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) - SECOND SEMESTER

Second Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Tensor Analysis	5	100
2	Algebra-II	4	100
3	Classical Mechanics	5	100
4	Continuum Mechanics	5	100
5	Functional Analysis	5	100
Total		**24**	

Subject Name: TENSOR ANALYSIS

UNIT –1 : Cartesian Tensor Algebra:

Scalars**,** vectors and Tensors; Suffix Notation, Cartesian summation convention, Kronecker delta, Permutation symbols, Matrices and determinants in Index notation, scalar multiplication, Cartesian Vector, Addition of vectors-coplanar vectors, Unit vectors, A basis of non-coplanar vectors, Scalar product-orthogonality, Vector product, Triple scalar product, Triple vector product, Reciprocal base system, Second order tensors, Examples of second order tensors, Scalar multiplication and addition, Contraction and multiplication, The vector of an antisymmetric tensor, Canonical form of a symmetric tensor, Higher order tensors, The quotient rule, Isotropic tensors.

UNIT–2 : Cartesian Tensor Calculus:

Cartesian tensor notations for :Tensor function of time-like variables, Line integrals, Surface integrals, volume integrals, Change of variable with multiple integrals, Vector fields, The Vector operator -Gradient of a scalar, The divergence of a vector field, The curl of a vector field, Green‟s theorem and some of its variants, Stokes theorem.

UNIT : 3 General Tensors:

Coordinate systems and conventions, Proper transformations, Contravariant vectors, Covarient vectors, The metric tensor, Examples, Absolute and relative tensor fields,

Isotropic tensor, Tensor algebra, The quotient rule, Length of a vector and angle between vectors, Principal directions of a symmetric second order tensor, Covariant and contravariant base vectors, The physical components of a vector, The physical components of a tensor,

UNIT - 4

Differential of tensors, Parallel vector field, Christoffel symbols, Christoffel symbols in orthogonal coordinates, covariant differentiation, The grade, divergence,Laplacian and curl, Green‟s and Stoke‟s theorem in general tensor notation, Euclidean and other spaces . Intrinsic derivatives and its applications.

REFERENCE BOOKS :

1. *Vector and Tensor Analysis,* Author : Utpal Chaterjee and Nandini Chaterjee Academic Publishers.
2. *Introduction to Tensor Calculus and Continuum Mechanics* by J. H. Heinbockel **.**
3. *Vectors, Tensors and the Basic Equations of Fluid Mechanics* Author: Rutherford Aris Dover Publication, Inc., New York. ISBN 0-486-66110-5
4. *Vector and Tensor Analysis,* Author Bosenko Tarapov Silverman, ISBN 10:0486638332, Dover Publication

Subject Name: ALGEBRA-II

UNIT-I:

Unique factorization domain, Principal Ideal Domain, Euclidean Domain

UNIT-II:

Polynomial rings- Polynomials over the rational field – Polynomial rings over Commutative rings

UNIT-III:

Algebraic Extensions of Fields, Adjunction of roots, Algebraic extensions, Algebraically closed fields

UNIT-IV:

Splitting fields, Normal extensions, Multiple roots, finite fields , Separable extensions

REFERENCE BOOKS :

1. I.N.Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian edition, 1997

3. D.S. Dummit, R.M. Foote: Abstract Algebra –John Wiley&Sons,2003
4. Thomas W.Hungerford, Algebra, Springer-Verlag, New york, 1974

Subject Name: CLASSICAL MECHANICS

Unit 1:

Introduction to the ideas of constrained motion, Different classifications of constrains of motion, Holonomic and nonholonomic constraints, rhenomic and scleronomic dynamical constraints, Concept of degree of freedom.
Introduction to generalized coordinates, generalized velocities, Total Kinetic energy of a system of particles in terms of generalized velocity. Introduction to generalized momenta and generalized force.
D‟Alemberts principle and Lagrangian form of equation motion of a dynamical system of N particles. Few examples to explain the application of Lagrange‟s form of equation of motion, motion of projectile of a particle, motion of double pendulum and similar few other simple problems.

Unit II:

Introduction to Technique of Calculus of variation : Euler‟s Lagrange differential equation, discussion of examples to explain the application of Euler‟s Lagrange differential equation, Brchistochrone problem, problem of shortest distance between two points on plane.
Introduction of Hamilton‟s Principle of least action. Derivation of Lagrange‟s form of equation of motion using Hamilton‟s principle of least action. Lagranges form of equation for problems associated with nonholonomic constrains, conservation principles and symmetry properties, Lagranges, equation of motion for small oscillations.

Unit III:

Introduction to phase space and Equationian : Hamilton‟s canonical equation of motion, canonical variables, cyclic co-ordinates, Canonical transformations and generating functions, Discussion on problem of motion of simple pendulum, double pendulum, motion of particle in a Use of Hamilton‟ canonical equation to solve certain simple dynamical problems (these includes all problems considered to explain use of Lagrange equatin of motions).
Lagranges and Poissons‟s brackets: Integral invariant of Poincare, The Jacobi‟s identity, Hamilton‟s equation and Poison‟ bracket.
Lagranges brackets, poison bracket, integral invariant of Poincare, the Jacobi‟s identity, Poisson‟s bracket and Hamilton‟s canonical equations.

Unit IV:

Hamilton Jacobi Method : Hamilton - Jacobi equation, Time independent Hamilton - Jacobi equation, canonical transformation generated by Hamilton characteristic function, application of Hamilton - Jacobi equation in solving problems of mechanics.

Action and angle variables, regular frequencies, costant action torus in phase space, periodic systems, degenerated systems, completely degenerated systems.

REFERENCE BOOKS :

1. Classical Mechanics by Herbert Goldstein, Addision Wesley Publishing Company, INC. USA.
2. Lagrangian and Hamiltonian Mechanics by M.G. Calkin, World Scientific, Singapore. 1996

Subject Name: CONTINUUM MECHANICS

Unit-1: Continuum Hypothesis and Stress

Continuum hypothesis, mass and density, body force and surface force, stress components, Cauchy‟s law, state of stress at a point, stress tensor, normal and shear stresses, principal stress, stress invariants, stress deviator, boundary condition for stress tensor.

Unit-2: Deformation and Strain

Continuum configuration, Lagrangian and Eulerian description, material and spatial co-ordinates, deformation, displacement and deformation gradients, stretch and rotation tensor, strain tensor, strain-displacement relations, infinitesimal strain tensor, interpretation of linear strain tensor, compatibility conditions, principal strains, strain deviator.

Unit-3: Motion and Fundamental Laws of Continuum Mechanic

Material and local time derivatives, velocity and acceleration, steady, uniform and linear motion, irrotational motion and potential flow, path lines, streamlines and vortex lines, Reynolds transport theorem, circulation and vorticity, conservation of mass, continuity equation, linear momentum principle, equation of motion, angular momentum principle, general solution of the equation of equilibrium, energy equation.

Unit-4: Equation of Fluid Mechanics

Viscous and inviscid fluids, viscous stress tensor, fluid pressure, incompressible and compressible fluids, Euler‟s equation of motion, Bernoulli‟s equation, circulation theorem, Stokes‟s condition, governing equations for a viscous fluid flow, initial and boundary conditions, Navier-Stokes equation.

REFERENCE BOOKS :

1. CONTINUUM MECHANICS by D. S. Chandrasekharaiah and Lokenath Debnath, PRISM BOOKS PVT. LTD., Bangalore.
2. MATHEMATICAL THEORY OF CONTINUUM MECHANICS by Rabindranath Chatterjee, Narosa Publishing House.
3. SCHAUM‟S OUTLINE OF THEORY AND PROBLEMS OF CONTINUUM MECHANICS by George E. Mase., SCHAUM‟S OUTLINE SERIES, McGraw-Hill.

4. VECTORS, TENSORS AND BASIC EQUATIONS OF FLUID MECHANICS by Rutherford Aris, DOVER PUBLICATIONS, INC., New York.

Subject Name: FUNCTIONAL ANALYSIS

Prerequisite :

Analysis, Set, Function, Countable Set, Uncountable Set, Cardinality and Inequalities linear Algebra, Vector Space, Linear Transformation between Vector Spaces. Metric Space, Definitions and Examples, Open Set, Close Set, Neighbourhood, Basic Topology, Continuity and Equivalent Metrics, Compactness, Sequences, Convergence, Cauchy Sequences and Completeness, Completion of Metric Spaces

Unit 1: Normal and Banach Space

Normed Space , Definition and Properties, Banach Space, Definition Properties, Finit Dimensional Mormed Spaces and Subspaces, Compactness and Riesz‟s Lemma, Quotient Spaces, Series in Normed Space, Absolutely Convergence Series in Normed Spaces, Operators, Fixed Point Theorem, Contraction Mappings Principle and Applications.

Unit 2 : Bounded Linear Operators/Functionals

Linear operators, Bounded Linear Operator, Spaces of Bounded Linear Operators, Inverse Operators, Continuous Linear Operator, Open Mapping Theorem, Closed graph Theorem and their Consequences, Uniform Boundedness Principal, Linear Functional, Linear Functional on Finite Dimensional Space, , Hanh-Banach Theorem and its Consequences.

Unit 3: Banach Algebra

Algebra, Normed Algebra, Definition and Properties, Banach Algebra, Definition and Properties, The Gelfand-Mazur Theorem, Homomorphism, Isomorphism, Units, Regular Points, Non-Regular Points, Spectrum, Eigen value and Eigen Vector of an operator,

Unit 4: Hilbert Space

Inner Product Space, Swartz Inequality, Hilbert Space, Isomorphic Hilbert Spaces, Orthogonal and Orthonormal Sets, Gram-Schmidt Orthogonalization Process, Parallelogram Law, Fourier Coefficient, Riez-Fischer Theorem , Total Sets, Parseval‟s Theorem, Orthogonal Sum, Operators On Hilbert Spaces: Adjoint of a Bounded Linear Operator**,** Self-Adjoient Operator.

REFERENCE BOOKS :

1. *Introductory Functional Analysis with Applications* by E. Kreyszing John Wiley & Sons..
2. *Foundation of Functional Analysis* by S. Ponnusamy, Narosa Publishing House.
3. *Functional Analysis* by P.K. Jain, O.P. Ahuja, K. Ahmed, New Age International (P) Limited.