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PHYSICS DEPARTMENT
COURSE OUTLINE

PHYS 215 INTRODUCTION TO QUANTUM PHYSICS

An introduction to selected topics in modern physics. Various topics include quantum theory of light; atomic structure; matter waves; quantum mechanics in one dimension; quantum mechanics in three dimensions.

OFFERED:	Winter
CREDIT:	4
IN-CLASS WORKLOAD:	4 lecture, 2 lab (Semester)
PREREQUISITES:	Physics 200 and Math 220. *Math 235 recommended.*
COREQUISITES:	Math 225

Intended Learning Outcomes
(If any changes are made to this part, changes must also be made on the Course Outline)

At the end of the course the student will be able to:

1. Describe and account, on the basis of the light quantum (photon) concept, blackbody radiation, photoelectric effect, pair production, and the Compton effect, and solve technical problems involving this concept in each case.
2. Describe the classical principles of wave motion, superposition and interference and their use in the development of the Schrödinger equation.
3. Describe the chief features of the Rutherford scattering experiment, and it relevance to the determination of nuclear sizes, and to solve technical problems involving the scattering of charged particles under a central force.
4. Describe and define de Boglie waves, wave-packets, the Davisson-Germer experiment and the Heisenberg Uncertainty principle.
5. Describe the Bohr theory of the hydrogenlike atom, and solve technical problems associated with the absorption/emission of photons in transitions between allowed levels.
6. State the postulates of Quantum Mechanics. State Schrödinger's equation in 1D (time dependent and independent forms) and apply this equation to simple 1D systems (harmonic oscillator, particle in a box).
7. State the Schrödinger equation in 3D and solve technical problems involving energy levels of the hydrogenlike atom, and state and describe the differences between the Bohr atom and the quantum-mechanical atom.

8. Provide an account of the classification of elementary particles, applicable conservation laws, and the Standard Model.

REQUIRED MATERIALS:

Textbook: Modern Physics, 2nd edition, Serway, R.A., Moses, C.J. & Moyer, C.A.

Additional References: Physics for Scientists & Engineers with Modern Physics, 6th edition, Serway, .R.A. and Jewett, J.W.Jr.,

Supplementary material provided by instructor

Physics 200 lab manual

DEPARTMENT POLICIES REGARDING TESTING:

1. The final exam will cover the entire course and will be 3 hours long. As stated in the current college calendar on page 39, "students are expected to write tests and final exams at the scheduled time and place." Exceptions will only be considered due to emergency circumstances as outlined in the calendar. Holidays or scheduled flights are not considered to be emergencies.

2. Instructors are not required to provide make-up tests. At their discretion, instructors may waive a test or provide a make-up test only in the event of documented illness or other extenuating circumstances.

3. Refer to your instructor's information page for any additional policies regarding testing and grade calculation.

DEPARTMENT POLICIES REGARDING LABS:

1. All assigned laboratory exercises and reports must be completed with an overall grade of 60% in order to obtain credit for this course. A lab may be waived or made up at a later time only in the case of documented illness or other extenuating circumstances.

2. At the discretion of the instructor, a student who is repeating this Physics course may apply for lab exemption.

STUDY TIME

It is recommended that between 5 and 10 hours per week (or more for students with a weak background) be spent studying for this course outside of class time.

GRADING

The standard mark distribution for this course is as follows:

Final Exam	50%
Midterms	30%
Lab Reports and other work	20%
	100%

This distribution may be amended by the instructor (see your Instructor's Information sheet).

GRADE SCALE

Final letter grades are normally assigned as follows (subject to above conditions):

Percentage	Letter Grade
95 to 100	A+
90 to 94	A
85 to 89	A-
80 to 84	B+
75 to 79	B
70 to 74	B-
65 to 69	C+
60 to 64	C
50 to 59	D
Below 50	F

OUTLINE:

I. **Review of Wave Motion**

A. The wave equation
B. Superposition and interference

II. **Quantum Theory of Light (Text Chapter 2)**

A. Blackbody radiation
B. Photoelectric effect
C. Compton effect
D. Pair production

III. **Particle Nature of Matter (Text Chapter 3)**

A. Rutherford scattering
   1. Derivation of alpha particle scattering formula
   2. Derivation of Rutherford's scattering formula
B. Bohr atom
   1. Energy levels
   2. Spectra

IV. **Matter Waves (Text Chapter 4)**

A. de Broglie waves
B. Davison-Germer experiment
C. Wave packets
D. Heisenberg's uncertainty principle

V. **Quantum Mechanics in one dimension (Text Chapters 5 & 6)**

A. Postulates of quantum mechanics
B. Schroedinger's equation
    1. Time dependent form
    2. Time independent form
C. Particle in a box
    1. Energy levels
    2. Expectation values
    3. Probability density
D. Finite square well and harmonic oscillator
E. Barrier tunneling
    1. Transmission coefficient
    2. Square barrier

VI. **Quantum Mechanics in three dimensions (Text Chapter 7)**

A. Particle in a 3-D box
B. Schroedinger's equation for the Hydrogen atom
    1. Wave functions
    2. Radial probability density
    3. Quantum numbers
    4. Selection rules

VII. **Atomic Structure (Text Chapter 8)**

A. Zeeman effect
B. Spin
C. Pauli's exclusion principle
D. Periodic table

VIII. **Particle Physics (Text Chapter 15)**

A. Classification of particles
B. Four forces
C. Standard model