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PHY 50095 – Special Topics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge and understanding of major concepts and/or theoretical principles in the topic area.
2. Communicate effectively in a variety of formats as appropriate to the topic.
3. Engage in critical discussions about the topic.
4. Use the concepts, language, and major theories of the discipline.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification on discussion topics.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters.
2. Students will be responsible for solving chapter related homework problems.

PHY 51010 – Biophotonics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

*Physics:*

1. Understand the fundamental properties of light.
2. Understand optical elements by building and testing systems of lenses to magnify a specimen.
3. Explain how polychromatic light can be separated into light of specific wavelengths.
4. Design and build a collection of lenses/filters to examine light of different wavelengths and relate this to the properties and use of fluorescent molecules.
5. Demonstrate an understanding of energy conservation as it applies to fluorescence.
6. Understand the optical properties of fluorescent molecules.

*Physical Chemistry:*

1. Understand how the fluorescent properties of molecules are altered in different environments.
2. Understand and be able to use advanced fluorescence spectroscopy methods like resonance energy transfer, fluorescence quenching and fluorescence anisotropy measurements.
3. Understand the difference between steady state and fluorescence lifetime measurements and how fluorescence lifetime experiments can be used to obtain information about biomolecules.

*Organic Chemistry:*

1. Understand how molecular structure and photonic properties are related.
2. Outline the syntheses of fluorescent dyes and discuss the implications of altering their structure.
3. Understand how molecular structure and intracellular targeting of the fluorophore are related.

*Microscopy Applications in Biology:*

1. Describe and demonstrate the use of the light microscope and image formation without and with contrast enhancement.
2. Understand the basics of sterile cell culture and requirements for cell growth.
3. Demonstrate an understanding of scale for organs, tissues, cells, and subcellular structures.
4. Explain the basic structural features and functions of intracellular organelles.
5. Explain epifluorescence and design a system for a specific fluorescent probe.
6. Explain the principles of confocal microscopy and produce images illustrating its utilization.
7. Describe the interactions light might have with biological systems.
8. Show knowledge of advanced current methods and techniques in Biophotonics.

*General Aspects:*

1. Identify personal or common misconceptions about light or its interactions with matter, including biological materials.
2. Understand the methods of science and experimental design by identifying a problem, designing an experiment, collecting data, and interpreting the results.
3. Become more adept at working with others to solve problems.
4. Become proficient at presenting scientific concepts and experimental results in oral and written work.

In-class Activities:

1. Listening to lecture.
2. Taking note during lecture.
3. Group discussion.
4. Hands-on laboratory exercises.
5. Electronic portfolio documenting successful completion of the learning objectives.

Out-of-class Activities:

1. Reading outside class.
2. Studying.
3. Writing assignments.
4. Lab reports.
5. Group projects.
6. Portfolio development.

PHY 54291 – Planetarium Operation and Programming

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Conduct planetarium shows for lower division classes and the general public.
2. Develop suitable programs for such shows.
3. Have a working knowledge of the solar system and yearly changes of what is visible from earth.

In-class Activities: N/A

Out-of-class Activities:

1. Students will assist with publicity and coordination with audiences.

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PHY 54802 – Astrophysics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Describe the regular features of the Solar System.
2. Explain how scientists determine planetary and stellar masses.
3. Describe how stellar spectra are used to determine temperatures and compositions of stars.
4. Explain how stars form and evolve.
5. Demonstrate an understanding of the different types of stellar remnants, including white dwarfs, neutron stars, and black holes.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification on discussion topics.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters.
2. Students will be responsible for solving chapter related homework problems.

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PHY 55201 – Electromagnetic Theory

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate a satisfactory level of familiarity with classical electromagnetism, especially with Maxwell’s equations in both integral and differential form, and in explicitly relativistic form.
2. Solve a good variety of quantitative problems of the type that are customarily assigned in standard textbooks on electromagnetism aimed at the senior undergraduate level.
3. Have a good familiarity with the GRE Subject Test curriculum, of which nominally 18% of the questions are based on the material covered in this course.

In-class Activities:

1. Students will take notes and be responsible for asking questions when clarification is needed.
2. All students should participate in in-class discussion of problem-solving strategies when sample problems are being worked.
3. There is no laboratory activity in this course, but there are occasional in-class demonstrations of electromagnetic phenomena in which students are encouraged to take an active role.
4. A major fraction of the total course credit is based on student performance on in-class tests and on a comprehensive final exam.

Out-of-class Activities:

1. Students are required to read sections of the assigned textbook and consult other reference material as a preparation for class activities, homework, and tests.
2. Students are assigned regular homework sets, which mostly consist of quantitative problems. Homework problems often include more lengthy problems that would be impractical to assign on an in-class test or on the final exam.

Students are expected to meet with the instructor during office hours whenever they have difficulty with homework or with test preparation.

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PHY 55301 - Thermal Physics

Learning Outcomes:

Upon successful completion of this course, students will be able to:

1. Demonstrate a satisfactory level of familiarity with basic concepts of Thermal Physics, with application to heat engine and refrigerators, and phase transformations.
2. Solve quantitative fundamental problems of the type that are customarily assigned in standard textbooks on thermal physics aimed at the senior undergraduate level, using appropriate mathematical techniques and concepts.
3. Have a good familiarity with the GRE Subject Test curriculum, of which nominally 10% of the questions are based on the material covered in this course.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification and participate in discussion topics posed by the instructor.
2. Students will participate in in-class discussions of relevant topics and problems.
3. Students will work with teaching assistants to practice solving content-related mathematical problems.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters and assigned additional reading materials from supplementary texts.
2. Students will be responsible for solving weekly quantitative homework assignments.
3. Students are expected to meet out of class with the instructor for clarification on course material and assistance with homework or test preparation, as necessary and appropriate.

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PHY 55401 - Mathematical Methods in Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Solve problems and derive theorems involving of differential and integral multi-variable calculus.
2. Solve problems and derive theorems involving linear algebra, tensors, and group theory.
3. Solve problems and derive theorems involving ordinary differential equations.
4. Solve problems and derive theorems involving functions of complex variables.

In-class Activities:

1. Students will take notes and will be responsible for asking questions when clarification is needed.

Out-of-class Activities

1. Students will be responsible for reading relevant textbook chapters and assigned additional reading materials from supplementary texts.
2. Students will be responsible for solving weekly homework assignments

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PHY 55403 - Data Analysis and Computational Physics Techniques

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate proficiency with data reduction and error analysis techniques in physical measurements, the Monte Carlo simulation method, and basic computational physics techniques.
2. Solve quantitative fundamental problems of data analysis with emphasis in mean calculation and error estimation, simulation of discrete and continuous probability distributions, and fitting of experimental data using least-squares regression.

In-class Activities:

1. Students will take notes, perform calculations using computer software (scientific-level spreadsheet and/or high-level programming language), be responsible for asking questions when clarification is needed, and participate in discussion topics posed by the instructor.
2. Course is taught in a computer laboratory environment.
3. The course credit is based mostly on student performance on in-class and homework problem assignments, in-class midterm exam, and a comprehensive take-home exam.

Out-of-class Activities:

1. Students are required to read sections of mandatory or recommended textbooks and consult other reference material.
2. Students are assigned homework problem sets weekly, which mostly consist of quantitative problems.
3. Students are expected to meet out of class with the instructor for clarification on course material and assistance with homework or test preparation, as necessary and appropriate.

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PHY 55501 – Electromagnetic Waves and Modern Optics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Describe both qualitatively and quantitatively electromagnetic waves in materials from both the microscopic and macroscopic views. This includes the microscopic origin of the refractive index and dispersion.
2. Analyze reflection, refraction, and scattering of electromagnetic waves at interfaces using Maxwell’s equations.
3. Apply geometric optics to real-world optical systems, including an understanding of the limits of such systems in terms of aberrations and diffraction.
4. Understand and apply the wave properties of light including interference, diffraction, scattering, polarization, and master the Fourier transform description of these wave properties.
5. Understand how light is used as a primary tool to explore the universe around us.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, and solve problems in class individually and in groups.
2. Students will actively participate in demonstrations and laboratory activities that illustrate important concepts in optics and their application.
3. Students will present a topic of their choice related to modern optics at the end of the semester.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters and supplementary readings.
2. Students will be responsible for weekly homework assignments including qualitative discussions of optical phenomena, quantitative problems, and the analysis of optical data that develop analytic skills and reinforce critical physics concepts in optics.
3. Students will prepare a presentation and paper on the application of optics to the topic of their choice.

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PHY 56301 - Introduction to Nuclear Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate a satisfactory level of familiarity with basic concepts of Nuclear Physics, including properties of the atomic nucleus, nuclear models, nuclear decay, fission and fusion, and elementary particles.
2. Solve quantitative fundamental problems of subatomic physics with emphasis on radioactivity, experimental techniques, nuclear structure, and nuclear/particle reaction kinematics.

In-class Activities:

1. Students will take notes, be responsible for asking questions when clarification is needed, and participate in discussion topics posed by the instructor.
2. There is no laboratory activity in this course.
3. The course credit is based mostly on student performance on a midterm and a final exam.

Out-of-class Activities:

1. Students are required to read sections of mandatory or recommended textbooks and consult other reference material.
2. Students are assigned homework problem sets weekly, which mostly consist of quantitative problems.
3. Students are expected to meet out of class with the instructor for clarification on course material and assistance with homework or test preparation, as necessary and appropriate.

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PHY 56401 - Introduction to Solid State Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand crystal lattice structures underlying solids, their representations, and how they are determined experimentally.
2. Understand vibrations of the lattice and be able to calculate associated phonon modes and their thermodynamic and other properties.
3. Understand the role of electrons in solids using basic quantum mechanics and be able to calculate contributions of electrons to thermal, electromagnetic, and optical properties of solids.
4. Understand electronic band structures and the origin of band gaps, and be able to calculate the most basic electronic band structures.
5. Have a basic understanding of semiconductors, their role in everyday life, and understand their charge transport properties.
6. Appreciate how to synthesize knowledge of the basic elements of physics – mechanics, electromagnetism, quantum mechanics, thermodynamics -- for the purpose of understanding properties of solids.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, and solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters and assigned additional reading materials from supplementary texts.

Students will be responsible for solving weekly homework assignments comprised of problems, derivations, and short essays.

PHY 60199 – Thesis I

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Execute a project that involves a structured approach to problem solving, planning, and project management.
2. Execute a literature search that involves an effective use of the university library and relevant search engines.
3. Demonstrate the ability to present and discuss their project in-depth and communicate the critical issues and key factors of the project.
4. Identify basic principles and knowledge related to their project.
5. Summarize their learning experiences verbally and written.
6. Work constructively with a faculty mentor and with other students.

In-class Activities:

1. Students will give a public presentation about their thesis project at their thesis defense at the end of their Thesis studies.

Out-of-class Activities:

1. Students will carry out a faculty supervised research project.

Students will write a thesis summarizing their project before the end of their Thesis studies.

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PHY 64101 – Advanced Problem Solving

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Identify problem solving strategies for graduate level problems in the core areas of physics.
2. Understand what constitutes a completed solution.
3. Identify basic principles that are required.
4. Present clearly formulated and written solutions.

In-class Activities:

1. Students will discuss solution strategies and techniques with fellow students and instructor.

Out-of-class Activities:

1. Students will carry out homework assignments.

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PHY 65101 – Classical Mechanics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Apply the Lagrange and Hamilton’s formalism to solve standard classical mechanics problems: small oscillations, motion in the central field potential and rigid body motion.
2. Demonstrate a basic understanding of integrable systems, integrals of motion and corresponding conservation laws.
3. Solve problems using the variational approach and the principle of least action.
4. Have a basic understanding of the underlying principles of classical mechanics.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification on discussion topics.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters.
2. Students will be responsible for reading course supplementary materials.
3. Students will be responsible for solving weekly homework problems.

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PHY 65203 – Classical Electrodynamics I

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Solve boundary-value problems in electrostatics in a variety of coordinate systems.
2. Demonstrate a basic understanding of Green Functions and their applications
3. Solve problems using special functions, such as Bessel functions and Legendre polynomials.
4. Have a basic understanding of magneto-statics.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification on discussion topics.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters.
2. Students will be responsible for solving weekly homework problems.

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PHY 65204 – Classical Electrodynamics II

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Apply Maxwell’s equations to a variety of problems involving time-dependent phenomena.
2. Solve problems involving the propagation and scattering of electromagnetic waves in a variety of media.
3. Demonstrate an understanding of the characteristics of electromagnetic radiation.
4. Have a good understanding of Special Relativity, especially as applied to electrodynamics.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification on discussion topics.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters.

2. Students will be responsible for solving weekly homework problems.

PHY 75204 – Classical Electrodynamics II

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Apply Maxwell’s equations to a variety of problems involving time-dependent phenomena.
2. Solve problems involving the propagation and scattering of electromagnetic waves in a variety of media.
3. Demonstrate an understanding of the characteristics of electromagnetic radiation.
4. Have a good understanding of Special Relativity, especially as applied to electrodynamics.

In-class Activities:

1. Students will take notes and will be responsible for asking questions for clarification on discussion topics.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters.

2. Students will be responsible for solving weekly homework problems.

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PHY 65301– Statistical Mechanics I

Upon successful completion of this course, the student will be able to:

* 1. Apply a statistical approach to meso- and macroscopic physics.
  2. Make the connection between thermodynamics and statistical mechanics.
  3. Explore the wide range of problems to which statistical mechanics can be applied.
  4. Use and appreciate the power of both analytic and numerical methods in statistical physics.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, and actively participate in class discussions.
2. Students will present a topic of their choice related to statistical mechanics at the end of the semester.

Out-of-class Activities:

1. Students will be responsible for reading relevant textbook chapters and supplementary readings.
2. Students will be responsible for weekly homework assignments including qualitative and quantitative discussions of classical and quantum phenomena at the meso- and macroscopic scales to develop analytic skills and reinforce critical physics concepts in statistical mechanics.
3. The students will be responsible for working together in groups on numerical simulations of statistical phenomena such as random walks and the Ising model.
4. Students will prepare a presentation on the application of statistical mechanics to the topic of their choice.

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PHY 66161 – Quantum Mechanics I

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the basic physical and mathematical foundations of Quantum Mechanics, such as the postulates, and Dirac formalism.
2. Solve a wide variety of quantum problems in one spatial dimension using Schroedinger equation.
3. Gain an understanding of symmetries and their consequences for quantum mechanics.
4. Understand rotational invariance and angular momentum, and apply these concepts to 3-diemnsional rotationally invariant problems, such as the Hydrogen atom and other cases of particles in central potential.
5. Have a detailed understanding of the concept of spin, spin algebra and spin dynamics of quantum particles.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from required and supplementary texts.

2. Students will be responsible for solving weekly assigned homework problems.

PHY 76161 – Quantum Mechanics I

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the basic physical and mathematical foundations of Quantum Mechanics, such as the postulates, and Dirac formalism.
2. Solve a wide variety of quantum problems in one spatial dimension using Schroedinger equation.
3. Gain an understanding of symmetries and their consequences for quantum mechanics.
4. Understand rotational invariance and angular momentum, and apply these concepts to 3-diemnsional rotationally invariant problems, such as the Hydrogen atom and other cases of particles in central potential.
5. Have a detailed understanding of the concept of spin, spin algebra and spin dynamics of quantum particles.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from required and supplementary texts.

2. Students will be responsible for solving weekly assigned homework problems.

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PHY 66162 – Quantum Mechanics II

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand how to deal with a system of identical particles, such as fermions and

bosons, construct the respective N-body wave functions, and solve simple problems

involving bosons and fermions.

1. Tackle the problem of addition of angular momentum and spin, calculate Clebsch-Gordan coefficients involved in going between basis, and relation to tensor operators and Wigner-Eckart theorem.
2. Learn about approximate methods to solve a wide variety of quantum problems in 1-, 2-, and 3-dimensions, including variational techniques, time-independent and time-dependent perturbation theories; apply perturbation techniques to solve problems in non-degenerate and degenerate cases.
3. Understand how to solve problems of scattering of a particle with another and/or subjected to a variety of potentials; learn about Born approximation and partial wave expansion as means to solve scattering problems.
4. Get an appreciation for Berry phase and its manifestations

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from required and supplementary texts.

2. Students will be responsible for solving weekly assigned homework problems.

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PHY 76162 – Quantum Mechanics II

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand how to deal with a system of identical particles, such as fermions and

bosons, construct the respective N-body wave functions, and solve simple problems

involving bosons and fermions.

1. Tackle the problem of addition of angular momentum and spin, calculate Clebsch-Gordan coefficients involved in going between basis, and relation to tensor operators and Wigner-Eckart theorem.
2. Learn about approximate methods to solve a wide variety of quantum problems in 1-, 2-, and 3-dimensions, including variational techniques, time-independent and time-dependent perturbation theories; apply perturbation techniques to solve problems in non-degenerate and degenerate cases.
3. Understand how to solve problems of scattering of a particle with another and/or subjected to a variety of potentials; learn about Born approximation and partial wave expansion as means to solve scattering problems.
4. Get an appreciation for Berry phase and its manifestations

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from required and supplementary texts.

2. Students will be responsible for solving weekly assigned homework problems.

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PHY 66201 - Introduction to Particle Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge at a satisfactory level with basic concepts of Particle Physics, including the quark model, elementary forces and their properties, symmetries and quantum numbers, and elements of relativistic electrodynamics using the Feynman calculus.
2. Solve quantitative fundamental problems related to elementary particle interactions and quantum number conservation.

In-class Activities:

1. Students will take notes and ask clarifying questions.
2. Students will participate in discussions and example-problem solving.

Out-of-class Activities:

1. Students are required to read sections of mandatory or recommended textbooks and consult other reference material.
2. Students are assigned homework problem sets weekly, which mostly consist of quantitative problems.

PHY 76201 - Introduction to Particle Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge at a satisfactory level with basic concepts of Particle Physics, including the quark model, elementary forces and their properties, symmetries and quantum numbers, and elements of relativistic electrodynamics using the Feynman calculus.
2. Solve quantitative fundamental problems related to elementary particle interactions and quantum number conservation.

In-class Activities:

1. Students will take notes and ask clarifying questions.
2. Students will participate in discussions and example-problem solving.

Out-of-class Activities:

1. Students are required to read sections of mandatory or recommended textbooks and consult other reference material.
2. Students are assigned homework problem sets weekly, which mostly consist of quantitative problems.

PHY 66401 - Solid State Physics I

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of (a)classification of structures of crystals, (b) quantum states of the lattice (phonons), (c) energy bands of the electrons in a solid, and (d) thermal properties of crystals.
2. Solve problems using the equations and formalism related to the knowledge listed

above.

In-class Activities:

1. Students will take notes and be responsible for asking questions when clarification

is needed.

1. There will be exams (typically one midterm and one final) for the purpose of

evaluating individual knowledge.

Out-of-class Activities:

1. Students are expected to read chapters of textbooks and other cited reference

materials.

2. Homework problems are regularly assigned.

1. Students are expected to meet out of class with the instructor for clarification on

course material and assistance with homework or test preparation, as necessary and

appropriate.

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PHY 66402 – Solid State II

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate insight and overview of electronic properties of different solids
2. Show basic understanding of transport properties in solids
3. Recognize and relate principal theoretical models and experimental methods and results
4. Show basic understanding of magnetic and superconductive properties of solids.

In-class Activities:

1. Students will take notes and will be responsible for asking questions when clarification is needed.

Out-of-class Activities

1. Students will be responsible for reading relevant textbook chapters and assigned additional reading materials from supplementary texts or journal articles.
2. Students will be responsible for solving weekly homework assignments.
3. Typically, students will research an approved topic of their choice and communicate their finding to the class through oral or poster presentation.

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PHY 66403 -- Advanced Condensed Matter

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Attain a basic knowledge of mean field theory in condensed matter systems, and application to model systems.
2. Understand the basic features of phase transitions, and critical phenomena; Landau mean field theory of phase transitions; quantum phase transitions and quantum critical point.
3. Understand the phenomena of broken symmetry, and Goldstone theorem.
4. Understand magnetic ordering of localized spins, such as ferromagnetism and antiferromagnetism through study of Ising, Heisenberg, and X-Y models; understand spin-wave theory using bosonization techniques such as Holstein-Primakoff transformation.
5. Have a knowledge of magnetic impurities in solids, and learn about emergence of localized moments in materials, as described by Anderson single impurity model; use equation of motion method to solve Anderson model.
6. Understand the collective phenomena of plasmons in quantum solid using random phase approximation.
7. Get an understanding of the phenomena of Cooper pairing and Bardeen-Cooper-Schrieffer (BCS) superconductivity in quantum condensed matter.
8. Have an appreciation for quantum physics in ultracold atoms.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from supplementary texts and journal articles.

2. Students will be responsible for solving regularly assigned homework problems; read journal articles and write a limited number of short essays; prepare materials for in-class presentation on a topic relevant to the course.

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PHY 76163 – Quantum Mechanics III

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand how to deal with a system of an infinite number of identical particle degrees of freedom by the method of second quantized field operators.
2. Be able to derive and interpret Goldstone diagrams, and more importantly, Feynman diagrams for the Green functions and physical processes.
3. Be able to interpret and apply Wick’s theorem in the context of time-dependent perturbation theory, and be able to make diagrammatic derivations for the Hartree-Fock approximation, RPA, and the ladder approximation.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from required and supplementary texts.

2. Students will be responsible for solving weekly assigned homework problems.

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PHY 76403 – Advanced Nuclear Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the central concepts in relativistic quantum field theory as applicable to interacting systems of bosons and fermions, with emphasis upon the strong interaction.
2. Be able to derive and interpret Feynman diagrams for the Green functions and physical processes of such systems in the context of perturbation theory for second quantized fields, and also in the context of functional path integrals.
3. Be familiar with the essential features of Quantum Chromodynamics and be able to derive the mean field or saddle point approximation to the Nambu—Jona-Lasinio model for the pion as a quark-gluon bound state.
4. Be familiar with the essentials of deep inelastic scattering of leptons from hadrons and

the field theory origins of parton distribution functions.

In-class Activities:

1. Students will take detailed lecture notes, ask questions for clarification on lecture topics, and solve problems in class individually and in groups.

Out-of-class Activities:

1. Students will be responsible for reading from required and supplementary texts.

2. Students will be responsible for solving weekly assigned homework problems.

PHY 68401 - Liquid Crystal Physics

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of liquid crystal phases and their classifications, with emphasis on both

microscopic molecular descriptions and macroscopic properties.

1. Apply the appropriate equations to solve various theoretical and practical problems in the physics of liquid crystals.

In-class Activities:

1. Students will take notes and be responsible for asking questions when clarification

is needed.

1. There will be exams (typically a midterm and a final) for the purpose of assessing individual knowledge.

Out-of-class Activities:

1. Students are expected to read sections of textbooks and various other cited

reference materials.

1. To aid in preparation for exams and to develop skills, homework problems will be regularly assigned.
2. Students are expected to meet out of class with the instructor for clarification on course material and assistance with homework or test preparation, as necessary and appropriate.

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1. Students are expected to read sections of textbooks and various other cited

reference materials.

1. To aid in preparation for exams and to develop skills, homework problems will be regularly assigned.
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PHY 80097 – Physics Colloquium

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Maintain a general knowledge of what are topical developments in the physics discipline.
2. Know the names of key active researchers in the discipline.
3. Know the institutions where forefront research is being conducted.

In-class Activities:

1. Students will listen to the presentation and ask questions if clarification is needed.

Out-of-class Activities:

1. Students will often have the opportunity to meet with visiting speakers.

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PHY 80098 – Research

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Execute a research project that involves a structured investigation of a physical system.
2. Demonstrate the ability to present and discuss their project in-depth and communicate the critical issues and key factors of the project.
3. Work constructively with a faculty mentor.

In-class Activities: N/A

Out-of-class Activities:

1. Students will carry out faculty supervised research with a degree of independence.

PHY 54291 – Planetarium Operation and Programming

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Plan and conduct Planetarium shows for the public and for classes,
2. Understand how the optical and electronics systems of the Planetarium work,
3. Speak publicly with confidence,
4. Work constructively with a faculty mentor.

In-class Activities: Planetarium operation.

Out-of-class Activities:

1. Organize publicity and advertising.

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