ASTRON 331: Astrophysics (Spring 2017)

This course is an introduction to several of the main concepts in modern astrophysics, with an emphasis on the physics of stars and their remnants (white dwarfs, neutron stars, and black holes). Stars are the building blocks of galaxies, they synthesize most elements in the Universe, and are used as tools in astronomical measurements, including cosmological distances (e.g., using Cepheid stars and Type Ia supernovae). The course is based on undergraduate physics and will emphasize physical understanding and basic principles.

Instructor: Prof. Claude-André Faucher-Giguère
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Office: Tech F243
Office hour: TBD
Course website: http://galaxies.northwestern.edu/teaching (follow links).

To save trees, problem sets will be posted on the course web site. If you miss a lecture, be sure to monitor the course web page and ask your classmates about possible assignments.

Zach Hafen (Tech F224, ZacharyHafen2019@u.northwestern.edu) will be the grader for the course.

Time and location: Tuesday and Thursday, 2:00-3:20, in Tech L168.

Textbooks (required): 1) Astrophysics in a Nutshell: Second Edition, by Dan Maoz. Princeton University Press (ISBN: 0691164797).

2) The Physics of Stars, 2nd Edition, by A. C. Phillips. Wiley (ISBN: 0471987980).

The class notes will largely follow the order of presentation in Maoz' book. However, Maoz is often terse in its explanations, so additional reading in Phillips will be assigned. Phillips is a better reference for students who may need to brush up on details of the physics needed to understand the structure and evolution of stars. Problems will be drawn from the two textbooks.

Course pre-requisites: The course builds on a broad foundation in undergraduate physics. The official pre-requisite is PHYSICS 339-3, but the best way to judge if your preparation is adequate is to look through the textbooks and see if you can follow the derivations. The most advanced physics topics that we will use include concepts in quantum mechanics and statistical mechanics necessary to understand nuclear reactions and the different forms of pressure inside stars and their degenerate remnants (including quantum tunneling, Pauli's exclusion principle, and the Bose-Einstein/Fermi-Dirac distributions). This course does not have a specific astronomy pre-requisite.

Course evaluation: Grades for the course will be determined as follows:

40% homework assignments
20% midterm exam

40% final exam

For the homework assignments, you are welcome to discuss problems with other students, but you must write up your own solutions. For many problems, the textbooks provide a short answer or hint; your grade will be based on your solution rather than just your final answer. There will be approximately 5 homework assignments. Assignments will be due in class. Grades for late assignments will be automatically reduced by 20% and a further 10% will be deducted for each day late. Assignments turned in more than five days late will not be graded except under extraordinary circumstances (competing deadlines or other predictable events are not extraordinary).

The midterm and final exams will be closed-books but you will be allowed one hand-written "cheat sheet" of notes (8.5"×11", both sides) that you can use, e.g., for equations. The exams will consist of problems similar to the homework problems.

The midterm will be held during the regular class time on Thursday, April 27. The final exam will take place in the regular class room, at the time determined by the registrar, Friday June 9, 9-11 AM.

Topics to be covered: Basic observations of stars; the equations of stellar structure; nuclear energy production; radiative energy transport; convection; white dwarfs; supernovae; neutron stars; black holes. Time-permitting, additional topics including star formation and galaxies.