Astronomy 101: Principles of Astronomy
San Diego State University
Spring, 2006

Lecture times and location: Tuesday and Thursday 9:30 - 10:45 AM, Rm. PA 216 (Physics-Astronomy building)

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Office Hours: Tuesday & Thursday 2:00 – 4:00 PM (drop-in)
Thursday 4:00 – 5:00 PM (individual appointments only, scheduled in advance)
other times possible by prior arrangement

Website: http://sciences.sdsu.edu/∼leonard/astro101

Course text: *Voyages Through the Universe* (Third Edition), by Andrew Fraknoi, David Morrison, & Sidney C. Wolff

Course Description

Astronomy 101. Principles of Astronomy

Finding our place in the universe has been a perennial human pastime. Here we present the results of this ongoing endeavor with a very broad brush, covering such topics as the solar system, stars, galaxies, black holes, and cosmology. Particular emphasis will be placed on the historical development of ideas, as well as their philosophical implications. The class assumes no prior background in astronomy, although a general knowledge of science at the high-school level will be helpful. Mathematics will be limited to algebra and geometry.

Prerequisite: Interest.

Course Syllabus

Week 1 (January 16 → January 20): *A Beginning*

Topics covered – Astronomy in ancient times I: The entrenchment of Aristotelian thought and the invisible supernova of 1054 A.D.; introduction to the night sky and the celestial sphere; the nature of science; the construction of cosmologies: the finite speed of light, looking back in time, and the two-sphere cosmology; the spherical Earth.

Readings from text – Prologue Sections 1 → 6; chapter sections 1.1.1, 1.1.2

Week 2 (January 23 → January 27): *Finding our Place in the Universe I*

Topics covered – A grain of sand; what I did this weekend; Eratosthenes measures the Earth; constellations; the zodiac; astronomy in ancient times II: the geocentric cosmology that (nearly) everyone believed; Aristarchus' heliocentric proposal; parallax; Hipparchus and precession; *The Almagest* and *Tetrabiblos*: Ptolemy's cosmological system and the power of astrological prediction; Copernicus' *De Revolutionibus*: A Polish monk moves the Earth; Galileo's telescope.

Readings from text – ch. 1.1.3 → 1.4.4

→ Homework assignment #1 due at the start of class, Tuesday, January 24.

Week 3 (January 30 → February 3): *Gravity Explains it All*

Topics covered – A mathematical toolkit; Tycho's observations and painful death; Kepler puts us in our place; the world of genius: Isaac Newton's *Principia*, and the occult force of gravity; orbital motions; the discovery of Neptune.

Readings from text – ch. 2

Week 4 (February 6 → February 10): *Light – It's All We Have*

Topics covered – Phases of the moon; solar and lunar eclipses; nature of light; electromagnetic spectrum; radiation laws; Fraunhofer's mysterious dark lines and the fingerprints of the elements; Wien's Law; Stefan-Boltzmann Law; Kirchoff's Laws.

Readings from text – ch. 3.5.1, 3.5.2; 3.7; 4.1, 4.2, 4.3

Week 5 (February 13 → February 17): *Other Worlds*

Topics covered – The strange world of atoms; Doppler effect; an inventory of our solar system: planets, moons, asteroids, and comets.

Readings from text – ch. 4.4, 4.5, 4.6; 6.1, 6.2

→ Homework assignment #2 due at the start of class, Thursday, February 16.

Week 6 (February 20 → February 24): *Cecelia's Thesis*

Topics covered – Cecelia Payne-Gaposchkin's thesis, and the sun's composition; solar photosphere; sunspots.

Readings from text – ch. 14.1.1, 14.1.2, 14.2.1, 14.2.2

→ Midterm Exam #1 taken in class on Thursday, February 23.

Week 7 (February 27 → March 3): *Powering the Sun*

Topics covered – The famous $E = mc^2$; nuclear fusion; hydrostatic equilibrium; solar neutrinos; analyzing starlight.

Readings from text – ch. 15.1, 15.2, 15.3.1, 15.3.2, 15.3.3, 15.4.2; 16.1, 16.2, 16.3

Week 8 (March 6 → March 10): *Reading by Starlight*

Topics covered – Spectroscopy; properties of stars; the Hertzsprung-Russell diagram.

Readings from text – ch. 16.4, 17

Week 9 (March 13 → March 17): *Matter at Rest.*

Topics covered – Sitting on the beach.

Readings from text – Subliminal message: astronomy makes excellent beach reading.

Week 10 (March 20 → March 24): *Celestial Distances*

Topics covered – Parallax; Henrietta Swan Leavitt: A cool middle name, and an even cooler relation; standard candles.

Readings from text – ch. 18

Week 11 (March 27 → March 31): *The Lives of Stars*

Topics covered – Stellar evolution; red giants; star clusters; mass-loss and planetary nebulae; stellar behemoths: Eta Carinae and the end-state of the most massive stars; preparing to die.

Readings from text – ch. 21

→ Homework assignment #3 due at the start of class, Thursday, March 30.

Week 12 (April 3 → April 7): *Going Out with a Whimper*

Topics covered – White dwarfs and the fate of low-mass stars.

Readings from text – ch. 22.1, 22.2.1, 22.2.2, 22.2.3

→ Midterm Exam #2 taken in class on Thursday, April 6.

Week 13 (April 10 → April 14): *Going Out with a Bang: Supernovae*

Topics covered – Supernovae, and the fate of high-mass stars; synthesis of heavy elements; SN 1987A; pulsars and the discovery of neutron stars; we thought they were wimpy: novae and supernovae from white-dwarfs; introduction to black holes.

Readings from text – ch. 22.2.4, 22.3, 22.4, 22.5

Week 14 (April 17 → April 21): *Black Holes: The End of Space and Time*

Topics covered – Principle of equivalence; spacetime and gravity; introduction to general relativity; black holes; finding black holes; adventures in space and time.

Readings from text – ch. 23

Week 15 (April 24 → April 28): *Finding our Place in the Universe II: Fuzzy Things*

Topics covered – Types of galaxies; the Milky Way; dark matter; extragalactic distance scale; Hubble discovers a law: The expanding universe.

Readings from text – ch. 24.3, 25

→ Homework assignment #4 due at the start of class, Thursday, April 27.

Week 16 (May 1 → May 5): *The Big Bang and the Big Surprise*

Topics covered – Dark matter; the Big Bang; age of the universe; effects of gravity and the expected deceleration; the surprise of the decade (century?): The accelerating universe.

Readings from text – ch. 27.5; 28.1, 28.3

→ Midterm Exam #3 taken in class on Thursday, May 4.

Week 17 (May 8 → May 12): *The End and the Beginning*

Topics covered – The surprising fate of the universe (or so we think); the first 3 minutes; cosmic microwave background radiation; grand unified theories and inflation; anthropic principle.

Readings from text – ch. 28.3 → 28.7

→ Final Exam: Tuesday, May 16, 10:30 AM → 12:30 PM, Rm. PA 216 (normal lecture room).

Assignments and Course Grades

Course grades will be based on the following scale:

Grade	Percentage
A	92.50 – 100%
A-	89.50 – 92.49%
B+	87.00 – 89.49%
B	82.50 – 86.99%
B-	79.50 – 82.49%
C+	77.00 – 79.49%
C	72.50 – 76.99%
C-	69.50 – 72.49%
D+	67.00 – 69.49%
D	62.50 – 66.99%
D-	59.50 – 62.49%
F	$< 59.49\%$

Students taking the course using the credit/no credit option ("Cr/NC") will receive a grade of "Credit" for achieving an equivalent letter grade of C or better. "No credit" will be given for equivalent letter grades of C- and below.

The final course grade will be determined based on your work in the following areas:

•*Homework assignments*: 10%. Nearly every week there will be one or two questions or problems assigned, which should be completed along with the weekly reading assignment. Keep your completed assignments together, as they will be collected together three times during the semester, roughly every five weeks (see syllabus for specific dates); note that the first homework assignment is due on the second day of class. All homeworks will be graded using a "check" system, which can be translated into percentages via: $\surd$+ (A, 95%); $\surd$ (B, 85%); $\surd$- (C, 75%). (A grade of $\surd$++ (A+, 100%) may also be awarded for truely exceptional work; a $\surd$- - (D, 65%) may also be given for extremely poor work.) Of your four homework marks, only the top 3 grades will count towards your final mark. All responses to homework questions must be typed; responses to mathematical problems may be handwritten.

•*Midterm Examinations*: 50%. There will be three midterm exams in this course, given in class on **Thursday, February 23**, **Thursday April 6**, and **Thursday May 4**. The nature of the exams will be discussed a few weeks into the course. Of the three grades received on the exams, only the top 2 will count towards your final mark (25% each, for a total contribution of 50%).

•*Final Examination*: 40%. The final examination will be given on Tuesday, May 16, 10:30 AM – 12:30 PM, Rm. PA 216 (normal lecture room).

Please note that no late assignments will be accepted, or make-up exams given. If you should miss an assignment or an exam, then that will simply be the grade that is dropped from your average for that component of the course. The final exam must be taken at the scheduled time. There will be no "extra credit" projects given. Finally, no form of cheating will be tolerated, and will result in automatic failure in the course and/or additional disciplinary action by the University.

Grade Calculator Worksheet

To compute your final grade in the course:
Step 1: Write down your 4 homework grades (percentage equivalents):

Step 2: Now, cross out the *lowest* homework grade. Add the remaining three grades together and divide by 3. Write down that number here:

Step 3: Take the number obtained in step 2, and multiply it by 0.1. Write that number down here, and put a box around it:

Step 4: Write down your 3 midterm exam percentages here:

Step 5: Now, cross out the *lowest* grade written in Step 4. Add the remaining two numbers together and divide by 2. Write down that number here:

Step 6: Take the number obtained in step 5, and multiply it by 0.5. Write that number down here and put a box around it:

Step 7: Multiply your final exam percentage by 0.4, and write that number here, and put a box around it:

Step 8: Add the boxed numbers from Steps 3, 6, and 7 together and write it here:

Step 9: Use the grade scale given on the previous page to calculate your final letter grade, and write it down here:

In all likelihood, this is your final grade for the course. In exceptional cases, I may *raise* your grade by up to one mark (e.g., C- to C; B+ to A-, etc.) based on such subjective criteria as my sense of your overall *enthusiasm* for the class and course material. This can be demonstrated in many ways, including "class participation" (note that giving the sense that you are an engaged listener is considered to be just as important as actively contributing to the discussion), attendance, coming to office hours, effort and dedication, and so forth. Note that I will never *lower* a grade that you have earned; your enthusiasm can only help you.