# Specialization: Advanced Electronics

| Semester-III | |
|---|---|
| **Course Code** | **Course Name** |
| 21MSP614T | Basic Communication Systems |
| 21MSP615T | Organic Electronics |
| 21MSP616T | Semiconductor Physics and Devices |
| 21MSP617P | Advanced Electronics Laboratory |
| 21MSP601 | Project-I |
| | |
| | **Semester-IV** |
| | Project - II |

| M.Sc. course | | | | | 21MSP614T- Basic Communication Systems | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 03 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Know amplitude modulation an demodulation techniques in detail
- Understand frequency modulation an demodulation techniques in detail
- Learn various digital communication techniques.
- Have an understanding of cellular communication and satellite communication.

| **UNIT 1 Amplitude Modulation/demodulation techniques** | **12 Hrs.** |
|---|---|
| Noise-Introduction, internal and external noises, signal to noise ratio and noise figure, Block diagram of electronic communication system. Modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBS, Limitations of AM, Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms, Block diagram of AM transmitter and Receiver. | |
| **UNIT 2 Frequency Modulation/demodulation techniques** | **10 Hrs.** |
| Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator, FM detector – principle, slope detector-circuit, principle of working and waveforms. Block diagram of FM transmitter and Receiver. Comparison of AM and FM. | |
| **UNIT 3 Digital communication** | **10 Hrs.** |
| Introduction to pulse and digital communications, digital radio, sampling theorem, types- PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, MODEM– modes, classification, interfacing (RS232). TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA | |
| **UNIT 4 Cellular and Satellite Communication:** | **10 Hrs.** |
| Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts, Introduction, to Orbit, types of orbits, Block diagram of satellite transponder | |
| | **Max. 42 Hrs.** |

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Explain Cellular communication and importance of frequency and amplitude modulations.
CO2: Apply the knowledge of statistical theory of communication and explain the conventional digital communication system.
CO3: Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.
CO4: Apply the knowledge of digital electronics to the real world problems.
CO5: Describe and analyze the digital communication system with spread spectrum modulation.
CO6: Analyze performance of spread spectrum communication system.

**TEXT/REFERENCE BOOKS**


1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
3. Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
4. Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition- Pearson education


**END SEMESTER EXAMINATION QUESTION PAPER PATTERN**

| **Max. Marks: 100** | **Exam Duration: 3 Hrs** |
|---|---|
| Part A/Question: 3 Questions from each unit, each carrying 3 marks | 36 Marks |
| Part B/Question: 2 Questions from each unit, each carrying 8 marks | 64 Marks |

| M.Sc. | | | | | 21MSP615T- Organic Electronics | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 0 | 25 | 0 | 100 |

**COURSE OBJECTIVES**

- To develop the fundamental understanding of organic semiconductors.
- To provide the comprehensive knowledge of the charge transport mechanism.
- To analyse the processing and optical-electrical characteristics of organic semiconductor devices
- Obtain the hands-on experience on organic device fabrication and characterizations

| UNIT 1 Introduction to Organic Semiconductors | 12 Hrs. |
|---|---|
| Organic Semiconductors: Introduction, Organic versus Inorganic solids, Molecular materials, Electronic states in conjugated molecules, Polymer fundamentals, Conjugated polymers. Electronic transport in crystalline organic materials and conductive polymers, Charge injection at metal/organic interface. | |
| **UNIT 2 Processing of organic materials** | **8 Hrs.** |
| The essential characteristic of the electrode materials for organic electronic devices, R&D for new electrode materials, Organic electronic materials, and their processing techniques. Flexible electronics. | |
| **UNIT 3 Optoelectronic devices** | **12 Hrs.** |
| The basic structure of organic devices, OLEDs and PLEDs, Flexible displays, operating principles of organic lasers, Bulk-heterojunction, Inverted, and Tandem organic photovoltaic (OPV) devices; Carrier loss mechanisms in OPVs; Nanomorphology; Hybrid Perovskite solar cells, Dye-sensitized solar cells. | |
| **UNIT 4 other electronic devices** | **8 Hrs.** |
| Hybrid Memory devices, detector and organic thin-film transistors (OTFTs): fundamentals and working principles, | |
| | **Max. 40 Hrs.** |

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1 – Explain the difference between organic and inorganic semiconductors.

CO2 – Analyze of the charge transport phenomenon in organic materials

CO3 – Design, and analysis of different layers of electronic devices.

CO4 – To explain and analysis different organic device processing

CO5 – Explain the operating principle and efficiency limitations in OPV, OLED, Laser, OTFT, Memory and Detectors

CO6 – Fabricate and characterize the hybrid devices

**TEXT/REFERENCE BOOKS**

1. Suganuma Katsuaki, Introduction to Printed Electronics, Springer, 2014.
2. Stergios Logothetidis, Handbook of Flexible Organic Electronics - Materials, Manufacturing, and Applications, 1st Ed., Woodhead Publishing, 2014.
3. Wolfgang Brütting and Chihaya Adachi, Physics of Organic Semiconductors, 2nd Ed., Wiley-VCH, 2012.
4. Anna Köhler and Heinz Bässler, Electronics Processes in Organic Semiconductors - An Introduction, 1st Ed., Wiley-VCH, 2015.
5. Wenping Hu, Organic Optoelectronics, 1st Ed., Wiley-VCH, 2013.

6. Sam-Shajing Sun and Larry R. Dalton, Introduction to Organic Electronic and Optoelectronic Materials and Devices, 2nd Ed., CRC Press, 2015.
7. Franky So, Organic Electronics: Materials, Processing, Devices, and Applications, CRC Press, 2010

## END SEMESTER EXAMINATION QUESTION PAPER PATTERN

| **Max. Marks: 100** | **Exam Duration: 3 Hrs** |
|---|---|
| Part A/Question: 3 Questions from each unit, each carrying 3 marks | 36 Marks |
| Part B/Question: 2 Questions from each unit, each carrying 8 marks | 64 Marks |

| M.Sc. | | | | | 21MSP616T- Semiconductor Physics and Devices | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 100 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Develop the knowledge of applications and the necessity of electronic devices in different applications.
- Obtain the fundamental understanding of semiconductor physics
- Obtain the knowledge of electronic properties and analysis of the two-terminal and three-terminal semiconductor devices
- Apply the acquired knowledge to the operation mechanism of various semiconductor diodes
- Develop the skills in solving various real-world problems in the semiconductor device and engineering aspects.

| UNIT 1 Semiconductor Physics and PN Junction | 12 Hrs. |
|---|---|
| Introduction to Semiconductor Materials, Basic Crystal Structure, Basic Crystal Growth Technique, Valence Bonds, Energy Bands, Intrinsic Carrier Concentration, Donors and Acceptors Carrier Drift, Carrier Diffusion, Generation and Recombination Processes, Continuity Equation, Thermionic Emission Process, Tunnelling Process. Basic Structure of the pn Junction, Space Charge Width and Electric Field, Junction Capacitance, One-Sided Junctions, Non-uniformly Doped Junctions: Linearly Graded Junction | |
| **UNIT 2 Semiconductor Heterojunctions and MOSFET Devices** | **8 Hrs.** |
| The Schottky Barrier Diode, Metal-Semiconductor Ohmic Contacts, Heterojunctions, The Two-Terminal MOS Structure, Capacitance-Voltage Characteristics, The Basic MOSFET Operation, Nonideal Effects, MOSFET Scaling, Threshold Voltage Modifications, Additional Electrical Characteristics, JFET Concepts, The Device Characteristics, Nonideal Effects, High Electron Mobility Transistor. | |
| **UNIT 3 Semiconductor and nanoelectronic devices** | **10 Hrs.** |
| Introduction to binary and ternary compound semiconductors, Tunnel Diode, IMPATT Diode, Transferred-Electron Devices, Quantum-Effect Devices, Radiative Transitions and Optical Absorption, Light-Emitting Diodes, Semiconductor Laser, Photodetector, Solar. High Electron Mobility Transistors, Quantum Interference Transistors | |
| **UNIT 4 Microwave Physics and Devices** | **10 Hrs.** |
| Semiconductor microwave bipolar transistor, hetrojunction bipolar transistors, microwave tunnel diodes, MESFETs, CCD Devices, Gunn effect and Gunn Diode Ridley-Walkinhilsum (RHW) theory, microwave linear beam tube(O type), klystron,reflex clystron, helix travelling wave tube(TWTs), Microwave cross field Tubes(M Type), Magnetron | |
| | **Max. 40 Hrs.** |

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1 – Explain the basic concepts of semiconductor physics.

CO2 – Analysis of the charge transport phenomenon in semiconducting materials and devices.

CO3 – Explain and analyze the role of different interfaces

CO4 – Design the structure and analysis the bipolar transistor and MOSFET devices.

CO5 – Identify and rationalize the different two-terminal semiconductor and nano-electronic devices

CO6 – Explain the operating principle and fundamentals of Microwave Physics and Devices

**TEXT/REFERENCE BOOKS**

1. S.M. Sze: Physics of Semiconductor Devices

2. J. Singh, Semiconductor Devices - Basic Principles, John Wiley & Sons Inc., 2001
3. S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford University Press, 1997.
4. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons Inc, 1991.
5. M. Shur, Introduction to Electronic Devices, John Wiley & Sons Inc., 2000
6. R. T. Howe and C. G. Sodini, Microelectronics: An Integrated Approach, Prentice-Hall Inc. 1997.
7. B. G. Streetman, Solid State Electronic Devices, $5^{th}$ Ed., PHI, 2001

**END SEMESTER EXAMINATION QUESTION PAPER PATTERN**

| | |
|---|---|
| **Max. Marks: 100** | **Exam Duration: 3 Hrs** |
| Part A/Question: 3 Questions from each unit, each carrying 3 marks | 36 Marks |
| Part B/Question: 2 Questions from each unit, each carrying 8 marks | 64 Marks |

| M.Sc. | | | | | 21MSP617P- Advanced Electronics Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Teaching Scheme** | | | | | **Examination Scheme** | | | | | |
| **L** | **T** | **P** | **C** | **Hrs/Week** | **Theory** | | | **Practical** | | **Total Marks** |
| | | | | | **MS** | **ES** | **IA** | **LW** | **Viva** | |
| **0** | **0** | **6** | **3** | **6** | **-** | **-** | **-** | **50** | **50** | **100** |

**COURSE OBJECTIVES**

- To develop the experimental knowledge of various semiconductor devices.
- To give hands-on experience of various semiconductor devices to understand their working mechanism and applications.
- To implement the electronic devices, generate the data, and interpret it.

**List of Experiments**

1. To measure and compare the I-V characteristics of Silicon & Germanium PN Junction diodes
2. To study I-V characteristics of Zener diode.
3. To study I-V characteristics of BJT transistor in common (a) emitter and (b) base configuration.
4. Study the characteristics of FET in Common Source Configuration.
5. To measure and analysis the I-V characteristics of the supplied solar cell and find its spectral response.
6. Measurement of the resistivity of semiconductor by four-probe method.
7. Estimation of charge carrier concentration and mobility of a given semiconductor using the Hall effect method.

**List of students mini-projects**

1. Thin-film growth by solution process and their structural and optical characterizations
2. Fabrication and characterization of hybrid memristor devices.
3. Fabrication and characterization of hybrid solar cell devices.

**COURSE OUTCOMES**

On completion of the course, the students will be able to

CO1 - Identify and explain the basic electronic components and use them to design mini-projects
CO2 - Understand and analyze the characteristics of diodes and transistors
CO3 - Understand the mechanism of diodes and FET and their applications
CO4 - Hand-on experience on thin-film growth and their characterizations
CO5 - Have hands-on experience of fabrication of hybrid electronic devices.
CO6 - Able to analysis and explain the mechanism of hybrid solar cells and memristors

**TEXT/REFERENCE BOOKS**

1. S.M. Sze: Physics of Semiconductor Devices
2. J. Singh, Semiconductor Devices - Basic Principles, John Wiley & Sons Inc., 2001
3. J.P. Holmann, Experimental methods for engineers
4. Organic-Inorganic Halide Perovskite Photovoltaics: From Fundamentals to Device Architectures, Editors: **Park**, Nam-Gyu, **Grätzel**, Michael, **Miyasaka**, Tsutomu, Springer International Publishing AG, 2015.
5. Sorab K. Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, 2ed, John Wiley & Sons Inc., 2008