Grande Prairie Regional College

Department of Science

PC 1310 MECHANICS 4.3(3-2/2-3/2) UT(4.3) Fall 93
U of A Equivalent - EN PH 131
Course Information

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:	M TR	2:00 - 2:50 p.m., J226 9:30 - 10:20 a.m., J226
Laboratory:	T	3:00 - 5:50 p.m., J107
Seminar:	T R	1:30 - 2:30 p.m., J204 (Section S2) 1:30 - 2:30 p.m., J204 (Section S1)
Primary Textbook:	**Engineering Mechanics, Statics and Dynamics, 6th Edition** by R. C. Hibbeler (Maxwell-MacMillan)	
Secondary Textbook:	**Physics for Scientists and Engineers, 3rd Edition, Updated Version** by R. A. Serway (Saunders)	
Laboratory Manual:	**Physics 131/137/141/143 Laboratory Manual** by Physics Department, University of Alberta (McGraw-Hill Ryerson)	

Grading:	Assignments	5%
	Seminars	5%
	Laboratory	20%
	Midterm Examination	20%
	Final Examination	50%

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Textbooks:

Although there are two textbooks for this course, they are each used for other courses as well. Hibbeler is used for EG 2300 and MEC E 250 (U of A). Serway is also used for PC 1370 and PC 2380 (Physics 238 at U of A). The lecture will follow the notation used by Hibbeler.

Marking:

Students must pass the laboratory course in order to pass the course. A student who fails to pass the laboratory course must repeat the entire course. Students who have previously taken the course and passed the laboratory component with at least 65% may choose not to repeat the lab.

Re-writing of the final examination may be allowed in special circumstances under rules approved by the College.

Seminars:

Students will be required to solve 2 to 3 problems to be handed in at the end of the 1-hour period. Help in doing these problems will be available from the instructor. Students absent during seminars will receive a mark of zero unless excused by the instructor for valid reasons. If a seminar session is canceled due to weather, fire alarms, and/or other College sanctioned activities, students in the canceled seminar will not be required to hand them in for marking. Appropriate adjustments will be made to their grades. Seminar problems are the same as U of A's when possible.

Assignments:

There will be approximately 12 problem sets in this course. Assignments are normally handed out on Mondays and due one week later. The actual number of assignments and their due dates will depend on class progress. Appropriate adjustments will be made to take into consideration topics already covered in the lecture. Problem sets will be the same as U of A's when possible except for two sets. At the U of A, only 10 problem sets are normally assigned.

Laboratory:

Laboratory work is performed every two weeks alternating with chemistry lab. At any time, half the class will be doing the physics lab while the other half will be doing the chemistry lab. There is no final exam in the lab. Lab mark is totally based on individual lab reports.

Laboratory reports are due at the end of the period. No late reports will be accepted. Lab reports should be handwritten (pencils are OK) on black Physics Laboratory Books available at the bookstore. A student who misses a lab due to illness or other extreme reasons may perform the lab at a different time if the lab equipment for the experiment is still set up or if the lab technician agrees to set them up again. The lab technician has sole discretion whether to set up the equipment again or not. If the equipment is not available anymore and the absence is excused by the instructor, the student will not be required to hand the lab and his/her mark adjusted accordingly.

Midterm Examination:

The midterm exam is tentatively scheduled for **21 October, 1993 from 9:30 a.m. to 11:00 a.m.** Writing of midterm exams will done in the regularly assigned classroom. There is no provision for rescheduling if a student misses the exam.

Final Examination:

Final exams are 3 hours long and are normally held at the College Gym. Dates and times will be announced later by the registrar's office. Any conflicts should be reported to the registrar.

PC 1310 - MECHANICS
Course Outline (1993-94)

A. Introductory Material (4) September T7, R9, M13, T14

1. Mechanics - Where does dynamics of particles fit into the field of mechanics?
2. Brief Historical Survey
3. Fundamental Quantities
   - definitions of mass, length and time
4. Idealizations
   - particles and concentrated forces
   - when can a finite body be considered a particle?
5. Units of measurement
6. Dimensions
7. Numerical calculation
   - significant figures
8. Trigonometry and geometry review
9. Calculus review
   - it is assumed that students know how to differentiate and integrate polynomial functions of a single variable.

The first six items are covered in Hibbeler STATICS, chapter 1, sections 1.1-1.6, while similar material is covered in Serway in chapter 1, sections 1.1, 1.3-1.7. A review of important trigonometric formulae and calculus us given in Hibbeler STATICS, appendix A. In Serway, similar material is given in appendix B, sections B4, B6 and B7.

B. Kinematics of rectilinear motion of a particle (4) September R16, M20, T21, R23

1. Absolute motion of a particle along a line
2. Definition of position, speed, velocity and acceleration
3. Difference between average speed, velocity and acceleration and instantaneous values of speed, velocity and acceleration.
4. $v = \frac{ds}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2s}{dt^2}, \quad a = v\frac{dv}{ds}$
5. Special case: constant acceleration, freely falling bodies
6. General case: variable acceleration - solution of problems using separation of variables
   - consider $a = a(t)$, $a = a(v)$, and $a = a(s)$.
7. Graphical methods

This material is covered in Hibbeler DYNAMICS, chapter 12, sections 12.1-12.2, while similar material is contained in Serway, chapter 3, sections 3.1-3.6. The case of variable acceleration is treated briefly by Serway in section 6.4.

C. Kinematics of planar motion of a particle (6), September M27, T28, R30, October M4, T5, R7

1. Position, velocity and acceleration vectors
2. Vector addition and subtraction
3. Scalars and magnitude of a vector
4. Scalar (dot) product, components of a vector
5. Rectangular Cartesian components
   - motion of a projectile
6. Normal and tangential components
   - general planar motion

$$\mathbf{v} = v\mathbf{u}_t, \qquad \mathbf{a} = \dot{v}\mathbf{u}_t + \frac{v^2}{\rho}\mathbf{u}_n$$

   special case: uniform circular motion (v = constant, ρ = constant)
7. Absolute dependent motion of two or more particles
   - pulley systems
8. Relative motion of two or more particles
   - relative motion along a line
   - relative planar motion

This material is covered in Hibbeler STATICS chapter 2, sections 2.1-2.9, and chapter 4, section 4.1, and in DYNAMICS, chapter 12, sections 12.3-12.9. There is similar material in Serway in chapter 2, sections 2.1-2.4, chapter 7, section 7.3 and chapter 4, sections 4.1-4.6. Note the difference in notation used in the two textbooks for the normal and tangential unit vectors.

D. Dynamics of a particle (5) October T12, R14, M18, T19, M25. Note that October 11 is Thanksgiving Day holiday.

1. Newton's laws for a single particle
   - definition of force
   - inertial frames of reference
2. Newton's law of gravitational attraction
   - mass and weight
3. Free body diagram
   - equations of motion of a single particle
4. Rectangular Cartesian components
   - friction
5. Normal and tangential components
6. Motion in a circle: uniform circular motion
7. Central force motion
   - Kepler's laws: state these laws in complete form but apply to circular orbits only
   - introduce angular momentum of a particle as $r \times p$
   - significance of a central force

This material is covered in Hibbeler DYNAMICS, chapter 13, sections 13.1, 13.2, 13.4-13.7 and friction is covered in STATICS, chapter 8, section 8.1. Similar material is covered in Serway in chapter 5, sections 5.1-5.9 and chapter 6, sections 6.1, 6.2 and 6.4. An introduction to gravitation and Kepler's laws is given in Serway chapter 14, sections 14.1-14.6.

The midterm exam is expected to be based on material up to the end of section D4. The exact details will depend on how the term progresses. The midterm exam will be on Thursday, 21 October at 9:30 a.m. The exam is 1½ hours long.

E. Systems of particles I (2) October T26, R28

1. Extension of Newton's second law to a system 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
3. Center of mass, center of gravity, and centroid
4. Center of mass of a discrete system of particles.

This material is covered in Hibbeler DYNAMICS, chapter 13, section 13.3, and STATICS chapter 9, sections 9.1-9.3. Similar material is in Serway chapter 9, section 9.6-9.7.

F. Work and Energy (5) November M1, T2, R4, M8, T9

1. Work done by a force
   - spring force (Hooke's law)
   - force of gravitational attraction
   - weight
   - friction
2. Principle of work and energy for a single particle
3. System of particles II
   - extension of the work-energy principle to a system of particles
4. Power and mechanical efficiency
5. Conservative forces and potential energy
6. Conservation of mechanical energy

This material is covered in Hibbeler DYNAMICS, chapter 14, sections 14.1-14.6, while similar material is in Serway chapter 7, sections 7.1-7.6, and chapter 8, sections 8.1-8.7 and 8.9.

G. Linear momentum and impulse (5) November M15, T16, R18, M22, T23
Note that November 11 is Remembrance Day holiday.

1. Definition of linear momentum
   - Newton's second law written in terms of linear momentum
2. Principle of linear impulse and momentum
   - definition of the impulse of a force
3. Systems of particles III
   - extension of the 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 the coefficient of restitution, e
   - impacts with two or more particles along a line: $e \neq 0$, $e \neq 1$
   - special cases: elastic impact, $e = 1$ and plastic impact $e = 0$
   - oblique impact of two particles

This material is considered in Hibbeler DYNAMICS chapter 15, sections 15.1-15.4, while similar material is considered in Serway chapter 9, sections 9.1-9.5. Note that Serway only considers perfectly elastic collisions ($e = 1$) and perfectly inelastic collisions ($e = 0$) and does not consider collisions for which $0 < e < 1$.

H. Introduction to dynamics of a rigid body (about a fixed axis) (4) November R25, M29, T30, December R2

1. Definition of a rigid body
2. Angular displacement, velocity and acceleration of a rigid body: kinematics
3. Kinetic energy of a rigid body
4. Definition of the moment of inertia
   - computation of moment of inertia for simple bodies
5. Vector cross product
6. Moment of a force about a point
7. Relation between moment of force and angular acceleration
   - moments about a fixed point
   - moments about the center of mass
8. Equations of motion for a rigid body in planar motion
   - free body diagram

It is recommended that Serway be used for rigid body dynamics in syllabus sections H and I.

This material is considered in Hibbeler DYNAMICS chapter 16, sections 16.1-16.3 and chapter 17, sections 17.1-17.4. Similar material is considered in Serway in chapter 10, sections 10.1-10.8 and chapter 11, sections 11.1-11.4.

I. Angular momentum (moment of momentum) and angular impulse (3) December M6, T7, R9

1. Definition of angular momentum (moment of momentum) and angular impulse
2. Principle of angular momentum for a system of particles
3. Conservation of angular momentum
4. Angular momentum of a rigid body

This material is considered in Hibbeler DYNAMICS chapter 15, sections 15.5-15.7, while similar material is considered in Serway chapter 11, sections 11.3-11.5.