

Syllabus

Course Information

Course Number:	PHYS 222
Course Title:	Modern Physics for Engineers
Sections:	All Sections
Lecture Time:	MWF 10:00 -11:35 am
Recitation Time:	None
Location:	MPHY 204,
Credit Hours:	3
Course Website:	http://people.tamu.edu/~abanov/courses/P222/index222.php

Instructor Details

Instructor:	Dr. Artem G. Abanov
Office:	MPHY 415
E-Mail:	abanov@tamu.edu
Office Hours:	Mondays, 12:30-1:30 pm, or by appointment (in-person or zoom)

Course Description

Atomic, quantum, relativity and solid state physics

Course Prerequisites

PHYS 207 or PHYS 208 with grade no less than D; MATH 308 with grade no less than D or concurrent enrollment; also taught at Qatar campus.

Special Course Designation

None

Course Learning Outcomes

At the end of this course students should be able to understand where our modern understanding of physics came from, what the relation between classical mechanics, relativity, electromagnetism, and quantum mechanics is. Also the students should be familiar with

- **Classical Mechanics:** Different formulations, role of symmetries, Maxwell equations, gauge invariance, structure of space-time.
- **Relativity:** Michelson-Morely experiment, time dilation, length contraction, relativistic Doppler shift, relativistic velocity addition, invariant space-time intervals, relativistic energy and momentum, mass-energy equivalency, a bit of general relativity.
- **Introduction to Quantum Mechanics:** blackbody radiation, Planck distribution, quantization of light, photoelectric effect, Compton scattering, wave/particle duality, Millikan's experiment, Rutherford atomic model, Bohr atomic model, quantization of angular momentum.
- **Quantum Mechanics:** De Broglie relation, matter waves, Heisenberg uncertainty principle, 1-D Schrödinger's equation, infinite square well potential, simple harmonic oscillator potential, operators, quantum tunneling, 3-D Schrödinger's equation & atomic hydrogen, angular momentum coupling, Pauli exclusion principle, periodic potential, solid state, metals, insulators.

Textbook and/or Resource Materials

- Book for the course (recommended). Modern Physics, by Serway, Moses, and Moyer.
- Lecture notes on the course website.

Grading Policy

- Mid-term (at around week 5) exam 30%, Final exam 30%, Weekly homework 40%
- Each homework and exam is graded out of 100 points.
- Scale: 90-100 A, 75-89.9 B, 60-74.9 C, 45-59.9 D, <45 F. Grades may be curved upward.
- Extra homework problems will be provided.

Late Work Policy

- An exam missed without a University excused absence will count as a zero when computing your final grade.
- Late homework will not be accepted unless there is instructors approval prior to the due date.
- Missed homework will count as a zero when computing your final grade.

Course Schedule

Lecture 1. Introduction. Geometry.

Lecture 2. Math, calculus.

Lecture 3. Geometry. Topology.

Lecture 4. Mechanical world. Galilean invariance. Newton's laws.

Lecture 5. Homework. Calculus of many variables.

Lecture 6. Newton's law. Energy conservation. Motion in 1D.

Lecture 7. Hamiltonian.

Lecture 8. Lagrangian.

Lecture 9. Hamilton principle. Oscillations.

Lecture 10. Dissipation. Resonance. Response.

Lecture 11. Spontaneous symmetry breaking.

Lecture 12. Oscillations with time dependent parameters.

Lecture 13. Waves.

Lecture 14. Currents

Lecture 15. Gauss theorem. Lorenz force.

Lecture 16. Maxwell Equations: Gauss electric and magnetic laws.

Lecture 17. Maxwell Equations: Faraday's and Ampere's Laws.

Lecture 18. Maxwell equations: Full set. Gauge invariance.

Lecture 19. Let there be light! Electromagnetic waves. Speed of light.

Lecture 20. Special theory of relativity.

Lecture 21. Special theory of relativity. General theory of relativity.

Lecture 22. Problems with classical theory.

Lecture 23. Beginnings of the Quantum Mechanics.

Lecture 24. Particles as waves. The Schrödinger equation.

Lecture 25. Wave function. Time independent Schrödinger equation.

Lecture 26. Discrete spectrum. Classically prohibited region. Tunneling.

Lecture 27. Wave function. Wave packet.

Lecture 28. Band structure. Tunneling. Density of states.

Lecture 29. Commutators. Quantum harmonic oscillator.

Lecture 30. Many-particle states. Identical particles.

- It is your responsibility to determine what material is being covered each class and the dates of all exams
- Team work is encouraged outside of class but not on exams
- Calculators, Computers, books, and notes are permitted on exams
- You should come to lecture having read about the topic and ideally tried problems

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" ([Section 20.1.2.3, Student Rule 20](#)).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services](#) (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's [Title IX webpage](#).

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.