UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS AND ASTRONOMY
COURSE OUTLINE

1. Course: Phys 343, Classical Mechanics II Winter 2017

Instructor: Dr. D. Hobill | Science B 539 | 403.220.6965|
email: hobill@ucalgary.ca
Office Hours: W 10:00 – 11:00, R 16:00 – 17:00 or by appointment

Lecture Sections: LEC 01: TR 14:00-15:15 | SA 124A

Course Website: d2l.ucalgary.ca

Departmental Office: SB 605 | 403.220.5385 | phasugrd@ucalgary.ca

2. Prerequisites: Physics 341
Note: The Faculty of Science policy on pre- and co-requisite checking is outlined in the 2015-2016 Calendar. A student may not register in a course unless a grade at least" C-" has been obtained in each pre-requisite course; it is the responsibility of students to ensure that their registrations are in order. See http://www.ucalgary.ca/pubs/calendar/current/sc-3-5.html for details.

3. Grading: The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Assignments: 35%
MidTerm Test I: 15%
MidTerm Test II: 15%
Final Examination: 35% (To be scheduled by the Registrar)

The in-class tests will be held on Thursdays in February and March (dates: TBA). Percentage grades will be given for all elements of term work and examinations. A weighted course percentage will be calculated for each student after the final exam is written. Percentage to letter grade conversion scale:

> = 95 %	A +	> = 75 %	B +	> = 60 %	C +	> = 42 %	D +
> = 85 %	A	> = 70 %	B	> = 55 %	C	> = 40 %	D
> = 80 %	A -	> = 65 %	B -	> = 50 %	C -	< 40 %	F

The University policy on grading and related matters is also found in the UofC Calendar. Details can be found at;
http://www.ucalgary.ca/pubs/calendar/current/f.html

4. Missed Components of Term Work: The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in Section 3.6. It is the student's responsibility to familiarize himself/herself with these regulations. See also Section E.6 of the University Calendar.

5. Scheduled out-of-class activities: none

6. Course Materials: "*Analytical Mechanics*", Fowles & Cassiday, 7th. ed., Thomson – Brooks Cole is recommended

7. Examination Policy: Exams will be closed book, closed notes, but a calculator will be allowed. Students should also read the Calendar, Section G, on Examinations.

8. Course fees: none

9. Human studies statement: Students in this course are not expected to participate as subjects or researchers. See also Section E.5 of the University Calendar.

10. OTHER IMPORTANT INFORMATION FOR STUDENTS:

(a) Academic Misconduct: Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties.

(b) Assembly Points: In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on assembly points.

(c) Student Accommodations: Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf. Students needing an Accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics and Astronomy, Dr. David Feder, by email (dfeder@ucalgary.ca) or by phone (403.220.3638).

(d) Safewalk: Campus Security will escort individuals day or night (http://www.ucalgary.ca/security/safewalk/). Call 2205333 for assistance.
Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

(e) Freedom of Information and Privacy: This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also http://www.ucalgary.ca/secretariat/privacy.

(f) Student Union Information: VP Academic Phone: 220-3911 Email: suvpaca@ucagary.ca.
SU Faculty Rep: Phone: 220-3913 Email:
science1@su.ucalgary.ca, science2@su.ucalgary.ca and science3@su.ucalgary.ca
Student Ombuds Office: 403 220-6420 Email:
ombuds@ucalgary.ca; http://ucalgary.ca/provost/students/ombuds

(g) Internet and Electronic Device Information: You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

(h) U.S.R.I.: At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses (www.ucalgary.ca/usri). Your responses make a difference - please participate in USRI Surveys.

11. OTHER COURSE RELATED INFORMATION:

(a) Course Description

Multiple particle interactions; centre-of-mass; general rotations of rigid bodies; inertia tensor; angular momentum and torque; rotational stability; Lagrangian and Hamiltonian mechanics; perturbation theory.

(b) Course Learning Outcomes

This course continues the analysis of physical systems subject to Newton's laws of motion, but with even more sophisticated methods using multi-variable calculus. The applications are aimed more toward systems consisting of more than a single particle and develops the concept of continuous distributions of matter and how that relates to the dynamics. Using the concepts and methods used in PHYS 341 the students will:

- compute the centre-of-mass of discrete multi-particle systems and understand how to compute the linear momentum, angular momentum and kinetic energies of the system and relate that to the individual motions of each particle
- be able to analyze the collisions between particles in a laboratory frame using the conservation of momentum and energy. In addition they should be able to relate the coefficient of restitution to the energy lost or gained in a collision.

- recognize the concept of an extended rigid object and be able to compute the centre of mass and moment of inertia about a fixed axis for continuous mass distributions
- be familiar with the parallel and perpendicular axis theorems use their ability to simplify calculations of moments of inertia cases where complicated integral methods might otherwise be required
- use Newton’s second law for rotating systems and understand the relationship between rotational motion and linear motion
- understand how the calculus of variations and extremization procedures can be used to solve some difficult problems involving shortest distances, times etc. (e.g. geodesics, brachistochrone problem, Snell’s law)
- develop an understanding of both Lagrangian and Hamiltonian mechanics and the use of an appropriate set of generalized coordinates, In addition they should be aware of Noether’s theorem and its relation to conservation laws in dynamics

(c) Course Learning Incomes

- Vector algebra and how it is used in examining physical systems
- Differential equations: separation of variables for first order ODE's, methods for second order ODE's with constant coefficients
- Time dependent forces, velocity dependent forces, position dependent forces
- Potential energy functions, conservation of mechanical energy, equilibrium conditions, turning points for bound motion
- Forced damped simple harmonic oscillator, phase space and phase space portraits, perturbations dynamical variables.
- Central forces, angular momentum conservation, Kepler's laws, bound and scattering motions, effective potentials
- Non-inertial frames, linearly accelerated motion, rotational motion, inertial forces.

(d) Syllabus

Topics to be covered in this course include:

Chapter 7. Dynamics of Systems of Particles

1. Centre of mass
2. Linear momentum
3. Angular momentum
4. Kinetic energy
5. Reduced mass of two interacting bodies
6. Collisions in Lab and Centre-of-Mass frames
   a. Elastic collisions
   b. Inelastic collisions

Chapter 8. Planar Motion of Rigid Bodies

1. Centre of mass
2. Moment of inertia
3. Perpendicular and Parallel axis Theorems
4. Applications
   a. Physical Pendulum
   b. Rolling motion

Chapter 9. 3D Motion of Rigid Bodies

1. 2D Concepts generalized to 3D
   a. Moment of inertia tensor
   b. Angular momentum
   c. Rotational kinetic energy
2. Principal axes of rotating objects
3. Euler's equations of motion
4. Applications

Chapter 10. Lagrangian and Hamiltonian Dynamics

1. Variational Principles
2. Generalized coordinates
3. Kinetic and Potential energy
4. Lagrange's equations of motion
5. Generalized momenta
6. Hamilton's equations

Department Approval_____Date_____