Established by Govt. of Arunachal Pradesh vide Act 9 of 2012, the Arunachal University of Studies Act, 2012
Recognized as per u/s 2(f) of University Grants Commission Act, 1956
NH-52, Namsai, Arunachal Pradesh -792103

MASTER OF SCIENCE (MATHEMATICS) - FOURTH SEMESTER

Fourth Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Measure Theory	5	100
2	Non-linear Dynamical System and Chaos	5	100
3	Discrete Structure and Graph Theory	4	100
	Any Two		100
4 5	1. Magnetohydrodynamics 2. Mathematical Modelling 3. Computational Fluid Dynamics 4. Algebraic Graph Theory	5 5	100 100
Total		**24**	

Subject Name: MEASURE THEORY

Unit 1: Measurable Sets

Outer measure, Lebesgue measure, measurable sets and their properties, Borel sets, Characterization of measurable sets, non-measurable sets.

Unit 2: Measurable Functions

Properties, Step functions, Characteristic functions, Simple functions, Continuous functions, Set of measure zero, Borel measurable function, Realization of non-negative measurable functions in terms of simple functions, Convergence in measure.

Unit 3: Lebesgue Integrals

Riemann integrals, Lebesgue integration of a simple function, Bounded convergence theorem, Fatou‟s lemma, Monotonic Convergence Theorem, integrable functions, General Lebesgue Integral, Dominated convergence theorem.

Unit 4: Differentiation and Indefinite integrals

Dini Derivatives, functions of bounded variation, Jordan decomposition Theorem, Indefinite integrals, Signed measures and their derivatives, Hahn decomposition, Radon Nykodym theorem.

Unit 5: Lp –Space

The Lp space, Holder, Minkowski‟s inequalities, summable sequence, essential supremum, Completeness of Lp space, Riesz- Fischer theorem, Bounded linear functional on Lp spaces, Riesz representation theorem.

REFERENCE BOOKS:

1. H.L. Royden, *Real Analysis*, Mc-Millan
2. G.D. Berra, *Measure Theory and Integration*, Wiley Eastern LTD
3. W. Rudin, *Principles of Mathematical Analysis* (Ed-3), McGraw Hill

Subject Name: NON-LINEAR DYNAMICAL SYSTEM AND CHAOS

Unit-1 : One Dimensional Flows and Bifurcations

Introduction, Fixed points and Stability, Population Growth, Linear Stability Analysis, Existence and Uniqueness, Impossibility of oscillations, Potentials, Saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation, Imperfect bifurcations, Flow on the circle.

Unit-2 : Two Dimensional Flows and Bifurcations

Linear Systems: Definition, examples and classification of linear systems,
Phase planes: Introduction, phase portraits, conservative systems, Reversible systems, Index theory,
Limit cycles: Introduction and examples, Ruling out closed orbits, Liapunov Functions, Poincare-Bendixson, theorem, Lienard Systems, Relaxation Oscillators, Weakly non-linear oscillators, Saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation, Hopf bifurcation,

Unit 3 : Chaos

Lorenz Equations: Introduction, Simple properties of the Lorenz equation, Definitions of chaos, attractors and strange attractors, One dimensional maps: Introduction, Fixed points and Cobwebs, Numeric and analysis of Logistic map, Renormalization, Fractals: Countable and uncountable sets, Cantor set and its fractal property, Dimensions of self similar fractals, Box Dimension, The von Koch curve, Strange attractors, The Baker‟s map B.

REFERENCE BOOKS :

1. Nonlinear Dynamics and Chaos by Steven H. Strogatz Westview Press, ISBN – 13 978-0-7382-0453-6
2. Understanding Nonlinear Dynamics, Author Daniel Kaplan and Leon Glass, Springer, New York.
3. Nonlinear Dynamics and Chaos by Thompson JMT and Stewart H B John Wiley and Sons, Chichester.

Subject Name: DISCRETE STRUCTURE AND GRAPH THEORY

Discrete Structure

Unit – 1 : Grammars and Languages

Definitions and Examples, Context- free grammar, Regular grammar, Operations on Languages, Regular Grammar, Finite State Automata: State diagram of an Automata.

Graph Theory

Unit - 2 : Graphs and Trees

Graph, Basic definitions, Isomorphism of graphs, Subgraphs, Walks, Paths, Circuits, Connected graphs, Disconnected graphs, Trees, Some properties of trees, Distance and centers in a tree, Rooted and binary trees, On counting trees, Spanning trees, Cut-sets, Some properties of a cut-set, Connectivity and Separability, Blocks.

Unit – 3 : Operations On Graphs

Planar and non-planar graphs, Kuratowski‟s two graphs, Different representations of a planar graph, Matrix representation of graphs, Incidence matrix, Adjacency matrix , Graph matchings, Graph coverings.

Unit - 4 : Directed Graphs and Enumeration of Graphs

Definition of Directed graphs (digraph), Some types of digraphs, Digraphs and binary relations, Directed paths and connectedness, Acyclic digraphs and decyclization, Enumeration of graphs, Types of enumeration, Counting labeled trees, Counting unlabelled trees.

Unit - 5 : Graph Algorithms

Algorithms, Shortest-path algorithms, Transitive closure of a digraph, Activity network, Topological sorting, Critical path, Graphs in computer programming (basic concepts).

REFERENCE BOOKS :

1. Discrete Mathematical Structures with Applications to Computer Science, by J. P. Tremblay, R. Manohar, Tata McGraw Hill, 1997

2. Graph theory with applications to engineering and computer science by Narsigh Deo, Prentice- Hall of India Private Limited, New Delhi.

Subject Name: MAGNETOHYDRODYNAMICS

Unit 1: **MHD Approximations**

The electrical properties of Fluid, electric and magnetic field, Lorentz force , action at a distance, the low frequency approximations, energetic aspects of MHD, magnetic energy.

Unit 2: The Kinematic aspects of MHD

The magnetic induction equation, the anlogy with vorticity, diffusion and convection of magnetic field , Magnetic reynold number, the dynamo problem, Alfven‟s theorems, Cowling problem, , the two dimensional kinematic problem with flow in the direction of no variation, the two dimensional kinematic problem with field in the direction of no variation, the two dimensional kinematic problem with current in the direction of no variation.

Unit 3: The magnetic force and its effects

The magnetic force and the inertia force , magnetic stress , principal directions and stress, Magnetohydrostatic, The linear pinch confinement scheme, the force free fields, the magnetic field in moving fluid, invalidation of kelvin‟s theorem on vorticty, the case of irrotational force per unit mass.

Unit 4: Boundary Conditions

Boundary conditions for magnetic field, boundary condition for current, boundary conditions for electric field, boundary condition on velocity.

Unit 5: Linear magnetohydrodynamics : Linearised MHD equations for

i) 1-D case : The steady Hartmaan Flow problems, Poiseuille type flow, Coutte type of Flow, Linear Alfven waves, MHD Rayleigh problem
ii) 2-D case : Steady laminar flow in a pipe under uniform transverse field.

REFERENCE BOOKS:

1. A text book of Magnetohydrodynamics , J.A. Schercliff, Pergamon Press, New York (1965).
2. Magnetohydrdynamics by T. G. Cowling, Interscience Publishers, 1957.

Subject Name: MATHEMATICALMODELLING

Unit 1 : Introduction:

The Technique on Mathematical Modelling, Mathematical Modelling Through Calculus, Mathematical Modelling Through Ordinary Differential Equations of first order, Linear Growth and Decay Models, Non-Linear Growth and Decay Models, Compartment Model, Mathematical Modelling in Dynamics through Ordinary Differential Equations of first order.

Unit 2 : Application Of Mathematical Modelling:

Mathematical Modelling in Population Dynamics, Mathematical Modelling of Epidemics through systems of Ordinary Differential Equations of first order, Mathematical Modelling in Economics based on systems of Ordinary Differential Equations of first order, Mathematical Models in Medicine, Arms Race Battles and International Trade in terms of Ordinary Differential Equations.

Unit 3 : Modeling Through Difference Equations

Modelling through Difference Equations, Some Simple Models, Mathematical modelling through Difference Equations in Economics, Finance, Population Dynamics and Genetics.

Unit 4 : Modelling Through Partial Differential Equations

Partial Differential Equation Model for Birth-Death-Immigration-Emigration Process, Partial Differential Equation Model for a Stochastic-Epidemic Process, Model for Traffic on a Highway.

REFERENCE BOOKS:

1. Mathematical Modelling by J.N.KAPUR, Wiley Eastern Ltd, New Delhi

2.An Introduction to Mathematical Modelling by EDWARD A. BENDER, John Wiley and sons, New York.

Subject Name: COMPUTATIONAL FLUID DYNAMICS

Section A :Unit – I
Computational Fluid Dynamics, Governing Equations of Fluid Dynamics, Boundary Conditions, Forms of Governing Equations suitable for CFD, Classification of partial Differential Equations.

Unit – II :Basic aspects of Discretization :

Finite difference, Difference and Transformations Equations, Explicit and Implicit Approaches, Errors and Stability, General Transformation Equations, Stretched grid, Boundary-Fitted Co-ordinate Systems.

Unit – III CFD Techniques :

The Lax-Wendroff and MacCormack‟s Techniques, Relaxation, Central Difference Equations for Navier-Stokes Equations.

Section B : Practical

Numerical Formulation using Crank-Nicholson Technique for Couette flow and two-dimensional problems. Program development and execution.

REFERENCE BOOKS:

1. John D Anderson, Jr. : *Computational Fluid Dynamics,* Mc-Graw Hill
2. John C. Tannehill, Dale A. Anderson and *Computational Fluid Dynamics and Heat Transfer*; Taylors and Francis.
3. T.J. Chung : *Computational Fluid Dynamics*, Cambridge Univ. Press
4. Tapan K. Sengupta : *Computational Fluid Dynamics*, University Press

Subject Name: ALGEBRAIC GRAPH THEORY

Unit – 1 : Reviews :

Basic Definitions of Graph theory and Linear Algebra, Matrix Representations of a graph : Adjacency matrix and Incidence matrix.

Unit - II

Eigenvalues of Graphs : A Little Matrix Theory, Eigenvalues and Walks, Eigenvalues and Labeling of graphs, Lower and Upper Bounds for the Eigenvalues, S eidel matrix of a graph.

Unit - III

Graph Laplacians : Laplacian of a graph, Laplace Eigenvalues, Eigenvalues & Vertex partition of graphs, The Max-Cut Problem, Travelling Salesman Problem, Random Walks on graphs.

Unit – IV

Spectral Graph Theory : Introduction, Angles, Star sets and Star partitions, Integral Graphs.

REFERENCE BOOKS:

1. R.J. Wilson, l. W. Beineke, Topics in Algebraic Graph Theory, Cambridge University Press, 2004.
2. C. Godsil, G. Royle, Algebraic Graph Theory, Springer Verlag Newyork, 2001.

Note: The Normal Rule and Regulation pertaining to the Examination and other issues will be applicable in Faculty of Science as per Arunachal University of Studies Act 2012, Subsequent Statute and Rules & Regulations.