ADVANCED DYNAMICS

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PRE-REQUISITES : Undergraduate Mechanics, Dynamics, and Engineering Mathematics

INTENDED AUDIENCE : Mechanical Engineering, Aerospace Engineering, Physics

INDUSTRIES APPLICABLE TO : Automotive, Railway, and Aerospace industry

COURSE OUTLINE :
A study of dynamics is useful not only in determining dynamic forces for design (such as in automotive and aerospace systems, machine tools etc.), but also in understanding the phenomena of tides, cyclonic circulation, precession of tops, flight of boomerangs etc. This course will cover the fundamental topics in dynamics of particles and rigid bodies using the approaches of Newtonian and analytical dynamics. The coverage will start with kinematics in inertial and non-inertial (rotating) frames, discuss the different approaches to study the dynamics of a single particle, system of particles, rigid bodies in two and three dimensions, and finally introduce the approach of analytical dynamics. The course will have a strong emphasis on problem solving, and is expected to build a strong foundation in dynamics.

ABOUT INSTRUCTOR :
Prof. Anirvan DasGupta is a faculty in Mechanical Engineering at IIT Kharagpur since 1999. His interests are in the mechanics of discrete and continuous systems. He has extensively taught courses at undergraduate and postgraduate levels like Mechanics, Kinematics of Machines, Dynamics of Machines, Vibration Analysis, Wave Propagation in Continuous Media, and Rail Vehicle Dynamics.

COURSE PLAN :

Week 1**:** Coordinate systems, Kinematics of particles, rotating frames, relative motion

Week 2**:** Kinetics of particles, cyclonic circulation, Foucault pendulum

Week 3**:** Integrals of Newton's second law, angular momentum, conservation laws

Week 4**:** Impact, Newton's law of gravitation and tidal dynamics

Week 5**:** Systems with variable mass, systems with flow

Week 6**:** Dynamics of rigid bodies, Newton-Euler equations

Week 7**:** Dynamics of tops, gyroscopes and boomerangs

Week 8**:** Rotation matrix and its parametrization, geometry of rotation

Week 9**:** Introduction to analytical dynamics, configuration space, constraints, generalized coordinates and forces

Week 10**:** Hamilton's principle, Lagrange's equation of motion, constraint forces

Week 11**:** Generalized momentum, cyclic coordinates and conservation laws

Week 12**:** Symmetry and Noether's theorem, Hamiltonian and its conservation