Course Syllabus

✎ Edit

Phys675 - Introduction to Relativity, Gravitation and Cosmology

University of Maryland, College Park, Fall 2024

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3 credits; Prerequisite: PHYS610 and PHYS611 (or advanced undergraduate electrodynamics and classical mechanics and permission of the the instructor)

Class meetings: TuTh 12:30pm -1:45pm, CCC 1200 (Cambridge Community Center)
Tutoring sessions with TA: Wednesday, 5:30pm-7:00pm, PSC 3150
Professor: Ted Jacobson, **jacobson@umd.edu; (mailto:jacobson@umd.edu;)** **Office hrs**: after class, or by appointment
TA: Sagnik Mondal, **sagnik@ umd.edu (mailto:sagnik@umd.edu)** , **Office hrs** by appointment

Text: Evolving 675hnotes ("TJNotes"), linked under Resources at course Piazza forum.
Course plan: See Modules link at ELMS
Topics: Spacetime, special relativity, gravity as curved spacetime, orbits of massive bodies and light rays, black holes, tensor calculus and curvature, Einstein field equation, gravitational waves, Einstein-Hilbert action, cosmology, quantum gravity (?)
Track 2: Students desiring a more thorough introduction to the mathematical foundations and/or more advanced topics of general relativity are invited, through self-study or with a group, to study for example the first six chapters or more of *General Relativity,* by Robert M. Wald. Professor will be happy to answer questions about this material. We can also use Piazza to ask and answer questions (see below).
Supplementary Resources: To supplement the course materials students are encouraged to consult other sources like books, lecture notes, papers, etc. Some recommended books and notes are listed at the beginning of the TJNotes; and many papers, articles, web pages and diagrams are linked under General Resources at the course Piazza forum.

ELMS course website: syllabus, course plan, assignments, grades
Piazza course forum: **piazza.com/umd/fall2024/phys675 (http://piazza.com/umd/fall2024/phys675)** .We'll use Piazza for the (continuously updating) TJNotes and other resources, and for questions and discussion. Students are strongly encouraged to make use of Piazza. It is super convenient, it's active any day and hour, and enhances learning for everyone. (You can choose to get notifications whenever something is posted, or to be sent a digest after a specified amount of time.)

Homework policies:

+ Usually assigned weekly, usually due Thursday, 11:59pm.

+ Take care to make your work easily legible, and turn in electronically at ELMs.

+ Late homework accepted only under dire circumstances: if you know -- or *should* know -- it will be impossible to turn in an assignment on time, you must discuss this with me in advance of the due date.

+ Some problems will be graded for accuracy, some for effort. In the total score for each assignment, equal "size" problems will be weighted equally, regardless of whether graded for accuracy or effort.

+ You are allowed and encouraged to discuss homework with others, use Piazza, ask the professor or TA for guidance, and consult other books and online sources regarding the basic material. **However** ...
+ It is forbidden to consult solutions found online or elsewhere, or to copy (all or part of) solutions from a classmate. *The write-up you turn in should be your own formulation*, and should reflect your own understanding, and you should be prepared to explain and defend it in detail on your own. Violation of this policy would 1) be a violation of the UMD Code of Academic Integrity and may lead to a referral to the Student Honor Council with severe consequences (see below); 2) result in a grade of 0 on the homework assignment; and 3) leave you without a solid comprehension of the material. It is easy for the TA and professor to detect copying, so don't fool yourself into thinking it won't be noticed!

Grades: The course grade is based entirely on the homework. (There will be no exams.) The lowest homework score will be dropped. The letter grade corresponding to the total numerical score will be determined after reviewing the class performance as a whole, consistent with the standard University of Maryland grade definitions indicating mastery of the material: A: excellent, B: good, C: adequate, D: borderline.

Help: **Seek help *immediately* if you don't understand the material or can't solve the problems.** Help is available via Piazza, and from the TA and th ssor directly. It's best to start with Piazza, since then the question and answer benefits all students.

At **https://www.ugst.umd.edu/courserelatedpolicies.html (https://www.ugst.umd.edu/courserelatedpolicies.html)** (for undergraduate students) and **https://gradschool.umd.edu/faculty-and-staff/course-related-policies (https://gradschool.umd.edu/faculty-and-staff/course-related-policies)** (for graduate students) you'll find resources and counseling services that can help with learning, study skills, and mental health issues.

Academic integrity: The University of Maryland, College Park has a nationally recognized Code of Academic Integrity. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. Academic dishonesty is a serious offense that may result in suspension or expulsion from the university. In addition to any other action taken, a grade of "XF", denoting "failure due to academic dishonesty," will normally be recorded on the transcript of the offending student. For more information on the Code of Academic Integrity or the Student Honor Council, visit the above Courre Related Policies links.

Phys 675 --- Fall 2024 --- Course Plan

This plan will be adjusted as we go. (...) refers to TJ notes sections

date (Tues.)	Tuesday	Thursday
Aug. 27	course intro & nature of spacetime	Minkowski spacetime & free particle action
Sep. 3	momentum & energy, 4-vectors, Lorentz transformations	examples of relativistic kinematics
Sep. 10	main idea of GR, Newtonian limit, geodesics	Schwarzschild orbits
Sep. 17	orbits	perihelion precession, light bending, Shapiro time delay
Sep 24	Killing vectors, redshifted spectral lines	lensing
Oct. 1	Eddington-Finkelstein, Kruskal extensions; Penrose diagrams	Kerr (rotating black hole)
Oct. 8	orbits of Kerr, Penrose process	black hole mechanics
Oct. 15	vectors and tensors	covariant derivative, parallel transport, curvature
Oct. 22	tidal tensor, vacuum Einstein equation	linearized Einstein equation, gauge freedom
Oct. 29	gauge fixing, gravitational waves	charge current density, energy-momentum tensor, Einstein eq with matter
Nov. 5	initial value formulation	Einstein-Hilbert action, field equations
Nov. 12	cosmology: introduction and history	homogeneous isotropic spacetime, redshift, Friedman equation
Nov. 19	cosmo. dynamics, redshift-luminosity relation, flatness problem	thermal history of the Universe
Nov. 26	horizon problem, inflation, primordial fluctuations & CMB	
Dec. 3	who is the inflaton?	quantum gravity

Monday Dec. 16, 11:59 pm, final hw due