ENPH/PHYS 436 Solid State Physics

Department: Mathematics, Physics and Engineering
Credit Hours: 3

Current Catalog Description:
The basic ideas of physics are applied to the understanding of the properties of crystalline materials to include the definition of such materials, electrical and thermal conductivity, heat capacity, crystalline binding, the nature of metals, insulators, and semiconductors, dielectric properties, and magnetic properties. Credit for both ENPH 436 and PHYS 436 will not be awarded.

Course Schedule:
3 lecture hr/ wk, 0 lab hr/week

Coordinator:
Dr. Denise Martinez

Prerequisites by Topic:
Phys 334 – Modern Physics I
Math 306 – Differential Equations (corequisite)

Program Outcome and Course Learning Goals Map:
The Program Outcomes for Engineering Physics are:

A. an ability to apply knowledge of math, engineering & science
B. an ability to design and conduct experiments, as well as to analyze and interpret data
C. an ability to design system, component or process to meet needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
D. an ability to function on multi-disciplinary teams
E. an ability to identify, formulate, and solve engineering problems
F. an understanding of professional and ethical responsibility
G. an ability to communicate effectively
H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
I. a recognition of need for, and ability to engage in life-long learning
J. a knowledge of contemporary issues
K. an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
L. a depth and breadth of knowledge in engineering and physics necessary to work in a multidisciplinary environment

Course Learning Goals:
Upon completion of this course with a C or better, students will:

1. be able to identify the 14 fundamental 3D crystal structures and determine Miller indices for crystal planes.
2. be able to describe the wave-particle duality of the electron
3. understand the Hall effect and be able to determine the Hall coefficient mathematically and experimentally in the presence of both holes and electrons as charge carriers.
4. be able to use and solve Maxwell's equations
5. be able to solve the 1D Schrödinger's equation for potential barrier, narrow barrier, and potential well problems.
6. distinguish between conductors, semiconductors, and insulators based on band structure,
7. use the Fermi Distribution to calculate density of occupied states and Fermi level of a metal and semiconductor
8. distinguish between intrinsic and extrinsic semiconductors

9. be able to describe at an electron level the behavior of a pn junction
10. be able to describe the behavior of diodes, transistors and tunneling.
11. be able to describe the electron behavior in a dielectric material.
12. gain familiarity with state of the art applications of solid state physics.

Topics Covered:

Topic	**Course Goals**	**Program Outcomes**	**# Lec/Lab (approx.)**
Crystal structures and terminology	1	a	2
Quantum/modern review	2,3,4,5	a,b,d,e,g	4
Electron as a wave and particle, Hall effect and coefficient, Maxwell's equations, Schrödinger's equation, quantum numbers, Pauli's Exclusion Principle, Heisenberg Uncertainty Principle.			
Band Theory	4,5,6,7	a,e,k	10
Free electron theory, Fermi-Dirac Distribution, Kronig-Penney model, band theory, effective mass, density of states			
Semiconductors	5,6,8,9	a,e,k	8
Intrinsic/extrinsic, Fermi level and electron statistics			
Semiconductor Devices	5,9,10	a,e,h,k	2
Dielectric and magnetic properties	4,5,11	a,e,k	4
Superconductivity	12	a,i,j	*
Crystalline Defects	12	a,i,j	*
Exams		a,e	*
Projects		a,b,d,e,g,j,k	*

*outside class

Academic Honesty:

Cheating, plagiarism (submitting another person's materials or ideas as one's own), or doing work for another person who will receive academic credit are all-impermissible. This includes the use of unauthorized books, notebooks, or other sources in order to secure of give help during an examination, the unauthorized copying of examinations, assignments, reports, or term papers, or the presentation of unacknowledged material as if it were the student's own work. Disciplinary action may be taken beyond the academic discipline administered by the faculty member who teaches the course in which the cheating took place.

Students with Disabilities Policy:

It is the policy of Tarleton State University to comply with the Americans with Disabilities Act (ADA) and other federal, state, and local laws relative to the provision of disability services. Students with disabilities attending Tarleton State University may contact the Office of Disability Services at (254) 968-9478 to request appropriate accommodation. Furthermore, formal accommodation requests cannot be made until the student has been officially admitted to Tarleton State University.

Contribution of Course to Meeting the Professional Requirement:
Engineering Topics: 100%

Status of Continuous Improvement Review of this Course:
Prepared by: *Denise Martinez*
Date: *04/21/04*

Reviewed by: *Michael Hibbs*
Date: *05/24/05*
Review Notes: Topics covered for materials engineering seem appropriate

Reviewed by: *Denise Martinez*
Date: *03/15/09*
Review Notes: updated pre-/co-requisites to include DE.