Course Title: Advance Mathematics- IV (Mechanics)
Course Rating: 4 Cr. Hours

Vector Integration
- Line integrals
- Surface area and surface integrals
- Volume integrals

Integral Theorems
- Green's theorem
- Gauss divergence theorem
- Stoke's theorem

Curvilinear Coordinates
- Orthogonal coordinates
- Unit vectors in curvilinear systems
- Arc length and volume elements
- The gradient, Divergence and curl
- Special orthogonal coordinate systems

Tensor Analysis
- Coordinate transformations
- Einstein summation convention
- Tensors of different ranks
- Contravariant, Covariant and mixed tensors
- Symmetric and skew symmetric tensors
- Addition, Subtraction, Inner and outer products of tensors
- Contraction theorem, Quotient law
- The line element and metric tensor
- Christoffel symbols

Non Inertial Reference Systems
- Accelerated coordinate systems and inertial forces
- Rotating coordinate systems
- Velocity and acceleration in moving system: Coriolis, Centripetal and transverse acceleration
- Dynamics of a particle in a rotating coordinate system

Planar Motion of Rigid Bodies
- Introduction to rigid and elastic bodies, Degrees of freedom, Translations, Rotations, instantaneous axis and center of rotation, Motion of the center of mass
- Euler's theorem and Chasle's theorem
- Rotation of a rigid body about a fixed axis: Moments and products of inertia of various bodies including hoop or cylindrical shell, circular cylinder, spherical shell
- Parallel and perpendicular axis theorem

- Radius of gyration of various bodies

Motion of Rigid Bodies in Three Dimensions

- General motion of rigid bodies in space: Moments and products of inertia, Inertia matrix
- The momental ellipsoid and equimomental systems
- Angular momentum vector and rotational kinetic energy
- Principal axes and principal moments of inertia
- Determination of principal axes by diagonalizing the inertia matrix

Euler Equations of Motion of a Rigid Body

- Force free motion
- Free rotation of a rigid body with an axis of symmetry
- Free rotation of a rigid body with three different principal moments
- Euler's Equations
- The Eulerian angles, Angular velocity and kinetic energy in terms of Euler angles, Space cone
- Motion of a spinning top and gyroscopes- steady precession, Sleeping top

Evaluation Criteria

Examination	Type	Marks
Internal Examination	Sessional Work	15%
	Mid-Semester	25%
External Examination	Final Semester	60%

Recommended Books
1. G. E. Hay, *Vector and Tensor Analysis*, (Dover Publications, Inc., 1979)
2. G. R. Fowles and G. L. Cassiday, *Analytical Mechanics*, (Thomson Brooks/Cole, 2005)
3. H. Goldstein, C. P. Poole and J. L. Safko, *Classical Mechanics*, (Addison-Wesley Publisihng Co., 2001)
4. M. R. Spiegel, *Theoretical Mechanics*, (McGraw Hill Book Company, 1980)
5. M. R. Spiegel, *Vector Analysis*, (McGraw Hill Book Company, 1981)
6. D. C. Kay, *Tensor Calculus,* (McGraw Hill Book Company, 1988)
7. E. C. Young, *Vector and Tensor Analysis*, (Marcel Dekker, Inc., 1993)
8. L. N. Hand and J. D. Finch, *Analytical Mechanics*, (Cambridge University Press, 1998)