NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	MTech Semiconductor Technology
Course Code:	6EC371CC24
Course Title:	Photonics: Materials and Devices
Course Type:	Departmental Elective
Year of Introduction:	2024-25

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Course Learning Outcomes (CLOs)

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

1. comprehend the basic concepts of optoelectronics and optoelectronic devices (BL2)
2. analyse of photodetectors such as light emitting diodes, display devices and avalanche photodiodes (BL3)
3. apply the concepts of quantum mechanical view to study the properties of semiconductor lasers (BL4)
4. evaluate the existing electronic devices and their comparison with proposed nanodevices. (BL5)

	Contents	Teaching hours (Total 45)
Unit I	**Semiconductor Device Physics** Energy band formation in solids and concept of energy band gap, the E-k diagram, density of states, Fermi Dirac distribution function, Fermi level, p-n junction diode and its energy band diagram, semiconductor optoelectronic materials, band gap modification, heterostructures and quantum wells, quantum wires and quantum dots: formation, materials and characteristics, interaction of photons with charge carriers in semiconductors: quantum mechanical view of interaction of radiation with matter, condition for amplification by stimulated emission, concepts of population inversion and metastable state, optical resonator	**09**
Unit II	**Semiconductor Optical Amplifiers and Modulators:** Semiconductor optical amplifier (SOA): basic structure, types of SOA, operation of SOA, characteristics and its applications, concept of quantum confined Stark effect; electroabsoption modulators and their mechanisms	**07**
Unit III	**Semiconductor Photodetectors:** Types of photodetectors, photoconductors, single junction under illumination: photon and carrier-loss mechanisms, noise in photodetection, photodiodes: PIN diodes (p-intrinsic-n diodes) and avalanche photo diode (APD): structure, materials, characteristics and device performance; phototransistors, solar cells, and CCDs, optoelectronic integrated circuits (OEICs)	**06**

Unit IV	**Semiconductor Photon Sources:** Electroluminescence, LED: device structure, materials and characteristics, semiconductor laser: basic structure, theory and device characteristics, direct current modulation, quantum-well lasers, vertical cavity surface emitting lasers (VCSEL)	**08**
Unit V	**Display Devices:** Concepts of photoluminescence and electroluminescence, fluorescence and phosphorescence, EL display, LED display, plasma panel display, liquid crystal display (LCD) and its properties, synthesis techniques, display device manufacturing, process and technology	**09**
Unit VI	**Applications of Optoelectronic Devices:** Optical Sensors, optical fluid level detector, flow Sensors, displacement sensors, micro-bend optical fibre sensors, fluoroptic temperature sensors, photo elastic pressure sensors, phototransistors, applications of optical sensors in medical, military and aerospace	**06**

Self Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggested Readings/References:

1. B. Streetman and S. Banerjee, Solid State Electronic Devices, Prentice Hall.
2. J Palais, Introduction to optical electronics, Prentice Hall.
3. Jasprit Singh, Semiconductor optoelectronics, McGraw-Hill.
4. P Bhattacharya, Semiconductor optoelectronic devices, Prentice Hall.
5. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Prentice Hall.