ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences and Business

COURSE: TAM 2001 Theoretical and Applied Mechanics

Date: Spring 2023

Credit Hours: 5

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): PHY 2011

Enrollment by assessment or other measure? ☐ Yes ☒ No
If yes, please describe:

Corequisite(s): None

Pre- or Corequiste(s): MTH 2002

Consent of Instructor: ☐ Yes ☒ No

Delivery Method:	☒ **Lecture**	**5 Contact Hours** (1 contact = 1 credit hour)
	☐ **Seminar**	**0 Contact Hours** (1 contact = 1 credit hour)
	☐ **Lab**	**0 Contact Hours** (2-3 contact = 1 credit hour)
	☐ **Clinical**	**0 Contact Hours** (3 contact = 1 credit hour)

Offered: ☒ **Fall** ☐ **Spring** ☐ **Summer**

CATALOG DESCRIPTION and IAI NUMBER (if applicable):
This course employs a vector approach to statics and dynamics. The topics covered include resultants of force systems; algebraic and graphical methods of resolution; analysis of forces acting on members of trusses, frames, etc.; friction; centroids; virtual work; kinematics of particles and rigid bodies; moments of inertia; kinetics of particles and rigid bodies; solution of kinetics problems by methods of work, energy, impulse and momentum; mechanical vibrations. **IAI Equivalent: EGR 944**

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

1. General Principles.
- 1.1 Mechanics.
- 1.2 Fundamental Concepts.
- 1.3 Units of Measurement.
- 1.4 The International System of Units.
- 1.5 Numerical Calculations.

2. Force Vectors.
- 2.1 Scalars and Vectors.
- 2.2 Vector Operations.
- 2.3 Vector Addition of Forces.
- 2.4 Addition of a System of Coplanar Forces.
- 2.5 Cartesian Vectors.
- 2.6 Addition and Subtraction of Cartesian Vectors.
- 2.7 Position Vectors.
- 2.8 Force Vector Directed Along a Line.
- 2.9 Dot Product.

3. Equilibrium of a Particle.
- 3.1 Condition for the Equilibrium of a Particle.
- 3.2 The Free-Body Diagram.
- 3.3 Coplanar Force Systems.
- 3.4 Three-Dimensional Force Systems.

4. Force System Resultants.
- 4.1 Moment of a Force–Scalar Formation.
- 4.2 Cross Product. Moment of a Force–Vector Formulation.
- 4.3 Principle of Moments.
- 4.4 Moment of a Force About a Specified Axis.
- 4.5 Moment of a Couple.
- 4.6 Equivalent System.
- 4.7 Resultants of a Force and Couple System.
- 4.8 Further Reduction of a Force and Couple System.
- 4.9 Reduction of a Simple Distributed Loading.

5. Equilibrium of a Rigid Body.
- 5.1 Conditions for Rigid-Body Equilibrium.
- 5.2 Free-Body Diagrams.
- 5.3 Equilibrium in Two Dimensions.
- 5.4 Equations of Equilibrium.
- 5.5 Two- and Three-Force Members.
- 5.6 Equations of Equilibrium.
- 5.7 Constraints and Statistical determinacy

6. Structural Analysis
- 6.1 Simple Trusses.
- 6.2 The Method of Joints.
- 6.3 Zero-Force Members.
- 6.4 The Method of Sections.
- 6.5 Frames and Machines.

7. Internal Forces.
- 7.1 Internal Forces Developed in Structural Members.
- 7.2 Shear and Moment Equations and Diagrams.
- 7.3 Relations between Distributed Load, Shear, and Moment.
- 7.4 Cables.

8. Friction.
- 8.1 Characteristics of Dry Friction.
- 8.2 Problems Involving Dry Friction.
- 8.3 Wedges.
- 8.4 Frictional Forces on Screws.
- 8.5 Frictional Forces on Flat Belts.
- 8.6 Frictional Forces on Collar Bearings, Pivot Bearings, and Disks.
- 8.7 Frictional Forces on Journal Bearings.
- 8.8 Rolling Resistance.

9. Center of Gravity and Centroid.
- 9.1 Center of Gravity, Center of Mass, and Centroid for a Body.
- 9.2 Composite Bodies.
- 9.3 Theorems of Pappus and Guldinus.
- 9.4 Resultant of a General Distributed Force System.
- 9.5 Fluid Pressure.

10. Moments of Inertia.
- 10.1 Definitions of Moments of Inertia for Areas.
- 10.2 Parallel-Axis Theorem for an Area.
- 10.3 Radius of Gyration of an Area.
- 10.4 Moments of Inertia for Composite Areas.
- 10.5 Product of Inertia for an Area.
- 10.6 Moments of Inertia for an Area About Inclined Axes.
- 10.7 Mohr's Circle for Moments of Inertia.
- 10.8 Mass Moment of Inertia.

11. Virtual Work.
- 11.1 Definition of Work and Virtual Work.
- 11.2 Principle of Virtual Work for a Particle and a Rigid Body.
- 11.3 Principle of Virtual Work for a System of Connected Rigid Bodies.
- 11.4 Conservative Forces.
- 11.5 Potential Energy.
- 11.6 Potential Energy Criterion for Equilibrium.
- 11.7 Stability of Equilibrium.

12. Kinematics of a Particle.
- 12.1 Introduction.
- 12.2 Rectilinear Kinematics: Continuous Motion.
- 12.3 Rectilinear Kinematics: Erratic Motion.
- 12.4 General Curvilinear Motion.
- 12.5 Curvilinear Motion: Rectangular Components.
- 12.6 Motion of a Projectile.
- 12.7 Curvilinear Motion: Normal and Tangential Components.
- 12.8 Curvilinear Motion: Cylindrical Components.
- 12.9 Absolute Dependent Motion Analysis of Two Particles.

13. Kinetics of a Particle: Force and Acceleration.
- 13.1 Newton's Laws of Motion.

13.2 The Equation of Motion.
13.3 Equation of Motion for a System of Particles.
13.4 Equations of Motion: Rectangular Coordinates.
13.5 Equations of Motion: Normal and Tangential Coordinates.
13.6 Equations of Motion: Cylindrical Coordinates.
13.7 Central-Force Motion and Space Mechanics.

14. Kinetics of a Particle: Work and Energy.

14.1 The Work of a Force.
14.2 Principle of Work and Energy.
14.3 Principle of Work and Energy for a System of Particles.
14.4 Power and Efficiency.
14.5 Conservative Forces and Potential Energy.
14.6 Conservation of Energy.

15. Kinetics of a Particle: Impulse and Momentum.

15.1 Principle of Linear Impulse and Momentum.
15.2 Principle of Linear Impulse and Momentum for a System of Particles.
15.3 Conservation of Linear Momentum for a System of Particles.
15.4 Impact.
15.5 Angular Momentum.
15.6 Relation Between Moment of a Force and Angular Momentum.
15.7 Angular Impulse and Momentum Principles.
15.8 Steady Fluid Streams.

16. Planar Kinematics of a Rigid Body

16.1 Planar Rigid-Body Motion.
16.2 Translation.
16.3 Rotation About a Fixed Axis.
16.4 Absolute General Plane Motion Analysis.
16.5 Relative-Motion Analysis: Velocity.
16.6 Instantaneous Center of Zero Velocity.
16.7 Relative-Motion Analysis: Acceleration.
16.8 Relative-Motion Analysis Using Rotating Axes.

17. Planar Kinetics of a Rigid Body: Force and Acceleration.

17.1 Moment of Inertia.
17.2 Planar Kinetic Equations of Motion.
17.3 Equations of Motion: Translation.
17.4 Equations of Motion: Rotation About a Fixed Axis.
17.5 Equations of Motion: General Plane Motion.

18. Planar Kinetics of a Rigid Body: Work and Energy.

18.1 Kinetic Energy.
18.2 The Work of a Force.
18.3 The Work of a Couple.
18.4 Principle of Work and Energy.
18.5 Conservation of Energy.

19. Planar Kinetics of a Rigid Body: Impulse and Momentum.

19.1 Linear and Angular Momentum.
19.2 Principle of Impulse and Momentum.
19.3 Conservation of Momentum

20. Three-Dimensional **kinematics of a Rigid Body.**

20.1 Rotation about a Fixed Point
20.2 General Motion

INSTRUCTIONAL METHODS:

1. Lectures and interactive lecture demonstration (ILDs), Activity-based physics and other audio-visual aids and technologies.
2. Homework assignments and related class discussion sessions.
3. Micro – computer-based laboratory exercises.
4. Modeling and guided practice of a variety of physics problems.

EVALUATION OF STUDENT ACHIEVEMENT:

Reading of textbook, note taking, and participation in classroom discussions as well as performing laboratory experiments are required of the students. Students are assigned approximately 15 homework problems per Chapter. Solutions of graded problems are discussed after grading if and when necessary. Evaluation of the students will include written problem class tests and one problem-orientated comprehensive final exam, written reports of laboratory experiments, quizzes and homework assignments

A = 90 -100
B = 80 – 89
C = 70 – 79
D = 60 – 69
F = 59 and below

INSTRUCTIONAL MATERIALS:

Textbooks: Engineering Mechanics, Statics and Dynamics, R.C. Hibbeler

Resources

Vector Mechanics For Engineers - Schwaum's Outline Series, McGraw-Hill Publishing Company Engineering mechanics, Kraige L. G, and Meriam J.L

LEARNING OUTCOMES AND GOALS:

Institutional Learning Outcomes

☐ 1) Communication – to communicate effectively;
☒ 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;
☐ 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;
☐ 4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies

This course stresses the use of mathematical methods to solve problems in statics and dynamics. Upon completion of this course, students should be able to use (vector) algebra, trigonometry, and differential and integral calculus (whichever methods are appropriate) to:

1. Demonstrate a superior command in unit analysis (both SI system and US customary units) in engineering.
2. Demonstrate an understanding of a variety of procedures used in analyzing/solving engineering problems, as well as a general guide in solving problems in statics and dynamics.
3. Add, subtract, and multiply vector quantities, e.g. vector forces and displacements.
4. Apply dot product and parallelogram law to analyze force vectors
5. Compute the resultant force, moment, and couple acting on a rigid body.
6. Determine whether a rigid body is in equilibrium under the action of a group of forces, moments, or couples.
7. Compute particle/rigid body equilibrium problems.
8. Determine/compute the forces and bending moments acting on or in trusses, frames or beams. This includes being able to draw shear and bending moment diagrams for these structures.
9. Determine/compute internal loading in structural members
10. Analyze and solve problems involving frictional forces (including wedges, screws, belts, bearings etc)
11. Determine the centers of gravity of two or three dimensional objects.
12. Determine and evaluate the centroids of lines, areas, or volumes.
13. Determine and evaluate the moments of inertia for areas, and mass moment of inertia
14. Solve problems involving equilibrium of particle and rigid body using virtual work.
15. Determine and compute the position, velocity, and acceleration of moving bodies as functions of time and position.
16. Apply Newton’s second law, work and energy to solve problems involving particle kinetics.
17. Apply Impulse and momentum methods to solve problems involving particle kinetics.
18. Describe mathematically the translational and rotational motion of rigid bodies.
19. Apply Newton’s law, work, and energy to solve problems involving the kinetics of rigid bodies.
20. Apply impulse and momentum methods to solve problems involving the kinetics of rigid bodies.
21. Solving problems involving three dimensional kinematics and kinetics of a rigid body
22. Solve problems involving mechanical vibrations.