

## **Syllabus for Topics in Astronomy – Black Holes**

- Instructor: Trace Tessier
- Class Time: Monday and Wednesday, 12:00pm – 2:30pm
- Location: UNM West
- Office Hours: By arrangement
- Email: [tessiert@unm.edu](mailto:tessiert@unm.edu)
- Text (Optional): Black Holes and Time Warps: Einstein's Outrageous Legacy, by Kip S. Thorne
- Course Website: [http://physics.tsu-li.com/courses/black\\_holes](http://physics.tsu-li.com/courses/black_holes)

*“We have lost a great deal, I fear, when we are no longer capable of being shock'd by the universe; when we clip and trim all our perceptions to fit some abstract system pre-existing those perceptions; when we disregard and defame all reports that do not suit our system; when we no longer believe that the universe contains mysteries and is capable, in the next half-hour, of such prodigies that we must reverse all that we hitherto have taken for granted.”*

- Robert Anton Wilson, *The Widow's Son*

### **Course Description**

Black holes are perhaps the most enigmatic objects in the entire universe. They are regions of space where gravity acts so intensely that nothing can escape. This course will survey a broad range of topics associated with black holes including: how black holes are formed, why nothing (not even light) can escape from them, and how they are detected. We will also study some of the strange phenomena that occur near a black hole such as: enormous tidal forces that stretch objects out like spaghetti, clocks that run more and more slowly as they approach the event horizon, the possibility of using cosmic wormholes for interstellar travel, and various other theoretical predictions. Finally, we will discuss the black hole information paradox, some proposed resolutions, and insights that black holes may yield towards formulating a quantum theory of gravity.

### **Prerequisites**

Successful completion of a class in introductory astronomy is the only prerequisite for this course and possession of such basic knowledge will be assumed of the student. The amount of mathematics in this course will be kept to a minimum. This course is designed so that everyone who puts forth the required effort can do well.

### **Goals**

We will focus on achieving a conceptual understanding of black hole phenomena, as well as an appreciation for the scientific reasoning that has led to our current state of knowledge. This is a vast subject that cannot be treated in detail in an eight-week course. Our approach will instead be to survey several distinct topics while at the same time learning about the overarching physical principles that govern these enigmatic objects.

### **Attendance**

My teaching and testing style assume that you attend class on a regular basis. We will cover material that is not in the textbook. This includes information about the latest theoretical and experimental findings and topics presented in several in-class videos. Much of this material will show up on the tests. Often I will tell you in class which information from these outside sources you are likely to be tested on. There will also be several in-class exercises designed to reinforce certain topics. Finally, it will sometimes be necessary for me to change a test date or to announce a change to the class schedule. Missing class is not an excuse for not knowing this information.

### **Lectures**

My goal is to make this class both fun and informative and to do this I need your help. Please turn off your cell phones before coming to class, and please do not participate in side conversations during the lectures. Ringing cell phones and chatting are distracting to the entire class.

Please ask questions at any time during the lecture. If you are confused about something I am probably not doing a very good job of explaining it, so let me know. Most likely, many of the other students share your confusion.

Often I will ask for volunteers to help me with in-class demonstrations designed to illustrate a certain topic. There will also be in-class group work assigned that will be directly relevant to the tests.

## **Contacting Me**

Email is the best way to contact me to arrange office hours, to let me know that you have had an emergency and will have to miss class for an extended period of time, etc., but not for answering questions about the lecture material. Please use the lectures and office hours for questions of this type.

## **Course Website**

The website for this course is designed to supplement the lectures and to provide curious students with links to additional resources. Please check it often (at least once a week). There is a section called “Course Announcements” which I may use to communicate important information to the class. This section is meant to be a convenience for students, not a comprehensive bulletin board for those who miss class. Do not rely on these announcements to keep you up-to-date if you miss class. Talk with your fellow students.

The website also contains links to a “Downloads” page and a “Links” page. The downloads page contains downloadable versions of this syllabus, a tentative course schedule, and the powerpoint slides used in lectures. The links page provides easy access to useful physics, black hole, and UNM websites. Often I will access a website dedicated to a certain topic during class. When I do this I will also post these links on this page for your personal use.

**Note:** The course website is provided for your convenience, but I cannot guarantee that it will be available over the internet at all times. Unavailability of the site is not a valid excuse for poor performance in any aspect of this course.

## **Homework**

There will be regular reading assignments and a list of study questions that will help you prepare for the tests, but there will be no graded or turned-in homework. The solutions to the in-class group activities will be presented at the end of each activity, and so will not be turned in to be graded. However, test questions will be taken directly from these exercises.

## **Tests**

There will be two tests in this course which will cover the foundational material presented in the first two-thirds of the course. Each test will consist of a certain number of equally weighted multiple-choice questions

totaling 100 points. The tests will not be cumulative, but will only include material presented since the last test. Cheating on the exams will not be tolerated.

### **Student Projects**

Each student will be required to give one 20 minute oral presentation on some aspect of black holes or related phenomena, followed by a 5 minute question and answer session. Topics must be approved by me and will be assigned on a first-come, first-served basis. In any case, each student must submit a topic to be approved by me by the date listed on the course schedule. Student presentations will be given as each assigned topic comes up, mainly in the last two or three weeks of class. 90% of your project grade will be based on your presentation and the remaining 10% on your attendance/participation during the presentations of other students.

### **Grading**

Your grade in this course will be an equally weighted average of your two test scores and your project grade.

### **Extra Credit**

In addition to the attendance component of the student projects, your overall attendance will count towards extra credit. I will multiply the percentage of classes that you attend by five and add that number to your final grade as calculated above. For example, if you attend every class, then five points will be added to your final grade.

Additionally, if I decide to scale a test in this class, the fraction of the additional points that a student will receive will be determined by the percentage of classes leading up to that test that he/she has attended. The rationale is that I scale tests when it seems that I have failed to effectively convey information, but if someone is not present when I try to pass on this information then he/she does not deserve to benefit from the scaling.

To receive credit for a given class period you must attend the entire lecture. Since I am only interested in whether or not you attend class, all absences (excused or not) will be counted as absences. Please note that this is the only extra credit opportunity that I offer.

### **Grading Scale**

Depending on class performance, I may or may not grade according to a curve. Grading on a curve can only improve your grade; it cannot lower it. In any case, I will assign letter grades according to the following scale (rounded to the nearest whole number):

|    |           |   |         |    |         |
|----|-----------|---|---------|----|---------|
| A+ | 97 – 100  | A | 93 – 96 | A- | 90 – 92 |
| B+ | 87 – 89   | B | 83 – 86 | B- | 80 – 82 |
| C+ | 77 – 79   | C | 73 – 76 | C- | 70 – 72 |
| D+ | 67 – 69   | D | 63 – 66 | D- | 60 – 62 |
| F  | Below 60. |   |         |    |         |

### **Dropping This Course**

Unfortunately, there seems to be a trend emerging among academic advisors to tell students doing poorly in a class to petition instructors to drop them after the posted drop deadline to avoid (i) receiving a low grade, (ii) losing a scholarship, and/or (iii) being placed on academic probation. Doing this is in direct violation of UNM policies. Accordingly, I will not drop a student after the posted deadline for the semester on account of poor performance in this class, regardless of the circumstances. Each student must evaluate his/her performance in this class and make the decision whether or not to drop prior to this deadline. Do not assume that I will drop you if you simply stop coming to class and taking the tests; I will not. Be sure to drop the class through the registrar's office.

**Note:** If you take this class “Credit/No Credit”, according to university policy, your final grade must be “C” or better in order to receive credit.

I hope that everyone will enjoy this class and come away with a new appreciation for how strange and wonderful the universe (and in particular, black holes) can be. Good luck and have a great semester!