ACHARYA NAGARJUNA UNIVERSITY

CENTRE FOR DISTANCE EDUCATION

NAGARJUNA NAGAR,

GUNTUR

ANDHRA PRADESH

PROGRAM PROJECT REPORT

06. MASTER OF SCIENCE (MATHEMATICS)

Master of Science (Mathematics)

PROGRAMME CODE: 6

MISSION :

Mathematics is a broad field. Master in Mathematics can help supplement knowledge of science, including Physics, Chemistry and Biology.

OBJECTIVES :

This program has the following broad objectives:

To emphasize the relevance and usefulness of mathematics from an application point of view

To equip the learners with the core mathematical knowledge and training necessary for use in many application areas.

To expose the learner to real life problems and promote the use of mathematics in industry.

To develop a work force that is equipped with the mathematical skills that are necessary in the changing industrial and economic scenario of the country.

RELEVANCE :

The M.Sc. (Mathematics) programme offered through Open and Distance Learning mode is purely relevant and aligned with the goals and mission of CDE, ANU. This programme is structued inorder to equip the learners with core competence in research and analytical aspects of scientific evolution there by new areas will be unfolded. This programme is helpful for enhancing the employability skills with the global perspective and conforming to the vision and mission of ANU.

NATURE OF PERSPECTIVE TARGET GROUP OF LEARNERS :

Aim of open and distance eduation is to enhance the academic competence in those who were deprived of higher education for various socio-economic reasons. This programme is designed for candidates which is helpful in their career advancement, updating the knowledge, upgrading their qualification for school teachers etc. Mathematics Subject as a universal language of logic helps to get job opportunities in all sectors namely Banking, Actuary, Statistics , all government sectors and IT fields.

SKILLS AND COMPETENCE OF THE PROGRAMME :

In consideration of the huge gap in education and industry and also in skill development now it is imperative on the part of every university to reach out every nooc and corner of the country where the institutions with significant infrastructure are not availble in order to elevate the status of the marginalised sections of the society especcially living in rural areas of the country. The only solution appears to be "open and distance education" and Acharya Nagarjuna University takes initiative by reaching out those unreached by ICT enabled blended mode of distance learning programmes. M.Sc. (Mathematics) propgramme is an innovative programme. The learning outcomes of this programme are as follows:

- Professional development of teachers.
- Incorporating generic transferrable skills and competencies
- To develop critical learning, anylitical skills and research skills.

INSTRUCTIONAL DESIGN: Course structure and detailed syllabi

ACHARYA NAGARJUNA UNIVERSITY : CENTRE FOR DISTANCE EDUCATION

Master of Science (Mathematics) - Program code: 06

Program Structure

Course code	Course Name	Internal assessment	External exams	Max. Marks	credits
SEMISTER 1					
101MA24	ALGEBRA	30	70	100	4
102MA24	ANALYSIS-I	30	70	100	4
103MA24	DIFFERENTIAL EQUATIONS	30	70	100	4
104MA24	TOPOLOGY	30	70	100	4
105MA24	ADVANCED DISCRETE MATHEMATICS	30	70	100	4
106MA24	PRACTICAL- Papers from 101MA24 to 105MA24	30	70	100	4
SEMISTER 2					
201MA24	GALOIS THEORY	30	70	100	4
202MA24	ANALYSIS-II	30	70	100	4
203MA24	MEASLTRE AND INTEGRATION	30	70	100	4
204MA24	INTEGRAL EQUATIONS	30	70	100	4
205MA24	GRAPH THEORY	30	70	100	4
206MA24	PRACTICAL- Papers from 201MA24 to 205MA24	30	70	100	4
SEMISTER 3					
301MA24	RINGS AND MODULES	30	70	100	4
302MA24	COMPLEX ANALYSIS	30	70	100	4
303MA24	FUCNTIONAL ANALYSIS	30	70	100	4
304MA24	FUZZY SETS AND TIEIR APPLICATIONS	30	70	100	4
305MA24	LINEAR PROGRAMMING	30	70	100	4
SEMISTER 4					
401MA24	NON-COMMUTATTVE RINGS	30	70	100	4
402MA24	PARTIAL DIFFERENTIAL EQUATIONS	30	70	100	4
403MA24	NEAR RINGS	30	70	100	4
404MA24	LATTICE THEORY	30	70	100	4
405MA24	OPERATION RESEARCH	30	70	100	4
406MA24	PROJECT	--	--	100	4
407MA24	Comprehensive VIVA-VOCE	--	--	100	4

Master of Science (Mathematics) Syllabus

SEMESTER-I

101MA24: ALGEBRA

Unit-I: Group theory: Definition of a Group - Some Examples of Groups - Some Preliminary Lemmas - Subgroups - A Counting Principle - Normal Subgroups and Quotient Groups - Homomorphisms– Automorphisms. (2.1 to 2.8 of the prescribed book [1]).

Unit-II: Group Theory Continued: Cayley's theorem - Permutation groups-Another counting principle -Sylow's theorem. (2.9 to 2.12 of the prescribed book [1])

Unit-III: Direct products - finite abelian groups; Ring Theory: Definitions and Examples of Rings - some special classes of rings-Homomorphisms - Ideals and quotient Rings
(2.13 to 2.14 and 3.1 to 3.4 of the prescribed book [l])

Unit-IV: Ring Theory Continued: More Ideals and quotient Rings - The field of quotients of an Integral domain -Euclidean rings- A particular Euclidean ring -Polynomial Rings - Polynomials over the rational field. (3.5 to 3.10 of the Prescribed book [l]).

Unit-V: Polynomial Rings over Commutative Rings; Vector Spaces: Elementary Basic Concepts - Linear Independence and Bases - Dual spaces.
(3.11 and 4.1 to 4.3 of the prescribed book [1]).

PRESCRIBED BOOK: | I.N. Herstein, 'Topics in Algebra', Second Edition, John Wiley & Sons, 1999.

REFERENCE BOOKS:

1. P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul. "Basic Abstract Algebra", Second Edition, Cambridge Press, 1995.
2. Thomas W. Hungerford, 'Algebra', Springer- Verlag, New York, 1974.
3. Serge Lang, 'Algebra', Revised Third Edition, Springer-Verlag, New York, 2002.

102MA24: ANALYSIS-I

UNIT-I

Numerical Sequences and Series: Convergent sequences, Subsequences, Cauchy Sequences. (3.1 to 3.14 of Chapter 3 of the Text book) **(Questions not to be given in 3.1 to 3.14)**

Upper and Lower limits, Some special sequences, Series, Series of non-negative terms , Number e , The Root and Ratio tests, Power series , Summation by parts , Absolute convergence , Addition and Multiplication of series. (3.15 to 3.51 of Chapter 3 of the Text book)

UNIT-II

Continuity: Limits of functions, Continuous functions, Continuity and Compactness, Continuity and Connectedness. Discontinuities, Monotonic functions, Infinite limits and limits at infinity. (Chapter 4 of the Text book)

UNIT-III

Differentiation: Derivative of a real function ,Mean value theorems, The continuity of derivatives, L'Hospital's rule, Derivatives of higher order, Taylor's theorem. (5.1 to 5.15 of Chapter 5 of the Text book).

UNIT-IV

Differentiation of vector-valued functions. Riemann-Stieltjes Integral: Definition and Existence of the Integral. (5.16 to 5.19 of Chapter 5 and 6.1 to 6.11 of Chapter 6 of the Text book)

UNIT-V

Properties of the Integral, Integration and Differentiation, Integration of vector-valued functions , Rectifiable curves. (6.12 to 6.27 of Chapter 6 of the Text book)

TEXT BOOK:

Principles of Mathematical analysis by Walter Rudin 3rd Edition.

REFERENCE BOOK:

Mathematical Analysis by Tom M. Apostal, Narosa Publishing House, 2nd Edition, 1985.

103MA24: DIFFERENTIAL EQUATIONS

UNIT-I

Linear equations of the first order: Linear equations of the first order – The equation $y^1 + ay = 0$ – The equation $y^1 + ay = b(x)$ - The general linear equation of the first order. (Sections 4-7 Chapter 1 of Prescribed Text book).

Linear Equations with constant co-efficients: Introduction **-** The second order Homogeneous equation – Initial value problems for the second order equations. (Sections 1 to 3 in Chapter 2 Prescribed Book).

UNIT – II

Linear Equations with constant co-efficients: Linear dependence and independence – A formula for the Wronskian – The non-homogeneous equation of order two – The homogeneous equation of order n – Initial value problems for n-th order equations. (Sections 4 to 8 in Chapter 2 Prescribed Text Book).

UNIT – III

Linear Equations with Variable Co-efficients: Introduction – Initial value problems for the homogeneous equation – Solutions of the homogeneous equation – The Wronskian and linear independence – Reduction of the order of a homogeneous equation – The non-homogeneous equation – Homogeneous equations with analytic coefficients. (Sections 1 to7 in Chapter 3 Prescribed Text Book).

UNIT – IV

Linear Equations with Regular Singular Points: Introduction – The Euler equation – Second order equations with regular singular points – A convergence proof - The exceptional cases – The Bessel equation.(Sections 1 to 7 in Chapter 4 Prescribed Text Book).

UNIT- V

Existence and Uniqueness of Solutions to First Order Equations: Introduction – Equation with variables separated – Exact equations – The method of successive approximations – The Lipschitz condition – Convergence of the successive approximations – Non-local existence of solutions.
(Sections 1 to 7 in Chapter 5 Prescribed Text Book).

Prescribed Text Book : An introduction to Ordinary Differential Equations by Earl A. Coddington, Prentice-hall of Indial Private Limited, NEW DELHI, 1974.

104MA24: TOPOLOGY

UNIT-I

Metric Spaces: Definition and some examples, Open sets, Closed sets, Convergence, completeness and Baire's theorem, Continuous mappings. (Sections 9 to 13 of chapter 2)

UNIT-II

Topological spaces: The Definition and some examples, Elementary Concepts, Open bases and open subbases, Weak topologies. (Sections 16 to 19 of chapter 3)

UNIT-III

Compactness: Compact spaces, Products of spaces, Tychonoff's theorem and locally compact spaces, Compactness for metric spaces, Ascoli's theorem. (Sections 21 to 25 of chapter 4)

UNIT-IV

Separation: T_1 –spaces and Hausdorff spaces, completely regular spaces and normal spaces, Urysohn's Lemma and the Tietze extension theorem. (Sections 26 to 28 of chapter 5).

UNIT-V

The Urysohnimbedding theorem, Connected spaces, The components of a space (Section 29 of chapter 5 and sections 31 to 32 of chapter 6).

TEXT BOOK:

Introduction to Topology and Modern Analysis by **G.F. Simmons**, McGraw-Hill Book Company, New York International student edition.

105MA24: ADVANCED DISCRETE MATHEMATICS

UNIT –I: Propositional Calculus: Statements and Notations- Connectives and Truth Tables – Tautology and Contradiction – Equivalence of Statement / Formulas – Duality Law and TautologicalImplication – Normal Forms . (Chapter – I of the reference [3]).

UNIT –II: The theory of Inference for Statement Calculus – Consistency of Premises and Indirect Method of Proof. (Chapter – I of the reference [3]).
Predicate Calculus: Predicate Logic – Statement Functions, Variables and Quantifiers – Free and Bound Variable – Inference Theory for the Predicate Calculus (Chapter – 2 of the reference [3]).

UNIT –III: Finite Machines: Introduction, state tables and state diagrams, simple properties, Dynamics and Behavior. (refer Chapter 5 of the reference book [1]).

UNIT – IV: Properties and Examples of Lattices, Distributive Lattices, Boolean polynomials.(Sections 1 to 4 of Chapter 1 of [2]).

UNIT –V: Ideals, filters and equations, Minimal forms of Boolean polynomials, Application of Lattices: Application of switching circuits, (Sections 5,6 of Chapter -1 and sections 7 and 8 of Chapter 2of [2]).

Note: For units –III and IV the material of pages 1 to 66 of [2] is to be covered.

REFERENCE BOOKS:

[1] "Application oriented Algebra" JAMES L FISHER , IEP, Dun- Downplay pub.1977.
[2] " Applied abstract algebra", Second Edition, R.LIDL AND G. PILZ, Springer,1998.
[3] " Bhavanari Satyanarayana, Tumurukota Venkata Pradeep Kumar and Shaik Mohnddin Shaw, "Mathematical Foundation of Computer Science" BS Publications (A unit of BSP Book Pvt Ltd),Hyderabad, India 2016. (ISBN. 978-93-83635-81-8).
[4] Rm. Somasundaram "Discrete Mathematical Structures" Prentice Hall of India, 2003.
[5] Bhavanari Satyanarayana & Kuncham Syam Prasad, "Discrete Mathematics and Graph theory"(For B.Tech/B.Sc./M.Sc (Maths)), Printice Hall of India, New Delhi, April 2014.

106MA24: PRACTICAL

M.Sc. MATHEMATICS-II SEMESTER
201MA24- GALOIS THEORY

UNIT-I: Algebraic extensions of fields: Irreducible polynomials and Eisenstein criterion-Adjunction of roots - Algebraic extensions. (Sections 15.1 to 15. 3 of Chapter15 of the Prescribed book)

UNIT-II: Algebraically closed fields; Normal and Separable extensions: Splitting fields - Normal extensions - Multiple roots. (Section 15.4 of Chapter 15 and Sections 16.1 to 16.3 of Chapter16 of the prescribed book)

UNIT-III: Finite fields - Separable extensions-Automorphism groups and fixed fields. (Sections 16.4 to 16.5 of Chapter 16and Section 17.1 of Chapter 17 of the prescribed book)

UNIT-IV: Galois Theory: Fundamental theorem of Galois theory - Fundamental theorem of Algebra; Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials - Cyclic extensions.
(Sections 17.2 to 17.3 of Chapter 17 and Sections 18.1 to 18.2 of Chapter 18 of the prescribed book).

UNIT-V: Polynomials solvable by radicals -Symmetric functions – Ruler and Compass constructions
(Sections 18.3 to 18.5 of Chapter 18 of the prescribed text book)

PRISCRIBED BOOK:

P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul. "Basic Abstract Algebra", Second Edition, Cambridge Press, 1995.

REFERENCE BOOKS:

1. I.N. Herstein, 'Topics in Algebra', Second Edition, John Wiley &Sons, 1999.
2. Thomas W. Hungerford , 'Algebra', Springer-Verlag, New York, 1974.
3. Serge Lang, 'Algebra', Revised Third Edition, Springer-Verlag, New York, 2002.

202MA24- ANALYSIS.II

UNIT-I: Sequences and series of functions: Discussion of main problem, Uniform convergence, Uniform convergence and Continuity, Uniform convergence and Integration. (7.1 to 7.16 of Chapter 7 of the Text Book)

UNIT-II: Uniform Convergence and Differentiation, Equicontinuous families of functions, Stone-Weierstrass theorem. (7.17 to 7.27 of Chapter 7 of the Text Book)

UNIT-III: Algebra of functions, Power series, Exponential and logarithmic functions, Trigonometric functions. (7.28 to 7.33 of Chapter 7 and 8.1 to 8.7 of Chapter 8 of the Text Book)

UNIT-IV: Linear transformations, Differentiation, Contraction principle, Inverse function theorem.
(9.1 to 9.25 of Chapter 9 of the Text Book)

UNIT-V : Implicit function theorem, Determinants, Derivatives of higher order, Differentiation of integrals.
(9.26 to 9.29 and 9.33 to 9.43 of Chapter 9 of the Text Book)

TEXT BOOK: Principles of Mathematical Analysis by Walter Rudin, 3rd Edition.

REFERENCE BOOK:

Mathematical Analysis by Tom M. Apostal, Narosa Publishing House, 2nd Edition, 1985.

203MA24-MEASLTRE AND INTEGRATION

UNIT-I: Lebesgue Measure: Introduction, outer measure, Measurable sets and Lebesgue measure, A non measurable sets, Measurable functions, Littlewoods's three principles **(Chapter 3)**

UNIT-II: The Lebesgue integral: The Riemann Integral, The Lebesgue integral of a Bounded function over a set of finite measure, the integral of a non- negative function. The general Lebesgue Integral, Convergence in measure. **(Chapter 4)**

UNIT-III: Differentiation and Integration: Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity**. (Sections 1 to 4** of **Chapter 5)**

UNIT-IV: Convex functions, The Classical Banach Spaces**:** The L^P spaces, The Minkowski and Holder inequalities. (Secton **5** of **chapter 5** & **sections 1 to 2 of Chapter 6**)

UNIT-V: Convergence and completeness, Approximation in L^P, Bounded linear functionals on the L^P spaces. **(Sections 3 to 5 of Chapter 6)**

TEXT BOOK: Real Analysis **by H.L. Royden, Third Edition, Pearson Publication.**

204MA24-INTEGRAL EQUATIONS

UNIT-I

Volterra Integral Equations: Basic Concepts – Relationship between linear differential equations and volterra Integral equations – Resolvent Kernel of Volterra Integral Equation- Solution of Integral Equation by Resolvent Kernel – Method of Successive Approximations – Convolution type equations.(Sections 1 to 5 of Chapter –I of the Reference Book)

UNIT-II

Solution of Integro differential equations with the Aid of the Laplace Transformation – Volterre Integral Equations with limits $(x, +\infty)$ -Volterra Integral Equations of the First Kind – Euler Integrals – Abel's Problem, Ables Integral Equations and its generalizations – Volterra Integral Equations of the First kind of the Convolution type. (Sections 6 to 11 of Chapter – I of the reference book).

UNIT-III

Fredholm Integral Equations: Fredholm equations of the Second kind. Fundamentals – the method of Fredholm determinants – Iterated Kernels. Constructing the Resolvent Kernel with the Aid of iterated Kernels – Integral equations with degenerate kernel – Characteristic Numbers and Eigenfunctions. (Sections 12 to 16 of Chapter –II of Reference Book).

UNIT-IV

Solution of Homogeneous Integral Equations with Degenerate Kernel – Nonhomogeneous Symmetric Equations – Fredholm Alternative – Construction of Green's Function for Ordinary Differential Equations – Using Green's Function if the Solution of Boundary Value Problems. (Sections 17 to 21 of Chapter –II of the Reference Book).

UNIT – V

Boundary value problems containing a parameter reducing them to Integral equations – Singular Integral equations – Approximate methods of Solving Integral equations. (Sections 22, 23, of Chapter –II and 24 of Chapter-III of Reference Book).

Reference Book: Problems and Exercises in Integral Equations, MIR Oybkusgers, Moscow, 1971 by M. Krsnov, A. Kiselev and G. Makarendo.

Text Books:

1. Integral Equations and their Applications, WIT press, 25 Bridge Street, Billerica, MA 01821, USA, by M. Rahman.
2. Introduction to Integral Equations with Applications, John Wiley & Sons, 1999, by Jerri, A.
3. Linear Integral Equation, Theory and Techniques, Academic Press, 2014 by Kanwal R. P.
4. A first course in Integral Equations, 2nd edition, World Scientific Publishing Co. 2015 by Wazwaz, A. M.

205MA24-GRAPH THEORY

UNIT – I: Paths and Circuits : Isomorphism, Subgraphs, A puzzle with multi colored cubes, Walks, Paths and circuits, Connected graphs, Disconnected graphs, Components, Euler graphs, Operations on graphs, More on Euler graphs.
(Sections 2.1 to 2.8 of chapter 2 of the Text Book.)

UNIT – II: Hamiltonian Graphs: Hamiltonian paths and circuits, Traveling salesman problem.

Trees: Trees, Some properties of trees, Pendent vertices in a tree, Distance and centers in a tree, Rooted and binary trees, On counting trees.
(Sections 2.9 to 2.10 of Chapter 2 and 3.1 to 3.6 of Chapter 3 of the Text Book.)

UNIT – III ; Fundamental Circuits: Spanning trees, Fundamental circuits, Finding all spanning trees of a graph, Spanning trees in weighted Graphs.

Cut-sets: Cut-sets, All cut-sets in a graph, Fundamental circuits and cut-sets.
(Sections 3.7 to 3.10 of Chapter 3 and 4.1 to 4.4 of Chapter 4 of the Text Book .)

UNIT – IV ; Cut-vertices : Connectivity and separability, Network flows, 1- Isomorphism, 2-Isomorphism.

Planar Graphs: Combinatorial Vs. geometric graphs, Planar graphs, Kuratowski's two graphs, Different representations of a planar graph.
(Sections 4.5 to 4.8 of Chapter 4 and 5.1 to 5.4 of Chapter 5 of the Text Book.)

UNIT – V: Dual Graphs: Detection of planarity, Geometric dual.

Vector Spaces of a Graph: Sets with one operation, Sets with two operations, Modular Arithmetic and Galois fields, Vectors and Vector Spaces, Vector Space associated with a graph, Basis vectors of a graph.
(Sections 5.5 to 5.6 of Chapter 5 and 6.1 to 6.6 of Chapter 6 of the Text Book.)

TEXT BOOK:

" Graph Theory with Applications to Engineering and Computer Science" by 'NARSINGH DEO', Prentice Hall of India, Pvt Ltd., New Delhi, 1993.

206MA24-PRACTICAL

M.Sc. MATHEMATICS-III SEMESTER

301MA24:RINGS AND MODULES

UNIT-I: Rings and related Algebraic systems, Subrings, Homomorphisms, Ideals. (Sections 1.1, 1.2 of chapter 1).

UNIT-II : Modules, Direct products and Direct sums, Classical Isomorphism Theorems. (Sections 1.3, 1.4 of chapter 1).

UNIT-III: Prime ideals in Commutative Rings, Prime ideals in Special Commutative Rings. (Sections 2.1, 2.2 of Chapter 2).

UNIT-IV: The Complete Ring of Quotients of a Commutative Ring (Section 2.3 of Chapter 2).

UNIT-V: Ring of quotients of Commutative Semi Prime Rings, prime ideal spaces. (Sections 2.4& 2.5 of Chapter 2).

TEXT BOOK: "Lectures on Rings and Modules", J. Lambek, Blaisdell Publications.

Course outcome: The student attains more mathematical sophistication extending the concepts of rings introduced in the introductory course 101.

302MA24: COMPLEX ANALYSIS

UNIT-I: Sums and products, basic algebraic properties, further properties, vectors and moduli, complexconjugates, exponential form, products and powers in exponential form, arguments of products and quotients, Roots of complex numbers- examples – Regions in the complex plane. **(Sections 1 to 11 of Text Book) (Questions not to be given in Sections 1 to 11).**

Functions of a complex variable, mappings, mappings by the exponential function,limits, Theorems on limits, limits involving the point at infinity, continuity, derivatives, Differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability,polar co-ordinates, Analytic functions, Examples. **(Sections 12 to 25 of Text Book).**

UNIT-II: Harmonic functions, Uniquely determined Analytic functions, Reflection principle. The exponential function, the logarithmic function, branches and derivatives of logarithms, contours, contour integrals, Some examples - Examples with branch cuts, upper bounds for moduli of contour integrals, anti-derivatives, Proof of the Theorem (45), Cauchy-Goursat theorem, Proof of the Theorem (47), simply connected domains, multiply connected domains.
(Sections 26 to 31 & 39 to 49 of Text Book).

UNIT-III: Cauchy integral formula, An extension of the Cauchy integral formula – Some consequences ofthe extension. Liouvelli's theorem and the fundamental theorem of Algebra, maximum modulus principle. Convergence of sequences, Convergence of series, Taylor series, proof of Taylor's theorem, Examples.
(Sections 50 to 59 of Text Book)

UNIT-IV: Laurent series, proof of Laurents theorem, Examples absolute and uniform convergence of power series, continuity of sums of power series, integration and differentiation of power series, uniqueness of series representations, Isolated singular points, Residues, Cauchy residue theorem, Residue at infinity – The three typesof isolated singular points. **(Sections 60 to 72 of Text Book)**

UNIT-V: Residues at poles, Examples, zeros of analytic functions, zeros and poles, behavior of a function near isolated singular points. Evaluation of improper integrals, Examples - Improper integrals from Fourier analysis, Jordan's Lemma, definite integrals involving Sines and Cosines, Argument Principle, Rouche's Theorem. **(Sections 73 to 81 & 85 to 87 of Text Book)**

Text Book: Complex variables and Applications, James Ward Brown, Ruel V.Churchill, Mc Graw Hill, Eighth Edition, 2009.

Reference Books:

Complex Variables, H.Silvermen
Complex Variables by H.S.Kasana, Prentice Hall of India
Complex Variables by Murrey Rspiegel, Scheam's Outline series.

303MA24: FUCNTIONAL ANALYSIS

UNIT-I

Review of properties of Metric spaces (Chapter-1);Vector space - Normed spaces, Banach space - Further properties of normed spaces - Finite dimensional normed spaces- compactness and finite Dimension.
(2.1 to 2.5 of Chapter 2)

UNIT-II

Linear operators – Bounded and continuous linear operators – Linear functionals – Linear operators and functionals on Finite dimensional spaces – Normed spaces of operators, Dual Space.(2.6 to 2.10 of Chapter 2)

UNIT-III

Banach fixed point theorem – Applications of Banach fixed point theorem to linear equations and differential equations–Zorn's lemma - Hann Banach theorem – Hann Banach theorem to complex vector spaces and normed spaces.
(5.1 to 5.3 of Chapter5 and 4.1 to 4.3 of Chapter 4)

UNIT- IV

Applications to bounded linear functionals onC[a, b] - Adjoint Operator – Reflexive spaces – Category theorem and Uniform boundedness theorem.
(Sections 4.4 to 4.7 of Chapter 4)

UNIT- V

Strong and weak convergence - Convergence of sequences of operators and functionals – Open mapping theorem – Closed graph theorem
(Sections 4.8,4.9,4.12 and 4.13 of Chapter 4).

TEXT BOOK:

Introductory Functional analysis with applications by Erwin Kreyszig, John Willy and sons.

Reference Books:

1. Introduction to Topology and Modern Analysis by G.F. Simmons, McGraw Hill Book Company, New York International student edition.
2. Introduction to Functional Analysis, by A. E. Taylor, Wiley, New York, 1958.

304MA24: FUZZY SETS AND THEIR APPLICATIONS

UNIT-1: From Classical (Crisp) sets to Fuzzy sets: **Introduction, Crisp Sets:** An overview,Fuzzyset: Basic types, Fuzzy sets: Basic Concepts, Characteristics and significance of the paradigm shift. (Sections 1.1-1.5 of Chapter -1 of text book)

Fuzzy sets versus Crisp sets: Additional Properties of α-cuts, Representations of Fuzzy sets,Extension principle for Fuzzy sets (Sections 2.1-2.3 of Chapters 2 of Text book).

UNIT – II: Operations on Fuzzy sets: Types of Operations, Fuzzy Compliments, Fuzzy Intersections: t-Norms, Fuzzy unions: t-Conorms, Combinations of operations, AgreegationOperations (Sections 3,1-3.6 of Chapter-3 of Text book).

UNIT- III: Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals, Arithmetic Operations on Fuzzy numbers, Lattice of fuzzy numbers, Fuzzy equations(Sections 4.1-4.6 of Chapter 4 of Text book).

UNIT-IV: Fuzzy Relations: Crisp versus fuzzy relations, Projections and Cylindric Extensions,Binary Fuzzy Relations, Binary Relations on a Single set, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations. **(**Sections 5.1-5.6 of Chapter 5 of Text book).

UNIT-V:
Fuzzy Ordering Relations, Fuzzy Morphisms, Sup – i Compositions of Fuzzy Relations, Inf- ω_i Compositions of fuzzy Relations.(Sections 5.7-5.10 of Chapter 5 of Text book).

PRESCRIBED BOOK: "Fuzzy sets and Fuzzy Logic, Theory and Applications",G.J.Klir & B.YUAN, Prentice - Hall of India Pvt. Ltd., New Delhi., 2001.

305MA24: LINEAR PROGRAMMING

UNIT – I

Mathematical Back ground: Lines and hyper planes: Convex sets, convex sets and Hyper planes, convex cones. (Sections 2.19 to 2.22 of Chapter 2of [1]).

Theory of the simplex method : restatement of the problem, slack and surplus Variables , reduction of any feasible solution to a basic feasible solution , some definitions and notations ,improving a basic feasible solution, unbounded solutions, optimality conditions alternative optima , Extreme points and basic feasible solutions. (Sections 3.1, 3.2, 3.4 to 3.10 of Chapter 3 of [1])

UNIT –II

Detailed development and Computational aspects of the simplex method, The Simplex method, selection of the vector to enter the basis, degeneracy and breaking ties further development of the transportation formulas, the initial basic feasible solution –artificial variables, Tableau format for simplex computations, use of the tableau format, conversion of a minimization problem to a maximization problem, Review of the simplex method, illustrative examples. (Sections 4.1 to 4.5 & 4.7 to 4.11 of Chapter 4 of [1]).

UNIT –III

Transportation problems: Introduction, properties of the matrix A: the simplex Method and transportation problems, simplifications resulting from all $y_{ij}\alpha\beta = \pm 1$or 0, The Stepping-Stone algorithm.(Sections 9.1 to 9.7 of Chapter 9of [1]).

UNIT –IV

Determination of an initial basic feasible solution, alternative procedure for computing $z_{ij} - c_{ij}$; duality (Sections 9.10 & 9.11 of chapter 9 of [1])

UNIT –V

The assignment problem: Introduction, description and mathematical statement of the problem, Solution using the Hungarian method, the relationship between transportation and assignment problems, further treatment of the assignment problem, the bottle neck assignment problem. (Sections 6.1 to 6.6 of Chapter-6 of [2])

TEXT BOOK:

[1] **G. Hadley** "Linear Programming" Addison-Wesley Publishing Company.

[2] **Benjamin Lev and Howard J.Weiss** "Introduction to Mathematical Programming" Edward Arnold Pub, London, 1982.

M.Sc. MATHEMATICS-IV SEMESTER

401MA24: NON COMMUTATIVE RINGS

UNIT –I: Primitive Rings, Radicals, completely reducible modules. (Sections 3.1 to 3.3 of Chapter 3).

UNIT – II: Completely reducible rings, Artinian and Noetherian rings, On lifting idempotents,. (Sections 3.4, to 3.6 of Chapter 3).

UNIT – III: Local and semiperfect rings, Projective modules, Injective modules.(Section 3.7 of Chapter 3 & Sections 4.1 to 4.2 of Chapter 4).

UNIT –IV: The complete ring of quotients, Rings of endomorphism's of injective modules. (Sections 4.3 to 4.4 of Chapter 4).

UNIT –V: Tensor products of modules, Hom and functors exact sequences.(Sections 5.1 to 5.3 of Chapter 5).

TEXT BOOK:

J. Lambek "**Lectures on Rings and Modules**" A Blaisdell book in Pure and Applied Mathematics.

M.Sc. MATHEMATICS-IV SEMESTER
402MA24: PARTIAL DIFFERENTIAL EQUATIONS

UNIT-I

First Order Partial Differential equations: Curves and Surfaces - Genesis of first order partial differential equations - Classification of integrals - linear equations of the first orderPartial Differential equations - Compatible systems. (Sections 1.1 to 1.6 of Chapter 1 of [1])

UNIT-II

Charpit's method – Jacobi's method - Integral surfaces through a given curve- **Second order Partial differential Equations**: Genesis of Second Order Partial Differential Equations - Classification of Second Order Partial differential equations.
(Sections 1.7 to 1.9 of Chapter 1 and Sections 2.1 to 2.2 of Chapter 2 of [1]).

UNIT-III

One Dimensional Waves equations: Vibrations of an infinite string - Vibrations of a semi-infinite string - Vibrations of a string of Finite Length - Riemann's Method - Vibrations of a string of finite length (method of separation of variables) - **Laplaces Equation**: Boundary value problems - Maximum and minimum principles.
(Sections 2.3.1 to 2.3.5 of Chapter 2 and Sections 2.4.1to 2.4.2 of Chapter 2 of [1]).

UNIT-IV

The Cauchy problem - The Dirichlet problem for the upper Half plane - The Neumann problem for the upper Half plane - the Dirichlet problem for a circle - the Dirichlet Exterior problem for a circle –TheNeumann problem for a circle- The Dirichlet problem for a Rectangle – Harnack's Theorem.
(Sections 2.4.3 to 2.4.10 of Chapter 2 if [1])

UNIT-V

Laplace's Equation – Green's Function- The Dirichlet problem for a Half plane -The Dirichlet problem for a circle - Heat conductioninfinite rod case - Heat conduction Finite rod case -**Duhamel's principle**: Wave equation - Heat conduction equation.
(Sections 2.4.11 to 2.4.13 and 2.5.1 to 2.5.2 and 2.6.1 to 2.6.2 of Chapter 2 of [1])

TEXT BOOK: An Elementary course in Partial Differential Equations by T.Amaranath, Published by Narosa Publishing House.

M.Sc. MATHEMATICS-IV SEMESTER
403MA24– NEAR-RINGS

Unit I

The Elementary Theory of Near-Rings

(a) Fundamental definitions and properties:

Near-rings, N-groups, Substructures, Homomorphisms and ideal-like concepts, Annihilators and Generated objects. (Section (a) of Chapter – 1)

Unit II

(a) Constructions: Products, direct sums and subdirect products

(b) Embeddings: Embeddings in M (□)

Ideal Theory

(a) Sums:

1. Sums and direct sums
2. Distributive sums

(b) Chain conditions

(Sections (b) (1) & (c) (1) of Chapter – 1 and Sections (a) & (b) of Chapter – 2)

Unit III

(c) Decomposition theorems

(d) Prime ideals

1. Products of subsets
2. Prime ideals
3. Semiprime ideals

(Sections (c) & (d) of Chapter -2)

Unit IV

(a) Nil and nilpotent

Structure Theory:

Elements of the structure theory

(a) Types of N-groups

(b) Change of the Near-ring

(c) Modularity

(Section (e) of Chapter-2 and Sections (a), (b) & (c) of Chapter-3)

Unit V

Structure Theory:

(d) Quasiregularity

Primitive Near-Rings:

(a) General

1. Definitions and elementary results
2. The centralizer
3. Independence and density

(b) 0-primitive near-rings

(Section (d) of Chapter-3 and Sections (a) & (b) of Chapter-4)

Prescribed Book:

Near-Rings, The Theory and its Applications by Gunter Pilz, North-Holland PublishingCompany, AMSTERDAM, Revised Edition, 1983.

M.Sc. MATHEMATICS –IV SEMESTER

404MA24 – LATTICE THEORY

UNIT –I

Partly Ordered Sets:

Set Theoretical Notations, Relations, Partly Ordered Sets, Diagrams, Special Subsets of a Partly OrderedSet, Length, Lower and Upper Bounds, The Jordan–Dedekind Chain Condition, Dimension Functions.(Sections 1-9 of Ch I)

UNIT – II

Algebras, Lattices, The Lattice Theoretical Duality Principle, Semi Lattices, Lattices as Partly Ordered Sets, Diagrams of Lattices, Sub Lattices, Ideals, Bound Elements of a Lattice, Atoms and Dual Atoms, Complements, Relative Complements, Semi Complements, Irreducible Prime Elements of a Lattice, The Homomorphism of a Lattice, Axiom Systems of Lattices.(Sections 10-21 of Ch II)

UNIT – III

Complete Lattices, Complete Sub Lattices of a Complete Lattice, Conditionally Complete Lattices,Compact Elements and Compactly Generated Lattices, SubAlgebra Lattice of an Algebra, Closure Operations, Galois Connections, Dedekind Cuts, Partly Ordered Sets as Topological Spaces.(Sections 22-29 of Ch III)

UNIT – IV

Distributive Lattices, Infinitely Distributive and Completely Distributive Lattices, Modular Lattices, Characterization of Modular and Distributive Lattices by their Sublattices, Distributive Sub lattices ofModular Lattices.(Sections 30-34 of Ch IV)

UNIT – V

The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representation in Modular and Distributive Lattices.(Sections 35-36 of Ch IV)
Boolean Algebras, De Morgan Formulae, Complete Boolean Algebras, Boolean Algebras and Boolean Rings.(Sections 42-46 of Ch VI)

PRESCRIBED BOOK: "Introduction to Lattice Theory", Gabor Szasz, Acadamic press.

REFERENCE BOOK: "Lattice Theory", G. Birkhoff, Amer. Math.Soc**.**

M.Sc. MATHEMATICS-IV SEMESTER

405MA24:OPERATION RESEARCH

UNIT –I: Further Discussion of the simplex method: Further discussion; the two phase Method for artificial variables; phase-I; Phase-II; Numerical examples of the two phase method. [Sections 5.1 to 5.4 of Chapter -5 of [1]]

UNIT –II: Duality theory and its Ramifications: Alternative formulations of linear programming problems; Dual linear programming problems; Fundamental properties of dual problems; other formulations of dual problems; unbounded solution in the primal; the dual simplex algorithm –an example. Post optimality problems, changing the price vector, changing the requirements vector, adding variables or constraints
(Sections 8.1 to 8.7; 8.10 of Chapter 8 and 11.2 to 11.5 Chapter 11 of [1]).

UNIT –III: The Revised simplex method: Introduction; Revised simplex method-standard form I; computational procedure for standard form I; Revised simplex method-Standard form II; computational procedure for standard form II; Initial identity matrix for phase –I ; comparison of the simplex method and Revised simplex method.
(Sections 7.1 to 7.6 & 7.8 of Chapter 7 of [1]).

UNIT –IV: Game theory: Game theory and Linear programming; Introduction; reduction of a game to a linear programming problem; conversion of a linear programming problem to a game problem.(Sections 11.2 to 11.14 of Chapter 11 of [1])

UNIT –V: Goal programming, Integer programming: Introduction; Gomory's cut, Balas Implicit Enumeration Technique, Goal programming.
(Sections 7.1, 7.2 and 7.4 of Chapter 7 and Section 10.3 of Chapter10 of [2])

TEXT BOOKS:

[1] **G.Hadley** "Linear programming" Addison Wesley Publishing Company.
[2] **Benjamin Lev and Howard J. Weiss** "Introduction to Mathematical Programming" Edward Arnold Pub, London, 1982.

406MA24: PROJECT

407MA24:: VIVA-VOCE

Duration of the Programme:

Minimum: Two Academic Years from the year of joining of the course (Four Semesters). **Maximum**: Five Academic Years from year of joining of the course for securing First Class or Second Class.

INSTRUCTIONAL DESIGN :

Instructional delivery mechanism: University has its own faculty for M.Sc. Mathematics department and all the faculty members will act as resource persons. Our University has blended mode delivery mechanism i.e., ICT and Conventional modes. Media of delivery mechanisms:

• **Printing:** The study material delivery media include Printing of books which are issued to the students who are enrolled for the programme.

• **Online:** On line PDF format content is also given access to the students who wish to study through online mode.

• **Interactive sessions, and Discussion boards:** In distance Education, face to face contact between the learners and their tutors is relatively less and therefore interactive sessions are conducted. The purpose of such interactive session is to answer some of the questions and clarify doubts that may not be possible in other means of communication. This programme provides an opportunity to meet other fellow students. The Counsellors at the study centres are expected to provide guidance to the students. The interactive sessions are conducted during week ends and vacations to enable the working students to attend.

• **Student support services:** Student support services include Internet enabled student support services like e-mails, SMS and even an app is planned. Student feed back mechanism is created and feed back is designed. Student Learning Managemnet Sysyem (LMS) is customized to every student. For every student customized examination management system (EMS) is also created facilitationg self evaluation, demo tests, model question papers and periodical Internal Assessments.

• **Credit System:** University has adopted Choice Based Credit System (CBSE) under semester mode from 2013. The same has been approved by relevant Statuatory boards in Distance mode also.

• **Admission procedure:** In M.Sc. (Mathematics) programme candidates can take admission directly. For this purpose, CDE, ANU will advertise for admissions. Then candidates should apply in prescribed format of the CDE after publication of the advertisement.

• **Eligibility Criteria:** The eligibility for admission into this course is a pass in B.A. or B.Sc. with Mathematics as main or ancellary or one of the three equal subjects. • Fee Structure: The total course fee is Rs.16,600/-.

• **Policy of programme delivery:** Our University has blended mode delivery mechanism i.e., ICT and Conventional modes. In conventional mode printed material is given and also online mode of delivery with learning management system is adopted.

• **Activity planner:** There is an yearly academic plan and as per plan interactive sessions, assignments, examinations etc are conducted to the candidates.

• **Evaluation System:** Periodical progress of learning is evaluated by web based feed back mechanism in the Learning Management System. Evaluation of learner progress is conducted as follows:

(i) The examination has two components i.e., continuous evaluation by way os assignments (30 %) and term end University Examination (70 %).

(ii) Each student has to complete and submit assignment in each of the theory paper before appearing to the term end examination. The term end examination shall be of 3 hours duration.

(iii) Minimum qualifying marks in each paper is 40 % indivually in internal and term end examination. The candidates who get 60 % and above will be declared as passin First Division, 50 % to below 60 % as Second Division and 40 % to below 50 % as Third Division.

(iv) THe Centre for Distance Education, Acharya Nagarjuna University will conduct the examinations, evaluations and issue certificates to the successful candidates.

(v) All the term end examinations will be conducted at the examination centres fixed by the CDE.

(vi) Qualitatively the examinations conducted for the students of the Distance Education are on par with the examinations conducted for the regular University students.

LIBRARY SUPPORT AND LIBRARY RESOURCES :

The M.Sc. (Mathematics)) program is based on the theory and practical papers. Laboratory support is available to students. Further, entire University Library is accessble to all the students of distance education. Additionally every department in the University has a well equipped library which is accessable to all the students. CDE also provides a compendium of web resources to every student to support learning.

COST ESTIMATE :

The Programme fee for I year is Rs.7,500/-, and II year is Rs. 9,100/-. The university will pay the remuneration to Editors and lesson writers as per university norms. DTP charges, Printing of books and Examination fees will be paid by the ANUCDE as per prescribed norms. This institution is providing high quality programmes at low cost.

QUALITY ASSURANCE :

Quality assurance comprises the policies, procedures and mechanisms which that specified quality specifications and standards are maintained. These include continuous revision and monitoring activities to evaluate aspects such as suitability, efficiency, applicability and efficacy of all activities with a view to ensure continuous quality improvement and enhancement. The programme is designed with a focus on the proposed learning outcomes aimed at making the learner industry ready also for career advancement, enterprenureal development, and as wealth creators. There is a continuous evaluation of learning and of competence internally and also by ICT enabled feed back mechanism and Centre for Internal Quality Assurance (CIQA). The University ensures maintaining quality in education provided through open and diatance learning mode. As per the need of the information society and professional requirement, the University ensures to change the mechanism from time to time along with enhancement of standard in course curriculum and instructional design. Therefor, the outcomes of the programme can meet the challenges in the changing society.

DIRECTOR
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Acharya Nagarjuna University
Nagarjuna Nagar,
GUNTUR-522 510.

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