**EE 506 Semiconductor Physics**

30530R
9:30-10:50am Tu –Th
VHE206

Semiconductor devices in the form of Si integrated circuits have revolutionized our life by facilitating communications, computation and control of most aspects our daily living. The emergence of new semiconductor materials and devices are now enabling another revolution in energy, visual display, personal wireless communications and a myriad of other technologies. This course provides a unified understanding of the physical origins of semiconducting materials properties and device characteristics that enable these new applications. This is done by exploring the relationship between atomic properties and bonding in semiconductors, the crystalline structure and the energy band structure of materials more diverse than Si and the thermal, electronic transport and optical properties that are characteristic of these materials. Finally, we will discuss interfaces between materials and the properties of heterojunctions made from them. Heterojunctions will lead us to discuss artificially structured materials and quantum structures. This journey will take us from atoms to crystals and back to artificial atoms. During this time we will constantly expand our understanding of the influence of the atoms that make up a semiconductor on the resulting crystals and develop a methodology for designing new device concepts.

**Prereqisite:** MS/EE 501 Solid State Physics; EE 539 Quantum Mechanics

**Instructor:** P. Daniel Dapkus

**Text Book:** *Electronic and Optoelectronic Properties of Semiconductor Structures*, Jasprit Singh. Cambridge University Press ISBN-10: 0521035740 | ISBN-13: 978-0521035743; Kindle Version Available

**Grading:**

| | |
|---|---|
| Homework | 20% |
| Midterm Exam | 30% |
| Final Exam | 30% |
| Term Paper | 20% |

Outline:

| Week | Topic |
|---|---|
| 1 | Atomic Structure, Bonding and Crystalline structure |
| 2 | Crystalline Structures and Symmetry |
| 3 | Covalent Bonding and Energy Bands |
| 4 | Energy Bands in Semiconductors |
| 5 | Tight Binding Approximation |
| 6 | k•P Formalism for band structure calculations |
| 7 | Band structure of alloys and the effect of strain and polarization |
| 8 | Intrinsic and extrinsic carrier densities; Midterm |
| 9 | Boltzmann transport equation; Impurity scattering |
| 10 | Phonon dispersion and phonon scattering |
| 11 | High field transport |
| 12 | Optical Properties- interband transitions in 2- and 3-D materials |
| 13 | Excitonic states and optical properties |
| 14 | Heterojunctions and artificial materials |
| 15 | Mesoscopic systems; nanostructures |
| 16 | Optional Material |