Eastern Illinois University
Revised Course Proposal
PHY 2400, Dynamics

1. Catalog Description

2400 PHY. Dynamics. (3-0-3) S. Kinematics and dynamics of the three-dimensional motion of particles; kinematics and dynamics of the plane motion of rigid bodies; methods of work-energy and impulse-momentum; moving reference frames, vibrations, central force motion. Prerequisite: PHY 2390 and MAT 2443. **EGR 943**

Catalog change effective Fall 2004.

2. Student Learning Objectives and Evaluation

a) Students will demonstrate the ability to:

- Determine the velocity and position of a particle when given its acceleration: a(t), a(x), or a(v).
- Describe the motion of a particle in either Cartesian, Cylindrical, Tangential-Normal, or Spherical coordinate systems.
- Apply Newton's 2nd Law to solve for the motion of a particle, or a system of particles.
- Use the concepts of energy-momentum, momentum-impulse to solve for the motion of a system of particles.
- Use the concepts of torque-angular momentum to solve for the motion of objects.
- Use the relationship between velocity and angular velocity for points on a rigid body to determine the angular velocities of linked objects and the velocities of points on these objects.
- Use the concept of instantaneous center of zero velocity to determine the motion of linked objects.
- Use the relationship between acceleration and angular acceleration for points on a rigid body to determine the angular accelerations of linked objects and the accelerations of points on these objects.
- Apply the rigid body formulas to the case of pure rolling.
- Use the relationship between the velocities of a point with respect to two different frames of reference to solve for the motion of objects.
- Use the relationship between the accelerations of a point with respect to two different frames of reference to solve for the motion of objects.
- Calculate the angular momentum of a rigid body in planar motion using its moments and products of inertia.
- Use Euler's 2nd Law and Newton's 2nd Law to solve for the motion of rigid bodies in planar motion.
- Use the concepts of work-energy and impulse-momentum to solve for the plane motion of rigid bodies.
- Determine the velocity and acceleration as seen from moving frames of reference.
- Solve for the motion of a damped harmonic oscillator.
- Solve for the motion of particles under the influence of a central force.

b) Assessment regarding student achievement of the stated learning objectives, and the assignment of grades, will be based upon weekly homework assignments (15%), three hour exams (20% each), and a comprehensive final examination (25%). Homework and exams will involve the use of appropriate mathematical skills (through differential and integral calculus) to solve problems related to topics in dynamics.

c) N.A.
d) N.A.
e) N.A.

3. Outline of the Course

a)Kinematics of Material Points or Particles (6 hr)

- Reference Frames and Vector Derivatives
- Position, Velocity, and Acceleration
- Kinematics of a Point in Rectilinear Motion
- Rectangular Cartesian Coordinates
- Cylindrical Coordinates
- Tangential and Normal Coordinates
- Spherical Coordinates

Dynamics of a Particle and of a System of Particles (10 hr)

- Newton's Laws, Euler's Laws and Center of Mass
- Applications
- Work / Energy
- Impulse / Momentum
- Euler's 2nd Law

Kinematics of 2D Motion of Rigid Bodies (6 hr)

- Velocity and Angular Velocity Relationship for Two Points of the Same Rigid Body
- Translation
- Instantaneous Center of Zero Velocity
- Acceleration and Angular Acceleration Relationship for Two Points of the Same Rigid Body
- Rolling
- Relationship Between the Velocities of a Point with Respect to Two Different Frames of Reference
- Relationship Between the Accelerations of a Point with Respect to Two Different Frames of Reference

Dynamics of 2D motion of rigid bodies (8 hr)

- Angular Momentum of a Rigid Body in Plane Motion
- Moments and Products of Inertia / The Parallel-Axis Theorems
- Euler's 2nd Law
- 2D Problems of Plane Motion
- Rotation of Unbalanced Bodies

Methods of work-energy and impulse-momentum (4 hr)

- Kinetic Energy of a Rigid Body in Plane Motion
- Derivation of the Principle, Work = Change in Kinetic Energy
- Conservative Forces, Potential Energy and the Principle of Conservation of Energy
- The Principles of Impulse, Momentum and Conservation of Momentum

Kinematics of a Rigid Body in 3D Motion (4 hr)

- Relation Between Derivatives / The Angular Velocity Vector
- Properties of Angular Velocity
- The Angular Acceleration Vector
- Velocity and Acceleration in Moving Frames of Reference.
- The Earth as a Moving Frame

Vibrations (2 hr)

- Free Vibration
- Damped Vibration
- Forced Vibration

Central Force Motion (2 hr)
Hour exams (3)
Total Hours: 45

b) N.A.

4. Rationale

a) This is a required transfer course for many students in our Pre-engineering and B. S. in Engineering programs, and is also a requirement for Physics majors. The course meets IAI criteria for ENGR 943 (Dynamics), and is equivalent to UIUC's TAM 212 course.

b) Since this course requires pre-requisite mathematical skills at the MAT 2443 level, it is appropriately placed at the sophomore level.

c) Similarity to existing courses:

(1) No other EIU courses are similar to this course.

(2) PHY 2400 already exists. This updates its catalog description.

d) Impact on Program(s):

(1) There will be no change in currently listed requirements to any program.

(2) N.A.

5. Implementation

a) Any physics faculty member may be assigned to teach this course.

b) There is no additional cost to students.

c) Engineering Mechanics, An Introduction to Dynamics, 2nd Edition, by David J. McGill and Wilton W. King, PWS-Kent, 1989

6. Community College Transfer

A community college course may be judged equivalent to this course.

7. Date approved by the department or school: 10/02/2003
8. Date approved by the college curriculum committee: 10/24/2003
9. Date approved by CAA: 11/6/2003 CGS _____