BECE201L	Electronic Materials and Devices	L	T	P	C
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Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To introduce the students with concepts of electronic materials and their properties
2. To demystify semiconductor device physics and electronics.
3. To equip the students with the tools for solving problems of semiconductor devices and circuits.
4. To familiarize the students with various electronic devices and their circuit applications.

Course Outcome

Students will be able to:

1. Comprehend the basics of electronic materials, crystal structure, electrical and thermal conduction in solids.
2. Draw and analyze the band diagrams of semiconductor devices.
3. Understand and model the carrier transport mechanisms in semiconductors.
4. Design and model the PN- junctions for given specifications.
5. Develop small signal models for BJT and also design BJT amplifiers under different Configurations.
6. Model MOS capacitors, MOSFETs; learn and mitigate the short channel effects and design future technology nodes.

Module:1	**Electrical and Thermal conduction in Solids**	**6 hours**

Crystalline state – Crystalline defects – Single Cyrstal Growth -Czochralski Growth – Amorphous Semiconductor - Classical Theory: Drude Model – Temperature dependence of resistivity – The Hall Effect and Hall Devices – Thermal conduction – Electrical conductivity of non-metals – Skin Effect – Thin metal films.

Module:2	**Semiconductor Fundamentals**	**7 hours**

Introduction to Solids, Crystals, and Electronic materials – Formation of energy bands – Energy band Model – Effective mass - Direct and indirect bandgap – Elemental and compound semiconductors, Intrinsic and extrinsic semiconductors. The density of states, Carrier statistics, Fermi level, Equilibrium carrier concentration, Quasi-equilibrium, and Quasi-Fermi level.

Module:3	**Carrier Transport Mechanism**	**6 hours**

Charge carriers in semiconductors – Drift and Diffusion of carriers – Mobility – Generation, Recombination and injection of carriers – Carrier transport equations – Excess carrier lifetime.

Module:4	**Junction diodes**	**8 hours**

PN Junction – Equilibrium and biased – Contact potential and space charge phenomena, Current – Voltage relationship, Diode capacitances, One-sided PN junction, Avalanche and Zener breakdown, Zener diode, small-signal model of PN junction. Metal-Semiconductor Contact: Schottky diode, current-voltage characteristics, Ohmic contacts. Varactor diode, Tunnel diode, Photo Diode, Solar Cells.

Module:5	**Bipolar Junction Transistor**	**5 hours**

Device structure and physical operation, Current – Voltage relationship – CB, CE, and CC configuration – Nonideal effects – Base width modulation – Ebers-Moll model. Small signal models, Device capacitances – Equivalent circuit model.

Module:6	**Field Effect Transistor**	**7 hours**

JFET, MOS Capacitors: Energy-band diagrams, flat-band, accumulation, depletion, inversion, threshold voltage, Capacitance-Voltage characteristics. MOSFETs: Current-Voltage characteristics, velocity saturation, leakage currents, short channel effects – Vt roll-off and drain-induced barrier lowering, scaling limits, alternative technologies. Equivalent circuit model-second order effects.

Module:7	**Other Electronic Materials**	**4 hours**
Dielectrics, Insulators, Ferroelectric Materials, Supercapacitors, Graphene, Carbon Nanotubes, Superconductors		
Module:8	**Contemporary Topics**	**2 hours**
Guest lecture from industry and R & D organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	S.O.Kasap, Principles of Electronic Materials and Devices , 2018, 4th Edition, McGraw Hill Education.
Reference Books	
1.	Simon Sze, Ming-Kwei Lee, Semiconductor Devices, Physics and Technology,2012, 3rd Edition, Wiley International Student Version.
2.	Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson.
3.	Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits: Theory and Applications,2014, 7th Edition, Oxford University Press, New York.
4.	Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar / group discussion / fieldwork (include only those that are relevant to the course. Use ',' to separate the evaluations. Eg. CAT, Quiz and FAT.

Recommended by Board of Studies	09-11-2021		
Approved by Academic Council	No. 64	Date	16-12-2021