ME 340 AL1 / ZJ1: Dynamics of Mechanical Systems
Fall 2025

Instructor: Alexander F. Vakakis, avakakis@illinois.edu
Office hours (in 3003 MEL): *Thursdays 12noon-1pm and Fridays 12noon-1pm*

Lectures: *10-10:50pm MWF, 2100 Sidney LuMEB*

Course website: https://canvas.illinois.edu/

Teaching Assistants (All TAs' office hours will be at the TA-Study rooms at LL of LuMEB)

Nitin Tiwari, nitinkt2@illinois.edu — Office hours: *Fridays 4-6pm*

Argyris Michaloliakos, am71@illinois.edu — Office Hours: *Thursdays 5-7pm*

Aryan Arora, aryana7@illinois.edu — Office hours: *Thursdays 2-3pm and Fridays 3-4pm*

Shashwatam Bhadani, bhadani4@illinois.edu — Office hours: *Fridays 4-6pm*

Hyun Gyu, hyungyu2@illinois.edu — Office hours: *Thursdays 6-8pm*

Jialin Li, jialin13@illinois.edu — Office hours: *Thursdays 6-8pm*

Graders: Antheria Jiang, David Whatcott

Textbook (recommended but not required): *Modeling and Analysis of Dynamic Systems*, by R.S. Esfandiari and B. Lu, CRC Press, 2018 edition. Reserved for ME340 at Grainger Reserves.

Also another relevant textbook is *Engineering Dynamics: A Comprehensive Introduction*, by N.J. Kasdin and D.A. Paley, Princeton Univ. Press, 2011. This is also reserved for ME340 at Grainger Reserves.

Accommodations for Disabilities:

To obtain disability-related accommodations for this class, students with disabilities are advised to contact the instructor and the Division of Rehabilitation-Education Services (DRES) (http://www.disability.illinois.edu/) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign (Hours: 8:30am to 5pm, M-F), call 333-1970, or email disability@illinois.edu.

Equity and Diversity:

This is an equal opportunity classroom environment. We value the diversity represented by all students and participants in this course. Our diversity is a primary source of ideas and perspectives. As you work through the course, practice using this diversity to your advantage.

Grading: Midterm1: 15%, Midterm2: 15%, Final Exam: 30%,
Homeworks: 30%, Labs: 10%

Homework and Exam Policy:

There will be a weekly homework assignment which will be posted on the course website on Mondays, with your solutions being due a week later in class. Note that due to logistical constraints and in fairness to your fellow students no late homeworks will be accepted unless there is a serious (e.g., medical or family) reason; the homework solutions will be posted on the course website on the homework due date. You are encouraged to collaborate with your fellow students in solving the homework assignments, however you should hand in your own original homework.

Exams: Midterm 1: *Wednesday, October 8, 7-9pm*
Midterm 2: *Wednesday, November 12, 7-9pm*
Final Exam: *Thursday, December 18, 8-11am*

Please mark your calendars with these dates and plan accordingly, since due to logistical constraints and in fairness to your fellow students no conflict exams will be given; the only possible exceptions could be for serious reasons (e.g., in case of a medical reason the necessary medical certifications need to be provided to the instructor). Evidence of plagiarism in an exam will be dealt with seriously.

Lab Assignments (Dr. Daniel J. Block, d-block@illinois.edu, is supervising the ME340 labs): Information and instructions will be available (we are currently working on it) at http://coecsl.ece.illinois.edu/me340/. The labs will be held bi-weekly starting the week of September 15. Please come prepared and familiar with that week's lab handout material. Specific questions regarding the lab exercises should be addressed to your individual TA.

Lab Handouts, Prelabs and Lab Reports are at, http://coecsl.ece.illinois.edu/me340/labhandouts.htm. There is a Prelab assignment to be completed before you attend the first lab. The Prelab assignment can be downloaded at http://coecsl.ece.illinois.edu/me340/Lab1_handout.pdf. If needed, Matlab®, Mathematica® and/or any other relevant software can be downloaded at https://webstore.illinois.edu/.

The Lab schedule is as follows (all Labs will be held in room 3073 ECEB except for Lab 3):

Week of	
Aug 25	No Lab
Sept 1	No Lab (Labor Day)
Sept 15	ME 340 Lab #1
Sept 29	ME 340 Lab #2
Oct 13	ME 340 Lab #3 in Room 0036 LuMEB
Oct 20	ME 340 Lab #4
Nov. 3	ME 340 Lab #5
Nov 17	ME 340 Lab #6
Nov 24	No Lab (Thanksgiving)
Dec. 1	ME 340 Lab #7

ME340: Objectives

ME 340 covers dynamic modeling and analysis of mechanical components and systems. By the end of the course you should be able to do a variety of tasks, including:

- Create dynamic models of single- and multi-degree-of-freedom mechanical components and systems.
- Perform time-domain and frequency-domain analyses of linear time-invariant systems.
- Be familiar with important topics in mechanical engineering such as resonance, natural frequency and mode shape, and be able to design basic vibration/shock isolation systems
- Apply basic principles to linearize nonlinear systems.
- Use Lagrangian dynamics to model a dynamical system.
- Model a system using state (phase) space representation.
- Perform dynamical analysis in the time and frequency domains
- Be able to apply Laplace transforms to study the dynamics of discrete models of mechanical systems
- Understand the notion of frequency and its role in dynamics
- Use MATLAB/Simulink/Python to model and analyze the response of single- and multi-degree-of-freedom dynamical systems.

ME340: Tentative List of Topics to Be Covered

INTRODUCTION TO DYNAMICAL SYSTEMS

- Physical and mathematical models of dynamical systems
- Basic classification of dynamical systems – Linear versus nonlinear systems
- Examples

MODELING

- Elements of physical systems, and principles of conservation
- Free-body diagrams and Newton's 2nd Law: Equations of Motion
- Translational and rotational systems
- Analytical dynamics: Principle of virtual work, Lagrange's equations of motion

REPRESENTATION AND SIMPLIFICATION

- State or phase space representation
- Linearization of nonlinear systems

SINGLE-DEGREE-OF-FREEDOM SYSTEMS: INPUT/OUTPUT RESPONSES

- Free and forced responses- time constants, damping ratios, dynamic overshoot
- Convolution (Duhamel's) integral
- Laplace transforms, transfer functions and stability analysis
- Frequency response, complex analysis, resonance; vibration absorber
- Fourier series analysis and introduction to Fourier transforms
- Applications to mechanical systems

MULTI-DEGREE-OF-FREEDOM SYSTEMS: MODAL ANALYSIS

- Matrix representation
- Modal analysis: natural frequencies, mode shapes and modal damping ratios
- Frequency responses and resonances
- Applications to shock and vibration isolation