Physics 404G Mechanics
Fall 2011
Syllabus

I. The course

Instructor: Kwok-Wai Ng
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Office Hours: Mon. 10 – 11, or by appointment

Time: MWF 9:00-9:50
Place: CP397

Text book: Classical Mechanics by John R. Taylor
An Introduction to Mechanics by Daniel Kleppner and Robert Kolenkow

Course web page: http://www.pa.uky.edu/~kwng/fall2011

II. Goals and learning outcomes

Most of you have studied mechanics in high school or PHY231 already. This will be the first course that gives a formal treatment to this subject. Mechanics is the mother of all sciences. It revolutionized the way we study nature, and eventually lead to the industrial revolution that changed the whole course of civilization. It is the first subject that allows us to predict the future course from a few initial conditions. It is also the first subject that has a rigorous mathematical framework that allows us to solve a wide variety of problems with a few principles. This makes physics different from other "stamp collecting" sciences*. Nearly all later subjects in physics, including electricity and magnetism, relativity, and quantum mechanics are developed based on the foundation of classical mechanics.

Mechanics is a subject that all physicists need to have a good grasp. In this class, you will learn how to appreciate the beauty of the simplicity in the structure of classical mechanics, how to think analytically, and how to apply a few simple principles to analyze different problems and natural phenomena. To be successful in this class, you need to think often and practice hard. To help you work towards this goal, we will have special arrangement in the 50 minutes class time. At the beginning of each class, we will have a short quiz in which you will be asked to recite some of the basic formulae we discussed in the last class. You will have less than 3 minutes to complete the quiz. The quizzes will be collected and graded. After the quiz, I will use 15 minutes to work out one or two examples demonstrating the use of the formulae or principles we learned from last class. You will then use 15 minutes to work on yourself, or as a group, on one or two assigned problems. Your work will be collected and your effort (i.e. not the final answer) will be graded. After this, you will receive one homework set of similar problems that is due by

the next class. In the last 15 minutes, I will present and discuss another set of formulae for the next class.

The whole course can be divided into parts.

Part A.

In the first half (about 20 classes) we will review major topics in Newtonian mechanics that you may have some experience before. We will begin with the three equivalent descriptions of Newton's laws of motion, energy, and momentum, then simple harmonic oscillation, and finally rigid body motion. You have most of the knowledge from PHY231 already, but our goal is to train you to use the knowledge effectively in solving problems. In this first part of the course, we will use the text book by Daniel Kleppner and Robert Kolenkow. Each homework set will have about five problems, covering the topics we have practiced in each class.

Part B.

In the second half of the course we will study newer topics like Lagrangian and Hamiltonian mechanics, central force field problem, Euler's equations, and vibration modes etc. We will use the John R. Taylor. Since these are newer topics, so we will have less (but still a lot) emphasize on problem solving. Whenever there is less homework problem on the topic discussed, I will add extra problems from part A of the course to make up the same number of problems.

Learning outcomes:

- Build up a good foundation in Newtonian mechanics. Solve variety of problems analytically and systematically with confidence.
- Learn analytical mechanics. Know how to set up Lagrangian equations and obtain the equations of motion in generalized coordinates.
- Acquire the knowledge of some advanced topics, like central force field, gyroscopic motion, and normal modes.

III. Class work

(i) Classroom behavior and cheating

Well behavior is expected. Eating, drinking, cell phone and laptop are not allowed during class. Any action that hinders the class progress is prohibited.

Students are not discouraged from working together on the homework assignments. However, after developing the idea, each student should work independently towards the final solution. Copying homework, either from a classmate or internet, is considered as plagiarism, which is a serious academic offense. Plagiarism or cheating in examinations will result in an E in the final grade, or a more severe punishment.

(ii) Attendance and participation

Attendance is not mandatory. However, attendance is important because we will discuss many examples during class that will help you finish the homework at home. Furthermore, if you miss classes, you will miss quizzes and class work also.

You are encouraged to participate in the discussion as we work out the examples. Discussion is one of the most effective ways to learn a new concept.

(iii) Quizzes

The quizzes given at the beginning of each class is a pure memorization of the formulae I gave in the previous class. This will help you follow my examples better, and able to do class work and homework without consultation to the textbook. These are basic formulae that you need to keep in mind so you can think effectively. There will be no conceptual or calculation problem in these quizzes. There will be no quiz if I do not give out any formula in the previous class.

(iv) Class work

I will assign one to two problems for you to work out during the class. At the end of the given time, I will collect your work for grading. The grading will mostly base on your participation and engagement, and your effort and in solving the problems. Correct answer or final answer is not necessary for a full score. You are encouraged to discuss with other classmates or myself about the problem. In any case, you have to write up your own answer. Copying is not allowed because it is not the right way in learning. Writing down the idea in your own effort will help you tremendously in understanding the materials.

(v) Homework

There will be a lot of homework in this class, about five problems for every class. I will grade one randomly selected problem thoroughly, and half of the homework score will base on this graded problem. The other half of homework score will be assigned according to the completeness of your work. You need to complete all problems for a good score.

(vi) Tests

Two in-class one hour close book tests will be given. These tests will be held in the classroom where the lectures are given and will consist of problems similar to, but not the same as, those assigned for homework. Students must bring calculators to the tests. The programming function of the calculator is not allowed, though I do not think it will do any help. You are required to turn off all electronic devices except the calculator.

Students with an academic excuse for missing an exam should discuss it with the instructor before the exam, if possible. A grade of zero will be given for an unexcused absence from an exam. A student with an excused absence will be given the option of taking a make-up exam or receiving a ‘virtual’ score base on your scores in the other test and the final examination in

comparison to the class average. In order to use this 'virtual' score option, you must complete the other test, or its make-up, and the final exam.

(vii) Final examination

The final exam will be given on Wednesday, 14 Dec. at 8:00 AM., in the classroom where the lectures are given (CP397). The final examination will have the same format as the in-class hour test, but twice as long in length and the students will have two hours to complete the examination. The final examination is comprehensive and covers all materials we have studied in this semester.

There is no 'virtual' score option for the final examination. You are required to take the final examination physically. If you have a valid excuse in missing the final examination, you will receive an I grade.

(viii) Grading policy

Graduate students enrolled in the course will occasionally be given one or more supplementary homework problems which they will need to solve and turn in, in addition to the usual homework assignment. These extra problems will generally be somewhat more difficult, and will require some extra effort to solve. While the percentage scores which graduate students accrue on their homework assignments will reflect their work on these more challenging problems, no other distinction will be made between undergraduate and graduate students in this course. That is, both groups will take the same quizzes and exams, and both groups will be combined and simultaneously evaluated when final course grades are assigned. The following formula will be applied to both undergraduate and graduate students:

Quizzes	50 points
Class work	50 points
Homework	200 points
2 1-hour tests	400 points
Final examination	400 points
Total	1100 points

Relationship between your numerical score and letter grade (note that graduate students are not eligible to receive a grade of D):

Undergraduate students		Graduate students	
1000 points or above	A	1000 points or above	A
880 points or above	B	880 points or above	B
660 points or above	C	660 points or above	C
500 points or above	D	Below 660 points	E
Below 500 points	E		

The actual curve at the end of the semester may be adjusted according to the class performance and it may be slightly easier than the above letter grade assignment.

(ix) Midterm grade

At midterm, an estimate of your current letter grade based on the criteria listed above will be given. The midterm grade will be sent to the registrar to review the student's performance at that point.

IV. Course evaluation

Course evaluations are an important component of our Department's instructional program. An on-line course evaluation system was developed to allow each student ample time to evaluate each component of the course and instructor, thus providing the Department with meaningful numerical scores and detailed commentary while minimizing the loss of instructional time in the classroom. To access the system, simply go the Department of Physics Web page at www.pa.uky.edu and click on the link for Course Evaluations; then follow the instructions. You will need to use your student ID# to log into the system, and this will also allow us to monitor who has filled out evaluations. However, when you log-in you will be assigned a random number that will keep all your comments and scores anonymous.

V. Academic accommodations due to disability

If you have a documented disability that requires academic accommodations, please see me as soon as possible during scheduled office hours. In order to receive accommodations in this course, you must provide me with a Letter of Accommodation from the Disability Resource Center (Room 2, Alumni Gym, 257-2754, email address jkarnes@email.uky.edu) for coordination of campus disability services available to students with disabilities.

VI. Tentative schedule

Class #	Date	Topics – formula review	Textbook
1	Aug 24 (W)	Math review	KK Ch.1
2	Aug 26 (F)	Velocity and acceleration. Relative velocity	KK Ch.1
3	Aug 29 (M)	Projectile motion	KK Ch.1
4	Aug 31 (W)	Circular motion	KK Ch.1
5	Sept 2 (F)	Tangential and normal components. Polar coordinates	KK Ch.1
	Sept 5 (M)	Labor day. No class	
6	Sept 7 (W)	Newton's 1^{st} and 3^{rd} Law	KK Ch.2
7	Sept 9 (F)	Newton's 2^{nd} Law	KK Ch.2
8	Sept 12 (M)	Kinetic energy, work, and conservative force	KK Ch.4 and Ch.5
9	Sept 14 (W)	Conservation of energy	KK Ch.4
10	Sept 16 (F)	Momentum and impulse	KK Ch.3
11	Sept 19 (M)	Conservation of momentum. Center of mass	KK Ch.3

		and reduced mass	
12	Sept 21 (M)	Coefficient of restitution and elastic collision	KK Ch.3 and 4.14
13	Sept 23 (F)	Combined use of conservation of energy and momentum	KK Ch. 4
14	Sept 26 (M)	Simple harmonic motion	KK Ch.10, T Ch. 5
15	Sept 28 (W)	Calculation of natural frequency	KK Ch.10, T Ch. 5
16	Sept 30 (F)	Damped and force simple harmonic motion	KKCh.10, T Ch. 5
17	Oct 3 (M)	Moment of inertia	KK Ch.6
18	Oct 5 (W)	Rigid body motion I	KK Ch.7
19	Oct 7 (F)	Rigid body motion II	KK Ch.7
20	Oct 10 (M)	Calculus of variation	T Ch. 6
21	Oct 12 (W)	Test I	
22	Oct 14 (F)	Generalized coordinates and constraints	T Ch. 7
23	Oct 17 (M)	Kinetic energy and generalized force, Lagrange equation with applied forces	T Ch. 7
24	Oct 19 (W)	Lagrangian	T Ch. 7
25	Oct 21 (F)	Lagrange's equation	T Ch. 7
26	Oct 24 (M)	Conjugate momentum	T Ch. 7
27	Oct 26 (W)	Hamiltonian and conservative law	T Ch. 13
28	Oct 28 (F)	Hamilton equations	T Ch. 13
29	Oct 31 (M)	Phase space orbits and Liouville's theorem	T Ch. 13
30	Nov 2 (W)	Non-inertial frame and Coriolis force	T Ch. 9, , KK Ch. 8
31	Nov 4 (F)	Central force field: Equations of motions	T Ch. 8, KK Ch. 9
32	Nov 7 (M)	Equivalent 1D problem	T Ch. 8, KK Ch. 9
33	Nov 9 (W)	Test 2	
34	Nov 11 (F)	Coordinate geometry of conic curves	T Ch. 8, KK Ch. 9
35	Nov 14 (M)	The orbits	T Ch. 8, KK Ch. 9
36	Nov 16 (W)	Inertia tensor and principal axes	T Ch. 10
37	Nov 18 (F)	Euler’s equation	T Ch. 10
38	Nov 21 (M)	Euler’s angles	T Ch. 10
	Nov 23 (W)	Thanksgiving. No class	
	Nov 25 (F)	Thanksgiving. No class	
39	Nov 28 (M)	Motion of a spinning top	T Ch. 10
40	Nov 30 (W)	Normal mode - Matrix equation of motion	T Ch. 11
41	Dec 2 (F)	Normal mode - Solution and eigenvalue problem	T Ch. 11
42	Dec 7 (M)	Normal mode - Example	T Ch. 11
43	Dec 9 (W)	Review	
44	Dec 11 (F)	Review	

KK= An Introduction to Mechanics by Daniel Kleppner and Robert Kolenkow
T= Classical Mechanics by John R. Taylor
Schedule may be readjusted if necessary.

Final exam: Wednesday, 13 Dec at 8:00 AM., in the classroom where the lectures are given.