MSE 3015: Electronic, Optical and Magnetic Properties of Materials

Credit hours and contact hours: 3-0-0-3

Instructor: Eric Vogel

Textbook: S. O. Kasap, *Principles of Electrical Engineering Materials and Devices*, 3rd Edition, McGraw-Hill, 2006.

Specific course information

Catalog description: Introduction to quantum mechanics and the band theory of solids to describe semiconducting, superconducting, dielectric, optical, and magnetic properties of nano- and micro-structured materials.

Prerequisites: MSE 2001 – Principles & Applications – Engineering Materials

Course: Required

Specific goals for the course

Outcomes of instruction:

1. Demonstrate understanding of the behavior or electrons and nuclei in solids by answering questions and solving relevant problems.
2. Demonstrate understanding of the electrical properties of materials and applications of these properties in fabrication of modern electronic devices. Students will be able to design basic electronic devices and predict electronic properties of the samples.
3. Demonstrate understanding of the optical properties of materials and applications of these properties in fabrication of modern optical and electro-optical devices.
4. Demonstrate an understanding of the magnetic properties of materials and their applications.

Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

(3) An ability to communicate effectively with a range of audiences.

(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Topics covered:

1. Classical Physics: Electrical Conductivity of Metals
2. Classical Physics: Thermal Conductivity of Solids
3. Classical Physics: Motion of Electron in a Magnet Field / Hall Effect
4. Quantum Mechanics: Quantum Effects and Wave-Particle Duality
5. Quantum Mechanics: Schrödinger Equations and their Applications
6. Classical and Quantum description of a Hydrogen Atom
7. Quantum Mechanics: Absorption and Emission of Radiation and Optical Devices
8. Classical and Quantum Description: Bonding in Molecules and Solids
9. Quantum Mechanics: Band Theory, Electron Transport and Emission in Solids
10. Semiconductor Devices
11. Magnetic Properties of Atoms and Solids
12. Superconductivity
13. Classical and Quantum Description: Dielectric Properties of Insulators
14. Classical and Quantum Description: Optical Properties of Materials

Correlation between Outcomes of Instruction and Student Outcomes:

Outcomes of Instruction	**Student Outcomes**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1. Demonstrate understanding of the behavior or electrons and nuclei in solids by answering questions and solving relevant problems.	X	X	X	X			
2. Demonstrate understanding of the electrical properties of materials and applications of these properties in fabrication of modern electronic devices. Students will be able to design basic electronic devices and predict electronic properties of the samples.	X	X	X		X		
3. Demonstrate understanding of the optical properties of materials and applications of these properties in fabrication of modern optical and electro-optical devices.	X	X	X	X			
4. Demonstrate an understanding of the magnetic properties of materials and their applications.	X	X	X	X			

School of Materials Science and Engineering Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.