

## HONR 229X: Black holes and the extremes of space, time, and gravity

### Instructor:

Professor: Cole Miller, CSS 1239, (301) 405-1037, miller at astro.umd.edu

Office hours: by appointment only.

Class web page: <http://www.astro.umd.edu/~miller/teaching/honr>

I will post written lecture notes a few days before each class, and assume you have read them before the actual lecture.

### Schedule:

Classes on Mondays from 2:00 to 4:30, CSS 2416

### Textbook:

Required: *Black Holes and Time Warps: Einstein's Outrageous Legacy* by Kip Thorne

### Academic Integrity

Feel free to discuss your work with other students, but you must work out and write up the answers yourself. I am looking for your unique words and not those of a fellow student, our textbook or other books, the Web, or any other source. If, in a rare case, you feel that a short quote is essential to your answer, put it in quote marks and cite your source. For example, "As Carl Sagan said: 'billions and billions' (source: Cosmos)". Copying of words in bulk without attribution (even with small wording changes) or copying of another student's work risks being sent up for a possible violation of academic integrity. See <http://www.studenthonorcouncil.umd.edu/code.html> if you have any questions about academic integrity. Copying of large parts of a source *with* attribution is not a violation of academic integrity but it will result in a lower grade on the assignment; I want to know your thoughts, not those of some other source! Your best bet in all this is to do whatever research you need, but write up your answers without looking at any sources. Then, you can go back to see if you accidentally copied more than you realized.

### Students with Disabilities

Students wishing to request academic accommodations for a disability should notify the professor at the beginning of the semester. The student should also register with Disability Support Services (DSS) <http://www.counseling.umd.edu/DSS/> (301-314-7682).

### Attendance Policies

University policy excuses the absences of students for illness (self or dependent), religious observances, participation in University activities at the request of University authorities, and compelling circumstances beyond the student's control. Students must submit the request in writing and supply appropriate documentation, e.g., medical documentation. Except in the cases mentioned above, students are expected to attend all sessions since class participation will be graded. For more information, see the University's Attendance and Assessment Policy. Students will not be penalized in any way for participation in religious observances and they be allowed to make up academic assignments that are missed due to such absences. However, it is the student's responsibility to inform the instructor of

any intended absences for religious observances in advance of the projected absence within two weeks of the start of the semester and with a written notification. The request should not include travel time.

### **Inclement Weather**

Assignments will be rescheduled if necessary due to inclement weather and campus emergencies. Official closures and delays are announced on the campus website and snow phone line (301-405-SNOW) as well as local radio and TV stations.

### **Course Grading**

Class participation	15%
Reading responses	25%
Midterm Exam	15%
Term project	20%
Final Exam	25%

### **Course Work**

#### *Class participation*

Considerable class time will be devoted to discussion. You may use your Reading Response as the launching point for your contribution to the discussion. We will also pose specific questions to debate, and discuss some issues in small groups prior to wider class discussion. For the terribly shy: don't worry, this is not onerous. With 20 people in the class, the challenge is to get a word in edge-wise. For the loquacious: good - please express yourself. But also be respectful of your fellow students and don't overly monopolize the conversation. The discussion and debate topics will be listed on the webpage prior to class. Therefore, full participation means that you will look up these topics and be prepared in advance, rather than simply relying on what is discussed in that class.

#### *Weekly reading responses*

At the beginning of each class, I will ask for a one single-spaced page typed response (which can be printed out from a computer) to assigned reading. I will ask you that you give me a hardcopy, so that I can comment on it and return it to you, and also an electronic version in Word, PDF, or any other format that I can read (I'll let you know if there is a problem), so that I have a record of your responses. A good essay will include a concise description of the topic covered, and your reaction to it. Your reaction should be critical (though not necessarily negative) and may be emotional (do you find the idea compelling? stupid?), but must be well argued and must include your thought instead of just being a summary of the reading. I will also require that as part of your one page response you have a paragraph in which you indicate a webpage not listed on the reading that is on the topic, and your response to it. You are free, for example, to pick a crackpot site and refute it.

#### *Term project*

These will be a team project, with individual presentations. Get together with three other people who are interested in the same general topic that you are. Each of the four of you will write your own 10 page (double spaced, 12 pt) discussion of some aspect of the

topic, plus figures if you choose; the four essays must address different aspects of the topic. This will count for half of your project grade (10% of the total 20%). The second half of your participation grade will be based on your presentations of your projects in the last class, May 10. The four of you will give 5 minute presentations each, and consecutively, about your topic. NOTE: do not go over time! We will have enough time if everyone sticks to five minutes, but for much more than that I will take off points. Of the 10% that is based on your presentations, 8% will be based on your individual presentation and 2% will be based on the coordination of your four presentations. Be creative! If you are artistic, you could imagine producing a comic strip related to the topic; or you could sing a humorous song about the topic with your three partners acting as the chorus; or you could give a sermon with your partners calling out the hallelujahs; or you could have active and coordinated demonstrations; or whatever. The topics can be anything in the class. I will require that you and your four partners hand in a proposal for your topic and division of labor at the beginning of the class after spring break, so that I can evaluate appropriateness and try to avoid conflicts between groups.

### *Midterm and Final Exams*

Exams will be a mixture of essays, fact based knowledge, and challenges of critical reasoning.

### **Allowed sources**

There is no limitation on sources. You should use as many as you need. The textbook has many good references and is a fine place to start. By the same token, in no case will the book suffice as the sole source. Indeed, you should not rely exclusively on any one source. Try to avoid predominantly relying on a single source if at all possible. (The extent to which this is possible will depend on the nature of your topic.) Books, the internet, video (e.g., Nova programs), Uncle Joe... any potential source is fair game. You must learn to use your judgment about what constitutes a reliable source: don't believe everything you read or hear from Uncle Joe. For example, Wikipedia is often a fine place to start, but I can't imagine that it will be sufficient for any topic. Moreover, it is exceedingly uneven - quite good sometimes, sometimes just plain wrong. Obviously, you must not cut and paste from there or any other source.

### **Letter Grades**

I will guarantee that you will receive no worse than the following letter grades for a given percentage of the total available points (note: there will be no extra credit):

90%–100%	A
80%–90%	B
70%–80%	C
60%–70%	D

I may grade on a curve if the average is significantly lower than suggested by the table. Note that not all of you will get A grades, and unless you can demonstrate that I have added up your number grade improperly (as opposed to some argument that you should have received more credit on an assignment), I will not accept any complaints about your

final letter grade. Students who are mainly interested in an A should not attend this class. On the other hand, students who are mainly interested in learning are more than welcome.

### **Laptop Policy**

In principle, laptops can allow you to take notes faster and access the class website. In practice, it is more likely to be used for non-class purposes :). Therefore, what I will require is that if you use a laptop (1) you sit in the far back row, so that there are no students behind you to be distracted, and (2) you turn the sound off and do not use headphones. This will minimize the potentially negative impact. If despite these approaches the use of laptops turns out to be too distracting for the class as a whole, I may need to ban them entirely, but let's hope that doesn't happen.

## **Tentative Course Outline**

**Jan 24:** Introduction, and ancient conceptions

**Jan 31:** The Renaissance and the scientific revolution

**Feb 7:** Galileo and Kepler: breaking away from the ancients

**Feb 14:** Newton and the concept of mathematical modeling of physics

**Feb 21:** Between Newton and Einstein

**Feb 28:** Special relativity: the union of space and time

**Mar 7:** General relativity and its tests

**Mar 14:** Midterm

**Mar 21:** Spring break

**Mar 28:** Implications and rejection: black holes and the expanding universe

**Apr 4:** Do black holes exist? Observations of black holes; how can we rule out alternatives?

**Apr 11:** The mathematical golden age: acceptance, proofs, and evaporation

**Apr 18:** The influence of supermassive black holes on their surroundings

**Apr 25:** Gravitational waves

**May 2:** The far-out future: wormholes and time machines

**May 9:** Presentation of term projects

**May 16:** Final exam, 1:30-3:30 PM, CSS 2416