

## COURSE SYLLABUS

### ELECTRONIC AND PHOTONIC MATERIALS

A MAT 535 is a three-hour credit, one semester course, which introduces graduate students to the material science of electronic materials. The internal structure, chemistry and physics of semiconductors, magnetic and photonic materials are related to their electronic and optical properties, and their applications. The course also includes: how electronic materials and devices are produced and how to control processing to achieve desired materials performance.

**OBJECTIVES:**

1. Coherently explain in writing topics and concepts covered in the course.
2. Properly interpret, sketch diagrams for, and solve a variety of reasonable problems.

**PREREQUISITES:**

1. General Physics
2. General Chemistry
3. MATS 530, Materials Science

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Office hours: M., T., W., Th. 4:30-5:30

**TEXT:**

**Basic:** M. Sze, *Semiconductor Devices, Physics and Technology*, 2d Edition, S. John Wiley & Son, 2002  
**Advanced:** H. B. Gray, *Electrons and Chemical Bonding*, W. A. Benjamin Inc. NY, Amsterdam, 1965.  
C. Kittel, *Introduction to Solid State Physics*, John Willey, NY, 1986.

**GRADING:**

Homework	30%
Midterm	30%
Final Exam	40%

**FINAL EXAM:** Wednesday, May 3, 3:30-5:30 P.M.

#### COURSE CONTENT

1. The Basic Structure of Electronic Materials
  - Atomic bindings in solids
  - Crystal structures
  - Defects and diffusion in solids

- Materials Characterization Tools
2. Electrical Properties of Solids
    - Electrons in Solids
    - Electronic Band Structure
    - Conductors
    - Semiconductors
    - Insulators
  3. Optical Properties and Applications
    - Light and Solid Interactions
    - The Light Absorption
    - The Light Emission
    - Optoelectronics Devices: Imagers, Displays, Solid State Lasers, Signal-Transmission Media

#### MIDTERM

4. p-n Junctions and Related Devices
  - Concept of p-n Junction
  - Schottky Junction and Its Electronic Properties
  - Metal-Semiconductor Contact
  - MIS Junction and Field-Effect Properties
  - Structures and Operations of Transistors
5. Processing Techniques
  - Bulk Crystal Growth and Epitaxy
  - Thin-Film Deposition
  - Impurity Doping
6. Magnetic Properties and Applications
  - Magnetic Properties and Sources of Magnetization
  - Magnetic Devices and Applications

#### FINAL TEST

#### HOMEWORK:

You are expected to complete all homework assignments. Study groups are encouraged; however, plagiarism of homework is unacceptable. In order to receive full credit for homework assignments, the following criteria must be met, in addition to obtain the correct answer:

1. Each problem solution must include a sketch of the situation when possible.
2. Problem solutions must be presented coherently. Include written statements to explain your approach to the problem and your reason for selecting the equations you use.

## Advanced reading:

### Semiconductors:

- W. Sze, *Semiconductor Devices: Physics and Technology*, 2d Edition, John Wiley & Son, 2002.
- H. L. Kwok, *Electronic Materials*, PWS, 1997
- R. H. Bube, *Electrons in Solids*, 3d Edition, Academic Press, San Diego, 1992.
- E. G. Bylander, *Materials for Semiconductor Functions*, Hyden Book Company, New York, 1971.
- C. Grovenor, *Microelectronic Materials*, A. Hilger, 1989.
- R. E. Hummel, *Electronic Properties of Materials*, 2d Edition, Springer-Verlag, Berlin, Heidelberg, New York, 1992.
- S. P. Murarka, *Electronic Materials: Science and Technology*, Academic Press, 1989.
- L. A. A. Warnes, *Electronic Materials*, Van Nostrand Reinhold, New York, 1990.

### Optical Materials:

- J. H. Simmons and K. S. Potter, *Optical Materials*, Academic Press, 2000.
- M. Fox, *Optical Properties of Solids*, Oxford University Press, 2001.
- A. A. Kaminskii, *Crystalline Lasers: Physical Processes and Operating Schemes*, CRC Press, 1996.
- W. D. Kingery, H. K. Bowen, and D. R. Uhlman, *Introduction to Ceramics*, 2d Edition, John Wiley & Sons, New York, 1976, Chapter 13.

### Magnetic Materials:

- S. Blundell, *Magnetism in Condensed Matter*, Oxford University Press, 2001.
- D. J. Clark, *Structure and Properties of Magnetic Materials*, Pion, 1971.
- Y. Ishikawa and N. Miura, *Physics and Engineering Applications of Magnetisms*, Springer-Verlag, Berlin, Heidelberg, New York, 1991.