PYL 102: Principles of Electronic Materials

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Schedule: Mon, Wed (11-11.50 AM); Thurs(12:00 – 12:50 PM)
Room #: LH 325
Office: VI-415B
Phone #: x 1382
Office Hours: By appointment only

: +91 95827 33597 (For Immediate/Urgent Correspondence)

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Course Objectives

To present the principles of behaviour of electrons in metals, semiconductors, dielectric and magnetic materials and thus develop understanding of the basis properties of electronic materials. The course lays foundation for advanced courses in engineering aspects of materials and their applications.

Concepts of Brillouin Zone, Concept of effective mass and hole, Density of states in metal and semiconductor in 3D to 1D, The Fermi–Dirac Probability, Semiconductors in Equilibrium, Charge Carriers in Semiconductors, The Intrinsic Carrier Concentration, The Intrinsic Fermi-Level Position, The Extrinsic Semiconductor, Degenerate and Nondegenerate Semiconductors Equilibrium Distribution of Electrons & Holes., M-S junction, p-n junction, direct and indirect band gap semiconductors.

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Structure of Solids like Copper, Silicon, Diamond and Graphene in real & Reciprocal space, Interaction of Xray and neutron with solids for determination of crystal and magnetic structures. Classical and quantum free electron theory, Drude Model, DC and AC conductivity of metal, Hall effect, Fermi Sphere and their temperature correlation. Energy bands (Bloch & K-P), Finding distinction of electronic materials: Basics of Magnetism, types of interactions, Ordering temperature, Magnetic domains, Anisotropies etc.

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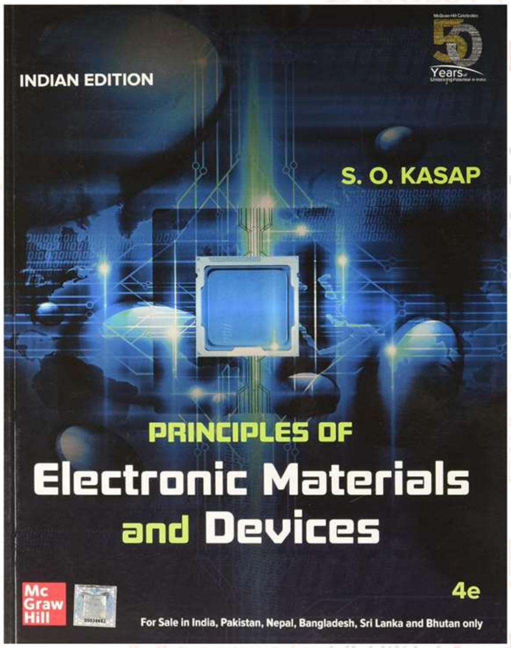
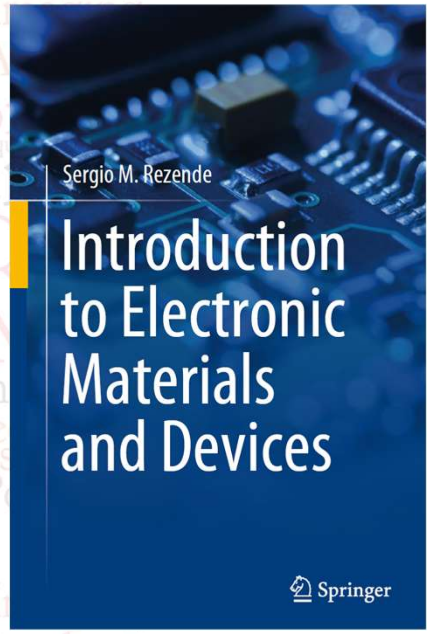
Course References





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Attendance & Grading Policy

Quiz/Assignment: 20 marks
MS Exams: 30 marks

Examinations – CLOSED BOOK with 1 A4 Formula Sheet

Syllabus – All topics covered till Mid-Semester exams

Assignments: 20 marks
ES Exams: 30 marks

Examinations – Will be announced by the Instructor

Syllabus – All topics covered from Mid-Sem exams – End Sem Exams

- **NO** electronic devices are allowed during the lecture (EXCEPT When Directed)
- To Obtain Pass grade, you must score at least 30% marks overall **AND** you have to obtain at least 25% marks in each individual component.
- **No** Re-Quiz or Re-Exam will be given.
- Re-Major will only be given if the attendance is >75%, have submitted all assignments, have taken all examinations and 25% marks in each individual component has been obtained.
- Institute Attendance policy will be followed (for each session individually): if your attendance is < 75%, you will get one grade less, < 60%, you will get 2 grades less. (ONLY PAPER BASED ATTENDANCE IN CLASS WILL BE CONSIDERED)

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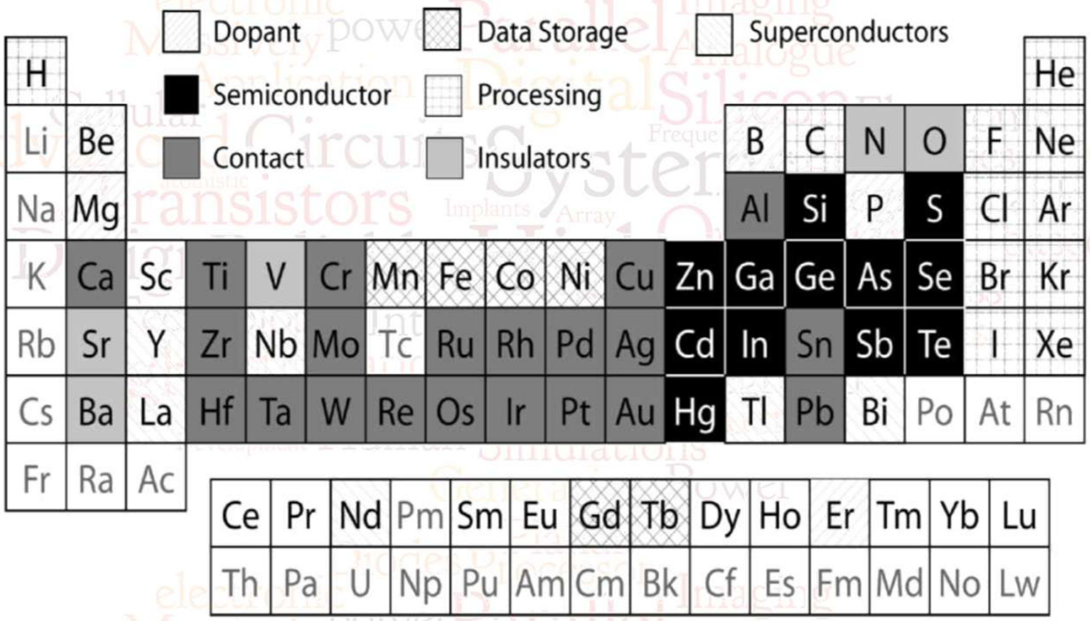
Periodic Table in Microelectronics



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Purity & Performance

The fundamental property that most clearly links electronic materials is purity. In many cases extreme measures are taken to prevent contamination.

Example: One trillion Si atoms fill a cube ~ 3 μm on a side. No more than 1 Fe atom can be allowed in such a volume of typical Si. This is more than 1000 times the purity requirement of other applications.

Performance can have many aspects including electronic properties of the material such as conductivity, free carrier mobility, etc., and physical and chemical properties such as mechanical strength, stability against diffusional mixing or reaction with adjacent materials, and many more.

Example: (a) Metal Contacts: It has taken years to switch from Al to Cu as the metal connecting devices in integrated circuits. Copper diffuses rapidly and causes very large problems if it gets into the active device regions.

(b) Semiconductors: Electrons can be more easily accelerated in GaAs than in Si and live a shorter time. Both of these contribute to faster device speeds. However, GaAs is frail and also, there is lack of a good insulator and good contacts. These problems have never been solved, while all of the major problems facing applications of Si, except its inability to emit light, have been overcome.

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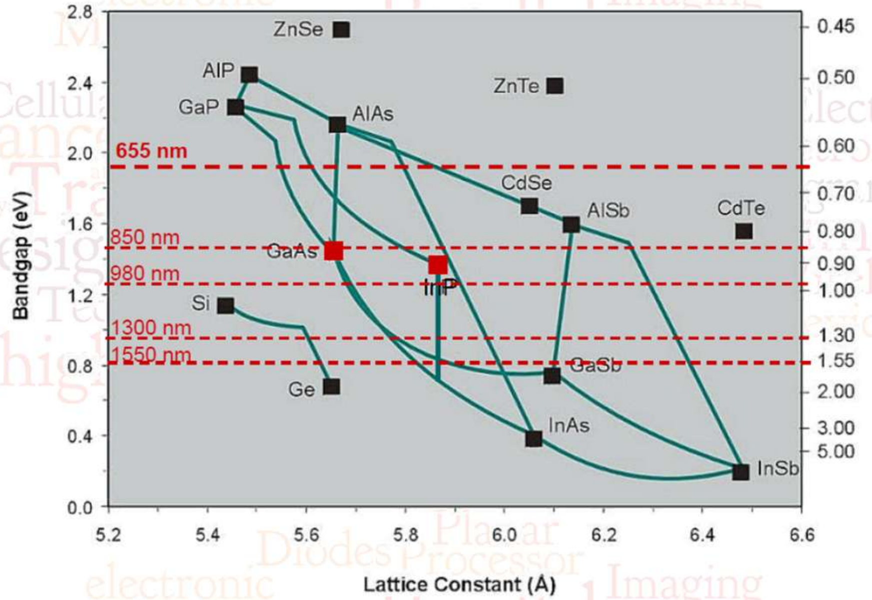
Semiconducting Materials



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