Physics 371 Spring 2022 **Modern Physics** Sec. 201 **Prof. B. L. Hu**

Description: This 3 credit course, a prerequisite to PHYS 401 and 404, has three components: Special Relativity, Thermodynamics, and Basic Quantum Mechanics. It is part of the core sequence for physics and astronomy majors, but it can also be useful to non-majors that are interested in learning these three subjects with more quantitative emphasis than taught in PHYS420. Prerequisites: PHYS273 and PHYS274.

Lectures: **Mon** and **Wed 12:30-1:45pm** in **CHM 1228** (Chemistry) Plse Read: Covit-free classroom
Lecturer: **Prof. B.L. Hu** Office: PSC3153, Phone: 301-405-6029 leave message. You will get faster response via email, send directly to blhu@umd.edu rather than route through ELMS.
Any important document you wish to present to me please pre-warn me by email. Do not hang anything on, or slip it under, my door, it may easily get lost. Leave it with our MCFP
Faculty Assistant: Melanie Knouse in PSC 3140 Phone 301-405-6016 mknouse@umd.
My Office hours: M W after class -- please email me ahead of time to make arrangements.
TA: **Hanyu Liu**, Office: 1120 Toll, Phone: x5 5982; cell: 240-4670046 Email:hanyuliu@terpmail.umd.edu

Textbooks: No required texts. Course materials are based on the professor's lectures (one reason to attend classes regularly). However, you may find the materials in these two books by David Griffiths: *Introduction to Electrodynamics* (EM) and *Introduction to Quantum Mechanics* (QM) useful, specifically: Chapter 12 of EM for special relativity, and Chapters 1 & 2 of QM for basic quantum mechanics. They are often used as textbooks for PHYS 411 and 401, respectively.

Recommended: 1) S. J. Blundell and K. M. Blundell, *Concepts in Thermal Physics*, Oxford University Press; 2nd edition (2009) ISBN: 978-0199562107. We shall use its chapters on thermodynamics only. This book is required text adopted by some instructors of PHYS404.

2) Serway, Moses and Moyer, *Modern Physics* 3rd edition, Thomson, Brooks, Cole 2005. ISBN 0-534-49339-4. The first 7 chapters are useful (first two chapters for special relativity, Chap 3-5 for early quantum physics, Bohr model, particle-wave duality, Chap 6-7 on basic quantum mechanics). The later chapters treat introductory atomic, molecular, optical, solid state, nuclear and particle physics.

* You may wish to wait till after the first lecture to decide whether to purchase any of the above books.

Reading: The progression of lectures for the planned topic(s) can be found in the Course Schedule below. T*ry to read the material in the text before coming to the lecture*. This will enable you to ask questions about ideas you may not grasp fully on the first reading and to gain a better overall perspective. *Study the lecture notes as that form the backbone of the course*. Follow the examples in the book, work on the assigned problems. Keep this routine so you wouldn't fall behind.

Course webpage: Please check for new announcements, adjustment of topics or due dates in the course website at ELMS/CANVAS system: www.elms.umd.edu/page/student-support where you will also be able to access your exam grades. For questions call the Help Desk at 301.405.1500 or email elms@umd.edu.

Homework: There are 9 sets of homework problems, each set worth 20 points. Your lowest scored set will not be counted. Homework will contribute a max of 160 points^ out of a total of 600 points max towards your course grade. Please scan your HW and submit through ELMS before 8pm on the due dates. Solutions will be posted soon after, thus no late homework will be accepted. I encourage group discussions but stress strongly the importance of thinking through and working out all the assigned problems on your own. *Don't rely on others' help, don't copy from the web, or just passively read the solutions.* It makes a real difference in your grasp of the subject matter which shows clearly in your exam performance.

^Grading scheme: 5 problems per set. One problem worth 8 points will be graded in detail, the remaining 4 problems, each worth 3 points, will be looked over, with partial credits assigned for approach and accuracy.

A 20 min **Test on Feb 9 (Wed)** will be on relativistic kinematics only. Relativistic dynamics and thermodynamics will be in the **Mid-Term Exam,** a full 75-minute closed book exam, scheduled on **March 16 (Wed).** The test and the exams are likely to contain one or more problems based on the assigned homework. The test counts 40 points and the midterm exam counts 150 points, out of a total of 600 points max in the course score. **Note:** If you know for sure that you cannot take an exam (excuses are only for certified medical, official university or legal duty-related reasons, as stipulated in the University Rules) please notify me well in advance to discuss alternatives. There will be **no make-up exams.**

Final Exam is on **May 17 (Tue) 8-10am, in a room to be announced** covering materials in quantum physics only. It counts 250 points out of a total of 600 points. Not showing up for the final exam will automatically set your course grade to an F.

Exams are meant to test your understanding and ability to apply concepts and techniques taught in the course, not how well you memorize the materials. You may bring one 4x6" index card (write on both sides) to the each exam. Only definitions of quantities and defining equations, but no derivations or solutions, are allowed. The values of constants and some integrals will be provided. Only a non-programmable calculator with standard trigonometry function is allowed, no smart phones, I-Pads etc.

Academic dishonesty is a serious violation and will be dealt with strictly, according to University policy.

Course Grade: Your course score has 600 points max, with 160 points for the homework, 40 points for the test, 150 points for the mid-term exam and 250 points for the final exam. Your course grade will be `curved', but the mean course grade could be set higher or lower in accordance to the performance of the whole class.

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PHYSICS 371 Sec. 201 **Spring 2022** **CONTENTS and SCHEDULE** Prof. B. L. Hu

[Reading sources: **R** for *Griffiths E&M*, **B**: Blundel[2] **S:** *Serway,Moses and Moyer* **Q:** *Griffiths QM*]

Week/Dates	**Readings**	**Topics:** [check *schedule* updates]	**Homework # Due Date**
1 1/24, 26,	**S1, R12.1,**	Relativity Principle, Lorentz Transformations, Spacetime diagram	**#1** 2/2
2 1/31, 2/2	**S2, R12.2 ,**	Spacetime Interval, Relativistic Energy-Momentum, 4-vectors.	**#2** 2/14 (mon)
3. 2/7	**S2**,	Relativistic scattering and decay processes. Metric, Tensor. Minkowsky geometry.	
2/9		Equivalence Principle. Acceleration and gravity. Intro to General Relativity. Curved spacetime.	
2/9		At the end of class 20 min **Test** on Special relativity kinematics (before scattering)	
4 2/14	**B1,2,4**	Thermal Physics: Micro (μ: kinetic theory) - Macro (M:thermodynamics). Accessible States	
2/16	**B11**	Entropy (μ), Temperature. Boltzmann Distribution. Heat. First Law	**#3** 2/23
5 2/21, 23	**B12, 13**	Adiabatic, Isothermal Processes; Heat Engines, Second Law	**#4** 3/2
6 2/28, 3/2	**B14, 16, 18**	Entropy (M). Thermodynamic Potentials. Third Law	**#5** 3/9
7 3/7, 9	**S3**	Quantum theory of light. Photoelectric effect.	
8 3/14		Early Quantum Physics. Particle nature of waves.	**#6** (S3) 3/30
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3/16 (Wed) **Mid-term Exam** covers Relativistic Dynamics and Thermodynamics

9 March 21-25, 2022 **Spring Break**

10 3/28, 30 S**4** Bohr Atom. Wave nature of matter. Einstein-de Broglie

11 4/4, 6 S**5** Uncertainty Principle. Fourier Analysis, Wave functions **#7** (S4, S5) 4/13

12 4/11, S**6** Wave mechanics. Schrodinger Equation. Operators. Eigenvalue problem

4/13 Probability Interpretation, Born Rules. Quantum – Classical correspondence

13 4/18 S**6** Particle in a 1-D Box. Eigenvalues, expectation values. #**8** (S6) Mon 4/25

4/20 S**8.1** in 2 & 3 D boxes. Degeneracy of eigenvalues, Density of State.

14 4/25 S**6** Quantum Oscillators

4/27 S**7** Particle Flux, Junction Condition, Step/Barrier Potentials **#9** (S7) Mon 5/9

15 5/2, 4 S**6.5**, **7** Finite-Depth Well, Tunneling/ Reflection

16 5/9 Review

Final Exam **Covers** Quantum Theory *only*: **May 17 (Tuesday)** **8-10am in a classroom to be announced**

*** *Good Luck to all your exams! Have a safe, productive and rejuvenating summer*! ***