昆山杜克大学
DUKE KUNSHAN UNIVERSITY

Introductory Astronomy

Physics 134K

Fall 2016

Dates / contact hours: 7 week course; 300 contact minutes per week
Academic Credit: 1
Areas of Knowledge: NS
Modes of Inquiry: QS
Course format: Lecture/Discussion. If possible will incorporate astronomical observation as a lab

Instructor's Information

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Prerequisite(s), if applicable

Familiarity with High School level algebra is required.

Course Description

In this class, we will be studying, quite literally, everything in the universe. We will start with "classical" astronomy, describing the night sky and organizing what we see as was done in ancient times. We will then embark on a journey, starting here on Earth and progressing outward, to study the Solar system, the Milky Way galaxy, and the wonderful and strange objects we observe in deep space, such as black holes, quasars, and supernovae. We will end with some discussion of what scientists know today about the universe as a whole. Along the way we will introduce some of the methods, theoretical and experimental, that have been used to understand all of this, from Newton's laws, through our understanding of light and matter, to Einstein's theory of relativity, and from Galileo's telescope to WMAP.

Course Goals / Objectives

Students will develop an appreciation for the way in which scientists have been able to piece together an incredibly thorough and comprehensive understanding of the range of phenomena observed in the

Universe. They will be able to apply fundamental principles of physics to perform calculations of the physical properties of astronomical phenomena and compare these with observations. Along the way they will acquire a passing familiarity with physical theories from Newtonian Mechanics to General Relativity. Observations will provide a familiarity with the night sky and facility with using a modern telescope. Specific course objectives will be aligned with assignments. Students will receive detailed information about what is expected for exams and assignments, including guidelines for how grading will be done.

Required Text(s)/Resources

There is no required text for this course.

Recommended Text(s)/Resources

There are many standard texts on Introductory Astronomy, and any of these can be helpful as a resource. The free online text at http://en.wikipedia.org/wiki/Book:Astronomy or the notes http://www.astronomynotes.com/ are examples. Other online resources on specific topics will be suggested during class.

I have recorded a version of this course for Coursera. Students will be encouraged to use my recorded lectures to preview material before lecture and/or review after lecture.

Additional Materials (optional)

The course can benefit from in-class demonstrations. Some of the equipment these use can be easily transported or cheaply acquired. Demos requiring apparatus not available will be replaced by video recordings I have produced for online use.

Course Requirements / Key Evidences

Students will be assigned weekly homework in which they will apply concepts learned during the week to study real astrophysical phenomena.

In addition there will be lab sessions in which students will learn to operate a modern telescope and use it to observe some of the objects discussed in class. Depending on class size and weather, each student will observe 3-4 times during the semester. Students will produce lab reports summarizing their observations and including some simple calculations using these to determine physical properties of the objects observed.

Technology Considerations, if applicable

Access to a computer will be necessary for all students. Video lectures I have recorded may be assigned as “readings” before class so web access is needed.
Planetarium software (available for $15 or a free alternate) will be used.
Lab component will require purchase of a telescope (cost ~$2500).

Assessment Information / Grading Procedures

Grades will be based on performance on homework assignments, weekly in-class quizzes, and a final exam. Final grade will be the ***higher*** of final exam score and a weighted average as follows:

- Homework: 40
- Quizzes: 20
- Labs: 10
- Final Exam: 30

Homework will be assigned weekly and I will ask you to apply concepts from the material covered to understand astronomical phenomena. For the most part, in this course, “understand” implies calculating physical properties. This approach may not be familiar to all students. To help students adjust, I will

- Have a first assignment that is corrected, but not graded, to help me see where students are and to help students understand what I expect.
- Correct student work and provide detailed feedback on possible improvements to their approach.
- Post detailed solutions to all homework assignments (after due date) so students can see what I intend.
- If there is interest, hold optional review sessions in which weekly assignments can be discussed and clarified.
- Hold office hours or otherwise make myself available for individual discussions with students.

Note that it is in principle possible to earn a good grade in the course without doing the homework. This is theoretically possible but not likely. The best way to learn this challenging material is to work with it, and homework is carefully designed to help you understand things in a deeper way. You are strongly encouraged to do the homework.

We will have quizzes weekly, on the day after homework is due. Quizzes will cover material included in the homework assignment (for which solutions will have been posted, although grading may not yet be complete). Questions on quiz will **not** be slightly changed homework questions.

Students will produce a lab report after each observation session following detailed directions to be provided. This will include descriptions of objects observed, some simple calculations based on the observations, and a rough sky map locating the objects as observed. For final observation, students will be asked to produce a list of interesting targets for their observations.

The final exam will cover all course material, and as with homework assignments will challenge students to apply the concepts learned to predict physical properties of astronomical phenomena.

Quizzes and exams will always be **open book** with access to notes, text, etc. A calculator may be required so please be sure to bring these on quiz dates. To accommodate online texts you may use a laptop or other device to connect to your online text. Please note that inappropriate use of such a device (such as to ask for help from someone outside the classroom) may result in your quiz/exam being invalidated and a grade of 0 issued.

Diversity and Intercultural Learning (see Principles of DKU Liberal Arts Education)

The course is technical in nature and is not focused on addressing the cultural diversity of students or fostering intercultural learning. Team-based exercises and interactive activities will promote communication and exchanges among all participants.

Course Policies and Guidelines

- Academic Integrity:
    - Collaboration with other students on homework assignments is **encouraged**. This is how science is done. Collaborators should be listed on assignment handed in. Students should write up their own assignment presenting collaboratively found solution, to be sure they really understand it and are not just repeating others' work.
    - Collaboration on quizzes or exams is **not** permitted.
- Attendance in class is strongly encouraged. I will freely assume that you are familiar with any topic discussed in class whether or not it is covered in readings.
- Participation in labs (observations) will be mandatory.
- Homework will not be accepted past due date, on which solutions will be posted.
- There will be no opportunity to make up missed assignments. Quizzes missed due to justified absence from class will be dropped from quiz absence. Homework not submitted by due date for justified reasons will be dropped from homework average.

- Use of technology during class will sometimes be helpful. Technology use will be considered inappropriate if it is disruptive to the class. Students who are disruptive will be asked to cease using the device or leave the classroom.

Tentative Course Outline or Schedule

Week 1: Positional Astronomy (naked-eye Astronomy)

We will spend our first week familiarizing ourselves with descriptions of the positions and motions of celestial objects. We will introduce some mathematical tools we will use throughout the term. While the math used is simple, the three-dimensional visualization required in this week is often challenging to students.

Week 2: Newton's Universe

Newtonian physics revolutionized the way we understand our Universe. We will discuss Newton's laws of mechanics, the conservation laws that follow from them, his theory of gravity and some applications to Astronomy, as well as some properties of radiation. The last clip will be a quick look at the features of quantum mechanics relevant to our course. This will be a particularly busy and challenging unit, but hard work here will pay off later.

Week 3: Planets

We will not have time in this course to do justice to the broad and exciting field of planetary science. We will spend the week on a general review of the properties and structure of our Solar System and our understanding of its origins and history. We will end with some discussion of the exciting discoveries over the past decade of many hundreds of extrasolar planets.

Week 4: Stars

What we know about stars and a bit about how we found out. We will begin with a quick review of the best-studied star of all, our Sun. We will then talk about classifications; H-R diagrams and main sequence stars; distance, mass, and size measurements; binaries; clusters; and stellar evolution through the main sequence

Week 5: Post-Main-Sequence Stars

Final stages of stellar evolution and stellar remnants. Giants, white dwarfs, novae, variable stars, supernovae, neutron stars and pulsars.

Week 6: Relativity and Black Holes

We will spend most of this week acquiring an understanding of the special theory of relativity. We will then discuss the general theory in a qualitative way, and discuss its application to black holes, gravitational lensing, and other phenomena of interest.

Week 7: Galaxies and Cosmology

Galactic structure and classification. Active galactic nuclei, quasars and blazars. Galactic rotation curves and dark matter. Galaxy clusters and large-scale structure. Hubble Expansion. Big bang cosmology. The cosmic microwave background. Recent determination of cosmological parameters.

Bibliography (optional)