ENGRD 2030 / TAM 2030 Dynamics

Designation as Required or Elective course: Elective, but may be required in some majors.

Course (catalog) description: Fall, spring. 3 credits.

Newtonian dynamics of a particle, systems of particles, a rigid body. Kinematics, motion relative to a moving frame. Impulse, momentum, angular momentum, energy. Rigid-body kinematics, angular velocity, moment of momentum, the inertia tensor. Euler equations, the gyroscope. Laboratory experiments demonstrate basic principles of dynamics.

Prerequisite(s): Engrd 2020 (Mechanics of Solids), Math 2930 (Differential Equations for Engineers), or permission of instructor.

Textbook(s) and other required material:
1. *Engineering Mechanics: Dynamics,* J.L. Meriam and L.G. Kraige, John Wiley & Sons, Fifth Edition, 2002, or equivalent.
2. *Lab Manual,* T&AM, self-produced.

Course learning outcomes:
Upon completion of the course, students should be able to:

1. Draw free-body diagrams, distinguishing forces from inertial effects (a);
2. Describe particle motion in 1-D, 2-D and 3-D employing Cartesian and path coordinates (a);
3. Characterize 2-D motion, including vector angular velocities and accelerations (a);
4. Apply Newton/Euler laws to the motion of particles and rigid bodies (a);
5. Use the principles of linear/angular impulse-momentum and work-energy to solve dynamics problems (a);
6. Recognize simple harmonic motion for 1-degree-of-freedom mechanical systems (a).

Topics covered:

- Free-body diagrams
- Kinematics of a particle, including Cartesian, path and polar coordinates
- Relative and constrained motions
- $\mathbf{F} = m\mathbf{a}$
- Vibrations of single-dof systems
- Principles of work-energy, linear and angular impulse-momentum for a particle
- Finite systems of particles
- Planar rigid-body kinematics
- Relative velocity and acceleration for rigid bodies
- Motion with respect to rotating axes
- Planar rigid-body kinetics
- Principles of work-energy and impulse-momentum for rigid bodies
- General motion of a rigid body
- 3-D rotational kinetics
- Angular momentum and $\boldsymbol{M} = d\boldsymbol{H}/dt$
- Lab topics: 1 DOF vibrations, Normal modes, Slider-crank kinematics, Gyroscope phenomenology.

Class/laboratory schedule: Two 50-minute lectures and one 50-minute recitation each week. Labs meet four times during the semester for 2 hours each.

Contribution of course to meeting the ABET curriculum requirements: Basic engineering sciences with experimental experience. May be used to partially satisfy the engineering distribution requirement.

Relationship of course to program outcomes: This course meets MAE/ABET Outcome a.

Outcome Assessment: In addition to analyzing student surveys administered by the College, the instructor will assess the six outcomes of the course by considering student results in specific questions on homeworks, exams and laboratory reports.

Person(s) who prepared this description and date of preparation:
Alan T. Zehnder, Andy Ruina, Joe Burns, Wolfgang Sachse, March 11, 2004
David Gries, Related outcomes to (a), June 19, 2004
Alan T. Zehnder, Andy Ruina, Joe Burns, May 19, 2008
Alan T. Zehnder, Bing Cady and Joe Burns, May 8, 2009