

AAE 34000: Dynamics and Vibrations

Credit Hours	3
Offered	Fall and Spring
Pre-requisites	AAE 203, MA 266 or 366, MA 303 or 304
Co-requisites	None
Instructional Method	3 hours of lecture per week
Required	Yes

1. Course Description

This course is about kinematics and dynamics of particles and rigid bodies. Topics include a particle in orbit, systems of particles, vibrations, Euler angles, translation and rotation of rigid bodies, and aerospace vehicle dynamics.

2. Instructor Information

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3. Topics Covered

- Mass Spring Damper: undamped free vibrations; under, critically - and overdamped free vibrations; amplification factor and phase angle for forced vibrations; resonance
- Review of Kinematics: basic kinematic equation (BKE) = Transport Theorem; coordinate systems (cylindrical, spherical, etc.)
- Numerical Integration: Euler; Runge-Kutta; MATLAB ode toolbox

- Particle Dynamics: free body diagrams; kinematics; Newton's laws; equations of motion; integrals of motion; conservation of linear and angular momentum; conservation of total mechanical energy; principles of linear/angular impulse and momentum; principles of work and kinetic energy; orbital mechanics
- Systems of Particles: Newton's and Euler's laws for systems of particles; integrals of motion; rocket problem; collisions
- Rigid Body Dynamics: degrees of freedom; moments and products of inertia; inertia matrix and coordinate transformations; principal axes and principal moments of inertia; Euler's theorem; derivation of Euler's equations of motion
- Euler Angles: sequences (e.g., 313); angular velocities in terms of Euler angles; free motion of an axisymmetric rigid body; body cone and space cone

4. Intended Learning Outcomes

Upon completing this course, the student shall be able to both, analytically and numerically using MATLAB:

- Construct idealized (particle and rigid body) dynamical models of real world systems including translation, rotation, and vibration
- Predict classical mechanics model response to applied forces using Newton's and Euler's law, and harmonic oscillation in three dimensions
- Simulate the motion of aircraft and spacecraft

5. Assessment Method

Weekly homework assignments, three in-class midterm exams

6. Relation to ABET Outcomes

	Program Learning Outcomes	Included?
1.	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	Yes

2.	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	No
3.	An ability to communicate effectively with a range of audiences.	No
4.	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	No
5.	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	No
6.	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	No
7.	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	No