The City College of New York Department of Physics

Physics 20900 BB University Physics III

Syllabus Fall 2022

Instructor: Swapan K. Gayen, Professor of Physics

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Office Hours: Monday 2:00 P.M. – 3:00 PM (Room: CDI 2.380)

Wednesday 2:30 P.M. – 3:30 PM (Room: CDI 2.380)

Communication: Black board and email. I welcome you to email me and I will respond within 24 – 48 hours.

Course Description

Required core for physics majors

Calculus-based study of the basic concepts of wave motion, physical optics, and modern physics

Topics include: Wave equation, Electromagnetic Waves, Dispersion; Interference, Diffraction, Polarization; Special Theory of Relativity; Particle properties of Waves, Photoelectric Effect, Compton Effect; Wave Properties of Particles, Wave-particle duality; The Nuclear Atom, Bohr Model, Franck-Hertz Experiment; The Schrodinger Equation, Harmonic Oscillator, Hydrogen Atom; Atomic Physics; Molecular Structure and Atomic Spectra; Structure of Solids, Conduction; Nuclear Physics, Nuclear Structure, Nuclear Force, Radioactivity.

Prerequisite: Physics 20800 or equivalent, Math 21300; 4 lect. hr./wk.; 4 cr.

Class Schedule: Monday, Wednesday 10:00 – 11:40 A.M. (In-Person) **Room: MS 417S**

Readings & Resources

Textbook

- *Fundamentals of Physics*, 10th Edition (Extended), Halliday, Resnick and Walker, Wiley, ISBN 978-1-118-23072-5 (*Extended edition*) Binder-ready version ISBN 978-1-118-23061-9 (Extended edition)" (*Required*) [Same text used for Physics 20700 and Physics 20800. However, only the *Extended* edition contains Modern Physics topics.]

References

- *Optics* (4th Edition) by Eugene Hecht, Addison Wesley (ISBN 0-8053-8566-5)
- *Modern Physics for Scientists and Engineers* (2nd Edition) by John R. Taylor, Chris D. Zafiratos, and Michael A. Dubson, Pearson/Prentice Hall (ISBN 0-13-805715-X)

Additional Materials

- Some journal articles will be discussed. Those will be made available in the content area of the Black Board.

Course Objectives

After successfully completing this course, students should be able to:

a. Understand attributes of electromagnetic waves and their propagation: reflection, refraction,

dispersion.

b. Understand and solve simple problems involving interference and diffraction of light, interferometers
c. Understand solve problems involving polarization: polarizers, dichroism, birefringence, etc.
d. Understand and apply special theory relativity to relativistic mechanics
e. Understand the role of important experiments in elucidating the nature of atoms, light, and matter
f. Understand the Bohr model of hydrogen atom and quantization of atomic energy levels
g. Understand elements of quantum mechanics, wave functions; set up and solve Schrodinger equation for simple systems, such as, potential wells and barriers, simple harmonic oscillator, and hydrogen atom
h. Understand Pauli Exclusion Principle, atomic structure and molecular spectra and basics of laser
i. Understand and solve problems involving nuclear size, binding energy, and radioactivity
j. Understand structure of solids, energy bands, conduction etc.

Relevant Program Outcomes

The Department of Physics has established several outcomes for the undergraduate program leading to the B.S. degree in physics. This course targets a subset of those outcomes, and endeavors to have students:

A. employ scientific and quantitative reasoning

1. to analyze a variety of physical phenomena at an introductory level,
2. to understand the core physical theories with mathematical rigor,
3. in studying a specialized or applied field of physics.

B. understand the design and role of experiments in furthering scientific knowledge.

C. convey technical information effectively in writing.

Course Outline

A. Physical Optics

- Electromagnetic Waves: Wave Equation in three-dimension; Transverse wave, Energy, Momentum, Poynting vector
- Propagation of Electromagnetic waves: Scattering, Reflection, Refraction, Fresnel Equations, Dispersion
- Polarization: Linear, Circular, Elliptical, Representation as superposition of two orthogonal components; Dichroism, Birefringence, Retarders
- Interference: Review of Young's Double-Slit Experiment, Coherence, Thin-Film interference, Interferometers (Michelson and Fabry-Perot)
- Diffraction: Fraunhofer Diffraction, Review of Single-slit and double-slit experiments; Multiple-slit diffraction, Intensity distribution; Diffraction grating

B. Modern Physics

- Special Theory of Relativity, Lorentz Transformation, Relativistic Mechanics, Energy and Momentum
- Particle Properties of Waves, Photoelectric Effect, Compton Effect
- Wave Properties of Particles, de Broglie Waves, Wave-Particle Duality
- The Nuclear Atom, Bohr Model, Franck-Hertz Experiment
- The Schrodinger Equation, Potential Well, Potential Barrier
- Quantum Theory of Harmonic Oscillator and Hydrogen Atom
- Atomic Physics, Many Electron Atoms, Pauli Principle, Periodic Table; Lasers

- Molecular Structure and Spectra
- Structure of Solids, Conduction
- Nuclear Physics: Nuclear Structure, Nuclear Force, Radioactivity

Assignment, Assessment, and Grading

- Homework Sets: 20%
- Short Quizzes: 10%
- In-class Tests (2) 40% (2 X 20% each)
- Cumulative Final 30%

Total: **100%**

Assignments and Activities

- ***Homework:*** Several homework sets will be assigned throughout the semester. Solving the homework problems is crucial for success in the course. The problems in the tests will relate to the concepts covered in the homework problems and in the worked out problems in the class and in the textbook. Homework assignments have to be submitted within the deadline.
- ***Short Quizzes:*** Several *synchronous* short quizzes (10-15 minutes each) will be given, commonly one after completing a major topic.
- ***Tests:*** Two *synchronous in-class tests* will be given. Each test will count 20% towards the final grade. *Final* will be *synchronous*, *cumulative* and carry 30% weight.

Course Organization

- ***Course Materials***: Materials covered in the course are organized into two broad areas: Physical Optics and Modern Physics. Approximately 50% time will be devoted to topics belonging to these areas.
- ***Attendance:*** Class sessions will focus on discussion of concepts, derivation of key formulae, and problem solving. You should attend every class, arrive on time, and participate in discussions. If extenuating circumstances arise that you cannot attend a class, please let me know. *You should take the tests as scheduled. Please let me know if verifiable unavoidable circumstances (such as, sickness, emergency, etc.) arise.*
- ***Study Tips***: To derive *maximum benefit* from lectures, please read the material indicated in the schedule before the class. To be up to date, please go through the lecture notes, textbook, and rewrite your lecture notes before the next class. To develop *comprehension* of the materials and to be able to *use* those, *solve the homework problems*, and engage your classmates and instructor in *discussions*. While individual efforts may vary, on the average expect to spend 6-10 hours per week, studying, discussing and solving problems, in addition to the time spent in lecture.
- ***Communication and Access***: Other than the class room and face-to-face office hours, *Black Board* (BB), Zoom and *E-mail* will be our principal modes of communication and interaction. You may want to check that your Black Board access is in place. If you need any support, please contact *CCNY Black Board Support* by phone at (212) 650-6990 or/and by email at bbsupport@ccny.cuny.edu.

  You may also want to brush up your BB skills by visiting and consulting the site https://www.ccny.cuny.edu/it/blackboardguides
- ***Technology Requirement:*** It is recommended that you have a computer with reasonable audio and video capabilities and a dependable Internet access that enable you to attend online classes

and office hour, if necessary. While CCNY is committed that in-person classes will continue in that mode throughout the semester, situations may arise (such as, instructor gets sick, pandemic situation worsens) when the classes may have to go online temporarily. If you do not have your own computer and need to borrow one, please contact *CCNY Laptop Loaner Program* by phone at (212) 650-5480 or/and e-mail at: iMEDIA@ccny.cuny.edu.

General Information

Academic Integrity and Plagiarism: The CCNY Policy on Academic Integrity will be strictly adhered to. The document entitled, "CUNY Policy on Academic Integrity" is available at https://www.cuny.edu/about/administration/offices/legal-affairs/policies-procedures/academic-integrity-policy/. Make sure you have read the details regarding plagiarism and cheating, and be clear about the rules that the college follows. Cases where academic integrity is compromised will be prosecuted to the fullest extent according to these rules.

Please note use of external help including use of services, such as, Chegg for solving homework problems, exams and quizzes is considered ***cheating***, and will be treated as such.

Considerations pertaining to COVID-19: The ongoing pandemic poses challenges and needs individuals to make adjustments for safety and public health. Two most relevant CUNY recommendations are:

- COVID-19 vaccines will be required for CUNY students to attend in-person classes for the Fall 2022 semester. Alternative is regular testing.
- Wearing a face mask and social distancing are *recommended* but not required inside all CUNY campuses and office buildings.

Please see the link below which provides current directives. However, guidelines may change during the semester. So, you may return to the link for updates as well:

The City College of New York COVID-19 Safety Plan for Fall '22 | The City College of New York (cuny.edu). It is highly recommended that you bookmark this page, and/or subscribe to RSS feeds of content sections to ensure quick and easy access to relevant content.

Accommodations for students with disabilities: Qualified students with disabilities will be provided reasonable academic accommodations. Prior to granting disability accommodations in this course, the instructor must receive written verification of a student's eligibility from the CCNY Accessibility Center / Student Disability Services (AAC/SDS), which is located in NAC 1/218. It is the student's responsibility to initiate contact with the AAC/SDS and to follow the established procedures for having the accommodation notice sent to the instructor. AAC/SDS may be contacted by phone at (212) 650-5913; TTY/TTD: (212) 650-844, and by email at: disabilityservices@ccny.cuny.edu