

| Course No | Course Title | L | P | U |
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| PHY309 | Digital electronics and Solid State Devices | 4 | 0 | 4 |

Course Objective:

To provide an insight into the basic semiconductor concepts. To provide a sound understanding of current semiconductor devices and technology to appreciate its applications to electronics circuits and systems. To provide an insight into the measuring apparatus and their working principle.

Course outcome:

The student should have the following **learning outcomes** after completion of the course:

The students should have a good knowledge in semiconductor theory and electronic devices.

Learning the working principle of different measuring apparatus.

Understanding the basic physical concepts of Oscilloscopes.

Learning the devices of energy conversion.

Syllabus:

Unit I: Measurement, Error and Measuring Instruments: Measurement and Error: Definitions, Accuracy, Precision, Resolution and Significant Figures, Types of Errors, Measurement error combinations. **Ammeters, Voltmeters and Multimeters. Digital Instruments:** Introduction, Digital multimeters, Digital Frequency Meter, Digital Measurement of Time, Universal Counter.

Unit II: Oscilloscopes and Signal Generators: Oscilloscopes: Introduction, Basic principles, CRT features, Block diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, Sweep or Time Base Generator, Measurement of Frequency by Lissajous Method, Digital Storage Oscilloscope. **Signal Generators:** Introduction, Fixed and Variable AF Oscillator, Standard Signal Generator, Laboratory Type Signal Generator, AF sine and Square Wave Generator, Function Generator.

Unit III: Transducers: Introduction, Electrical transducers, Selecting a transducer, Resistive transducer, Resistive position transducer, Strain gauges, Resistance thermometer, Thermistor, Inductive transducer, LVDT, Piezoelectric transducer, Photo cell, Photo voltaic cell, Semiconductor photo diode and transistor.

Unit IV: Basics of Semiconductors: Elemental and compound semiconductors, Fermi-Dirac distribution, Equilibrium and steady state conditions, Equilibrium concentration of electrons and holes, Temperature dependence of carrier concentration, Carrier transport in

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semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping,

High Field Effects, Hall effect, Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers. PN junctions : Contact potential, Electrical Field, Potential and Charge density at the junction, Energy band diagram, Minority carrier distribution, Ideal diode equation, Electron and hole component of current in forward biased p-n junction, piecewise linear model of a diode effect of temperature on V-I characteristics. Diode capacitances, switching transients, Electrical Breakdown in PN junctions, Zener and avalanche break down (abrupt PN junctions only), Tunnel Diode basics only, Metal Semiconductor contacts, Ohmic and Rectifying Contacts, current voltage characteristics

Unit V: Transistor Characteristics: Bipolar junction transistor , current components, Minority carrier distributions, basic parameters, Evaluation of terminal currents (based on physical dimensions), Transistor action, Base width modulation

Unit VI: MOS and MOSFET Characteristics: Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage MOSFET: Output characteristics, transfer characteristics, sub threshold characteristics, MOSFET scaling (basic concepts)

Small Project based course.

Text Book

T1: Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 6/e, 2010

T2: H. S. Kalsi, Electronic Instrumentation, McGraw Hill Education (2015)

T3: Tyagi M.S., Introduction to Semiconductor Materials and Devices, Wiley India, 5/e, 2008



Reference Books:

R1: Sze S.M., Physics of Semiconductor devices. John Wiley, 3/e, 2005

R2: C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill (1998)

Lecture-wise plan:

| Lecture | Learning Objective | Topics to be covered | Chap./Sec. |
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