(Proposed) Syllabet for
ME/ENGRD 2030 Dynamics

This syllabet is of the style required by ABET (Accreditation Board for Engineering and Technology). All undergraduate engineering courses at Cornell have such a syllabet. It is intended to be the core of a process of continual course improvement.

Required or Elective course: Elective for engineers as a whole, but required for Mechanical Engineering and some other majors.

Course catalogue description

> **ME/ENGRD 4735 - Dynamics**
> Spring. 3 credits. Staff.
>
> Newtonian dynamics of a particle, systems of particles, a rigid body, and of simple mechanisms. Kinematics, motion relative to a moving frame. Impulse, momentum, angular momentum, energy. Rigid-body kinematics, angular velocity and angular momentum. Setting up the differential equations of motion and solving them both analytically and numerically.
> **Prerequisites:** Engrd/TAM 2020 (Mechanics of Solids), Math 2930 (Differential Equations for Engineers), familiarity with Matlab, or permission of instructor. **Co-requisite:** Math 2940.

Textbooks and/or other required material

Engineering Mechanics: Dynamics, J.L. Meriam and L.G. Kraige, John Wiley & Sons, Fifth Edition, 2002, or equivalent.

Course learning outcomes

On completion of this course, a student should be able to (ABET outcomes a-e shown in parentheses)

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 coordinates, polar coordinates, and rotating coordinate systems. (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).
7. For simple 2D systems, set up equations of motion, numerically solve them, and graphical show the resulting motion(s)(a)

Topics covered

1. Free-body diagrams
2. Linear and angular momentum balance: $\vec{\boldsymbol{F}} = m\vec{\boldsymbol{a}}$ and $\vec{\boldsymbol{M}} = \dot{\vec{\boldsymbol{H}}}$

3. Kinematics of a particle, including Cartesian, path and polar coordinates
4. Relative and constrained motions
5. Vibrations of single-DOF systems
6. Principles of work-energy, linear and angular impulse-momentum for a particle
7. Finite systems of particles
8. Planar rigid-body kinematics
9. Relative velocity and acceleration for rigid bodies in 2D
10. Motion with respect to rotating axes
11. Planar rigid-body kinetics
12. Principles of work-energy and impulse-momentum for rigid bodies
13. General motion of a rigid body in 2D
14. Simple analytical and numerical solution of the 'Equations of motion' ODEs.
15. Lecture demonstrations, including, e.g., 1 DOF vibrations, Normal modes, and Slider-crank kinematics.

Class schedule: Two 50 minute lectures per week. One 50 minute problem solving session per week, scheduled as per the former recitations (groups of 12 students working in pairs on blackboards in rooms with many blackboards).

Contribution of course to meeting MAE/ABET curriculum requirements

This is a course in Basic engineering sciences. It may be used to satisfy the Engineering Distribution Requirement.

Relationship to ABET outcomes: This course meets ABET outcome a.

Outcome Assessment

The instructor will assess the enumerated outcomes of the course by considering student results in specific questions on homeworks and exams. The instructor will also analyzing student surveys administered by the College to assess student views as to what learning mechanisms were most useful.

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
Andy Ruina, May 21, 2013