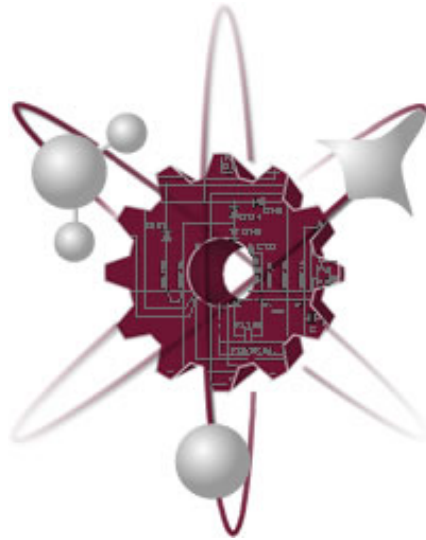


Appendix A – Course Syllabi

Appendix A: Syllabi

Engineering Physics

Bachelor of Science in Engineering Physics



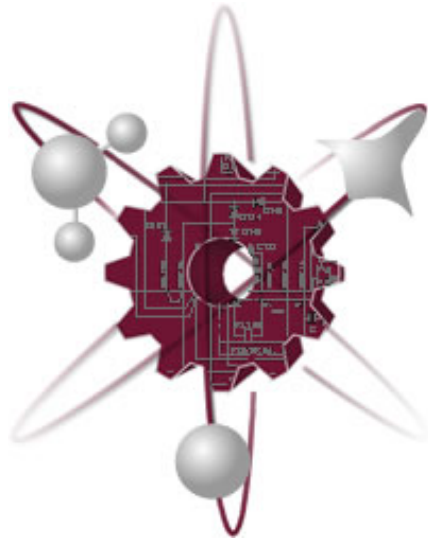
Self-Study Report

New Mexico State University



Physics Courses

Physics Courses



Course Number and Name: Physics 213, Mechanics

Credits and Contact Hours: 3 credits (three 50-minute classes each week); an additional 2 contact hours each week (during office hours); optional 1 credit supplemental instruction.

Instructor or Course Coordinator Name: Michaela Burkardt

Textbook: D. Young & R. A. Freedman, *University Physics with Modern Physics*, Pearson/Addison Wesley, 12th Edition, 2008

a) other supplemental materials: Mastering Physics for Young and Freedman, 12th edition.

Specific Course Information:

a) catalog description: Newtonian Mechanics

b) prerequisites or co-requisites: MATH 191G

c) This course is required for majors in Physics and Engineering Physics as well as Chemistry; (alternative: PHYS215G, *Engineering Physics I*)

Specific Goals of the Course:

a) specific outcomes of instruction: This course sets the foundation for undergraduate physics and engineering curriculum. It provides the fundamental ideas underlying classical mechanics, the application of these ideas to quantitative physics problems, and the relationship between models physicists use and real-world phenomena.

b) related ABET Outcomes: PHYS 213 addresses Program Outcome a) *apply knowledge of math, science and engineering.*

Brief List of Topics Covered:

The course covers material from Chapters 1-13, 15 of Young and Freedman's textbook. Number of lectures spend on each section are indicated.

Chapter 1: Units, Physical Quantities, and Vectors, Sec. 1-10: (2 lectures)

Chapter 2: Motion Along a Straight Line, Sec. 1-5: (3 lectures)

Chapter 3: Motion in Two or Three Dimensions, Sec. 1-5: (3.5 lectures)

Chapter 4: Newton's Laws of Motion, Sec. 1-6: (2 lectures)

Chapter 5: Applying Newton's Laws, Sec. 1-4: (4.5 lectures)

Chapter 6: Work and Kinetic Energy, Sec. 1-4: (1 lecture)

Chapter 7: Potential Energy and Energy Conservation, Sec. 1-5: (4 lectures)

Chapter 8: Momentum, Impulse, and Collisions, Sec. 1-6: (5 lectures)

Chapter 9: Rotation of Rigid Bodies, Sec. 1-6: (2 lectures)

Chapter 10: Dynamics of Rotational Motion, Sec. 1-7: (3 lectures)

Chapter 11: Equilibrium and Elasticity, Sec. 1-3, 5 (1 lectures)

Chapter 12: Gravitation, Sec. 1-5: (2 lectures)

Chapter 13: Periodic Motion, Sec. 1-8: (3 lectures)

Chapter 15: Mechanical Waves, Sec. 2-3, 6-8: (2 lectures)

Prepared by Michaela Burkardt, Spring 2012.

Course Number and Name: Physics 213L, Experimental Mechanics

Credits and Contact Hours: 1 credits (one 2-1/2 hour lab per week).

Instructor or Course Coordinator Name: Chris Pennise

Textbook: The lab materials were developed by Dr. Steve Kanim of the NMSU Department of Physics. They are distributed on the on the course website. Lab one is printed out for the students; students are responsible for printing out other lab and homework materials

Specific Course Information:

- a) **catalog description:** Laboratory experiments associated with the material presented in PHYS 213.
- b) **prerequisites or co-requisites:** PHYS 213 (*co-requisite*).
- c) This course is the companion laboratory to Physics 213, Mechanics. It is required by all physics and engineering physics majors. Engineering Physics major can satisfy the requirement by taking PHYS 215L instead.

Specific Goals of the Course:

- a) **specific outcomes of instruction:** Students in this course perform a series of experiments that apply the principles and concepts highlighting the main objectives covered in the coursework for PHYS 213.
- b) **related ABET Outcomes:** PHYS 213L addresses program outcome *b) an ability to design and conduct experiments*.

Brief List of Topics Covered:

Experiments are performed, data collected and analyzed encompassing: kinematics, dynamics, energy, work, momentum, and their conservation concepts and rotational motion and extended body problems. Below is the list of labs covered over the course of the semester:

1. ***Descriptions of motion***
2. ***Acceleration in one dimension***
3. ***Motion in two dimensions***
4. ***Forces***
5. ***Addition of forces***
6. ***Newton's second law***
7. ***Energy***
8. ***Conservation of momentum***
9. ***Rotational motion***
10. ***Torque***
11. ***Simple harmonic motion***
12. ***Standing waves***

Prepared by Heinz Nakotte, Spring 2012.

Course Number and Name: Physics 214, Electricity and Magnetism

Credits and Contact Hours: 3 credits (three 50-minute classes each week); an additional 2 contact hours each week (during office hours); optional 1 credit supplemental instruction (50-minute workshop) available.

Instructor or Course Coordinator Name: Michaela Burkardt

Textbook: D. Young & R. A. Freedman, *University Physics with Modern Physics*, Pearson/Addison Wesley, 12th Edition, 2008

a) **other supplemental materials:** MasteringPhysics for Young and Freedman, 12th edition.

Specific Course Information:

a) **catalog description:** : Electricity and Magnetism.

b) **prerequisites:** PHYS 213 or PHYS 215G

prerequisites or co-requisites: MATH 192G

c) This course is required for majors in Physics and Engineering Physics as well as Chemistry; (alternative: PHYS216G, *Engineering Physics II*)

Specific Goals of the Course:

a) **specific outcomes of instruction:** This course teaches the fundamental ideas underlying electricity and magnetism, the interplay between these ideas of physics and mathematics, and the application of these ideas to quantitative physics problems and real-world phenomena.

b) **related ABET Outcomes:** PHYS 214 addresses Program Outcome a) *apply knowledge of math, science and engineering.*

Brief List of Topics Covered:

The course covers material from Chapters 1-13 of Young and Freedman's textbook. Number of lectures spend on each section are indicated.

Chapter 21: Electric Charge and Electric Field, Sec. 1-7: (7 lectures)

Chapter 22: Gauss's Law, Sec. 1-5: (3 lectures)

Chapter 23: Electric Potential, Sec. 1-5: (3 lectures)

Chapter 24: Capacitance and Dielectrics, Sec. 1-6: (2 lectures)

Chapter 25: Current, Resistance and Electromotive Force, Sec. 1-6: (2 lectures)

Chapter 26: Direct-Current Circuits, Sec. 1-5: (3 lectures)

Chapter 27: Magnetic Field and Magnetic Forces, Sec. 1-9: (4 lectures)

Chapter 28: Sources of Magnetic Fields, Sec. 1-8: (3 lectures)

Chapter 29: Electromagnetic Induction, Sec. 1-7: (4 lectures)

Chapter 30: Inductance, Sec. 1-6: (2 lectures)

Chapter 31: Alternating Current, Sec. 1-6: (2 lectures)

Chapter 32: Electromagnetic Waves, Sec. 1-4: (2 lectures)

Prepared by Michaela Burkardt, Spring 2012.

Course Number and Name: Physics 214 L, Electricity and Magnetism Laboratory

Credits and Contact Hours: 1 credits (one 2-1/2 hour lab per week).

Instructor or Course Coordinator Name: Chris Pennise

Textbook: Tutorials in Introductory Physics and Homework Package, by McDermott and Shaffer, Addison-Wesley Publishers, 2002.

Specific Course Information:

- a) **catalog description:** Laboratory experiments associated with the material presented in PHYS 214.
- b) **prerequisites or co-requisites:** Pa C or better in PHYS 213L or PHYS 215GL. (*pre-requisites*) and PHYS 214G (*co-requisite*).
- c) This course is the companion laboratory to Physics 214, Electricity and Magnetism. It is required by all physics and engineering physics majors. Engineering Physics majors can satisfy the requirement by taking PHYS 216L instead.

Specific Goals of the Course:

- a) **specific outcomes of instruction:** Students in this course perform a series of experiments that apply the principles and concepts highlighting the main objectives covered in the coursework for PHYS 214.
- b) **related ABET Outcomes:** PHYS 214L addresses program outcome *b) an ability to design and conduct experiments*.

Brief List of Topics Covered:

Experiments are performed, data collected and analyzed encompassing: electrostatics, electric circuits, magnetism, electromagnetism and light, including geometrical and physical optics.

Below is the list of labs covered over the course of the semester:

1. **Charge**
2. **Electric field and flux**
3. **Gauss's Law**
4. **Electric potential difference**
5. **Circuits I**
6. **Circuits II**
7. **Magnets and fields**
8. **Magnetic interactions**
9. **Lenz's law**
10. **Faraday's law**
11. **Plane and curved mirrors**
12. **Ray diagrams and convex lenses**

Prepared by Heinz Nakotte, Spring 2012.

Course Number and Name: Physics 215G, Engineering Physics I

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional contact hour each week (during office hours). Evening review sessions before exams. Tutoring room assistance and supplemental instruction also available (optional).

Instructor or Course Coordinator Name: Stefan Zollner

Textbook: H.D. Young and R.A. Freedman, *University Physics*, 13th edition, Pearson, 2012

a) other supplemental materials: *Mastering Physics* for Young and Freedman, 13th edition.

Specific Course Information:

- a) catalog description:** Calculus-level treatment of kinematics, work and energy, particle dynamics, conservation principles, simple harmonic motion.
- b) prerequisites or co-requisites:** MATH 191G (*pre-req*). The PHYS 215 course is calculus based and students should be able to take basic derivatives.
- c)** This course is required for most engineering disciplines, except Engineering Technology and Survey Engineering. It can also be used as a substitute for majors in Physics, Chemistry, and Engineering Physics with concentrations in *Aerospace*, *Chemical*, *Electrical*, and *Mechanical*.

Specific Goals of the Course:

- a) specific outcomes of instruction:** This course provides a calculus-based introduction to mechanics, especially Newton's laws, the linear motion of particles, and the rotational motion of rigid bodies. PHYS 215G and PHYS 216G (Engineering Physics II) prepare students for upper-division courses in engineering and physical sciences. Students learn how to apply their knowledge of mathematics (including algebra, trigonometry, geometry, and calculus) to problems in mechanics.
- b) related ABET Outcomes:** This course supports ABET outcome a), an ability to apply knowledge of mathematics, science, and engineering.

Brief List of Topics Covered:

The course covers the following chapters in the Young & Freedman textbook. The number of lectures spent on each section are indicated.

Chapter 1, Sec. 1-10: Units, physical quantities and lectures (2 lectures)

Chapter 2, Sec. 2-5: Motion along a straight line (2 lectures)

Chapter 3, Sec. 1-4: Motion in two or three dimension (3 lectures)

Chapter 4, Sec. 1-6: Newton's laws of motion (2 lectures)

Chapter 5, Sec. 1-5: Applying Newton's laws (2 lectures)

Chapter 6, Sec. 1-4: Work and kinetic energy (2 lectures)

Chapter 7, Sec. 1-5: Potential energy and energy conservation (2 lectures)

Chapter 8, Sec. 1-5: Momentum, impulse, and collisions (3 lectures)

Chapter 9, Sec. 1-5: Rotation of rigid bodies (2 lectures)

Chapter 10, Sec. 1-6: Dynamics of rotational motion (2 lectures)

Chapter 11, Sec. 1-3: Equilibrium and statics (1 lecture)

Chapter 13, Sec. 1-5: Gravitation (1 lecture)

Chapter 14, Sec. 1-5: Periodic motion (1 lecture)

Chapter 15, Sec. 1-4: Mechanical waves (1 lecture)

Prepared by Stefan Zollner, Spring 2012.

Course Number and Name: Physics 215L, Engineering Physics I Laboratory

Credits and Contact Hours: 1 credits (one 2-1/2 hour lab per week).

Instructor or Course Coordinator Name: Chris Pennise

Textbook: The lab materials were developed by Dr. Steve Kanim of the NMSU Department of Physics. They are distributed on the on the course website. Lab one is printed out for the students; students are responsible for printing out other lab and homework materials

Specific Course Information:

- a) **catalog description:** Laboratory experiments associated with the material presented in PHYS 215G. Co-requisite: PHYS 215G. Students wishing to use the PHYS 215G-216G sequence to satisfy the basic natural science general education requirement must register for either PHYS 215GL or PHYS 216GL
- b) **prerequisites or co-requisites:** PHYS 215(*co-requisite*).
- c) This course is the companion laboratory to Physics 215, Engineering Physics I. It is required by all engineering majors with the exception of Engineering Technology.

Specific Goals of the Course:

- a) **specific outcomes of instruction:** Students in this course perform a series of experiments that apply the principles and concepts highlighting the main objectives covered in the coursework for PHYS 215.
- b) **related ABET Outcomes:** PHYS 215L addresses program outcome *b) an ability to design and conduct experiments*.

Brief List of Topics Covered:

Experiments are performed, data collected and analyzed encompassing: kinematics, dynamics, energy, work, momentum, and their conservation concepts and rotational motion and extended body problems. Below is the list of labs covered over the course of the semester:

1. ***Descriptions of motion***
2. ***Acceleration in one dimension***
3. ***Motion in two dimensions***
4. ***Forces***
5. ***Addition of forces***
6. ***Newton's second law***
7. ***Energy***
8. ***Conservation of momentum***
9. ***Rotational motion***
10. ***Torque***
11. ***Simple harmonic motion***
12. ***Standing waves***

Prepared by Thomas Hearn, Spring 2012.

Course Number and Name: Physics 216G, Engineering Physics II

Credits and Contact Hours: 3 credits (three 50-minute lectures each week); an additional contact hour each week (during office hours). Tutoring assistance also available.

Instructor or Course Coordinator Name: Thomas Hearn

Textbook: H.D. Young and R.A. Freedman, *University Physics*, 13th edition, Pearson, 2012

a) other supplemental materials: *Mastering Physics* online homework for Young and Freedman, 13th edition.

Specific Course Information:

- a) catalog description:** Calculus-level treatment of topics in electricity, magnetism, and optics.
- b) prerequisites or co-requisites:** MATH 192G (*pre-requisite*). The PHYS 216 course is calculus based and students should be able to take basic derivatives and integrals.
- c)** This course is required for most engineering disciplines, except Engineering Technology and Survey Engineering. It can also substitute PHYS214 for Engineering Physics majors.

Specific Goals of the Course:

- a) specific outcomes of instruction:** This course provides a calculus-based introduction to electricity, magnetism, basic electronic circuits, and basic optics. Together, PHYS 215G and PHYS 216G prepare students for upper-division courses in engineering and physical sciences.
- b) related ABET Outcomes:** This course supports ABET outcome a), an ability to apply knowledge of mathematics, science, and engineering.

Brief List of Topics Covered:

The course covers the following chapters in the Young & Freedman textbook. The number of lectures spent on each section are indicated. There are about 32 total lectures.

Chapter 21: Introduction and electric charge (3 lectures)

Chapter 22: Gauss's law (2 lectures)

Chapter 23: Electric potential (2 lectures)

Chapter 24: Capacitance (3 lectures)

Chapter 25: Current, resistance, and voltage (3 lectures)

Chapter 26: DC circuits (2 lectures)

Chapter 27: Magnetic fields and forces (2 lectures)

Chapter 28: Magnetic sources (3 lectures)

Chapter 29: Induction (3 lectures)

Chapter 33: Nature of light (3 lectures)

Chapter 34: Geometric optics (4 lectures)

Chapter 35: Diffraction (2 lectures)

Prepared by Thomas Hearn, Spring 2012.

Course Number and Name: Physics 216L, Engineering Physics II Laboratory

Credits and Contact Hours: 1 credits (one 2-1/2 hour lab per week).

Instructor or Course Coordinator Name: Chris Pennise

Textbook: Tutorials in Introductory Physics and Homework Package, by McDermott and Shaffer, Addison-Wesley Publishers, 2002.

Specific Course Information:

- a) **catalog description:** Laboratory experiments associated with the material presented in PHYS 216G. Prerequisite: a C or better in PHYS 213L or PHYS 215GL. Corequisite: PHYS 216G. Students wishing to use the PHYS 215G-216 sequence to satisfy the basic natural science general education requirement must register for either PHYS 215GL or PHYS 216GL.
- b) **prerequisites or co-requisites:** PHYS 213L or 215L (*prerequisites*) and PHYS 216G (*corequisite*).
- c) This course is the companion laboratory to Physics 216, Engineering Physics II. It is required by all engineering majors with the exception of Engineering Technology.

Specific Goals of the Course:

- a) **specific outcomes of instruction:** Students in this course perform a series of experiments that apply the principles and concepts highlighting the main objectives covered in the coursework for PHYS 216.
- b) **related ABET Outcomes:** PHYS 216L addresses program outcome *b) an ability to design and conduct experiments*.

Brief List of Topics Covered:

Experiments are performed, data collected and analyzed encompassing: electrostatics, electric circuits, magnetism, electromagnetism and light, including geometrical and physical optics. Below is the list of labs covered over the course of the semester:

1. **Charge**
2. **Electric field and flux**
3. **Gauss's Law**
4. **Electric potential difference**
5. **Circuits I**
6. **Circuits II**
7. **Magnets and fields**
8. **Magnetic interactions**
9. **Lenz's law**
10. **Faraday's law**
11. **Plane and curved mirrors**
12. **Ray diagrams and convex lenses**

Prepared by Thomas Hearn, Spring 2012.

Course Number and Name: Physics 217: Heat, Light, and Sound

Credits and Contact Hours: 3 credits (three 50-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Stephen Pate

Textbook: Young and Freedman, *University Physics with Modern Physics*, 13th ed., Pearson Addison-Wesley.

a) other supplemental materials: numerous handouts distributed via web page

Specific Course Information:

a) catalog description: Calculus-level treatment of thermodynamics, geometrical and physical optics, and sound.

b) prerequisites or co-requisites: PHYS 213 or 215 (*pre-req*)

c) This course is required for all majors in Physics and Engineering Physics.

Specific Goals of the Course:

a) specific outcomes of instruction: Students should become familiar with the concepts of waves, wave propagation, and the description of these phenomena and how these concepts can be generalized to give insight into optical processes. The section on thermodynamics in the course discusses the laws of thermodynamics and their use to describe thermal processes in engineering applications.

b) related ABET Outcomes: PHYS 217 addresses the following Program Outcome:

a) Apply knowledge of math, science, and engineering.

Brief List of Topics Covered:

The course covers material from Chapters 13, 15-20, 33-36 of the Young and Freedman textbook. The number of lectures spent on each section are indicated.

Chapter 13: Periodic Motion (3)

Chapter 15: Mechanical Waves (4)

Chapter 16: Sound and Hearing (4)

Chapter 33: Nature and Propagation of Light (2)

Chapter 34: Geometric Optics (3)

Chapter 35: Interference (3)

Chapter 36: Diffraction (3)

Chapter 17: Temperature and Heat (4)

Chapter 18: Thermal Properties of Matter (4)

Chapter 19: First Law of Thermodynamics (4)

Chapter 20: Second Law of Thermodynamics (3)

Prepared by Stephen Pate, Spring 2012.

Course Number and Name: Physics 217L: Experimental Heat, Light, and Sound

Credits and Contact Hours: 1 credit (one 150-minute lab each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Stephen Pate

Textbook: Lab manual that was developed in the Department of Physics for this course.

a) **other supplemental materials:** numerous handouts distributed via web page

Specific Course Information:

a) **catalog description:** Laboratory experiments associated with the material presented in PHYS 217.

b) **prerequisites or co-requisites:** PHYS 217 (*co-requisite*)

c) This course is required for all majors in Physics and Engineering Physics.

Specific Goals of the Course:

a) **specific outcomes of instruction:** Students should become familiar with the experimental exploration of basic phenomena in nature, data analysis, and the preparation of laboratory reports.

b) **related ABET Outcomes:** PHYS 217L addresses the following Program Outcome:

b) Design and conduct experiments, as well as to analyze and interpret data.

Brief List of Topics Covered:

The students perform 13 experiments during the semester, and each student writes an individual lab report for each experiment.

1. Error analysis
2. Modes of a string
3. Resonance tube
4. Diffraction
5. Reflection/mirrors
6. Refraction/lenses
7. Bragg refraction
8. Thermal expansion
9. Thermal conduction
10. Thermal radiation
11. Calorimetry
12. Mechanical equivalent of heat
13. Ideal gas laws

Prepared by Stephen Pate, Spring 2012.

Course Number and Name: Physics 305V, The Search For Water In The Solar System

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional contact hour each week (during office hours)

Instructor or Course Coordinator Name: Boris Kiefer

Textbook: Harry Y. McSween, Jr. Stardust To Planets – A Geological Tour of the Universe

a) other supplemental materials: none

Specific Course Information:

a) catalog description: Examines the formation, abundance and ubiquity of water in our Solar System

b) prerequisites or co-requisites: None

c) This course is an elective in Engineering Physics for students with Electrical and Mechanical concentrations.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides the fundamental knowledge interdisciplinary reasoning. Students should become proficient in combining diverse sources of knowledge and information to discuss interdisciplinary topics including nuclear synthesis, Solar System formation, remote sensing, as well as past, present and future NASA missions for water.

b) related ABET Outcomes: f) an understanding of professional and ethical responsibility; h) the broad education necessary to understand impact of engineering solutions in global, economic, environmental and societal context; i) a recognition of the need for, and the ability to engage in lifelong learning; j) a knowledge of contemporary issues.

Brief List of Topics Covered:

The course covers material from Chapters 1-15 Harry Y. McSween book.

Chapter 1: The Yellow Pages – Organization of the Solar System

Chapter 3: Could You Eat a Comet – A Close Encounter with the Nucleus of Comet Halley

Chapter 7: A Piece of the Red Planet – Meteorites From Mars?

Chapter 8: Hardened Hearts – Cores and Mantles of the Terrestrial Planets

Chapter 9: No Stone Left Unturned – Regolith on the Moon, Asteroids, and Planets

Chapter 10: And Not a Drop to Drink – Water on Mars

Chapter 14: Twinkle, Twinkle, Little Lump – Abundance of Elements in the Solar System

Chapter 15: Living in the Fast Lane – A Planetary Foothold for the Spark of Life

Prepared by Boris Kiefer, Spring 2012.

Course Number and Name: Physics 315, Modern Physics

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Stephen Pate

Textbook: Young and Freedman, *University Physics with Modern Physics*, 12th ed., Pearson Addison-Wesley; or equivalent modern physics textbook in consultation with the instructor.

a) other supplemental materials: numerous handouts distributed via web page

Specific Course Information:

a) catalog description: An introduction to relativity and quantum mechanics, with applications to atoms, molecules, solids, nuclei, and elementary particles.

b) prerequisites or co-requisites: PHYS 214 or 216, MATH 291 (*all pre-reqs*)

c) This course is required for all majors in Physics and Engineering Physics.

Specific Goals of the Course:

a) specific outcomes of instruction: Students should become familiar with the principles and basic equations of the special theory of relativity and quantum mechanics and their applications in simple problems in various fields of physics. This knowledge will be applied in more advanced and specialized topics to be studied in later years.

b) related ABET Outcomes: PHYS 315 addresses the following Program Outcomes:

a) Apply knowledge of math, science, and engineering.

f) Have an understanding of professional and ethical responsibility.

h) Understand the impact of engineering solutions in a global, economic, environmental, and societal context.

i) Recognize the need for, and have the ability to engage in, lifelong learning.

j) Have a knowledge of contemporary issues

Brief List of Topics Covered:

The course covers material from Chapters 37-44 of the Young and Freedman textbook. The number of lectures spent on each section are indicated.

Chapter 37: Relativity (3)

Chapter 38: Photons, Electrons and Atoms (4)

Chapter 39: The Wave Nature of Particles (4)

Chapter 40: Quantum Mechanics (4)

Chapter 41: Atomic Structure (4)

Chapter 42: Molecules and Condensed Matter (4)

Chapter 43: Nuclear Physics (4)

Chapter 44: Particle Physics and Cosmology (1)

Prepared by Stephen Pate, Spring 2012.

Course Number and Name: Physics 315L, Experimental Modern Physics

Credits and Contact Hours: 3 credits (two 150-minute labs each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Stephen Pate

Textbook: no textbook

a) **other supplemental materials:** numerous handouts distributed via web page

Specific Course Information:

a) **catalog description:** Elementary laboratory in modern physics which supports the subject matter in PHYS 315.

b) **prerequisites or co-requisites:** PHYS 214L or 216L (*pre-req*); PHYS 315 (*co-req*)

c) This course is required for all majors in Physics and Engineering Physics.

Specific Goals of the Course:

a) **specific outcomes of instruction:** Students perform a series of classic experiments in quantum physics and apply techniques of measurement, interpretation, and presentation of experimental data.

b) **related ABET Outcomes:** PHYS 315L addresses the following Program Outcomes:

b) *Design and conduct experiments, as well as analyze and interpret data.*

c) *Design a system, component, or process to meet desired needs within realistic constraints.*

d) *Function on multidisciplinary teams.*

f) *Have an understanding of professional and ethical responsibilities.*

g) *Communicate effectively.*

k) *Use techniques, skills and modern tools necessary for engineering and physics practice.*

Brief List of Topics Covered:

The students work in teams of 3-4 people. Each team performs 8 experiments over the course of the semester. The first experiment concerns the uncertainties in counting experiments, and all students write a report on this measurement. Then comes a series of 6 short experiments; individual students are assigned to write a report for the whole team; each student writes two reports in total. Then comes a final longer experiment, lasting several weeks. The team writes a design report for this experiment, then performs the measurement, analyses the data, and makes presentation to the entire class during the last few lab meetings.

The First Experiment (done by all teams; all students write an individual report)

1. Counting Statistics

Short Experiments (each team does 6 of these; team reports written by individual members)

2. Atomic Spectroscopy
3. Electron Diffraction
4. Planck's Constant – Photoelectric Effect
5. Charge of the Electron – Millikan Oil Drop Experiment
6. Quantization of Atomic Energy Levels – Franck-Hertz Experiment
7. Nuclear Magnetic Resonance
8. Electrical Conductivity of Metals and Semi-conductors
9. Nuclear Spectroscopy

Long Experiments (done by one team only; requires design report, and final results presentation, done by the whole team)

10. The Hall Effect
11. The Speed of Light
12. The Zeeman effect
13. Infrared Absorption Spectroscopy – Barnes Spectrometer
14. Advanced Atomic Spectroscopy – Jarrell-Ash Spectrometer
15. Rutherford Scattering and the Range of Alpha Particles in Matter

Prepared by Stephen Pate, Spring 2012.

Course Number and Name: Physics 395, Intermediate Mathematical Methods of Physics

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Matthias Burkardt

Textbook: M.L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd edition, Wiley, ISBN: 978-0-471-19826-0

a) other supplemental materials: practice problems

Specific Course Information:

a) catalog description: Introduction to the mathematics used in intermediate level physics courses

b) prerequisites or co-requisites: MATH 291 (*pre-req*), MATH 392 (*pre/co-req*)

c) This course is required for majors in Physics and Engineering.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides basic competence in multiple areas of mathematics needed in upper division courses in physics, chemistry, and engineering. This course trains students in selected mathematical methods applied to science and engineering problems.

b) related ABET Outcomes: PHYS 395 addresses Program Outcome e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 2-8 of Boas' textbook. Number of lectures spend on each chapter are indicated.

Chapter 2: Complex Numbers (4 lectures):

Real and imaginary part of a complex number; the complex plane; complex algebra, Euler's formula; powers and roots of a complex numbers; logarithms

Chapter 3: Linear Algebra (8 lectures):

Vectors; matrices; matrix operations; row reduction; determinants; Cramer's rule; special matrices; eigenvalues; eigenvectors; matrix diagonalization; applications of diagonalization.

Chapter 4: Partial Differentiation (3 lectures):

Notation; total differential; chain rule; change of variables; waves

Chapter 5: Multiple Integrals (3 lectures):

Double and triple integrals; change of variables; Jacobian; surface integrals

Chapter 6: Vector Analysis 5 lectures):

Application of vector multiplication; triple products; differentiation of vectors; fields; gradient; line integrals; divergence; Gauss' theorem; curl; Stokes' theorem; Helmholtz theorem

Chapter 7: Fourier Series and Transforms (2 lectures)

Simple harmonic motion; wave motion; application of Fourier Series; Fourier integrals

Chapter 8: Ordinary Differential Equations (3 lectures)

Separable equations; Linear first order equations; other methods for first order equations; second order equations with constant coefficients; other second order equations; the Dirac delta function.

Prepared by Matthias Burkardt, Spring 2012.

Course Number and Name: Physics 450, Selected Topics: Capstone Design

Credits and Contact Hours: 3 credits (150 minutes combined meeting and lab time)

Instructor or Course Coordinator Name: Stephen Kanim

Textbook: None

a) other supplemental materials: Research paper reading as required

Specific Course Information:

a) catalog description: Readings, lectures or laboratory studies in selected areas of physics. May be repeated for a maximum of 12 credits.

b) prerequisites or co-requisites: None.

c) This is an elective course. May be used as part of the Engineering Physics capstone design experience.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides real-world experience in research, design, testing, development, and prototype manufacture.

b) related ABET Outcomes: PHYS 450 addresses Program Outcomes, to develop *c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; d) an ability to function in multidisciplinary teams; g) an ability to communicate effectively; and k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Brief List of Topics Covered:

Depends on specific design task or project.

Prepared by Stephen Kanim, Spring 2012.

Course Number and Name: Physics 451, Intermediate Mechanics I

Credits and Contact Hours: 3 credits (three 50-minute lectures each week); and additional 2 contact hours each week (during office hours).

Instructor or Course Coordinator Name: Thomas Hearn

Textbook: Analytical Mechanics, Seventh edition, by Fowles & Cassiday, Thompson/Brooks/Cole Publishing, 2005.

a) other supplemental materials: Occasional handouts by instructor.

Specific Course Information:

- a) catalog description:** Vector calculus, Lagrangian and Hamiltonian formulations of Newtonian mechanics. Topics include central force motion, dynamics of rockets and space vehicles, rigid body motion, non-inertial reference frames, oscillating systems, relativistic mechanics, classical scattering, and fluid mechanics.
- b) prerequisites or co-requisites:** PHYS 213 or PHYS 215G, and MATH 291G. Co-requisite: MATH 392.
- c)** This course is required for majors in Physics and Engineering Physics with concentrations in Electrical Engineering and Chemical Engineering. It is an elective for majors in Engineering Physics with concentrations in Mechanical or Aerospace Engineering.

Specific Goals of the Course:

- a) specific outcomes of instruction:** This course builds on their introductory mechanics course (PHYS 213 or PHYS 215) and is an integral part of the upper-division physics core, which includes PHYS 451, 454&455 and 461&462. The course views Newtonian mechanics from a differential equations viewpoint and provides an introduction to Lagrangian and Hamiltonian formulations of mechanics. Students should be able to solve Newton's equation from the viewpoint of a differential equation, understand polar, cylindrical, and spherical coordinate systems including their rotation, use Newton's Law of gravity, understand particle scattering and systems of particles, and apply Lagrange's equations to mechanical systems.
- b) related ABET Outcomes:** PHYS 451 addresses Program Outcomes e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 1-7, and 10 of the Fowles and Cassiday text. Approximate number of 50 minute lectures spend on each section are indicated. (38 lectures plus 4 test days).

Chapter 1: Fundamental Concepts: Vectors

Vectors, scalar and vector products, coordinate systems, changes in coordinate systems, vector derivatives, velocity and acceleration in different coordinate systems. (3 lectures).

Chapter 2: Newtonian Mechanics: Rectilinear Motion of a Particle

Newton's laws of motion, uniform acceleration under a constant force, forces that depend on position, kinetic and potential energy, forces that depend on velocity, fluid resistance, terminal velocity. (4 lectures).

Chapter 3: Oscillations

Linear restoring forces and simple harmonic motion, energy in harmonic motion, damped harmonic motion, forced harmonic motion. (4 lectures).

Chapter 4: General Motion of a Particle in Three Dimensions

Potential energy in three-dimensional motion, the del operator, forces of the separable type, projectile motion, harmonic oscillators in two and three dimensions, motion of charged particles in electric and magnetic fields, constrained motion of a particle. (5 lectures).

Chapter 5: Noninertial Reference Systems

Accelerated coordinate systems, rotating coordinate systems, effects of Earth rotation, the Foucault pendulum. (5 lectures).

Chapter 6: Gravitation and Central Forces

The gravitational force, Kepler's three laws of planetary motion, potential energy in gravitational and central force fields, the energy equation of an orbit in central and inverse-square fields, effective potential and orbital stability, apsides and apsidal angles, motion in inverse-square repulsive fields and scattering. (10 lectures).

Chapter 7: Dynamics of Systems of Particles

Center of mass and linear momentum, angular momentum and kinetic energy of systems, two-body problems and reduced mass, collisions and scattering, variable mass and rocket motion. (3 lectures).

Chapter 10: Lagrangian Mechanics

Hamilton's variational principle, generalized coordinates, kinetic and potential energy in generalized coordinates, Lagrange's equations of motion for conservative systems, generalized momenta, constraints and Lagrange multipliers, D'Lambert's principle and generalized forces, Hamilton's equations. (4 lectures).

Prepared by Thomas Hearn, Spring 2012.

Course Number and Name: Physics 454, Intermediate Modern Physics I

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional contact hour each week (during office hours)

Instructor or Course Coordinator Name: Boris Kiefer

Textbook: J. S. Townsend, *A Modern Approach to Quantum Mechanics*, University Science Books, 2000.

a) other supplemental materials: none

Specific Course Information:

- a) catalog description:** Introduction to quantum mechanics, focusing on the role of angular momentum and symmetries, with application to many atomic and subatomic systems.
- b) prerequisites or co-requisites:** PHYS 315 (*pre-req.*), PHYS 392 (*co-req.*), and MATH 392 (*co-req.*)
- c)** This course is required for majors in Physics and Engineering Physics with concentrations in Aerospace, Chemical, Electrical, and Mechanical Engineering.

Specific Goals of the Course:

- a) specific outcomes of instruction:** This course provides the fundamental knowledge of quantum mechanics and related phenomena. It is an integral part of the upper-division physics core, which includes PHYs 451, 454&455 and 461&462. Students should become proficient in a wide range of problems considering Schrödinger's equations including intrinsic spin, matrix representation of wave functions and observables, time evolution, and motion in one dimension.
- b) related ABET Outcomes:** PHYS 455 addresses Program Outcome e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 1-7 of the J. S. Townsend textbook.

Chapter 1: Stern-Gerlach Experiments

- 1.1. Original Stern-Gerlach Experiment
- 1.2. Four Experiments
- 1.3. The Quantum State Vector
- 1.4. Analysis of Experiment 3
- 1.5. Experiment 5

Chapter 2: Rotation of Basis States and Matrix Mechanics

- 2.1. The Beginnings of Matrix Mechanics
- 2.2. Rotation Operators
- 2.3. The Identity and Projection Operators
- 2.4. Matrix Representation of Operators
- 2.5. Changing Representations
- 2.6. Expectation Values
- 2.7. Photon Polarization and the Spin of the Photon

Chapter 3: Angular Momentum

- 3.1. Rotations Do Not Commute
- 3.2. Commuting Operators
- 3.3. Eigenvalues and Eigenstates of Angular Momentum
- 3.4. Matrix Elements of Raising and Lowering Operators
- 3.5. Uncertainty Relations and Angular Momentum
- 3.6. The Spin-1/2 Eigenvalue Problem
- 3.7. The Stern-Gerlach Experiment with Spin-1 Particles

Chapter 4: Time Evolution

- 4.1. The Hamiltonian and the Schrödinger Equation
- 4.2. Time Dependence of Expectation Values
- 4.3. Precession of a Spin-1/2 Particle in a Magnetic Field
- 4.4. Magnetic Resonance
- 4.5. The Ammonia Molecule and the Ammonia Maser
- 4.6. The Energy-Time Uncertainty Relation

Chapter 5: A System of Two Spin-1/2 Particles

- 5.1. Basis States
- 5.2. Hyperfine Splitting of the Ground State of Hydrogen
- 5.3. The Addition of Angular Momenta of Two Spin-1/2 Particles

Chapter 6: Wave Mechanics in One Dimension

- 6.1. Position Eigenstates and the Wave Function
- 6.2. The Translation Operator
- 6.3. The Generator of Translations
- 6.4. Momentum Operator in Position Basis
- 6.5. Momentum Space
- 6.6. Gaussian Wave Packet
- 6.7. Heisenberg Uncertainty Principle
- 6.8. General Properties of Solutions to the Schrödinger Equation in Position Space
- 6.9. The Particle in a Box
- 6.10. Scattering in One Dimension

Chapter 7: One-Dimensional Harmonic Oscillator

- 7.1. Importance of the Harmonic Oscillator
- 7.2. Operator Methods
- 7.3. Example: Torsional Oscillations of the Ethylene Molecule
- 7.4. Matrix Elements of the Raising and Lowering Operators
- 7.5. Position-Space Wave Functions
- 7.6. The Zero-Point Energy
- 7.7. The Classical Limit
- 7.8. Time Dependence
- 7.9. Solving Schrödinger's Equation in Position Space
- 7.10. Inversion Symmetry and the Parity Operator

Prepared by Boris Kiefer, Fall 2011.

Course Number and Name: Physics 455, Intermediate Modern Physics II

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional contact hour each week (during office hours)

Instructor or Course Coordinator Name: Boris Kiefer

Textbook: J. S. Townsend, *A Modern Approach to Quantum Mechanics*, University Science Books, 2000.

a) other supplemental materials: none

Specific Course Information:

a) catalog description: continuation of topics in PHYS454

b) prerequisites or co-requisites: PHYS 454 (*pre-req*)

c) This course is required for majors in Physics and Engineering Physics with concentrations in Aerospace, Chemical, Electrical, and Mechanical Engineering.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides the fundamental knowledge of quantum mechanics and related phenomena. It is an integral part of the upper-division physics core, which includes PHYs 451, 454&455 and 461&462. Students should become proficient in a wide range of problems considering Schrödinger's equations including rotation and translation in three dimensions, solution of central potential problems, perturbation theory, physics of identical particles, scattering theory, and the interaction between photons and atoms.

b) related ABET Outcomes: PHYS 455 addresses Program Outcome e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 9-14 of the J. S. Townsend textbook.

Chapter 9: Translational and Rotational Symmetry in the Two-Body Problem

- 9.1. Elements of Wave Mechanics in Three Dimensions
- 9.2. Translational Invariance
- 9.3. Center-of-Mass Coordinated
- 9.4. Ground-State Energies And Uncertainty Principle
- 9.5. Rotational Invariance
- 9.6. Complete set of Commuting Variables
- 9.7. Vibrations and Rotations of Diatomic Molecules
- 9.8. Position-Space Representation of Angular Momentum
- 9.9. Orbital Angular Momentum Eigenfunctions

Chapter 10: Bound States of Central Potentials

- 10.1. Asymptotic Behavior of Wave Functions
- 10.2. Hydrogen Atom
- 10.3. The Finite Spherical Well and the Deuteron

- 10.4. The Infinite Spherical Well
- 10.5. The 3-d Isotropic Harmonic Oscillator

Chapter 11: Time-Independent Perturbations

- 11.1. Nondegenerate Perturbation Theory
- 11.2. Example, Involving 1-d Harmonic Oscillator
- 11.3. Degenerate Perturbation Theory
- 11.4. Stark Effect in Hydrogen
- 11.6. Relativistic Perturbations of the Hydrogen Atoms
- 11.8. Zeeman Effect in Hydrogen

Chapter 12: Identical Particles

- 12.1. Indistinguishable Particles in Quantum Mechanics
- 12.2. Helium Atom
- 12.3. Multielectron Atoms and the Periodic Table
- 12.4. Covalent Bonding

Chapter 13: Scattering

- 13.1. Asymptotic Wave Function and the Differential Cross Section
- 13.2. Born Approximation
- 13.3. Example of the Born Approximation: Yukawa Potential
- 13.4. The Partial Wave Expansion
- 13.5. Examples of Phase-Shift Analysis

Chapter 14: Photons and Atoms

- 14.1. Aharonov-Bohm Effect
- 14.2. Hamiltonian for the Electromagnetic Field
- 14.3. Quantizing the Radiation Field
- 14.4. Properties of Photons
- 14.5. Hamiltonian of the Atom and the Electromagnetic Field
- 14.6. Time-Dependent Perturbation Theory
- 14.7. Fermi's Golden Rule
- 14.8. Spontaneous Emission

Prepared by Boris Kiefer, Spring 2012.

Course Number and Name: Physics 461, Intermediate Electricity and Magnetism I

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Heinrich Nakotte

Textbook: D.J. Griffiths, *Introduction to Electrodynamics*, 3rd edition, Prentice Hall, 1999

a) other supplemental materials: none

Specific Course Information:

a) catalog description: covers electro- and magneto-statics, dielectric and magnetic materials, DA and AC circuits, electromagnetic wave propagation, reflection, refraction, wave guides, radiating systems, interference and diffraction, Newtonian and relativistic electrodynamics, magnetohydrodynamics and plasma physics*

**catalog description is no longer up-to-date and will be changed in the next Undergraduate Catalog*

b) prerequisites or co-requisites: PHYS 214 or 216G, MATH 291(*pre-reqs.*)

c) This course is required for majors in Physics and Engineering Physics with concentrations in Aerospace, Chemical and Mechanical Engineering. It is an elective for majors in Engineering Physics with a concentration in Electrical Engineering.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides the fundamental knowledge of electrodynamics and related phenomena. It is an integral part of the upper-division physics core, which includes PHYS 451, 454&455 and 461&462. Students should become proficient in a wide range of problems of electro- and magnetostatics, including dielectrics and magnetic materials.

b) related ABET Outcomes: PHYS 461 addresses Program Outcome e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 1-6 of Griffiths textbook. Number of lectures spend on each section are indicated.

Chapter 1: Vector Analysis

- 1.1. Vector Algebra (1/3 lecture)
- 1.2. Differential Calculus (1/3)
- 1.3. Integral Calculus (1/3)
- 1.4. Curvilinear Coordinates (1/3)
- 1.5. The Dirac Delta Function (1/3)
- 1.6. The Theory of Vector Fields (1/3)

Chapter 2: Electrostatics

- 2.1. The Electric Field (1)
- 2.2. Divergence and Curl of Electrostatic Field (1)

- 2.3. Electric Potential (1)
- 2.4. Work and Energy in Electrostatics (1/2)
- 2.5. Conductors (1/2)

Chapter 3: Special Techniques

- 3.1. Laplace's Equation (1)
- 3.2. The Method of Images (1)
- 3.3. Separation of Variables (1)
- 3.4. Multipole Expansion (1)

Chapter 4: Electric Fields in Matter

- 4.1. Polarization (1)
- 4.2. The Field of a Polarized Object (1)
- 4.3. The Electric Displacement (1)
- 4.4. Dielectrics (2)

Chapter 5: Magnetostatics

- 5.1. The Lorentz Force Law (1)
- 5.2. The Biot-Savart Law (1)
- 5.3. The Divergence and Curl of B (1)
- 5.4. Magnetic Vector Potential (1)

Chapter 6: Magnetic Fields in Matter

- 6.1. Magnetization (1)
- 6.2. The Field of a Magnetized Object (1)
- 6.3. The Auxiliary Field H (1)
- 6.4. Linear and Nonlinear Media (1)

Prepared by Heinz Nakotte, Fall 2011.

Course Number and Name: Physics 462, Intermediate Electricity and Magnetism II

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Heinrich Nakotte

Textbook: D.J. Griffiths, *Introduction to Electrodynamics*, 3rd edition, Prentice Hall, 1999

a) other supplemental materials: none

Specific Course Information:

a) catalog description: continuation of topics in PHYS461

b) prerequisites or co-requisites: PHYS 461(*pre-req*)

c) This course is required for majors in Physics and Engineering Physics with concentrations in Aerospace, Chemical and Mechanical Engineering. It is an elective for majors in Engineering Physics with a concentration in Electrical Engineering.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides the fundamental knowledge of electrodynamics and related phenomena. It is an integral part of the upper-division physics core, which includes PHYS 451, 454&455 and 461&462. Students should become proficient in a wide range of problems considering Maxwell's equations in vacuum and matter, magnetic induction, electromagnetic wave propagation (including reflection, refraction, absorption, dispersion), waveguides, dipole radiation and relativistic electrodynamics.

b) related ABET Outcomes: PHYS 462 addresses Program Outcome e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 7-12 of Griffiths textbook. Number of lectures spend on each section are indicated.

Chapter 7: Electrodynamics

7.1. Electromotive Force (1 lecture)

7.2. Electromagnetic Induction (2)

7.3. Maxwell's Equations (2)

Chapter 8: Conservation Laws

8.1. Charge and Energy (1)

8.2. Momentum (1)

Chapter 9: Electromagnetic Waves

9.1. Waves in One Dimension (1)

9.2. Electromagnetic Waves in Vacuum (1)

9.3. Electromagnetic Waves in Matter (1)

9.4. Absorption and Dispersion (1)

9.5. Guided Waves (1)

Chapter 10: Potential and Fields

10.1. The Potential Formulation (1)

10.2. Continuous Distributions (1)

10.3. Point Charges (1)

Chapter 11: Radiation

11.1. Dipole Radiation (1.5)

11.2. Point Charges (1.5)

Chapter 12: Electrodynamics and Relativity

12.1. The Special Theory of Relativity (1)

12.2. Relativistic Mechanics (1)

12.3. Relativistic Electrodynamics (2)

Prepared by Heinz Nakotte, Spring 2012.

Course Number and Name: Physics 473, Introduction to Optics

Credits and Contact Hours: 3 credits (three 50-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Michael DeAntonio

Textbook: Hecht, *Optics*, 4th edition, Addison Wesley, 2001

a) other supplemental materials: none

Specific Course Information:

- a) catalog description:** The nature of light, geometrical optics, basic optical instruments, wave optics, aberrations, polarization, and diffraction. Elements of optical radiometry, lasers and fiber optics.
- b) prerequisites or co-requisites:** PHYS 216 or 217. Cross-listed as PHYS 473.
- c)** This course is an elective for majors in Physics and Engineering Physics .

Specific Goals of the Course:

- a) specific outcomes of instruction:** Describe general waves and wave motion. Use the basic laws of electromagnetism to determine the wave equations for electromagnetic radiation. Calculate the energy, momentum and Poynting vector for particular electromagnetic waves. Describe the dipole source of waves including basic radiation theory and polarization. Describe the effect of waves on a dielectric by the use of simple forcing functions. Describe in detail the process of Rayleigh scattering. Calculate the angles and intensity of light after single or multiple reflection or refraction. Describe the basic process of Huygens' wavelets and Fermat's principle. Predict the final color of light when two colors are mixed in emitting sources, after reflection and after transmitting through color filters. Calculate the RGB values for primary and secondary colors on a computer. Calculate the value of the critical angle and the intensity of light under total internal reflection. Calculate the effect of multiple mirrors and lenses in a system. Determine the effects of an aperture in a complex optical system. Find the entrance and exit pupil in a complex optical system. Perform ray traces for complex optical systems graphically. Calculate the deviation of light through a prism.
- b) related ABET Outcomes:** PHYS 473 addresses Program Outcome e) *an ability to identify, formulate, and solve engineering problems*, i) *a recognition of the need for and an ability to engage in life-long learning*, j) *a knowledge of contemporary issues*, k) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering physics practice*.

Brief List of Topics Covered:

The course covers material from Chapters 2-9 of Hecht's textbook. Number of lectures spent on each chapter are indicated.

Chapter 2: Wave Motion (5 lectures)

2.1. One-Dimensional Waves

2.2. Harmonic Waves

- 2.3. Phase and Phase Velocity
- 2.4. The Superposition Principle
- 2.5. The Complex Representation
- 2.6. Phasors and the Addition of Waves
- 2.7. Plane Waves
- 2.8. Three-Dimensional Differential Wave Equation
- 2.9. Spherical Waves
- 2.10. Cylindrical Waves

Chapter 3: Electromagnetic Theory, Photons and Light (4 lectures)

- 3.2. Electromagnetic Waves
- 3.3. Energy and Momentum
- 3.4. Radiation
- 3.5. Light in Bulk Matter
- 3.6. The electromagnetic-Photon Spectrum

Chapter 4: The Propagation of Light (7 lectures)

- 4.3. Reflection
- 4.4. Refraction
- 4.6. The Electromagnetic Approach
- 4.7. Total Internal Reflection
- 4.9. Familiar Aspects of the Interaction of Light with Matter
- 4.10. The Stokes Treatment of Reflection and Refraction

Chapter 5: Geometrical Optics (6 lectures)

- 5.2. Lenses
- 5.3. Stops
- 5.4. Mirrors
- 5.5. Prisms

Chapter 6: More on Geometrical Optics (5 lectures)

- 6.1. Thick Lenses and Lens Systems
- 6.2. Analytical Ray Tracing
- 6.3. Aberrations

Chapter 7: The Superposition of Waves (2 lectures)

- 7.1. The Addition of Waves of the Same Frequency
- 7.2. The Addition of Waves of Different Frequency

Chapter 8: Polarization (4 lectures)

- 8.1. The Nature of Polarized Light
- 8.2. Polarizers
- 8.6. Polarization by Reflection

Chapter 9: Interference (4 lectures)

- 9.1. General Considerations
- 9.2. Conditions for Interference
- 9.3. Wavefront-splitting

Prepared by Michael DeAntonio, Spring 2012.

Course Number and Name: Physics 475, Advanced Physics Laboratory

Credits and Contact Hours: 3 credits (two 150-minute labs each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Vassilios Papavassiliou

Textbook: None

a) other supplemental materials: Instructor's handouts, equipment manuals, web resources

Specific Course Information:

a) catalog description: Advanced undergraduate laboratory, involving experiments in atomic, molecular, nuclear, and condensed-matter physics.

b) prerequisites or co-requisites: PHYS 315 and PHYS 315L (*pre-req*)

c) This course is required for majors in Physics (for the Bachelor of Science degree) and Engineering Physics

Specific Goals of the Course:

a) specific outcomes of instruction: This course is a fundamental part of the upper-division physics course sequence. Students perform complex experiments, performed extensive error analysis, and present their results in written and oral reports. The course provides up to three credits of engineering physics.

b) related ABET Outcomes: PHYS 475 addresses Program Outcomes *b) an ability to design and conduct experiments, as well as to analyze and interpret data; d) an ability to function in interdisciplinary teams; f) an understanding of professional and ethical responsibility; g) an ability to communicate effectively; and k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Brief List of Topics Covered:

The lab includes lectures in probability, statistics, and error propagation as well as radiation safety, and lab sessions performing experiments in nuclear, particle, and condensed-matter and materials physics. The number of sessions devoted to each topic is listed. Each group performed two out of three experiments 4-6 and two out of three experiments among 7-9.

- 1. Lectures in statistical and error analysis (2 sessions)**
- 2. Radiation safety lecture (1 session)**
- 3. Practical exercise in statistics with Geiger counters (2 sessions)**
- 4. Muon decay (4 sessions)**
- 5. Gamma-gamma angular correlation (4 sessions)**
- 6. Compton scattering (4 sessions)**
- 7. Infrared spectroscopy (4 sessions)**
- 8. Small-angle X-ray scattering (4 sessions)**
- 9. X-ray fluorescence**

Prepared by Vassilios Papavassiliou, Spring 2012.

Course Number and Name: Physics 476, Computational Physics

Credits and Contact Hours: 3 credits, an additional 2 office hours

Instructor or Course Coordinator Name: William Gibbs

Textbook: W. R. Gibbs, Computation in Modern Physics, World Scientific

Specific Course Information:

- a) **catalog description:** An introduction in finite difference methods, Fourier expansions, Fourier integrals, solution of differential equations, Monte-Carlo calculations, and applications to advanced physics problems.
- b) **prerequisites or co-requisites:** MATH 392 (*pre-req*). senior standing
- c) This course is required for majors in Physics (for the Bachelor of Science degree) and Engineering Physics with concentrations in Electrical Engineering. It is a possible elective for the other Engineering Physics concentrations

Specific Goals of the Course:

- a) **specific outcomes of instruction:** Students should become proficient in the higher level methods of treating physics problems with a computer. The course provides an in-depth study of computational physics
- b) **related ABET Outcomes:** PHYS 476 addresses Program Outcomes a) apply knowledge of math, science and engineering, e) to identify, formulate and solve engineering and physics problems, and k) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Brief List of Topics Covered:

Classical integration techniques (trapezoidal and Simpson's rules, Gauss-Legendre and Gauss-Laguerre integration, principal-value integrals), Monte Carlo techniques (sampling, evaluation of multi-dimensional integrals, radiation transport), Differential equations (classical motion, molecular dynamics), Computer architecture for Scientists, Systems of equations (linear algebra, elimination and eigenvalue techniques), Finite element methods in one and two dimensions, Signal processing, Chaotic systems (Feigenbaum's numbers).

Prepared by Dr. William R. Gibbs, Fall 2011.

Course Number and Name: Physics 480, Thermodynamics

Credits and Contact Hours: 3 credits (three 50-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Stephen Pate

Textbook: Kittel and Kroemer, *Thermal Physics*, 2nd edition, Freeman, 1980

a) other supplemental materials: numerous handouts distributed via web page

Specific Course Information:

- a) catalog description:** Thermodynamics and statistical mechanics. Basic concepts of temperature, heat, entropy, equilibrium, reversible and irreversible processes. Applications to solids, liquids, and gases.
- b) prerequisites or co-requisites:** PHYS 217, PHYS 315, MATH 291 (*all pre-reqs*)
- c)** This course is required for all majors in Physics, and those in Engineering Physics with concentration in Electrical Engineering. It is an elective for majors in Engineering Physics with a concentration in Aerospace, Chemical or Mechanical Engineering.

Specific Goals of the Course:

- a) specific outcomes of instruction:** PHYS 480 is an introduction to thermodynamics and statistical physics. The material is taught from the point of view of quantum mechanics from the very beginning, but the knowledge of quantum mechanics required of the student is in fact very slight. We will cover the fundamental topics of equilibrium thermodynamics -- entropy, temperature, energy, heat, reversible and irreversible processes -- and see applications to some simple systems.
- b) related ABET Outcomes:** PHYS 480 addresses Program Outcome e) *develop an ability to identify, formulate, and solve engineering problems.*

Brief List of Topics Covered:

The course covers material from Chapters 1-10 of the Kittel and Kroemer textbook. The number of lectures spent on each section are indicated.

Chapter 1: States of a Model System (4)

Chapter 2: Entropy and Temperature (3)

Chapter 3: Boltzmann Distribution and Helmholtz Free Energy (4)

Chapter 4: Thermal Radiation and Planck Distribution (5)

Chapter 5: Chemical Potential and Gibbs Distribution (3)

Chapter 6: Ideal Gas (5)

Chapter 7: Fermi and Bose Gases (5)

Chapter 8: Heat and Work (4)

Chapter 9: Gibbs Free Energy and Chemical Reactions (3)

Chapter 10: Phase Transformations (5)

Prepared by Stephen Pate, Spring 2012.

Course Number and Name: Physics 488, Condensed Matter Physics

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Heinz Nakotte

Textbook: Charles Kittel, *Introduction to Solid State Physics*, 8th edition, John Wiley & Sons, 2005.

a) other supplemental materials: hand-outs from various sources

Specific Course Information:

a) catalog description: crystal structure, X-ray diffraction, energy band theory, phonons, cohesive energy, conductivities, specific heats, p-n junctions, defects surfaces, and magnetic, optical, and low-temperature properties.

b) prerequisites or co-requisites: PHYS 315(*pre-req*)

c) This course is a possible technical elective for majors in Physics and Engineering Physics with any of the concentrations. In general, it is cross-listed with PHYS588, a slightly more advanced course taken by physics graduate students. The class material covered in PHYS 488 and PHYS588 is the same for both undergraduate and graduate students; however, graduate students are required to do additional (more difficult) assignments.

Specific Goals of the Course:

a) specific outcomes of instruction: This course provides a general introduction to solid state physics, such as crystal structures, diffraction techniques, type of chemical bonding, energy- band theory, phonons, electronic (transport, thermal, optical and magnetic) properties. Some classes of materials, such as semiconductors, superconductors, nanomaterials and permanent-magnet materials may be discussed as well.

b) related ABET Outcomes: PHYS 488 addresses Program Outcomes: f) *an understanding of professional and ethical responsibility*, h) *the broad education necessary to understand impact of engineering solutions in a global, economic, environmental, and societal context*, i) *a recognition of the need for and an ability to engage in lifelong learning*, and j) *a knowledge of contemporary issues*.

Brief List of Topics Covered:

The course covers material from the following chapters in Kittel's textbook. Some chapters are covered in more detail than others. The number of lectures spend on each chapter are indicated.

Chapter 1: Crystal Structure (2 lectures)

Chapter 2: Wave Diffraction and Reciprocal Lattice (2)

Chapter 3: Crystal Binding and Elastic Constants (2)

Chapter 4: Phonons I. Crystal Vibrations (2)

Chapter 5: Phonons II. Thermal Properties (2)

Chapter 6: Free Electron Fermi Gas (2)

Chapter 7: Energy Bands (2)
Chapter 8: Semiconductor Crystals (1)
Chapter 10: Superconductivity (1)
Chapter 11: Diamagnetism and Paramagnetism (1)
Chapter 12: Ferro- and Antiferromagnetism (1)
Chapter 15: Optical Processes (1)
Chapter 16: Dielectrics and Ferroelectrics (1)
Chapter 18: Nanostructures (3)
Chapter 19: Non-Crystalline Solids (2)

Prepared by Heinz Nakotte, Fall 2011

Course Number and Name: Physics 489, Introduction to Modern Materials

Credits and Contact Hours: 3 credits (two 75-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Peter de Châtel

Textbook: no particular textbook required. *For some general guidance, however, Philip Ball published an excellent book called "Made to Measure - New Materials for the 21st Century" (Princeton University Press, 1999), which introduces a variety of advanced materials to the general audience.*

a) other supplemental materials: hand-outs from various sources

Specific Course Information:

a) catalog description: structure and mechanical, thermal, electric, and magnetic properties of materials; modern experimental techniques for the study of materials properties.

b) prerequisites or co-requisites: PHYS 315 (*pre-req.*)

c) This course is a possible technical elective for majors in Physics and Engineering Physics with any of the concentrations. In general, it is cross-listed with PHYS589, a slightly more advanced course taken by physics graduate students. The class material covered in PHYS 489 and PHYS589 is the same for both undergraduate and graduate students; however, graduate students are required to do additional (more difficult) assignments.

Specific Goals of the Course:

a) specific outcomes of instruction: The main goal of this course is for students to identify and understand the microscopic mechanisms responsible for an improved performance of modern materials. The materials to be discussed will be those, which have enabled recent breakthroughs in the fastest growing industries: communication and information storage, energy and aerospace industry. To understand the mechanisms alluded to above, we shall have to touch some aspects of solid state physics (magnetism, mechanical, optical and electrical properties of materials, magneto-optics and –resistivity, semiconductors). Chapters of textbooks available in the library and handouts will be provided to help students to familiarize themselves with these subjects.

b) related ABET Outcomes: PHYS 489 addresses Program Outcomes: *f) an understanding of professional and ethical responsibility, h) the broad education necessary to understand impact of engineering solutions in a global, economic, environmental, and societal context, i) a recognition of the need for and an ability to engage in lifelong learning, and j) a knowledge of contemporary issues.*

Brief List of Topics Covered:

Below is the list of topics covered over the course of the semester:

Weeks 1&2: Magnetism and Magnetic Materials

Week 3: Magneto-Optic Effects

Weeks 4&5: Magneto-electronic Materials and Devices

Weeks 6&7: Magnetic Multilayers and Spintronics

Weeks 8-10: Fiber Optics and Photonics

Weeks 11&12: Materials for Alternative Energy (solar, wind, batteries & fuel cells)

Weeks 13&14: Nanomaterials (in particular, carbon)

Prepared by Peter de Châtel, Spring 2012.

Course Number and Name: Physics 495, Mathematical Methods of Physics

Credits and Contact Hours: 3 credits (three 50-minute lectures each week); an additional 2 contact hours each week (during office hours)

Instructor or Course Coordinator Name: Stephen Pate

Textbook: Dennery and Krzywicki, *Mathematics for Physicists*, Dover

a) **other supplemental materials:** numerous handouts distributed via web page

Specific Course Information:

a) **catalog description:** Applications of mathematics to experimental and theoretical physics. Topics selected from: complex variables; special functions; numerical analysis; Fourier series and transforms, Laplace transforms.

b) **prerequisites or co-requisites:** PHYS 395, MATH 392 (*both pre-reqs.*)

c) This course is an elective for all majors in Physics and Engineering Physics.

Specific Goals of the Course:

a) **specific outcomes of instruction:** Students should become proficient at these advanced mathematical topics so that they will easily understand the interplay between the mathematical tools and physics concepts. The advanced mathematics should become an aid to understanding, and not a barrier.

b) **related ABET Outcomes:** PHYS 495 addresses Program Outcome *k) Use techniques, skills and modern tools necessary for engineering and physics practice.*

Brief List of Topics Covered:

The course covers material from Chapters 1-3 of the Dennery and Krzywicki textbook. The number of lectures spent on each section are indicated.

Chapter 1: The Theory of Analytic Functions (11)

Chapter 2: Linear Vector Spaces (18)

Chapter 3: Function Space, Orthogonal Polynomials, and Fourier Analysis (9)

Prepared by Stephen Pate, Spring 2011.