

ME 380: KINEMATICS AND MACHINE DYNAMICS

Fall 2021

Instructor:	Aykut C. Satici	Time:	TT 12:00 – 1:15 p.m.
Email:	aykutsatici@boisestate.edu	Place:	MEC 114
Room:	RUCH 233	Office hours:	RUCH 336

Course Page:

- Class website: <https://canvas.boisestate.edu/>
- Youtube playlist: <https://bit.ly/3fhTrUg>

Office Hours: Tuesday and Thursday 10:30 a.m. – 11:30 a.m. at RUCH 336, or by appointment.

Prerequisites: This class requires an understanding and working knowledge of basic engineering dynamics (ENGR 220), linear algebra, calculus (MATH 275), differential equations (MATH 333), and programming (ME 271). Since linear algebra is not sufficiently covered, I will be providing the necessary background as it becomes necessary throughout the course.

Course Description: This course is designed to equip students with the fundamental theories and methodologies that are used in kinematic and dynamic analysis, and synthesis of mechanisms commonly encountered in machine design.

Learning Outcomes:

- Describe fundamental concepts in mechanisms (linkages, cams, gears)
- Describe the mechanism design process
- Identify basic types of mechanisms, joints, and motion
- Determine degrees of freedom (mobility) of mechanisms and equivalent linkages
- Perform position, velocity, and acceleration analyses using graphical, analytical, and computer methods
- Perform force analysis in linkages using static and dynamic methods
- Synthesize mechanisms for prescribed path and motion generation using graphical, analytical, and computer methods
- Analyze (and design) gear trains, cam-followers, belt and chain drives

Texts and Materials: I have prepared a textbook that we will follow throughout the semester. This book follows various sections from the books listed below and some other recent journal publications.

- T. R. Kane and D. A. Levinson, *Dynamics: Theory and Applications*, McGraw-Hill, 2005.
[Click here to download the book](#)
- T. R. Kane and P. W. Likins, *Spacecraft Dynamics*, McGraw-Hill, 2005.
[Click here to download the book](#)
- Norton, *An Introduction to the Synthesis and Analysis of Mechanisms and Machines*, McGraw-Hill, 2003.
- Erdman, Sandor and Kota, *Mechanism Design: Analysis and Synthesis, Volume I*, Prentice Hall, 2001.

- Wilson and Sadler, *Kinematics and Dynamics of Machinery*, Prentice Hall, 2003.

Grading Policy: Ancillary material (10%), Midterm Exam #1 (20%), Midterm Exam #2 (20%), Project (20%), Final (25%), Participation (5%).

- Homework must be submitted at the beginning of the relevant lecture (10:30 a.m.). Extensions may be granted for special circumstances and only when requested at least one day in advance.
- You are responsible for all the information given in class verbally and/or in writing. Any information about the course on the web may be superseded by the information given in the class.

Important Dates:

Midterm Exam #1	October 05, 2021
Midterm Exam #2	November 02, 2021
Project Deadline	Just before the final exam
Final Exam	December 14, 2021

Course Policy:

- All exams are comprehensive and closed book.
- A cheat sheet may be provided with relevant formulas.
- Write legibly and present your work neatly.
- Your solution to the problem must follow a logical progression.
- Staple all the pages of everything you submit.

Class Policy:

- Class participation and cooperation among students are highly encouraged.
- Student feedback will be collected throughout the semester and adaptation will be undertaken.
- Extra lectures or problem solving sessions may be scheduled when necessary.

Project:

- Students may be given the freedom to choose a project topic of their interest subject to the instructor's approval.
- A candidate project topic should address a real life problem and should involve enough to let students demonstrate their proficiency.

Academic Honesty: Academic dishonesty is **NOT** tolerated. Students are responsible for reading and understanding the student code of conduct. For more information, click [here](#).

Make-up Policy: Students are eligible for a make-up exam if they miss a scheduled exam due to a death in the immediate family, serious illness or military service.

- Students are responsible for informing the instructor of their excused absence as soon as possible and their excused absence must be *officially verified*.
- If your excuse is acceptable, you will be given a single *comprehensive* make-up exam, which will be delivered during the last week of the classes.

Disabilities Policy: Students with disabilities needing accommodations to fully participate in this class should contact the [Educational Access Center](#).

Tentative Course Outline:

- Week 1: Basic Concepts
 - Machines, mechanisms and nomenclature
 - Motion, relative motion
 - Kinematic diagrams and kinematic inversion
 - Degrees of freedom/mobility, Grashof criteria
 - Mechanism design process
- Week 2: Linear Algebra Review
- Week 3 – 5: Displacement and Velocity Analyses
 - Displacement analysis: analytical and computational methods
 - Angular velocity and vector calculus
 - Relative velocity
 - Velocity analysis: analytical methods
- Week 6 and 7: Acceleration Analysis
 - Acceleration analysis: analytical methods
 - Coriolis acceleration
 - Equivalent linkages
- Week 8 and 9: Force Analysis
 - Static force analysis of mechanisms
 - Mass moment of inertia, center of gravity
 - Inertial forces and torques in linkages
 - Dynamic force analysis
- Week 10 and 11: Dynamics
 - Free body diagrams
 - Newton-Euler equations of motion
 - Dynamic simulation and time response of mechanisms
- Week 12 – 13: Cams and Gears
- Week 14: Kinematic Synthesis
 - Type synthesis
 - Number synthesis
 - Dimensional synthesis
 - Synthesis for function generation
 - Synthesis for prescribed path and motion generation