Course: Department Specific Elective 4 - HPHDS6041T

Semester	VI
Paper Number	HPHDS6041T
Paper Title	LASER PHYSICS & FIBER OPTICS
No. of Credits	06 (Theory – 5, Tutorial-1)
Theory/ Composite	Theory
No. of periods assigned	Th:5 periods/week Tutorial:1 period/week
Name of Faculty member(s)	
Course description/ objective	1) To teach the principles of operation of gas lasers and solid state lasers 2) To acquaint students with applications of lasers 3) To educate students about safety precautions while handling lasers 4) To teach the principles of light propagation in optical fibers 5) To discuss the different types of optical fibers 6) To teach students the principles of communication systems using lasers 7) This course includes an introduction to the area of fiber optics (which is of current significance due to its application in innumerable areas of science and technology). The different kinds of fibers as well as the parameters of importance are categorised in viewpoint of their application in communication. 8) Using the concepts of EM theory, the planar waveguide is studied to introduce the general concept of modes in an optical waveguide. 9) The different loss mechanisms and their measurement method are studied to give a practical approach in understanding the use of an optical fiber. Fabrication methods and different connection techniques are also covered in brief. 10) With the basic understanding of the fiber, the students are introduced to the building blocks of an optical fiber communication system including the fiber amplifier, which plays a key role.
Syllabus	As enclosed
Texts	As enclosed
Reading/ Reference List	As enclosed
Evaluation	Total – 100 Theory-80, CIA – 20 **Group A : (50 marks)** Three 10 marks qs out of five qs Four 5 mark qs out of six qs **Group B (30 marks)** Two 10 mark qs out of three qs Two five mark qs out of three qs

Syllabus:

HPHDS6011T – LASER & FIBER OPTICS [Credits: Theory-05, Tutorials-01; Lectures : Theory - 65, Tutorial – 13]

Module A **[39 lectures]**

Laser Physics

Spontaneous and Stimulated emission, Einstein's A and B coefficients. [1 lecture]

Helium neon gas laser, the CO_2 laser. [2 lectures]

Energy levels in solids – Dielectric laser materials, narrow line width laser: Ruby laser, broadband tunable laser: alexandrite laser. Energy levels in conductors, semiconductors and insulators. Direct and indirect bandgap semiconductors [4 lectures]

Introduction to semiconductor lasers [1 lecture]

Basic components of a laser: active medium, optical resonator, pumping source. Absorption and gain, Population inversion, Saturation intensity, Development and growth of a laser beam, threshold requirements for a laser: laser with no mirrors, laser with one mirror, laser with two mirrors, processes that destroy inversions [5 lectures]

Inversions and two-level systems, steady-state inversions in three and four-level systems. [4 lectures]

Laser resonators: Fabry-Perot resonator and its modes [1 lecture]

The wave equation in quadratic index media, the Gaussian beam in a homogeneous medium, the fundamental Gaussian beam in a lens-like medium – the ABCD law [5 lectures]

Laser applications, Laser hazard classification and laser safety [1 lectures]

Homogeneous and inhomogeneous broadening mechanisms [2 lectures]

Optical resonators – spherical mirror resonances, mode stability confinement criteria and the self-consistent resonator solutions, the resonance frequencies, losses in optical resonators. [5 lectures]

Laser Oscillation condition, general treatment [5 lectures]

Q-switching – theory and methods. [2 lectures]

Nd:YAG laser – principle of operation and applications [1 lecture]

Module B **[26 lectures]**

Fiber Optics

Advantages of glass fibers, the coherent bundle, numerical aperture, ray propagation in step-index and graded-index fibers, Single mode & Multimode fibers, Intramodal dispersion, Intermodal dispersion , effect of material dispersion. [8 lectures]

Wave propagation in planar waveguide: TE modes of a symmetric, step-index planar waveguide, V-parameter. [5 lectures]

Loss mechanisms, Scattering losses, Loss measurement in optical fiber – Cut-back method [3 lectures]

Fiber fabrication methods, optical fiber connections and related losses, fiber splices, Fiber connectors, optical fiber communication system [7 lectures]

Brief introduction to fiber amplifiers [3 lectures]

References

(1) Optics by A. Ghatak
(2) Fundamentals of Optics by F.A. Jenkins and H.E. White
(3) Optical Electronics by A. Ghatak and K. Thyagarajan
(4) Laser Fundamentals by W. Silfvast
(5) Quantum Electronics by A. Yariv
(6) Fiber Optics and Optoelectronics by R.P. Khare
(7) Optoelectronics and Photonics by S. O. Kasap
(8) Light: Introduction to Optics and Photonics by J. Donnelly and N. Massa
(9) Femtosecond Laser Pulses, Eds. C. Hirlimann et al., Springer