Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2022-2023

Course Handout Part II

29-08-2022

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : EEE F426
Course Title : Fiber Optics and Optoelectronics
Instructor-in-Charge : Prasant Kumar Pattnaik

Course Description:

Theory of optical fibers, image transmission by fibers, technology of fiber production, fiber testing, characterization of optical fibers, detectors and sources for fiber optic systems; active fibers, applications of optical fibers; optoelectronic devices and applications.

Scope & Objective:

In the recent past, tremendous advances have been achieved in fiber optics and associated optoelectronics. These developments have made fiber - optic communication synonymous with the current worldwide revolution in information technology.

This course aims at providing the undergraduates with a firm grounding in the major aspects of this emerging technology. Thus the course deals with the study of various building blocks of fiber optic systems, e.g. optical fibers, sources, detectors, modulators, optical amplifiers, etc. together with overall system design and performance analysis for communication as well as sensing.

Text Book: Khare, R.P.: "Fiber Optics and Optoelectronics" Oxford University Press (2004)

Reference Book: Agrawal, G.P.: "Fiber-optic communication systems" (3rd Ed) John Wiley, N.Y. (2002)

Course Plan:

Lec. No.	Learning Objectives	Topic (s) to be covered	Chapter in the Text Book
1.	i. What is the basic configuration of a fiber-optic system?	A generalized configuration of a fiber optic system	Chap1./Sec 1.1 – 1.3
	ii. What are the merits of such a system?	Attractive features.	Chap1/Sec.1.4
	iii. What role are they going to play in the sociological evaluation?	The role of fiber optic systems.	Chap1/Sec. 1.5-1.6

2.	How rays propagate through different types of optical fibers?	Review of fundamental laws of optics	Chap2/Sec.2.2
		Ray propagation in step index fibers	Chap2/Sec 2.3
		Ray propagation in graded index fibers	Chap2/Sec. 2.4
3.	To estimate the causes of pulse broadening.	Effect of material dispersion	Chap2/Sec. 2.5
		Effect of multipath-dispersion and combined effect	Chap2/Sec. 2.6
4.	Learning the calculation of different parameters of optical fibers.	Numerical problems	Review Q. of Chap2
5.	Familiarization with the background for learning electromagnetic wave propagation	Maxwell's equations Solution in an inhomogeneous medium	Chap3/Sec. 3.2 Chap3/Sec. 3.3
6.	Modal analysis of planar optical wave guides	Planar optical waveguide TE modes of a symmetric step index planar waveguide	Chap3/Sec. 3.4 Chap3/Sec. 3.5
7.	Modal analysis contd.	Power distribution and confinement factor	Chap3/Sec. 3.6
8.	Reinforcing concepts	Numerical Problems	Review Q. of Chap3
9.	Modal analysis of cylindrical optical waveguide.	Wave propagation in an ideal s.i fiber	Chap 4/Sec 4.2
10.	Modal analysis contd.	Modal power distribution in s.i. fibers	Chap4/Sec. 4.3
11.	Modal analysis contd	Wave propagation in graded index fiber	Chap4/Sec. 4.4
12.	Propagation through Single mode fibers	Characteristic parameters of SM fibers	Chap 5/ Sec.5.2-5.3
13.	Single mode fibers contd	Dispersion in SM fibers	Chap 5/Sec. 5.4
		Attenuation in SM fibers	Chap 5/Sec. 5.5
14.	Single mode fibers contd	Design of SM fibers and related problems	Chap5/Sec. 5.6 & review Q.
15.	Fabrication of low loss optical fibers	Fiber material requirements	Chap6/Sec. 6.2
		Fiber fabrication methods	Chap6/Sec. 6.3
16.	Design aspects of optical fiber cables and connections	Fiber optic cables, connection and related losses	Chap6/Sec. 6.4 – 6.7
17.	Evaluating the performance of optical fibers	Characterization of optical fibers	Chap6/Sec 6.8
18.	To understand the fundamental aspects of optoelectronic sources	Intrinsic and extrinsic semi-conductors	Chap7/Sec. 7.2
		p-n junction, Life time and diffusion length of minority carriers	Chap7/Sec. 7.3

19.	Fundamental aspects of optoelectronic sources contd	Current density and injection efficiency	Chap 7/Sec.7.4
20.	Principle of operation of light emitting diodes(LED)	LED, its internal and external quantum efficiency	Chap7/Sec. 7.5
21.	Design aspects of LED	Heterojunction	Chap7/Sec. 7.6
		LED designs	Chap7/Sec7.7
22.	Principles of injection laser diode (ILD)	ILD, condition for laser action, laser modes & laser action in semi conductors	Chap7/Sec. 7.9 –7..9.3
23.	Design aspects of ILD and source fiber coupling	ILD structures	Chap7/Sec.7-9.5
		Source Fiber coupling	Chap7/Sec. 7.10
24.	Reinforcing concepts	Problems of Chap 7	Review Q. of Chap7
25.	Principle of operation and types of optoelectronic detectors.	Basic principle of opto-electronic detection	Chap8/Sec. 8.2 to 8.3
		Types of photodiodes	Chap8/Sec 8.4
26.	Reinforcing concepts	Problems of Chap 8.	Review Q. of Chap 8
27.	Review of basic principles of optoelectronic modulator	Polarization, birefringence, retardation plates	Chap9/Sec. 9.1 & 9.2
28.	Electro optic effect and related modulators	Electro optic modulators and related problems	Chap9/Sec 9.3
29.	Acousto-optic effect and related modulators	Acousto-optic modulators & related problems.	Chap9/Sec. 9.4
30.	Optical amplification	Semiconductor optical amplifiers	Chap.10/Sec 10.2
31.	Optical amplification contd	Erbium doped fiber amplifiers	Chap. 10/ Sec. 10.3
32.	Optical amplification contd	Fiber Raman amplifiers	Chap 10/Sec. 10.4
33.	Wavelength division multiplexing	WDM and DWDM	Chap. 11/Sec. 11.2 – 11.3
34.	WDM contd	Components	Chap. 11/Sec. 11.4
35.	Fiber- optic communication systems	System design considerations	Chap. 12/Sec. 12.2
36.	Fiber- optic communication systems contd	System architectures	Chap. 12/Sec.12.3
37.	Fiber- optic communication systems contd	Non-linear effects and system performance	Chap. 12/Sec. 12.4 – 12.5
38	Fiber optic sensors (FOS)	What is FOS? Classification of fos, Intensity-modulated fos	Chap. 13/Sec. 13.2 – 13.4
39	Fiber optic sensors (FOS) contd	Phase-modulated and spectrally-modulated fos	Chap. 13/ Sec. 13.5 – 13.6

40.	Fiber optic sensors (FOS) contd	Distributed fos and Smart Structures	Chap. 13/ Sec. 13.7- 13.9
41.	Laser-based systems	Different types of lasers	Chap. 14 / Sec14.2 –14.6
42.	Laser-based systems contd	Applications of lasers	Chap. 14 / Sec. 14.7

Evaluation Scheme:

EC. No.	Evaluation Component	Duration	Weightage (Percentage)	Marks	Date, Time & Venue	Nature of Component
1.	Midsem	90 min.	25	75	31/10 11.00 - 12.30PM	CB
2.	Quizzes	30 min each	15	45	During class hour	CB
3.	Assignment/Term Paper	---	20	60	-----	OB
4.	Comprehensive Exam	180 min	40	120	17/12 AN	CB

Chamber Consultation Hour: To be announced in the class

Notices: All notices of this course will be displayed in the CMS

Make-up Policy: No make-up will be given for Quizzes and Assignments. However, for mid-semester test and comprehensive exam, make-up examination will be granted for genuine reasons with prior-permission from Instructor-in-charge.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Prof. Prasant Kumar Pattnaik
INSTRUCTOR-IN-CHARGE