INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

MICROELECTRONICS								
VI Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AECD36	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: VLSI Design								

I. COURSE OVERVIEW:
The objective of this course is to develop the ability to analyze and design electronic circuits both analog and digital, discrete and integrated. The course uses incremental and large-signal techniques to analyze and design bipolar and field effect transistor circuits, with examples chosen from digital circuits, single-ended and differential linear amplifiers, micro fluidic technology. Greater emphasis is placed on the fundamentals of photonic circuits and other integrated circuits

II. COURSES OBJECTIVES:
The students will try to learn

I. The operational **principles**, characteristics of bipolar junction transistor and its applications using linear and nonlinear analysis.
II. The principles of operating operational amplifier fo**r rectification, amplification** conditioning and voltage regularization of signals.
III. The analytical skills needed to model crystal growth and wafer preparation based on conventional silicon process

III. COURSE OUTCOMES:
At the end of the course students should be able to:

CO 1 Understand Physical Structure and Modes of operation BJT and MOSFET.

CO 2 Realize various circuit models using SPICE Model and realize the electrical parameters of operations.

CO 3 Use their knowledge of the theory of semiconductor physics to describe and demonstrate the principles of semiconductor building blocks such as pn junction and MOS structures.

CO 4 Derive the mathematical relationships that determine the operational characteristics of advanced bipolar and CMOS device architectures that make possible modern nanoscale integrated circuits;

CO 5 Use their understanding of the processing steps used in semiconductor microfabrication to produce integrated manufacturing procedures that will enable the production of advanced microelectronic products.

CO 6 Envisage novel technologies and contribute to the ongoing road mapping that will secure the future of the global microelectronics industry.

IV. COURSE CONTENT:

MODULE - I: BIPOLAR JUNCTION TRANSISTOR (09)
Physical Structure and Modes of operation, Operation in Active Mode, circuit symbols and conventions, BJT as an Amplifier, small circuit model, BJT as a switch and Ebers Moll Model, Simple BJT inverter and Second Order Effects, MOS Transistor Basic, MOS Parasitic & SPICE Model; CMOS Inverter Basics, Biasing of MOS Amplifier and its behavior as an analog switch, CMOS CS/CG/SF Amplifier Configuration, Internal cap models and high frequency modeling, JFET, structure and operation.

MODULE –II: MULTISTAGE AND DIFFERENTIAL AMPLIFIER (10)
Small Signal Operation and Differential Amplifier, MOS Differential Amplier, BiCMOS Amplifier with Active Load, Multistage Amplifier with SPICE Simulation, s-domain analysis, transfer function, poles and zeros, High Frequency Response of CS and CE Amplifier, Frequency Response of CC and SF Configuration, Frequency Response of the Differential Amplifier, Cascode Connection and its Operation, General Feedback structure and properties of negative feedback, Basic Feedback Topologies, Design of Feedback Amplifier for all configuration, Stability and Amplifier poles, Bode Plots and Frequency Compensation.

MODULE –III: OPERATIONAL AMPLIFIER (10)
Ideal Operational Amplifier and its terminals, Inverting and Non- Inverting Configuration, As an integrator and Differentiator, Introduction to Analog Computer, Large Signal Operation of Op Amp and Second order offset.

Butterworth and Chebyshev Filters, First and Second Order Filter Functions, Switched Capacitor based filters, Single-Amplifier Biquadratic Filters, Second Order LCR Resonator, Combinational Logic Design, Sequential Logic Design.

MODULE –IV: CRYSTAL GROWTH AND WAFER PREPARATION (09)
Crystal growth techniques: czochralski and gradient freeze techniques, physics involved in CZ growth, Energy flow balance, pull rate considerations, problems and solutions, defects involved in CZ method, **DIFFUSION:** The nature of diffusion, diffusion mechanisms – interstitial, substitution, interstitial substitution combined, interstitially and grain boundary, Fick's law of diffusion, limited and constant source diffusion, models of diffusion in solid, diffusion equation, atomic diffusion mechanisms, diffusion system for silicon and gallium arsenide.

MODULE –V: FABRICATION PROCESS (10)
ION IMPLANTATION: Introduction, physics of implantation, range theory, projected range, ion stopping Mechanisms. LITHOGRAPHY**:** Pattern generation and mask making, exposure sources, photolithography, photo resists, optical lithography, electron lithography, X-ray lithography, ion lithography ,
DEPOSITION**:** Need for film deposition, film deposition methods- physical and chemical, deposition processes,
ETCHING: Wet chemical etching, wet etchants, dry physical etching, dry etchants, plasma etching,
METALLIZATION**:** Introduction, metallization applications, metallization choices, physical vapour deposition, patterning, metallization problems..

V. TEXT BOOKS:

1. Howe, R. T., and C. G. Sodini, "Microelectronics: An Integrated Approach", Upper Saddle River, Prentice Hall, 1996.
2. Fonstad, C. G, "Microelectronic Devices and Circuits" New York, NY: McGraw-Hill, 1994.
3. Rabaey, Chandrakasan and Nikolic, "Digital Integrated Circuit A Design Perspective", PHI Latest Edition.
4. Weste and Eshraghian, "Principles of CMOS VLSI Design" Addison Wesley, Latest Edition.

VI. REFERENCE BOOKS:

1. Sedra, AS., and K.C.Smith, "Microelectronic Circuits" , New York, NY: Oxford University Press, 4th Edition, 1998.
2. Pierret, R. F, "Semiconductor Device Fundamentals" Upper Saddle River, NJ: Prentice Hall, 1995.

3. B.G.Streetman and S. Banerjee, “Solid State Electronic Devices”, Prentice Hall.

VII. ELECTRONICS RESOURCES:

1. NPTEL :: Electrical , Electronics and Communication: Microelectronics: Devices To Circuits
2. https://ocw.mit.edu/courses/6-012-microelectronic-devices-and-circuits-fall-2009/pages /

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper - I
7. Model question paper - II
8. Lecture notes
9. Early learning readiness videos (ELRV)
10. Power point presentations