Course syllabus

Modern Physics

PHYS 371
Spring 2020

Overview

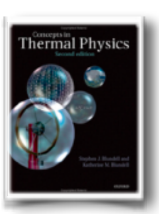
This course covers Special relativity (plus a smidgen of General relativity), a few key concepts in Thermodynamics, and the historical background and introductory ideas of Quantum mechanics. It is thus the bridge between the classical physics of the XIX century, which culminated with Maxwell's equations beautifully encapsulating Electromagnetism, and the modern physics of the XX century.

The student will learn some of the limitations of classical physics and how they were solved with the revolutionary ideas that led to Special relativity and Quantum mechanics. The impacts of many of these ideas are not obvious at human speeds and scales, so a key goal of this course will be to start developing an intuition for concepts such as time dilation, length contraction, or tunnel effect.

The course is part of the core sequence for physics majors and is a prerequisite to PHYS 401 and 404, but it can also be useful to non-majors that are interested in learning modern physics more quantitatively than PHYS 420 allows.

Textbooks

There are no required textbooks for this course as the core content will be covered on the slides that will be provided. For thermodynamics we will follow closely Blundell & Blundell, which is a good book to deepen your understanding as well



Concepts in Thermal Physics
S. J. Blundell and K. M. Blundell
Oxford University Press; 2nd edition (2009)
ISBN: 978-0199562107

Additionally, physics majors are encouraged to obtain "Introduction to Electrodynamics" and "Introduction to Quantum Mechanics", both by David Griffiths. These are the textbooks for the upper-level requirements PHYS 411 and 401, and cover relativity and the Schrödinger equation in the style and at the level that will be taught in this course.

Prof. Manuel Franco Sevilla
manuelf@umd.edu
Last name is "Franco Sevilla" following Spanish tradition

Class meets
Tuesdays & Thursdays
9:30am – 10:45am
PHY #1204 (Toll bld.)

Office hours
PSC #3114
Mon 3:00pm-4:30pm
and by appointment

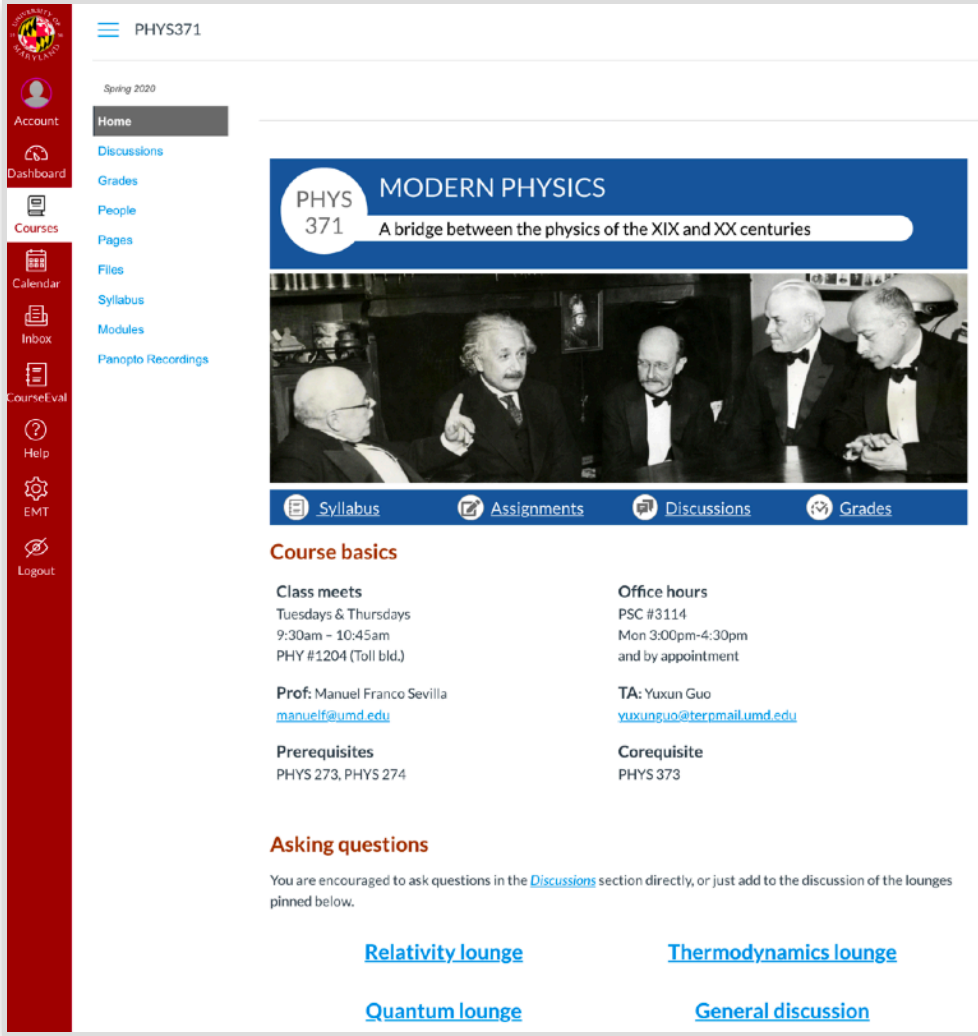
Teaching assistant
Yuxun Guo
yuxunguo@terpmail.umd.edu

Prerequisites
PHYS 273, PHYS 274

Corequisite
PHYS 373

Course communication
ELMS will be the primary source for class communication (homework posting and submission, lecture notes, grades, time-sensitive announcements) and to ask course questions that would benefit every one to hear. Email is the preferred way of communicating directly with me. Here you have helpful guidance on writing professional emails ter.ps/email

ELMS



ELMS will be the **primary source for class communication** (homework posting and submission, lecture notes, grades, time-sensitive announcements) and to ask course questions that would benefit every one to hear.

I will try to oversee the conversation and provide answers when I can, but **students are encouraged** to **both ask and answer questions themselves**.

Lectures will be recorded and, in the case of lectures based on slides, the videos will be posted together with the slides in ELMS.

Campus policies

It is our **shared responsibility** to **know and abide by the University of Maryland's policies** that relate to all courses, which include topics like:

- **Accessibility and accommodations**: we in UMD are committed to providing appropriate accommodations for students with disabilities. Students with a documented disability should inform me within the add/drop period if academic accommodations are needed.
- **Academic integrity**: the UMD Honor Code prohibits students from cheating, fabricating information, facilitating academic dishonesty, and plagiarism in any course. Consequences of academic dishonesty are severe if caught, and, in most cases, even if not caught right away or ever.
- **Student and instructor conduct**: students are responsible for upholding UMD's standards of conduct, and I am responsible for meeting the expectations for faculty providing undergraduate courses, such as providing a complete syllabus promptly, evaluating and sharing the student's performance throughout the course, or being reasonably available with regular office hours or by appointment.

Please visit www.ugst.umd.edu/courserelatedpolicies.html for the Office of Undergraduate Studies' full list of campus-wide policies and follow up with me if you have questions.

Grades

The final grade will be based on the following:

- **Homework (20%)**: weekly or bi-weekly homework, and the lowest two scores will be dropped
- **Two midterm exams (20% each)**
- **Final exam (40%)**

"In mathematics you don't understand things. You just get used to them"
Von Neumann

This wise saying applies to pretty much everything but especially to trying to learn concepts that one does not encounter in their daily lives. This is why homework is very important in this course as it will help develop an intuition for the non-intuitive effects that arise in Relativity and Quantum mechanics. This intuition will be critical to solve correctly and quickly the problems in this and future courses exams, and for those who plan on taking the Physics GRE.

You are encouraged to work on the homework in groups but the final solution write up should be entirely yours. Only a subset of the problems in each homework set will be graded, and this choice will only be made public after the homework is submitted. **Homework submission will be done online via ELMS** (you can upload a typeset pdf file or a picture of your hand-written solution). **Late work will not be accepted** as solutions will be provided shortly after the deadline, so please plan to have it submitted well in advance. After uploading your work for an assignment, **preview the file(s) uploaded in ELMS** as it is common to upload the wrong file. I am happy to discuss any of your grades with you, and if I have made a mistake I will immediately correct it. Any formal grade disputes must be submitted in writing and within one week of receiving the grade.

The exams are taken in class and are strictly individual. They determine the majority of the grade, so homework should be seen primarily as a means to learn the material and prepare for the exams.

Final letter grades are assigned based on the percentage of total assessment points earned. These percentages may be adjusted, but only in the downwards direction. The meaning of letter grades is specified here

Final Grade Cutoffs									
+	95%	+	80%	+	65%	+	50%		
A	90%	**B**	75%	**C**	60%	**D**	45%	**F**	<40%
-	85%	-	70%	-	55%	-	40%		

Course schedule

Note: This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. In the unlikely event of a prolonged university closing, or an extended absence from the university, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.

EM: *"Introduction to Electrodynamics"* by David Griffiths
BB: *"Concepts in Thermal Physics"* by S. J. Blundell and K. M. Blundell

Week	#	Date	Topics	Book sections
Relativity				
1	**1**	Jan 28	Course overview, index manipulation	
	2	Jan 30	Galilean relativity, Michelson-Morley experiment, Einstein's postulates	EM 12.1.1
2	**3**	Feb 4	Time dilation, length contraction, simultaneity, paradoxes	EM 12.1.2
	4	Feb 6	Space-time diagram, Lorentz transformation	EM 12.1.3
3	**5**	Feb 11	4-vectors, space-time interval	EM 12.1.4
	6	Feb 13	Minkowski space	EM 12.1.4
4	**7**	Feb 18	Developing intuition for relativistic kinematics	EM 12.1.4
	8	Feb 20	Relativistic dynamics: 4-velocity, 4-momentum	EM 12.2.1, 12.2.2
5	**9**	Feb 25	Relativistic dynamics in particle collisions and decays	EM 12.2.3
	10	Feb 27	Review of Special relativity	EM 12
6	**11**	Mar 3	GR: Equivalence principle, tensors, manifolds, geodesics	
	12	Mar 5	GR: Einstein equations, Schwarzschild solution	
Thermodynamics				
7	**13**	Mar 10	Thermodynamical limit, heat, work	BB 1, 2, 4
	14	Mar 12	First and second laws of thermodynamics	BB 11, 12, 13
16-22 March - Spring break				
8	**-**	**Mar 24**	**MIDTERM EXAM 1**	
	15	Mar 26	Guest lecture on particle physics: Dist. Prof. Hassan Jawahery	
9	**16**	Mar 31	Midterm and thermodynamics review	
	17	Apr 2	Heat engines	BB 13
10	**18**	Apr 7	Entropy, equipartition theorem	BB 14, 19

Course schedule (cont.)

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QM: *"Introduction to Quantum Mechanics"* by David Griffiths

WEEK	#	DATE	TOPICS	BOOK SECTIONS
			Quantum mechanics	
10	**19**	Apr 9	Black body spectra, photo-electric effect, notion of a photon	
11	**20**	Apr 14	Atomic models, Bohr theory	
	21	Apr 16	Matter waves, Schrödinger equation	QM 1.1
12	**22**	Apr 21	Born rule, properties of the wavefunction	QM 1.2, 1.3, 1.4, 1.5
	23	Apr 23	Time-independent Schrödinger equation, infinite square well	QM 2.1, 2.2
13	**24**	Apr 28	The finite square well	QM 2.6
	-	**Apr 30**	**MIDTERM EXAM 2**	
14	**25**	May 5	Midterm and quantum mechanics review	
	26	May 7	Harmonic oscillator, free particle, tunneling	QM 2.3, 2.4, 2.5, 2.6
15	**27**	May 12	Uncertainty principle, hydrogen atom, quantum interpretations, study guide	QM 1.6, 4.2, 1.2, 12
			Friday May 15, 8:00-10:00am - FINAL EXAM	