ME 301: Dynamics of Mechanical Systems

Term: Fall 2026
Credits: 3.0
Lecture Times & Location: Tuesday & Thursday 4:00–5:15 p.m., Rowan Engineering Center 130
Modality: In-Person

Instructor Information

- **Instructor:** Prof. Anthony Greer (Associate Professor of Mechanical Engineering)
- **Email:** agreer@university.alkimi.ai
- **Office:** Rowan Engineering Center 222
- **Office Hours:**
  - Wednesday & Friday: 11:30 a.m.–1:00 p.m. (In person, Rowan Engineering Center 222)
  - Monday: 9:00–10:00 a.m. (Virtual via Zoom; link posted in Canvas)
  - Also available by appointment.

Course Description

Kinematics and kinetics of rigid bodies in plane and three-dimensional motion, work-energy and impulse-momentum methods, and an introduction to mechanical vibrations. ME 301 expands engineering mechanics from static equilibrium and particle motion to the planar and spatial dynamics of rigid body mechanisms. Students analyze complex multi-body kinematics using relative velocity and acceleration formulations, investigate Newtonian and energy methods for rigid body kinetics, and study spatial rotations via Euler's equations. The semester concludes with a mathematical treatment of single- and two-degree-of-freedom mechanical vibrations, preparing students for system dynamics, controls, and machine design.

Prerequisites

ME 201 and MATH 240.

Measurable Student Learning Outcomes

Upon successful completion of ME 301, students will be able to:

1. **Analyze Planar Kinematics:** Calculate linear and angular velocities and accelerations in rigid body mechanisms using instantaneous centers of zero velocity, moving reference frames, and Coriolis terms.
2. **Apply Kinetics to Rigid Bodies:** Formulate equations of motion for translating, rotating, and general plane-motion rigid bodies using Newton-Euler formulations, work-energy, and impulse-momentum methods.
3. **Model Three-Dimensional Dynamics:** Compute inertia tensors, angular momentum vectors, and dynamic reactions for rotating systems and gyroscopes using Euler's equations of motion.
4. **Simulate Dynamic Systems Computationally:** Implement numerical integration algorithms in MATLAB or Python to simulate non-linear planar linkages and evaluate kinematic responses.

5. **Characterize Mechanical Vibrations:** Derive equations of motion for undamped and damped single- and two-degree-of-freedom mechanical vibratory systems and calculate natural frequencies, damping ratios, and harmonic frequency response.

Required Course Materials & Approximate Costs

1. **Meriam, James L., L. G. Kraige, and J. N. Bolton. *Engineering Mechanics: Dynamics*. 9th ed., Wiley, 2018.** Approx. $75 digital rental ($180 hardcover purchase; library reserve copies available).
2. **MATLAB and Simulink Student Suite (available via Alkimi University campus site license).** Free to registered engineering students.
3. **Total estimated cost:** Approx. $0 (library reserve & campus software) to $75 (digital rental).

Generative AI Policy (AI Level 2: AI Permitted with Disclosure for Specified Tasks)

In accordance with Alkimi University Academic Policies (Student Handbook §5.8), ME 301 operates under **AI Level 2**.

- **What is permitted:** Students may utilize AI tools and automated symbolic math environments to generate syntax for numerical ODE integration in MATLAB or Python, plot kinematic trajectories, and clarify foundational vector calculus derivations.
- **What is prohibited:** AI tools must not be used to complete analytical kinematic derivations, generate closed-form kinetic equations, or solve weekly homework problems without independent verification. No AI use is permitted during examinations.
- **Disclosure:** Whenever code, scripts, or mathematical structures in computational projects incorporate AI assistance, students must include an appendix citing the prompt, the model version, and the testing steps performed to validate correctness.

Grading Components and Weights

- **Weekly Problem Sets:** 15% (Due Wednesdays at 11:59 p.m. in Canvas (weeks 2–14; lowest dropped))
- **Computational Project 1: Planar Linkage Kinematics:** 10% (Due Friday, October 9 at 11:59 p.m.)
- **Computational Project 2: Numerical Simulation of Damped Vibration:** 10% (Due Friday, November 20 at 11:59 p.m.)
- **Midterm Exam 1 (Planar Kinematics & Kinetics):** 20% (In class, Thursday, October 1)
- **Midterm Exam 2 (Energy, Momentum & 3D Kinetics):** 20% (In class, Thursday, November 12)
- **Comprehensive Final Examination:** 25% (Thursday, December 17, 2026, 3:30–5:30 p.m.)

Grading Scale (Alkimi University Standard)

- **A:** 93–100% | **A-:** 90–92%
- **B+:** 87–89% | **B:** 83–86% | **B-:** 80–82%
- **C+:** 77–79% | **C:** 73–76% | **C-:** 70–72%
- **D+:** 67–69% | **D:** 60–66% | **F:** Below 60%
- **Extra credit:** No individual extra credit assignments will be provided under any circumstances.

Course Schedule (Fall 2026)

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 1	Aug 27	**Particle Kinetics Review and Moving Reference Frames:** Review of particle equations of motion, Cartesian and polar frames, moving translation reference frames, and relative position and velocity formulations. *Reading: Meriam & Kraige Ch. 1–2, 5.1*	*First day of classes: Wed Aug 26.*

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 2	Sep 1, 3	**Planar Kinematics: Translation and Fixed-Axis Rotation:** Rigid body motion categories, angular velocity and acceleration vectors, rotation about a fixed axis, and gear train velocity transmission ratios. *Reading: Meriam & Kraige Ch. 5.2–5.3*	*Wed Sep 2: Add/section change deadline.*
Week 3	Sep 8, 10	**Planar Kinematics: Relative Velocity and Instantaneous Centers:** Relative velocity equations using moving frames, vector cross-product methods, and determination of instantaneous centers of zero velocity for four-bar linkages. *Reading: Meriam & Kraige Ch. 5.4–5.5*	*Mon Sep 7: Labor Day (no classes). Wed Sep 9: Census date (last day to drop without a W).*
Week 4	Sep 15, 17	**Planar Kinematics: Relative Acceleration and Coriolis Terms:** Relative acceleration analysis, normal and tangential acceleration components of pin joints, and the physical origin and calculation of the Coriolis acceleration. *Reading: Meriam & Kraige Ch. 5.6–5.7*	—
Week 5	Sep 22, 24	**Planar Kinetics: Mass Moments of Inertia and Equations of Motion:** Mass moments of inertia of 3D bodies about planar axes, parallel-axis theorem, radius of gyration, and general plane motion equations (sum of forces and moments). *Reading: Meriam & Kraige Ch. 6.1–6.4*	—
Week 6	Sep 29, Oct 1	**Planar Kinetics of Constrained Bodies and Midterm Exam 1:** Non-slipping rolling contact, connected rigid bodies, slider-crank mechanisms, and administration of Midterm Exam 1 during Thursday class. *Reading: Meriam & Kraige Ch. 6.5–6.6*	**Midterm Exam 1 (Planar Kinematics & Kinetics) (in class).**
Week 7	Oct 6, 8	**Work-Energy Methods for Planar Systems:** Work done by external forces and couples, kinetic energy of general planar rigid bodies, principle of work and energy, and power; Project 1 due Friday. *Reading: Meriam & Kraige Ch. 6.7–6.8*	**Computational Project 1: Planar Linkage Kinematics due Fri Oct 9 at 11:59 p.m.**
Week 8	Oct 15	**Impulse-Momentum Principles and Impact:** Linear and angular impulse and momentum of rigid bodies, conservation laws, eccentric impact, and restitution coefficients for extended bodies. *Reading: Meriam & Kraige Ch. 6.9*	*Oct 12–Oct 13: Fall break (no classes).*
Week 9	Oct 20, 22	**Three-Dimensional Kinematics of Rigid Bodies:** Rotation about a fixed point, instantaneous axis of rotation, finite and infinitesimal rotations, Euler angles, and time derivatives of rotating vectors. *Reading: Meriam & Kraige Ch. 7.1–7.4*	—
Week 10	Oct 27, 29	**Three-Dimensional Kinetics: Inertia Tensors and Angular Momentum:** Products of inertia, principal axes of inertia, 3D angular momentum formulation, kinetic energy in spatial motion, and general dynamic reactions on bearings. *Reading: Meriam & Kraige Ch. 7.5–7.7*	—
Week 11	Nov 3, 5	**Euler's Dynamic Equations and Gyroscopic Motion:** Derivation of Euler's equations of motion for rotating bodies, torque-free rotation, gyroscopic moment, steady precession, and nutation phenomena. *Reading: Meriam & Kraige Ch. 7.8–7.9*	*Fri Nov 6: Last day to withdraw (W) or elect Pass/No Pass.*
Week 12	Nov 10, 12	**Introduction to Vibrations: Free Undamped 1-DOF Systems:** Simple harmonic motion, mass-spring-damper idealizations, equivalent stiffness, natural frequency derivations, and administration of Midterm Exam 2 in Thursday class. *Reading: Meriam & Kraige Ch. 8.1–8.2*	**Midterm Exam 2 (Energy, Momentum & 3D Kinetics) (in class).**
Week 13	Nov 17, 19	**Damped Free Vibrations and Energy Dissipation:** Viscous damping models, overdamped, critically damped, and underdamped response; damping ratio and logarithmic decrement; Project 2 due Friday. *Reading: Meriam & Kraige Ch. 8.3*	**Computational Project 2: Numerical Simulation of Damped Vibration due Fri Nov 20 at 11:59 p.m.**
Week 14	Nov 24	**Harmonically Forced Vibrations and Resonance:** Harmonic excitation, steady-state vs. transient response, magnification	*Nov 25–Nov 27: Thanksgiving break (no classes).*

Week	Dates	Topics & Readings	Assignments & Deadlines
		factor, phase angle, resonant behavior, and rotating unbalance mechanics. *Reading: Meriam & Kraige Ch. 8.4*	
Week 15	Dec 1, 3	**Two-Degree-of-Freedom Systems and Vibration Absorbers:** Equations of motion for coupled 2-DOF systems, characteristic equation, normal modes, mode shapes, and principles of tuned mass dampers. *Reading: Meriam & Kraige Ch. 8.5*	—
Week 16	Dec 8	**Comprehensive Synthesis and Final Examination Review:** Integrated review linking planar kinematics, Euler rotational dynamics, and vibration modeling; sample final exam problem synthesis. *Reading: Review Meriam & Kraige Ch. 5–8*	*Wed Dec 9: Last day of classes. Thu Dec 10: Reading Day.*
Finals	Dec 17	**Comprehensive Final Examination:** Thursday, December 17, 2026, 3:30–5:30 p.m., Rowan Engineering Center 130.	Comprehensive.

Course Policies

Attendance Policy

Class attendance at every lecture session is expected. Dynamic systems analysis requires progressive conceptual mastery of vector calculus and differential equations that cannot be attained from lecture slides alone. If an unavoidable absence arises due to illness or collegiate conflict, contact Prof. Greer promptly. Students who miss the first two class meetings without notifying the instructor may be dropped. Students may miss class for religious observance without penalty if they notify the instructor in writing within the first two weeks of the semester (by Wednesday, September 9, 2026). Absences for university-sponsored activities (athletics, performances, conferences) are excused with a letter from the sponsoring office at least one week in advance.

Late Work Policy

Weekly problem sets submitted after the deadline will be assessed a penalty of 15% per day up to 48 hours late, after which no credit will be granted. The lowest problem set grade is dropped to accommodate personal illness or travel conflicts. Computational project submissions lose 10% per 24 hours.

Final Exam Policy

The final examination (Thursday, December 17, 2026, 3:30–5:30 p.m.) is scheduled by the University Registrar and can't be moved without the Dean's written approval (Faculty Handbook §5.5). A student with three or more final exams on the same calendar day may reschedule one of them. Requests go to the instructor of the middle exam by the last day of classes. For this term, send the request by Wednesday, December 9, 2026 (Student Handbook §6.4).

Academic Integrity

Alkimi University is an academic community devoted to rigorous scholarship, open intellectual inquiry, and uncompromising ethical conduct. All students are subject to the regulations of the Alkimi University Academic Integrity Policy. Academic dishonesty—including plagiarism, cheating on examinations, unauthorized collaboration, fabrication of empirical data, and unauthorized submission of academic work generated by artificial intelligence—undermines the integrity of the university and carries severe disciplinary sanctions. Sanctions range from a failing grade on an assignment or exam to an administrative course failure recorded as an 'XF' on the official transcript, academic suspension, or expulsion. Suspected violations are formally investigated and resolved through the Office of Academic Integrity in accordance with Faculty Handbook §6. For detailed information, consult the Office of Academic Integrity, Lovell Hall 315, (555) 555-0163, integrity@university.alkimi.ai.

Accessibility Services

Alkimi University is committed to providing equitable educational access and reasonable accommodations for all students with documented disabilities, including physical, sensory, psychological, learning, and chronic health conditions. Students requesting academic accommodations must formally register with the Office of Accessibility Services, Harlan Hall 204, (555) 555-0155, access@university.alkimi.ai. Once approved, students will receive an official Faculty Accommodation Letter detailing approved accommodations. Students should present this letter to the instructor as early in the semester as possible, and at least one week prior to any exam or assignment requiring accommodation. Accommodations cannot be applied retroactively.

Student Wellness and Mental Health

Your physical health, psychological well-being, and mental health are essential to your academic success. If you experience heightened stress, anxiety, depressive symptoms, personal trauma, or academic burnout, free, confidential counseling and medical care are available through the Hollis Health & Counseling Center, located in the Hollis Center. Routine appointments are available Monday–Friday 8:00 a.m.–6:00 p.m. and Saturday 10:00 a.m.–2:00 p.m. during the semester by calling (555) 555-0190 or emailing health@university.alkimi.ai. Urgent, 24/7 crisis psychological counseling is accessible immediately at (555) 555-0199.

Campus Student Support Services

- **Academic Advising Center:** Lovell Hall 101 | (555) 555-0158 | advising@university.alkimi.ai
- **Writing Center:** Whitcombe Library 3rd Floor | Free consultations on papers, reports, and research projects at any stage.
- **Whitcombe Library:** Whitcombe Library, Main Floor | (555) 555-0170 | askalibrarian@university.alkimi.ai
- **Hollis Health & Counseling Center:** Hollis Center | (555) 555-0190 | 24/7 Counseling Line: (555) 555-0199 | health@university.alkimi.ai
- **Engineering Dynamics Peer Tutoring:** Rowan Engineering Center 140 | Drop-in mechanics and vibration assistance available Monday and Wednesday 6:00–8:30 p.m.