Semiconductor Optoelectronics - Web course

COURSE OUTLINE

This course introduces the students to the field of *Semiconductor Optoelectronics*, which deals with the physics and technology of semiconductor optoelectronic devices such as light emitting diodes, laser diodes and photodiodes, which are becoming important components in consumer optoelectronics, IT and communication devices, and in industrial instrumentation.

Assuming a general science undergraduate level background, the course begins with a recap of essential (to this course) semiconductor physics, followed by the study of interaction of photons with electrons and holes in a semiconductor, leading to the realization of semiconductor photon amplifiers, sources, modulators, and detectors. A variety of designs and configurations of these devices have been emerging with application-specific characteristics.

The course is 'applied' in nature, and could be offered at the level of B.E/B.Tech IIIrd/ IVth Year, M.Sc and M.Tech.

COURSE DETAIL

Sl.No.	Topic/s	No. of Hrs.
1.	**Review of Semiconductor Device Physics:** Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells.	10
2.	**Interaction of photons with electrons and holes in a semiconductor:** Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.	5
3.	**Semiconductor Photon Sources:** Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation. Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Device packages and handling.	10
4.	**Semiconductor Optical Amplifiers & Modulators:** Semiconductor optical amplifiers (SOA), SOA	5

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Physics

Pre-requisites:

General B.Sc/ B.Sc (Hons.) Physics or II Year B.E/B.Tech Engineering Physics/ Electrical Engineering level background in basic Quantum Mechanics, Semiconductor Physics, Optics and Electronics.

Additional Reading:

1. M. C. Gupta, *Handbook of Photonics*, CRC Press (1997).

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	characteristics and some applications, Quantum-confined Stark Effect and Electro-Absorption Modulators.	
5.	**Semiconductor Photodetectors:** Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection; Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance. Photo-transistors, solar cells, and CCDs. Optoelectronic integrated circuits - OEICs.	10
	Total	40

References:

1. B. E. A. Saleh and M. C. Teich, *Fundamentals of Photonics*, John Wiley & Sons, Inc., 2nd Ed. (2007), Ch.16, 17, and 18.
2. P. Bhattacharya, *Semiconductor Optoelectronic Devices*, Prentice Hall of India (1997).
3. J. Singh, *Semiconductor Optoelectronics: Physics and Technology*, McGraw-Hill Inc. (1995).
4. G. Keiser, *Optical Fiber Communications*, McGraw-Hill Inc., 3rd Ed. (2000), Ch.4, 6.
5. A. Yariv and P. Yeh, *Photonics: Optical Electronics in Modern Communications*, Oxford University Press, New York (2007), 6th Ed. Ch.15-17.
6. J. M. Senior, *Optical Fiber Communication: Principles and Practice*, Prentice Hall of India, 2nd Ed.(1994), Ch.6-8.