1. **MEEG 211** **DYNAMICS**
2. **Credits 3** **Contact Hours 3**
3. **Fall 2016** Dr. R. Valery Roy; Office 332 Spencer Lab
4. **Textbook** "A First Course in Engineering Dynamics", by R.V. Roy. Softcover ISBN-13: 978-0990696919, ISBN-10: 099069691X
5. **Specific course information**
    a. **Catalog Description:** Intermediate-level development of the kinematics and dynamics of particle systems and rigid bodies. Solution of engineering problems by force, momentum and energy methods with applications to mechanisms, machines, and vehicles. Computer problems.
    a. **Prerequisite:** Grade of C- or better in MEEG112 or CIEG211
    b. **Course is required.**
6. **Specific goals for the course**
    a. **Specific Outcomes of Instruction:** The course aims to provide Mechanical Engineering students in their sophomore year with the fundamentals of Dynamics. The emphasis is on understanding the physical principles governing motion of rigid bodies and applying them to solve engineering problems. More specifically, at the conclusion of this course, students will be able to:
        - solve problems involving the kinematics of one, two and three-dimensional motion of particles, with specific application to pulley systems, using Cartesian, polar/cylindrical, and intrinsic (NT) coordinate systems.
        - convert from one coordinate system to another and solve problems involving a combination of coordinate systems.
        - apply the concepts of angular velocity/acceleration to determine the velocity and acceleration of points attached to rigid bodies.
        - apply the concept of an instantaneous center of rotation to analyse the kinematics of a large variety of planar mechanisms by graphical methods.
        - analyze the kinematics of rigid-bodies undergoing rolling without slipping motion.
        - develop general kinematic methods of analysis of planar mechanisms by geometric methods and kinematic loop closure.
        - relate the relative and absolute velocities and accelerations of particles between two referentials in relative planar motion.
        - apply kinetics methods with a linear momentum formulation for particle motions (Newton's second law in one, two and three dimensions) and rigid bodies in translation (Euler's first principle), including problems involving friction.
        - recognize physical conditions leading to conservation of linear momentum.

- apply kinetics methods with a angular momentum formulation for particle motions and rigid bodies in general planar motion (Euler's second principle).
- recognize physical conditions leading to conservation of angular momentum.
- apply kinetics methods with an energy formulation for particle and rigid body motions (Work-Energy Principle). Recognize physical conditions leading to conservation of mechanical energy.
- learn to apply energy methods to systems of particles and rigid bodies by taking into account internal work or internal potential of interaction.
- apply kinetics methods with an impulse/momentum formulation for particle and rigid body motions with applications to impact.

b. Student Outcomes Addressed:

No outcomes are directly assessed/evaluated in freshmen or sophomore level courses.

7. Brief list of topics to be covered

- 1. Particle kinematics: 1.1 Referentials, 1.2 Rectilinear Motion, 1.3 General Curvilinear Motion, 1.4 Cartesian Coordinate System, 1.5 Cylindrical/Polar Coordinates, 1.6}Intrinsic Coordinates, 1.7 The Frenet Basis, 1.8 Kinematics of Particles in Constrained Motion.
- 2. Rigid Body Kinematics: 2.1 Basic Definitions, 2.2 Translational Motion, 2.3 Rotational Motion, 2.4 General Planar Motion, 2.5 Joints between Pairs of Rigid Bodies, 2.6 Rolling Motion, 2.7 Instantaneous Center of Rotation, 2.8 Kinematics from Geometric Analysis, 2.9 Relative Motion Analysis, 2.10 General Method of Kinematic Analysis.
- 3. Kinetics: Linear Momentum Formulation: 3.1 Newton's Laws of Motion, 3.2 Newtonian Referentials, 3.3 Gravitational Forces, 3.4 Contact Forces, 3.5 Force exerted by strings and springs, 3.6 Solution Method of Particle Kinetics Problems, 3.7 Euler's First Principle, 3.8 Dynamics of a Closed System of Two Particles, 3.9 Foucault's Pendulum, 3.10 Central Force Motion.
- 4. Kinetics: Angular Momentum Formulation. 4.1 Angular Momentum Form of Newton's Second Law, 4.2 Euler's Second Principle for Systems of Particles, 4.3 Angular Momentum of a Rigid Body, 4.4 Determination of Moments and Products of Inertia, 4.5 Euler's Second Principle, 4.6 Contact Forces, 4.7 Frictionless Joints, 4.8 Solution Method of Rigid Body Kinetics Problems, 4.9 Kinetics for Multi-Body Systems, 4.10 Dynamic Balancing of a Rigid Body in Rotation.
- 5. Kinetics: Energy Formulation. 5.1 Power, Work and Potential Energy, 5.2 Work-Energy Principle, 5.3 Motion in a One-Dimensional Potential, 5.4 Work-Energy Principle for a System of Particles, 5.5 Kinetic Energy of a Rigid Body, 5.6 Work done by Mechanical Actions Exerted on a Rigid Body, 5.7 Work-Energy Principle for a Rigid Body, 5.8 Work-Energy Principle for a System of Rigid Bodies.
- 6. Kinetics: Impulse/Momentum Formulation. 6.1Impulse/Momentum Formulation for System of Particles, 6.2 A Simple Theory of Impact, 6.3 Impulse/Momentum Formulation for Rigid Bodies, 6.4A Second Theory of Impact.