MAE 30A

Mechanics I: Statics & Introduction to Dynamics (4 units)

Class/Laboratory Schedule: four hours of lecture, eight hours of outside preparation.
12 hours/week total

Course Coordinator(s): Marko Lubarda

Textbooks/Materials:

1. Beer and Johnston, Vector Mechanics for Engineers - Statics, McGraw-Hill, 2019 (12^{th} Edition)
2. Hibbeler, R.C., "Engineering Mechanics: Statics", Pearson Prentice Hall, 2016 (14^{th} Edition)

Catalog Description: Statics of particles and statics of rigid bodies in two and three dimensions. Free body diagrams. Moment of force, couples, equivalent systems of forces. Distributed forces and centers of gravity. Static analysis of trusses, frames, and machines. Introduction to dynamics. Kinematics and kinetics of particles. Curvilinear motion. Tangential and normal acceleration. Newton's equations of motion. Problems with friction.

Prerequisites: Math 20C and Phys. 2A

Course Type: Required

Performance Criteria:

Objective 1 (1, ME10)

1.1 Students will demonstrate an understanding of force balance in case of equilibrium (Newton's first law of motion), the principle of action and reaction (Newton's third law), and the principle of transmissibility of force for rigid bodies.

1.2 Students will demonstrate the ability to model and analyze 2D and 3D supports constraining the movement of rigid bodies and determine the corresponding reactions.

1.3 Students will demonstrate the ability to make simplifying assumptions in constructing first-approximation models of simple engineering structures such as bridges, trusses, frames, and machines.

1.4 Students will demonstrate the ability to isolate portions of a structure and to draw their appropriate free-body diagrams.

1.5 Students will demonstrate the ability to apply knowledge referred to in 1.1-1.4 to formulate and solve equilibrium equations for particles and rigid bodies in 2D and 3D.

Objective 2 (1, ME10)
2.1 Students will demonstrate the ability to find centroids of simple and composite shapes.
2.2 Students will demonstrate the ability to replace systems of forces and couples with reduced equivalent systems.
2.3 Students will demonstrate the ability to apply the knowledge referred in 2.1 and 2.2 to facilitate the determination of support reactions and the solution to equilibrium problems involving concentrated and distributed loads.

Objective 3 (1, ME10)
3.1 Students will demonstrate the ability to apply the method of joints and the method of sections to determine internal forces in members of statically determinate trusses.
3.2 Students will demonstrate the ability to analyze statically determinate frames and machines by creating free-body diagrams of isolated portions of these structures and by applying equilibrium equations to determine internal forces at connecting sites.

Objective 4 (1, ME10)
4.1 Students will demonstrate an understanding of Newton's laws of motion and basic equations underlying kinematics and kinetics of particles.
4.2 Students will demonstrate the ability to identify known and unknown kinematic and kinetic variables.
4.3 Students will demonstrate the ability to construct free-body diagrams, impose Newton's second law of motion, and solve for the unknown variables.
4.4 Students will demonstrate an understanding of tangential and normal acceleration, and the ability to analyze dynamics of particle in curvilinear motion.
4.5 Students will demonstrate the ability to use polar coordinate representation in the solution to particle dynamics problems.
4.6 Students will demonstrate the ability to identify and effectively account for kinematic constraints, such as occur in particle motion in a curved groove, and their kinetic consequences.

Objective 5 (1, ME10)
5.1 Students will learn how to analyze and solve statics and particle dynamics problems with friction.

Course Objectives:
(Numbers in parenthesis refer to ME and AE Program Outcomes)

Objective 1: To introduce students to the rigid-body model, and the notions of force as a sliding vector and couple as a free vector (1, ME10).

Objective 2: To teach students the formulation of equilibrium equations for planar and spatial rigid bodies (1, ME10).

Objective 3: To teach students the process of modeling external forces, drawing free-body diagrams, and evaluating internal forces (1, ME10).

Objective 4: To teach students the basic principles underlying the dynamics of particles (1, ME10).

Objective 5: To teach students to identify, formulate, and solve engineering problems of particle dynamics (1, ME10).

Objective 6: To teach students how to analyze and solve statics and particle dynamics problems in the presence of friction (1, ME10).

Course Topics:

1. Statics of particles
2. Moment of a force, couples, equivalent systems of forces
3. Equilibrium of rigid bodies in 2D and 3D
4. Distributed forces, centroids, and centers of gravity
5. Static analysis of trusses, frames, and machines
6. Kinematics and kinetics of particles
7. Statics and particle dynamics problems with friction