Course description:

The field of Solid State Electronics has expanded tremendously in recent years. Starting from the advent of the transistor in 1947 to Intel's i7 microprocessors in around 2008, we owe all socio-technological advancements to this one area of semiconductor devices. From smartphones, to laptops, to TVs, to refrigerators, to airconditioners, to luxury cars, to solar geysers, to LED bulbs, to pen drive, to micro-SD card, to high end sophisticated security devices, to camera, to any entertainment gadget – solid state electronics is omnipresent. The purpose of this course is a gradual introduction of solid-state theory leading to building the capacity to analyze device properties. The other objective is to expose the undergrad students with the basic theories of this ever-growing field with which they can learn about the newly developed devices and applications.

Course is designed in a very simple, basic format. Starting from how solids are formed, on the basis of conductivity how these solids are grouped, what are semiconductors, what carries current in a semiconductor material, how fast these carriers can move in a semiconductor, how can this motion be controlled, how a device is designed – all these will be covered in this technical elective course during the semester.

Detailed course contents:

Crystal structure: primitive lattice cell, basic lattice structures, miller indices, direction, simple crystal structures, diamond and Zincblende lattice unit cell, growth of a crystal

Energy Bands in crystals: Band Diagram representation of semiconductors. Conduction in metals and semiconductors, Bond model of solids, Carriers, Introduction of holes as carriers, how to manipulate carrier density by doping, Intrinsic and Extrinsic material, Equilibrium carrier concentrations.

Density of States: Energy levels, energy states, Band gap, introduction of Fermi Energy level for Fermions, Maxwell-Boltzman and Fermi-Dirac statistics, probability of occupancy of an energy state by a carrier, Density of states, determination of carrier concentration in a band.

Carrier motion in semiconductors: How carriers move in a solid, Conductivity and mobility, Drift and resistance, Excess carriers and concentration gradient, Diffusion process, Recombination process, Built-in fields, The continuity equation, Diffusion length, Currents due to drift and diffusion.
Junctions: How junctions form, p-n junction, Equilibrium Fermi levels, Space-charge at a junction, Forward and reverse biased junctions, Steady state conditions, p-n junction in equilibrium and under forward and reverse biases, Avalanche multiplication and Zener breakdown, Time variation of stored charge, switching diodes, Capacitance of a p-n junction

Metal-Semiconductor junctions: Schottky barriers

Field Effect Transistors (FET): The junction FET, Metal-Semiconductor FET, Metal-Insulator-Semiconductor FET, analysis of mobility in each case, Bipolar Junction Transistors (BJTs)

Optoelectronic Devices: Photodiodes, LEDs, LDs, Solar cells.

Evaluation
2 Insem exams
1 Final sem exam

Attendance Policy

1. 80% attendance is compulsory.

2. Failing this, your grade will be pulled down according to the following metric:

<table>
<thead>
<tr>
<th>Attendance</th>
<th>Penalty</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>61-79%</td>
<td>1 level down</td>
<td>if getting a BB grade, you will be awarded a BC</td>
</tr>
<tr>
<td>45-60%</td>
<td>2 levels down</td>
<td>if getting a BC grade, you will be awarded a CD</td>
</tr>
<tr>
<td>&lt; 45%</td>
<td>cannot write end sem exam</td>
<td>likely to get F or DE grade</td>
</tr>
</tbody>
</table>

3. Attendance will be taken in all classes of the present students only. Remaining students will be considered absent from the class of that day (date).

4. Leave during semester is governed as per the Institute’s policy. PI refer to \daiictpdc\Academic\Student Leave Policy_WEF_Autumn_2012.pdf

Text book:

4. Robert F. Pierret, Semiconductor Device Fundamentals
6. Robert F. Pierret, Field Effect Devices
7. C. Kittel, Quantum Theory of Solids