

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 4: PHYSICS OF DEVICES

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Devices DSE – 4	4	2	0	2	Class XII Pass with PCM	‘Mathematical Physics-I’, ‘Mechanics’ and ‘Electrical Circuit Analysis’.

LEARNING OBJECTIVES

This paper is based on advanced electronics which covers the devices such as UJT, JFET, MOSFET, CMOS etc. Process of IC fabrication is discussed in detail.

LEARNING OUTCOMES

At the end of this course, students will be able to,

- Develop the basic knowledge of semiconductor device physics and electronic circuits along with the practical technological considerations and applications.
- Understand the operation of devices such as UJT, JFET, MOS, various bias circuits of MOSFET, basics of CMOS and charge coupled devices.
- Learn to analyse MOSFET circuits and develop an understanding of MOSFET I-V characteristics and the allowed frequency limits.
- Learn the IC fabrication technology involving the process of diffusion, implantation, oxidation and etching with an emphasis on photolithography and electron-lithography
- Apply concepts for the regulation of power supply by developing an understanding of various kinds of RC filters classified on the basis of allowed range of frequencies.
- Learn to use semiconductor diode as a clipper and clamper circuit

SYLLABUS OF DSE - 4

THEORY COMPONENT

Unit – I **(7 Hours)**

Semiconductors (P and N type), Energy band diagram, Barrier formation in pn junction diode, Derivation of barrier potential and barrier width, storage and depletion capacitances, current flow mechanism in forward and reverse bias junction, current components in a transistor, tunnel diode, metal-semiconductor contacts, Schottky junction and Ohmic junction

Unit – II **(6 Hours)**

Diode as clipper and clamper circuits, RC Filters: Passive-Low pass and High pass filters, Active (1st order Butterworth)-Low Pass, High Pass, Band Pass, and band reject Filters.

Unit – III **(11 Hours)**

Characteristic and small-signal equivalent circuits of UJT and JFET, introduction to metal oxide semiconductor (MOS) device/MOSFET, MOSFET - their frequency limits, enhancement and depletion mode MOSFETS, basic idea of CMOS and charge coupled devices, importance of power devices: power diode, SCR. Construction and I-V characteristics of DIAC and TRIAC.

Unit – IV **(4 Hours)**

(Basic idea) Basic process flow for IC fabrication, diffusion and implantation of dopants, passivation/oxidation technique for Si, contacts and metallization technique, basic idea of thermal evaporation and sputtering techniques, basic idea of photolithography, electron-lithography, SSI, MSI, LSI, VLSI and USI.

Unit – V **(2 Hours)**

Basic idea about sensors (gas/fire) and piezoelectric transducer

References:

Essential Readings:

- 1) Physics of Semiconductor Devices, S. M. Sze and K. K. Ng, 3rd edition 2008, John Wiley and Sons
- 2) Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
- 3) Electronic communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- 4) Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Grav Hill.
- 5) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.
- 6) Solid State Electronic Devices, B. G. Streetman and S. K. Banerjee, 7th edition
- 7) Power Electronics, M. D. Singh and K. B. Khanchandani, 2006, Tata Mc-Grav Hill

Additional Readings:

- 1) Op-Amps and Linear Integrated Circuits, R. A. Gayakwad, 4th edition, 2000, PHI Learning Pvt. Ltd
- 2) Introduction to Measurements and Instrumentation, A. K. Ghosh, 4th edition, 2017, PHI Learning
- 3) Semiconductor Physics and Devices, D. A. Neamen, 4th edition, 2011, Tata McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

- 1) To design the active low pass and high pass filters of given specification.
- 2) To design the active filter (wide band pass and band reject) of given specification.
- 3) To study the output and transfer characteristics of a JFET.
- 4) To design a common source JFET amplifier and study its frequency response.
- 5) To study the output characteristics of a MOSFET.
- 6) To study the characteristics of a UJT and design a simple relaxation oscillator.
- 7) To study diode as clipper circuit.
- 8) To study diode as a clamper circuit.
- 9) Pattern the given structure on silicon wafer by wet chemical etching.

Suggested extra experiment:

- 1) Deposition of metallic thin films using thermal evaporation technique.
- 2) Preparation of a pn junction and study its IV characteristics.

References for laboratory work:

- 1) Advanced PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India
- 2) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino, M. A. Miller, 1994, McGraw Hill
- 3) Introduction to PSPICE using ORCAD for circuits and Electronics, M. H. Rashid, 2003, PHI Learning.