

Course: SC 618 Analytical and Geometric Dynamics (3 0 0 6)

Instructors: : Sukumar Srikant (Room No.204, Ext. 7832) and Ravi Banavar (Room No.101 A, Ext. 7888),
Systems and Control (situated behind the Mathematics department.)

Prerequisites: An understanding of vector spaces.

Outline:

- **Elementary Newtonian Dynamics:** Dynamics of systems of particles - Newton's laws and rotational analogues, work-energy and impulse-momentum relationships, Kinematics of particles and rigid bodies, Impact problems, Changing mass problems
- **Kinematics** Reference frames - orthonormal, dextral frames, sequence of rotations, Rates of change of vectors in various frames, Coriolis acceleration and effects
- **Analytical Dynamics** - Lagrangian/Hamiltonian formulations, Constraints, generalized coordinates, Virtual work principle, generalized forces, Extension of dynamics (D'Alembert principles), Lagrange's Equations, Conserved quantities and Cyclic coordinates, Generalized momenta, Hamilton/Jacobi integral, Hamilton's equations, Routhian and Routh's equations, Non-Holonomic Constraints, Lagrange Multipliers
- **Dynamics on smooth manifolds:** Introduction to smooth manifolds and Lie groups, kinematics on the Lie groups $SO(3)$ and $SE(3)$, a geometric view of the rigid body motion both in a Hamiltonian and Lagrangian geometric framework, the rigid body stability and heavy top stability. More details in Ravi's webpage, <http://www.sc.iitb.ac.in/~banavar/styled-4/index.html>.

References:

Introduction to Robotics: Mechanics and Control - J. J. Craig, Addison Wesley, 2nd Edition, 1989.

Analytical Mechanics - Joseph S. Torok, Wiley-Interscience, 1999
Principles of Dynamics - Donald T. Greenwood, Prentice-Hall, 2nd Edition, 1987
Methods of Analytical Dynamics - Leonard Meirovitch, McGraw-Hill, 1970
Geometric Mechanics and Symmetry - D .D. Holm, T. Schmah and C. Stoica, Oxford University Press, 2009.
Introduction to Mechanics and Symmetry - J. Marsden and T. Ratiu, Springer-Verlag, 1994.

Evaluation scheme: 4 quizzes (70 %), assignments (20 %), class participation (10 %)