

## **MSE 1058: Electromagnetic Properties of Materials**

*(Modifications to this syllabus may be required during the semester. Any changes to the syllabus will be posted on the course website and announced in class)*

### **Instructor: Yijing Yin Ph.D**

Materials Science and Engineering (MSE) Faculty

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**Office Hours:** Tuesday & Thursday, 12:30 pm-1:30pm

### **Lecture Times: Class of 2016**

MSE1058 Electron. Properties of Materials			3 credits
Sec	Time	Location	Instructor
MSE	T 13:50 - 16:25 pm	4 - 204	Yijing Yin

**Catalog Description:** 3 Credits; Review of basic principles – quantum theory, band and zone theory. Transport, electrical and thermal properties; semiconductors and semiconductor devices; superconductivity; magnetic materials – hard and soft; dielectric and optical properties.

**Prerequisite and Co-requisite:** ENGR 0022 “Materials Structure & Properties”.

### **Course Objectives:**

- ❖ Understand the physical origins of electronic, magnetic, and optical properties of materials.
- ❖ Predict how and why these properties vary between different types of materials.
- ❖ Choose appropriate materials for devices based on these properties.
- ❖ Describe common processing methods for making electronic/optical/magnetic devices.

### **Required Textbook:**

“Electronic Properties of Materials”, Hummel, Rolf E., 4th ed. (2011)  
ISBN: 978-1-4419-8164-6

**Course learning outcomes/expected performance criteria:**

- ❖ Electronic Band Diagram and Population Density of Electrons (70%)
- ❖ Impurity Doping and Depletion Layer of P-N Junctions (70%)
- ❖ Transistor and Solar Cells (70%)
- ❖ Charge Storage in Capacitors (70%)
- ❖ Light Absorption and Color (70%)
- ❖ Optically and Electrically Induced Luminescence (70%)
- ❖ Magnetic Devices (70%)

**Course topics and lecture hours devoted to each topic:**

- ❖ Introduction and electrical conduction in metals and alloys (4 hours)
- ❖ Quantum mechanical explanation of electrons – wave/particle duality, band theory, Brillouin zone (4 hours)
- ❖ Electrons in crystals – Fermi energy level, density of states, band diagram, effective mass (6 hours)
- ❖ Electrical conduction and measurement (4 hours)
- ❖ Group IV and III-V Semiconductors – band gap, impurity doping, p-n junction, devices, processing (12 hours)
- ❖ Electrical properties of polymers and metal oxides – conducting polymer, defects, dielectrics, ferroelectrics (6 hours)
- ❖ Optical properties of materials – optical constant, reflectance/absorption, Drude model, application (6 hours)
- ❖ Magnetic materials and superconductors (6 hours)

**Contribution of course to meeting the requirements of criterion 5:**

Engineering Science:	1.5 Credits
Engineering Design:	0.5 Credit
College Level Mathematics:	0 Credits
Basic Science:	0.75 Credits
Realistic Constraints:	Economic, Environmental, Social, Political, Health, Safety Factors, Manufacturability, & Sustainability 0.25 Credits
Engineering Standards:	TEMA, API, & ASME

**Course Grading:**

❖ Attendance & Homework	30%
❖ 2 In-Class Quiz	20%
❖ Midterm Exam	20%
❖ Final Exam	30%

**Materials Science Program outcomes addressed:**

- ❖ Physics on classical and quantum mechanical explanation of electrons and math are applied in the solution of homework problems and class examples.
- ❖ Theories on electrical conduction, semiconductors, optics, and magnetism are applied to the analysis and design of electrical/optical/magnetic devices. Examples in the class show criteria on the selection of materials and fabrication process within constraints of manufacturability and sustainability.
- ❖ Examples in the class show criteria on the selection of materials and fabrication process within constraints of manufacturability and sustainability.
- ❖ Some homework and class examples on devices require the ability to choose proper materials systems under realistic constraints as economic and safety factors.
- ❖ Examples in the class and home works enable students to understand the state-of-the-art devices in microelectronics and renewable energy generation/storage.

**Grading Scale:**  $A \geq 90$ ,  $90 > B \geq 80$ ,  $80 > C \geq 70$ , etc. (The grading scale might change according to the degree of difficulty) An additional curve may be applied, as determined by the overall final grade distribution of the class. Grades of A-, B+, B-, etc. will be determined at the instructor's discretion.

**Class Policies:** Regular class attendance is expected and encouraged. Each student is responsible for all of the material presented in class and in the reading assignments. Exams will emphasize treatment of material covered in lectures. In general, no late assignments will be accepted or makeup exams given. Exceptions will be made for a valid excuse consistent with University Policy. If you cannot attend an exam or meet a due date, you must contact the instructor prior to the exam or due date. Arrangements will be made for students on a case by case basis. (Failure to contact the instructor prior to the exam or assignment due date will result in a zero on that exam/assignment.)

**Academic Integrity Policy:** “Violations of academic integrity include, but are not limited to, cheating, plagiarism, or misrepresentation in oral or written form. Such violations will be dealt with severely, in accordance with University policy. Plagiarism means representing someone else’s idea or writing as if it were your own. If you use someone else’s ideas or writing, be sure the source is clearly designated.” It is expected that students adhere to the academic integrity policy that is presented in the Student’s Honor Code of Conduct / Student Handbook.

**Disability Services:** Any personal learning accommodation that may be needed by the student to be successful in this course must be told to the instructor immediately in order to assure compliance and accommodation. Audio or video recording (or any other form of recording) of classes is not permitted unless expressly allowed by the instructor as a special accommodation for students who are currently registered with the Disability Resource Services Program and are approved for this accommodation. Recordings allowed as special accommodations are for the personal use of the DRS-approved student, and may only be distributed to other persons who have been approved by the DRS program. The instructor may require the student to sign an Audio/Video Recording Agreement, which they may keep for their records.