

## AS 102 – The Astronomical Universe (Spring 2010)

Lectures: TR 11:00 am – 12:30 pm, CAS Room 316

Course web page: <http://firedrake.bu.edu/AS102/AS102.html>

### Instructor:

Professor Tereasa Brainerd

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### Teaching Fellows:

Ren Cashman

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Katie Garcia

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### Office Hours:

Professor Brainerd: Mon. 2:00pm to 3:30pm, Fri. 1:30pm to 3:00pm, and by appointment

Ren Cashman: Mon. 11:00am to 12:30pm, Thurs. 12:30pm to 2:00pm

Katie Garcia: Tues. 2:00pm to 3:30pm, Weds. 1:30pm to 3:00pm in Room 524

### Grading:

In-class “Minute Papers”: 5%

Laboratory Exercises (best 5 of 6 day labs plus 2 night labs): 25%

Homework Assignments (roughly 10; two lowest scores dropped): 15%

Midterm Examinations (15% each, best 2 out of 3): 30%

Final Examination: 25%

### Required Textbook:

*Stars, Galaxies & Cosmology: The Cosmic Perspective, Fifth Edition* by Bennett, Donahue, Schneider, and Voigt (available at the BU bookstore)

### Important Dates:

Midterm Examination #1: **Thursday, February 11**

Last day to drop a class without a “W”: Thursday, February 18

Night Lab #1 due: Friday, March 5 (no later than 5:00 pm)

Midterm Examination #2: **Tuesday, March 23**

Last day to drop a class with a “W”: Monday, April 5

Midterm Examination #3: **Tuesday, April 20**

Night Lab #2 due: Wednesday, April 28 (no later than 5:00 pm)

Final Examination: **Tuesday, May 4, 9:00–11:00 am**

### Examinations:

All examinations will be closed book and may include a combination of multiple choice, true/false, fill-in-the-blank, and short essay questions. Questions requiring simple mathematical computations may also be included on the examinations and you may bring a standard calculator to use during examinations if you like. **Cell phones and PDAs may not be used at any time.** Note that because the lowest midterm exam score is automatically dropped, **there will be no make-up exams for midterms missed due to illness or family emergency.** If you must miss a midterm exam due to illness or family emergency, you will receive a score of zero for that exam, and your final course score will be based on your other two midterm exams. Also note that the date of the final exam is set by the university and cannot be rescheduled for anyone.

### Laboratory Exercises:

AS102 is a course that satisfies the CAS Natural Sciences laboratory requirement. Therefore, the laboratory exercises will count towards a large fraction of your grade. In these laboratories you will become familiar with the tools of astronomy and gain a practical knowledge of the sky. The lab schedule, the lab exercises, and the lab due dates will be posted on the class web page. **It is your responsibility to print out copies of the labs and bring them to your lab section. The TAs will not provide you with hard copies of the labs.** There are two laboratory components to the class. The biggest component to the labs are daytime labs which meet once a week (in CAS B4 and CAS 606). You will complete 6 day labs. You must attend the day lab in which you are enrolled. Space is very limited in the rooms and it is not possible for students to attend different lab sections at will. All lab reports will be due by 5:00pm on the assigned day.

You must also complete two nighttime labs. These labs take place on the roof of the CAS building. The first night lab must be completed in the first half of the semester, and the second night lab must be completed in the second half of the semester. Night labs will be offered every **CLEAR** Monday, Tuesday, and Thursday night starting at 8:30pm. The first night lab will be offered from January 19 through March 4. The second night lab will be offered from March 15 through April 27. **Night laboratory reports are due in the homework box by 5:00pm the day after the last scheduled opportunity to do the lab.** Each of the night labs can be completed in one rooftop session, so you will only need to spend a total of two evenings on the roof. You may attend **ANY** night lab session that you choose, but since the weather can be very unpredictable, don't put off doing your night labs to the very last week. **If it's going to be a clear night, get you night lab done!** There is an answering machine with a recorded message telling whether or not the night labs will be held on each day. The phone number is 617-353-2630 and the message is finalized around 6:00 pm each day. But, be aware that the weather can change rapidly and clear weather at 6:00 pm could turn into cloudy weather at 8:30 pm. So, use some common sense and **LOOK UP AT THE SKY** before coming to the night lab. Please also remember that **it will be dark** when you are on the roof for the night labs. It will make it much easier to write the things that you will need to write if you bring a small flashlight with you on the night of the lab. Lastly, be sure to wear lots of warm clothing. You will be out on the roof in the cold and wind for about an hour.

To get to the roof, go through the door on the 5th floor that is marked ASTRONOMY LIBRARY/OBSERVATORY (opposite Prof. Oppenheim's office) and go up the stairs.

### **Homework Assignments:**

Throughout the semester there will be a number of homework assignments. These will be announced in class and posted on the course website. The lowest two homework grades will automatically be dropped in the final calculation of the homework section of the course. So, if the class completes 10 homework assignments, your homework score will be computed as the average of your top 8 scores. **All homework assignments must be handed in no later than 5:00 pm on the due date. Late homework assignments will receive a grade of zero. Please be sure to staple multiple pages together. Hand in your homework assignments in the mail slot marked AS102 in the big wooden box in the Astronomy Department main office (CAS 514).** Although you should feel free to discuss possible solutions to the homework problems with other members of the class, you must hand in **independent** solutions to the problems.

### **Absences:**

Students are expected to attend all lectures and their scheduled labs during the semester. Students who must miss a lecture due to illness or family emergency should be sure to consult the course web site for the slides that were shown in class, but should also consult with another student in the class for copies of notes taken in class. Students may miss up to 3 in-class "minute papers" without any effect on their grade.

### **Letter Grades:**

Letter grades will be assigned at the end of the course and **will not** be given on examinations. Instead, you will receive an indication of your ranking in the class on each examination (for example, 15th out of 50). The final class grading curve will be determined after all elements of the grading scheme have been tabulated. and your final letter grade will be determined based upon your ranking in the class overall. Historically, the final average letter grade in AS102 has been approximately a B- (i.e., 2.7 honor points). Shown below is a sample curve for a class with a total of 50 students, which is approximately the number of students in this year's class. Note: this is not the curve which will necessarily be used for this class; this is just is an example of the typical letter grades.

#### Approximate Letter Grade / Final Ranking in Class (Out of 50)

A	: 1st to 5th
A-	: 6th to 11th
B+	: 12th to 19th
B	: 20th to 26th
B-	: 27th to 33rd
C+	: 34th to 38th
C	: 39th to 42th
C-	: 43th to 47th
D	: 48th to 50th

### **Academic Conduct:**

It is the student's responsibility to know and understand the CAS Academic Conduct Code, copies of which are available in room CAS 105. Cases of suspected academic misconduct (e.g., plagiarism or cheating on examinations) will be referred to the Dean's Office.

### **Physics & Mathematics:**

Astronomers use the laws of physics to interpret observations of the universe. Physics is a mathematical description of nature and, thus, at times it will be necessary to use mathematics in this course. The focus of this course will be on a qualitative understanding of the concepts; however, from time to time we will need to resort to simple formulae to make certain points clear. The mathematics will never exceed the level of high school algebra and all formulae will be explained in words. Professor Alan Marscher of BU's Department of Astronomy has written a very nice math primer for 100-level astronomy students. You should obtain a copy of this from the course website, read it thoroughly, and consult it when you are working on your homework assignments.

### **Course Overview:**

This is a course that is intended to introduce non-science majors to astronomy (science majors should consider enrolling in AS203). The focus of AS102 is on astronomy outside our own solar system. We will cover in depth the formation and evolution of stars, the interstellar medium, the Milky Way (our home galaxy), the universe of galaxies, and current theories of the formation and evolution of the universe from the hot Big Bang to the present day.

Although we will be following the textbook fairly closely and will cover material from many of the chapters, there is far too much information in the book to be covered in detail over the course of only one semester. Students will be expected to read the material in the text that is appropriate to the lectures and to use the index in the book to look up specific topics when necessary. If there is a topic in the textbook that we have not discussed in class, it will not be on an examination. However, if there is a topic that we have discussed in class but which is not in the textbook, that topic could appear on an examination.

### **Lecture Outline:**

#### Our Place in the Universe (Ch. 1)

- modern view of the universe
- scale of the universe
- spaceship earth

#### Discovering the Universe (Ch. 2)

- patterns in the night sky
- seasons
- moon in the sky
- planets in the sky

### Science of Astronomy (Ch. 3)

- ancient astronomy
- Copernican revolution
- Kepler's laws of planetary motion
- Galileo

### Making Sense of the Universe (Ch. 4)

- speed, velocity, acceleration
- Newton's laws of motion
- Newton's law of gravity
- energy

### Light and Matter (Ch. 5)

- properties of light
- the electromagnetic spectrum
- properties of matter
- emission, absorption, and continuous spectra
- Doppler shift

### Space and Time (S2)

- special relativity

### Spacetime and Gravity (S3)

- general relativity

### Surveying the Stars (Ch. 15)

- properties of stars
- the H-R diagram

### Star Birth (Ch. 16)

- where, why, and how do stars form

### Star Stuff (Ch. 17)

- nuclear fusion
- high-mass vs. low-mass stars
- stellar death

### The Bizarre Stellar Graveyard (Ch. 18)

- white dwarfs
- neutron stars
- black holes

### Our Galaxy (Ch. 19)

- the structure of the Milky Way
- nebulae
- star forming regions
- the black hole at the center of the Milky Way

Galaxies and the Foundation of Modern Cosmology (Ch. 20)

- spiral, elliptical, and irregular galaxies
- Hubble's Law

Galaxy Evolution (Ch. 21)

- the universe as a time machine
- quasars and other active galaxies
- supermassive black holes

Dark Matter, Dark Energy and the Fate of the Universe (Ch. 22)

- evidence for dark matter
- evidence for dark energy
- the large-scale structure of the universe
- the fate of the universe

The Beginning of Time (Ch. 23)

- Big Bang predictions
- observational tests of the Big Bang