Grande Prairie
Regional College

Department of Science

PC 1310 MECHANICS 4.3(3-2/2-3/2) UT(4.3) Fall 92
U of A Equivalent - EN PH 131
Course Outline

Calendar Description:

PC 1310 Mechanics 4.3(3-1-1.5) UT(4.3) Kinematics and dynamics of particles; gravitation; work and energy; linear momentum; angular momentum; systems of particles; introduction to dynamics of rigid bodies. **Prerequisite: MATH 30, MATH 31, PHYSICS 30. Corequisite: MA 1000**

Instructor:	Dr. Jaime P. Santiago J209 539-2865
Lecture:	MWF 2:00 - 2:50 p.m., J229
Laboratory:	T 3:00 - 5:50 p.m., J103
Seminar:	R 1:30 - 2:20 p.m., J226 (Section S1) T 1:30 - 2:20 p.m., J226 (Section S2)
Primary Textbook:	**Engineering Mechanics, Statics and Dynamics, 6th Edition,** R. C. Hibbeler (MacMillan)
Secondary Textbook:	**Physics for Scientists and Engineers, 3rd Edition** R. A. Serway (Saunders)
Laboratory Manual:	**Physics 131/137/141/143 Laboratory Manual** Physics Department, University of Alberta (McGraw-Hill Ryerson)
Assignments:	10 problem sets 25% deduction per day late Assignments more than 2 days late will not be accepted

Grading:		
	Assignments	10%
	Seminars	5%
	Laboratory	20%
	Midterm Exam	20%
	Final	45%

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Detailed Course Description

A. Introductory Materials (2 -- 50 minute lectures)

1. Mechanics
   - Where does dynamics of particles fit into the field of Mechanics?
2. Historical Background
   - Galileo, Newton, Euler, D'Alembert, Lagrange, Hamilton
3. Fundamental Quantities
   - Definitions of mass, length and time.
4. Idealizations and Models
   - Particles and concentrated forces
   - When can a finite dimensioned body by considered a particle?
5. Units of Measurement
6. Numerical calculations
   - Dimensional consistency
   - Unit conversions
   - Significant figures
7. Trigonometry Review

B. Mathematics Review (2 -- 50 minute lectures plus 1 -- 3 hour lab period)

1. Scalars
   - Examples and properties
2. Vectors
   - Examples (use velocity vectors)
   - Right handed coordinate systems
   - Mathematical properties, vector addition, scalar product, vector product
3. Differential Calculus
   - functions, limits, continuity
   - derivative as slope of a function
   - some standard derivatives.
4. Integral Calculus
   - anti-derivative, indefinite integrals,
   - evaluation of integration constants
   - definite integrals, integral as area under the curve of a function
   - some standard integrals.

C. Kinematics of Rectilinear Motion of a Particle (4)

1. Absolute motion of a particle along a line
2. Definition of position, displacement, velocity and acceleration vectors

3. Difference between average velocity and acceleration and instantaneous values of velocity and acceleration; distance and speed

4. $v = \frac{ds}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2s}{dt^2}, \quad a = v\frac{dv}{ds}$

5. Special case, a = constant

6. General case, a ≠ constant
   - Consider a = a(t), a = a(v), and a = a(s)

7. Graphical methods

D. Kinematics of Planar Motion of a Particle (5)

1. Position, displacement, velocity, and acceleration vectors

2. Cartesian components
   - projectile motion

3. Normal and tangential components
   - General planar motion

   - Special case, uniform circular motion (ρ = constant, v = constant)

4. Cylindrical components
   - General planar motion

   - Special case, circular motion (r = constant)

5. Absolute dependent motion of two or more particles (motion subject to constraints)
   - Pulley systems

6. Relative motion of two or more particles
   - Relative motion along a line
   - Relative planar motion

E. Dynamics of a Particle (5)

1. Newton's Laws for a Single Particle
   - Definition of force
   - Inertial frames of reference
   - Inertial mass
   - When can a finite dimensioned body be considered a particle?

2. Newton's Law of Universal Gravitation
   - Historical background
   - Gravitational mass
   - Principle of equivalence
   - Gravitational force of spherical mass distributions
   - Mass and weight
   - Acceleration of gravity, g

3. Free body diagrams
   - The equations of motion for a single particle

4. Static and kinetic friction

5. Rectangular Cartesian components

6. Normal and tangential components

7. Cylindrical components

7. Central force motion
   - Kepler's Laws of planetary motion

F. Systems of Particles (1)

1. Extension of Newton's second law for systems of particles
   - Definition of the system being considered
   - Internal and external forces to the system

2. Importance of the center of mass of the system of particles

G. Determination of Center of Mass (2)

1. Center of mass, center of gravity, centroid

2. Center of mass of a system of discrete particles

3. Center of mass of a finite dimensioned body. (Use of integration techniques)

4. Center of mass of composite bodies

H. Work and Energy (4)

1. Work by a force
   - Spring force
   - Gravitational force
   - Weight
   - Friction

2. Principle of work and energy for a single particle

3. Systems of particles II
   - Extension of work energy principle to a system of particles

4. Power and mechanical efficiency

5. Conservative forces and potential energy

6. Conservation of mechanical energy

7. Work-Energy Principle with conservative and non-conservative forces

I. Linear Momentum and Impulse (5)

1. Definition of linear momentum
   - Newton's second law in terms of linear momentum
2. Principle of linear impulse and momentum
   - Definition of impulse of a force
3. System of particles III
   - Extension of principle of linear impulse and momentum to a system of particles
4. Conservation of linear momentum for a system of particles
5. Collisions
   - Definition of coefficient of restitution, e
   - Impacts with two or more particles along a single line
   - Special cases: elastic impacts, e = 1 and plastic impacts e = 0
   - Oblique impacts of two particles

J. Angular Impulse and Angular Momentum (3)

1. Definition of angular momentum (moment of momentum)
2. Relationship between moment of a force (torque) and rate of change of angular momentum for a system of particles
   - Moments about the center of mass
   - Moments about a fixed point
3. Principle of angular impulse and angular momentum for a system of particles
4. Conservation of angular momentum

K. Introduction to Dynamics of Rigid Bodies (5)

1. Definition of a rigid body
2. Equations of motion for a rigid body in planar motion
   - Kinematics of rotational motion
   - Free body diagram
   - Definition of moment of inertia for a body
   - Computation of moment of inertia for simple bodies
   - Newton's Second Law for rotating rigid body
3. Kinetic energy for a rigid body
4. Angular momentum of a rigid body

Laboratory Work

All laboratory reports are due at the end of the laboratory period. There will be a 25% deduction per day late. No late reports will be accepted after two days.

Schedule

Number	Date	Expt. #	Title
	Sept. 8		High School Calculus Review
1	Sept. 15, 22	1	Graphical Error Analysis
2	Sept. 29, Oct. 6	2	Kinematics
3	Oct. 13, 27	3	Acceleration of Gravity
4	Nov. 3, 10	4	Atwood's Pulley
5	Nov. 17, 24	8	Collision: Ramp
6	Dec. 1, 8	9	Moment of Inertia