University of Wisconsin - Madison College of Engineering [EGR] Last Offered: 2012 Spring [1124] Direct Link to this Syllabus:

http://aefis.engr.wisc.edu/index.cfm/page/CourseAdmin.ViewABET?coursecatalogid=514&pdf=True

- 1. E C E 466, Electronics of Solids
- 2. Credits: 3.00 Contact Hours: 5.5
- 3. **Textbook and Materials :** "Introduction to Nanoelectronics", by V.V. Mitin, V.A. Kochelap, and M.A. Stroscio, Cambridge University Press (2008), ISBN 978-0-521-88172-2.
 - a. Other Supplemental Materials: None

4. Specific Course Information:

- a. Brief description of the content of the course (Course Catalog Description): Electronic, optical and thermal properties of crystalline solids. Energy-momentum dispersion of fundamental particles and excitations in solids leading to microscopic theories of conductivity, polarizability and permeability. Influence of materials characteristics on the performance of electronic and photonic devices.
- b. Pre-requisites or Co-requisites: ECE 335, 305, or cons inst
- c. This is a Selected Elective course.

5. Specific Goals for the Course:

- a. Course Outcomes:
 - 1. The course is intended to provide a broad perspective of the role that nanoelectronics and solid state physics plays for Engineering and to serve as the engineering foundation for subsequent, more advanced courses.
 - 2. Applications starting from electrical (nano-electronics), over to magnetic (spintronics), and nanomechanical engineering perspectives will be discussed in both descriptive and quantitative terms.
 - 3. The overall goals of this course are to instill physical intuition regarding nanoelectronic systems and to allow students to develop an appreciation for how engineering and mathematics can be applied to the analysis and constructive manipulation of these.

b. ABET Student Learning Outcomes:

- (a) Ability to apply mathematics, science and engineering principles.
- (b) Ability to design and conduct experiments, analyze and interpret data.
- (e) Ability to identify, formulate and solve engineering problems.
- (g) Ability to communicate effectively.
- (i) Recognition of the need for and an ability to engage in life-long learning.
- (j) Knowledge of contemporary issues.
- (k) Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

6. Brief List of Topics to be Covered:

- 1. Wave-particle duality, Schrodinger equation, free electrons
- 2. Particle-in-a-box
- 3. Electrons in periodic potentials
- 4. Real and reciprocal lattices, Brillouin zones and Wigner-Seitz cells
- 5. Electron energy levels in real materials
- 6. Review of electricity and electrical measurements, Drude model

- 7. Consequences of the Drude model, electrical properties of metals
- 8. Large scale optical properties
- 9. Electrons in a magnetic field
- 10. Semiconductors: Band structure and doping I
- 11. Heterostructures
- 12. Density of states, effective mass
- 13. Fermi distribution, Fermi surfaces
- 14. Electrical properties of metals revisited
- 15. Band structures of real metals and metallic glasses
- 16. Band structure and doping II
- 17. Hall effect, conduction by holes in semiconductors and metal
- 18. PN junctions, Schottky diodes
- 19. BJTs and FETs
- 20. Optical absorption, spectra of metals and semiconductors
- 21. Organic "metals" and semiconductor
- 22. Magnetism: electron spin, para- and diamagnetism in solid
- 23. Superconductors