Annexure – Final Lesson Plan

Module - 1
Electrical and Thermal conduction in Solids

S. No.	Topic	Hours Required	Week	Book to be referred
1.	Crystalline state – Crystalline defects	1	Week -1	S. O. Kasap
2.	Single Crystal Growth -Czochralski Growth – Amorphous Semiconductor	1		S. O. Kasap
3.	Classical Theory: Drude Model – Temperature dependence of resistivity	1		S. O. Kasap
4.	The Hall Effect and Hall Devices	1	Week -2	S. O. Kasap
5.	Thermal conduction – Electrical conductivity of non-metals, Skin Effect	1		S. O. Kasap
6.	Thin metal films, Problems	1		S. O. Kasap

Module – 2

Semiconductor Fundamentals

Topics	No. of Hours	Reference Book
Introduction to Solids, Crystals, and Electronic materials	1 hr	Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson.
Formation of energy bands		
Energy band Model	1 hr	**Chapter 3 : 3.1 to 3.3**
Effective mass		
Direct and indirect bandgap	1hr	Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill
Elemental and compound semiconductors		
Intrinsic and extrinsic semiconductors	1hr	S.O.Kasap, Principles of Electronic Materials and Devices, 2018, 4th Edition, McGraw Hill Education.
The density of states		
Carrier statistics		

Fermi level	1hr	
Equilibrium carrier concentration		
Quasi-equilibrium, Quasi-Fermi level	1hr	
Problems related to energy band diagram	1hr	

Module – 3
Carrier Transport Mechanism

Name of the Content	Sub-topics to be covered	Hours	Reference Books
Charge carriers in semiconductors + Numerical Problems	▪ *Equilibrium Distribution of Electrons and Holes* ▪ *The n_0 and p_0 Equations* ▪ *The Intrinsic Carrier Concentration*	2	Chapter – 4 (R4)
Drift and Diffusion of carriers, Mobility, Carrier transport equations + Numerical Problems	▪ ***Carrier Drift*** • *Drift Current Density* • *Net mobility equation* • *Conductivity equation* ▪ ***Carrier Diffusion*** • *Diffusion Current Density* • *Total Current Density*	2	Chapter – 5 (R4)
Generation, Recombination and Injection of carriers	▪ *The Semiconductor in Equilibrium* ▪ *Excess Carrier Generation and Recombination*	1	Chapter – 6 (R4)
Excess carrier lifetime	▪ *Shockley–Read–Hall Theory of Recombination* ▪ *Relation between carrier life time and recombination rate*	1	Chapter – 6 (R4)

Module – 4
Junction diodes

Topics	Sub Topics	To be covered	No. of hours	Books
PN Junction	Equilibrium and biased	PN junction structure, No applied bias, Forward and reverse bias (Depletion width, built in potential, Carrier concentration profile)	4	S.O.Kasap, Principles of Electronic Materials and Devices, 2018, 4th Edition, McGraw Hill Education. (or) Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson
	Contact potential and space charge phenomena			
	Current – Voltage relationship	PN junction band diagram		
	Diode capacitances	Depletion capacitance and diffusion capacitance		
	One-sided PN junction	Depletion layer capacitance, built in potential, Carrier concentration profile		Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill
	Avalanche and Zener breakdown	Avalanche effect, Zener effect, I-V characteristic		S.O.Kasap, Principles of Electronic Materials and Devices , 2018, 4th Edition, McGraw Hill Education
	small-signal model of PN junction	Small signal admittance, Equivalent circuit model		Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill

Topics	Sub Topics	To be covered	No. of hours	Books
Zener diode		I-V characteristic, application as voltage regulator	1	Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson or Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill
Metal-Semiconductor Contact	Schottky diode, current-voltage characteristics, Ohmic contacts	Energy band diagram, barrier height, depletion width	1	
Varactor diode		Capacitance calculation	1	
Tunnel diode		Energy band diagram, I-V characteristic		Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill
Photo Diode		Space charge density, built in field	1	S.O.Kasap, Principles of Electronic Materials and Devices, 2018, 4th Edition, McGraw Hill Education.
Solar cells		Principle, series and shunt resistance, materials and Efficiency		

Module – 5
Bipolar Junction Transistor

Sl. No.	Course Content	Reference Book	No. of periods to be handled (5 Hours)
1	Device structure and Physical Operation	Donald A. Neamen - Microelectronics Circuit Analysis and Design -McGraw-Hill (2009) Problems: Microelectronic Circuits,7th Edition, Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar	1 Hour
2	Current – Voltage relationship		
	Tutorial		1 Hour
3	CE ,CB Configuration		
4	CC Configuration		1 Hour
	Tutorial		
5	Non - ideal effects -Base width Modulation	Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition Problems: Microelectronic Circuits,7th Edition, Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar	1 Hour
	Tutorial		
7	Eber-Moll model		
8	Small signal models-Hybrid-Pi Model		1 Hour
9	Device capacitances		
10	Equivalent circuit model		

Module – 6
Field Effect Transistor

S. No.	JFET	2 hours	Reference Books
1	Basic principle of transistors	1 hour	Donald A. Neamen, Semiconductor Physics and Devices Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson
2	Construction of n-channel JFET and symbol		
3	Transistor action		
4	Biasing in JFET	1 hour	Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson Electronic-Devices-And-Circuits-by-Millman-and-Halkias-ISBN-0-07-462243-9/253938593214
5	JFET V- I characteristic		
6	Numerical		

S. No.	MOS	1 hours	Reference Books
1	Energy-band diagrams	1 hour	Donald A. Neamen, Semiconductor Physics and Devices Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson
2	MOS capacitance (accumulation, depletion and inversion)		
3	Threshold voltage		
4	Capacitance-Voltage characteristics of MOS Numerical		
5	Numerical		

S. No.	Topic	Sub – Topic	2 hours	Reference Books
1	**MOSFETs:**	D, E-MOSFET	1 hour	Donald A. Neamen, Semiconductor Physics and Devices Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson
2		Construction of n channel		
3		Operation, characteristics, and parameters of n– channel MOSFET		
4		Comparison of JFET and MOSFET		Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson Electronic-Devices-And-Circuits-by-Millman-and-Halkias-ISBN-0-07-462243-9/253938593214
5	**Velocity saturation**	Velocity saturation in MOSFET at nanoscale		
6	**Leakage currents**	• Reverse bias - PN junction leakage current. • Subthreshold leakage current. • Tunneling into and through gate oxide leakage current. • Leakage current due to hot carrier injection from the substrate to gate oxide. • Leakage current due to gate-induced drain lowering	1 hour	Simon Sze, Ming-Kwei Lee, Semiconductor Devices, Physics and Technology

S. No.	Topic	Sub – Topic	2 hours	Reference Books
1	Short Channel effects	• Mobility Degradation • V_{th} roll-off • Drain-induced barrier lowering, scaling limits, • Alternative technologies. • Equivalent circuit model	1 hour	Donald A. Neamen, Semiconductor Physics and Devices Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7th Edition, Pearson
2	Second Oder Effects	• Subthreshold conduction • Channel Length Modulation • Body effect	1 hour	

Module – 7
Other Electronic Materials

Topic Name	Subtopics	No. of Hour	Book
Dielectrics, Insulators	✓ Relative Permittivity, ✓ Polarization, ✓ Insulation Breakdown, ✓ Capacitor Dielectric materials	1	Chapter 7 (T1)
Ferroelectric materials, Super capacitors	✓ Ferroelectric Crystals, ✓ Electrical Double Layer Super capacitor, ✓ Applications	1	Chapter 7 (T1)
Graphene, CNTs	✓ Need, ✓ Types, ✓ Usage and Applications	1	Chapter 4 (T1)
Super Conductors	✓ Meissner Effect, ✓ Type I and Type II Superconductors	1	Chapter 8 (T1)