

## Course Information

Course Number:	PHYS222
Course Title:	Modern Physics for Engineers
Section:	300
Time:	MWF 10:00-11:35 (10-week Summer term)
Location:	MPHY204 and Zoom (link TBD), synchronously
Credit Hours:	3

## Instructor Details

Instructor:	Dr. Artem G. Abanov
Office:	MPHY 415
Phone:	979-845-7717
E-Mail:	abanov@tamu.edu
Office Hours:	12:30-1:30, Mondays, or by appointment (in-person or Zoom)

Mid-term Exam:	Take home Exam on Friday, July 7, due Monday, July 10, 10:00 am;
Final Exam:	Wednesday, August 9, 10:30 am –12:30 pm.

## Course Description

Introduction to foundational areas of modern physics, aimed at STEM majors with emphasis on Engineers. The course will cover the fundamentals of: atomic physics, quantum mechanics, special relativity and solid-state physics, among other topics.

## Course Prerequisites

PHYS 207 or PHYS 208; MATH 308 or concurrent enrollment; also taught at Qatar campus.

## Course Learning Outcomes

- **Classical Mechanics:** Describe and apply different formulations of classical mechanics, including the role of symmetries and gauge invariance in Maxwell's equations as well as the role and the structure of space-time
- **Relativity:** Explain the Michelson-Morley experiment. Apply the concepts of time dilation, length contraction, relativistic Doppler shift, and relativistic velocity addition to solve problems in special relativity. Understand the concepts of invariant space-time intervals, relativistic dispersion relation, and mass-energy equivalency.
- **Introduction to Quantum Mechanics:** Describe physical effects and experiments which provided the evidence for quantum physics: the spectrum of blackbody radiation, photoelectric effect, Compton scattering, Millikan's experiment, Rutherford scattering experiment, atomic spectra. Apply physical laws such as conservation of energy and momentum and the concept of wave/particle duality in order

to interpret these experiments and solve problems. Formulate the basic assumptions and results of Bohr's atomic model and apply them evaluate and interpret atomic spectra.

- Formalism of Quantum Mechanics: Use the De Broglie relation, matter waves, Heisenberg uncertainty principle, 1-D Schrödinger's equation, energy quantization, and quantum tunneling to interpret physical phenomena and experiments. Identify the basics of 3-D Schrödinger's equation & atomic hydrogen, Pauli exclusion principle, quantum motion in periodic potential and solid state crystals. Describe the quantum origin of the difference between metals and insulators.

### Textbook and/or Resource Materials

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

### Grading Policy

- Mid-term exam: 30%; Final exam: 30%; Weekly homework: 40%
- Each homework and exam are graded out of 100 points.
- Grading 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.
- It is your responsibility to determine what material is being covered during 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

### Grading Policy Changes

Faculty must provide grading policies to students by the first class period. As such, faculty cannot change the course grading policy after the second class session. (See Student Rule 10.)

### 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 instructor's approval prior to the due date.
- Missed homework will count as a zero when computing your final grade.
- Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy ([Student Rule 7](#)).

### Course Schedule – 10-week summer session

#### Week 1

Lecture 1. Introduction. Geometry.

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Lecture 2. Math, calculus.

Lecture 3. Geometry. Topology.

**Week 2**

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.

**Week 3**

Lecture 7. Hamiltonian.

Lecture 8. Lagrangian.

Lecture 9. Hamilton principle. Oscillations.

**Week 4**

Lecture 10. Dissipation. Resonance. Response.

Lecture 11. Spontaneous symmetry breaking.

Lecture 12. Oscillations with time dependent parameters.

**Week 5**

Lecture 13. Waves.

Lecture 14. Currents

Lecture 15. Gauss theorem. Lorenz force.

A take-home midterm exam will be given this week

**Week 6**

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.

**Week 7**

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.

**Week 8**

Lecture 22. Problems with classical theory.

Lecture 23. Beginnings of the Quantum Mechanics.

Lecture 24. Particles as waves. The Schrödinger equation.

**Week 9**

Lecture 25. Wave function. Time independent Schrödinger equation.

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

Lecture 27. Wave function. Wave packet.

**Week 10**

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

Lecture 29. Commutators. Quantum harmonic oscillator.

Lecture 30. Many-particle states. Identical particles.

Final exam according to the University schedule.

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## 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](http://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 the Disability Resources office on your campus (resources listed below). 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.

*Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit [disability.tamu.edu](http://disability.tamu.edu).*

## 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, a person who is subjected to the alleged conduct 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 healthy self-care by utilizing available resources and services on your campus

*Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or 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](https://suicidepreventionlifeline.org).*

*The following statements below are optional. Leave as is to include, or delete if preferred. Either way, delete this note.*

### Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings. Currently enrolled students wishing to withhold any or all directory information items may do so by going to [howdy.tamu.edu](https://howdy.tamu.edu) and clicking on the "Directory Hold Information" link in the Student Records channel on the MyRecord tab. The complete [FERPA Notice to Students](#) and the student records policy is available on the Office of the Registrar webpage.

Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class.

Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees honors and awards received, participation in officially recognized activities and sports, medical residence location and medical residence specialization.