1.1.3

List of Employability/ Entrepreneurship/ Skill Development Courses with Course Contents

Colour Codes		
Name of the Subjects	Yellow	
Employability Contents	Green	
Entrepreneurship Contents	Light Blue	
Skill Development Contents	Pink	

List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : *Mathematics*

Programme Name : *B.Sc., MSc., Ph.D.*

Academic Year : 2023-24

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	MD-1	Basics of Statistics
02.	SEC-2	Linear Programming Problem
03.	AMUCTT3	Probability and Statistics
04.	AMUETD4	Linear Programming
05.	AMUETD5	Information Theory and Coding
06.	AMUFTD4	Mathematical Finance
07.	AMUFTD5	C++Programming for Mathematics
08.	AMUFTD6	Cryptography
09.	AMPATO1	Applications of Fuzzy Sets & Fuzzy Logic
10.	AMPBTD5	Mathematical Statistics
11.	AMPDTD3	Applications of Fuzzy Logic
12.	AMPDTD5	Cryptography
13.	AMPDTD6	Financial Mathematics and its Applications
14.	AMPDTD8	Operations Research

विभागाध्यक्ष
Head
गणित विभाग
Department of Mathematics
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर (छ.ग.) 495009, भारत
Bilaspur (C.G.), 495009, India

Annexure-I

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (CG)

DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE& SYLLABUS-04 Years B.Sc. (Hon.) in Mathematics with Multiple Entry-Exit Options

Sem.	Course Type	Course Code	Course Name	Credit/ Hours (L-T-P)	Marks CCA	Marks ESE	Total Marks
I	Major-1	AMUATT2	Algebra and Geometry	4 (3-1-0)	30	70	100
	Minor-1		Opted from the Pool Course offered by University	4 (3-1-0)			
	Multidisciplinary-1		Opted from the Pool Course offered by University	3			
	AEC-1		Opted from the Pool Course offered by University	2			
	SEC-1		Opted from the Pool Course offered by University	3			
	VAC-1		Opted from the Pool Course offered by University	2			
	VAC-2		Opted from the Pool Course offered by University	2			
	Additional Credit Course						
			Total Credit		**20**		
II	Major-2	AMUBTT3	Calculus	4(3-1-0)	30	70	100
	Minor-2		Opted from the Pool Course offered by University	4(3-1-0)			
	Multidisciplinary-2		Opted from the Pool Course offered by University	3			
	AEC-2		Opted from the Pool Course offered by University	2			
	SEC-2		Opted from the Pool Course offered by University	3			
	VAC-1		Opted from the Pool Course offered by University	2			
	VAC-2		Opted from the Pool Course offered by University	2			
	Additional Credit Course						
			Total Credit		**20**		

The student must complete the 4 credit vocational course/ Internship during summer term to get UG Certificate if he wish to exit the program after first 2 semesters

CCA: Continuous Comprehensive Assessment, ESE: End-Semester Examination

Minor course (MR) offered by the Department:

Sem.	Course Type	Course Code	Course Name	Credit/ Hour (L-T-P)	Marks CCA	Marks ESE	Total Marks
I	MR-1	AMUATG2	Geometry	4(3-1-0)	30	70	100
II	MR-2	AMUBTG1	Algebra and MatrixTheory	4(3-1-0)	30	70	100

Multidisciplinary course (MD) offered by the Department:

Sem.	Course Type	Course Code	Course Name	Credit/ Hour (L-T-P)	Marks CCA	Marks ESE	Total Marks
I	MD-1 (Any one)		Basics of Statistics	3(2-1-0)	30	70	100
			Introduction to Calculus	3(2-1-0)	30	70	100
II	MD-2 (Any one)		Curve Tracing	3(2-1-0)	30	70	100
			Interpolation	3(2-1-0)	30	70	100

Ability Enhancement course (AEC) offered by the Department:

Sem.	Course Type	Course Code	Course Name	Credit/Hour(L-T-P)	Marks CCA	Marks ESE	Total Marks
I	AEC-1		Set, Matrix and theory of Equations	2(2-0-0)	30	70	100
II	AEC-2		Special Function	2(2-0-0)	30	70	100

Skill Enhancement Course (SEC) offered by the Department:

Sem.	Course Type	Course Code	Course Name	Credit/Hour(L-T-P)	Marks CCA	Marks ESE	Total Marks
I	SEC-1	AMUATL3	Number System	3(2-1-0)	30	70	100
II	SEC-2	AMUBTL3	Linear Programming Problem	3(2-1-0)	30	70	100

Value Added Course (VAC) offered by the Department:

Sem.	Course Type	Course Code	Course Name	Credit/Hour (L-T-P)	Marks CCA	Marks ESE	Total Marks
I	VAC-1		Laplace Transform	2(2-0-0)	30	70	100
	VAC-2		Geometry in India-I	2(2-0-0)	30	70	100
II	VAC-3		Quantitative Techniques	2(2-1-0)	30	70	100
	VAC-4		Geometry in India-II	2(2-1-0)	30	70	100

L-Lecture, T- Tutorial, P- Practical

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR

DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE & SYLLABUS-B.Sc. (Hon.) in Mathematics

Sem	Course Type	Course Code	Course Name	Credit/Hours (L-T-P)	Marks CCA^	Marks ESE#	Total Marks
I	CORE 1	AMUATT1	Calculus	5(4-1-0)	30	70	100
	CORE 2	AMUATT2	Algebra and Geometry	5(4-1-0)	30	70	100
	GE-1		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-1		Opted from the Pool Course offered by University	2	30	70	100
	SEC-1		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**19**			
II	CORE 3	AMUBTT1	Multivariable Calculus	5(4-1-0)	30	70	100
	CORE 4	AMUBTT2	Ordinary Differential Equations	5(4-1-0)	30	70	100
	GE-2		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-2		Opted from the Pool Course offered by University	2	30	70	100
	SEC-2		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**19**			
III	CORE 5	AMUCTT1	Real Analysis	5(4-1-0)	30	70	100
	CORE 6	AMUCTT2	Group Theory	5(4-1-0)	30	70	100
	CORE 7	AMUCTT3	Probability and Statistics	5(4-1-0)	30	70	100
	GE-3		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-3		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**22**			

विभागाध्यक्ष
Head
गणित विभाग
Department of Mathematics
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर (छ.ग.) 495009, भारत
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IV	CORE 8	AMUDTT1	Mechanics	5(4-1-0)	30	70	100
	CORE 9	AMUDTT2	Linear Algebra	5(4-1-0)	30	70	100
	CORE 10	AMUDTT3	Partial Differential Equations and Calculus of Variations	5(4-1-0)	30	70	100
	GE-4		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-4		Opted from the Pool Course offered by University	2	30	70	100
	Internship*	AMUDEF1		06			100
	Additional Credit Course						
			Total Credit	**22+6***			
V	CORE11	AMUETT1	Set Theory and Metric Spaces	5(4-1-0)	30	70	100
	CORE 12	AMUETT2	Advanced Algebra	5(4-1-0)	30	70	100
	DSE (any two)	AMUETD1	Tensors and Differential Geometry	5(4-1-0)	30	70	100
		AMUETD2	Mathematical Logic	5(4-1-0)	30	70	100
		AMUETD3	Integral Transforms and Fourier Analysis	5(4-1-0)	30	70	100
		AMUETD4	Linear Programming	5(4-1-0)	30	70	100
		AMUETD5	Information Theory and Coding	5(4-1-0)	30	70	100
		AMUETD6	Graph Theory	5(4-1-0)	30	70	100
		AMUETD7	Special Theory and Relativity	5(4-1-0)	30	70	100
	AEC-5		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**22**			
VI	CORE 13	AMUFTT1	Complex Analysis	5(4-1-0)	30	70	100
	CORE 14	AMUFTT2	Numerical Analysis	5(4-1-0)	30	70	100
	DSE (any one)	AMUFTD1	Discrete Mathematics	5(4-1-0)	30	70	100
		AMUFTD2	Wavelets and Applications	5(4-1-0)	30	70	100
		AMUFTD3	Number Theory	5(4-1-0)	30	70	100

		AMUFTD4	Mathematical Finance	5(4-1-0)	30	70	100
		AMUFTD5	C++Programming for Mathematics	5(4-1-0)	30	70	100
		AMUFTD6	Cryptography	5(4-1-0)	30	70	100
		AMUFTD7	Advanced Mechanics	5(4-1-0)	30	70	100
	Seminar	AMUFST1 ~		02			100
	Dissertation/Project	AMUFDT1 ~		07			100
	Additional Credit Course						
			Total Credit	**24**			

~The Code generated by the Department., *May be offered during the summer;
^ Continuous Comprehensive Assessment (CCA), # End-Semester Examination (ESE)

विभागाध्यक्ष
Head
गणित विभाग
Department of Mathematics
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर (छ.ग.) 495009, भारत
Bilaspur (C.G.), 495009, India

Generic Elective (GEN) offered by the Department:

	Course Type	Course Code	Course Name	Credit/Hour(L-T-P)	Marks CCA^	Marks ESE#	Total Marks
1	GE-1 (Any one)	AMUATG1	Finite Element Methods	5(4-1-0)	30	70	100
		AMUATG2	Geometry	5(4-1-0)	30	70	100
2	GE-2 (Any one)	AMUBTG1	Algebra and Matrix Theory	5(4-1-0)	30	70	100
		AMUBTG2		5(4-1-0)	30	70	100
3	GE-3 (Any one)	AMUCTG1	Differential Calculus	5(4-1-0)	30	70	100
		AMUCTG2	History of Indian Mathematics	5(4-1-0)	30	70	100
4	GE-4 (Any one)	AMUDTG1	Applications of Algebra	5(4-1-0)	30	70	100
		AMUDTG2	Combinatorial Mathematics	5(4-1-0)	30	70	100
		AMUDTG3	Theory of Equations	5(4-1-0)	30	70	100

Ability Enhancement Course (AEC) offered by the Department:

	Course Type	Course Code	Course Name	Credit/Hour (L-T-P)	Marks CCA^	Marks ESE#	Total Marks
1	AEC-1 (Any one)	AMUATA1	Set Theory and Logic	2(2-0-0)	30	70	100
		AMUATA2	Basics of Statistics	2(2-0-0)	30	70	100
2	AEC-2 (Any one)	AMUBTA1	Theory of Interpolation	2(2-0-0)	30	70	100
		AMUBTA2		2(2-0-0)	30	70	100
3	AEC-3 (Any one)	AMUCTA1	Curve Tracing	2(2-0-0)	30	70	100
		AMUCTA2		2(2-0-0)	30	70	100
4	AEC-4 (Any one)	AMUDTA1	Matrix and Determinant	2(2-0-0)	30	70	100
		AMUDTA2		2(2-0-0)	30	70	100
5	AEC-5 (Any one)	AMUETA1	Integral Transform	2(2-0-0)	30	70	100
		AMUETA2					

Skill Enhancement Course (SEC) offered by the Department:

	Course Type	Course Code	Course Name	Credit/Hour (L-T-P)	Marks CCA^	Marks ESE#	Total Marks
1	SEC-1 (Any one)	AMUATL1	Introduction to Cryptography	2(2-0-0)	30	70	100
		AMUATL2	Special Function	2(2-0-0)	30	70	100
2	SEC-2 (Any one)	AMUBTL1	Graph Theory	2(2-0-0)	30	70	100
		AMUBTL2	Linear Programming	2(2-0-0)	30	70	100

L-Lecture, T- Tutorial, P- Practical

		AMUETD7	Special Theory and Relativity	05
VI	CORE	AMUFTT1	Complex Analysis	05
		AMUFTT2	Numerical Analysis	05
	DSE (any two)	AMUFTD1	Discrete Mathematics	05
		AMUFTD2	Wavelets and Applications	05
		AMUFTD3	Number Theory	05
		AMUFTD4	Mathematical Finance	05
		AMUFTD5	C++Programming for Mathematics	05
		AMUFTD6	Cryptography	05
		AMUFTD7	Advanced Mechanics	05
		AMUFTD8	Dissertation on Any Topic of Mathematics	05

M.Sc. Mathematics (CBCS)

Semester	Course Name	Course code	Course	Credit Hours
I	Core	AMPATT1	Abstract Algebra	05
		AMPATT2	Topology	05
		AMPATT3	Discrete Mathematical Structures	05
		AMPATT4	Geometry of Manifolds	05
	Open Elective	AMPATO1	Applications of Fuzzy Sets & Fuzzy Logic	05
II	Core	AMPBTT1	Real Analysis	05
		AMPBTT2	Numerical Analysis	05
	DSE (Any Two)	AMPBTD1	Coding Theory	05
		AMPBTD2	Finsler Geometry	05
		AMPBTD3	Fluid Mechanics	05
		AMPBTD4	Mathematical Methods of Applied Mathematics	05
		AMPBTD5	Mathematical Statistics	05
		AMPBTD6	Riemannian Manifold and connections	05
		AMPBTD7	Fractional Calculus and Integral Transforms	05
	Research Methodology	AMPBTT3	Research Methodology	02

III	(Core)	AMPCTT1	Functional Analysis	05
		AMPCTT2	Theory of ordinary differential equations	05
	DSE (Any Two)	AMPCTD1	Algebraic Topology	05
		AMPCTD2	Complex Manifold	05
		AMPCTD3	Difference Equations	05
		AMPCTD4	Fuzzy Sets and Fuzzy Logic	05
		AMPCTD5	Information Theory and its Applications	05
		AMPCTD6	Integral Equation and Calculus of Variations	05
		AMPCTD7	Multipoint Iterative Methods	05
		AMPCTD8	Fundamentals of Elasticity	05
	Project	AMPCPF1	Project Phase-I	05
IV	Core	AMPDTT1	Complex Analysis	05
		AMPDTT2	Theory of partial differential equations	05
	DSE (Any Two)	AMPDTD1	Advanced Differential Equations	05
		AMPDTD2	Advanced Functional Analysis	05
		AMPDTD3	Applications of Fuzzy Logic	05
		AMPDTD4	Ring and Category of Modules	05
		AMPDTD5	Cryptography	05
		AMPDTD6	Financial Mathematics and its Applications	05
		AMPDTD7	Mathematical Ecology	05
		AMPDTD8	Operations Research	05
		AMPDTD9	Theory of Relativity	05
		AMPDTD10	Fundamentals of theoretical Seismology	05
	Project	AMPDPF1	Project Phase-II	05

23/01/2025

Dr. P. P. Murthy
(Head &Chairman)

Prof. A. S. Ranadive
(Member)

Prof. R. P. Dubey
(External-Member)

Dr. Sandeep Singh
(Member)

SEM-I

Multidisciplinary-1: BASICS OF STATISTICS - Credit 3 (2-1-0)

Sub Code	L	T	P	Duration	CCA	ESE	Total	Credits
	2	1	----	3 Hours	30	70	100	3

COURSE OBJECTIVE:

This course will enable the students to:

1. Explain the basic ideas of measures of central tendency, dispersion and their applications.
2. Adapt the knowledge of various Probability distributions and their applications.
3. Apply statistical techniques for sampling of big data.
4. Explain a formulation helping to predict one variable in terms of the other that I, correlation and linear regression.

Frequency Distribution, Measures of Central Tendency (Mean, Median and Mode), Measure of dispersion.

Basics of Probability, Sample Space Probability, Additional and Multiplication theorems Conditional Probability, Random Variables, Expected Value, Probability Distributions, Binomial Distribution, Poission Distribution and Normal Distribution.

Correlation and Regression: Correlation Karl Pearson's Coefficient of correlation, Rank correlation, linear regression, Lines of regression. Inferences concerning the regression coefficients.

Text Books:

1. S. C. Gupta and V. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Son's, New Delhi.
2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications*(8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India. Jim Pitman (1993). *Probability*, Springer-Verlag.

Reference Books:

3. Robert V. Hogg, Joseph W. McKean & Allen T. Craig(2013), Introduction to Mathematical Statistics(7th Edition), Person Education.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition).Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

COURSE OUTCOMES: This course will enable the students to:

CO1: Basic idea's of statistics and probability.

CO2: Find the correlation with real life examples.

CO3: Identify Mean, Median and Mode with example real life .

CO4: Expanded the probability, binomial and normal distribution etc.

CO5: Apply the knowledge of probability in real life.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	1							2	1	2	1
CO2	3	2	2	2	1							2	3	1	2
CO3	1	3	2	3	2							1	1	2	1
CO4	3	2	3	3	3							2	3	3	2
CO5	1	3	2	3	1							1	3	3	2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SEM-II

SEC-2: LINEAR PROGRAMMING - Credit 3 (2-1-0)

Course Code	L	T	P	Duration/Week	CCA	ESE	Total	Credits
AMUBTL3	2	1	0	3 Hours	30	70	100	3

COURSE OBJECTIVE: This course will enable the students:

1. To understand basic terminology & basic concepts related to linear programming problems (LPP) of real life situations.
2. To understand the few initials method for the solutions of linear programming problems.
3. To acquaint with the problem solving techniques theoretically as well as graphically.
4. To understand the duality concept of linear programming problems.
5. To tackle several parameters into account while dealing with the problem.

Linear Programming Problem, Convexity and Basic Feasible Solutions: Formulation, [illegible] standard form; Graphical method; Convex and polyhedral sets, Hyper planes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Optimality criterion, improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format, artificial variables, Big-*M* method.

Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Text Book:

1. Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition) Pearson.

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010), Linear Programming and Network Flows (4th edition) John Wiley & Sons.

2. G. Hadley (2002) - Linear Programming, Narosa Publishing House.

COURSE OUTCOMES:

On satisfying the requirement of this course, students will have the knowledge and skills:

CO1: To Understand a basic thoughtfulness for linear programming problem.

CO2: To Distinguish use of different methods to various kinds of L.P.P. on the basis of type of constraints and number of variable.

CO3: To Use the simplex method to solve small linear programming models by hand.

CO4: To Understand the concept of duality in linear programming issues.

CO5: To apply LPP in Various fields such as Science, Engineering, Industry, Business, etc.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2				2		2	3	3	2	2
CO2	2	3	3	3	3				2		3	3	3	2	2
CO3	2	3	3	3	3				2		2	3	3	2	2
CO4	2	3	2	3	3				2		2	2	3	2	2
CO5	2	3	3	3	3				2		2	3	3	2	2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTT3	4	1	0	5 HOURS	30	70	5

Paper Code - AMUCTT3

PROBABILITY AND STATISTICS

Course Objectives: This course will enable the students to:

1) Understand distributions in the study of the joint behavior of two random variables.
2) Establish a formulation helping to predict one variable in terms of the other variable using the technique of correlation and linear regression.
3) Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve.
4) Translate real-world problems into probability models.
5) Learn the process of measuring the uncertainty of a random experiment.

Unit-I: Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit-II: Univariate Discrete and Continuous Distributions

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit-III: Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Unit-IV: Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, Themethod of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law oflarge numbers, Central limit theorem and weak law of large numbers.

Unit-V: Modeling Uncertainty

Uncertainty, Information and entropy, Uniform Priors, Polya's urn model and random graphs.

References:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction toMathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller & Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.

5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

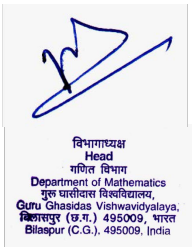
Course Outcomes: Upon successful completion of this course, students will be able to –

1) Use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events.
2) Identify the type of statistical situation to which different probability distributions can be applied.
3) Use discrete and continuous probability distributions to solve statistical problems and make decisions.
4) Calculate and interpret the correlation between two variables and employee the principles of linear regression and correlation, predicting a particular value of Y for a given value of X and significance of the correlation coefficient.
5) Evaluate the degree of uncertainty of experiments.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	1	3	3	1		2	3	3	3	2		
CO2	3	2	2	3		2	1		1	1	2	3	2		
CO3	3	3	2	2	3	3	3		3	3	3	3	2		
CO4	3	3	3	3	3	3	3		3	3	3	3	2		
CO5	3	3	3	3	3	3	3		3	3	3	3	2		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD4	4	1	0	5 HOURS	30	70	5

Paper Code - AMUETD4

LINEAR PROGRAMMING

Course Objective: This course will enable the students to –

1) To understand basic terminology &basic concepts related to linear programming problems (LPP) of real life situations.
2) To understand the few initials method for the solutions of linear programming problems.
3) To understand the duality concept of linear programming problems.
4) To know about sensitivity analysis of linear programming problems.
5) To learn about the applications of LPP for solving transportation, assignment and two-person zero-sumgame problems.

Unit-I: Linear Programming Problem, **Convexity and Basic Feasible Solutions** Formulation**,** Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutionsand extreme points.

Unit-II: Simplex Method

Optimality criterion, improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-*M* method.

Unit-III: Duality

Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit-IV: Sensitivity Analysis

Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programming problem.

Unit-V: Applications

*Transportation Problem***:** Definition and formulation, Methods of finding initial basic feasiblesolutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution.

*Assignment Problem***:** Mathematical formulation and Hungarian method.

*Game Theory***:** Formulation and solution of two-person zero-sum games, Games with mixedstrategies, Linear programming method for solving a game.

References:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). *Linear Programmingand Network Flows* (4th edition). John Wiley & Sons.
2. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.

3. Frederick S. Hillier & Gerald J. Lieberman (2015). *Introduction to OperationsResearch* (10th edition). McGraw-Hill Education.
4. Hamdy A. Taha (2017). *Operations Research*: *An Introduction* (10th edition). Pearson.
5. Paul R. Thie & Gerard E. Keough (2014). *An Introduction to Linear Programmingand Game Theory* (3rd edition). Wiley India Pvt. Ltd.

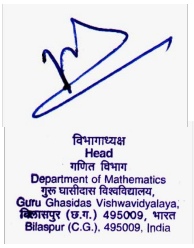
Course Outcome: Students will try to learn -

1) Basic understanding & terminology related to linear programming problems (LPP) of real life situations.
2) Some initials method for the solutions of linear programming problems.
3) The duality concept of linear programming problems.
4) Aware about sensitivity analysis of linear programming problems.
5) Applications of LPP for solving transportation, assignment and two-person zero-sumgame problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	3	3	3	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	3	2	1
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: 1-Sightly; 2-Moderately; 3-Strongly



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD5	4	1	0	5 HOURS	30	70	5

Paper Code - AMUETD5

INFORMATION THEORY AND CODING

Course Objectives: The main concern of information Theory and coding is -

1) To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.
2) To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.
3) To encourage and train to design coding schemes for data compression and error correction.
4) They will also get an overall perspective of how this impacts the design of an optimum communication receiver.
5) Understanding the encoding and decoding algorithms for common data compression techniques, such as Huffman coding, arithmetic coding.

Unit-I: Concepts of Information Theory

Communication processes, A model of communication system, A quantitative measure of information, Binary unit of information, A measure of uncertainty, *H* function as a measure of uncertainty, Sources and binary sources, Measure of information for two-dimensional discrete finite probability schemes.

Unit-II: Entropy Function

A sketch of communication network, Entropy, Basic relationship among different entropies, A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, efficiency, and channel capacity; Binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rules for entropy, Conditional relative entropy and conditional mutual information, Jensen's inequality and its characterizations, The log sum inequality and its applications.

Unit-III: Concepts of Coding

Block codes, Hamming distance, Maximum likelihood decoding, Levels of error handling, Error correction, Error detection, Erasure correction, Construction of finite fields, Linear codes, Matrixrepresentation of linear codes, Hamming codes.

Unit-IV: Bounds of Codes

Orthogonality relation, Encoding and decoding of linear codes, The singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert-Varshamov bound, Mac-Williams' identities.

Unit-V: Cyclic Codes

Definition and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose Chaudhury-Hocquenghem (BCH) code as a cyclic code.

References:

1. Robert B. Ash, (2014). *Information Theory*. Dover Publications.
2. Thomas M. Cover & Joy A. Thomas (2013). *Elements of Information Theory* (2nd edition). Wiley India Pvt. Ltd.
3. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition), Cengage.
4. Fazlollah M. Reza, (2003). *An Introduction to Information Theory*. Dover Publications.
5. Ron M. Roth (2007). *Introduction to Coding Theory*. Cambridge University Press.
6. Claude E. Shannon & Warren Weaver (1969). *The Mathematical Theory of Communication*. The University of Illinios Press.

Course Outcomes: This course will enable the students to -

1) Study simple ideal statistical communication models.
2) Understand the development of codes for transmission and detection of information.
3) Learn about the input and output of a signal via transmission channel.
4) Study detection and correction of errors during transmission.
5) Represent a linear code by matrices-encoding and decoding.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	1						1	1	1	2	1
CO2	3	2	2	2	1	1				1	2	2	2	1	1
CO3	3	3	1	2	2	2				1	2	1	1	1	2
CO4	3	3	1	3	2	1				2	1	2	1	3	2
CO5	3	3	1	3	3	2				1	1	2	2	2	3

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

विभागाध्यक्ष
Head
गणित विभाग
Department of Mathematics
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर (छ.ग.) 495009, भारत
Bilaspur (C.G.), 495009, India

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD4	4	1	0	5 HOURS	30	70	5

Paper Code - AMUFTD4

MATHEMATICAL FINANCE

Course Objectives: The student will be able -

1) To understand the similarities and differences among the main asset classes: equities, fixed income securities.
2) To internalize the concept of pricing by replication. Use pricing by replication to determine the value of forward contracts, stock options, and fixed income securities.
3) To develop short but rigorous proofs of true mathematical statements about financial models. Construct counter-examples for false statements.
4) To understand risk neutral probability measures and the fundamental theorems of asset pricing.
5) To understand the concept of Hedging so that the loss may be minimized.

Unit-I: Basic Theory of Interest and Fixed-Income Securities

Principal and interest: simple, compound and continuous; Present and future value of cash flow streams; Net present value, Internal rates of return and their comparison; Inflation, Annuities; Bonds, Bond prices and yields, Macaulay duration and modified duration.

Unit-II: Term Structure of Interest Rates, Bonds and Derivatives

Spot rates, forward rates and explanations of term structure; Running present value, Floating- rate bonds, Immunization, Convexity; Putable and callable bonds; Exchange-traded markets and over-the-counter markets; Derivatives: Forward contracts, Future contracts, Options, Types of traders, Hedging, Speculation, Arbitrage.

Unit-III: Mechanics of Options Markets

No-arbitrage principle, Short selling, Forward price for an investment asset; Types of options: Call and put options, Option positions, Underlying assets, Factors affecting option prices, Upper and lower bounds for option prices, Put-call parity, Effect of dividends.

Unit-IV: Stochastic Analysis of Stock Prices and Black-Scholes Model

Binomial option pricing model, Risk neutral valuation: European and American options on assets following binomial tree model; Lognormal property of stock prices, Distribution of rate of return, Expected return, Volatility, Estimating volatility from historical data, Extension of risk-neutral valuation to assets following geometric Brownian motion, Black-Scholes formula for European options.

Unit-V: Hedging Parameters, Trading Strategies and Swaps

Hedging parameters: Delta, gamma, theta, rho and vega; trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.

References:

1. John C. Hull & Sankarshan Basu (2018). *Options, Futures and Other Derivatives* (10th edition). Pearson Education.
2. David G. Luenberger (2013). *Investment Science* (2nd edition). Oxford UniversityPress.
3. Sheldon M. Ross (2011). *An Elementary Introduction to Mathematical Finance* (3rd edition). Cambridge University Press.

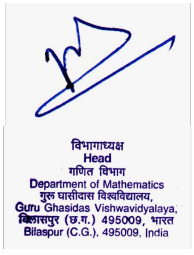
Course Outcomes: This course will enable the students to:

1) Understand financial markets and derivatives including options and futures.
2) Appreciate pricing and hedging of options, interest rate swaps and no-arbitragepricing concepts.
3) Learn stochastic analysis, Ito's formula, Ito integral and the Black−Scholes model.
4) Study and use Hedging parameters, trading strategies and currency swaps.
5) Understand pros and cons of the financial market with reference to future and options.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	1			2	1	2	1	2	1	2
CO2	2	2	1	1	2	2			1	1	1	2	1	1	2
CO3	2	1	2	1	2	1			1	1	2	2	2	2	1
CO4	2	1	2	2	2	1			2	1	2	2	2	1	1
CO5	2	1	2	2	2	2			1	1	1	2	2	1	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD5	4	1	0	5 HOURS	30	70	5

Paper Code - AMUFTD5

C++ PROGRAMMING FOR MATHEMATICS

Course Objectives: A course on C++ in mathematics may have the following objectives**:**

1) Introduction to programming: The course aims to introduce students to the fundamental concepts of programming using C++. This includes topics such as variables, data types, control structures, functions, and classes.
2) Applications in mathematical modelling and simulation: C++ is a powerful tool for mathematical modelling and simulation. The course aims to help students understand how to use C++ to solve mathematical problems, such as numerical analysis, optimization, and differential equations.
3) Development of computational skills: The course aims to develop students' computational skills by providing opportunities to solve mathematical problems using C++. This includes programming assignments and projects that require students to write efficient and effective code.
4) Introduction to libraries and tools: There are many libraries and tools available for C++ that is commonly used in mathematical applications, such as the Boost C++ libraries and the GNU Scientific Library. The course aims to introduce students to these libraries and tools and teach them how to use them effectively.
5) Code optimization: The course aims to teach students how to write efficient code by optimizing algorithms and data structures. This includes topics such as algorithmic complexity, memory management, and code profiling.

Unit-I: C++ Essentials

Fundamentals of programming, Organization of logic flow in stored program model of computation, C++ as a general purpose programming language, Structure of a C++ program, Common compilers and IDE's, Basic data-types, Variables and literals in C++, Operators, Expressions, Evaluation precedence and type compatibility; Outline of program development in C++, Debugging and testing; Applications**:** Greatest common divisor and random numbergeneration.

Unit-II: Structured Data

Structured data-types in C++, Arrays and manipulating data in arrays; Objects and classes**:** Information hiding, modularity, constructors and destructors, methods and polymorphism; Applications**:** Factorization of an integer, Euler's totient, Images in Cartesian geometry usingpoints in two & three dimensions, Pythagorean triples.

Unit-III: Containers and Templates

Containers and Template Libraries**:** Sets, iterators, multisets, vectors, maps, lists, stacks and queues; Applications**:** Basic set algebra, modulo arithmetic and congruences, projective plane, permutations, monotone sequences and polynomials.

Unit-IV: Libraries and Packages

Libraries and Packages for arbitrary precision arithmetic and linear algebra**;** Features of C++ for input/output and visualization**:** Strings, streams, formatting methods, processing files in a batch, command-line arguments, visualization packages and their uses; Applications**:** Arbitrary precision arithmetic using GMP, BOOST; Finding nullity, rank, eigen values, eigen vectors, linear transformations, systems of linear equations; Plots.

Unit-V: Odds and Ends

Runtime errors and graceful degradation, Robustness in a program; Exception handling: Try- catch and throw; Defining and deploying suitable exception handlers in programs; Compiler options; Conditional compilation; Understanding and defining suitable pragmas; Applications**:** Identification and description of install parameters of mathematical libraries, debugging installation, working with multiple libraries simultaneously and maintaining correctness and consistency of data.

References:

1. Nell Dale & Chip Weems (2013).*Programming and Problem Solving with C++* (6th edition). Jones & Bartlett Learning.
2. Peter Gottschling (2016). *Discovering Modern C++***:** *An Intensive Course for Scientists, Engineers, and Programmers*. Pearson.
3. Nicolai M. Josuttis (2012). *The C++ Standard Library*: *A Tutorial and Reference* (2nd edition). Addison-Wesley, Pearson.
4. Donald E. Knuth (1968). *The Art of Computer Programming.* Addison-Wesley.
5. Edward Scheinerman (2006). *C++ for Mathematicians*: *An Introduction for Studentsand Professionals*. Chapman & Hall/CRC. Taylor & Francis.
6. B. Stroustrup (2013). *The C++ Programming Language* (4th edition). Addison-Wesley.

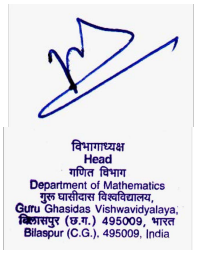
Course Outcomes: Programme Specific Outcomes Students will:

1) Become technology-oriented with the knowledge and ability to develop creative solutions.
2) Better understand the effects of future developments of computer systems and technology on people and society as a whole. Acquire some development experience within a specific field of Computer Science, through project work.
3) An ability to apply knowledge of mathematics, computer science in practice. An ability to enhance not only comprehensive understanding of the theory but its application too in diverse field.
4) In order to enhance programming skills of the young IT professionals, the program has introduced the concept of project development in each language/technology learnt during semester.
5) Gain ability to communicate scientific information in a clear and concise manner.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	2	2	1				1			1		1
CO2	2	2	2	1	2	1					1	1	1	1	
CO3	2	2	2	1	1	1				1		1	2	1	2
CO4	2	3	3	2	2	2				1	1	2	1	2	1
CO5	2	3	2	2	3	2				1	2	1	2	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD6	4	1	0	5 HOURS	30	70	5

Paper Code - AMUFTD6

CRYPTOGRAPHY

Course Objectives: A course on cryptography aims to introduce students to -

1) Understanding of basic cryptographic concepts: The course aims to introduce students to the basic concepts and techniques used in cryptography, including encryption, decryption, key management, and digital signatures. This includes an overview of classic and modern cryptographic algorithms and their properties.
2) Analyze cryptographic protocols for their security and privacy properties. This includes topics such as formal verification, threat modeling, and security testing.
3) Implement cryptographic algorithms using programming languages such as C++ and Python. This includes topics such as key generation, encryption, decryption, and digital signatures.
4) The applications of cryptography in various fields such as computer networks, e-commerce, and secure messaging and also, includes an overview of various standard cryptographic protocols.
5) Understanding of the challenges and issues faced by real-world cryptographic systems, such as side-channel attacks, timing attacks, and implementation flaws. This includes discussions on recent security breaches and case studies of successful and unsuccessful cryptographic implementations.

Unit I: Introduction to Cryptography and Classical Cryptography

Cryptosystems and basic cryptographic tools: Secret-key cryptosystems, Public-key cryptosystems, Block and stream ciphers, Hybrid cryptography, Message integrity: Message authentication codes, Signature schemes, Nonrepudiation, Certificates, Hash functions, Cryptographic protocols, Security; Hybrid cryptography: Message integrity, Cryptographicprotocols, Security, Some simple cryptosystems, Shift cipher, Substitution cipher, Affine cipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis of affine, substitution, Vigenère, Hill and LFSR stream ciphers.

Unit-II: Cryptographic Security, Pseudo Randomness and Symmetric Key Ciphers

Shannon's theory, Perfect secrecy, Entropy, Spurious keys and unicity distance; Bit generators, Security of pseudorandom bit generators. Substitution-permutation networks,Data encryption standard (DES), Description and analysis of DES; Advanced encryptionstandard (AES), Description and analysis of AES; Stream ciphers, Trivium.

Unit-III: Basics of Number Theory and Public-Key Cryptography

Basics of number theory; Introduction to public-key cryptography, RSA cryptosystem, Implementing RSA; Primality testing, Legendre and Jacobi symbols, Solovay-Strassen algorithm, Miller-Rabin algorithm; Square roots modulo *n*, Factoring algorithms, Pollard *p*-1 algorithm, Pollard rho algorithm, Dixon's random squares algorithm, Factoring algorithms in practice; Rabin cryptosystem and its security.

Unit-IV: More on Public-Key Cryptography

Basics of finite fields; ElGamal cryptosystem, Algorithms for the discrete logarithm problem, Shanks' algorithm, Pollard rho discrete logarithm algorithm, Pohlig-Hellman algorithm; Discrete logarithm algorithms in practice, Security of ElGamal systems, Bit security of discrete logarithms.

Unit-V: Hash Functions and Signature Schemes

Hash functions and data integrity, SHA-3; RSA signature scheme, Security requirements for signature schemes, Signatures and Hash functions, ElGamal signature scheme, Security of ElGamal signature scheme, Certificates.

References:

1. Jeffrey Hoffstein, Jill Pipher & Joseph H. Silverman (2014). *An Introduction toMathematical Cryptography* (2nd edition). Springer.
2. Neal Koblitz (1994). *A Course in Number Theory and Cryptography* (2nd edition).Springer-Verlag.
3. Christof Paar & Jan Pelzl (2014). *Understanding Cryptography*. Springer.
4. Simon Rubinstein-Salzedo (2018). C*ryptography*. Springer.
5. Douglas R. Stinson & Maura B. Paterson (2019). *Cryptography Theory and Practice* (4th edition)., Chapman & Hall/CRC Press, Taylor & Francis.

Course Learning Outcomes: This course will enable the students to:

1) Gain knowledge of modern cryptographic algorithms, including symmetric-key and public-key cryptography, as well as their strengths and weaknesses.
2) Understand the basic cryptographic concepts of confidentiality, integrity, authenticity, and non-repudiation, and how these concepts relate to cryptographic algorithms and protocols.
3) Learn how to analyze the security of cryptographic systems, including the identification of vulnerabilities and attacks, and the selection of appropriate cryptographic algorithms and protocols to mitigate risks.
4) Develop critical thinking and problem-solving skills through practical exercises and assignments that require the application of cryptographic concepts and techniques.
5) Develop effective communication skills through written and oral presentations of technical material related to cryptography.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1			1	1	1	2	1	1	1
CO2	3	2	2	2	1	1			2	2	1	2	2	1	1
CO3	3	2	2	3	2	2			2	2	1	2	2	3	1
CO4	3	2	2	3	2	3			1	1	2	2	3	2	1
CO5	3	2	3	3	3	2			2	2	3	3	3	3	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPATO1	4	1	-	5 hours	30	70	100	5

APPLICATIONS OF FUZZY SETS AND FUZZY LOGIC

Course Objective:

1. To learn to deal with uncertainty (of Fuzzy nature) and understand the scope of the subject.

2. To learn basic operations on Fuzzy sets and to understand the flexibility of various operations.

3. To understand the possibility theory and compare it with probability theory.

4. To understand the Fuzzy logic, implication rules, Fuzzification and Defuzzification methods.

5. To understand the application of Fuzzy logic in decision making under Fuzzy environment.

Syllabus Content:.

1. **From Classical (Crisp) sets to fuzzy sets: A grand paradigm shift and Operation on fuzzy sets**

Introduction, Crisp Sets: An overview, Fuzzy sets: basic types, Fuzzy sets: Basic concepts, Characteristics and signification of paradigm shifts.Types of operations, Fuzzy complements, Fuzzy intersections: t-Norms, Fuzzy unions: t-conorms, Combination of operations, Aggregation of operations

2. **Possibility Theory and Fuzzy Logic**

Fuzzy measures, Evidence Theory, Possibility theory, Fuzzy sets and possibility theory, Possibility theory vs. probability theory. Classical logic: An overview, multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges

3. **Approximate Reasoning**

Fuzzy expert system: an overview, Fuzzy implications, Selection of fuzzy implications, Multi conditional approximate reasoning, the role of fuzzy relation Equations, Interval-valued approximate reasoning.

4. **Fuzzy Systems**

General discussion, Fuzzy controllers: An overview, Fuzzy controllers: An Example, Fuzzy systems and neural networks, Fuzzy neural networks, Fuzzy automata, Fuzzy dynamic systems.

5. **Fuzzy decision making**

General discussion, Individual decision making, multi-person decision making, Multicriterial decision making, Multistage decision making, Fuzzy ranking methods, Fuzzy linear programming.

Text Book:

1. George J. Klir, Bo Yuan, Fuzzy sets and fuzzy logic Theory and Applications, PHI Publications 2002.

Reference Books:

1. Zimmermann, H. J. Fuzzy set theory and its applications. Springer Science & Business Media (2011).
2. Garg, H. Pythagorean, Fuzzy Sets- Theory and Applications. Springer, Singapore (2021).

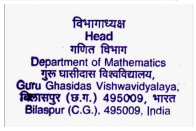
Course Outcomes: After completion of this course a student is supposed to know:

1. Learn to deal with real world uncertainties especially of the fuzzy nature and use it as mathematical tool available for cutting edge research in the area of his/her choice
2. Basics of fuzzy sets and the significance of application of fuzzy sets.
3. Use of fuzzy logic for decision making under real world scenario which is mostly fuzzy.
4. A student is supposed to understand the application as Fuzzy measures evidence theory, Possibility theory and probability theory.
5. Basics of fuzzy controller, idea of fuzzification and defuzzification.

Course Outcome and Their Mapping with Program Outcome & Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03	PS04
CO1	3	3	3	2		2	1	2	2	-	1	2	1	1	2	2
CO2	3	3	2	2		1	1	-	2	-	1	2	2	2	2	2
CO3	3	3	3	2		2	-	1	2	1	1	2	2	2	2	2
CO4	2	2	2	2		-	-	-	-	-	-	-	1	1	2	2
CO5	2	2	2	2		1	-	-	1	1	-	1	2	2	2	2

WEIGHTAGE: 1- Slightly, 2 – Moderately, 3 - Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD5	4	1	-	5 hours	30	70	100	5

MATHEMATICAL STATISTICS

Course objective: This course will enable the students to:

1. Understand different type of probability distributions.
2. Apply sampling technique to draw inferences about population.
3. Establish a formulation helping to predict one variable in terms of the other variables using the technique of correlation and regression.
4. Estimate the population parameters and evaluate the properties of estimators.
5. Translate real-world problems into probability models.

Basics of Random Variables: Introduction of Probability**,** Discrete and continuous random variables, probability mass function, probability density function, expectation, normal distribution.

Large Sample Theory: Types of sampling, parameter and statistic, tests of significance, procedure for testing of hypothesis, tests of significance for large samples, sampling of attributes, sampling of variables.

Exact sampling distributions-I: Derivation of the chi-square distribution, M.G.F. of chi-square distribution, some theorems on chi-square distribution, and applications of chi-square distribution.

Exact sampling distributions-II: Students 't' distribution, Fisher's 't', applications of t-distributions, distribution of sample correlation coefficient when population correlation coefficient is zero(ρ=0), F-distribution, applications of F-distribution, relation between t and F distributions, relation between F and chi-square distributions, Fisher's z-distribution, Fisher's z- transformation.

Theory of estimation: Estimators, characteristics of estimators, Cramer-Rao inequality, complete family of distributions, methods of estimation, confidence interval and confidence limits.

Correlation and regression: Linear regression (introduction) and curvilinear regression, regression curves, correlation ratio, multiple and partial correlation, plane of regression, properties of residuals, coefficient of multiple correlation, coefficient of partial correlation, multiple correlation in terms of total and partial correlation, expression for regression coefficient in terms of regression coefficients of lower order, expression for partial coefficient in terms of regression coefficients of lower order.

Text Book:

1. S. C. Gupta and V. K. Kapoor: Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi (2004).

Reference Books

1. M. Ray and H. S. Sharma: Mathematical Statistics, Ram Prasad & Sons (1966).
2. D. N. Elhance, Fundamentals of Statistics, Kitab Mahal (1964).

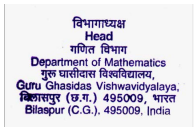
Course Outcomes: After completion of this paper students will be able to

1. Handle the real world problems regarding uncertainty of certain kind associated with random experiment.
2. Perform test of hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases and draw inferences about population.
3. Perform non-parametric test such as the Chi-square test for independence as well as goodness of fit.
4. Compute and interpret the results of bivariate and multivariate regression and correlation analysis, for forecasting. This paper is also useful for further study of statistics.
5. Apply the theory of estimation to draw valid conclusions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	1	2	3	3	3	1	2	2	2
CO2	3	3	3	3	3	3	2	1	2	3	2	3	2	2	2	2
CO3	3	3	2	2	3	3	3	1	2	3	3	3	2	2	2	2
CO4	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2
CO5	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD3	4	1	-	5 hours	30	70	100	5

APPLICATIONS OF FUZZY LOGIC

Course Objectives: *Objective of the course is to make Students will able:*

1. To acquaint a student with modern tools of decision making.
2. Learn to tailor a fuzzy set as per requirement.
3. Learn generalization of rules of classical logic into the realm of fuzzy universe.
4. Learn decision making and finding solution of leaner programming problems.
5. Find out applications of fuzzy tools and the techniques in real world seniors.To learn the properties of direct sums and products of ring and modules.

1. Fuzzy Logic and Constructing Fuzzy Sets and Operation on Fuzzy Sets

Classical logic: An overview, multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges .General discussion, Methods of construction: An overview, Direct methods with one expert, Direct method with multiple experts, Indirect methods with one expert, Indirect methods with multiple experts, Construction from sample data

2. Approximate Reasoning

Fuzzy expert system: an overview, Fuzzy implications, Selection of fuzzy implications, Multi conditional approximate reasoning, the role of fuzzy relation Equations, Interval-valued approximate reasoning.

3. Fuzzy Systems

General discussion, Fuzzy controllers: An overview, Fuzzy controllers: An Example, Fuzzy systems and neural networks, Fuzzy neural networks, Fuzzy automata, Fuzzy dynamic systems.

4. Fuzzy decision making

General discussion, Individual decision making, multi-person decision making, Multicriterial decision making, Multistage decision making, Fuzzy ranking methods, Fuzzy linear programming.

5. Miscellaneous Applications

Introduction, Medicine, Economics, Fuzzy systems and genetic algorithm, Fuzzy regressions, Interpersonal communications, other applications

Text Book:

1. George J. Klir, Bo Yuan, Fuzzy sets and fuzzy logic Theory and Applications, PHI Publications 2002.

Reference Books:

2. Zimmermann, H. J., Fuzzy set theory—and its applications. Springer Science & Business Media (2011).
3. Garg, H., Pythagorean Fuzzy Sets- Theory and Applications. Springer, Singapore (2021).

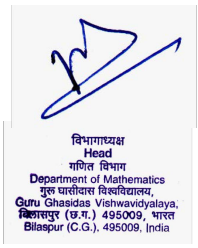
Course Outcomes: Students will be able to understand after learning the course:

1. Use of fuzzy logic for decision making under real world scenario which is mostly fuzzy.
2. Basic idea of set theory and basics of fuzzy sets. The significance of application of fuzzy sets.
3. Basics of fuzzy controller, idea of fuzzification and defuzzification. Study of fuzzy controllers by mean of examples, Individual and Multiple decision making, Multicriteria and Multistage decision making.
4. Use of individual and multiple decision making, multicriteria and multi stage decision making methods under the fuzzy environment.
5. Over all use of fuzzy methods in the various disciplines in the general and particular areas of his\her interest.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS02	PSO3	PSO4
CO1	3	3	2	**2**		**1**		**1**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**2**
CO2	2	**2**	3	2		-		**1**	2	**1**	**1**	2	3	**3**	2	2
CO3	**2**	**2**	**3**	**2**		-		**1**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**
CO4	**2**	**2**	**2**	**2**		-		**1**	**2**	**2**	**1**	**2**	**2**	**2**	**1**	**2**
CO5	3	**2**	**2**	**2**		-		**1**	**2**	**2**	**1**	**3**	**3**	**2**	**3**	**2**

Weightage: 1-Sightly; 2-Moderately; 3-Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD5	4	1	-	5 hours	30	70	100	5

CRYPTOGRAPHY

Course Objective: The Students undergoing this course are expected:

1. To learn fundamentals of cryptography and its application to network security.
2. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
3. Describe the process for implementing cryptographic systems and Identify processes for key administration and validation.
4. Describe the implementation of secure protocols, raise awareness of some of the legal and socio-ethical issues surrounding cryptography.
5. Explain the principles and underlying mathematical theory of today's cryptographic algorithms and provide an understanding of potential weaknesses and problems with ciphers and cryptographic protocols.

Unit I:

Introduction to cryptography: Basic Cryptography Concepts, Mono-alphabetic and Polyalphabetic cipher, The Shift Cipher, The Substitution Cipher, The Affine Cipher, The Vigenere Cipher, The Hill Cipher, The Permutation Cipher, Cryptanalysis, Some Cryptanalytic Attacks, Stream & Block ciphers, Mode of operations in block and stream cipher.

Unit II:

Shannon's Theory of Perfect Secrecy: Perfect Secrecy, Birthday Paradox, Vernam One Time Pad, Random Numbers, Pseudorandom Numbers.

DES & AES: The Data Encryption Standard (DES), Feistel Ciphers, Description of DES, Security analysis of DES, Differential & Linear Cryptanalysis of DES, Triple DES, The Advanced Encryption Standard (AES), Description of AES, analysis of AES.

Prime Number Generation: Trial Division, Fermat Test, Carmichael Numbers, Miller Rabin Test, Random Primes.

Unit III:

Public Key Cryptography: Principle of Public Key Cryptography, *RSA Cryptosystem*, Factoring problem, Cryptanalysis of RSA, RSA-OAEP, *Rabin Cryptosystem*, Security of Rabin Cryptosystem, Quadratic Residue Problem, Diffie-Hellman (DH) Key Exchange Protocol, Discrete Logarithm Problem (DLP), *ElGamal Cryptosystem*, ElGamal& DH, Algorithms for DLP, Elliptic Curve, Elliptic Curve Cryptosystem (ECC), Elliptic Curve Discrete Logarithm Problem (ECDLP).

Unit IV:

Cryptographic Hash Functions: Hash and Compression Functions, Security of Hash Functions, Iterated Hash Functions, SHA-1, Others Hash Functions, Message Authentication Codes.

Digital Signatures: Security Requirements for Signature Schemes, Signature and Hash Functions, RSA Signature, ElGamal Signature, Digital Signature Algorithm (DSA), ECDSA, Fail Stop Signature, Undeniable Signature, Blind Signature, Proxy Signature, Group Signature.

Unit V:

Identification and Authentication: Passwords, One Time Passwords, Challenge-Response Identification, Zero-Knowledge Proofs, The Schnorr Identification Scheme, The Okamoto Identification Scheme, Identity-based Identification Schemes.

Secret Sharing: The Principle, Shamir Secret Sharing Protocol.

Text Books:

1. Wenbo Mao, Modern Cryptography: Theory and Practice. Pearsion Education, 2004
2. J Buchmann, Introduction to Cryptography, Springer (India) 2004.
3. Bruce Schenier, Applied cryptography, John Wiley & Sons, 1996.B. Forouzan, Cryptography and Network security, Tata McGraw Hill, 2011.

Reference Books:

1. D. R. Stinson, Cryptography: Theory and Practice. CRC Press, 2000.
2. W. Starling, Cryptography and Network security, Pearson Education, 2004.

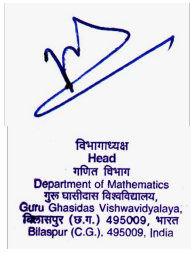
Course Outcomes: Upon the successful completion of the course, students will be able to:

1. Gain knowledge of modern cryptographic algorithms, including symmetric-key and public-key cryptography, as well as their strengths and weaknesses.
2. Understand the basic cryptographic concepts of confidentiality, integrity, authenticity, and non-repudiation, and how these concepts relate to cryptographic algorithms and protocols.
3. Learn how to analyze the security of cryptographic systems, including the identification of vulnerabilities and attacks, and the selection of appropriate cryptographic algorithms and protocols to mitigate risks.
4. Develop the skills necessary to implement cryptographic algorithms, including the generation of keys, encryption, decryption, and digital signatures.
5. Develop critical thinking and problem-solving skills through practical exercises and assignments that require the application of cryptographic concepts and techniques.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	2	1			2	1	1	2	2	2	2	3
CO2	3	2	2	2	2	2			2	2	1	2	2	2	2	3
CO3	3	2	2	3	2	2			2	2	3	2	2	3	2	2
CO4	3	2	2	3	2	3			2	3	2	2	3	2	2	3
CO5	3	2	3	3	3	2			2	3	3	3	3	3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD6	4	1	-	5 hours	30	70	100	5

FINANCIAL MATHEMATICS AND ITS APPLICATIONS

Course Objective: The objective of this paper is to study:

1. Various types of financial instruments and their applications in various fields.
2. The Mathematical concepts of Black-Scholes formula and option Greeks for option pricing will be explained.
3. To have a proper understanding of mathematical applications in Economics, Finance, Commerce and Management.
4. Understand and assess the principles underlying the evaluation of the main securities that are available in the financial markets.
5. Explain how to evaluate, and assign a single value to a series of cash flows under different assumptions on the time value of money (interest).

Financial Derivatives: Meaning of financial derivatives, Types of financial derivatives – Forwards and futures, Advantages and disadvantages of forward and future contracts, Features of future contracts. Hedging using futures, Difference between forward and future contracts.

Technical analysis: Meaning of technical analysis, basic principal of technical analysis, bullish trend, bearish trend, support and resistance.

Mathematical Indicators: Moving averages, simple moving averages and exponential moving averages.

Options: Definition of option, types of options, call option and put option. Long call, long put, short call, short put, purpose of options, profit and pay of curve, open interest, change in open interest, volume, put call ratio based on open interest and volume, Volatility and implied volatility, Swaps.

Pricing contract via arbitrage: Explanation of option pricing and arbitrage with examples, the Arbitrage Theorem, proof of the Arbitrage Theorem, The multi-period binomial model.

The Black-Scholes Formula: Proof of Black-Scholes formula, properties of Black-Schole's option formula, the delta hedging arbitrage strategy.

Option Greeks: Delta, gamma, Vega, theta and rho, Mathematical and theoretical explanation of option Greeks.

Text Books:

1. John C Hall, Options, features and other derivatives, Prentice- Hall of India Private Limited.
2. Sheldon M Ross, An introduction to Mathematical Finance, Cambridge University Press.

Reference Books:

1 Sahil N. Nettci and Ali Hirsa, An introduction to Mathematics of financial derivatives, Academic Press Inc

2 Robert J Elliot and P. ekkehard Kopp, Mathematics of financial markets, Springer-verlag New Yark Inc
3 S. Kevin, Security analysis and portfolio management, PHI learning Private limited.
4 Redhead, Keith, 1998, Financial Derivatives- An Introduction to Futures, Forwards, Options and Swaps, PHI New Delhi.

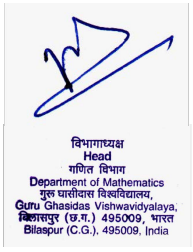
Course Outcomes: After successful completion of this paper the students will be able to:

1. Understand about the financial derivatives, technical analysis, Mathematical indicators and option Greeks used in option pricing of securities.
2. Employ methods related to these concepts in a variety of financial applications.
3. Apply logical thinking to problem solving in financial context.
4. Understand the mathematical concept of black schole's option prizing formula.
5. Use appropriate technology to aid problem solving.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2			2	1	3	2	2	2	2	2
CO2	2	2	2	2	3	2			2	3	2	1	2	3	2	2
CO3	3	3	3	2	2	2			2	2	2	2	3	3	3	2
CO4	3	3	3	2	2	2			3	2	2	3	2	2	2	2
CO5	3	3	2	2	3	2			3	2	3	2	3	3	3	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD8	4	1	-	5 hours	30	70	100	5

OPERATIONS RESEARCH

Course Objectives: Student will be able to:

1. Formulate and solve some real life problems where integer optimal value is desirable.
2. Aware about CPM/PERT techniques.
3. Handle many optimization problems that involve large number of decision variables and/or large number of inequality constraints by the technique of dynamic programming.
4. Handle the queuing problem.
5. Solve unconstrained and constrained nonlinear programming problems.

Operation research: Origin and development of O.R., Nature and future of O.R., scientific method in O.R., Modelling in operation research, advantages and limitations of models, general solution methods for OR models, methodology of operation research, operation research and decision – making, applications of operational research.

Brief Review of LPP, simplex method, duality, Integer Programming: Introduction, Pure and mixed integer problems, Gomory's All I. P. P. method, construction of Gomory's constants, fractional cut method All I.P.P. , fraction cut method -mixed integer linear programming problem, Branch and bound method, applications of integer programming.

CPM/PERT: Basic definitions, activity, fullkerson's rule, event numbering, critical path, critical path method, forward and backward pass computation, network diagram, PERT.

Queuing theory: Queuing system, elements of a Queuing system, operating characteristics of a Queueing system, deterministic Queueing system, probability distributions in Queueing system, classification of Queueing models, definition of transient and steady states, Poisson Queueing systems, non-Poisson Queueing systems, cost models in Queueing, other Queueing models.

Dynamic programming problem: Introduction, the recursive equation approach, characteristics of dynamic programming, dynamic programming algorithm, solution of DPP, some applications, solution of LPP by dynamic programming.

Non-Linear Programming: Introduction, formulating a Non-linear programming problem (NLPP), general NLPP, constraint optimization with equality constraints, constraint optimization with inequality constraints.

Text Book:

1. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.

Reference Books:

1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison –Wesley, Reading Mass.
3. H. A. Taha, Operation Research- An Introduction, Macmillan Publishing Co. Inc., New York.
4. S. D. Sharma, Operation Research, S. Chand Publ. New Delhi.

Course Outcomes: Upon completion of this course, the student will be able to:

1. Formulate and solve some real life problems where integer optimal value is desirable.
2. Aware about CPM/PERT techniques.
3. Handle many optimization problems that involve large number of decision variables and/or large number of inequality constraints by the technique of dynamic programming.
4. Handle the queuing problem.
5. Solve unconstrained and constrained nonlinear programming problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	1	2	3	3	3	1	2	2	2
CO2	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2
CO3	3	3	2	2	3	3	3	1	2	3	3	3	2	2	2	2
CO4	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2
CO5	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly