Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD521	OPTOELECTRONIC MATERIALS AND DEVICES	3	0	0	3

Prerequisite: Condensed Matter Physics, Electrodynamics, Laser Physics and Technology

Course Objective

- To expose students to the field of optoelectronics;
- To specialize and get them ready for research and development in academics and industry.

Learning Outcomes

The students will be learnt on the physics of luminescence, semiconducting and non-semiconducting materials viable for optoelectronics, their functional mechanisms, and various kinds of optoelectronic devices like radiative recombination, photoelectric, photoconducting, stimulated emission, photoemissivity, display type and other devices.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Elements of light**: Nature of light, Light sources, Black body, Colour temperature, Units of light, Radio metric and photometric units, Light propagation in media and waveguides, Electro-optic effects.	3	This unit will give the basic idea of luminosity including the units of luminosity. In addition, the students will get to know about black body radiation.
2	**Overview of luminescence**: Photoluminescence, Cathodoluminescence, Electroluminescence, Injection-luminescence.	3	This part will give the idea of different types of luminescent materials.
3	**Materials for optoelectronics**: Structural properties.	2	Here the students will learn what are different materials and structural properties necessary for optoelectronics.
4	**Semiconducting materials and Heterostructures**; Electronic, transport and optical properties of semiconductors: Direct and Indirect bands; Degenerate and non-degenerate semiconductors, Doping and degeneracy; Carrier mobility in semiconductors, Electron and Hole conductivity in semiconductors; Metal-semiconductor contacts, Schottky barrier; Band bending and effect on bulk properties; Recombination processes; Excitons; Allowed, forbidden and phonon assisted optical transitions; Switching; Colour centres; Photoconductivity; Internal quantum efficiency, External quantum efficiency; Double heterojunction, Fabrication of heterojunction, Quantum wells and superlattices.	10	In this topic, different types and properties of semiconducting materials will be discussed and how they are relevant for optoelectronics.
5	**Non-Semiconducting materials**: Fibre optic materials, Lithium Niobate, Organic materials, Polymers etc.	4	In this topic, how some of the non-semiconducting materials can act as optoelectronic devices, will be discussed.
6	**Radiative recombination devices:** Light-emitting diodes (LED), Organic Light Emitting Devices (OLED).	3	In this unit, different light emitting devices will be discussed that are based on radiative recombination of the generated e-h pairs.
7	**Photoelectric devices**: Photodiodes, Solar cells and Photovoltaic devices, Phototransistors, Photomultipliers, Optoisolators.	3	This topic focuses on various photoelectric devices.
8	**Photoconducting devices**: Photodetectors and photoconductors, Photoresistors, Photo transistors, PIN diode, Thermal detectors, Photoconductive camera tubes, Charge-coupled imaging devices.	5	This unit will help student to understand various photoconductive devices.
9	**Stimulated emission devices**: Injection laser diodes, Quantum cascade lasers.	2	In this topic, the mechanisms of the stimulated emission devices will be discussed.
10	**Photoemissivity device**: Photoemissive camera tube.	2	In this unit, the students will learn how a photo-emissive device works.
11	**Display devices**: Electro Luminescence display, Plasma display, Liquid Crystal Display (LCD), LED Display.	3	In this unit, the students will gain knowledge about the display devices that we use in our daily life.
12	Introduction to Modulators, Opto-Electronic packaging, Integrated Optical Circuits (IOC).	2	This part will summarize various types of Modulators and other optical circuits.
	Total	**42**	

Text Books:

1. Optoelectronics – An Introduction to materials and devices; Jasprit Singh, McGraw-Hill, 1996.
2. Materials for Optoelectronics; Maurice Quillec, Springer Science, 1996.
3. Optoelectronic Devices and Systems; S. C. Gupta, Prentice Hall India, 2005.
4. Optoelectronics - An introduction; J. Wilson and J. Hawkes, Prentice-Hall India, 1996.

5. Semiconductor optoelectronic devices; P. Bhattacharya, Prentice Hall India, 2006.

Reference Books:

1. Optoelectronics - Advanced Materials and Devices; Pyshkin and Ballato, InTech, 2013.
2. Optoelectronic materials and device concepts; Manijeh Razeghi, SPIE, 1991.
3. Introduction to Organic Electronic and Optoelectronic Materials and Devices; Sun and Dalton, CRC Press, 2008.
4. Physics of Semiconductor Devices; Sze; Wiley, 1969.
5. Semiconductor Devices - Basic Principles; Singh; John Wiley.
6. Physics and Technology of Semiconductor Devices; Grove; Wiley, 1967.
7. Metal-Semiconductor Schottky Barrier Junction and their Applications; Sharma; Plenum, 1984.
8. Metal-Semiconductor Contact; Rhoderick and Williams; Oxford, 1988.
9. Principles of Electronic Materials and Devices; Kasap; McGraw-Hill, 2005.
10. Optical fibre communication; J. M. Senior, Prentice Hall India, 1985.
11. Optical fibre communication systems; J. Gowar, Prentice Hall, 1995.
12. Introduction to optical electronics; J. Palais, Prentice Hall, 1988.
13. Semiconductor optoelectronics; Jasprit Singh, McGraw-Hill, 1995.
14. Fiber Optics and Optoelectronics, R. P. Khare, Oxford, 2004.