GS2530
Technical Physics
[Onsite]

Course Description:

This technical course introduces students to concepts of applied physics. Topics include electricity, magnetism, mechanics, light, dynamics and waves. This course includes a laboratory component.

Prerequisite(s) and/or Corequisite(s):

Prerequisite: MA1310 College Mathematics II or equivalent

Credit hours: 4.5

Contact hours: 56 (34 Theory Hours, 22 Lab Hours)

Where Does This Course Belong?

Program Scope

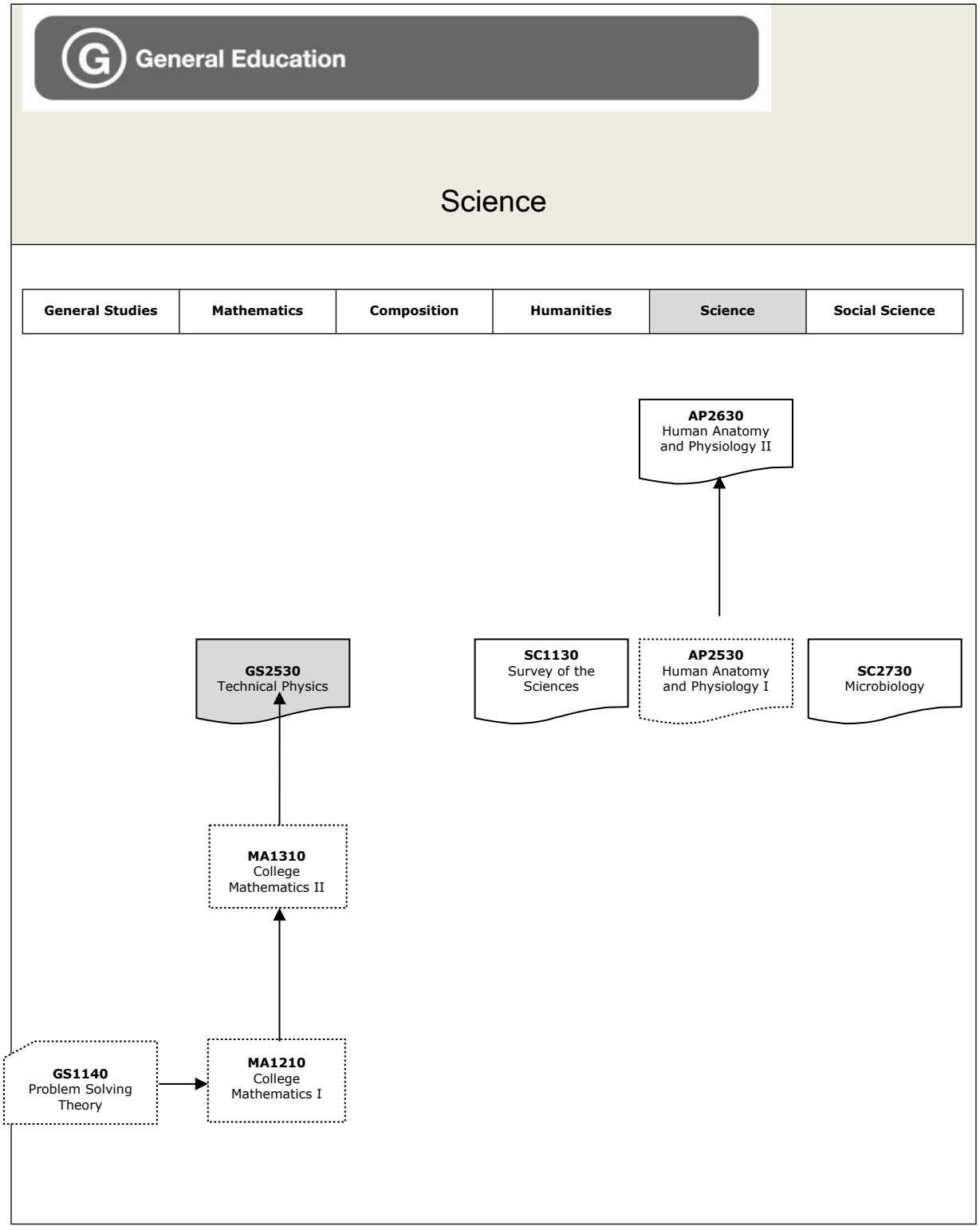
General Education courses include courses in the humanities, composition, mathematics, the sciences, and the social sciences.

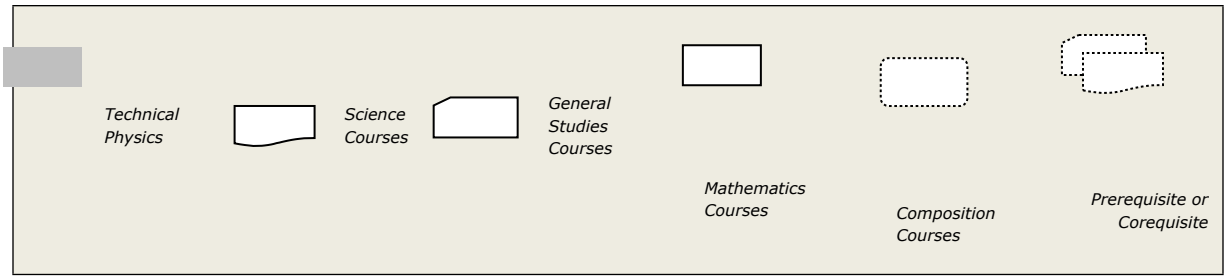
Program Goals and Objectives

General Education courses are designed to provide ITT Tech students with a well-rounded education in the context of their technical programs. Each course emphasizes one or more of ITT Tech's General Education Student Learning Outcomes.

1. The student will be able to demonstrate personal responsibility.
2. The student will be able to analyze information.
3. The student will be able to solve complex problems.
4. The student will be able to communicate effectively in oral, written, and visual forms.
5. The student will be able to contribute as a member of a team.
6. The student will be able to pursue lifelong learning opportunities.

The following diagram demonstrates how this course fits in the program:





Course Summary

Major Instructional Areas

1. Classical mechanics
2. Electromagnetism
3. Thermodynamics
4. Modern physics

Detailed Topical Outline

1. Scientific Method
    1.1. Five-step method
        1.1.1. Observation
        1.1.2. Hypothesis
        1.1.3. Prediction
        1.1.4. Test prediction
        1.1.5. Draw conclusion
    1.2. Facts, theory, and hypothesis

2. Scientific Measurements and Units
    2.1. Metric units
    2.2. Unit conversion
3. Kinematics: Description of Motion
    3.1. Kinematic quantities
        3.1.1. Displacement
        3.1.2. Distance
        3.1.3. Speed
        3.1.4. Velocity
        3.1.5. Acceleration
    3.2. Free fall
4. Dynamics: Description of Force and Motion
    4.1. Newton's laws
        4.1.1. 1st Law – Inertia
            4.1.1.1. Mass versus weight
        4.1.2. 2nd Law – Force = (mass) (acceleration)
            4.1.2.1. Definition of force
            4.1.2.2. Balanced forces
            4.1.2.3. Net force
        4.1.3. 3rd Law – Law of Action/Reaction
            4.1.3.1. Identify action/reaction pairs
    4.2. Free-body diagrams

5. Work and Energy
    5.1. Definition of mechanical work
    5.2. Calculations
        5.2.1. Work
        5.2.2. Kinetic energy
        5.2.3. Potential energy
    5.3. Work-energy theorem
6. Linear Momentum and Collisions
    6.1. Conservation of momentum
    6.2. Elastic and inelastic collisions
    6.3. Impulse
        6.3.1. Force and momentum
        6.3.2. Stopping time
7. Angular Momentum and Torque
    7.1. Rotational motion
        7.1.1. Rotational inertia
        7.1.2. Lever arms
        7.1.3. Conservation of angular momentum
    7.2. Torque
8. Gravity
    8.1. Newton's law of gravitation
        8.1.1. Gravitational potential energy

- 8.1.2. Projectile Motion
- 8.1.3. Satellites
  - 8.1.3.1. Circular orbit
  - 8.1.3.2. Elliptical orbit
  - 8.1.3.3. Escape velocity
- 8.2. Inverse-square law

9. Fluids
   - 9.1. Pressure and Pascal’s Principle
     - 9.1.1. Density
     - 9.1.2. Pressure as a function of depth
   - 9.2. Archimedes' Principle
   - 9.3. Buoyancy
   - 9.4. Flowing fluids
     - 9.4.1. Bernoulli's Principle
10. Temperature and Heat
    - 10.1. Difference between temperature and heat
    - 10.2. Specific heat capacity
      - 10.2.1. Thermal expansion
      - 10.2.2. Heat of fusion
      - 10.2.3. Heat of vaporization
    - 10.3. Laws of Thermodynamics
      - 10.3.1. 1st Law–Conservation of Energy

- 10.3.2. 2nd Law–Law of Entropy
- 10.3.3. 3rd Law–Law of Absolute Zero

11. Electricity and Magnetism
    - 11.1. Coulomb's Law
        - 11.1.1. Test charge
        - 11.1.2. Electric field
        - 11.1.3. Electric potential
    - 11.2. Circuits
        - 11.2.1. AC and DC
        - 11.2.2. Ohm's Law
        - 11.2.3. Parallel and series
    - 11.3. Magnetism
        - 11.3.1. Current and magnetism
        - 11.3.2. Motors and generators

12. Vibrations and waves
    - 12.1. Waves
        - 12.1.1. Wavelength
        - 12.1.2. Amplitude
        - 12.1.3. Frequency
        - 12.1.4. Period
        - 12.1.5. Velocity
    - 12.2. Transverse and longitudinal waves

- 12.3. Interference
- 12.4. Doppler Effect

13. Physical optics
    - 13.1. Law of reflection
    - 13.2. Laws of refraction
    - 13.3. Total internal reflection
    - 13.4. Electromagnetic spectrum
14. 14 Introduction to Modern Physics
    - 14.1. Photoelectric effect
    - 14.2. Bohr's atomic model
    - 14.3. Radioactivity
        - 14.3.1. Half-life
        - 14.3.2. Radiometric dating
    - 14.4. Fission and fusion

Course Objectives

1. Apply scientific methods to analyze graphical data and predictions.
2. Use units and measurements to solve conversion problems.
3. Apply concepts of kinematics and dynamics to solve problems involving motion.
4. Apply Newton’s three laws to solve problems.
5. Use energy and momentum concepts to solve motion problems.
6. Apply Newton’s law of gravitation.
7. Apply pressure, density, buoyancy, and Pascal’s principle to solve problems.

8. Apply the concepts of density, pressure, temperature, and heat to different phases of matter.
9. Use the concepts of electric and magnetic fields to solve problems in electrostatics, electric current, and magnetism.
10. Apply properties of waves to sound and light.
11. Use the principles of modern physics to explain basic ideas of quantum mechanics.
12. Use the ITT Tech Virtual Library and other ITT Tech resources to research various topics as appropriate.

Learning Materials and References

Required Resources

Textbook Package	New to this Course	Carried over from Previous Course(s)	Required for Subsequent Course(s)
Hewitt, P. G. (2008). *Conceptual physics fundamentals*. Boston, MA: Pearson Addison-Wesley.	■		
Wright, B. (2010). *Physics lab manual.* (Custom 2nd ed.). Indianapolis, IN: Pearson Learning Solutions.	■		
PhET Interactive Simulations for Physics [CD]. (2012)	■		
Other Items	**New to this Course**	**Carried over from Previous Course(s)**	**Required for Subsequent Course(s)**
PhET: Interactive Simulations—University of Colorado at Boulder: • Faraday's Electromagnetic Lab http://phet.colorado.edu/en/simulation/faraday • Bending Light http://phet.colorado.edu/en/simulation/bending-light	■		
Recommended Equipment: Scientific calculator (Casio fx-115/MS) OR		■	

Web2.0calc: http://web2.0calc.com/ (last accessed 1/3/12) This Web page contains a free online scientific calculator.			

Technology Requirements

- Intel Pentium processor
- Microsoft Windows XP/Vista/7
- 256MB RAM minimum
- Approximately 267 MB available disk space (for full installation)
- 1024x768 screen resolution or better
- Sun Java 1.5.0_15 or later
- Adobe Flash Player 9 or later
- Microsoft Internet Explorer 6 or later, Firefox 2 or later

Recommended Resources

Books, Professional Journals

- Benenson, W., Harris, J. W., Stöcker, H., & Lutz, H. (2006). *Handbook of physics*. New York: Springer Publishing Co.

ITT Tech Virtual Library (accessed via Student Portal)

- Reference Resources
    - Access Science
    - Mathematics
- School of Study: General Education
    - Tutorial Links
        - Math Tutorials from Brightstorm
        - Physics Tutorials
        - Physics Videos from Brightstorm
        - The Physics Classroom
- Books 24x7
    - Kodicek, D. (2005). *Mathematics and physics for programmers*. Stamford, CT: Cengage Charles River Media.

Other References

- Physics Forums

  http://www.physicsforums.com/ (accessed 10/03/11)

  A discussion forum for questions and answers, guidance, and links to tutorials.

- Physics Today

http://www.physicstoday.org/ (accessed 10/03/11)

The Web site of *Physics Today* magazine, a publication of the American Institute of Physics, with news about related science, politics, and policy.

- Scientific American Magazine
  http://www.scientificamerican.com/sciammag/ (accessed 10/03/2011)

  Web site of the 150-year-old magazine covering science and technology issues.

- Free Online MIT Course Materials

  http://ocw.mit.edu/OcwWeb/Physics/index.htm (accessed 10/03/2011)

  Portal page for course materials, such as videos, lecture notes, assignments and solutions, images, and online textbooks for various physics courses taught at MIT. Related sites:

  - Professor Walter Lewin's Webpage at MIT
  - Lewin's MIT Physics 8.01 video: Classical Mechanics
  - Lewin's MIT Physics 8.02 video: Electricity and Magnetism
  - Lewin's MIT Physics 8.03 video: Vibrations and Waves

- Free online math videos

http://www.cosmolearning.com/courses/math-110-college-algebra-406/ (accessed 10/03/2011)

- Free online math and physics videos and practice

http://www.khanacademy.org/about (accessed 10/03/20100)

NOTE: All links are subject to change without prior notice.

Information Search

Use the following keywords to search for additional online resources that may be used for supporting your work on the course assignments:

- Scientific method

- Hypothesis
- Momentum
- Photoelectric effect
- Magnetic field
- Angular momentum
- Escape velocity
- Doppler effect
- Total internal reflection

Course Plan

Suggested Learning Approach

In this course, you will be studying individually and within a group of your peers. As you work on the course deliverables, you are encouraged to share ideas with your peers and instructor, work collaboratively on projects and team assignments, raise critical questions, and provide constructive feedback.

Use the following advice to receive maximum learning benefits from your participation in this course:

DO	DON'T
▪ Do take a proactive learning approach. ▪ Do share your thoughts on critical issues and potential problem solutions. ▪ Do plan your course work in advance. ▪ Do explore a variety of learning resources in addition to the textbook. ▪ Do offer relevant examples from your experience. ▪ Do make an effort to understand different points of view. ▪ Do connect concepts explored in this course to real-life professional	▪ Don't assume there is only one correct answer to a question. ▪ Don't be afraid to share your perspective on the issues analyzed in the course. ▪ Don't be negative about the points of view that are different from yours. ▪ Don't underestimate the impact of collaboration on your learning. ▪ Don't limit your course experience to reading the textbook. ▪ Don't postpone your work on the course deliverables – work on small assignment

situations and your own experiences.	components every day.

Course Outline

Unit 1: THE SCIENTIFIC METHOD AND 1-D MOTION

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Identify the steps in the scientific method.
- Distinguish among observations, facts, hypotheses, laws, and principles.
- Use the scientific method to predict the outcome of an experiment.
- Distinguish between systems of units.
- Identify the Système International (SI).
- Specify the references for the three main base units of the SI system.
- Use common metric prefixes and nonstandard metric units.
- Use conversion-factor relationships to convert units within a system or from one system of units to another.
- Identify graphs of directly proportional, inversely proportional, power, and inverse square relationships.
- Apply concepts of kinematics and dynamics to solve problems involving linear motion.
- Distinguish between vector and scalar quantities.
- Define displacement, distance, speed, velocity, and acceleration.
- Describe linear and rotational motion.
- Distinguish between instantaneous and average velocity.
- Calculate acceleration.
- Describe the motion of an object in free fall.
- Use the kinematic equations to solve problems involving motion.
- Use graphs to describe distance and speed as time changes.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)

▪ Hewitt, Chapter 1, pp. 1-7 ▪ Hewitt, Appendix A ▪ Hewitt, Chapter 3	Problem Set	Unit 1 Problem Set 1: Using the Scientific Method	1.5%
	Assignment	Unit 1 Assignment 1: The Scientific Method and Newton's Laws	2%
	Lab	Unit 1 Lab 1: Kinematics in One Dimension	3%

Unit 2: NEWTON'S LAWS

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Describe force as it applies to linear motion.
- Explain what is meant by a net or unbalanced force.
- Explain Newton's first law of motion.
- Explain Newton's second law of motion.
- Apply Newton's second law of motion to physical situations.
- Distinguish between weight and mass.
- Explain Newton's third law of motion.
- Identify action-reaction force pairs.
- Use Newton's second law to determine forces acting on an object and the acceleration produced by a net force.
- Use free-body diagrams to represent forces acting on an object.
- Explain the concept of translational and rotational equilibrium.
- Define torque as it applies to rotation.
- Explain what is meant by a net or unbalanced torque.
- Describe rotational inertia and its relationship to mass.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded

			work)
▪ Hewitt, Chapter 4 ▪ Hewitt, Appendix B (pp. 379-381) ▪ Hewitt, Appendix C	Problem Set	Unit 2 Problem Set 1: Third Law Scooter	1.5%
	Assignment	Unit 2 Assignment 1: Newton's Laws (PORTFOLIO)	2%
	Lab	Unit 2 Lab 1: Forces in One Dimension	3%

Unit 3: MOMENTUM AND ENERGY

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Define mechanical work.
- Describe the concept of work as it applies to motion.
- Define kinetic energy.
- Use the work-energy theorem to solve problems.
- Describe gravitational potential energy and the elastic potential energy of a spring.
- Calculate linear momentum and the components of momentum.
- Describe how impulse affects changes in momentum.
- Define conservation of linear momentum.
- Define angular momentum for rotating objects.
- Define conservation of angular momentum.
- Describe how energy affects changes in motion.
- Apply the condition for the conservation of energy to physical situations.

READING ASSIGNMENT	**GRADED ACTIVITIES / DELIVERABLES**		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)

▪ Hewitt, Chapter 5 ▪ Hewitt, Appendix B	Problem Set	Unit 3 Problem Set 1: Accident Reconstruction	1.5%
	Assignment	Unit 3 Assignment 1: Momentum and Energy	2%
	Lab	Unit 3 Lab 1: Energy	3%

Unit 4: GRAVITATION, SATELLITES, AND PROJECTILE MOTION

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Describe the motion of an object in two dimensions.
- Explain Newton's law of gravitation.
- Define the universal gravitational constant.
- Describe the significance of the inverse-square law.
- Describe how Newton's law of gravitation applies to orbital motion.
- Use two-dimensional motion to calculate the range, maximum height, and time of flight for a projectile.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
▪ Hewitt, Chapter 6	Exam	Unit 4 Exam 1 (Units 1,2, 3)	7%
	Problem Set	Unit 4 Problem Set 1: Real-World Projectiles	1.5%
	Assignment	Unit 4 Assignment 1: Gravitation, Satellites, and Projectile Motion	2%
	Lab	Unit 4 Lab 1: Two-Dimensional Motion	3%

Unit 5: FLUID MECHANICS

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Explain the pressure-depth relationship.
- Define Pascal's principle.

- Describe how to use Pascal's principle in practical applications.
- Describe Archimedes' principle.
- Determine if an object will float in a fluid based on its relative densities.
- Use the continuity equation and Bernoulli's equation to explain common effects of ideal fluid flow.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Hewitt, Chapter 7	Problem Sets	Unit 5 Problem Set 1: The Ideas Behind the Lift	1.5%
	Assignments	Unit 5 Assignment 1: Fluid Mechanics	2%
	Labs	Unit 5 Lab 1: Gas Properties	3%

Unit 6: TEMPERATURE AND HEAT

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Distinguish between temperature and heat.
- Describe temperature in terms of the kinetic energy of atoms.
- Distinguish between internal energy and heat.
- Define the laws of thermodynamics.
- Define specific heat.
- Calculate the thermal expansions of solids and liquids.
- Describe how water's high specific-heat capacity affects climate.
- Give examples and applications of thermal expansion of solids.
- Define modes of heat transfer.
- Identify the different phases of matter.
- Calculate the effect of adding or subtracting heat to matter leading to phase transitions.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Hewitt, Chapter 2, Sections 2.1-2.2, pp. 13-15 • Hewitt, Chapter 8 • Hewitt, Chapter 9, Sections 9.1-9.3 and 9.6-9.9, pp. 175-184, 186-192	Problem Sets	Unit 6 Problem Set 1: Engineering and Thermal Expansion	1.5%
	Assignments	Unit 6 Assignment 1: Temperature and Heat	2%
	Labs	Unit 6 Lab 1: Temperature and Heat	3%

Unit 7: STATIC AND CURRENT ELECTRICITY

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Describe the concept of electric charges.
- Identify Coulomb's Law.
- Use the concept of electric force to solve problems with static charges.
- Describe relationships among the concepts of electrostatic forces, electric fields, and electric potentials.
- Describe the difference between AC and DC current.
- Identify Ohm's Law.
- Use Ohm's Law to find voltages and currents in DC circuits.
- Apply Ohm's Law to simple series and parallel circuits.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Hewitt, Chapter 10	Exams	Unit 7 Exam 2 (Units 4, 5 and 6)	7%
	Problem Sets	Unit 7 Problem Set 1: Designing Circuits	1.5%
	Assignments	Unit 7 Assignment 1: Static and Current Electricity	2%
	Labs	Unit 7 Lab 1: Electricity	3%

Unit 8: MAGNETISM

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Identify the nature of magnetic forces.
- Describe the magnetic force on a moving charge.
- Describe the relationship between electric currents and magnetic fields.
- Describe how electric generators, transformers, and motors work.
- Describe Faraday's law for electromagnetic induction.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
▪ Hewitt, Chapter 11	Problem Set	Unit 8 Problem Set 1: Motors and Generators	1.5%
	Assignment	Unit 8 Assignment 1: Magnetism	2%
	Lab	Unit 8 Lab 1: Electromagnetism	3%

Unit 9: WAVES

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Apply properties of waves to sound and light.
- Differentiate between vibrations and waves.
- Define the properties of waves.
- Calculate the velocity, amplitude, wavelength, and frequency of a wave.
- Differentiate between transverse and longitudinal waves.
- Describe forced vibrations and resonance.
- Explain the sound frequency spectrum.
- Describe how the speed of sound differs in different media.
- Apply constructive and destructive interference properties to sound waves.
- Describe the Doppler effect of sound waves.

- Define the electromagnetic spectrum.
- Explain the law of reflection as it applies to light.
- Explain refraction in terms of the index of refraction of transparent media.
- Describe total internal reflection.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
▪ Hewitt, Chapter 12, pp. 246-251, 256-260	Problem Set	Unit 9 Problem Set 1: Doppler Helps	1.5%
▪ Hewitt, Chapter 13, pp. 271-272	Assignment	Unit 9 Assignment 1: Waves	2%
▪ Hewitt, Chapter 14, pp. 294-299, 302- 303, 310-312	Lab	Unit 9 Lab 1: Waves	3%

Unit 10: INTRODUCTION TO MODERN PHYSICS

Out-of-class work:

9 hours

Upon completion of this unit, students are expected to:

- Apply quantum theory to the photoelectric effect.
- Identify how Bohr's atomic model uses quantum ideas.
- Explain emission and absorption spectra in terms of quantum theory.
- Define radioactivity.
- Explain radioactive half-life.
- Define radiometric dating.
- Distinguish between nuclear fusion and fission.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)

▪ Hewitt, Chapter 15 ▪ Hewitt, Chapter 16	Exam	Unit 10 Exam 3 (Units 7, 8, and 9)	7%
	Problem Set	Unit 10 Problem Set 1: Useful Radiation	1.5%
	Assignment	Unit 10 Assignment 1: Quantum Pioneers	2%
	Lab	Unit 10 Lab 1: Quantum Theory	3%

Unit 11: COURSE REVIEW AND FINAL EXAM

Out-of-class work:

9 hours

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
▪ None	Exam	Final Exam	14%

Note: Your instructor may add a few learning activities that will change the grade allocation for each assignment in a category. The overall category percentages will not change.

Evaluation and Grading

Evaluation Criteria

The graded assignments will be evaluated using the following weighted categories:

Category	Weight
Assignment	20%
Problem Set	15%
Lab	30%
Exam	35%
TOTAL	**100%**

Grade Conversion

The final grades will be calculated from the percentages earned in the course, as follows:

Grade	Percentage	Credit
A	90–100%	4.0
B+	85–89%	3.5
B	80–84%	3.0
C+	75–79%	2.5
C	70–74%	2.0
D+	65–69%	1.5
D	60–64%	1.0
F	<60%	0.0

Academic Integrity

All students must comply with the policies that regulate all forms of academic dishonesty, or academic misconduct, including plagiarism, self-plagiarism, fabrication, deception, cheating, and sabotage. For more information on the academic honesty policies, refer to the Student Handbook and the Course Catalog.

(End of Syllabus)

