equations.
CO-2	**:**	Use different interpolation techniques to obtain approximate function from set of tabular data.
CO-3	**:**	Differentiate and integrate the functions that are difficult to deal analytically by several numerical techniques.
CO-4	**:**	Solve system of linear equations numerically that arise many practical applications.
CO-5	**:**	Solve different differential equations, difference equations that are framed while developing mathematical models of various practical problems.
CO-6	**:**	Understand the theoretical and practical aspects of the use of numerical analysis and proficient in implementing numerical methods for a variety of multidisciplinary applications.

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	2	3												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Numerical Solution to Algebraic, Transcendental Equations and System of Linear Equations	12: HOURS

Iteration methods based on first degree equations: Secant, Regula-Falsi and Newton Raphson Methods. Gauss Elimination Method, Gauss-Jordan Elimination Method, Inverse of a matrix by Gauss-Jordan Method. LU decomposition (Crout's) Method. Gauss-Seidel Iteration Method.

UNIT-II	Interpolation	12: HOURS

Unequal Space Interpolation: Lagrange and Newton interpolations. Finite difference operators. Relation between operators. Equal Space Interpolation: Interpolating Polynomials using finite differences. Hermite Interpolation, Piecewise and spline interpolation. (Basic Idea).

UNIT-III	Numerical Differentiation and Numerical Integration	12: HOURS

Differentiation: Derivatives using Newton's forward, Newton's backward and Central difference formulae (Stirling's formula). Integration: Trapezoidal and Simpson's rule. Gauss-Legendre and Gauss-Chebyshev Integration Methods. Romberg Integration.

UNIT-IV	**Numerical Solutions of ODE**	**12: HOURS**
Ordinary Differential Equations, Initial Value Problems: Introduction, Difference Equations, Numerical methods, Single step methods, Stability analysis of single step methods, multi-step-methods.		
UNIT-V	**Numerical Solutions of PDE**	**12: HOURS**
Classification of PDE of 2nd order, Finite difference approximation to derivatives, Laplace equation, Poisson's equation, One dimensional heat equation, One dimensional wave equation.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	M. K. Jain, S. R. K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation", Fifth Edition, New Age International Publishers, 2007. Chapter-2,4, 5, 6.

2.	P. Kandasamy, K. Thilagavathy and K. Gunavathi, "Numerical Methods", S. Chand & Company Ltd. Sultan Chand & Company.
3.	S. Arumugam, Thangapandi Isaac and A. Soma Sundaram, "Numerical Methods", 2nd edition, SCITECH publication, 2015. Chapter-4,8,10, 11.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC1004**	**No. of Credits:**	**4**
Course Name:	**ORDINARY DIFFERENTIAL EQUATIONS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Identify the type of a given differential equation and apply the appropriate analytical technique for finding the solution of higher order ordinary differential equations.
CEO-2	**:**	Understand the utility of the theory of power series which is studied in Real Analysis course through solving various second order differential equations.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Get introduced to the hypergeometric functions which arises in connection with solutions of the second order ordinary differential equations with regular singular points.
CO-2	**:**	Solve the problems arises in mathematical physics using properties of special functions.
CO-3	**:**	Understand the importance of studying well-posedness of the problem namely existence, uniqueness and continuous dependence of first order differential equations through Picard's theorem.
CO-4	**:**	Understand the utility of the concepts from linear algebra and analysis in the study of system of first order equations.
CO-5	**:**	Discuss the qualitative properties of solutions of first and second order equations. Also they will be able to work on numerous problems using comparison theorem in Sturm Liouville problems.
CO-6	**:**	Learn the nature of solutions which involves critical points and phase portrait of nonlinear equations.

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	1	3	3	2	3								
CO-2	3	1	3	3	2	3								
CO-3	3	1	3	3	2	3								
CO-4	3	1	3	3	2	3								
CO-5	3	1	3	3	2	3								
CO-6	3	1	3	3	2	3								
Avg.	3	1	3	3	2	3								

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Existence and Uniqueness of Solutions	12: HOURS

Preliminaries – Picard's successive approximations – Picard's theorem – Some Examples – Continuation and dependence on initial Conditions – Existence and Uniqueness for systems – Existence theorem – extremal solutions- Upper and Lower solutions.

UNIT-II	Linear Differential Equation of Higher Order and System of Linear Differential Equations	12: HOURS

Introduction – Higher Order Equations – Linear Dependence and Wronskian – Homogeneous Linear Equations with Constant Coefficients – Equations with Variable Coefficients – Method of Variation of Parameters – System of First Order Equations – Existence and Uniqueness Theorem – Fundamental Matrix – Non-homogeneous Linear Systems – Linear System with Constant Coefficients.

UNIT-III	Solution in Power Series	12: HOURS

Second Order Linear Equation with Ordinary Points – Legendre Equation and Legendre Polynomials – Second Order Equation with Regular Singular Points – Bessel's Functions.		
UNIT-IV	**Oscillation of Second Order Equations**	**12: HOURS**
Introduction – Sturm's Comparison Theorem – Elementary Linear Oscillations – Comparison theorem of Hille – Wintner – Oscillation of $x'' + a(t)x = 0$.		
UNIT-V	**Boundary Value Problems**	**12: HOURS**
Introduction – Sturm – Liouville Problem – Green's Functions – Applications (of BVPs) – Picards Theorem.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	S. G. Deo, V. Raghavendra and V. Lakshmikantam, "Textbook of Ordinary Differential Equations", 3rd edition, McGraw Hill Education (India) Private Limited, New Delhi.
2.	G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Edition, McGraw Hill, 2017.
3.	E.A. Coddington, Ordinary Differential Equaitons, McGraw Hill, 1989.
4.	Boyce and DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, John Wiley, 2009.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC1005**	**No. of Credits:**	**4**
Course Name:	**PROGRAMMING FOR PROBLEM SOLVING USING 'C'**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To formulate problem statements, translate into program and then execute the programs.
CEO-2	**:**	To analyse a problem for knowing its efficiency and decompose it into functions approach.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Memorize features of structure-oriented programming and describe control statements, arrays, structures and pointers.
CO-2	**:**	Classify various types of statements and demonstrate programs on control structures, arrays, functions, pointers and structures.
CO-3	**:**	Solve problems using different programming logics and can able to discover better solutions.
CO-4	**:**	Analyse different programs by experimenting on them and estimating their efficiency.
CO-5	**:**	Evaluate complex programs by verifying their logics and justify their results.
CO-6	**:**	Develop applications and projects using various features of structure-oriented programming.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	2	2												
CO-2	2	3												
CO-3	2	2												
CO-4	2	3												
CO-5	2	2												
CO-6	2	3												
Avg.	2	2.5												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Programming	12: HOURS
Basic structure of C program, C compilers, C Tokens, keywords, identifiers, data types, variables, standard I/O statements, Operators classifications. Branch Control Statements: if, if. Else, else if ladder, nested if, switch. case.		
UNIT-II	**Iteration Logic**	**12: HOURS**
while, do-while and for loop, nested loop. 1-D Array: declaration, initialization and 1-D array operations. 2-D Array: declaration, Initialization and 2-D array operations.		
UNIT-III	**Character arrays and Strings**	**12: HOURS**
String operationsand string handling functions: strcmp(), strcat(), strcpy(), strlen(). User Defined Functions: Function categories, parameter passing in functions, passing arrays to functions.		
UNIT-IV	**Structures**	**12: HOURS**
Declaration and initialization of structures, accessing structure elements, structures and arrays.		
UNIT-V	**Pointers**	**12: HOURS**
Declaration and initialization of pointers, pointer arithmetic, pointer with array, call by address concept.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	E. Balaguruswamy, Programming in ANSI C, 7th edition, Tata McGraw-Hill.

2.	Let us 'C' by Yashwant Kanethekar, 16th edition, BPB Publications.
3.	Programming in C, by Reema Thareja, 2nd edition, OUP India.
4.	C Programming and Coding by swati saxena, BPB Publications.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC1105**	**No. of Credits:**	**2**
Course Name:	**PROGRAMMING USING 'C' LABORATORY**	**Sem End Exam & Cycle Test Marks**	**50**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To develop programs for problems on different applications of array, functions, pointers and structure.
CEO-2	**:**	To analyze different problems by comparing and implementing in programming.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	To understand structure of 'C' program, writing programs, compilation and execution process.
CO-2	**:**	To develop programs using loop controls and arrays and understand different programs.
CO-3	**:**	To develop programs using strings and functions by decomposing a problem.
CO-4	**:**	To solve different problems using pointers, structures and understand their functionality.
CO-5	**:**	Evaluate complex programs by verifying their logics and justify their results.
CO-6	**:**	Develop applications and projects using various features of structure-oriented programming.

Mapping of COs with POs and PSOs

PSOs	**PO**												**PSO**	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	**2**	**3**												
CO-2	**2**	**3**												
CO-3	**2**	**3**												
CO-4	**2**	**3**												
CO-5	**2**	**3**												
CO-6	**2**	**3**												
Avg.	**2**	**3**												

1. Slight	**2. Moderate**	**3. Substantial**

COURSE CONTENT

UNIT -I	**Familiarization with Programming Environment and Introduction to the C Compiler.**	**6: HOURS**
1) Write a program to input radius of a circle and find the area, perimeter of it. 2) Write a program to input two numbers and swap them without using intermediate variable.		
UNIT - II	**Simple Computational Problems usiing Arithmetic Expressions.**	**6: HOURS**
1) Write a program to accept Fahrenheit and calculate its equivalent Celsius. 2) WAP to input three unequal numbers and find the greatest using conditional operator.		
UNIT - III	**Problems involving if..else, else if ladder, switch case, While… do… While and for loops.**	**6: HOURS**
1) Write a program to find the greatest using else..if ladder among three unequal numbers given input. 2) Write a program to find the real roots of a quadratic equation using if..else when its three coefficient values given input. 3) Write a program to input a lower-case alphabet and test whether it is vowel or consonant switch case. 4) Write a program to find the greatest among three numbers using switch case. 5) Write a program to test a number is palindrome or not using while loop. 6) Write a program to test a number is prime or not using for loop. 7) Write a program to test a number is Armstrong or not using do. While loop.		
UNIT - IV	**1D Array interaction, 2D Array & Strings and User Defined Functions.**	**6: HOURS**
1) Write a program to find largest and smallest integers in a given list of 10 numbers in an array. 2) Write a program to input values into two matrices into A[3][3], B[3][3]. Add A. 3) Write a program to input two strings and test whether they are equal or not using string handling functions. 4) Write a C program which contains three User defined functions namely add(), subtract() and multiply(). Each function accepts two integers as their arguments and calculate and return the results. 5) Write a program to create a user defined function and test a number is prime or not.		
UNIT-V	**Strings and User Defined Functions & Structures, pointer and dynamic memory allocation**	**6: HOURS**

1) Write a program to create a structure having members: product id, name, cost. Store 5 product information into the structure array and then display only those products whose cost>=500.
2) Write a program to create a function which swaps two given integers using call by address.
3) Write a program to store ‘n integers using dynamic memory allocation. Find the average value of the integers using a user defined function.

Total Number of Hours:	3**0: HOURS**

REFERENCE BOOKS:

1.	E. Balaguruswamy, Programming in ANSI C, 7th edition, Tata McGraw-Hill.
2.	Let us ‘C’ by Yashwant Kanethekar, 16th edition, BPB Publications.
3.	Programming in C, by Reema Thareja, 2nd edition, OUP India.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

I Semester

Course Code:	**24MTPC2105**	**No. of Credits:**	**1**
Course Name:	**PROGRAMMING LABORATORY (MATLAB)**	**Sem End Exam & Cycle Test Marks**	**50**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To develop programs for problems on different applications of array, functions,
CEO-2	**:**	To analyze different problems by comparing and implementing in programming.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	To learn to write codes using basics of MATLAB.
CO-2	**:**	To write code for problems from calculus and series sums.
CO-3	**:**	To Write MATLAB codes for problems linear Algebra.
CO-4	**:**	To write MATLAB code for finding roots of equations, for problems in Numerical analysis.

Mapping of COs with POs and PSOs

PSOs / COs	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	2	3												
CO-2	2	3												
CO-3	2	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	2	3												

1. Slight	**2. Moderate**	**3. Substantial**

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

COURSE CONTENT

Basics concept of MATLAB	**10: HOURS**
Basics concept of MATLAB, General commands. Interactive Computation: Creating Matrix and Array operations, Mathematical Operations with Arrays. Using arrays in matlab built-in math functions. Programming in MATLAB, Graphics: Basic 2-D Plots and its Command, Matrices: Eigenvalues and Eigenvectors, Solution for a system of linear equations	
List of the Experiments	**20: HOURS**

1. Find the real root of equation $x^3 - 3x + 1 = 0$ correct to three place of decimal by using Bisection method
2. Find the real root of equation $x^3 - x - 11 = 0$ correct to three place of decimal by using Bisection method.
3. Find the real root of equation $x^3 - 3x - 5 = 0$ correct to three place of decimal by using by Regula -falsi method.
4. Find the real root of equation $x e^x - 2 = 0$ correct to three place of decimal by using by Regula -falsi method
5. Find the real root of equation $x e^x - 2 = 0$ correct to three place of decimal by using by Newtown- Raphson method.
6. Find the real root of equation $\cos x - 3x + 1 = 0$ correct to four place of decimal by using Iteration method.
7. Solve the linear equation by Gauss Elimination method
   $9x + 2y + 8z = 32$, $2x + 12y - 4z = 36$, $8x - 4y + 18z = 22$
8. Solve the linear equation by Crout' s Method.
   $2x + y + 4z = 12$, $8x - 3y + 2z = 20$, $4x + 11y - z = 33$
9. Solve the linear equation by Gauss Seidel method
   $x + 5y - z = 10$, $x + y + 8z = 20$, $4x + 2y + z = 14$
10. Solve the linear equation by Doolittle's method.
    $x + 5y + z = 14$, $2x + y + 3z = 13$, $3x + y + 4z = 17$
11. Solve the differential equation by Euler's Method
    $\frac{dy}{dx} = x + y$, $y(0) = 1$, find y at $x = 0.1$
12. Solve the differential equation by Runge- Kutta Method
    $\frac{dy}{dx} = x + y^2$, $y(0) = 1$, find y at $x = 0.1$

Total Number of Hours:	**30: HOURS**

REFERENCE BOOKS:

1.	Amos Gilat, MATLAB: An Introduction with Applications, 4th edition.
2.	W. Y. Yang, W. Cao, T. S. Chung and J. Morris, Applied Numerical Methods using MATLAB, Wiley Interscience, 2005.
3.	Rudra Pratap, Getting Started with MATLAB Oxford University Press.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

II Semester

Course Code:	**24MTPC2001**	**No. of Credits:**	**4**
Course Name:	**ABSTRACT ALGEBRA**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To focus on groups, Permutation groups, Homomorphisms, Sylow's theorem and Cayley's theorem. To make them understand about the ring theory and related definitions.
CEO-2	**:**	To calculate the roots of the polynomials and know more about roots. Also, to check the reducibility and irreducibility of polynomial rings over different field.

COURSE OUTCOMES

After completion of this course, students will be able to

CO-1	**:**	To classify the different sets and have idea about different structures.
CO-2	**:**	To focus on various groups and it's orders.
CO-3	**:**	To understand the concepts on group homomorphism and can able to solve different problems.
CO-4	**:**	To introduce the concept of ring, field and it's different properties.
CO-5	**:**	To understand the concept of ring homomorphism, and ideals.
CO-6	**:**	To introduce the concepts of polynomial rings and the concept of reducibility and irreducibility.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	1	3	2											
CO-2	3	2	1											
CO-3	2	1	3											
CO-4	2	2	2											
CO-5	2	3	1											
CO-6	2	1	3											
Avg.	2	2	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Group (Basics)	12: HOURS
Groups, subgroups, normal subgroups, quotient groups, cyclic groups, Langrange's theorem, Cosets, permutation groups.		
UNIT-II	**Group Homomorphism**	**12: HOURS**
Homomorphisms, Isomorphism, Automorphisms, Cayley's Theorem, kernel, theorems on Automorphisms, Inner Automorphisms, Sylow's theorems and Sylow Subgroup.		
UNIT-III	**Rings**	**12: HOURS**
Rings, Quotient ring, Integral Domain, Field, Ring Homomorphism and correspondence theorems, Prime, primary and maximal ideals with examples, characterizations and their inter relations.		
UNIT-IV	**Factorization Domain**	**12: HOURS**
Euclidean and factorization domain, common divisor and greatest common divisor, prime and irreducible elements, Polynomial of rings, Noetherian rings, characterizations of prime and maximal ideals in terms of prime and irreducible elements.		
UNIT-V	**Field Extension Theory**	**12: HOURS**
Field Extension and Galois Theory Field extension – algebraic and transcendental extension and their characterizations, Splitting field and algebraic closure, Separable and normal extension, Cyclotomic polynomial and Galois field, Galois theory – introduction, basic ideas and results focusing the fundamental theorem of Galois.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS

1.	I. N. Herstein, Topics in Algebra, John Wiley and Sons, (2^{nd} Edition.) 2002.
2.	V. K Khanna and S. K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House, 1993.
3.	S. Singh and Q. Zameeruddin, Modern Algebra, Vikas Publishing House, 1990.
4.	P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press, 1995.
5	J. A. Gallian, Contemporary Abstract Algebra, CRC Press, 1996.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

II Semester

Course Code:	**24MTPC2002**	**No. of Credits:**	**4**
Course Name:	**COMPLEX ANALYSIS**	**Sem End Exam & Cycle Test Marks**	**60+40**

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:

After completion of this course, students will be able to

CO-1	**:**	Analyse the difference between differentiability and analyticity and its interconnection with Laplace equation.
CO-2	**:**	Demonstrate fundamental exhibition and explanation of complex integration.
CO-3	**:**	Identify the existence of power series for functions under certain condition.
CO-4	**:**	Analyse the technical twist existing in construction of Laurent series in presence of singular point.
CO-5	**:**	Describe comprehension and cognition of the role of coefficient in Laurent series in evaluation of complex integral, identify location and types of singularities and evaluate the real integrals using residue theorem.
CO-6	**:**	Apply problem-solving using complex analysis technique applied to diverse situations in physics, engineering and other mathematical context.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3	3											
CO-2	2	3	2											
CO-3	1	3	1											
CO-4	2	3	2											
CO-5	2	3	2											
CO-6	2	3	2											
Avg.	2	2	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Complex numbers, Limit, Continuity, Analytic functions	12: HOURS
Complex numbers: Definition and geometric interpretation, square roots, rational powers of complex numbers, topology of complex plane, limit, continuity and differentiability, analytic function.		
UNIT-II	**Harmonic Function, Complex Integration**	**12: HOURS**
Cauchy Riemann equations, Laplace's equation, linear fractional transformations, complex integration, line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula.		
UNIT-III	**Power Series, Radius of Convergence**	**12: HOURS**
Sequences and Series: Convergence tests (comparison test, geometric series test, ratio test, root test) power series, functions given by power series, radius of convergence.		
UNIT-IV	**Maximum Principle**	**12: HOURS**
Taylor's series theorem state and proof, and Laurent's series theorem state and proof, maximum modulus principle, maximum modulus theorem state and proof. The Schwarz lemma.		
UNIT-V	**Classification of Singularities, Calculus of Residue**	**12: HOURS**
Zeros and Singularities: Types of Singularities, Location and types of singularities, residue theorem, residue integration, evaluation of real integrals.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	S. Ponnusamy, Foundations of Complex Analysis (Second Edition), Narosa.

2.	Brown and Churchill, Complex Variable and applications, Tata Mc Graw Hill.
3.	J. B. Conway, Functions of one complex variable, Springer, 1978.
4.	Herb Silverman and S. Ponnusamy, Complex Variables with Applications, Birkhauser.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics
II Semester

Course Code:	**24MTPC2003**	**No. of Credits:**	**4**
Course name:	**PARTIAL DIFFERENTIAL EQUATIONS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Introduce students to Partial Differential Equations & Introduce students to how to solve linear Partial Differential with different methods.
CEO-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.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Recognize fundamental knowledge of partial differential equation classify partial differential equations and transform into canonical form and solve linear partial differential equations of both first and second order.
CO-2	**:**	Classify partial differential equations and transform into canonical form apply partial derivative equation techniques to predict the behaviour 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.
CO-5	**:**	Demonstrate the working knowledge of boundary value problems.
CO-6	**:**	Apply the theory PDEs in Laplace equation and its application.

Mapping of COs with POs and PSOs

PSOs	**PO**												**PSO**	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	**3**	**3**												
CO-2	**2**	**3**												
CO-3	**1**	**3**												
CO-4	**2**	**3**												
CO-5	**2**	**3**												
CO-6	**2**	**3**												
Avg.	**2**	**3**												

1. Slight	**2. Moderate**	**3. Substantial**

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

COURSE CONTENT

UNIT-I	**Partial Differential Equations of First Order**	**12: HOURS**
Formation of PDE, Solution of PDE of First order equation, Integral surfaces passing through a curve, Cauchy Problem, surfaces Orthogonal, Cauchy Method of Characteristics equation (First order), Compatible system, Charpit's Method Classification and canonical forms of PDE. Rieman's Method.		
UNIT-II	**Elliptic Differential Equations**	**12: HOURS**
Separation of Variables Elliptic PDE, 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.		
UNIT-III	**Parabolic Differential Equations**	**12: 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. Maximum Minimum principle and Consequences.		
UNIT-IV	**Hyperbolic Differential Equations**	**12: HOURS**
Formation and solution of one dimensional wave equation, canonical reduction, IVP D'Alembert's solution, Vibrating string , Forced Vibration of Non homogeneous equation, BVP and IVP for two-dimensional wave equation method of Eigen function, Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate.		
UNIT-V	**Solution of PDE by Laplace and Fourier Transform**	**12: HOURS**
Introduction and transform of elementary function, Solution of Wave equation, Laplace's equation by Laplace Transform and Fourier Transform Method.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	K. Sankar Rao, Introduction to Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi. 2005.
2.	W. A. Strauss, Partial Differential Equations an Introduction, 2nd Edition, John Wiley & Sons.
3.	I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.
4.	R. Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

II Semester

Course Code:	**24MTPC2004**	**No. of Credits:**	**4**
Course Name:	**PROGRAMMING USING PYTHON**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To understand the basics of programming using Python.
CEO-2	**:**	To Construct and execute basic programs in Python.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Understand the basic concept of Python like data types and syntax of programming.
CO-2	**:**	Use python programming with user defined & built in methods, objects of Python.
CO-3	**:**	design application using the concepts of file, database access and exception handling.
CO-4	**:**	Create practical and contemporary applications such as web applications and discrete-event simulations, data analysis and IoT devices.
CO-5	**:**	Understand Python syntax and semantics and be fluent in the use of Python flow control and Functions.
CO-6	**:**	Interpret the concepts of object oriented programming using Python.

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	2	2												
CO-2	2	3												
CO-3	2	2												
CO-4	2	3												
CO-5	2	2												
CO-6	2	3												
Avg.	2	2.5												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Foundations	12: HOURS
History of Python, Python installations, IDE (Anaconda, python idle, Jupiter, Eclipse, VScode, etc), Python datatypes, Operators, Conditional Statements, Control flow statements, Functions, Local and Global Variables, Modules, Collections (String, List, Dict, Tuples, Sets).		
UNIT-II	**OOPS Methods**	**12: HOURS**
OOPS,Classes and Objects, ADT, Recursion, Inheritance and Types , Encapsulation, Polymorphism, Array(1D, Index Address Calculation), Exception Handling, Stack, Queue, Linked Lists, Searching(Linear and Binary) , Sorting(Quick, Bubble, Merge)..		
UNIT-III	**Library Packages**	**12: HOURS**
(Numpy, Pandas, Scikit, seaborn, matplotlib,): **Numpy:** ndarray object, indexing, and slicing. Data types and data structures in NumPy, properties and functions: ones (), zeros (), empty (), shape, reshape (), copy (), view (), concatenate (), sort (), Numpy array, operations: max (), min (), s um (), prod (), broadcasting. **Pandas:** Introduction, installation. Series, labels, data frame, Load files into Data Frame: reading csv and json files. Finding the relationship: corr()..		
UNIT-IV	**Data Visualization**	**12: HOURS**
Introduction to Introduction to Matplotlib, Installation and Setup, Basic Plotting: Plotting simple graphs using plt. plot (), Line styles, colors, and markers, Adding labels, title, and grid. Different Types of Plots: Scatter plots, Bar plots, Histograms, Box plots, Pie charts, Contour plots, 3D plots [Applications-I] CGI, GUI, Data Visualization Plotting(Bar, Graph).		
UNIT-V	**Applications**	**12: HOURS**

Linear Algebra, Linear Equations, Eigen Values and Eigen Vectors, Taylor Series, Fourier Transform.
Total Number of Hours: **60: HOURS**

REFERENCE BOOKS:

1.	Qingkai Kong Timmy Siauw Alexandre M. Bayen Python Programming and Numerical Methods A Guide for Engineers and Scientists. .
2.	Martin C. Brown, Python: The Complete Reference McGraw-Hill/Osborne Media.
3.	David Beazley Python Essential Reference, Developers' Library, Sams Publishing.
4.	Mark Lutz, O'Reilly Media Learning Python Inc., Fifth Edition, 2013.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

II Semester

Course Code:	**24MTPC2005**	**No. of Credits:**	**4**
Course Name:	**GRAPH THEORY**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	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 the 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:

After completion of this course, 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.
CO-5	**:**	To describe the concepts Planarity including Euler identity, non-planarity of celebrated graphs and its practical.
CO-6	**:**	Explain major theorems and inventions in the history of graph theory and understand how it made the subject to develop to the present state.

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	2	2												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	3	2												
CO-6	2	2												
Avg.	2	2.5												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Graphs and Subgraphs and Trees	12: HOURS
Graphs, Sub-graphs and Trees: Graphs and simple graphs. Graph isomorphism. The incidence and adjacency matrices, sub graphs, vertex degrees, Paths and connection. Cycles, Trees, cut edges and bonds, Cut vertices.		
UNIT-II	**Connectivity, Euler Tours and Hamilton Cycles and Matchings**	**12: HOURS**
Connectivity, Euler tours and Hamilton cycles: Connectivity, Blocks, Euler tours, Hamilton Cycles. Matchings and Edge Colourings: Matchings. Matchings and coverings in bipartite graphs, Edge chromatic number, Vizing's theorem.		
UNIT-III	**Independent sets and Cliques**	**12: HOURS**
Independent sets and Cliques, Vertex Colorings: Independent sets, Ramsey's theorem, Chromatic number, Brook's theorem, Chromatic polynomials.		
UNIT-IV	**Planar Graphs**	**12: HOURS**

Planar graphs: Plane and planar graphs, Dual graphs, Euler's formula. The Fivecolor theorem and the four-Color conjecture.		
UNIT-V	**Directed Graphs**	**12: HOURS**
Directed Graphs: Directed Graphs, Directed Paths, Directed Path, Menger's Theorem, Feasible Flows.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	J. A. Bondy and U.S.R Murthy: Graph Theory and Applications, Macmillan, London, 1976.
2.	S. A. Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987.
3.	R. Gould. Graph Theory, Benjamin/Cummings. Mento Park,1989.
4.	A. Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge,1989.
5.	R. J. Wilson and J. J. Watkins, Graphs: An Introductory Approach, John Wiley and Sons, New York, 1989.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

II Semester

Course Code:	**24MTPC2104**	**No. of Credits:**	**2**
Course Name:	**PROGRAMMING USING PYTHON LAB**	**Sem End Exam & Cycle Test Marks**	**50**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To learn to write codes using basics of Python programming.
CEO-2	**:**	To write code for problems from calculus, linear Algebra and Numerical analysis.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Understand the basic concept of Python like data types and syntax of programming.
CO-2	**:**	Use python programming with user defined & built in methods, objects of Python.
CO-3	**:**	design application using the concepts of file, database access and exception handling.
CO-4	**:**	Create practical and contemporary applications such as web applications and discrete-event simulations, data analysis and IoT devices.
CO-5	**:**	Understand Python syntax and semantics and be fluent in the use of Python flow control and Functions.
CO-6	**:**	Interpret the concepts of object-oriented programming using Python.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	2	3												
CO-2	2	3												
CO-3	2	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	2	3												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

Basics concept of python	10: HOURS

List of the Experiments	20: HOURS

1. Finding the limit of functions,
2. Finding the derivative of functions, higher-order derivatives.
3. Finding the maxima and minima.
4. Finding the integrals of functions.
5. Verify the continuity of a function at a point.
6. Find Area between two curves
7. Finding the length of a curve
8. Polynomial Interpolation by Lagrange's Method, Newton's Method
9. Find Roots of Equations by Method of Bisection and Newton-Raphson Method
10. Gauss Elimination Method (excluding Multiple Sets of Equations),
11. Doolittle's Decomposition Method only from LU Decomposition Methods
12. Numerical Integration Newton-Cotes Formulas
13. Trapezoidal rule. And Simpson’s rule and Simpson's 3/8 rule.
14. Finding eigen value and eigen vectors
15. Finding Taylor series and Finding Fourier transforms

Total Number of Hours:	**30 : HOURS**

REFERENCE BOOKS:

1.	Book: "Python Programming and Numerical Methods A Guide for Engineers and Scientists" by " Qingkai Kong Timmy Siauw Alexandre M. Bayen" .
2.	Python : The Complete Reference by Martin C. Brown.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

II Semester

Course Code:	**24MTPC2105**	**No. of Credits:**	**1**
Course Name:	**DOCUMENTATION USING LATEX**	**Sem End Exam & Cycle Test Marks**	**50**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To know about installation, compilation, syntax of Latex and to write mathematical equations and matrices.
CEO-2	**:**	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.

COURSE OUTCOMES:

After completion of this course, 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.
CO-5	:	Hyperrefer, graphic, color, latexsym,natbib, setspace, multicol, subcaption, tikz, and geometry.
CO-6	:	To know about Article, Report, Book, Letter, Slides, Presentation.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	2	2											
CO-2	2	3	1											
CO-3	1	3	3											
CO-4	2	3	2											
CO-5	3	2	2											
CO-6	1	2	2											
Avg.	2	2.5	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Installation of the software LaTeX	12: HOURS
Understanding LaTeX compilation and LaTeX editors, Basic syntax, Writing mathematical equations, Matrices, Tables, Inclusion of graphics into LaTeX file.		
UNIT-II	**Page configurations**	**12: HOURS**
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	**Packages**	**12: HOURS**
Amsmath, amssymb, amsthm, amsfonts, hyperrefer, graphic, color, latexsym, natbib, setspace, multicol, subcaption, tikz, and geometry. Classes: Article, Report, Book, Letter, Slides, Beamer.		
UNIT-IV	**Applications**	**12: HOURS**
Writing reports, books, articles/ research papers, thesis, and official letters.		
UNIT-V	**Preparation of resumes**	**12: HOURS**
Making simple and modern resumes, figures, question papers, and presentations.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Firuza Karmali Aibara, A Short Introduction to Latex: A Book for Beginners, Create Space Independent Publishing Platform.

2.	Helmut Kopka and Patrick W Daly, A guide to latex, Addison Wesley publisher.
3.	Frank Mittelbach and Michel Goossens, The latex companion, Addison Wesley publisher.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPC3001**	**No. of Credits:**	**4**
Course Name:	**PROBABILITY AND STOCHASTIC PROCESSES**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Develop an understanding of the principles of probability & develop an ability to analyze problems in a systematic and logical manner, including the ability to draw free-body diagrams.
CEO-2	**:**	Provide the meaning of Markov processes with continuous state space, and critically describe the connection between the theory of Markov processes and differential equations.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	An ability to interrelate between probability space and probability measure.
CO-2	**:**	An understanding of the analysis of probability distributions.
CO-3	**:**	A knowledge of correlation and regression analysis for two variables
CO-4	**:**	An ability to testing the hypothesis for various populations.
CO-5	**:**	Understand the fundamental concept of homogeneous and non- homogeneous Poisson processes.
CO-6	**:**	Explain the fundamental concepts of discrete and continuous Markov chains.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3	1											
CO-2	2	3	1											
CO-3	1	3	3											
CO-4	2	3	3											
CO-5	2	3	3											
CO-6	2	3	1											
Avg.	2	3	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Random Variables and Distributions	14: HOURS

Random Variables: Properties of random variable, mathematical expectation, moments, moment generating function, characteristic function. Discrete Distribution: Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson. Continuous Distribution: Continuous uniform, exponential, Normal, Gamma, Weibull, Beta, Cauchy distributions, problems based on their distributions. Transformations of a random variable.

UNIT-II	Two-Dimensions random variable	12: HOURS

Joint Distributions: Joint, marginal and conditional distributions, independence of random variables, bivariate normal distribution, problems. Transformations: functions of random vectors, problems.

UNIT-III	Correlation and Regression	10: HOURS

Types of Correlation, Karl Pearsons Coefficient of Correlation and Spearmen's Rank Correlations, Method of Least Squares Regression.

UNIT-IV	Testing of Hypothesis	12: HOURS

Large sample test for single mean, difference of mean, simple proportions, difference of proportions. Small sample test: t-test for single mean and difference of mean, Paired t-test, F-tests for variances, Chi-square-test for independent of attributes and goodness of fit test and its applications, problems.

UNIT-V	Stochastic Processes	12: HOURS

Classification, WSS processes, SSS processes, Poisson processes, birth and death processes, Markov process, and Markov chains: Classification of states of Markov chains.

Total Number of Hours:	**60: HOURS**

REFERENCE BOOKS:

1.	Gupta S. C. and Kapoor V. K. Fundamentals of Mathematical Statistics, 6th Edition, Sultan Chand & Sons, New Delhi.
2.	Papoulis Athanasios, Probability, Random Variables and Stochastic Processes, 3rd Edition, McGraw-Hill, New York, London.
3.	Medhi Jyotiprasad, Stochastic Processes 3rd Edition, Wiley Eastern Limited, New Delhi.
4.	Veerarajan T. Probability, Statistics and Random Processes 3rd Edition –Tata Mcgraw-hill Education.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPC3002**	**No. of Credits:**	**4**
Course Name:	**TOPOLOGY**	**Sem End Exam & Cycle Test Marks**	**60+40**

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 with in these structures.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Define concept of basis and sub-basis of a topology.
CO-2	**:**	Demonstrate different types of topologies.
CO-3	**:**	Describe connected topological spaces.
CO-4	**:**	Demonstrate compact topological spaces.
CO-5	**:**	Organize higher topological spaces organize higher topological spaces.
CO-6	**:**	Formulate conjectures about topological concepts, and test these conjectures.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of Cos with Pos and PSOs

PSOs / Cos	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3	3											
CO-2	2	3	2											
CO-3	1	3	1											
CO-4	2	3	2											
CO-5	2	3	3											
CO-6	2	3	2											
Avg.	2	3	2.1											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Set Theory	12: HOURS

Definition and examples of topological spaces, neighbourhoods, neighbourhood system of a point and its properties, interior point and interior of a set, interior as an operator and its properties, definition of a closed set as complement of an open set, limit point (accumulation point) of a set, derived set of a set, adherent point (closure point) of a set, closure of a set, closure as an operator and its properties, dense sets and separable spaces.

UNIT-II	Topological spaces & Continuous function	12: HOURS

Definition and examples of topological spaces; basis and sub basis; order topology; subspace topology. Continuity and related concepts; product topology; quotient topology; countability axioms; Lindelof spaces and separable spaces.

UNIT-III	Connectedness	12: HOURS

Connected spaces, generation of connected sets; component, path component; local connectedness, local path-connectedness, Continuous functions, Homeomorphisms.

UNIT-IV	Compactness	12: HOURS

Compact spaces; limit point compact and sequentially compact spaces; locally compact spaces; one-point compactification; finite product of compact spaces, statement of Tychonoff's theorem (Proof of finite product only).

UNIT-V	Countability & Separation Axioms	12: HOURS

Separation axioms; Urysohn’s lemma; Tietze’s extension theorem; Urysohn’s embedding lemma and Urysohn’s metrization theorem for second countable spaces.

Total Number of Hours:	**60: HOURS**

REFERENCE BOOKS:

1.	J.R. Munkres, A First Course in Topology, Pearson.
2.	J. L. Kelley, General Topology, Springer.
3.	J. Dungundji, Topology, 1988.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPC3003**	**No. of Credits:**	**4**
Course Name:	**NUMBER THEORETIC CRYPTOGRAPHY**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To know the algorithms, properties and theorems of number theory.
CEO-2	**:**	To know the symmetric cryptography and techniques of symmetric key cryptography.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Understand the concept of numbers of different bases, multiplication under different bases, inverse under modulo operations.
CO-2	**:**	Understand the theorems as mentioned in the syllabus and prime factorization theorems.
CO-3	**:**	Explain the concepts of private and public key cryptography.
CO-4	**:**	Recognize different algorithms of private and public key cryptography.
CO-5	**:**	Explain the concepts of different factorization methods, Euclidian algorithm, Legendre and Jacobi symbols, Knapsack problems.
CO-6	**:**	Application of knapsack, RSA, and different factorization methods in both private and public key cryptography.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	2	3												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Some Topics in Elementary Number Theory	12: HOURS

Time estimates for doing arithmetic, divisors and divisibility, Euclidean algorithm, Euler phi function. Congruence, Fermat's little theorem, Chinese reminder theorem, some applications to factoring. Finite fields, existence and uniqueness of finite fields with prime number of elements. Quadratic residues, Gauss lemma, Law of Quadratic reciprocity, Legendre symbol and Jacobi symbol.

UNIT-II	Private Key Cryptography	12: HOURS

Shift transformation, Affine transformation, Diagraph Transformation. Linear algebra modulo N, inverse of matrix modulo N, encryption using matrix, affine enciphering transformation, solution of congruence modulo system of equations.

UNIT-III	Public Key Cryptography	12: HOURS

The idea of public key cryptography, classical versus public key, authentication, hash function, key exchange, probabilistic encryption. RSA, Discrete log, Diffie-Hellman, Knapsack problem, Knapsack algorithm.

UNIT-IV	Primarily and Factorization	12: HOURS

Zero knowledge proof of 3-coloribility, zero knowledge proof of having found a discrete logarithm. oblivious transfer: Oblivious transfer for a non-interactive proof of factorization. Pseudo primes, Carmichael number, strong pseudo primes, Euler pseudo primes, theorems on Carmichael number. The rho method, generalized rho method.

UNIT-V	Fermat factorization and factor bases	12: HOURS

Fermat factorization, Factor bases, Factor base algorithm. Continued fractions, continued fraction factoring algorithm. The quadratic sieve method.
Total Number of Hours: **60: HOURS**

REFERENCE BOOKS:

1.	Neal Koblitz., "A Course I n number theoretic Cryptography", Springer-Verlag, second edition,
2.	James S. Kraft Lawrence C. Washington., "An Introduction to Number Theory with Cryptography", CRC press, second edition, Taylor & Francis.
3.	Richard A. Mollin "An Introduction to Cryptography", Chapman & Hall/CRC, Taylor & Francis.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPE3011**	**No. of Credits:**	**4**
Course name:	**INTEGRAL TRANSFORMATIONS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	To analyse 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:

After completion of this course, students will be able to

CO-1	**:**	Understand to analyze properties of special functions by their integral representations and symmetries and determine properties of Fourier Transform which may be solved by application of special functions.
CO-2	**:**	Determine properties of Laplace Transform which may be solved by application of special functions and determine properties of Legendre Polynomial which may be solved by application of special functions.
CO-3	**:**	Understand integral calculus and special functions of various engineering problem and know the application of some basic mathematical methods via all these special functions.
CO-4	**:**	Explain the applications and the usefulness of these special functions and classify and explain the functions of different types of differential equations.
CO-5	**:**	Understand purpose and functions of the gamma and beta functions, Fourier series and Transformation.
CO-6	**:**	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

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3	2											
CO-2	2	3	1											
CO-3	1	3	3											
CO-4	2	3	2											
CO-5	2	3	2											
CO-6	2	3	2											
Avg.	2	3	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Laplace Transform	12: HOURS
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.		
UNIT-II	**Fourier series and Fourier Integral**	**12: HOURS**
Orthogonal set of functions, Fourier series, Fourier sine, and cosine series, Fourier integral Theorem, Fourier sine, and cosine integral Theorem.		
UNIT-III	**Fourier Transforms**	**12: HOURS**
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.		
UNIT-IV	**Z-transforms**	**12: HOURS**
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.		
UNIT-V	**Hankel Transform**	**12: HOURS**

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.
Total Number of Hours: **60: HOURS**

REFERENCE BOOKS:

1.	Sneddon Ian N., The use of Integral Transforms, 2nd Edition, McGraw Hill.
2.	Sneddon Ian N., Fourier Transforms, Dover Publications.
3.	Debnath Loknath, Integral Transforms and their applications, 2nd Edition, Chapman and Hall/CRC.
4.	Grewal B. S. . Higher Engineering Mathematics, 40th Edition, Khanna Publishers.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPE3012**	**No. of Credits:**	**4**
Course Name:	**FUZZY SET THEORY**	**Sem End Exam & Cycle Test Marks**	**60+40**

Course Educational Objectives:

CEO-1	**:**	Apply fuzzy set theory in modelling and analysing uncertainty in a decision problem.
CEO-2	**:**	Identify the similarities and differences between probability theory and fuzzy set theory and their application conditions.

Course Outcomes:

After completion of this course, students will be able to

CO-1	**:**	Understand the basics of fuzzy sets and its properties.
CO-2	**:**	Get a clear idea of various types of operations on fuzzy sets.
CO-3	**:**	Extends the essence of operations on fuzzy sets to fuzzy numbers.
CO-4	**:**	Define the concepts and properties of relations on fuzzy sets.
CO-5	**:**	Obtain the fuzzy relation equation and get the solution of fuzzy equations and fuzzy relation equation.
CO-6	**:**	Understand the concepts of fuzzy logic and inference from propositions.

Mapping of COs with POs and PSOs

PSOs / **COs**	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	**3**	**3**	**3**	**3**	**2**	**2**								
CO-2	**3**	**3**	**3**	**3**	**2**	**2**								
CO-3	**3**	**3**	**3**	**3**	**2**	**2**								
CO-4	**3**	**3**	**3**	**3**	**2**	**2**								
CO-5	**3**	**3**	**3**	**3**	**2**	**2**								
CO-6	**3**	**3**	**3**	**3**	**2**	**2**								
Avg.	**3**	**3**	**3**	**3**	**2**	**2**								

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	**Fuzzy Sets versus Crisp Sets**	**9: HOURS**
Fuzzy sets - Basic types - Fuzzy sets - Basic concepts - Additional properties of Alpha-cuts Representations of fuzzy sets - Extension principle for fuzzy sets.		
UNIT-II	**Operations on Fuzzy Sets**	**9: HOURS**
Types of operations - Fuzzy complements - Fuzzy intersections: t-norms - Fuzzy unions: t- co-norms - Combinations of operations.		
UNIT-III	**Fuzzy Arithmetic and Fuzzy Relations**	**9: HOURS**
Fuzzy numbers - Linguistic variables - Arithmetic operations on Intervals - Arithmetic operations on fuzzy numbers – Fuzzy equations. Crisp and fuzzy relations - Projections and Cylindric extensions - Binary fuzzy relations - Binary relations on a single set - Fuzzy equivalence relations - Fuzzy compatibility relations - Fuzzy ordering relations - $Sup - i$ composition and $Inf - \omega_i$ compositions of Fuzzy relations.		
UNIT-IV	**Fuzzy Relation Equations**	**9: HOURS**
General discussion - Problem Partition - Solution method - Fuzzy relation equations based on $Sup - i$ composition and $Inf - \omega_i$ compositions.		
UNIT-V	**Fuzzy logic**	**9: HOURS**
Classical Logic – Multivalued logics – Fuzzy Propositions – Fuzzy quantifiers, Linguistic Hedges – Inference from Conditional Fuzzy Propositions – Inference from Conditional and Quantified Propositions – Inference from Quantified Propositions.		
Total Number of Hours:		**45: HOURS**

REFERENCE BOOKS:

1.	George J. Klir and Yuan B., "Fuzzy Sets and Fuzzy Logic, Theory and Applications", Pearson, New Delhi , 2015.
2.	Dubois D. and Prade H., "Fuzzy sets and systems, Theory and Applications", Academic Press, New York,1997.
3.	Kaufmann A., "Introduction to the theory of Fuzzy Subsets Vol. I Fundamental Theoretical Elements", Academic Press, Orlando, 1985.
4.	Ganesh, M., "Introduction to Fuzzy sets and Fuzzy logic", Prentice Hall, New Delhi, 2006.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPE3013**	**No. of Credits:**	**4**
Course Name:	**INTRODUCTION TO DATA SCIENCE**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Fundamental coursework on the standards and practices for collecting, organizing, managing, exploring, and using data.
CEO-2	**:**	Topics include preparation, analysis, and visualization of data and creating analysis tools for larger data sets. Three hours each week.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Identify and describe the methods and techniques commonly used in data science
CO-2	**:**	Demonstrate proficiency with the methods and techniques for obtaining, organizing, exploring, and analysing data.
CO-3	**:**	Recognize how data analysis, inferential statistics, modelling, machine learning, and statistical computing can be utilized in an integrated capacity.
CO-4	**:**	Create and modify customizable tools for data analysis and visualization per the evaluation of characteristics of the data and the nature of the analysis.
CO-5	**:**	Demonstrate the ability to clean and prepare data for analysis and assemble data from a variety of sources.
CO-6	**:**	To describe Identify probability distributions, fit a model to data and use tools for basic analysis and communication.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	1	3	3	2	3								
CO-2	3	1	3	3	2	3								
CO-3	3	1	3	3	2	3								
CO-4	3	1	3	3	2	3								
CO-5	3	1	3	3	2	3								
CO-6	3	1	3	3	2	3								
Avg.	3	1	3	3	2	3								
1. Slight					2. Moderate					3. Substantial				

COURSE CONTENT

UNIT-I	Introduction	12: HOURS
Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – building the models – presenting and building applications.		
UNIT-II	**Describing Data - I**	**12: HOURS**
Frequency distributions – Outliers – relative frequency distributions – cumulative frequ distributions – frequency distributions for nominal data – interpreting distributions – grap averages – mode – median – mean – averages for qualitative and ranked data – descri variability – range – variance – standard deviation – degrees of freedom – interquartile ran variability for qualitative and ranked data.		
UNIT-III	**Describing Data - II**	**12: HOURS**
Normal distributions – z scores – normal curve problems – finding proportions – finding scores – more about z scores – correlation – scatter plots – correlation coefficient for quantitative data – computational formula for correlation coefficient – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2 – multiple regression equations – regression toward the mean.		
UNIT-IV	**Roles and Skills**	**12: HOURS**

AI: Cognitive Computing: Learning Perceptions – Terminologies - Machine Learning – Neural Networks – Deep Learning - NLP – Speech Processing – Big Data and AI – Ethics in AI Research - Advanced Applications – AI Myths – Data Science Roles Data Scientist, Data Architect, Data Analyst – Machine Learning Engineer – Skills.		
UNIT-V	**Data Science Use Cases**	**12: HOURS**
Data Science Use cases Specifications and Discussion – Data Sources Identification – Data Types –Data Classification – Data Characteristics of Big V‟s – Data Science P‟s – Applications of AI: Domains: Customer Insights – Behavioral Analysis –- Marketing – Retails – Insurance – Risk and Security –Health care – Supply Chain Logistics.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016. (first two chapters for Unit I)
2.	Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017. (Chapters 1–7 for Units II and III)
3.	Joel Grus, "Data Science from Scratch", 2nd Edition, O′Reilly Publisher, ISBN: 9781492041139, May 2019. (for Unit IV and V)
4.	Sinan Ozdemir, Sunil Kakade, "Principles of Data Science", Second Edition **(**EBook**).**

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPE3021**	**No. of Credits:**	**4**
Course Name:	**OPTIMIZATION TECHNIQUES**	**Sem End Exam & Cycle Test Marks**	**60+40**

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:

After completion of this course, students will be able to

CO-1	:	To understand optimization techniques using both linear and non-linear programming.
CO-2	:	To frame engineering minima maxima problems in the framework of optimization problems.
CO-3	:	To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
CO-4	:	To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.
CO-5	:	To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.
CO-6	:	Cast engineering minima/maxima problems into optimization framework.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	1	3	2											
CO-2	2	3	3											
CO-3	3	2	2											
CO-4	1	2	3											
CO-5	1	2	2											
CO-6	1	2	1											
Avg.	1.5	2.3	2.1											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Linear Programming Problem	12: HOURS

Concept of Basis, Mathematical formulation of the problem, Graphical solution method, Simplex Method, Artificial Variable Techniques – Big M method (Method of penalties), two phase method, Dual Simplex Method, Revised Simplex Method.

UNIT-II	Integer Linear Programming: Introduction	12: HOURS

Types of Integer Linear Programming Problems– Gomory's All Integer Cutting Plane Method – Gomory's mixed Integer Cutting Plane method – Branch and Bound Method.

UNIT-III	Transportation Problem	12: HOURS

Introduction, Mathematical Model of Transportation Problem, General Mathematical Model of Transportation Problem, The Transportation Algorithm, Methods for Finding Initial Solution: North-West Corner Method (NWCM), Least Cost Method (LCM), Vogel's Approximation Method (VAM) Assignment Problem: Introduction, Mathematical Models of Assignment Problem, Solution Methods of Assignment Problem, Hungarian Method for Solving Assignment Problem. Sequencing problem.

UNIT-IV	Theory of Games	12: HOURS

Introduction, Two-Person Zero-Sum Games, Pure Strategies (Minimax and Maximum Principles): Games with Saddle Point, Rules to Determine Saddle Point. Mixed Strategies: Games without Saddle Point, The Rules (Principles) of Dominance, Solution Methods Games without Saddle Point, Graphical Method, Matrix Method. Dynamic Programming.		
UNIT-V	**General Non- Linear Programming Problem**	**12: HOURS**
Quadratic Programming: Kuhn-Tucker Conditions - Wolf's Modified Simplex Method – Beale's Method.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Kanti Swarup, P. K. Gupta and man Mohan, Operations Research, Sultan Chand & Sons Publications.
2.	J. K. Sharma, Operations Research Theory and Applications, Second Edition, Macmillan (India) New Delhi.
3.	Manmohan & Gupta, Problems in Operation Research, Sultan Chand & Sons Publications.
4.	Hamdy A. Taha, Operations Research, (seventh edition), Prentice - Hall of India Private Limited, New Delhi.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPE3022**	**No. of Credits:**	**4**
Course Name:	**FINITE ELEMENT METHODS**	**Sem End Exam & Cycle Test Marks**	**60+40**

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:

After completion of this course, students will be able to

CO-1	**:**	Implement numerical methods to solve mechanics of solids problems
CO-2	**:**	Formulate and Solve axially loaded bar Problems
CO-3	**:**	Formulate and analyze truss and beam problems.
CO-4	**:**	Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
CO-5	**:**	Formulate and Solution of boundary value problem axially loaded bar Problems
CO-6	**:**	Solution for a steady state problem and one dimensional heat.

Mapping of COs with POs and PSOs

PSOs	**PO**												**PSO**	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	**3**	**3**												
CO-2	**2**	**3**												
CO-3	**1**	**3**												
CO-4	**2**	**3**												
CO-5	**2**	**3**												
CO-6	**2**	**3**												
Avg.	**2**	**3**												

1. Slight	**2. Moderate**	**3. Substantial**

COURSE CONTENT

UNIT-I	**Integral Formulation and Vibrational methods**	**12: HOURS**
Finite Element Method: Integral Formulation and Vibrational methods, weak formulation and Boundary Value Problem, Rayleigh-Ritz Method, second order boundary value problems and ts application (Heat Transfer, Fluid Mechanics, Solid Mechanics).		
UNIT-II	**Eigenvalue and Time Dependent Problem**	**12: HOURS**
Eigenvalue and Time Dependent Problem: Eigenvalue Problem, Finite Elements Models, application, Time Dependent Problem, semi discrete finite element models, Time approximations, Mass Lumping and its application.		
UNIT-III	**Numerical Integration and Computer Implementation**	**12: HOURS**
Numerical Integration: Natural coordinates, Isoperimetric Formulations, Numerical Integration, computer Implementation, Calculation of element matrices.		
UNIT-IV	**Single – Variable Problem**	**12: HOURS**
Boundary value Problems, Weak form finite element Model, Mesh generation and Imposition of Boundary condition Finite element analysis, Eigenvalue and Time Dependent Problem.		
UNIT-V	**Interpolation Functions**	**12: HOURS**
Interpolation Functions, Triangular Elements, Rectangular Elements, The Serendipity Elements, Numerical Integration, Integration over a Master Rectangular Element, Integration over a Master Triangular Element.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	J. N. Reddy, An introduction to the Finite Element Method, 2nd edition McGraw- Hill, Inc.
2.	T.J. Chung, Finite element analysis in Fluid Dynamics, McGraw- Hill, Inc
3.	O. C. Zienkiewiez and K. Morgan: Finite Elements and approximation, John Wieley, 1983.
4.	P.E. Lewis and J.P. Ward: The Finite element method- Principles and applications, Addison Weley, 1991.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

III Semester

Course Code:	**24MTPE3023**	**No. of Credits:**	**4**
Course Name:	**DIFFERENTIAL GEOMETRY**	**Sem End Exam & Cycle Test Marks**	**60+40**

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:

After completion of this course, 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.
CO-4	**:**	Find the derivative map of an isometry, analyse the equivalence of two curves by applying some theorems, defines surfaces and their properties.
CO-5	**:**	Find tangent spaces of surfaces, explain differential maps between surfaces and find derivatives of such maps, integrate differential forms on surfaces.
CO-6	**:**	Find minimal surfaces and consequences of the Poincar{\'e} index theory. and give examples of manifolds and investigate their properties.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	2	1	2											
CO-2	2	2	1											
CO-3	1	2	3											
CO-4	3	1	2											
CO-5	2	3	2											
CO-6	2	3	2											
Avg.	2	2	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Space Curve	12: HOURS
Definition of a space curve, Arc length, Tangent, Normal and binormal, Curvature and torsion, Contact between curves and surfaces, Tangent surface, Involutes and evolutes, Intrinsic properties.		
UNIT-II	**Surface**	**12: HOURS**
Intrinsic properties of a surface: Definition of a surface, Curves on a surface of revolution, Helicoids, Metric, Direction coefficients, Families of curves, Isometric correspondence.		
UNIT-III	**Geodesics**	**12: HOURS**
Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesics curvature – Gauss Bonnet theorem – Gaussian curvature – Surface of constant curvature.		
UNIT-IV	**Curvature**	**12: HOURS**
The second fundamental form Principal curvature – Lines of curvature – Developable – Developable associated with space curves and with curves on surface – Minimal surfaces – Rules surfaces.		
UNIT-V	**Compact Surface**	**12: 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.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS

1.	T. J. Wilmore: An Introduction to Differential Geometry, Oxford University Press, 17th Impression, New Delhi 2002 (Indian Print) [Ch1: Sections: 1- 5, Ch2:5-9, Ch3: 10-18, Ch3: 1-6, Ch3: 6-10]
2.	Struik, D. T. Lectures on Classical Differential Geometry, Addison – Wesley, Mass. 1950.

3.	Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Inter-science Publishers, 1963.
4.	Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1078.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTPC4001**	**No. of Credits:**	**4**
Course Name:	**FUNCTIONAL ANALYSIS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	The objectives of the course are the study of the main properties of bounded operators between Banach and Hilbert spaces.
CEO-2	**:**	The basic results associated to different types of convergences in normed spaces and the spectral theorem and some of its applications.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Understand the concept of dimension of a Hilbert space, bounded linear transformations, norms, inner products, dual spaces and their difference from the finite dimensional cases.
CO-2	**:**	Understand the fundamental theorems as mentioned in the syllabus and dual spaces and their properties.
CO-3	**:**	Explain the fundamental concepts of functional analysis and their role in modern mathematics and applied contexts.
CO-4	**:**	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-5	**:**	Identify orthogonal sets. Understand the notion of orthogonal complement and the decomposition of the space.
CO-6	**:**	Apply problem-solving using functional analysis technique applied to diverse situations in physics, engineering and other mathematical context.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	2												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	2												
Avg	2	2.66												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Fundamentals of Normed Spaces	12: HOURS
Normed spaces, Definition and theorems, Jensen's inequality, Riesz lemma, Unit sphere, Definition of stronger comparable and equivalent norms, Continuity of Linear maps, and theorems, Bounded linear maps definition and theorems, Hahn-Banach theorem, Hahn-banach separation theorem, hyperplane, Hahn-Banach extension theorem.		
UNIT-II	**Boundend Linear Maps on Banach spaces**	**12: HOURS**
Banach spaces, Summable and Absolutely summable, Second dual canonical embedding, Completion and exercise problems Uniform Boundedness principle. Closed Graph theorem, Open Mapping Theorem. Bounded inverse theorem.		
UNIT-III	**Geometry of Hilbert Spaces**	**12: HOURS**
Inner product spaces, Orthonormal sets, Definition and examples of Hilbert Spaces, Cauchy's Schwartz Inequality and Parallelogram Law, Orthonormal Systems, Bessel's Inequality, Gram Schmidth Orthogonalization Process, Approximation and Optimization and, Projections on a Hilbert space, and Riesz Representation Theorem.		
UNIT-IV	**Bounded Operators on Hilbert spaces**	**12: HOURS**
Spectrum of a Bounded operator and its theorems. The Conjugate Space, The Adjoint of an Operator on Hilbert Space and its Properties, Self-Adjoint Operators, Normal and Unitary Operators, and their properties.		
UNIT-V	**Spaces of Bounded Linear Functionals**	**12: HOURS**
Duals and Transposes, Eigenvalues and Eigen spectrum theorems. spectral radius., Weak and weak* convergence, Definition and Theorems on Reflexivity of Hilbert Space, and Finite Spectral Theorem for Normal Operators, Uniform convexity.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	B.V. Limaye, Functional Analysis New Age International Limited Publishers, Second Edition.
2.	S. Ponnusamy Foundations of functional analysis. Alpha Science International, Publishers 2002.
3.	Walter Rudin Functional analysis 2^{ND} Edition.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTPC4011**	**No. of Credits:**	**4**
Course Name:	**INTRODUCTION TO MACHINE LEARNING**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Understand the problem-solving methods using state space search.
CEO-2	**:**	Implement and apply the supervised and unsupervised machine leaning algorithms.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Recognize the characteristics of Machine Learning techniques that enable to solve real world problems.
CO-2	**:**	Recognize the characteristics of machine learning strategies.
CO-3	**:**	Apply various supervised learning methods to appropriate problems.
CO-4	**:**	Identify and integrate more than one technique to enhance the performance of learning.
CO-5	**:**	Understand basic AI Techniques.
CO-6	**:**	Apply various mathematical models for supervised machine learning models.

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	1	2	2											
CO-2	2	3	1											
CO-3	1	2	3											
CO-4	3	2	2											
CO-5	1	2	2											
CO-6	2	1	2											
Avg.	1.6	2	2											

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Introduction to machine learning	12: HOURS

Introduction, Components of Learning, Learning Models, Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, Designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension.

UNIT-II	Feature selection	12: HOURS

Feature Selection: Filter Methods, Wrapper Methods, Forward Selection, Backward Elimination), Dimensionality reduction: PCA, LDA

UNIT-III	Supervised and unsupervised learning	12: HOURS

Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K Nearest Neighbors. Introduction to clustering, K-means clustering, K-Mode Clustering.

UNIT-IV	**Ensemble and probabilistic learning**	**12: HOURS**
Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Gaussian mixture models - The Expectation-Maximization (EM) Algorithm, Information Criteria, Nearest neighbour methods - Nearest Neighbour Smoothing, Efficient Distance Computations: the KD-Tree, Distance Measures.		
UNIT-V	**Reinforcement learning and evaluating hypotheses**	**12: HOURS**
Introduction, Learning Task, Q Learning, Non-deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning, Generalization in reinforcement learning. Motivation, Basics of Sampling Theory: Error Estimation and Estimating Binomial Proportions, The Binomial Distribution, Estimators, Bias, and Variance.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, 3rd Edition.
2.	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, MIT Press.
3.	Tom Mitchell, Machine Learning, McGraw Hill, 3rdEdition.
4.	StephenMarsland, *MACHINE LEARNING - An Algorithmic Perspective*, Second Edition.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTPE4012**	**No. of Credits:**	**4**
Course Name:	**DESIGN AND ANALYSIS OF ALGORITHMS**	**Sem End Exam & Cycle Test Marks**	**60+40**

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:

After completion of this course, students will be able to

CO-1	**:**	Understand asymptotic notations to analyse the performance of algorithms.
CO-2	**:**	Identify the differences in design techniques and apply to solve optimization problems.
CO-3	**:**	Apply algorithms for performing operations on graphs and trees.
CO-4	**:**	Solve novel problems, by choosing the appropriate algorithm design technique for their solution and justify their selection.
CO-5	**:**	Analyze deterministic and nondeterministic algorithms to solve complex problem.
CO-6	**:**	Explain what an approximation algorithm is. Compute the approximation factor of an approximation algorithm (PTAS and FPTAS).

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / Cos	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	2	3												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Introduction and Recurrences	12: HOURS
Introduction: Characteristics of algorithms, Asymptotic analysis of complexity, average case and worst case, Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms. Recurrence relations: Substitution method, Iteration method and Masters' Method.		
UNIT-II	**Algorithmic Strategies**	**12: HOURS**
Algorithmic Strategies: Linear search, selection sort, Dynamic Programming: matrix chain multiplication, Longest common subsequence, Greedy method, Travelling Salesman Problem,		
UNIT-III	**Graphs Algorithms**	**12: HOURS**
Elementary Graphs Algorithms: Depth First Search (DFS) Breadth First Search (BFS), Topological sorting, Spanning Tree, Kruskal's Algorithm, Prim's Algorithm.		
UNIT-IV	**Shortest path algorithms**	**12: HOURS**
Shortest path algorithms, Dijkstra's Algorithm, The Bellman- Ford Algorithm, All pairs shortest paths (Floyd- Warshall Algorithm) Transitive closure. Network Flow Algorithm		
UNIT-V	**NP-completeness**	**12: HOURS**
Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems(Clique Decision, Node cover Decision and Chromatic Number Decision problem) and Reduction technique.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, Fourth Edition, The MIT Press.
2.	Horowitz and Sahni, Fundamentals of Computer Algorithms, Computer Science Press, Maryland, 2006.
3.	Aho, Ullman and Hopcroft, Design and Analysis of algorithms, Pearson education.
4.	M.T. Goodrich and R. Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, John Wiley and sons.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTPE4013**	**No. of Credits:**	**4**
Course Name:	**LINEAR REGRESSION ANALYSIS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Will gain knowledge in the basic concepts of Regression Analysis.
CEO-2	**:**	To acquire skills to build simple and multiple regression models.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Develop a deeper understanding of the linear regression model.
CO-2	**:**	To understand the implementation of regression in data science.
CO-3	**:**	Learn about R-square criteria for model selection.
CO-4	**:**	Understand the forward, backward and stepwise methods for selecting the variables.
CO-5	**:**	Understand the importance of multicollinearity in regression modelling.
CO-6	**:**	Ability to use and understand generalizations of the linear model to binary and countdata.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	1	3	3	2	3								
CO-2	3	1	3	3	2	3								
CO-3	3	1	3	3	2	3								
CO-4	3	1	3	3	2	3								
CO-5	3	1	3	3	2	3								
CO-6	3	1	3	3	2	3								
Avg.	3	1	3	3	2	3								

1. Slight	2. Moderate	3. Substantial

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

COURSE CONTENT

UNIT-I	**Simple Linear Regression**	**12: HOURS**
Introduction to regression analysis: Modelling a response – overview and applications of regression analysis - major steps in regression analysis. Simple linear regression (Two variables): assumptions - estimation and properties of regression coefficients - significance and confidence intervals of regression coefficients - measuring the quality of the fit.		
UNIT-II	**Multiple Linear Regression**	**12: HOURS**
Multiple linear regression model: assumptions - ordinary least square estimation of regression coefficients - interpretation and properties of regression coefficient- significance and confidence intervals of regression coefficients.		
UNIT-III	**Criteria For Model Selection**	**12: HOURS**
Mean Square error criteria - R2 and $\hat{R}2$criteria for model selection; Need of the transformation of variables - Box-Cox transformation – Forward - Backward and Stepwise procedures.		
UNIT-IV	**Residual Analysis**	**12: HOURS**
Residual analysis – Departures from underlying assumptions, Effect of outliers – Collinearity - Non-constant variance and serial correlation - Departures from normality - Diagnostics and remedies.		
UNIT-V	**Non Linear Regression**	**12: HOURS**
Introduction to nonlinear regression - Least squares in the nonlinear case and estimation of parameters - Models for binary response variable - estimation and diagnosis methods for logistic and Poisson regressions - Prediction and residual analysis.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Seber, A.F. and Lee, A. J. Linear Regression Analysis, John Wiley.
2.	Montgomery D. C., Peck E . A . and Vining G. G. Introduction to Linear Regression Analysis, John Wiley and Sons.
3.	Chatterjee S. and Hadi A. Regression Analysis, 4th Edition, John Wiley and Sons.
4.	Pardoe Iain Applied Regression Modelling, John Wiley and Sons.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTPE4021**	**No. of Credits:**	**3**
Course Name:	**THEORY OF COMPUTATIONS**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Explain and manipulate the different concepts in automata theory and formal languages.
CEO-2	**:**	Explain the power and the limitations of regular languages and context-free languages.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Understand basic properties of deterministic and nondeterministic finite automata and the relation between types of languages and types of finite automata.
CO-2	**:**	Understanding the Context free languages and grammars, and also Normalising CFG.
CO-3	**:**	Explain the minimization of deterministic and nondeterministic finite automata.
CO-4	**:**	An ability to design a system, component, or C. process to meet desired needs within realistic no Constraints such as economic, environmental, social, political, ethical, health and safety, Manufacturability and sustainability.
CO-5	**:**	Be able to design FAs, NFAs, Grammars, languages modelling, small compilers basics.
CO-6	**:**	Evaluate the challenges for Theoretical Computer Science and its contribution to other sciences.

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	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**	**12: 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**	**12: HOURS**
CFG. Parse Trees. Ambiguity in Grammars and Languages. Definition of the Pushdown Automata. Languages of a Pushdown.		
UNIT-IV	**Context free grammar and languages**	**12: HOURS**
Automata. Equivalence of Pushdown Automata and CFG, Deterministic Pushdown Automata.		
UNIT-V	**Properties of context free languages**	**12: HOURS**
Normal Forms for CFG. Pumping Lemma for CFL. Closure Properties of CFL. Turing Machines. Programming Techniques for TM.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	J. E. Hopcroft, R. Motwani and J. D Ullman., "Introduction to Automata Theory, Languages and Computations", Pearson Education, 2003.
2.	H. R. Lewis and C. H. Papadimitriou., "Elements of the theory of Computation", Second Edition, PHI, 2003.
3.	J. Martin., "Introduction to Languages and the Theory of Computation", Third Edition, TMH, 2003.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTPE4022**	**No. of Credits:**	**3**
Course Name:	**NUMBER THEORY**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Number theory is important because the simple sequence of counting numbers from one to infinity conceals many relationships beneath its surface.
CEO-2	**:**	This course helps to discover interesting relationships between different sorts of numbers and to prove that these are true. This course is very useful in the field of cryptography.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Solve divisibility problems using binomial theorem.
CO-2	**:**	Do some techniques of numerical calculations using congruence.
CO-3	**:**	Understand Quadratic Reciprocity and Quadratic Forms.
CO-4	**:**	Will have a good foundation in combinatorial number theory.
CO-5	**:**	Will have a good foundation in Diophantine Equations.
CO-6	**:**	Will have a good foundation on Elliptic curves.

Mapping of COs with POs and PSOs

PSOs	**PO**												**PSO**	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO-1	**3**	**1**	**3**	**3**	**2**	**3**								
CO-2	**3**	**1**	**3**	**3**	**2**	**3**								
CO-3	**3**	**1**	**3**	**3**	**2**	**3**								
CO-4	**3**	**1**	**3**	**3**	**2**	**3**								
CO-5	**3**	**1**	**3**	**3**	**2**	**3**								
CO-6	**3**	**1**	**3**	**3**	**2**	**3**								
Avg.	**3**	**1**	**3**	**3**	**2**	**3**								

1. Slight	**2. Moderate**	**3. Substantial**

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
UNIVERSITY, ODISHA, GUNUPUR

COURSE CONTENT

UNIT-I	**Divisibility**	**10: HOURS**
Introduction, Divisibility, Primes, The binomial theorem.		
UNIT-II	**Congruences**	**13: HOURS**
Congruences, Solutions of congruences, The Chinese - Remainder theorem, Techniques of numerical calculation.		
UNIT-III	**Quadratic reciprocity and quadratic forms**	**13: HOURS**
Quadratic residues, Quadratic Reciprocity, The Jacobi Symbol, Binary Quadratic Forms, Equivalence and reduction of quadratic forms.		
UNIT-IV	**Functions of number theory**	**12: HOURS**
Greatest integer function, Arithmetic functions, Mobius inversion formula, Recurrence Functions Combinational number theory.		
UNIT-V	**Diophantine equations**	**12: HOURS**
The equations ax + by = c Pythagorean triangle, Examples , Ternary quadratic forms, Rational points on curves, Elliptic curves, Factorization of Elliptic Curves.		
Total Number of Hours:		**60: HOURS**

REFERENCE BOOKS:

1.	Niven I., Zuckerman H.S., and Montgomery H.L., "An introduction to the theory of numbers", John Wiley & Sons Pvt., Ltd., Fifth Edition, Singapore, 2013.
2.	Bressoud D., Wagon S., "A Course in Computational Number Theory", Key College Publishing, New York, 2000.
3.	Graham R.L., Knuth D.E. and Patashnik O., "Concrete Mathematics", Addison-Wesley, Second Edition, New Jersey, 2017.
4.	David. M. Burton, "Elementary Number Theory, The McGraw Hill Companies, New York, Seventh Edition, 2011.

DEPART GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR
MENT OF MATHEMATICS SCHOOL OF SCIENCES

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**MTPE4023**	**No. of Credits:**	**4**
Course Name:	**MATHEMATICAL MODELLING**	**Sem End Exam & Cycle Test Marks**	**60+40**

COURSE EDUCATIONAL OBJECTIVES:

CEO-1	**:**	Students will be provided with the power of using the principles and methods of mathematical modelling for studies of complex systems in science, engineering and business.
CEO-2	**:**	Students will learn how to apply various tools to analyse the models including analytic and computational methods.

COURSE OUTCOMES:

After completion of this course, students will be able to

CO-1	**:**	Students will understand the basic components of the modelling process.
CO-2	**:**	Students will learn how to model "real" problems and prepare the mathematical models for analysis using dimensional analysis and scaling.
CO-3	**:**	Students will be able to construct models from physical laws and assumptions.
CO-4	**:**	Students will study how to compare modelling results to observations and how models can be improved.
CO-5	**:**	Students will apply the modelling techniques to 2 projects and produce detailed reports.
CO-6	**:**	Students will develop skills in communicating technical results through detailed writing of homework and projects as well as oral present to fellow students.

DEPART GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR
MENT OF MATHEMATICS SCHOOL OF SCIENCES

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	2	1												
CO-2	3	2												
CO-3	3	2												
CO-4	2	3												
CO-5	3	3												
CO-6	2	2												
Avg.	2.5	2.16												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Mathematical Modelling Through Ordinary Differenti Equations of First Order	15: HOURS

Introduction to mathematical modelling, the technique and classification of mathematical modelling, some characteristics of mathematical models, mathematical modelling through geometry, algebra, trigonometry, calculus and limitations of mathematical modelling. Mathematical Modelling through differential equations, linear growth and decay models, non-linear growth and decay models, compartment models, mathematical modelling in dynamics through ordinary differential equations of first order, mathematical modelling of geometrical problems through ordinary differential equations of first order.

UNIT-II	Mathematical Modelling Through Systems of Ordinary Differential Equations of the First Order	10: HOURS

Mathematical Modelling in population dynamics, mathematical modelling of epidemics, compartment models, economics through systems of ordinary differential equations of first order, mathematical models in medicine, arms race, battles and international trade in terms of systems of ordinary differential equations, mathematical modelling in dynamics through systems of ordinary differential equations of first order.

UNIT-III	Mathematical Modelling Through Ordinary Differential Equations of Second Order	10: HOURS

Mathematical Modelling of Planetary Motions, Mathematical Modelling of Circular Motions and Motion of Satellites, Mathematical Modelling Through Linear Differential Equations of Second Order, Miscellaneous Mathematical Models Through Ordinary Differential Equations of the Second Order.

UNIT-IV	Mathematical Modelling Through Partial Differential Equations	12: HOURS

Situations giving rise to partial differential equations models, mass-balance equations: first method of getting partial differential equation models, momentum-balance equations: the second method of obtaining partial differential equation models, variation principles: third method of obtaining partial differential equation models, probability generating function, fourth method of obtaining partial differential equation models, model for traffic flow on a highway, nature of partial differential equations initial and boundary conditions.

UNIT-V	**Mathematical Modelling Through Difference Equations**	**13: HOURS**

The need for mathematical modelling through difference equations some simple models, basic theory of linear difference equations with constant coefficients, mathematical modelling through difference equations in economics and finance, mathematical modelling through difference

equations in population dynamics and genetics mathematical modelling through difference equations in probability theory, miscellaneous examples of mathematical modelling through difference equations.
Total Number of Hours: **60: HOURS**

REFERENCE BOOKS:

1.	J. N. Kapur, "Mathematical Modelling", 3rd edition, New age International Publishers.
2.	Rutherford Aris, "Mathematical Modelling Techniques", Dover Publications, INC. New York.
3.	Edward A. Bender, "An introduction to mathematical modelling" Dover Publications, INC., Mineola, New York.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Syllabus for M. Sc Mathematics

IV Semester

Course Code:	**24MTOE4031**	**No. of Credits:**	**3**
Course Name:	**ETHICS & IPR**	**Sem End Exam & Cycle Test Marks**	**60+40**

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:

After completion of this course, students will be able to

CO-1	**:**	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.
CO-2	**:**	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.
CO-3	**:**	Gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas and devise business strategies by taking account of IPRs.
CO-4	**:**	Acquire more insights into the regulatory affair and assists in technology up-gradation for enhancing competitiveness.
CO-5	**:**	Obtain more awareness into the Patent infringement and assists in technology up-gradation for enhancing competitiveness..
CO-6	**:**	Obtain more perceptions into the litigation, remedies case studies.

DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCES
GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

Mapping of COs with POs and PSOs

PSOs / COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO-1	3	3												
CO-2	2	3												
CO-3	1	3												
CO-4	2	3												
CO-5	2	3												
CO-6	2	3												
Avg.	2	3												

1. Slight	2. Moderate	3. Substantial

COURSE CONTENT

UNIT-I	Introduction to Ethics	12: HOURS

Basic terms- Moral, Ethics, Ethical dilemma, Emotional intelligence Moral development theories of Kohlberg and Piaget. View on ethics by Aristotle. Governing factors of an individual's value system. Personal and professional ethics.

UNIT-II	Profession and Professionalism	12: HOURS

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

UNIT-III	Property and copyrights	12: 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-IV	Patentable invention and Applications	12: HOURS

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Sate 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.

UNIT-V	Patent Infringement and Case studies	12: HOURS

Introduction to History of GATT, WTO, WIPO, TRIPS, PCT and Implications; Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neem etc.

Total Number of Hours: **60: HOURS**