Syllabet for
MAE 4735/5735 Intermediate Dynamics and Vibrations

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.

Course catalogue description

> **MAE 4735/5735- Intermediate Dynamics and Vibrations**
> Fall. 3 credits. Staff.
>
> The course emphasizes the dynamics and vibrations of multi-degree-of-freedom systems including particles, rigid-objects and structures. Introduction to Lagrange's equations. Finding equations of motion, solving analytically and numerically; graphical presentation of solutions. Conservation laws. Modal analysis of discrete and continuous systems. Damped and undamped systems. Vibration absorbers and vibration control for discrete systems.
> **Prerequisites:** Math 2940, MAE 3260 or equivalents, or permission of the instructor.

Textbooks and/or other required material

The dynamics part of this course would use *Classical Mechanics* by John R. Taylor, 2005 (used in 5700 fall 2011), or *Principles of Dynamics* by Donald T. Greenwood (used in 5700 many times), or *Dynamics of Particles and Rigid Bodies: A Systematic Approach* by Anil Rao, or equivalent. The vibrations portion could use *Principles of Vibration* by Benson H. Tongue or *Engineering Vibrations* by Dan Inman, or equivalent.

4735 vs 5735

The lectures and readings will be the same. Students enrolled in 5735 will have some more advanced homeworks and projects.

Course learning outcomes

On completion of this course:

1. Given a description in sketches and/or simple words, for a variety of dynamical mechanical systems consisting of particles and rigid objects interacting with various standard connections (e.g., strings, springs, hinges, rolling, surface sliding) and forces (e.g., gravity, friction), the student should be able to find the governing differential equations, solve the simple cases by hand, solve the more complex cases with numerical integration (MATLAB), graphically represent the results, including animations, and check the reasonableness of the results using extreme cases and conservations laws (momentum, angular momentum and energy) (MAE/ABET outcomes a, e, k).
2. A student will be proficient at writing Lagrange equations for simple conservative systems (MAE/ABET outcomes a, e).
3. A student will understand and be able to do analysis associated with vibrations of multi-degree-of-freedom and continuous systems (MAE/ABET outcomes a, e, k).

4. A student will understand means of controlling vibrations using absorbers and elementary feedback approaches (MAE/ABET outcomes a, e, k).

Topics covered

1. Newton-Euler equations, constraint kinematics (hinges, rolling, sliding, skate) and constraint forces.
2. Introduction to 2D multi-object systems.
3. Lagrange equations (but not their derivation).
4. Conservation laws.
5. Numerical solution of ODEs in MATLAB. Simple animations in MATLAB.
6. Review of free and forced vibrations of SDOF systems.
7. Multiple degree of freedom systems: eigenvalues and eigenvectors; modal analysis; free and forced response.
8. Vibration absorbers and an intro to feedback control for structural damping.
9. Vibrations of continuous systems: strings, rods and beams. Modal analysis. Free vibrations and introduction to forced response.

Class schedule: Two 75 minute lectures per week.

Contribution of course to meeting MAE/ABET curriculum requirements

This course partially fulfills the requirement to complete three upper level MAE courses as a Major Approved Elective or it can be used to fulfill the Technical Elective requirement.

Relationship to ABET outcomes: This course meets ABET outcomes a, e and k.

Outcome Assessment

A review of prelims and the final exam will determine whether students mastered the subject. In addition, a questionnaire will be used to assess student views as to what learning mechanisms were most useful and on student perception of the educational impact of the course.

Person(s) who prepared this description and date of preparation

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