Semiconductor Device Modeling and Simulation (3–1–0) Credits: 4

MODULE – I (13 hours)

Semiconductor Electronics Review:
Elements of Semiconductor Physics, Physical Operation of a *PN* Junction, MOS Junction, MS Junction

PN–Junction Diode and Schottky Diode:
DC Current-Voltage Characteristics, Static Model, Large-Signal Model, Small-Signal Model, Schottky Diode and its Implementation in SPICE2, Temperature and Area Effects on the Diode Model Parameters, SPICE3, HSPICE and PSPICE Models

Bipolar Junction Transistor (BJT):
Transistor Convention and Symbols, Ebers-Moll Static Model, Ebers-Moll Large-Signal Model, Ebers-Moll Small-Signal Model, Gummel-Poon Static Model, Gummel-Poon Large-Signal Model, Gummel-Poon Small-Signal Model, Temperature and Area Effects on the BJT Model Parameters, Power BJT Model, SPICE3, HSPICE and PSPICE Models

MODULE – II (13 hours)

Junction Field-Effect Transistor (JFET):
Static Model, Large-Signal Model and its Implementation in SPICE2, Small-Signal Model and its Implementation in SPICE2, Temperature and Area Effects on the JFET Model Parameters, SPICE3, HSPICE and PSPICE Models

Metal-Oxide-Semiconductor Transistor (MOST):
Structure and Operating Regions of the MOST, LEVEL1 Static Model, LEVEL2 Static Model, LEVEL1 and LEVEL2 Large-Signal Model, LEVEL3 Static Model, LEVEL3 Large-Signal Model, The Effect of Series Resistances, Small-Signal Models, The Effect of Temperature, BSIM1, BSIM2, SPICE3, HSPICE and PSPICE Models

MODULE – III (14 hours)

BJT Parameter Measurements:
Input and Model Parameters, Parameter Measurements

MOST Parameter Measurements:
LEVEL1 Model Parameters, LEVEL2 Model (Long-Channel) Parameters, LEVEL2 Model (Short-Channel) Parameters, LEVEL3 Model Parameters, Measurements of Capacitance, BSIM Model Parameter Extraction

Noise and Distortions:

Noise, Distortion

Metal-Semiconductor Field-Effect Transistor (MESFET), Ion-Sensitive Field-Effect Transistor (ISFET) and Semiconductor-Controlled Rectifier (Thyristor):

The MESFET, The ISFET, The Thyristor

Textbooks:

1. Paolo Antognetti and Giuseppe Massobrio, *Semiconductor Device Modeling with SPICE,* 2nd edn., McGraw-Hill, New York, 1993, ISBN 0071349553 (paperback) or 007 0024693 (hardback).

Recommended Reading:

1. Richard S. Muller, Theodore I. Kamins, and Mansun Chan, *Device Electronics for Integrated Circuits*, 3rd edn., John Wiley and Sons, New York, 2003. ISBN: 0-471-59398-2. Listed as D

2. H. Craig Casey, *Devices for Integrated Circuits: Silicon and III-V Compound Semiconductors*, John Wiley, New York, 1999. Listed as DI

3. Dieter K. Schroder, *Semiconductor Material and Device Characterization*, John Wiley and Sons, New York, 1990. Listed as S