Course syllabus

Modern Physics

PHYS 371
Spring 2019

Overview

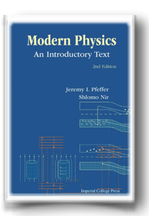
This course covers Special relativity (plus a smidgen of General relativity), a few key concepts in Thermodynamics, and the historical background and introductory ideas of Quantum mechanics. It is thus the bridge between the classical physics of the XIX century, which culminated with Maxwell's equations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

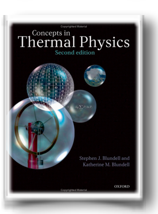
The course is part of the core sequence for physics majors and is a prerequisite to PHYS 401 and 404, but it can also be useful to non-majors that are interested in learning modern physics more quantitatively than PHYS 420 allows.

Textbooks

There are no required textbooks for this course (so it is very important to attend the lectures), but we will largely follow the books below:



Modern Physics: An Introductory Text
J. I. Pfeffer and S. Nir
Imperial College Press; 2nd edition (2012)
ISBN: 978-1848168794



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

Additionally, "Special Relativity" by Davin Morin is also a good resource. I will indicate the book sections that correspond to each lecture and I will share the lecture notes promptly.

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
Tue 2:00-3:30pm
and by appointment

Teaching assistant
Abu Patoary
abusaleh@terpmail.umd.edu

Prerequisites
PHYS 273, PHYS 274

Corequisite
PHYS 373

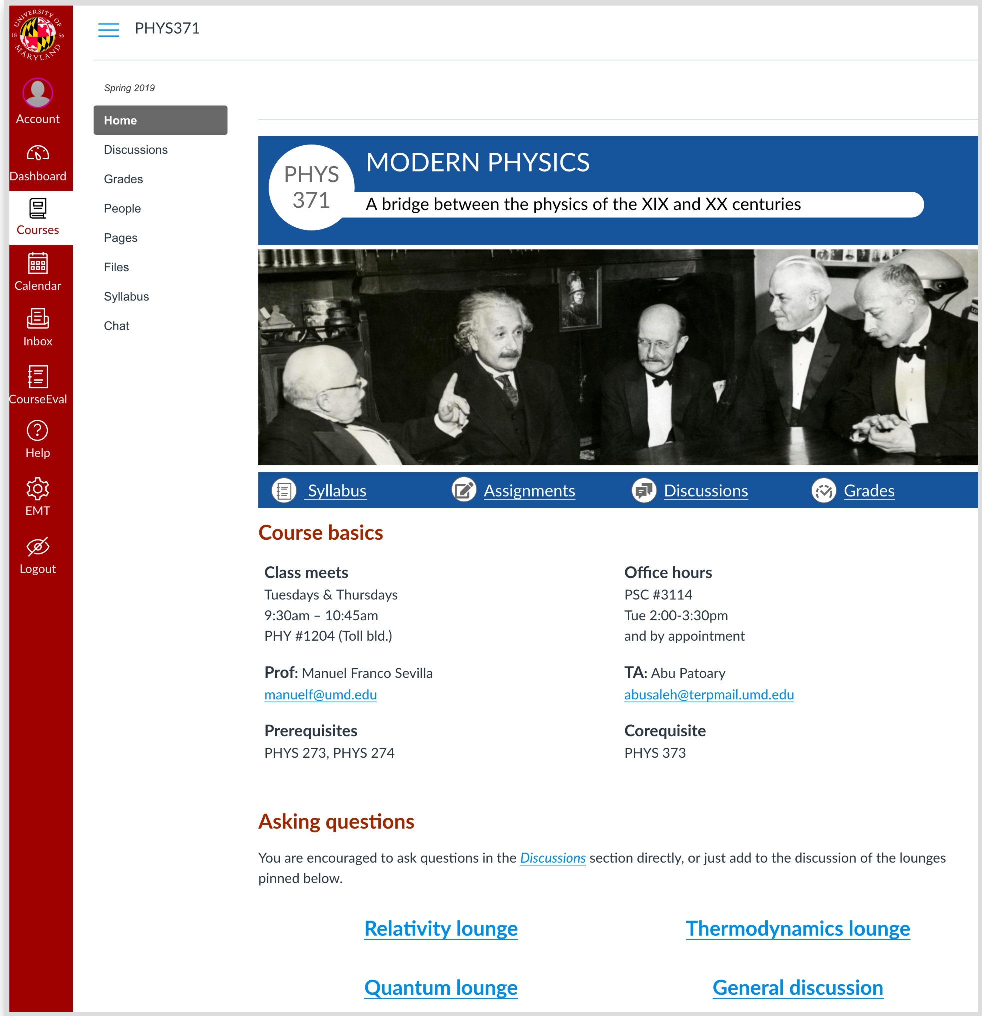
Course communication
ELMS will be the primary source for class communication (homework posting and submission, lecture notes, grades, time-sensitive announcements) and to ask course questions that would benefit every one to hear. Email is the preferred way of communicating directly with me. Here you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

There are four pinned general discussions (**Relativity lounge**, **Thermodynamics lounge**, **Quantum lounge**, and **General discussion**) that can be used to discuss anything related to those topics, but **new discussions can also be started** to ask specific questions.

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



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, but 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).

The exams are taken in class and are strictly individual.

All assessment scores will be posted on the course ELMS page. Late work will not be accepted for course credit so please plan to have it submitted well before the scheduled deadline. 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.

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									
+	97.00%	**+**	87.00%	**+**	77.00%	**+**	67.00%		
A	94.00%	**B**	84.00%	**C**	74.00%	**D**	64.00%	**F**	<60.0%
-	90.00%	**-**	80.00%	**-**	70.00%	**-**	60.00%		

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.

PN: *"Modern Physics: An Introductory Text"* by J. I. Pfeffer and S. Nir
BB: *"Concepts in Thermal Physics"* by S. J. Blundell and K. M. Blundell

WEEK	#	DATE	TOPICS	BOOK SECTIONS
Relativity				
1	**1**	Jan 29	Overview, Galilean relativity	PN 1.4.2
	2	Jan 31	Michelson-Morley experiment, Einstein's postulates	PN 1.4.3-1.4.4
2	**3**	Feb 5	Time dilation, length contraction, Lorentz transformation	PN 1.4.5-1.4.7
	4	Feb 7	Lorentz invariance of space-time interval, velocity addition	PN 1.4.7
3	**5**	Feb 12	Relativistic kinematics (Doppler effect), space-time, light cone	PN 1.4.7
	6	Feb 14	Relativistic paradoxes	PN 1.4.7
4	**7**	Feb 19	4-vector notation, energy-momentum	PN 1.4.8
	8	Feb 21	Energy-momentum 4-vector, Compton scattering	PN 1.4.8
5	**9**	Feb 26	Relativistic dynamics in collisions and decays	
	10	Feb 28	Overview of General relativity	PN 1.5
Thermodynamics				
6	**11**	Mar 5	Thermodynamic limit, intensive and extensive variables, heat, temperature, equilibrium	BB 1, 2, 4
	12	Mar 7	State functions, work, internal energy, First law of thermo	BB 11
7	**13**	Mar 12	Isothermal, adiabatic processes, Second law of thermo, Carnot engine	BB 12, 13
	14	**Mar 14**	**MIDTERM EXAM 1**	
18-24 March - Spring break				
8	**15**	Mar 26	Heat engines, refrigerators, entropy	BB 13, 14
	16	Mar 28	Thermodynamic potentials, phase transitions, latent heat	BB 16, 28
9	**17**	Apr 2	Perfect gas, van der Waals gas	BB 5, 6, 26

Course schedule (cont.)

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WEEK	#	DATE	TOPICS	BOOK SECTIONS
			Quantum mechanics	
9	**18**	Apr 4	First quantization, black body spectra	PN 2.1.1-2.1.5
10	**19**	Apr 9	Photo-electric effect and the notion of a photon	PN 2.2.1-2.2.3
	20	Apr 11	X-rays, diffraction, nuclear model of the atom	PN 2.2.4-2.2.5, 3.1.1-3.1.2
11	**21**	Apr 16	Bohr atom and concept of discrete levels and atomic transitions	PN 3.2.1-3.2.2
	22	Apr 18	Particles as waves, de Broglie hypothesis	PN 2.4.1
12	**23**	Apr 23	Davisson-Germer experiment, electron microscope, probability interpretation of the wavefunction	PN 2.4.4
	24	Apr 25	Motivating the Schrödinger equation	PN 2.4.5-2.4.6
13	**25**	**Apr 30**	**MIDTERM EXAM 2**	
	26	May 2	The infinite and finite square wells	PN 2.4.7
14	**27**	May 7	Quantum harmonic oscillator	
	28	May 9	Uncertainty principle at a qualitative level	PN 2.4.2
15	**29**	May 14	Observables and expectation values, tunneling	PN 2.4.8
			Friday May 17, 8:00-10:00am - FINAL EXAM	