

## Course Syllabus

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### Course Information

Math 6390.501/Phys 5V48.501, **Theory of Black Holes**, Spring 2019,  
Monday and Wednesday 7:00 pm -8:15 pm, FO 2.702.

### Professor Contact Information

Dr. Mohammad Akbar

**FO 2.602B** 972-883-6453 [akbar@utdallas.edu](mailto:akbar@utdallas.edu)

Office Hours: Tuesday, Thursday 3:00 pm to 4:00 pm or after class for as long as you need. And any time by appointment.

### Course Pre-requisites, Co-requisites, and/or Other Restrictions

Instructor's consent required.

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### Course Description

Math 6390.501/Phys 5V48.501 (Theory of Black Holes) (3 semester credit hours) Topics covered will include: Review of special relativity, Lorentz group and Minkowski space; Lorentzian geometry; gravitational collapse; static and stationary black hole spacetimes and their geodesic and causal structures (Carter-Penrose diagrams and beyond), uniqueness theorems, symmetries and conservation laws; laws of black-hole mechanics; Hawking radiation and laws of black-hole thermodynamics, aspects of quantum gravity, information loss paradox and others.

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### Required Textbooks and Materials

As a graduate course, I will primarily be using my own notes and sometime provide you with some specific reading materials. Generally, my notes from lecture will be rigorous and sufficiently detailed and should form the basis of your study. There are some excellent books on the subject, some of which are mentioned below. There are also plenty of course materials/lecture notes available online that you may find useful. If anything is unclear to you please consult me as soon as possible and clarify things.

### Suggested Textbook (note comments above):

*The large scale structure of space-time*, S.W. Hawking & G. F. R. Ellis

*General Relativity*, Robert M. Wald

*Semi-Riemannian Geometry*, Barrett O'Neill

**Additional Resources:** Some excellent expositions (not exclusively on black holes) and monographs that we may refer to from time to time:

*Gravitation*, by Misner, Thorne, and Wheeler, *General Relativity* by Robert Geroch, *Gravitation & Cosmology* by Steven Weinberg, *The Mathematical Theory of Black Holes* by Chandrasekhar, *Black Hole Physics* by V. P. Frolov and A. Zelnikov, *Advanced General Relativity* by J. M. Stewart, *The Noether Theorems: Invariance and Conservation Laws in the Twentieth Century* by Yvette Kosmann-Schwarzbach

The following lecture notes, available online, are from experts in the field and are **excellent**:

*Black Holes* by Paul K. Townsend

<https://arxiv.org/abs/gr-qc/9707012>

*Black Holes from A to Z* by Andrew Strominger

<https://pdfs.semanticscholar.org/13b8/9fc71d3efe1a97fc6fdded10011a1dd2323e.pdf>

*Introduction to Differential Geometry* by Gregory Galloway

<http://www.math.miami.edu/~galloway/IntroDGnotes.pdf>

*Notes on Lorentzian causality* by Gregory Galloway

<http://www.math.miami.edu/~galloway/vienna-course-notes.pdf>

For building/polishing general relativity background, you may find the following books interesting:

*Gravity: An Introduction to Einstein's General Relativity* by Jame Hartle

*General Relativity: 1972 Lecture Notes* by Robert Geroch.

To build an intuitive understanding of spacetime diagrams (and more), I strongly suggest reading *General Relativity from A to B* by Robert Geroch.

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**CALCULATOR:** No Graphing or Programmable Calculators, a scientific calculator is needed.

### Assignments & Academic Calendar

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#### IMPORTANT DATES AND HOLIDAYS

Martin Luther King Day	January 21
Last Day to Drop without a "W"	January 30
Spring Break	March 18 – March 24
MIDTERM	Wednesday, March 13th, in class
FINAL	early May (decided by UTD)

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#### Grading Policy

Your final class average will be determined based on the following weighting.

- **Assignments 30%**
- **Midterm 30%**
- **Final Exam 40%**

There will be no make-ups unless in extraordinary circumstances.

#### Course & Instructor Policies

**Assignments:** Assignments will be announced in class and/or by E-mail. There will in total of 4 major Assignments (and some simpler extra assignments). These will constitute 30% of your course-grade. In general, you are allowed to discuss and solve assignments with others, but you must complete your assignment on your own.

**Exams:** There will be two exams: one midterm and a comprehensive final exam. Midterm will be on 13 March in class. The Final exam date is decided by the university.

**Calculator:** A scientific calculator will be permitted on exams. Graphing calculators, programmable calculators, calculators with non-numeric displays, or calculators with calculus operations are NOT ALLOWED. Cell phones are NOT permitted on any exam.

#### Technical Support

If you experience any problems with your UTD account you may send an email to: [assist@utdallas.edu](mailto:assist@utdallas.edu) or call the UTD Computer Helpdesk at 972-883-2911.

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#### Field Trip Policies

##### Off-campus Instruction and Course Activities

*Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at the website address [http://www.utdallas.edu/BusinessAffairs/Travel\\_Risk\\_Activities.htm](http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm). Additional information is available from the office of the school dean. Below is a description of any travel and/or risk-related activity associated with this course.*

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#### Student Conduct & Discipline

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student

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conduct and activities. General information on student conduct and discipline is contained in the UTD printed publication, *A to Z Guide*, which is provided to all registered students each academic year.

The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the *Rules and Regulations, Series 50000, Board of Regents, The University of Texas System*, and in Title V, Rules on Student Services and Activities of the university's *Handbook of Operating Procedures*. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391) and online at <http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-HOPV.html>

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

### Academic Integrity

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrates a high standard of individual honor in his or her scholastic work.

Scholastic Dishonesty, any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts.

Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.

### Copyright Notice

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials, including music and software. Copying, displaying, reproducing, or distributing copyrighted works may infringe the copyright owner's rights and such infringement is subject to appropriate disciplinary action as well as criminal penalties provided by federal law. Usage of such material is only appropriate when that usage constitutes "fair use" under the Copyright Act. As a UT Dallas student, you are required to follow the institution's copyright policy (Policy Memorandum 84-I.3-46). For more information about the fair use exemption, see <http://www.utsystem.edu/ogc/intellectualproperty/copypol2.htm>

### E-mail Use

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD

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furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.

### Withdrawal from Class

The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

### Student Grievance Procedures

Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's *Handbook of Operating Procedures*.

In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the dean will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.

Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

### Incomplete Grade Policy

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.

### Disability Services

The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m.

The contact information for the Office of Disability Services is:  
The University of Texas at Dallas, SU 22  
PO Box 830688  
Richardson, Texas 75083-0688  
(972) 883-2098 (voice or TTY)  
[disabilityservice@utdallas.edu](mailto:disabilityservice@utdallas.edu)

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If you anticipate issues related to the format or requirements of this course, please meet with the Coordinator of Disability Services. The Coordinator is available to discuss ways to ensure your full participation in the course. If you determine that formal, disability-related accommodations are necessary, it is very important that you be registered with Disability Services to notify them of your eligibility for reasonable accommodations. Disability Services can then plan how best to coordinate your accommodations.

It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.

### **Religious Holy Days**

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated.

The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.

If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.

***These descriptions and timelines are subject to change at the discretion of the Professor.***