Indian Institute of Science

Mechanical Engineering
Indian Institute of Science
Bengaluru, 560 012
India

E-mail: chair.me@iisc.ac.in
URL: www.mecheng.iisc.ac.in
Telephone: +91 (80) 2293 2332 (office)

ME 226 (AUG) 3:0

Applied Dynamics I

Instructor(s): Andy Ruina, Jishnu Keshavan

Course description:
Part A: Tools for analysis of planar mechanisms. A 2D mechanism is a collection of rigid objects interacting with each other or to the fixed environment via hinges, sliding connections, collisions, springs, dashpots, non-holonomic constraints (rolling or skates) or body forces (e.g. gravity).
Part B: Analysis of motion of a single rigid object in 3D using dyads for representation of rotation and inertia tensors. Special cases of 3D motion including fixed axes rotation (static and dynamic balance), steady precession of axisymmetric objects, stability of rotation about a principle axis, and chaotic motions of a mass suspended by a spring.

Prerequisites:
Undergraduate Engineering Mathematics courses that include: vectors, linear algebra, differential equations, facility with computers (This course will use Matlab, but facility with any programming language suffices as preparation).

Resources:
1. Instructor's notes and lecture videos.
2. Classical Mechanics, John R. Taylor; University Science, 2004.
3. Principles of Dynamics, Donald T. Greenwood; Prentice Hall, 1988.
4. Dynamics of Particles and Rigid Bodies: A Systematic Approach, Anil Rao; Cambridge University Press, 2006.
5. Getting started with Matlab, Rudra Pratap; Oxford University Press, 2017.

Outcomes: At the end of the course the student will be able to
1. Start with a sketch or verbal description of any 2D mechanism and write equations of motion (EoM) using Newton-Euler with minimal coordinates, or with Lagrange Eqs, or using Maximal coordinates and DAEs (Differential Algebraic Equations); Solve the EoM numerically and animate the solutions (system response); Apply various checks (conservation laws, comparison between methods, limiting cases) to assure the validity of the results;
2. Have facility with various skills; solving ODEs with events, root finding, optimization, symbolic derivation of EoM, animation; 3. Have facility with dyads;

Have some intuition for 3D rotations, including representation using dyads, matrices, and axis-angle; Be able to animate 3D motion of a rigid object.

Grading:

A portfolio of completed HW problems brought to the final project presentation (50%); 2 midterm exams (10% each); A final exam (10%); Final (individual) project presentation (20%)

Final Project:
A complex system will be described. Using that system, or an instructor-approved alternative proposed by the student, the student will find the EoM 3 ways, solve and animate the solutions, and explain various checks that indicate that the solution is correct. Each student will have 25 minutes to show their HW portfolio and present their final project and answer questions about their project.

Additional information: This course is open to master's students, doctoral students and undergraduates who feel that they are adequately prepared. If you have taken other graduate courses in dynamics this course will re-enforce some things you learned and cover some things you did not learn.

Course website: