List of New Course(s) Introduced

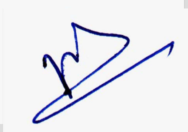
Department : Mathematics

Programme Name : B.Sc., M.Sc.

Academic Year : 2022-23

List of New Course(s) Introduced

Sr. No.	Course Code	Name of the Course
01.	AMUCTT1	Real Analysis
02.	AMUCTT2	Group Theory
03.	AMUCTT3	Probability and Statistics
04.	AMUCTG1	Differential Calculus
05.	AMUCTG2	History of Indian Mathematics
06.	AMUDTT1	Mechanics
07.	AMUDTT2	Linear Algebra
08.	AMUDTT3	Partial Differential Equations and Calculus of Variations
09.	AMUDTG1	Applications of Algebra
10.	AMUDTG2	Combinatorial Mathematics
11.	AMUDTG3	Theory of Equations
12.	AMUCTA1	Curve Tracing
13.	AMUDTA1	Matrix and Determinant
14.	AMPCTT1	Functional Analysis
15.	AMPCTT2	Theory of ordinary differential equations
16.	AMPCTD1	Algebraic Topology
17.	AMPCTD2	Complex Manifold
18.	AMPCTD3	Difference Equations
19.	AMPCTD4	Fuzzy Sets and Fuzzy Logic
20.	AMPCTD5	Information Theory and its Applications
21.	AMPCTD6	Integral Equations
22.	AMPCTD7	Multipoint Iterative Methods
23.	AMPCTD8	Fundamentals of Elasticity
24.	AMPCTD9	Advanced Numerical Analysis
25.	AMPCPF1	Project Phase-I
26.	AMPDTT1	Complex Analysis
27.	AMPDTT2	Theory of partial differential equations



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28.	AMPDTD1	Advanced Differential Equations
29.	AMPDTD2	Advanced Functional Analysis
30.	AMPDTD3	Applications of Fuzzy Logic
31.	AMPDTD4	Ring and Category of Modules
32.	AMPDTD5	Cryptography
33.	AMPDTD6	Financial Mathematics and its Applications
34.	AMPDTD7	Mathematical Ecology
35.	AMPDTD8	Operations Research
36.	AMPDTD9	Theory of Relativity
37.	AMPDTD10	Fundamentals of theoretical Seismology
38.	AMPDPF1	Project Phase-II

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Minutes of BOS Meeting held on January 13, 2022

Department of Mathematics

Guru Ghsidas Vishwavidyalaya, Bilaspur (CG)

The Following Members were Present:

1. **Dr. P. P. Murthy** (HOD) : (Chairman)
2. **Professor R. P. Dubey** (Subject Expert) (VC Nominee) (V.C. C. V. Raman University, Kota) Discussed over phone - excused
3. **Professor A. S. Ranadive** :(Member)
4. **Dr. Sandeep Singh**: (Member)

Chairman of BOS, P. P. Murthy welcome all the honourable member of **Board of Studies(BOS)** and briefed about the need of LOCF and CBCS at UG and PG level respectively. He also informed the honourable members about the **Curriculum Framework Worksop** in which all the faculty members of the Department were present and few experts like Prof A. P. Singh (Retd. Prof., Rajasthan Central Univeisty, Kisanganj), Prof. G.V.R. Babu (Prof. Andhra University, Visakhapatnam) and Dr. S. Pardhi (Education Department, GGV) discussed with the faculty members on the frame work of the course papers. He has informed that Professor **R. P. Dubey** is unable to attend personally but available over phone and WhatsApp during the meeting due some urgent unavoidable work and asked the HOD to go ahead with the meeting over phone. In this meeting the following agenda approved unanimously.

Syllabus for UG(LOCF Based) and PG(CBCS) from this academic session 2021-20. After fruitful discussion on the syllabus presented by the Chairman in front of BOS, members have agreed on the following syllabus for UG and PG as well. The instructions passed by university authorities and academic section followed.

Chairman extended his warm regards and thanks to honourable members of the BOS for the smooth conduct of the meeting.

Paper details are given below: **B.Sc. Honours in Mathematics (LOCF)**

Semester	Course Type	Course Code	Course Name	Credit/ Hours
I	CORE	AMUATT1	Calculus	05
		AMUATT2	Algebra and Geometry	05
	GENERIC ELECTIVE	AMUATG1	Finite Element Methods	05
		AMUATG2		05
	AEC (any one)	AMUATA1	Set Theory and Logic	02
		AMUATA2	Basics of Statistics	02
	SEC	AMUATL1	Introduction to Cryptography	02

		AMUATL2		02
II	CORE	AMUBTT1	Multivariable Calculus	05
		AMUBTT2	Ordinary Differential Equations	05
	GENERIC ELECTIVE (any one)	AMUBTG1	Algebra and Matrix Theory	05
		AMUBTG2		05
	AEC (any one)	AMUBTA1	Theory of Interpolation	02
		AMUBTA2		02
	SEC (any one)	AMUBTL1	Graph Theory	02
		AMUBTL2		02
III	CORE	AMUCTT1	Real Analysis	05
		AMUCTT2	Group Theory	05
		AMUCTT3	Probability and Statistics	05
	GENERIC ELECTIVE (Any one)	AMUCTG1	Differential Calculus	05
		AMUCTG2		05
IV	CORE	AMUDTT1	Mechanics	05
		AMUDTT2	Linear Algebra	05
		AMUDTT3	Partial Differential Equations and Calculus of Variations	05
	GENERIC ELECTIVE (any one)	AMUDTG1	Applications of Algebra	05
		AMUDTG2	Combinatorial Mathematics	05
V	CORE	AMUETT1	Set Theory and Metric Spaces	05
		AMUETT2	Advanced Algebra	05
	DSE (any two)	AMUETD1	Tensors and Differential Geometry	05
		AMUETD2	Mathematical Logic	05
		AMUETD3	Integral Transforms and Fourier Analysis	05
		AMUETD4	Linear Programming	05
		AMUETD5	Information Theory and Coding	05
		AMUETD6	Graph Theory	05

		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

	(Core)	AMPCTT1	Functional Analysis	05
		AMPCTT2	Theory of ordinary differential equations	05
III	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

13/01/2022

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

Prof. A. S. Ranadive (Member)

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

Dr. Sandeep Singh (Member)

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR

DEPARTMENT OF MATHEMATICS

Minutes of the Meeting

Date: Aug.16, 2022

Today on 16/08/2022at 3:00PM in the Room No. 36 of UTD A-winga meeting of theBoard of Studies in hybrid mode has been conducted.The following members are present in the meeting:

1) Dr. J. P. Jaiswal, Chairman, BOS
2) Prof. Bankteshwar Tiwari, External Subject Expert, BOS
3) Dr. Omkar L.al Shrivastava, Special Invitee, BOS
4) Prof. A.S. Ranadive, Member BOS
5) Dr. M. K. Gupta, Member BOS
6) Dr. Sandeep Singh, Special Invitee
7) Dr. B. B. Chaturvedi, Special Invitee
8) Dr. Santosh Verma, Special Invitee

In the hybrid mode meeting the following points have been concluded:

1. The syllabus of the course "Mathematical Statistics" (Code: AMPBTD5) of M. Sc. 2nd sem. (w.e.f. AY 2021-22) is approved (Annexure-I).
2. The syllabus of the course "Research Methodology" (Code: AMUBTT3) of M. Sc. 2nd sem. (w.e.f. AY 2021-22) is approved (Annexure-II).
3. The syllabus of the course "Theory of Interpolation" (Code: AMUBTA1) of B. Sc. 2nd sem. (w.e.f. AY 2021-22) is approved (Annexure-III).
4. The correct name of the course (Code: AMPBTD6) is "Riemannian Manifold and Connections" of M. Sc. 2nd sem. (w.e.f. AY 2021-22) is approved.
5. The correct name of the course (Code: AMPCTD6) is "Integral Equations" of M. Sc. 2nd sem. (w.e.f. AY 2021-22) is approved.
6. The syllabus of the course "History of Indian Mathematics"with (Code: AMUCTG2) of B. Sc. 3rdsem. (w.e.f. AY 2021-22) is approved (Annexure-IV).

The Chairman, BOS extended his thanks to all the members.

16/08/2022

Dr. J. P. Jaiswal	Prof. Bankteshwar Tiwari (Approved on email)	Dr. Omkar Lal Shrivastava
Prof. A.S. Ranadive	Dr. M. K. Gupta	Dr. B. B. Chaturvedi
Dr. Santosh Verma	Dr. Sandeep Singh	

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**			

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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	

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		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)

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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

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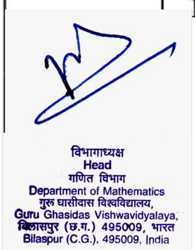
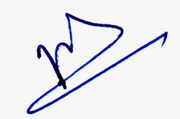
DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE & SYLLABUS - M.Sc. in Mathematics

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 (OE)	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	AMUBTT3	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 Equations	05



		AMPCTD7	Multipoint Iterative Methods	05
		AMPCTD8	Fundamentals of Elasticity	05
		AMPCTD9	Advanced Numerical Analysis	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



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SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTT1	4	1	0	5 HOURS	30	70	5

Paper Code - AMUCTT1

REAL ANALYSIS

Course Objectives: The objective of this course is –

1) To understand the basic concept of real number system and to identify the open and closed sets.
2) To examine the convergence, divergence, limit inferior and limit superior of the functions.
3) To apply the various test viz., Comparison, D'Alembert's, Cauchy and integral test for the convergence of infinite series.
4) To check the Riemann integrability of the functions.
5) To implement the test for uniform convergence.

Unit-I: Real Number System

Algebraic and order properties of ℝ, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of ℝ, The completeness property of ℝ, Archimedean property, Density of rational numbers in ℝ, Definition and typesof intervals, Nested intervals property; Neighborhood of a point in ℝ, Open, closed and perfect sets in ℝ, Connected subsets of ℝ, Cantor set and Cantor function.

Unit-II: Sequences of Real Numbers

Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence,Cauchy's convergence criterion.

Unit-III: Infinite Series

Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series**;** Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence,Rearrangement of series and Riemann's theorem.

Unit-IV: Riemann Integration

Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second meanvalue theorems.

Unit-V: Uniform convergence and Improper integral:

Pointwise and uniform convergence of sequence and series eierstrass's M-test, Dirichlet test and Abel's test for uniform converge convergence and continuity, Uniform convergence and differentiability, als, Dirichlet test and Abel's testfor improper integrals.

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Bilaspur (C.G.), 495009, India

References:

1. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition). Wiley India.
2. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
3. K. A. Ross (2013). *Elementary Analysis: The Theory of Calculus* (2nd edition). Springer.

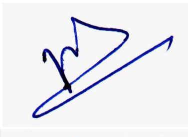
Course Outcomes: This course will enable the students to -

1) Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
2) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
3) Apply the ratio, root, and alternating series and limit comparison tests for Convergence and absolute convergence of an infinite series of real numbers.
4) Learn some of the properties of Riemann Integrable functions, and the applications of the fundamental theorems of integration.
5) Understand the concept of sequence and series of functions.

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	3		2	2	1			1			2	3	1	3
CO2	3	3		2	2	1			1			2	3	1	3
CO3	3	3		2	2	1			1			2	3	1	3
CO4	3	3		2	2	1			1			2	3	1	3
CO5	3	3		2	2	1			1			2	3	1	3

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



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SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTT2	4	1	0	5 HOURS	30	70	5

Paper Code – AMUCTT2

GROUP THEORY

Course Objectives: The objective of this course is –

1) To learn Basic concept of group theory and it properties.
2) To learn Subgroup and cyclic group.
3) To understand the Normal subgroup and permutation group.
4) Demonstrate the Ring and Fields.
5) To understand the group homomorphism, Cayley's theorem and its applications

Unit-I: Groups and its Elementary Properties
Symmetries of a square, Definition and examples of groups including dihedral, permutationand quaternion groups, Elementary properties of groups.

Unit-II: Subgroups and Cyclic Groups
Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem, Euler phi function, Euler's theorem, Fermat's little theorem.

Unit-III: Normal Subgroups
Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups;Classification of subgroups of cyclic groups.

Unit-IV: Permutation Groups
Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications.

Unit-V: Group Homomorphisms, Rings and Fields
Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups; Definitions and elementary properties of rings and fields.

References:

1. Michael Artin (2014). *Algebra* (2nd edition). Pearson.
2. John B. Fraleigh (2007). *A First Course in Abstract Algebra* (7th edition). Pearson.
3. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition). Cengage.
4. I. N. Herstein (2006). *Topics in Algebra* (2nd edition). Wiley India.
5. Nathan Jacobson (2009). *Basic Algebra* I (2nd edition). Dover Publications.
6. Ramji Lal (2017). *Algebra 1: Groups, Rings, Fields and Arithmetic*. Springer.
7. I.S. Luthar & I.B.S. Passi (2013). *Algebra: Volume 1: Group,* Narosa.

Course Outcomes: The course will enable the students to:

1) Recognize the mathematical objects called groups.
2) Link the fundamental concepts of groups and symmetries of geometrical objects.

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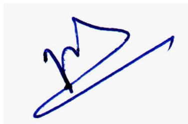
3) Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4) Analyze consequences of Lagrange's theorem.
5) Learn about structure preserving maps between groups and their consequences.

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	3	3	2						1	1	1	2	2	2
CO2	3	3	2	2						1	1	1	2	2	2
CO3	3	3	2	2						1	1	1	2	2	2
CO4	3	3	2	2						1	1	1	2	2	2
CO5	3	3	2	2						1	1	1	2	2	2

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



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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.

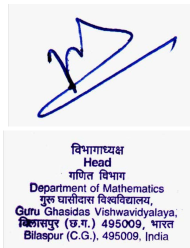
Course Outcomes: Upon successful completion of this course, students will be able to –

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
AMUDTT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUDTT1

MECHANICS

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

1) To familiarize basic concept of equilibrium of a particle in statics.
2) To understand of centre of gravity and common catenary of various plane areas.
3) To learn simple harmonic motion and its applications.
4) To study kinematics and kinetic motion of the particle.
5) To basic idea of equation of motion under a central force including Kepler's law of planetary motion.

Unit-I: Statics

Equilibrium of a particle, Equilibrium of a system of particles, Necessary conditions of equilibrium, Moment of a force about a point, Moment of a force about a line, Couples, Moment of a couple, Equipollent system of forces, Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omitted in forming the equations of virtual work.

Unit-II: Centres of Gravity and Common Catenary

Centres of gravity of plane area including a uniform thin straight rod, triangle, circular arc, semicircular area and quadrant of a circle, Centre of gravity of a plane area bounded by a curve, Centre of gravity of a volume of revolution; Flexible strings, Common catenary, Intrinsic and Cartesian equations of the common catenary, Approximations of the catenary.

Unit-III: Rectilinear Motion

Simple harmonic motion (SHM) and its geometrical representation, SHM under elastic forces, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varying mass.

Unit-IV: Motion in a Plane

Kinematics and kinetics of the motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates; Motion in a vertical circle, projectiles in a vertical plane andcycloidal motion.

Unit-V: Central Orbits

Equation of motion under a central force, Differential equation of the orbit, (p, r) equation ofthe orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion.

References:

1. S. L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
2. P. L. Srivatava (1964). *Elementary Dynamics*. Ram Narin Lal, Beni Prasad

PublishersAllahabad.
3. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.
4. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
5. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
6. R. S. Verma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.

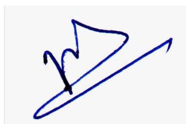
Course Outcomes: This course will enable the students to -

1) Familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers, and engineers together.
2) Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.
3) Determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.
4) Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
5) Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	1											1		
CO2	3	2											1		2
CO3	3	3			2								1		
CO4	3	2	1										1		2
CO5	3	3	1	2					2			2	2		2

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



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SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUDTT2

LINEAR ALGEBRA

Course Objectives: The objective of this course is -

1) To learn about fundamental concepts of vector spaces.
2) To learn about the concepts of matrix representation of linear transformations.
3) To discuss various properties of linear transformation.
4) To give idea of inner product space.
5) To discuss few other concepts of Linear Transformation and Canonical Forms.

Unit-I: Vector Spaces
Definition and examples, Subspace, Linear span, Quotient space and direct sum of subspaces, linearly independent and dependent sets, Bases and dimension.

Unit-II: Linear Transformations
Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem.

Unit-III: Further Properties of Linear Transformations
Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and Eigen values of a linear transformation, Characteristic polynomial and Cayley-Hamilton theorem, Minimal polynomial.

Unit-IV: Inner Product Spaces
Inner product spaces and Orthogonality, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalisation, Diagonalisation of symmetric matrices.

Unit-V: Adjoint of a Linear Transformation and Canonical Forms
Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces.

References:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). *Linear Algebra* (4th edition). Prentice-Hall of India Pvt. Ltd.
2. Kenneth Hoffman & Ray Kunze (2015). *Linear Algebra* (2nd edition). Prentice-Hall.
3. I. M. Gel'fand (1989). *Lectures on Linear Algebra.* Dover Publications.
4. Nathan Jacobson (2009). *Basic Algebra* I & II (2nd edition). Dover Publications.
5. Serge Lang (2005). *Introduction to Linear Algebra* (2nd edition). Springer India.
6. Vivek Sahai & Vikas Bist (2013). *Linear Algebra* (2nd Edition). Narosa PublishingHouse.
7. Gilbert Strang (2014). *Linear Algebra and its Applications* (2nd edition). Elsevier.

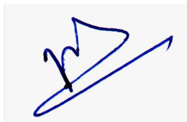
Course Outcomes: After completions of this course, students will be able -

1) To understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
2) To find matrix representation of linear transformations.
3) To understand various properties of linear transformation.
4) To understand inner product space and various proved inequalities.
5) To find various canonical forms.

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										3	3	
CO2	3	2	1										3	3	
CO3	3	2	1										3	2	
CO4	3	2	1	2									3	3	
CO5	3	2	1	1									3	3	

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



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTT3	4	1	0	5 HOURS	30	70	5

Paper Code - AMUDTT3

PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS

Course Objectives: The objective of this course is -

1) Formation of the partial differential equation and to solve the PDE of first order linear and non-linear.
2) To classify the second order partial differential equations.
3) To solve the second order PDE viz., heat and wave equations using the technique of variation of separations.
4) To identify and solve the Variational problem with fixed boundary.
5) To identify and solve the Variational problem with fixed boundary.

Unit-I: First Order Partial Differential Equations
Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than thegeneral method, Charpit's general method.

Unit-II: Second Order Partial Differential Equations with Constant Coefficients
Classification of linear partial differential equations of second order, Homogeneous and non-homogeneous equations with constant coefficients.

Unit-III: Second Order Partial Differential Equations with Variable Coefficients
Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Unit-IV: Calculus of Variations-Variational Problems with Fixed Boundaries
Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

Unit-V: Calculus of Variations-Variational Problems with Moving Boundaries:
Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendreconditions, Second variation.

References:

1. A. S. Gupta (2004). *Calculus of Variations with Applications*. PHI Learning.
2. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
3. Tyn Myint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation forScientists and Engineers* (4th edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on *Differential Equations and*

TheirApplications. CBS Publishers.
5. S. B. Rao & H. R. Anuradha (1996). *Differential Equations with Applications*.University Press.
6. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

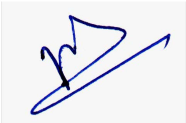
Course Outcomes: This course will enable the students to -

1) To identify the order and degree of the partial differential equations.
2) Apply a range of techniques to solve first & second order partial differential equations.
3) Model physical phenomena using partial differential equations such as the heat and wave equations.
4) Understand problems, methods and techniques of calculus of variations for fixed boundaries.
5) Understand problems, methods and techniques of calculus of variations for moving boundaries.

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	3	2			1			2	3	1	2
CO2	3	3	1	2	3	2			1			2	3	1	2
CO3	3	3	1	2	3	2			1			2	3	1	2
CO4	3	3	1	2	3	2			1			2	3	1	2
CO5	3	3	1	2	3	2			1			2	3	1	2

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



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SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTG1	4	1	0	5 HOURS	30	70	5

Paper Code: AMUCTG1

DIFFERENTIAL CALCULUS

Course Objectives: This course will enable the students to –

1) The goal of this course is for students to gain proficiency in calculus computations.
2) To learn three main tools for analyzing and describing the behavior of functions limits, derivatives and integral.
3) To demonstration Series solution, Rolle's theorems and Mean value theorems, etc.
4) To lean deep knowledge geometrical interpretations.
5) To understand the tools to solve application problems in a variety of setting ranging from physics and biology to business and economics etc.

Limit and Continuity: (ε, δ) definition, Types of discontinuities, Differentiability of functions, n^{th} Derivative, Successive differentiation, Leibniz rule and its applications.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves. Polar coordinates and tracing of curves in polar coordinates.

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cosx, e^x, $\log(1+x)$, $(1+x)^m$, Maxima and Minima, Indeterminate forms.

Functions of Two Variables: Limit, Continuity, Differentiability. Partial differentiation, Change of variables, Euler's and Taylor's theorem. Maxima and minima. Double and triple integrals, Change of order in double integrals. Beta and Gamma functions.

Text Books:

1. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
2. S. C. Mallik, Mathematical Analysis, Wiley Eastern Ltd, New Delhi.

Reference Books:

1. Gabriel Klaumber, Mathematical Analysis, Marcel Dekkar, New York 1975.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 1999.
3. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
4. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

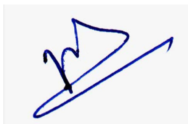
Course Outcomes: This course will enable the students to –

1) Assimilate the notions of limit of a sequence and convergence of a series of realnumbers.
2) Calculate the limit and examine the continuity of a function at a point.
3) Understand the consequences of various mean value theorems for differentiablefunctions.
4) Sketch curves in Cartesian and polar coordinate systems.
5) Apply derivative tests in optimization problems appearing in social sciences, physicalsciences, life sciences and a host of other disciplines.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2											3		
CO2	2	2											3		
CO3	2	2											3		
CO4	2	2											3		
CO5	2	2											3		

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



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SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTG2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUCTG2

HISTORY OF INDIAN MATHEMATICS

Course Objectives: This course will enable the students to –

1) The core objective of this course is related to understand Indian knowledge system specially area of mathematics and mathematical thoughts.
2) The foremost important objective of introducing this paper into learns about the work of the great Indian mathematicians.
3) It is important to understand development of mathematics is a branch of Indian traditional knowledge. The objective of doing so is supposed concepts in one of the oldest surviving India culture and society.
4) The course is aimed to let a student understand Indian traditional knowledge in geometry, common astronomy, infinite series and calculus.
5) This course is also having an objective to tend a student how mathematical thoughts and concepts have migrated from one culture to another and how Indian knowledge system has continued in development of modern mathematics.

History of Origin of Mathematics, The Number Symbols Arithmetic Operations, Ancient and Early Medieval Indian Mathematics, Early Hindu Mathematics, Hindu Arithmetic and Algebra, Hindu Geometry and Trigonometry, History of Mathematics in South Asia.

About Mathematics in Vedas, The *Sulba-Sutras*, The Vedas and Astronomy, The Jyotisa-Vedanga, Vedic India and Ancient Mesopotamia. Mathematics in Ancient, Early Medieval and Medieval India.

Numbers and Numerals, Astronomy, Astrology and Cosmology, Mathematics in Jain and Buddhist texts.

Geocentric Astronomy, Evolution of the Siddhanta and Astronomical Schools, Astronomical Calculations in Siddhantas, Geometric modes in Astronomy
Medieveal Mathematics:- Mathematics in Siddhanatas, Bakhshah Manuscript, Ganita-Sara-Sangraha.

The Development of "Canonical" Mathematics: - Mathematician and Society, About work Bhaskara & Narayana Pandita, Mathematical writing and thought.

The School of Madhava in Kerla: - Background, Lineage, Infinite Series and other Mathematics, Astronomy and Scientific Methodology, Questions of Transmission.

Exchanges with the Islamic World:- Indian Mathematics in the word, Mathematical Encounters in India, Influence and Synthesis.

Continuity and Changes in the Modern period:-Individuals, Families and Schools, Contacts with Europe, Mathematics and Astronomy, 1500-1800

Recommended Text Books:

1. Mathematics in India by Kim Plofker

Suggested Readings:

2. Mathematical Thought from Ancient to Modern Times volume-1 by Morris Kline
3. Culture and History of Mathematics Edited Volume editor C.S.Seshadri
4. वेदों में विज्ञान लेखक डॉ कपिलदेव.द्विवेदी

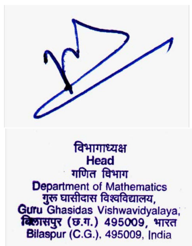
Course Outcomes: - After completing this course student is supposed to -

1. Learn about the history of contribution of Indian mathematics from Vedic era to medieval period.
2. Learn about the role of perception, inference, analogy and authoritative testimony in Indian mathematics.
3. Understand substantial differences between mathematics in the India tradition and its counter parts.
4. Multiply the interest by manifold in the traditional Indian mathematical development from numbers to Calculus, Infinite series, Geometry and Astronomy.
5. Understand the rich scientific and cultural heritage of India.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		1	2	2		2	2	3	1	1		2	2	1	2
CO2	3	2	2	2		1	2	2	1	1	1	2	1	1	1
CO3	1	1	1	1			1	1	1	1	1	2			
CO4	2	2	2	2				2	2	2	2	2	3	1	3
CO5	1	2	2	1		1			1	1		1	1		1

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



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTG1	4	1	0	5 HOURS	30	70	5

Paper Code: AMUDTG1

APPLICATIONS OF ALGEBRA

Course Objectives: The objective of this course is –

1) To learn about the concepts of Balanced incomplete block designs (BIBD).
2) To learn about basic concepts of coding theory.
3) To discuss various properties of symmetric groups.
4) To give idea about Special types of matrices.
5) To discuss few other Applications of linear transformations.

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs.

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of apositive semi- definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an $m \times n$ matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Books Recommended:

1. I. N. Herstein and D. J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S. K. Jain, *Topics in Applied Abstract Algebra*, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, *Linear Algebra and its Applications.* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, *Matrix theory*, Springer-Verlag New York, Inc., New York, 1999.

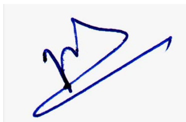
Course Outcomes: After completions of this course, students will be able -

1) To understand the concepts of Balanced incomplete block designs (BIBD).
2) To understand basic concepts of coding theory.
3) To understand symmetric groups with different orders with examples.
4) To understand idea about Special types of matrices and their properties.
5) To solve various kind of applications of linear transformations.

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	3		2								3	2	1
CO2	3	2	3	1	2								3	2	1
CO3	3	2	3	1	2								3	2	1
CO4	3	2	3	1	2								3	2	1
CO5	3	2	3	1	2								3	2	1

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



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SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTG2	4	1	0	5 HOURS	30	70	5

Paper Code: AMUDTG2

COMBINATORIAL MATHEMATICS

Course Objectives: In this course, students will become familiar with -

1) Fundamental combinatorial structures that naturally appear in various other fields of mathematics and computer science.
2) They will learn how to use these structures to represent mathematical and applied questions, and they will become comfortable with the combinatorial tools commonly used to analyze such structures.
3) Given a hypothetical combinatorial object that must satisfy certain properties, students will learn how to prove the existence or non-existence of the object, compute the number of such objects and understand their underlying structure.
4) Describe solutions to iterated processes by relating recurrences to induction, generating functions, or combinatorial identities.
5) Analyze a counting problem by proving an exact or approximate enumeration, or a method to compute one efficiently.

UNIT-1:
Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers.

UNIT-2:
Principle of Inclusion and Exclusion, Derangements, Inversion formulae.
Generating functions: Algebra of formal power series, Generating function models, calculating generating functions, Exponential generating functions.

UNIT-3:
Recurrence relations: Recurrence relation models Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.

UNIT-4:
Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

UNIT-5:
Latin squares, Hadamard matrices, combinatorial designs: *t* designs, BIBDs, Symmetric designs.

Books Recommended:

1. J.H. van Lint and R.M. Wilson, *A Course in Combinatorics*, 2nd Ed., Cambridge University Press, 2001.
2. V. Krishnamurthy, *Combinatorics, Theory and Application*, Affiliated East-West Press 1985.
3. P.J. Cameron, *Combinatorics, Topics, Techniques, Algorithms*, Cambridge University Press, 1995.
4. M. Jr. Hall, *Combinatorial Theory*, 2nd Ed., John Wiley & Sons, 1986.
5. S.S. Sane, *Combinatorial Techniques*, Hindustan Book Agency, 2013.
6. R.A. Brualdi, *Introductory Combinatorics*, 5th Ed., Pearson Education Inc., 2009.

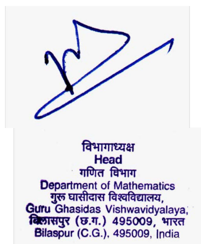
Course Outcomes: After successful completion of this paper the students will be able to -

1) Students will be able to utilize mathematics and computer applications to solve practical problems in mathematics.
2) This course will give students the combinatorial tools to model and analyze practical problems in various areas.
3) Students will be able to identify, formulate and solve problems in mathematics, including proof writing. The course will teach students how to understand and deal with enumerative problems.
4) They will put to practice problem solving techniques that they know and learn new ones, such as non-constructive existence proofs and the probabilistic method.
5) Students will be able to present technical information clearly in both oral and written formats.

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	1	1					1		1	1		1
CO2	2	2	2	1		1					1	1	2	1	1
CO3	2	2	1	2	1					2	1	1	2	2	2
CO4	2	2	1	2	1	1				1	1	2	1	2	2
CO5	2	2	1	1	2	1				1	2	2	2	1	1

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



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTG3	4	1	0	5 HOURS	30	70	5

Paper Code-AMUDTG3

THEORY OF EQUATIONS

Course Objective: The course should enable the students -

1) To learn about fundamental idea of solving algebraic equations.
2) To study the properties of equations and relations between roots and coefficients.
3) To study the symmetric functions and its applications.
4) To study the binomial, cubic, reciprocal and biquadratic equations.
5) To study the Sturm theorem, Newton's theorem and its applications.

General Properties of polynomials, graphical representation of a polynomial, maximum and minimum values of a polynomial, general properties of equations, Descarte's rule of signs positive and negative rule, relation between the roots and the coefficients of equations.

Symmetric functions, applications of symmetric function of the roots, transformation of equations, solutions of reciprocal and binomial equations, algebraic solutions of cubic and biquadratic, properties of the derived functions.

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

Separation of the roots of equations, Sturm theorem, application of Sturm's theorem, and sufficient condition for existence of real roots an equation and biquadratic equation.

Course Learning Outcomes: This course will enable the students to find the roots of general algebraic equations

Text Book:

1. C. C. Mac-Duffee (1954). Theory of Equations, John Wiley & Sons Inc.

Reference Books:

1. W. S. Burnside and A. W. Panton (1954). The Theory of Equations, Dublin University Press.
2. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.

Course Outcomes: On completion of the course, a student will be able to -

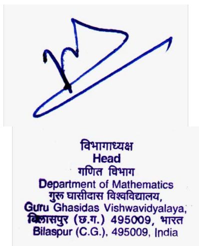
1) Find the roots of general algebraic equations.

2) Describe the graphical representation of a polynomial, maximum and minimum values of a polynomial.
3) Acquire the concept of symmetric functions.
4) Use Newton's theorem to find the sums of power of roots, homogeneous products, limits of the roots of equations.
5) Derive Sturm's theorem and its application.

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	1	1	2											2
CO2	1	1	1	2											2
CO3	1	1	1	1											2
CO4	1	1	1	1											2
CO5	2	1	1	1											2

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



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTA1	2	0	0	2 HOURS	30	70	2

Paper Code-AMUCTA1

CURVE TRACING

Course Objectives: This course will enable the students to –

1) To learn about basics of tracing complicated curve.
2) Tracing of conics in Cartesian coordinates/ polar coordinates.
3) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates
4) Explain how the sign of the first derivative affects the shape of a function's graph
5) Apply the concepts of asymptotes, and inflexion points in tracing of Cartesian curves.

Introduction, curves in Cartesian form, general procedure for tracing the algebraic curve-symmetry, region, Asymptotes, origin, tangents to the curve at the origin, intercepts, sign of first and second derivative, nature of curve, maxima and minima, inflection point, multiple point or singular point, curve tracing of standard curves in Cartesian form, folium of Descartes, Cissoid, lemniscate of Bernoulli, Strophoidetc, tracing of curves in polar and parametric curves.

Text Books:

1. Gorakh Prasad (2009), Differential Calculus, Pothishala Private Limited, Allahabad.
2. B. V. Ramana (2017), Higher Engineering Mathematics, McGraw Hill Education.

Reference Books:

1. E. H. Lockwood (1961), A book of Curves, Cambridge University Press.
2. W. W. Johnson (2010), Curve Tracing in Cartesian Coordinates, Coss Press.

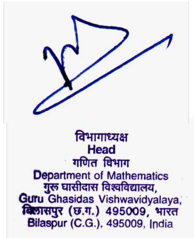
Course Outcomes: After the completion of the course student will be able to -

1) Draw the diagram of standard as well as little bit complicated curve which may occur in their problem of studies.
2) Trace standard curves in Cartesian coordinates and polar coordinates.
3) Sketch parametric curves (Ex. trochoid, cycloid, epicycloids, hypocycloid).
4) Apply the knowledge of curve tracing and geometry to precisely estimate areas and volumes.
5) Trace standard curves in Cartesian coordinates and polar coordinates.

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	1	1	1	1	1	2	1	1	1

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



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTA2	2	0	0	2 HOURS	30	70	2

Code-AMUCTA2
To be prepared later

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTA1	2	0	0	2 HOURS	30	70	2

Paper Code-AMUDTA1

MATRIX AND DETERMINANT

Course Objectives: This course will enable the students to –

1) Construct, or give examples of, mathematical expressions that involve vectors, matrices, and linear systems of linear equations.
2) Apply the row reduction algorithm to compute the coefficients of a polynomial.
3) Apply theorems to compute determinants of matrices that have particular structures.
4) Apply properties of determinants (related to row reductions, transpose, and matrix products) to compute determinants.
5) Express linear systems as vector equations and matrix equations.

Elementary transformation of a matrix, Rank of a matrix- normal form and Echelon form, inverse of matrix-Gauss-Jordan Method and Partition method, consistency of system of linear equations, solution of linear system of equations-Cramer's Rule, Gaussian Elimination Method and matrix inversion method, orthogonal matrix, eigen values and eigen vectors of a matrix, Cayley-Hamilton theorem (without proof), diagonalization of a matrix (without proof).

Text Books:

1. Kenneth Hoffman & Ray Kunze (2015), Linear Algebra (2nd edition), Prentice Hall India Learning Private Limited.
2. B. V. Ramana (2017), Higher Engineering Mathematics, McGraw Hill Education.

Reference Books:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra (4rth edition), Prentice-Hall of India Pvt. Ltd.
2. Nathan Jacobson (2009), Basic Algebra I (2nd edition), Dover Publications.

Course Outcomes: This course will enable the students to -

1) Understand basic concept of set, relation and functions.
2) Analyze the concepts of various types of groups.
3) Learn the basic of Ring theory.
4) Study the fields and related concepts.
5) Understand different types of matrix theory.

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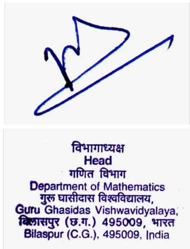
Course Outcomes and their mapping with Programme Outcomes:

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

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



SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTA2	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Code-AMUDTA2:
To be prepared later

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTT1	4	1	-	5 hours	30	70	100	5

FUNCTIONAL ANALYSIS

Course objective:

1. *The aim of this course is to put forward the most of the concepts from Real Analysis, Algebra and linear algebra as a basic foundation of functional analysis.*
2. *functional analysis which is essential for PG students to enhance their knowledge in the field of advanced analysis based on topology.*
3. *The topics include here are geometrical properties of normed linear spaces, Baanach spaces.*
4. *Most fundamental theorems of normed linear spaces and Banach spaces such as Hahn Banach Theorem, Open Mapping Theorem, Closed Graph Theorem, Uniform Boundedness Theorem, etc. should be understandable by the PG students.*
5. *Studies of Hyper plane such as Hilbert spaces and their applications. Operator Theory, etc.*

Normed linear spaces, Banach spaces, Properties of Normed linear spaces, Finite dimensional Normed linear spaces and subspaces, Compactness and finite dimension, Linear operators, Bounded and continuous operators, Linear functional, Linear operators and functional on finite dimensional spaces, Normed spaces of operators, Dual space.
Zorn's Lemma**,** Hahn-Banach Theorem, Hahn-Banach Theorem for complex vector spaces and Normed spaces, Applications to bounded linear functional on *C*[a, b], Ad-joint operator, Reflexive spaces, Category theorem, Uniform boundedness theorem, Strong and weak convergences, Convergences of sequences of operators and functional, Open Mapping Theorem, Closed linear operators, Closed Graph Theorem.

Inner product space, Hilbert space, Properties of inner product spaces, Orthogonal complements and direct sum, orthonormal sets and sequences, Series related to orthonormal sequences and sets Total orthonormal sets and sequences, Bessel's Inequality, Representation of functional on Hilbert spaces, Hilbert ad-joint operator, Self-ad-joint, Unitary and normal operators.

Contraction mapping principle and it's applications to Linear Equations, Differential Equations and Integral Equations.

Text Book:

2. Erwin Kreyszig, Introductory Functional Analysis with Applications, Wiley Classics Publications.

Reference Books:

1. Balmohan V. Limaye, Functional Analysis, New Age International Publications.
2. G. Bachman and L. Narici, Functional Analysis, Dover Publications.
3. B. K. lahri, Elements of Functional Analysis, Calcutta World Press.

4. P. K. Jain and Om P. Ahuja, Functional Analysis, New Age International Publications.

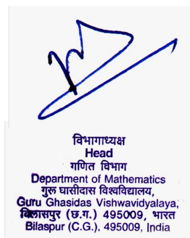
Course Outcomes:

1. To describe the concept of mathematics like Norms, Normed linear spaces, Banach spaces.
2. In a position to deal with inner product spaces, Hilbert spaces and their properties with elaborative examples and some fundamental theorems.
3. To identify variables controlling behaviour(s) and to generate hypotheses about its function(s) because Functional analysis is a methodology for systematically investigating relationships between problem behaviour and environmental events. So that students can understand how researcher uses concept of functional analysis to solve real world problems.
4. To do research work on Contraction principles in different spaces.
5. Applications of Banach Fixed Point Theory in different branches of Science and Technology.

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	3	2	2						1	2	1	2	2	2
CO2	3	3	2	2						1	2	1	2	2	2
CO3	3	3	2	2						1	2	1	2	2	2
CO4	3	3	2	1						1	2	1	2	1	2
CO5	3	3	2	2						1	2	1	2	2	2

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTT2	4	1	-	5 hours	30	70	100	5

THEORY OF ORDINARY DIFFERENTIAL EQUATIONS

Course Objectives:

1. To discuss the theoretical approach for the solution of linear ODE having constant coefficients.
2. To discuss the initial value problems.
3. To discuss the equations having analytic coefficients.
4. To discuss the linear equations with regular singular points.
5. To analyse the existence and uniqueness of solutions.

Linear Equations with Constant Coefficients: Second order homogenous equation, Initial Value Problem for Second Order Equation, Linear Dependence and Independence, A formula for Wronskian, The Non-homogeneous Equation of Order Two, Homogeneous Equation of Order n, Initial Value Problem for n^{th} Order Equation, The Non-Homogeneous Equation of Order n, A Special Method (Annihilator Method) for Solving the Non-homogeneous Equation.

Linear Equations with Variable Coefficients: Initial Value Problem for the Homogeneous Equation, Solution of the Homogeneous Equation, The Wronskian and Linear Independence, Reduction of the Order of a Homogeneous Equation, The Non-homogeneous Equation, Homogeneous Equation with Analytic Coefficients, The Legendre Equation, Justification of the Power Series Method.

Linear Equation with Regular Singular Point: The Euler Equation, Second Order Equation with Regular Singular Point (Example with General Cases as well), A convergence Proof, The Exceptional Cases, The Bessel Equation, Regular Singular Point at Infinity.

Existence and Uniqueness of Solutions: Equation with Variables Separated, Exact Equations, The method of Successive Approximations, Lipchitz Condition, Convergence of the Successive Approximations, Nonlocal Existence of Solution, Approximations to Solutions, Uniqueness of Solutions, Existence and Uniqueness of Solutions of System, Existence and Uniqueness for the Linear System.

Text Book:

1. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Dover Publications, INC, New York (1989).

Reference Books:

1. S. G. Deo, V. Lakshmikantham and V. Raghavendra., Text book of Ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

2. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, NY (1971).
4. Phillip Hartman, Ordinary Differential Equations, John Wiley & Sons, NY (1971).

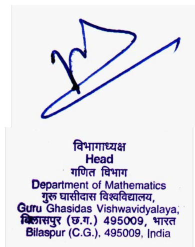
Course Outcomes: This course will enable the students to:

1. Find out the linear dependence, independence and Wronskian of the solution of ODE.
2. Apply the power series methods.
3. Check the convergence of the solution.
4. Apply the methods of successive approximations.
5. Check the existence and uniqueness of solutions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	2	1	2						2	3	2		1
CO2	3	3	3	3	1	1						2	3	2		1
CO3	3	3	3	3	1	1						2	3	2		1
CO4	3	3	3	3	1	1						2	3	2		1
CO5	3	3	3	2	1	1						2	3	2		1

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD1	4	1	-	5 hours	30	70	100	5

ALGEBRAIC TOPOLOGY

The proposed course is intended to stimulate the students

1. To understand the interconnection of topology and Geometry and its applications in other subjects.

2. To show how basic geometric structures may be studied by transforming them into algebraic questions.

3. To introduce the most important examples of such invariants, such as singular homology and cohomology groups, and to calculate them for fundamental examples and constructions of topological spaces.

4. To explain the fundamental concepts of algebraic topology and their role in modern mathematics and applied contexts.

5. To demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from algebraic topology.

Product Topology: Preliminaries from general Topology, Product Topology, Tychonoff Theorem (Arbitrary Case).

Metrization Theorems and Para-compactness: Local Finiteness, Nagata-Smirnov Metrization Theorem, Para-compactness, Para-compactness Housdorff Spaces.

Fundamental Group: Homotopy, Paths Homotopy, The fundamental groups, covering spaces, Fundamental group of the circle, Lifting lemma.

Retraction and Fixed Points: Retraction, Brouwer fixed point theorem, Fundamental theorem of Algebra, Borsuk-Ulam theorem.

Fundamental Group Of Surfaces: Projective plane, Theorems on projective plane and fundamental group.

Text Book:

1. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi.

Reference Books:

1. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co. New York.
2. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd).

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

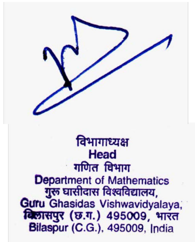
1. Understand the fundamental terms of topology.
2. Understand the rigorous aspects of Homotopy, Fundamental group.

3. Apply the concept of algebraic topology in the problems pertaining to topological fixed points and its applications.
4. To apply his or her knowledge of algebraic topology to formulate and solve problems of a geometrical and topological nature in mathematics.
5. Apply his or her knowledge of algebraic topology to formulate and solve problems of a geometrical and topological nature in mathematics.

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	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO2	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO3	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO4	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO5	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD2	4	1	-	5 hours	30	70	100	5

COMPLEX MANIFOLDS

Course objective:

1. To study almost complex manifold, Almost Hermite manifold, Kaehler Manifolds, Nearly Kaehler Manifolds and Para Kaehler Manifolds.
2. To study Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields.
3. To study Nijenhuis tensor and their properties in different complex Mnifolds.
4. To study Holomorphic Sectional Curvature, Bochner Curvature tensor, affine connection in almost Kaehler manifold.
5. To study different type of flat spaces/manifolds.

Complex Manifold and Almost complex manifold: Definition and example, Nijenhuis tensor, Eigen Values of an almost complex structure, Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields.

Almost Hermite manifold: Nijenhuis tensor, Almost analytic vector fields, Curvature in almost Hermite manifold, Holomorphic Sectional Curvature, Linear connection in an almost Hermite manifold.

Kaehler Manifolds: Holomorphic Sectional Curvature, Bochner Curvature tensor, affine connection in almost Kaehler manifold.

Nearly Kaehler Manifolds: Definition, Projective correspondence between two Nearly Kaehler manifolds, Curvature identities.

Para Kaehler Manifolds: Definition, Curvature Identities and conformal flatness of parakaehler manifold.

Text Book:

1. U. C. De and A. A. Shaikh, Complex and Contact Manifolds, Narosa Publishing House , New Delhi, 2009.

Recommended Books:

1. S. S. Chern, W.H. Chen and K.S. Lam, Lectures on Differential Geometry, World Scientific, 2000.
2. E.J. Flaherty, Hermitian and Kahlerian Geometry in Relativity, LNP 46, Springer, 1976. 3. Y. Matsushima, Differentiable Manifolds, Dekker, 1972.
3. R. S. Mishra: A course in Tensor with applications to Riemannian geometry, Pothishala (Pvt.) Ltd, Allahabad.
4. B. B. Sinha: an Introduction to modern differential geometry, Kalyani Prakashan, New Delhi, 1982.
5. K. Yano: Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

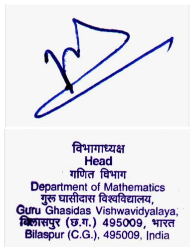
Course Outcomes: They are able to understand

1. Basics of almost complex manifold, Almost Hermite manifold, Kaehler Manifolds, Nearly Kaehler Manifolds and Para Kaehler Manifolds.
2. Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields in almost complex manifolds.
3. Nijenhuis tensor and their properties in different complex Mnifolds.
4. Different types of curvatures in different complex manifolds.
5. Different type of flat spaces/manifolds.

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	IA	ESE	Total	Credits
AMPCTD3	4	1	-	5 hours	30	70	100	5

DIFFERENCE EQUATIONS

Course objective: The aim of this course:

1. To teach students the basics of difference calculus, including the difference operator, summation, generating functions, and approximate summation.
2. To familiarize students with linear difference equations and their solutions, including equations with constant and variable coefficients, and the use of the z-transform.
3. To provide students with an understanding of stability theory for linear and nonlinear systems, including initial value problems and chaotic behavior.
4. To teach students asymptotic methods for the analysis of sums and solutions to linear and nonlinear equations.
5. To familiarize students with the self-adjoint second order linear equations and their properties, including Strurmian theory, Green's function, disconjugacy, the Riccati equations, and oscillation.

Difference Calculus: The Difference Operator, Summation, Generating functions and approximate summation.

Linear Difference Equations: First order equations, General result for linear equations, Equation with Constant coefficients, Applications, Equations with variable coefficients, nonlinear equations that can be linearized, the z-transform.

Stability Theory: Initial value problems for linear systems, Stability of linear systems, Stability of nonlinear systems, chaotic behavior.

Asymptotic methods: Introduction .of Asymptotic, Analysis of sums, Linear equations, Nonlinear Equations.

The self-ad-joint second order linear equations- Strurmian theory, Green’s function, Disconjugacy, The Riccati Equations and Oscillation.

Text Book:

1. W. G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

Reference Books:

1. S. Goldberg, Introduction to Difference equations, Wiley Publication.
2. V. Lakshmikantham and D. Trigiante, Theory of difference equations, Academic Press.

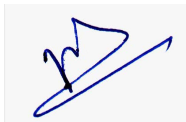
Course Outcomes:

1. Link to preliminaries of Numerical Analysis and knowledge about operators.
2. Understand about solve the difference equations and apply into applications.
3. Understand about stability theory concept for linear and nonlinear systems
4. Learn about asymptotic methods for linear equations and nonlinear equations
5. Link with Green's function and understand about solving the self-adjoint second linear difference equations, conjugate and dis-conjugate and Ricati equations

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	2	3									2	1		
CO2	3	3	1	1									2	3		
CO3	2	2	2	2									2	1		
CO4	3	3	2	1									2	2		
CO5	3	3	2	1									2	2		

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



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Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD4	4	1	-	5 hours	30	70	100	5

FUZZY SETS AND FUZZY LOGIC

Course objective:

1. Learn various type of uncertanities and specially of fuzzy type.
2. Learn the development of the concepts and operations on fuzzy sets through axiomatic approach.
3. Learn the scope of fuzzification of basic concepts of mathematics.
4. Learn various fuzzy relation equation solution methods.
5. Learn further development possibilities of basic fuzzy set theory.

1. **From Classical (Crisp) sets to fuzzy sets: A grand paradigm shift and Fuzzy sets vs. Crisp sets**
   Introduction, Crisp Sets: An overview, Fuzzy sets: basic types, Fuzzy sets: Basic concepts, Characteristics and signification of paradigm shifts. Additional properties of α- cuts, Representation of fuzzy sets, Extension principal for fuzzy sets
2. **Operation on fuzzy sets and Fuzzy Arithmetic**
   Types of operations, Fuzzy complements, Fuzzy intersections: t-Norms, Fuzzy unions: t-conorms, Combination of operations, Aggregation of operations. Fuzzy numbers, Linguistic variables, Arithmetic operation on intervals, Arithmetic operation on fuzzy numbers, Fuzzy equations.
3. **Fuzzy Relations**
   Crisp vs. fuzzy relations, Projections and cylindric extensions, Binary fuzzy relations, Binary relations on single sets, Fuzzy equivalent relations, Fuzzy compatibility relations, Fuzzy ordering relations, Fuzzy morphisms, Sup-i compositions of fuzzy relations, Inf-ω_i composition of fuzzy relations
4. **Fuzzy Relation Equations**
   General discussion, Problem partitioning, Solution methods, Fuzzy relation equation based on sup-I compositions, Fuzzy relation equation based on Inf-ω_i compositions, Approximate solutions, the use of neural networks.
5. **Various Generalizations of Fuzzy sets**
   Soft sets, Bipolar sets, Pythagorean fuzzy sets.

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

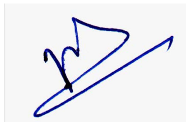
1. Need of techniques introduced under the course in using (logical) mathematical tools available for cutting edge research in the area of his/her choice.
2. Learn to deal with real world uncertainties especially of the fuzzy nature.
3. Basic idea of set theory and basics of fuzzy sets. The significance of application of fuzzy sets.

4. Binary and unary operations, combinations of operations on fuzzy sets. Aggregation operations.
5. Use of various types of fuzzy relation equation solution methods in his/her area of research.

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	1	1	2	2	2	2	2	1	2
CO2	2	2	2	2		1	1	1	1	1	1	2	2	2	2	2
CO3	2	2	3	3		2	1	1	2	1	2	2	1	2	2	2
CO4	3	3	3	2		1	1	1	2	1	2	2	1	1	2	2
CO5	3	3	3	2		1	-	-	1	1	1	2	1	1	2	2

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



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Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD5	4	1	-	5 hours	30	70	100	5

INFORMATION THEORY AND ITS APPLICATIONS

Course Objectives: The students will be able to gain the knowledge about information theory and its applications:

1. ***The main concern of Information theory is to discover Mathematical laws governing the system design to communicate or manipulate information.***
2. ***It sets of quantitative measure of information of capacity of various systems to transmit, store and process the information.***
3. ***Coding is the application of Information theory which will be taught to the students in this paper.***
4. **To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.**
5. **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.**

Concepts of Probability For Information Theory: Probability measure, frequency of events, combinatorial problems in probability, random variables, discrete probability functions and distributions, bivariate discrete distribution, binomial distribution, Poisson distribution, expected value of random variable.

Communication System: Introduction, communication process, a model for communication system, a quantitative measure of information, a binary unit of information.

Basic Concepts of Information Theory: A measure of uncertainty, intuitive justification, formal requirement for the average uncertainties, H-function as a measure of uncertainty, an alternative proof for the entropy function posses a maximum, sources and binary sources.

Measure of Information: Measure of Information for two dimensional discrete finite probability schemes, conditional entropies, a sketch of communication networks, derivation of noise characteristics of channels, some basic relationship among different entropies, a measure of mutual information, set theory interpretation of Shannon's fundamental inequalities redundancy, efficiency and channel capacities.

Elements of Encoding: The purpose of encoding, separate binary codes, Shannon's-Fano encoding, necessary and condition for noiseless coding, a theorem on decidability, average length of encoded messages, fundamental theorem of discrete noiseless coding.

Text Book:

1. F.M. Reza, An introduction to information theory, Dover Publications Inc. New York.

Reference Books:

1. Robert B. Ash, Information Theory , Inter-science Publisher, New York
2. John R. Pierce, An Introduction to Information Theory, Dower Publications Inc. New York.
3. John Avery, Information theory and evolution, World Scientific, New Jersey.

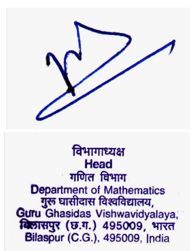
Course Outcomes: After successful completion of this paper the students will be able to:

1. To explain the concepts of entropy and mutual information.
2. The students will also be able to understand the concept of information theory and its usefulness in various fields such as in defence, in portfolio selection, in general election, in computer science, in pattern recognition and in image processing.
3. Perform mathematical analysis of problems in Information Theory and Coding, Implementation and verification using MATLAB simulation.
4. Implement the various types of source coding algorithms and analyse their performance.
5. Explain various methods of generating and detecting different types of error correcting codes

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	3	2	1			1	2	1	2	2	2	2	1
CO2	2	2	2	1	1	1				1	1	2	2	3	1	2
CO3	3	3	3	2	2	2			2	2	2	2	2	3	1	2
CO4	3	3	3	2	2	2			2	3	3	3	2	2	1	2
CO5	3	3	2	2	3	2			2	2	3	2	3	3	3	2

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD6	4	1	-	5 hours	30	70	100	5

INTEGRAL EQUATIONS

Course Objectives:

1. *The paper is to develop the basic concept of Integral equations.*
2. *. To learns boundary value problems and initial value problems and its applications.*
3. To learn transformation of differential equation into integral equation vice-versa etc.
4. *The special interest Green's function.*
5. *To Understood Method of successive approximations.*

Unit-1

Basic concept of integral equation: Classification of integral equations; Leibnitz's rule of differentiation under the sign of integration; Transformation of differential equation into integral equation and vice-versa, Illustrative examples.

Unit-2

Conversion of ODE's into integral equations: Initial value problems, method of converting an initial value problem into a Volterra integral equation; Alternative method of converting an initial value problem into a Volterra integral equation; BVP and method of converting BVP into a Fredholm integral equation.

Unit-3

Fredholm Integral Equations: Method of successive approximation: Orthogonal kernels, Iterated kernels; Fredholm determinants, Degenerated kernels; Eigen value and Eigen function of homogeneous integral equation.

Unit-4:

Volterra Integral Equations: Resolvent kernel; Method of successive approximation; Volterra integral equation of first kind and solution of non-linear Volterra integral equation.

Unit-5:

Applications of Integral Equations and Green's function to ODE: Green's function: Conversion of a BVP into Fredholm Integral Equations solution of BVP; Green's function approach for converting an IVP into an integral equation and modified Green's function.

Text Books:

1. M D Raisinghania, Integral Equations and boundary value Problems; S. Chand and Company PVT. LTD, New Delhi.
2. A BChandramouli, Integral Equations with boundary value problems, Shree ShikshaSahityaPrakashan, Meerut.

Reference Books:

1. Abdul-MajidWazwaz, A first course in Integral Equations, World Scientific Publishing Co. Pvt. Ltd.
2. M. Rahman, Integral Equations and their applications WIT press, Boston.

3. Ram P. Kanwal, Linear Integral Equations, Theory and Technique, Academic Press, New York.
4. A. D.Polyanin and A V Manzhirov, Handbook of Integral Equations CRC Press, Boca Raton/ London/ New York/Washington D C.

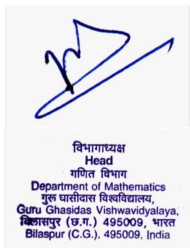
Course learning Outcomes:

1. The students will be able to solve Fredholm and Volterra integrals equation of boundary value problems, initial value problems.
2. To learn of Green's function and its applications.
3. This course will help to develop the extended mathematical modeling of fractional calculus in Science and Engineering.
4. Demonstrate their under standing for how are modeled using integral equations.
5. Explain the applications integral equations and solving boundary value problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	2	2											3		
CO3	1	2											3		
CO4	1	2											3		
CO5	1	2											3		

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD7	4	1	-	5 hours	30	70	100	5

MULTIPOINT ITERATIVE METHODS

Course Objective:

1. To Know the classifications of iterative methods (IMs) and important related concepts.
2. To know some cubically convergence iterative methods (IMs).
3. To understand optimal two-steps iterative methods (IMs).
4. To make aware about two-steps with memory iterative methods (IMs).
5. To learns two-steps iterative methods (IMs) for multiple roots.

Course Contents:

Unit-I: One-point iterative methods for simple and multiple roots
Classification of iterative methods, order of convergence, computational order of convergence (COC), *R*-order of convergence, computational efficiency of iterative methods, initial approximations, one-point iterative methods for simple zeros, methods for determining multiple zeros, stopping criteria.

Unit-II: Two-point without memory IM
Cubically convergent two-point methods: multipoint-point without memory IM, Traub's two-point methods, Two-point methods generated by derivative Estimation.

Unit-III: Optimal Two-point without memory IM
Ostrowski's fourth-order method and its Generalizations, Family of optimal two-point methods, Optimal derivative free two-point methods, Optimal two-point methods of Jarratt's Type.

Unit-III: Multi-point with memory IM
Multipoint methods with memory: Early works, Self-accelerating Steffensen-like method, Self-accelerating secant method, Multipoint methods with memory constructed by inverse interpolation, Generalized multipoint root-solvers with memory, Derivative free families with memory.

Unit-III: Optimal & Non-Optima IM for Multiple Roots
Non-optimal two-point methods for multiple Zeros, optimal Two-point methods for multiple roots, multipoint-point method for nonlinear systems,

Text/ Reference Books:

1. M. S. Petkovic, B. Neta, L.D. Petkovic, J. Dzunic (2013): Multipoint iterative methods for solving nonlinear equations, Elsevier, MA, USA.

2. J. F. Traub (1982): Multipoint iterative methods for solution of equations, Chelsea Publishing Company, NY, USA.
3. C. T. Kalley (1995): Iterative methods for linear and nonlinear equations, SIAM, Philadelphia.

Course Outcomes:

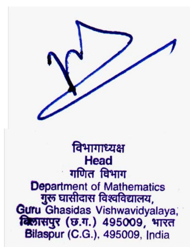
Students will try to learn:

1. The classifications of iterative methods (IMs) and important related concepts.
2. Some cubically convergence iterative methods (IMs).
3. Optimal two-steps iterative methods (IMs).
4. Two-steps with memory iterative methods (IMs).
5. Two-steps iterative methods (IMs) for multiple roots.

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	2	2	2						3	2	3	2	2	3
CO2	3	3	3	3	2						3	2	3	2	2	3
CO3	3	3	3	3	2						3	2	3	2	2	2
CO4	3	3	2	3	2						3	2	3	2	2	3
CO5	3	3	3	3	3						3	2	3	2	2	3

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD8	4	1	-	5 hours	30	70	100	5

FUNDAMENTALS OF ELASTICITY

Course Objectives:

1. To give the brief discussion about the stress.
2. To provide the basic concepts of strain.
3. To pave the basic concept of elasticity.
4. Brief discussion of mathematical theory of elasticity and technical mechanics.
5. To discuss the propagation of the waves in elastic solid media.

Analysis of Strain: Extension, Pure shear, Simple shear, Homogeneous strain, Component of strain, Strain quadric, Transformation of the components of strain, Types of strain, Identical relation between components of strain, Curvilinear orthogonal coordinates, Components of strain referred to curvilinear orthogonal coordinates, Dilatation and rotation referred to curvilinear orthogonal curvilinear orthogonal coordinates, Cylindrical and polar coordinates.

Analysis of Stress: Traction across a plane at a point, Surface traction and body forces, Equation of motion, Equilibrium, Specification of stress at a point, Measure of stress, Transformation of stress components, Stress quadric, Types of stress, Stress equation of motion and of equilibrium, Uniform stress and uniformly varying stress, Stress equation referred to curvilinear orthogonal coordinates.

The elasticity of solid body: Work and energy, Hook's law, Methods of determining the stress in a body, Elastic constants and modules of isotropic solids, Modulus's of elasticity, Initial stress.

The Relation Between the Mathematical Theory of Elasticity and Technical Mechanics: Limitation of the mathematical theory, stress-strain diagrams, Elastic limits, Saint-Venant's principle, Equation of Equilibrium in Terms of Displacements, Equilibrium Under Surface Traction Only, Various Methods and Results, Plane Strain and Plain Stress,

The Propagation of Waves in Elastic Solid Media: Waves of dilatation and waves of distortion, Motion of a surface of a continuity, Velocity of waves in isotropic medium, Velocity of waves in Allotropic solid medium, wave surfaces, Motion due to body forces, Waves propagated over the surface of an isotropic elastic solid body.

Text Book:

1. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity, Cambridge University Press (1906).

Reference Books:

1. Laurwerier, H.A and Koiter, W.T., Applied Mathematics and Mechanics, North-Holland Publishing Company - Amsterdam, London (1973).
2. Pujol, Jose, Elastic Wave Propagation and Generation in Seismology, Cambridge University Press (2003).
3. Sokolnikoff, I.S., Mathematical Theory of Elasticity, McGraw Hill Book Co., New-York (1956).
4. Kazimi, SMA, Solid Mechanics, McGraw Hill Education (India) Pvt. Ltd., (2013).

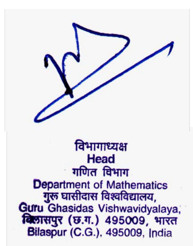
Course Outcomes: This course will enable the students to:

1. Measure the stress and to write the equation of motion.
2. Calculate the different types of strain.
3. Determine the stress in a body.
4. Find the relation among mathematical theory of elasticity and technical mechanics.
5. About the basic concept of wave propagation.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	2	2								2	3	2		1
CO2	2	2	2	2								2	3	2		1
CO3	2	2	2	2								2	3	2		1
CO4	2	2	2	2								2	3	2		1
CO5	2	2	2	2								2	3	2		1

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD9	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

ADVANCED NUMERICAL ANALYSIS

Course Objective:

1. To know about the computational procedure for solving linear systems
2. To know about the computational for solving tridiagonal system systems
3. To learns about the numerical techniques for the solution of integral equation
4. To know about techniques prior to finite element techniques
5. To learn about FEM for linear boundary value problems.

Course Contents:

Unit 1: Numerical linear algebra
Numerical linear algebra: Brief review of LU decomposition, vector and matrix norm, solution of linear systems-direct methods, necessity of pivoting, number of arithmetic operations, computation procedure for LU decomposition method.

Unit 2: Solution of tridiagonal system
Solution of tridiagonal systems, ill-conditioned linear systems, method for ill-conditioned linear systems, solution of linear systems-iterative methods, singular value decomposition.

Unit 3: Solution of integral equation
Numerical solution of integral equation: Transformation of integral equation in initial value problem and vice-versa, Numerical method for Fredholm equations: method of degenerate kernels, method of successive approximations, quadrature methods, cubic Spline method, singular kernels.

Unit 4: Prior to FEM

Finite element methods: functionals, base functions, method of approximation, Rayleigh-Ritz method, Galerkin's method, finite element, shape function.

Unit 5: FEM for linear boundary value problems.

Finite element method for one-dimensional problems, and finite element of linear boundary value problems.

Course Learning Outcomes: This course will enable the students to: aware about numerical methods for lineal algebra problems, aware about Numerical solution of integral equation, fundamental idea about finite element methods

Text/Reference Books:

1. *M. K. Jain, S.R.K. Iyenger, R. K. Jain (2012), Numerical Methods for scientific and Engineering Computation, New Age Int. Publ, New Delhi.*

2. *S. S. Sastry (2013), Introductory Methods for Numerical Analysis, PHI Learning Pvt. Ltd, New Delhi.*

3. *N. H. Kim (2016), Introduction to Nonlinear Finite Element Analysis, Springer.*

Course Objective:

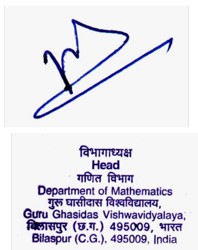
Students will try to learn:

1. The computational procedure for solving linear systems
2. The computational for solving tridiagonal system systems
3. The numerical techniques for the solution of integral equation
4. The techniques prior to finite element techniques
5. FEM for linear boundary value 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	2	2	2						3	2	3	2	2	3
CO2	3	3	3	3	2						3	2	3	2	2	3
CO3	3	3	3	3	2						3	2	3	2	2	2
CO4	3	3	2	3	2						3	2	3	2	2	3
CO5	3	3	3	3	3						3	2	3	2	2	3

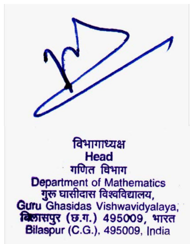
Weightage: **1-Sightly; 2-Moderately; 3-Strongly**



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCPF1	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

PROJECT PHASE - I

Note: Under the guidance of faculty member(s) on the topic relevant to the Master's Degree Course.



M.Sc. II YEAR IV SEMESTER SCHEME

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTT1	4	1	-	5 hours	30	70	100	5

COMPLEX ANALYSIS

Course Objectives:

1. To give the detail study about the Cauchy's theory.
2. To discuss the uniform convergence.
3. To detail discussions about singularities.
4. Evaluation of standard integrals by residue theorem.
5. To provide the discussion about the various transformation.

Brief review of analytic function, Cauchy's estimates, Poisson integral formula, Cauchy Hadamard theorem, Complex power series, power series, radius of convergence of power series,

Uniform convergence, general principle of uniform convergence of a sequence, uniform convergence of series, Weirstrass M-test, continuity of sum function, term by term integration, analyticity of sum function, term by term differentiation.

Uniqueness of Laurent series, Singularities, isolated singularities, poles and essential singularities, removable singularities, Riemann's theorem, Casorati-Weirstrass theorem, argument theorem, Rouches's theorem.

Holomorphic functions and their properties, maximum modulus theorem, zeros of analytic functions, analytic continuation,

Cauchy residue theorem and its applications, evaluation of standard types of integrals by the residue calculus method,

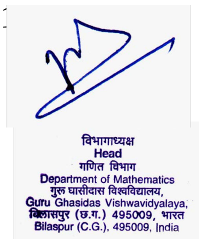
Conformal mapping, Mobius transformation, critical points, fixed points, cross-ratio, harmonic conjugates, transformation of harmonic functions, Schwarz lemma, open mapping theorem.

Text Book:

1. M. R. Spiegel, Seymour Lipschutz, John J. Schiller and Dennis Spellman: Complex Variables with an introduction to conformal mapping and its applications, Second Edition, Schaum's Outline Series, Mc Graw Hill, New York (2009).

Reference Books:

2. J. W. Brown and R. V. Churchill: Complex variables and applications, McGraw Hill Education (India) Pvt. Ltd., New Delhi, reprint (2016).
3. S. Ponnusamy: Foundations of Complex Analysis, Narosa Publishing House Pvt. Ltd., India second reprint (2008).
1. S. Lang: Complex Analysis, Springer-Verlag New York, 4^{th} edition (



Course Outcomes: This course will enable the students to:

1. Apply the Cauchy's theory and integral formula.
2. Check the uniform convergence for the complex series.

3. Find out the singularities.
4. Evaluate the standard integrals.
5. Apply the open mapping theorem.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2	3								2	3	3		2
CO2	3	3	2	3								2	3	3		2
CO3	2	3	2	3								2	3	3		2
CO4	3	3	2	3								2	3	3		2
CO5	3	3	2	3								2	3	3		2

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTT2	4	1	-	5 hours	30	70	100	5

THOERY OF PARTIAL DIFFERENTIAL EQUATIONS

Course Objective: *The objective of this course is*

1. *To learn to find solution of linear and non-linear PDE of first order.*
2. *To study to find solution of PDE of second order.*
3. *To discuss various application by using second order PDE.*
4. *To give idea about wave equations.*
5. *To discuss few other applications like diffusion equation.*

Unit-1. Cauchy Problem for First Order Equation, Cauchy's Method of Characteristics, Compatible System of First Order Equation, Charpit's Method, Jacobi's Method

Unit-2. Characteristics Curve of Second Order Equation, Solution of Linear Hyperbolic Equation, Separation of Variables, Nonlinear Equation of the Second Order

Unit-3. Occurrence of the Laplace Equation, Family of Equipotential Surface, Boundary Value Problem and its Solution by Separation of Variable, The theory of Green's Function for Laplace Equation, Mixed Boundary Value Problem.

Unit-4. Occurrence of the Wave Equation, Elementary Solution of the one Dimensional Wave Equation, Three Dimensional Problem, Green Function for the Wave Equation.

Unit-5. The Diffusion Equation, Duhamel's Theorem, Solution of Diffusion Equation, The use of Integral Transform and The use of Green Function.

Text Book:

1. Ian N. Sneddon, Elements of Partial Differential Equations, Dover Publications, (2006).

Reference Books:

1. Lawrence C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, American Mathematical Society (1998).
2. Phoolan Prasad and Renuka Ravindran, Partial Differential Equations, New Age International Publishers, (2011).
3. Rao, K.S., Introduction to Partial Differential Equations, PHI Learning, Private Limited, New Delhi, INDIA (2011).

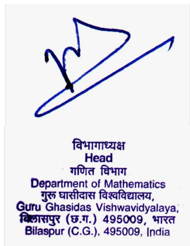
Course Outcomes: After completions of this course, students will be able:

1. *To solve the problems of linear and non-linear PDE of first order by using various techniques.*
2. *To solve the problems of linear and non-linear PDE of second order by using various methods.*
3. *To deal with boundary value problems and mixed boundary value problems, Laplace equations using separation of variable methods.*

4. *To obtain solution of wave equation and its applications.*
5. *To derive solution of diffusion equation and its applications. Also know the Duhamel's theorem and Green's function.*

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	2		1	1	2		2		2	2	1		3
CO2	3	2	2		1	1	2		2		2	2	1		3
CO3	3	3	2		1	1	2		3		3	2	1		3
CO4	3	3	2		1	1	2		2		3	2	1		3
CO5	3	3	2		1	1	2		3		3	2	1		3



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD1	4	1	-	5 hours	30	70	100	5

ADVANCED DIFFERENTIAL EQUATIONS

Course objective: The aim of this course:

1. To introduce students to the concepts of existence and uniqueness of solutions to differential equations and methods for their determination.
2. To teach students various numerical and analytical methods for solving boundary value problems, including Picard's theorem and Green's function.
3. To familiarize students with the theory of oscillations of second order equations and the comparison theorems of Hille and Wintner.
4. To provide students with an understanding of the stability of linear and nonlinear systems, including Lyapunov stability and the stability of quasi-linear systems.
5. To teach students how to solve differential equations with deviating arguments, including equations with constant delay and piecewise constant delay.

Existence and Uniqueness of Solutions: Preliminaries successive approximations – Picard’s iteration method with some examples – Continuation of solution of IVP and dependence on initial conditions, – Fixed point method.

Boundary value problems: Introduction Boundary value problems, Sturm – Liouville Problem – Green’s function –Application of Boundary Value Problem – Picard’s theorem.

Oscillations of second order equations: Fundamental results - Sturm’s Comparison theorem - Elementary linear oscillations - Comparison theorem of Hille – Wintner - oscillations of x’’+ a (t) x =0.

Stability of linear and nonlinear systems: Elementary critical points – system of equations with constant coefficients – Linear equation with constant coefficients – Lyapunov stability – stability of quasi linear systems – second order linear differential equations.

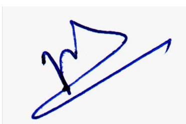
Equations with deviating arguments: Equations with constant delay – Equations with piecewise constant delay – a few other types of delay equations.

Text Book:

1. S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

Reference Books:

1. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. W. T. Reid, Ordinary Differential Equations, John Wiley & Sons, NY (1971).



3. Phillip Hartman, Ordinary Differential Equations, John Willy &Sons, NY (1971).
4. E.A. Coddington& N. Levinson, Theorem of Ordinary Differential Equations, Mac, Graw Hill, NY (1955).

Course Outcomes: The students will be able to understand

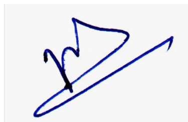
1. Develop a deep understanding of the theory of ordinary and partial differential equations, including existence and uniqueness of solutions, initial value problems.
2. Understand the techniques to solve Sturm – Liouville Problem, Green's function,– application of boundary value problem, Picard's theorem.
3. Understand the methods to solve oscillations of second order differential equations .
4. Understand about stability theory concept for linear and nonlinear systems.
5. Understand the fundamental concept of delay differential equations and its types

Overall, the course should provide students with a solid foundation in advanced differential equations that can be applied to a wide range of scientific and engineering 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	2	1									3	2	1	2
CO2	3	3	2	2									3	2	1	2
CO3	3	3	2	2									3	2	1	2
CO4	3	3	2	2									3	2	1	2
CO5	2	2	2	2									3	2	1	2

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD2	4	1	-	5 hours	30	70	100	5

ADVANCED FUNCTIONAL ANALYSIS

Course Objective:

1. ***The aim of this course is to put forward the most of the concepts from Real Analysis, Algebra, linear algebra, and functional analysis. as a foundation of applied functional analysis.***
2. ***Need to know the inner products and its geometrical properties.***
3. ***By using various examples to understand inner products, Hilbert spaces, product of Hilbert spaces, etc . Various types of operators and their applications in convex programming.***
4. ***Few fundamental theorems of Hahn Banach Theorem, Weak compactness theorem, Reisz Representation theorems to be for better understanding at the advance level.***
5. **Motivate to know the applications in the area of Differential Equations, Integral Equations, Game Theory, etc.**

After the Functional Analysis course in the previous semester student will be in a position to know more about the Applications of Functional in Differential Equations, Integral Equations, Operator Theory, Spectral Theory, Convex Programming.

Inner product spaces. Hilbert spaces. Orthonormal sets. Bessels inequality. Structure of Hilbert spaces. Projection theorem. Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces. Self adjoint operator, positive projection, normal and unitary operators.

Convex Sets and Projections, Orthogonality and Orthonormal Bases, Continuous Linear Functionals, Riesz Representation Theorem, Weak Convergence, Nonlinear Functionals and Generalized Curves, The Hahn-Banach Theorem.

Support Functional of a Convex Set, Minkowski Functinoals, The Support Mapping Theorem, Separation Theorem, Applications to Convex Programming, Generalization to Infinite Dimensional Inequality, The Fundamental Result of Game Theory: Minimax Theorem, Application: Theorem of Farkas.

Linear Operators and their adjoints, Spectral theory of Operators, Spectral theory of compact operators, Operators on separable Hilbert spaces.

Text Book:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. Alampallam V. Balakrishnan, Applied Functional Analysis (Applications of Mathematics), Springer, 2nd edition (May 4, 1981), ISBN-10: 0387905278.

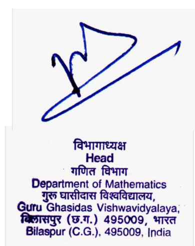
Course Outcomes:

1. After this course student may understand the basic properties of Convex Programming and fundamental result of Game Theory.
2. Might understand the applicability of various branches of mathematics such as Differential equations, Integral equations, Game Theory, etc.
3. Also, they can learn the applications of linear operators and their applications.
4. They may understand how to prove some theorems under weaker conditions.
5. This course will be helpful for them in joining research in Nonlinear Functional Analysis.

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	3	2	2						2	2	1	2	2	2
CO2	3	3	2	2						2	2	1	2	2	2
CO3	3	3	2	2						2	2	1	2	2	2
CO4	3	3	2	1						2	2	1	2	1	2
CO5	3	3	2	2						2	2	1	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

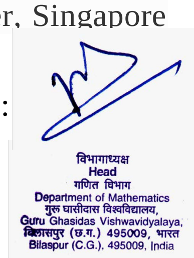
Text Book:

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:

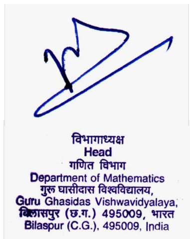


1. Use of fuzzy logic for decision making under real world scenario which is mostly fuzzy.
2. Basic idea of set theory and basics of fuzzy sets. The significance of application of fuzzy sets.
3. Basics of fuzzy controller, idea of fuzzification and defuzzification. Study of fuzzy controllers by mean 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
AMPDTD4	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

RINGS AND CATEGORIES OF MODULES

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

1. To understand the basic features of Rings and Categories of Module.
2. To learn the properties of direct sums and products of ring and modules.
3. To study the module categories including tensor Functors, flat modules natural transformations etc.
4. To introduce equivalence and duality for module categories.
5. To familiarize the injective modules, projective modules and their decompositions.

Unit-I: Rings, Modules and Homeomorphisms: Review of Rings and their Homomorphism's, Modules and Sub-modules, Homomorphism's of Modules, Categories of Modules, and Endomorphism Rings

Unit-II: Direct Sums and Products: Direct Summands, Direct Sums and Products of Modules, Decomposition of Rings, Generating and Cogenerating

Unit-III: Functors between Module Categories: The Hom Functors and Exactness-Projectivity and Injectivity, Projective Modules and Generators, Injective Modules and Cogenerators, the Tensor Functors and Flat Modules, Natural Transformations

Unit-IV: Equivalence and Duality for Module Categories: Equivalent Rings, the Morita Characterizations of Equivalence, Dualities, Morita Dualities.

Unit-V: Injective Modules, Projective Modules, and Their Decompositions: Injective Modules and Noetherian Rings-The Faith- Walker Theorems. Direct Sums of Countably Generated Modules-With Local Endomorphism Rings, Semi perfect Rings, Perfect Rings and Modules with Perfect Endomorphism Rings

Text Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University Press.

2. M. Artin, Algebra, Prentice Hall of India, 1991.

Reference Book:

1. Frank W. Anderson Kent R. Fuller, Rings and Categories of Modules, Springer-Verlag, New York.

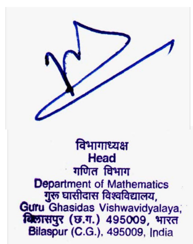
Course Outcomes: At the end of this course, the student will be able:

1. To solve the basic problems of Rings and Categories of Module.
2. To identify the problems of direct sums and products of ring and modules.
3. To learn the module categories including tensor Functors, flat modules natural transformations etc.
4. To new aspects of the equivalence and duality for module categories.
5. To distinguish the injective modules, projective modules and their properties.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1		1					1			1	1		1
CO 2	3	1		2					1			1	1		1
CO 3	3	1		1					1			1	1		1
CO 4	3	1		2					1			1	1		1
CO 5	3	1		2					1			1	1		1

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.

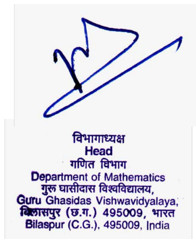
Course Outcomes: Upon the successful completion of the course, students will be able to:

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



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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.

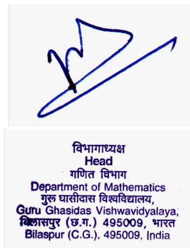
Course Outcomes: After successful completion of this paper the students will be able to:

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
AMPDTD7	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

MATHEMATICAL ECOLOGY

(To be prepared later)

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.

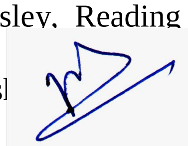
Non-Linear Programming: Introduction, formulating a Non-linear programming problem (NLPP), general NLPP, constraint optimization with equality constraints, constraint optimization with inequality constraints.

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 Publis New York.
4. S. D. Sharma, Operation Research, S. Chand Publ. New Delhi.



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Bilaspur (C.G.), 495009, India

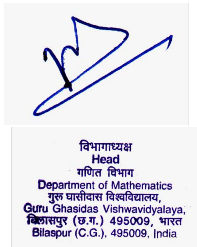
Course Outcomes: Upon completion of this course, the student will be able to:

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



Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD9	4	1	-	5 hours	30	70	100	5

Paper Code: AMPDTD9

THEORY OF RELATIVITY

(To be prepared later)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD10	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

FUNDAMENTALS OF THEORETICAL SEISMOLOGY

Course Objectives:

1. To provide the basic concept of continuum mechanics.
2. To give the discussion about seismic wave propagation.
3. To study the reflection and transmission of seismic wave.
4. To study the Ray methods.
5. To study the transport equation and their solution.

Basic Relations of Continuum Mechanics, Stress-Strain relation, Strain Energy function, Green's Function, Seismic Wave, Classification of Seismic Waves, Seismic Source, Equation of Motion-3D Problem, Equation of motion in the time and frequency domains, Wave Potentials, Separation of the Equation of Motion, Plane Wave, Harmonic Plane Waves, Spherical Waves, Reflection and Transmission of Plane Waves at a plane Interface, Love Waves in a layered half-space, Love Waves in a layer over half-space, Seismic Response. The Ray Method, The Ray Series in the Frequency domain, The Ray Series in the Time Domain, The Basic System of the Equations of the Ray Method, Ray and Ray Field, Transport Equation, Solution of Transport Equations.

Text Book:

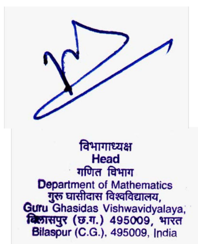
Peter Moczo, Introduction to Theoretical Seismology, Lecture Notes., http://www.fyzikazeme.sk/mainpage/stud_mat/Introduction_to_Theoretical_Seismology.pdf

Reference Books:

1. Shearer, P.M., *Introduction to Seismology*, Cambridge University Press (2012).
2. Ewing, W.M., Elastic Waves in Layered Media, McGraw-Hill Inc., US (2018).
3. Pujol, Jose, *Elastic Wave Propagation and Generation in Seismology*, Cambridge University Press (2003).

Course Outcomes: This course will enable the students to:

1. Understand the basic idea of continuum mechanics.
2. Understand the seismic wave propagation and their characteristics.
3. Evaluate the reflection and transmission coefficients.
4. Understand the Ray methods.
5. Solve the transport equation.



Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	2	2								2	1	1		1
CO2	2	3	2	2								2	1	1		1
CO3	2	3	2	2								2	1	1		1
CO4	2	3	2	2								2	1	1		1
CO5	2	3	2	2								2	1	1		1

Weightage: **1**-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDPF1	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

PROJECT PHASE - II

Note: Under the guidance of faculty member(s) on the topic relevant to the Master's Degree Course.