List of New Courses Introduced

Department : *Mathematics*

Program Name : *B.Sc., MSc., Pre Ph.D. Course Work*

Academic Year : 2021-22

List of New Courses Introduced

Sr. No.	Course Code	Name of the Course
01.	AMUATT1	Calculus
02.	AMUATT2	Algebra and Geometry
03.	AMUATG1	Finite Element Methods
04.	AMUATA1	Set Theory and Logic
05.	AMUATA2	Basic of Statistics
06.	AMUATL1	Introduction to Cryptography
07.	AMUBTT1	Multivariate Calculus
08.	AMUBTT2	Ordinary Differential Equations
09.	AMUBTG1	Algebra and Matrix Theory
10.	AMUBTA1	Theory of Interpolation
11.	AMUBTL1	Graph Theory
12.	AMPATT1	Abstract Algebra
13.	AMPATT2	Topology
14.	AMPATT3	Discrete Mathematical Structure
15.	AMPATT4	Geometry of Manifolds

16.	AMPATO1	Applications of Fuzzy Sets and Fuzzy Logic
17.	AMPBTT1	Real Analysis
18.	AMPBTT2	Numerical Analysis
19.	AMPBTD1	Coding Theory
20.	AMPBTD2	Finsler Geometry
21.	AMPBTD3	Fluid Mechanics
22.	AMPBTD4	Mathematical Methods of Applied Mathematics
23.	AMPBTD5	Mathematical Statistics
24.	AMPBTD6	Riemannian Manifold and Connections
25.	AMPBTD7	Fractional Calculus and Integral Transforms
26.	AMPBTT3	Research Methodology
27.	MaPhD01	RESEARCH METHODOLOGY
28.	MaPhD09	MECHANICS OF SOLIDS AND WAVE PROPAGATION
29.	MaPhD10	ADVANCED NUMERICAL ANALYSIS
30.	MaPhD11	ITERATIVE METHODS FOR SOLVING NONLINEAR EQUATIONS
31.	MaPhD12	FRACTIONAL CALCULUS

गुरु घासीदास विश्वविद्यालय
(केन्द्रीय विश्वविद्यालय अधिनियम 2009 क्र. 25 के अंतर्गत स्थापित केन्द्रीय विश्वविद्यालय)
कोनी, बिलासपुर - 495009 (छ.ग.)

Guru Ghasidas Vishwavidyalaya
(A Central University Established by the Central Universities Act 2009 No. 25 of 2009)
Koni, Bilaspur – 495009 (C.G.)

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

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

13/01/2021

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

Prof. A. S. Ranadive
(Member)

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

Dr. Sandeep Singh
(Member)

Department of Mathematics

Guru Ghsidas Vishwavidyalaya, Bilaspur (CG)

Minutes of BOS Meeting held on March 12, 2021

The Following Members were Present:

1. **Dr. P. P. Murthy,** Head	Chairman
2. **Professor Ravi Prakash Dubey**	Subject Expert
3. **Professor A. S. Ranadive**	Member
4. **Dr. Sandeep Singh**	Member
5. **Dr. J. P. Jaiswal**	Special invitee
6. **Dr. Dhananjay Gopal**	Special invitee
7. **Dr. M. K. Gupta**	Special invitee
8. **Dr.K. N. V. V. Vara Prasad**	Special invitee
9. **Dr. Uma Devi Patel**	Special invitee
10. **Dr. Santosh Verma**	Special invitee
11. **Dr. Brijendra Paswan**	Special invitee

Chairman of BOS welcome all the honourable members of **Board of Studies** and special invitees in this meeting. In the meeting, the following agenda approved unanimously. Most of the papers offered at Pre-Ph.D. Course level revised thoroughly and introduced new papers.

Pre-Ph.D. COURSE WORK in Mathematics

Examination Scheme

- There shall be a Course Work Examination for all provisionally admitted students after atleast six months from the commencement of classes of Pre-Ph.D. Course Work.
- For Pre-Ph.D. Course Work Examination, there shall be three papers of 100 marks each or such papers as mentioned in Ph.D. regulations/ Ordinances as amended from time to time.
- The duration of examination for each question paper shall be of three hours and there shall be two sections in each question paper in the following manner:

a. There shall be 10 (3 marks each) objective type or short-answer questions in first section/ part of the question paper for 30 marks.

b. There shall be 05 (14 marks each) descriptive / essay / interpretable type answer questions in second section/ part of the question paper for 70 marks.

- Examinee of Pre-Ph.D. Course Work has to score minimum 40 marks in each paper and overall, 55% marks in aggregate in examination in order to be eligible to continue in the program leading to the completion of Ph.D. thesis.
- Examinee of Pre-Ph.D. Course Work has to present a Seminar in the department. No marks shall be awarded for this Seminar presented by examinee; it can be assessed as Successful / Unsuccessful only. This qualifying seminar shall be evaluated by the concerned department only.

COURSE STRUCTURE

There should be **one compulsory paper**, **two optional papers** and **Seminar evaluations**. Students are required to choose any two (02) optional papers from the given list of Eleven (11) papers approved by BOS.

COMPULSORY PAPER

MaPhD01: RESEARCH METHODOLOGY

OPTIONAL PAPERS (ANY TWO):

MaPhD02: INTRODUCTORY FUZZY GROUP THEORY

MaPhD03: APPLIED FUNCTIONAL ANALYSIS

MaPhD04: CRYPTOGRAPHY

MaPhD05: DYNAMICAL SYSTEM

MaPhD06: GEOMETRY OF FINSLER SPACE

MaPhD07: STRUCTURES ON MANIFOLDS

MaPhD08: FIXED POINT THEORY AND APPLICATIONS

MaPhD09: MECHANICS OF SOLIDS AND WAVE PROPAGATION

MaPhD10: ADVANCED NUMERICAL ANALYSIS

MaPhD11: ITERATIVE METHODS FOR SOLVING NONLINEAR EQUATIONS

MaPhD12: FRACTIONAL CALCULUS

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

Semester-I

Paper Code- AMUATT1

Calculus

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

i) Assimilate the notions of limit of a sequence and convergence of a series of real numbers.

ii) Calculate the limit and examine the continuity of a function at a point.

iii) Understand the consequences of various mean value theorems for differentiable functions.

iv) Sketch curves in Cartesian and polar coordinate systems.

v) Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Unit-I: Sequences and Integration

Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

Unit-II: Limit and Continuity

ε-δ definition of limit of a real valued function, Limit at infinity and infinite limits; Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Unit-III: Differentiability

Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz's theorem.

Unit-IV: Expansions of Functions

Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder; Maxima and minima.

Unit-V: Curvature, Asymptotes and Curve Tracing

Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

References:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.

Paper Code- AMUATT2

Algebra and Geometry

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

i) Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
ii) Familiarize with relations, equivalence relations and partitions.
iii) Employ De Moivre's theorem in a number of applications to solve numerical problems.
iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
v) Find eigenvalues and corresponding eigenvectors for a square matrix.
vi) Explain the properties of three-dimensional shapes.

Unit-I: Theory of Equations and Complex Numbers

Elementary theorems on the roots of an equations including Cardan's method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots, Integral and rational roots; Polar representation of complex numbers, The n^{th} roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit-II: Relations and Basic Number Theory

Relations, Equivalence relations, Equivalence classes; Functions, Composition of functions, Inverse of a function; Finite, countable and uncountable sets; The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering.

Unit-III: Row Echelon Form of Matrices and Applications

Systems of linear equations, Row reduction and echelon forms, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation, Matrix operations, Determinants, The inverse of a matrix, Characterizations of invertible matrices; Applications to Computer Graphics; Eigenvalues and eigenvectors, The characteristic equation and the Cayley–Hamilton theorem.

Unit-IV: Planes, Straight Lines and Spheres

Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.

Unit-V: Locus, Surfaces, Curves and Conicoids

Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines.

References:

1. Titu Andreescu, & Dorin Andrica (2014). *Complex Numbers from A to...Z.* (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Macmillan India Ltd.
3. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
4. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
5. Edgar G. Goodaire & Michael M. Parmenter (2015). *Discrete Mathematics with Graph Theory* (3rd edition). Pearson Education Pvt. Ltd. India.
6. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.
7. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications* (5th edition). Pearson Education Pvt. Ltd. India.

GENERIC

Paper Code: AMUATG1
Finite Element Methods

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin'smethod.Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.

Applications to solving simple problems of ordinary differential equations.

Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries

Interpolation functions, numerical integration, and modelling considerations.

Solution of two dimensional partial differential equations under different Geometric conditions.

Books Recommended

1. J.N. Reddy, *Introduction to the Finite Element Methods*, Tata McGraw-Hill, 2003.

2. K.J. Bathe, *Finite Element Procedures*, Prentice-Hall, 2001.

3. R.D. Cook, D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite ElementAnalysis*, John Wiley and Sons, 2002.

4. Thomas J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite ElementAnalysis*, Dover Publication, 2000.

5. George R. Buchanan, *Finite Element Analysis*, McGraw Hill, 1994.

Paper Code: AMUATG2
To be prepared Later

Paper Code: AMUBTG1
Algebra and Matrix Theory

Sets, Relations, Function or mapping, injective and surjective mappings, Images and inverse images of a set under a mapping, Equivalence relation and partition, partial order relation and Zorn's lemma (without proof), Binary operations.

Group: Definition, examples, property. Subgroup, Union and intersection of groups, Cyclic group, order of the group, Group of symmetries and examples, Permutation group.
Ring: Definition and examples, property, Subring, Ideal, Integral Domain.

Field: Definition and, example

Matrix algebra: Introduction, Elementary operations of matrices. Inverse of a matrix. Rank of a matrix, Echlon form of a matix, Normal Form, Application of matrices to the system of linear equations, Consistency of the system of linear equations.

Books Recommended

1. Titu Andreescu and DorinAndrica, *Complex Numbers from A to Z*, Birkhauser, 2006.

2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson

3. P.R. Bhattacharya, S.K. Jain and S.R.Nagapaul Basic Abstract Algebra IInd Edition cambridge University press Indian Edition 1997.

4. I.N.Herstein Topics in Algebra, Wiley Eastern Ltd. New Delhi 1975.

Paper Code: AMUBTG2
To be prepared Later

Paper Code: AMUCTG1
Differential calculus

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.

Paper Code: AMUCTG2
To be prepared later

Paper Code: AMUDTG1
Applications of Algebra

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

Polya's theorems and their immediate applications.

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.

AEC

Paper Code: AMUATA1

Set Theory and Logic

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-ary relations.

Books Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

Paper Code: AMUATA2
Basics of Statistics

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

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

Unit-1: Review on Probability

Measures of Central Tendency, Measures of Dispersion, Probability, Conditional Probability, Random Variables, Expected Value, Moment generating function, Probability Distributions, Binomial Distribution, Poission Distribution, Normal Distribution.

Unit-2: Sampling Methods

Random Sampling and Methods of Samplings, Sampling distribution and standard error, Sampling distribution of the Sample Mean, Central limit theorem, Sampling distribution of the sample proportion, Sampling distribution of the difference between two sample means and Sampling distribution of the difference between two sample proportions.

Unit-3: Correlation and Regression

Correlation karl Pearson's Coefficient of correlation, Rank correlation, Linear regression, Lines of regression, Inferences concerning the regression coefficients.

References:

1. S. C. Gupta and V. Kapoor, Fundamentals of mathematical Stastics, Sultanchand and Son's, New Delhi.
2. Robert V. Hogg, Joseph W. McKean & Allen T. Craig(2013), Introduction to Mathematical Statistics(7th Edition), Person Education.
3. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications*(8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.JimPitman (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.

Paper Code: AMUBTA1

THEORY OF INTERPOLATION

To be prepared later

Paper Code: AMUBTA2

To be prepared later

SEC

Paper Code: AMUATL1

Introduction to Cryptography

Basic Concept of Cryptography, Information security, Background on functions, Basic terminology and concepts, Symmetric-key encryption, Digital signatures, Authentication and identification, Public-key cryptography, Hash functions, Protocols and mechanisms, Key establishment, management and certification, Pseudorandom numbers and sequences, Classes of attacks and security models, Identification and Entity Authentication, Digital Signatures, Efficient Implementation, Patents and Standards. Basic concepts of elliptic curve and quantum cryptography.

1. Wenbo Mao, Modern Cryptography: Theory and Practice. Pearsion Education, 2004
2. J Buchmann, Introduction to Cryptography, Springer (India) 2004
3. A. Menezes, P. van Oorschot and S. Vanstone, Handbook of Applied Cryptography, CRC Press

Paper Code: AMUATL2

To be prepared later

Paper Code: AMUBTL1

Graph Theory

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.

2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.

3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Paper Code: AMUBTL2

To be prepared later

Semester-II

Paper Code-AMUBTT1

Multivariable Calculus

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

i) Learn conceptual variations while advancing from one variable to several variables in calculus.

ii) Apply multivariable calculus in optimization problems.

iii) Inter-relationship amongst the line integral, double and triple integral formulations.

iv) Applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

v) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Unit-I: Partial Differentiation

Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Tangent planes, Chain rule, Directional derivatives, The gradient, Maximal and normal properties of the gradient, Tangent planes and normal lines.

Unit-II: Differentiation

Higher order partial derivatives, Total differential and differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables and more variables, Envelopes and evolutes.

Unit-III: Extrema of Functions and Vector Field

Extrema of functions of two and more variables, Method of Lagrange multipliers, Constrained optimization problems, Definition of vector field, Divergence, curl, gradient and vector identities.

Unit-IV: Double and Triple Integrals

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals, Dirichlet integral.

Unit-V: Green's, Stokes' and Gauss Divergence Theorem

Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.

References:

1. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.

2. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.
3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.
4. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.

Paper Code- AMUBTT2

Ordinary Differential Equations

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

i) Understand the genesis of ordinary differential equations.

ii) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.

iii) Know Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.

iv) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

v) Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

Unit-I: First Order Differential Equations

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

Unit-II: Second Order Linear Differential Equations

Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

Unit-III: Higher Order Linear Differential Equations

Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

Unit-IV: Series Solutions of Differential Equations

Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

Unit-V: Applications

Orthogonal trajectories, Acceleration-velocity model, Minimum velocity of escape from Earth's gravitational field, Growth and decay models, Malthusian and logistic population models, Radioactive decay, Drug assimilation into the blood of a single cold pill; Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Lotka–Volterra population model.

References:

1. Belinda Barnes & Glenn Robert Fulford (2015). *Mathematical Modelling with Case Studies: A Differential Equation Approach Using* Maple *and* MATLAB (2nd edition). Chapman & Hall/CRC Press, Taylor & Francis.
2. H. I. Freedman (1980). *Deterministic Mathematical Models in Population Ecology*. Marcel Dekker Inc.
3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
4. Daniel A. Murray (2003). *Introductory Course in Differential Equations*, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). *A Course in Ordinary Differential Equations* (2nd edition). Narosa.
6. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India.
7. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.

The syllabus of B. Sc. 2nd Sem. AEC paper name-Theory of Interpolation (Code: AMUBTA1) (which is the committed part of minutes of BoS meeting of B. Sc. LOCF held on 13/01/2022).

Code: AMUBTA1: Theory of Interpolation

Finite Difference: Forward difference, backward difference, central difference, difference of polynomial, other difference operator etc.

Interpolation: Introduction, Newton's forward interpolation formula, Newton's backward interpolation formula, Central difference interpolation formula, Gauss's forward and backward interpolation formula, Stirling's and Bessel's formulae .

Interpolation with unequal intervals: Lagrange's interpolation formula, divided difference, Newton's divided difference formula.

Text Books:

1. Jain M K, Iyengar S R K and Jain R K, Numerical Methods for Scientific and Engineering Computation, 4th Edn, New Age International Pvt Ltd (2005)
2. S S Sastry, Introductory Methods of Numerical Analysis, 5th Edn. Prentice Hall of India.

Reference book:

1. Jain M K, Numerical Solutions of Differential Equations, 2nd Edn, John Wiley and Sons Ltd (1984)

SEMESTER - 1

Paper Code: AMPATT1

ABSTRACT ALGEBRA

Course Aim: ***This course is designed in such a manner which creates ability among the students to understand the concepts of algebraic structures with their advance features.***

Pre-requisite: *Group theory, Ring theory, Linear algebra*

Normal and Subnormal series, Composition series, Jordan -Holder theorem, Solvable groups, Nilpotent groups

Modules, Sub modules, Quotient modules, Direct sums, Modules generated by a subset, Cyclic module, Homomorphism of modules, Isomorphism theorems, Exact sequences of modules, Simples modules, Schur's lemma, Free modules, Nilpotent and nil ideals, Noetherian and Artinian modules and rings, $\mathrm{Hom}_r(\oplus M_i, \oplus M_j)$, Hilbert Basis Theorem, Wedderburn Artin Theorem.

Smith normal form over a PID and rank, Fundamental structure theorem for finitely generated modules over a PID and its applications.

Field Theory**,** Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, Normal extensions, Perfect Fields, Finite Fields, Primitive elements, algebraically closed field.

Galois Theory, Galois Extension, Fundamental theorem of Galois Theory, Applications of Galois theory to classical problems.

Algebra of Linear transformations, Characteristic roots and matrices for linear transformations, Canonical forms - Similarity of linear transformation, Invariant subspaces, Reduction of triangular form, Nilpotent transformation, Index of Nilpotency, Invariants of a nilpotent transformation, The Primary Decomposition Theorem, Jordan blocks and Jordan forms

Text Books:

1. I. N. Herstein, Topics in Algebra,Wiely Eastern Ltd. New Delhi (1975).
2. P. B. Bhattacharya, S. K. Jain and S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, IInd Edition Cambridge University, Press Indian Edition.

Reference Books:

1. S. Lang, Algebra, Edition- Wisely.
2. M. Artin, Algebra, Prentice Hall of India, 1991.
3. N. Jacobson, Basic Algebra, Vol. I. II & III Hindustan Publishing Company.
4. D. S. Malik, J. N. Morderson& M. K. Sen, Fundamentals of Abstract Algebra, McGraw Hill International Edition 1997.

CourseOutcomes: Students will be able to understand after the completions of the course:

- To describe algebraic structures solvable and nilpotent groups, nilpotent and nil ideals, modules with isomorphism theorems and noetherian and artinian modules.
- To describe field theory with extensions, Galois Theory with application, smith normal forms over PID and finitely generated modules over PID with its applications.
- To describe about canonical forms, linear and nilpotent transformation.

Paper Code: AMPATT2

TOPOLOGY

Course Aim: ***To introduce the students to topology and elementary properties of topological spaces, continuous functions between topological spaces and to develop the student's ability to handle abstract ideas of Mathematics.***

Pre-requisite: *Basic concepts of topology.*

Geometry and topology, from geometry to metric spaces, topological spaces, basis, sub basis, order topology, subspace topology, closed sets, closure, interior, limit points, separable spaces.

Continuous functions and their characterization, comparison of topologies, weak topologies, sequential continuity, homeomorphism, topological property, constructing continuous functions, metric topology, quotient topology

Connected topological spaces, Path-connected topological spaces, continuity and connectedness, intermediate value theorem, components and path component of a topological space, local connectedness

Compact spaces, limit point compact spaces, sequentially compact spaces, continuity and compactness, extreme value theorem, uniform continuity theorem, local compactness, one point compactification.

Countability axioms, separation axioms, Hausdorff topological spaces, Regular topological spaces, Normal topological spaces, Urysohn lemma and Tietze extension theorem

Product topology and box topology, compactness and product topology, tube lemma, Tychonoff theorem, connectedness and product topology

Text Book:

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

Reference Books:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company.
2. K. D. Joshi, introduction to General topology, New Age International Pvt. Ltd. Publ., New Delhi.
3. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd).

Course outcomes: Upon successful completion of this course, the students will be able to understand the interconnection of metric space and topological spaces. They will know about the concepts of continuity and convergence in a more general sense. They will learn how to generalize the mathematical concepts.

Paper Code:AMPATT3

DISCRETE MATHEMATICAL STRUCTURES

Course Aim:***To develop logical thinking and its application to computer science (to emphasize the importance of proving statements correctly and de-emphasize the hand-waving approach towards correctness of an argument). The subject enhances one's ability to reason and ability to present a coherent and mathematically accurate argument.***

Pre-requisite:*Basic concepts of mathematical logic, Combinatorics, Lattice and Graph theory.*

Unit 1: Mathematical Logic:

Statements, Connectives, Statement formulas, Truth tables, Tautologies, Equivalence and Implications, functionally complete set of connectives, Normal forms (Disjunctive and Conjunctive), Ordering of normal forms, Rules of Inference, Consistency of premises, Indirect method of Proof, Automatic theorem proving, Predicate calculus, statement functions, Quantification, Predicate formulas, Inference theory for predicate calculus.

Unit 2: Set Theory:

Basics of set theory, Relations, different types of binary relations, relation matrix and graph of a relation, Partition and covering of a set, Equivalence and compatibility relation, Partial ordering, Hasse-diagram, Characteristic functions of a set.

Unit 3: Combinatorics:

Basic of Counting's, Permutations and Combinations, Enumeration of Permutations and Combinations, Principle of inclusion and exclusion, The pigeonhole principle, Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, The Method of Characteristic Roots.

Unit 4: Lattices and Boolean algebra:

Lattices as Partially Ordered Sets and as Algebraic systems, Properties of Lattices, Sub-lattices, Lattice homomorphism, Modular and Distributive Lattices, Complements, Boolean Algebra, Boolean homomorphism, Boolean identities, Stone Representation Theorem for finite Boolean Algebras (statement only), Boolean Functions and products, Free Boolean Algebras, Relationship with Statement Logic, Karnaugh Map.

Unit 5: Graph Theory:

Fundamental concepts of graphs and digraphs, path, reachability and Connectedness, Eulerian and Hamiltonian graphs, shortest path problems, chromatic numbers and chromatic index, Matrix representation of Graph, Planarity of Graphs, Tree and their properties, Binary tree, Spanning tree.

Text Books:

1. J. P. Trembly and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. Joe. L. Mott, Abraham Kandel, Theodore P. Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 2008.

Reference Books:

1. Kolman, Busby and Ross, Discrete Mathematical Structures, Prentice Hall Publication, New Jersey, USA.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India.
3. HalukBingol, Discrete Mathematics.
4. Preparata and Yeh: Discrete Mathematical Structures.

Course Outcomes: Students will be able to:

- Write an argument using logical notation and determine if the argument is or is not valid.
- Demonstrate the ability to write and evaluate a proof or outline the basic structure of and give examples of each proof technique described.
- Understand the basic principles of sets and operations in sets.
- Prove basic set equalities.
- Demonstrate an understanding of relations and functions and be able to determine their properties.
- Apply counting principles to determine probabilities.
- Demonstrate different traversal methods for trees and graphs.
- Model problems in Computer Science using graphs and trees.

Paper Code: AMPATT4

GEOMETRY OF MANIFOLDS

Course Aim: ***After the study of Differential Geometry in previous semesters in this course we introduce the basic concept of manifolds. The study of manifolds combines many important areas of mathematics. It generalizes concepts of Manifolds through linear algebra, Analysis and topology. In this part of the course student will learn about Manifolds, Integral curves and Flows, Linear Connection, Exterior Algebra, Exterior derivative Riemannian manifolds.***

Pre-requisite: *Manifolds and Differentiable manifolds.*

Manifolds: Topological manifolds smooth manifolds, Differentiable structures defined on sets, Differentiable functions on a manifold, Differentiable mapping from a manifold into another manifold.

Differentiable manifolds: smooth maps, chart, atlas, differentiable structure, Definition and examples of differentiable manifolds, differentials on smooth maps.

Vector fields and Lie bracket: vector fields as an equivalence class of curves, Tangent vector as a directional derivative operator, algebraic approach of tangent vectors, tangent spaces, Vector fields on differentiable manifolds, covariant Differentiation f- related vector fields, tangent bundle Immersions, embeddings and transversality.

Integral curves and Flows: Definition, examples and related theorems of Integral curves. Definition, examples and related theorems of one parameter group of transformation.

Exterior Algebra and Exterior derivative: Definition, examples related problems of tensor products, tensor algebra and exterior Algebra.

Text Book:

1. U. C. De and A. A. Shaikh, Differential Geometry of Manifolds, Narosa Publishing House, New Delhi, 2007.

Reference Books:

1. R. L. Bishop and R. J. Crittenden, Geometry of Manifolds, Academic Press, 1964.
2. S.S. Chern, W.H. Chen and K.S. Lam, Lectures on Differential Geometry, World Scientific, 2000.
3. N. J. Hicks, Notes on Differential Geometry, Von Nostrand, 1965.
4. J.M. Lee, Introduction to Smooth Manifolds, Springer, 2006.
5. Y. Matsushima, Differentiable Manifolds, Dekker, 1972.
6. M. Spivak, A Comprehensive Introduction to Differential Geometry Vol. 1&3rd Edition Publish or Perish, 1999.
7. F. Warner, Foundations of Differentiable Manifolds and Lie Groups, Springer, 1983.

Course Outcomes: They are able to understand Integral curves and Flows, Linear Connection, Exterior Algebra, Exterior derivative, Riemannian manifolds. Students learnt how topology, algebra and linear algebra involved in the study of Manifold. Also they recognized the application of manifold in different branches of Applied Sciences.

Paper Code: AMPATO1

APPLICATIONS OF FUZZY SETS AND FUZZY LOGIC

The basic aim of introducing this open elective is to introduce the application of fuzzy techniques in decision making. The aim is to be achieved without giving unnecessary emphasis on learning theoretical aspects of fuzzy set theory. Another aim is to study and compare the two methods/theories for dealing with uncertainty namely probability theory and possibility theory.

Course Aim: ***A student opting this open elective is supposed to know discrete mathematics up to the level of higher secondary schools and basic theory of probability from any board in India and basics of theory of probability. Besides a student must have a burning desire to find applications of the most modern branch of mathematics broadly termed as Fuzzy Set Theory and Fuzzy Logic.***

Target group: *Any P.G. student interested in using tools of mathematics in his/her discipline of studies.*

Objective:*Basicobjective of this course is help to learn the wide scope of application of fuzzy methods in various branches of disciplines like Economics, Political science, social science, Natural science and Life science etc. Of course this course is most desirable course for any branch of studies in engineering.*

From Classical (Crisp) sets to fuzzy sets: A grand paradigm shift: Introduction, Crisp Sets: An overview, Fuzzy sets: basic types, Fuzzy sets: Basic concepts, Characteristics and signification of paradigm shifts

Operation on fuzzy sets: Types of operations, Fuzzy complements, Fuzzy intersections: t-Norms, Fuzzy unions: t-conorms, Combination of operations, Aggregation of operations

Possibility Theory: Fuzzy measures, Evidence Theory, Possibility theory, Fuzzy sets and possibility theory, Possibility theory vs. probability theory

Fuzzy Logic: Classical logic: An overview, multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges

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.

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.

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

Text Book:

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

Reference Books:

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

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

- Need of techniques introduced under the course in using(logical) mathematical tools available for cutting edge research in the area of his/her choice.
- Learn to deal with real world uncertainties especially of the fuzzy nature.
- Use of fuzzy logic for decision making under real world scenario which is mostly fuzzy.
- Basic idea of set theory and basics of fuzzy sets. The significance of application of fuzzy sets.
- Binary and unary operations, combinations of operations on fuzzy sets. Aggregation operations.
- A student is supposed to understand the application as Fuzzy measures evidence theory, Possibility theory and probability theory.
- An overview of classical logic and basics types of fuzzy proposition. Basics inference rules.
- Basics of appropriate reasoning and selection of fuzzy implication.
- 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.

SEMESTER - 2

Paper Code: AMPBTT1

REAL ANALYSIS

Course Aim: ***The proposed course is intended to be a basic course on Mathematical analysis for M.Sc. students that enable to understand the basic concepts of Compact metric spaces, measure theory and integration.***

Pre-requisite: *Basic Concepts of Mathematical Analysis.*

Compact Metric Spaces: Totally bounded metric spaces**,** Compact metric spaces, Lebesgue Covering lemma and Characterization of Compact metric spaces.

Riemann-Stieltjes Integration: Riemann-Stieltjes Integration, Properties of Riemann-Stieltjes Integrals, Class of Riemann- StieltjesIntegrable functions.

Function ofBoundedVariation: Function of bounded variation, Total variation and its additive property, Variation function and its properties, Necessary and sufficient conditions for a function to be boundedvariation.

MeasurableSets: Measurable sets and their properties, Non- Measurable sets, set of measure zero, Cantor set, σ-algebra, Borel Algebra, Complete measure.

MeasurableFunctions: Measurable functions, Properties of Measurable functions, Positive and negative parts of function, Simple functions, Relation between continuity and measurability of function, Lusin's and Egoroff's Theorems.

LebesgueIntegral: Comparison of Lebesgue and Riemann integrals, Lebesgue integral of a bounded function over a set A of finite measure, Simple properties, Lebesgue integral for unbounded functions, Bounded convergence theorem for a sequence of function, Fatou's lemma, Classical Lebesgue dominated convergence theorem, Monotone convergence theorem, Fubini's Theorem.

Text Books:

1. Rudin W., "Principles of Mathematical Analysis", 3rd ed., McGraw-Hill,1983.
2. Royden H. L., "Real Analysis" (3rd Edition), Macmilan Publishing Co. Inc., New York, 4th Ed., 1993.
3. Rana I. K., "An introduction to measure and Integration", Narosa Publishing House, Delhi,1997.

Reference Books:

1. Apostol T., "Mathematical Analysis", 2nd ed., Narosa Publishers,2002.
2. G. de Barra, Measure theory and integration, Harwood Publishing Limited, Chichester, 2003.
3. E. M. Stein and R. Shakarchi, Real analysis, measure theory, integration and Hilbert spaces, Princeton University Press, 2005.

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

- Understand the fundamental terms of theory of Compact metric spaces, Integration, Function of bounded variation, Measure theory viz. algebra, σ-algebra, and Lebesgue Integral.
- Understand the basic concepts of measure theory namely Monotone convergence theorem, Fubini's Theorem.
- Apply the concept of measure in the problems pertaining to integration of function with respect to particular measure.
- Analyze and identify important dissimilarities between Riemann integration and Lebesgue integration.
- Evaluate the value of Lebesgue integration (with respect to its measure) of any measurable function.
- Construct proof of variety of results measure theory using the concept of outer measure and integration with respect to measure.

Paper Code: AMPBTT2

NUMERICAL ANALYSIS

Course Aim: ***The primary goal is to provide mathematics majors with a basic knowledge ofnumerical methods including: root finding, numerical linear algebra, interpolation, solving systems of linear equations, numerical solution to ordinary and partial differential equations. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs. The course will further develop problem solving skills.***

Pre-requisite: *Basic concepts of Numerical Analysis.*

Brief review of numerical basic method for algebraic and transcendental equations

Errors, rate of convergence, efficiency index, computational order of convergenceTranscendental & polynomial equations: Muller's method, Chebyshev's methods, higher order methods, modified Newton-Raphson method, method for finding multiple root in case of unknown multiplicity, Newton-Raphson method for nonlinear systems.

Cardano's method, Ferrari's method, Descarte's rule of signs, Sturm sequence, Birge-Vieta method, Bairstow method,Graeffe's root squaring method

System of linear equations: partial and complete pivoting in Gauss elimination method, Doolittle's' and Crout's method.

Eigen values & Eigen vectors: Bounds on Eigen values, method for finding Eigen values of symmetric matrices, method for finding Eigen values of arbitrary matrices,

Interpolation: existence & uniqueness of Lagrange's & divided interpolation, Truncation error, Hermite's interpolation, cubic spline interpolation, errors in interpolation.

Numerical solution of ordinary different equations: solution of boundary value problems by finite difference method, shooting method.

Numerical solution of partial differential equations: solution of elliptic, parabolic and hyperbolic partial differential equations problems by finite difference method.

Text Book:

1. Jain M K, Iyengar S R K and Jain R K, Numerical Methods for Scientific and Engineering Computation, 4th Edn, New Age International Pvt Ltd (2005).

Reference Books:

1. S. S. Sastry, Introductory Methods of Numerical Analysis, 5th Edn. Prentice Hall of India (2013).
2. J. H. Mathews and K.D. Fink: Numerical Methods using MatLabs, 4rth edition, PHI Learning Private Limited, New Delhi (2021).
3. B. Bradie: A Friendly Introduction to Numerical Analysis, Pearson Prenctice Hall, India (2006).

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

- Find the source of errors and its effect on any numerical computations and be familiar with finite precision computations.
- Solve an algebraic or transcendental equation using an appropriate numerical method andperform an error analysis for a given numerical method.
- Solve a linear system of equations using an appropriate numerical method which include directand iterative methods and apply numerical methods to find Eigen-values and corresponding Eigen-vectors.
- Approximate the given data with an interpolating polynomial and least square approximations.
- Calculate a definite integral numerically and solve initial and boundary value problems usingappropriate numerical methods.

Paper Code: AMPBTD1

CODING THEORY

Course Aim: ***Discuss various coding schemes. Implement the encoder and decoder of one block code using any program language and comprehend various error control code properties (Apply linear block codes for error detection and correction, convolution codes for performance analysis & cyclic codes for error detection and correction and Design BCH & RS codes for Channel performance improvement against burst errors.).***

Pre-requisite:*Basic concepts of Coding Theory.*

Block codes, linear codes, minimum distance, generator and parity check matrices, hamming codes, Nearest neighbour decoding for linear codes, syndrome decoding, weight enumerators.

Singleton and sphere packing bounds, MDS codes and perfect codes, Gilbert–Varshamov bound, Griesmer bound, Non-linear codes, Hadamard codes, binary and ternary Golay codes.

Constructions of linear codes, Reed-Solomon and Justesen codes, Reed–Muller codes, Subfield codes, Cyclic codes, generator and parity-check polynomials, Weight distribution of codes, Generalized BCH codes, Self-dual codes and invariant theory, Covering radius problem.

Reed Solomon codes, binary group code, polynomial code, binary cyclic codes of Length 2n (n odd), generalized Reed-Muller codes, Simplex codes, t-designs, Steiner systems, quadratic residue codes, Convolutional Codes.

Goppa codes, Quaternary codes, binary codes derived from codes over$\mathbb{Z}_4$, Galois ring over$\mathbb{Z}_4$, cyclic and quadratic residue codes over$\mathbb{Z}_4$, self-dual codes over$\mathbb{Z}_4$.

Text Books:

1. J. H. Van Lint, Introduction to Coding Theory, 3rd ed., Graduate Text in Mathematics, 86, Springer-Verlag, 1999.
2. W. C. Huffman and V. Pless, Fundamentals of Error-correcting Codes, Cambridge University Press, 2003.
3. S. Ling and C. Xing, Coding Theory, A First Course, Cambridge University Press, 2004.

Reference Books:

1. J Buchmann, T. Hoholdt, H. Stichtenoth, Coding Theory, Cryptography and Related Areas.
2. Wakerly, J. North-Holland, Error-correcting codes, self-checking circuits and applications, New York 1978.
3. Wan Zh. Wissenschaftsverlag, Algebra und Codes, Peking, 1980.
4. Welsh, D., VCH, Weinheim, Codes and Cryptography, 1991.
5. Wolfowitz, J., Coding theorems of information theory, Springer, Berlin, 1978.
6. Wozencraft, M., Jacobs, I. John Wiley Principles of communication engineering, New York.
7. Wozencraft, M., Reiffen, B Sequential Decoding, M.I.T. Press, Cambridge/Mass.
8. Wiggert, D. Artech, Boston/Mass, Codes for error control and synchronization, 1988.

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

- Design the channel performance using Coding theory.
- Comprehend various error control code properties.
- Compare various capacity reduction based coding techniques for image and video type of data.
- Illustrate various security oriented coding techniques for Block codes.
- Implement various error control techniques for Convolutional codes.

Paper Code: AMPBTD2

Finsler Geometry

Objective: The objective of this course is to enable the students, the basic concepts of Finsler geometry which are useful for further study.

Line element, degree of homogeneity, Finsler space, Euler's theorem, metric tensor, generalized Christoffel symbols, Cartan tensor, Minkowskian space, Tangent space, dual tangent space, length of a vector, Geodesic.
δ-differentiation, partial δ-differentiation, Berwald differentiation, commutation formulae, metrical connection, Landsberg space, Affinely connected space, Ricci commutation formula, Berwald curvature and torsion tensors, Berwald deviation tensor, Bianchi identities, Recurrent Finsler space, Symmetric Finsler space.
Projective change, projective deviation tensor, projective curvature and torsion tensors.
Cartan two processes of covariant differentiation, Cartan curvature and torsion tensors.

Books Recommended:

1. H. Rund, The Differential Geometry of Finsler Spaces, Springer-Verlag, Berlin, 1959.
2. M. Matsumoto, Foundations of Finsler Geometry and Special Finsler Spaces, Kaisheisha Press, Otsu, 1986.
3. P. L. Antonelli (ed.), Handbook of Finsler Geometry, Kluwer Academic Publishers, Dordrecht, the Netherlands, 2003.

Learning outcomes: After the completion of the course, students will be able to learn some basic concepts of Finsler geometry. They may understand covariant differentiation better.

Paper Code: AMPBTD3

FLUID MECHANICS

Course Aim: ***To introduce basic concepts of Fluid Mechanics.***

Pre-requisite: *Basic knowledge of Mathematics.*

Introduction and Basic Principles, Properties of Fluids and Fluid Statics: Density, Bulk Modulus, Viscosity, Newtonian fluid, Non-Newtonian fluids, Reynolds number, Rotational and Irrotational flows, Compressible and Incompressible flows, Governing equation of fluid statics, Fluid under rigid body motion.

Lagrangian and Eulerian descriptions, Concept of different flow lines, Acceleration of fluid flow, Deformation of fluid elements, Derivation of continuity equation, Stream Function, Circulation, Velocity Potential

Euler's equation, Euler's equation in streamline coordinates, Bernoulli's equation, Application of Bernoulli's equation, Kelvin's theorem, Reynolds Transport Theorem (RTT), Application of RTT: Conservation of mass, Conservation of linear momentum, Conservation of angular momentum.

Vortex motion, Helmholtz's vorticity equation, Vortex line and filament equation of surface formed by streamlines and vortex lines in case of steady motion, Strength of a filament, Velocity field and kinetic energy of a vortex system, Vortex pair, Vortex doublet, Images of a vortex with regards to plane and a circular cylinder.

Navier-Stokes equation, Pipe Flow, Principle of Similarity and Dynamical Analysis, Temperature distribution in Coutte flow and in flow past a flat plate. Mathematical formulation of the stability problem of incompressible flow, Stability of flows under different cases, Prandtl's momentum transfer theory.

Text Books:

1. M.D. Raisinghania, Fluid Dynamics with complete Hydrodynamics and Boundary layer Theory (Revised Edition) , S. Chand Publication.
2. F. Chorlton, Text Book of Fluid Dynamics, CBS Publication.

Reference Books:

1. L.M. Milne-Thomson, Theoretical Hydrodynamics, Dover Publications Inc.
2. Batechelor, G.K., An Introduction to Fluid Dynamics, Cambridge Press.
3. Drazin, P.G., Reid W. H., Hydrodynamic Stability, Cambridge Press
4. Arthur Stanley Ramsey, Hydrodynamics, G. Bell and Sons, Limited.
5. L.D. Landau and E.M. Lipschitz, Fluid mechanics, Pergamon Press.

Course Outcomes: Students will be able to apply different moment equations viz., equation of continuity, equation of motion and equation of pressure to discuss any problem of gas dynamics.

Paper Code: AMPBTD4

Mathematical Methods of Applied Mathematics

Course Aim: ***The aim of this course is to get the insights of methods of applied mathematics.***

Pre-requisite: *Basic knowledge of differential equations is required.*

Green's Function, Green's function for Laplace equation, The methods of Image, The Eigen function method, Green's Function for Wave Equation-Helmholtz theorem, Green's Function for Diffusion Equation.

Laplace transform methods, Transform of various functions, Complex Inversion Formula, Solution of Ordinary differential Equations, Solution of Partial Differential Equations, Solution of Diffusion Equation, Solution of Wave Equation.

Fourier Transform Methods, Transform of various functions, Multiple Fourier Transform, Solution of Diffusion Equation, Solution of Wave Equation and Solution of Laplace Equation.

Z – Transform and its Applications.

Text Book:

1. Rao, K.S., Introduction to Partial Differential Equations, PHI Learning, Private Limited, New Delhi, INDIA (2011).

Reference Books:

1. Jain, M.K., Iyenger, S. R. K and Jain, R.K., Computational Methods for Partial Differential Equations, Wiley Eastern, (1994).
2. Evans, L.C., Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS (1999).
3. B.S. Grewal., Higher Engineering Mathematics, Khanna Publishers.

The syllabus of M. Sc. 2nd Sem. optional paper name-Mathematical Statistics (Code: AMPBTD5) (which is the committed part of minutes of BoS meeting of M. Sc. (CBCS) held on 13/01/2022).

Paper Code: AMPBTD5

Mathematical Statistics

Course objective: To learn about curvilinear regression, multiple and partial correlation, sampling, hypothesis testing, theory of attributes.

Expected Outcomes: After completion of this paper students will be able to handle the real world problems regarding uncertainty of certain kind associated with random experiment. They may perform test of hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases, learn non-parametric test such as the Chi-square test for independence as well as goodness of fit, compute and interpret the results of bivariate and multivariate regression and correlation analysis, for forecasting. This paper is also useful for further study of statistics.

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

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

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

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

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

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

Text Book:

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

Reference Books

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

Course Outcomes: After the completion of this course, students will have the knowledge about mathematical concept of the methods of applied mathematics.

Paper Code: AMPBTD5

Mathematical Statistics

Prepared later

Paper Code: AMPBTD6

RIEMANNIAN MANIFOLDS AND CONNECTIONS

Course Aim: ***Base of the development of Differential Geometry during the 18th century and the 19th century is the theory of plane and space curves and surfaces in the three dimensional Euclidean space. Aim of the course Differential Geometry is to study the problems in geometry using the techniques of differential calculus, integral calculus and linear algebra. Since the late 19th century, differential geometry has grown into a field concerned more generally with the geometric structures on differentiable manifolds. Differential geometry is closely related to differential topology and the geometric aspects of the theory of differential equations.***

Pre-requisite: *Basic concepts of Riemannian Manifolds and Connections are required for this course.*

Linear Connection: Affine connections, Torsion tensor of affine connection, Curvature tensor of affine connection and related problems.

Riemannian Manifold Riemannian Connection: Definition and examples of Riemannian Metric, Riemannian Connection and Riemannian Manifolds, Fundamental theorem of Riemannian Geometry, Koszul's formula, First and Second Bianchi's identities, Ricci identity.

Curvatures in Riemannian Manifolds: Riemannian Curvature, Ricci curvature, scalar curvature, Sectional curvature, Gaussian Curvature, Schur's theorem, Projective curvature tensor, conformal curvature tensor, Conhormonic Curvature tensor, Concircular Curvature tensor.

Connections on Riemannian Manifolds: Gradient vector fields, Semi- symmetric metric connection and related theorems, Jacobi Fields. Complete manifolds, Vector fields, all space forms, Theorem of Cartan on the determination of the metric by means of the curvature. Fundamental equations for Riemannian submanifolds, conformal killing.

Transformations on Riemannian Manifolds: Conformal transformation, Conformal killing vector field, Locally symmetric Riemannian manifold, Recurrent Reimanian manifold, Ricci recurrent Reimanian manifold, Ricci-semi- symmetric Reimanian manifold and related theorems.

Text Book:

1. U. C. De and A. A. Shaikh, Differential Geometry of Manifolds, Narosa Publishing House , New Delhi, 2007.

Reference Books:

1. S.S. Chern, W.H. Chen and K.S. Lam, Lectures on Differential Geometry, World Scientific, 2000.
2. MP do Carmo, Riemannian geometry, Birkhauser, 1992.
3. N. J. Hicks, Notes on Differential Geometry, Von Nostrand, 1965.
4. P. Petersen, Riemannian geometry, Springer 2006.
5. J. Jost, Riemannian geometry and Geometric Analysis (6ed. Springer, 2011).

Course outcomes: In the sense of outcomes of the course Differential geometry students have learnt how Differential Geometry involved in the study of curves and surfaces in three dimensional Euclidean spaces. Also they are able to define surfaces and their properties, Tangent spaces; Singularities on a surface, first fundamental form Second fundamental form, Gauss and Weingarten equations, Normal Curvature. Differential Geometry has rich applications in Theory of Relativity and Cosmology.

Paper Code: AMPBTD7

FRACTIONAL CALCULUS AND INTEGRAL TRANSFORMS

Course Aim: ***The objective of the paper is to develop the basic concept of Fractional Calculus with the special interest recurrence relations and integral transformations.***

Pre-requisite: *A basic concept of fractional calculus and integral transforms.*

Hankel Transform: Introduction, Definition and formulae, some more integrals involving exponential functions and Bessel's function of first kind; Inversion formula and Parsival's theorem for Hankel transform. Hankel transform of the derivative of a function; Application of Hankel transforms of boundary value problems. Finite Hankel transmission formation and another form of Hankel transform.

Z-Transform: Introduction and basic operations on sequences of Z-transform; Properties and theorems of Z-transform; Solution of difference equation, Multiplication by K and division by K, Initial and final value problem; Partial sum. Convolution: Definition and property of casual sequence. Inverse of Z-transform: Inverse of Z-transform by Binomial expansion, partial fractions, residue method and convolution method.

Fractional Calculus: Introduction and historical background; Riemann-Liouville fractional integrals of arbitrary order α and Riemann-Liouville fractional derivatives; Basic properties and Illustrative Examples.

The syllabus of M. Sc. 2nd Sem. compulsory paper name- Research Methodology (Code: AMPBTT3) (which is the committed part of minutes of BoS meeting of M. Sc. CBCS held on 13/01/2022).

Code: AMUBTT3: Research Methodology

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method, Understanding the language of research, Concept, Construct, Definition, Variable. Research Process.

Research Design: Concept and Importance in Research, Features of a good research design, Exploratory Research Design, Descriptive Research Designs, Experimental Design: Concept of Independent & Dependent variables. Basic idea of few software's.

Reference book:

C. R. Kothari: Research Methodology: Methods Techniques , New Age International, 2004

MaPhD01: RESEARCH METHODOLOGY

Course Objectives:

This course is designed in such a manner which enables the students:

i. *to identify and discuss the role and importance of research in the Mathematical Sciences and its related areas.*

ii. *to identify and discuss the issues and concepts salient to the research process.*

iii. *to identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.*

iv. *to identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.*

v. *for Better presentation of the work in front of audience by using Latex.*

vi. *to understating MATLAB software for various implementation in the area of studies done by the candidate.*

Philosophy and Ethics: Introduction to philosophy, definition, nature and scope, concept, branches, Ethics, definitions, moral philosophy, nature of moral judgments and reactions.

Scientific conduct: Ethics with respect to science and research, Intellectual honesty and research integrity, scientific misconducts Falsification, Fabrication and Plagiarism (FFP), redundant publications, duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.

Publication Ethics: definition, introduction and importance, Best Practices/standards setting initiative and guideline, COPE, WAME, etc. Conflicts of interest, Publication misconduct, definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

MATLAB: Basics of Mathematical calculations such as Integration, Solving Matrices, Drawing Graphs, Citation, etc.

Latex: Basics of Latex such as typing a research paper, Insertion of Table, Graphs, Pictures, etc.

Wring a review of at least 01 research paper suggested by supervisor (to his student who is allotted as a Pre-PhD Course Work student by the DRC as per university guidelines).

Learning Outcomes:

Students who successfully complete this course will be able:

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On completion of the course the student should have the capability to define all the basic terms related to manifold and also student should have capability to know all the complex structures defined on different manifolds.

MaPhD08: FIXED POINT THEORY AND APPLICATIONS

Course Objectives:

The objective of this paper aims to prepare students with a deep understanding of development of fixed-point theory and the research-oriented attitude and skill of application of mathematical iterative technique and computational tools.

Introduction to metric fixed-point theory, Contraction Mapping in a Metric Space, Linear Operators, Some generalizations of the Contraction Mappings, Approximate Iteration; A Converse of the Contraction Principle; Some Applications of the Contraction Principle. Examples and applications.

Brouwer's Fixed Point Theorem, equivalent Formulations; The Elementary Proof of Brouwer's Fixed Point Theorem; Examples and Applications.

The Schauder Fixed Point Theorem; Darbo's Generalization of Schauder's Fixed Point Theorem; Browder's and Fan's Generalizations of Schauder's and Tychonoff's Fixed Point Theorem.

Nonlinear Operators, Lipschitzian Mappings, Picard Iterative Method, Mann Iterative Method, Ishikawa Iterative Method, a few convergence theorems.

Reference Books:

1. Vasile I. Istratescu, Fixed Point Theory; D. Reidel Publishing Company; 90-277-1224-7.
2. VasileBerinde "Iterative Approximation of Fixed Points" Springer.
3. Saleh Almezel, Qamrul Hasan Ansari, Mohamed Amine Khamsi, Topics in Fixed Point Theory, Springer.

Learning Outcomes:

By the end of course work, students will be get knowledge of the contraction. Brower's and Schauders' fixed point theorem and their development. Also student get the knowledge about the convergence theorem by using Picard, Mann and Ishikawa iteration process.

MaPhD09: MECHANICS OF SOLIDS AND WAVE PROPAGATION

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Course Objectives:

The prime objective of this paper is to develop the mathematical concept of solid mechanics with its applications to seismic wave propagation.

Introduction to Continuum Mechanics, Basic definitions of Solid Mechanics, Principles of Elasticity, Fundamentals of Tensor Calculus, Body and Surface forces, Effects of force: tension, compression and shear, Analysis of stress, principal stresses, principal planes, maximum shearing stresses, Computation of Traction Vector and Principal Axes.

Introduction to Strain, Affine Transformation, Infinitesimal Affine Deformation, Geometrical Interpretation of components of Strain, Principal Strains, Invariants, General Infinitesimal Deformation, Examples of Strain, Notations, Equations of Mohr's circle diagram, equations of deformation and strain, strain in form of displacement, compatibility concepts, need and physical significance.

Stress-strain relations, Generalized Hook's Law, different types of symmetry, density function, Airy's stress function, Poisson's ratio. Complementary Shear Stress, Shear Strain, Shear Modulus. Unit for elastic moduli, Relation between modulus of elasticity, modulus of rigidity and bulk modulus. Saint-Venant's Principle.

Wave equation, Solution of Wave equations, Seismic wave equation, Plane waves, Harmonic plane wave equation, Polarization of P and S waves, Wave propagation in unbounded elastic medium.

Study of propagation of waves in elastic, viscoelastic and poroelastic media, Waves in anisotropic medium, thermoelastic medium, study of surface waves (Rayleigh & Love waves) in elastic and viscoelastic medium including layered medium, Reflection and refraction of waves in elastic media.

Reference Books:

1. Love, A.E.H. *A Treatise on Mathematical Theory of Elasticity*, Cambridge University Press, New York.
2. Sokolnikoff, I.S., (1956) *Mathematical Theory of Elasticity*, McGraw Hill Book Co., NewYork.
3. Biot, M .A. (1965) *Mechanics of* Incremental Deformations, John Wiley & Sons , NewYork.
4. Ewing, W.M., (2018) *Elastic Waves in Layered Media*, Creative Media Partners,LLC.
5. Achenbach, J.D., (2012) *Wave Propagation in Elastic Solids*, North Holland,Elsevier.
6. Kazimi, SMA., (2013) Solid Mechanics, McGraw Hill Education (India) Pvt Ltd.

Learning Outcomes:

After the completion of this course, students will be able to examine the characteristics of seismic wave propagation in a mathematical sense. This course will be helpful in dealing the problems on reflection/transmission phenomena, crack propagation and moving load in anisotropic elastic materials.

MaPhD10: ADVANCED NUMERICAL ANALYSIS

Course Objectives:

To know about various types of Errors. Calculate the error correction and get actual root of the equation. Understand different methods of solution of the equations and compare them. To get the detailed knowledge about different numerical methods which are used in real world problems, with emphasis on how to prepare program for different methods.

Errors and Approximations: Rate of convergence of an Iterative method, Efficiency index of an Iterative method

Extension of Newton-Raphson method for finding multiple roots and to solve system of non-linear equations. Mullers method, Chebyshev's methods.

System of linear equations: LD decomposition techniques and its complexity analysis.

Interpolation: Newton's Divided difference method. Hermite's interpolation. Cubic spline interpolation. Errors in interpolation.

Numerical Integration: Method of undetermined coefficients. Errors in integration formulae. Iterative solution of linear equations.

Eigen values & Eigen Vectors: Bounds on eigen values, method for finding eigen values of symmetric matrices, method for finding eigen values of arbitrary matrices, method for finding largest eigen values of matrices.

Reference Books:

1. Jain M K, Iyengar S R K and *Jain* R K, Numerical Methods for Scientific and Engineering Computation, 4th Edn, New Age International Pvt Ltd (2005)
2. Jain M K, Numerical Solutions of Differential Equations, 2nd Edn, John Wiley and Sons Ltd (1984)
3. S S Sastry, Introductory Methods of Numerical Analysis, 5th Edn. Prentice Hall of India.

Learning Outcomes:

After completion of this course, student will be able to be aware of the use of numerical methods in modern scientific computing. Be familiar with finite precision Computing. Be familiar with numerical solutions of nonlinear equations in a single variable. Be familiar with numerical

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interpolation and approximation of functions. Be familiar with numerical integration. Be familiar with calculation and interpretation of errors in numerical methods

MaPhD11: ITERATIVE METHODS FOR SOLVING NONLINEAR EQUATIONS

Course Objectives:

To know about various types of iterative methods, theoretical and computational order of convergence. Two-step without memory iterative methods for solving nonlinear equations. Two-step with memory iterative methods. To get the detailed knowledge about optimal & non-optimal iterative methods with improve them.

Errors and Approximations: Rate of convergence of an Iterative method, Efficiency index of an Iterative method

Classification of iterative methods, computational order of convergence (COC), R-order of convergence, computational efficiency of iterative methods, initial approximations, stopping criteria, one-point iterative methods for simple roots.

Two-point without memory IM: Traub's two-point IM, Owtrowski's fourth order IM & its generalization, Kung-Traub's multipoint IM, Jarratt's type IM, Non-optimal two-point IM for multiple zeros, optimal two-point IM for multiple zeros,

Two-point with memory IM: Secant like method, Steffensen like method, two-step method with memory of Neta's type.

Higher order IM: Non-optimal IM, optimal IM, with derivative IM, derivative free IM, Higher order without memory IM, higher order with memory IM.

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.

   C. T. Kalley (1995): Iterative methods for linear and nonlinear equations, SIAM, Philadelphia.

Learning Outcomes:

After completion of this course, student will be able to be aware of the use of iterative methods in modern real-world problems. Be familiar with fundamental iterative methods such as Newton-Raphson method, Secant method, Kung-Traub's method, Steffensen method etc. Be familiar with multipoint without and with memory iterative methods. Be aware about the importance optimal iterative methods and how to improve non-optimal to optimal.

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MaPhD11: FRACTIONAL CALCULUS

Course Objectives:

The objective of the paper is to develop the advanced concept of Fractional Calculus with the special interest recurrence relations and the time space fractional diffusion equations.

Advance concept of Gamma and Beta function, Bessel functions.

Hypergeometric and Generalized hypergeometric functions: Definition and some identities, Recurrence formulae and Expansion formulae.

Mittag-Leffler and Generalized Mittag-Leffler functions and its applications.

Introductions and definitions of Riemann-Liouville fractional differential and Riemann-Liouville fractional integral of order α. Basic properties of fractional integrals. The Weyl fractional: Basic properties of Weyl integral with its applications. Kober operators and generalized Kober operators.

Reference Books:

1. Special functions: Earl D. Rainville, Chelsea publishing Company, Bronx, New York.
2. The H-functions of one and two variables with applications: H. M. Shrivastava, K. C. Gupta and S. P. Goyal, South Asian Publishers Pvt. Ltd.
3. An introduction to the fractional calculus and fractional differential equation: Kenneth S. Miller and Bertram Ross, John Wiley & Sons, Inc. New York.
4. Special function for applied scientists: A. M. Mathai and Hans J. Haubold, Springer publishers.
5. The H-function with application in statistics and other disciplines: A. M. Mathai and R. K. Saxena, Publishing John Wiley & Sons, New York.
6. The H-function Theory and application, A. M. Mathai, Ram Kishore Saxena and Hans J. Haubold, Springer publishers.

Learning Outcomes:

Students will be able to solve differential equation of arbitrary order. This course will help to develop the extended mathematical modelling of fractional order in Science and Engineering.

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