Techno India NJR Institute of Technology

Course File

Session 2021-22

Fiber Optics Communications(6EC4-03)

For Techno India NJR Institute of Technology
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SYLLABUS

III Year - VI Semester: B.Tech. (Electronics & Communication Engineering)

6EC4-03: Fiber Optics Communications

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to vector nature of light, propagation of light, propagation of light in a cylindricaldielectric rod, Ray model, wave model.Different types of optical fibers, Modal analysis of a step index fiber.	8
3	Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers andmeasurement techniques like OTDR	7
4	Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detectorresponsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.	8
5	Optical switches - coupled mode analysis of directional couplers, electro-optic switches.Optical amplifiers - EDFA, Raman amplifier.	8
6	WDM and DWDM systems. Principles of WDM networks.Nonlinear effects in fiber optic links. Concept of self-phase modulation, groupvelocity dispersion and solition based communication.	8
	Total	40

Course Overview:

Student will learn fundamentals of Fiber optic communication from this 40-hour course. In this course, student will study the fundamental concepts and application of optical communication. They will studydifferent optical measurement like noise analysis, attenuation signal degradation calculation etc. using devices like OTDR. Also, they will be able to design the different optical devices like sources, detectors and amplifiers.

Course Outcomes:

CO.NO.	Cognitive Level	Course Outcome
1	Knowledge	Explain basic knowledge of Ray theory principle & optical fiber working concepts.
2	Comprehension	The knowledge of optical communication subject helps the students to perform various experiments in laboratories which will help in understanding theory more clearly.
3	Analysis	Analyze the use of modern upcoming technologies in optical communication.
4	Synthesis	Design tools for optical system design, test and evaluation.

Prerequisites:

1. Fundamentals of various communication systems.
2. Must have completed the course on signal and systems.
3. Student should be able to solve the problems of system designing.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific					Domain Independent						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	0	0	0	0	0						
CO2	2	1	0	0	0	0						
CO3	2	1	0	0	0	0						
CO4	1	2	2	0	3	1						
1: Slight (Low) , 2: Moderate (Medium) , 3: Substantial (High)												

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	1	**OPTICAL FIBER OVERVIEW:** Introduction, Ray theory,

2	1	Optical fibers: multimode, single mode, step index, graded index
3	1	plastic & glass fibers.
4	1	**TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS:** Introduction, Attenuation,
5	1	Material absorption loss, Fiber bend loss
6	1	scattering, Dispersion (intermodal & intramodal),
7	1	Dispersion Shifted Fibers, Dispersion Compensating Fiber
8	1	**MANUFACTURING OF OPTICAL FIBERS:** preparation of optical fiber
9	1	Liquid phase techniques, vapor phase depositions techniques
10	**2**	**OPTICAL FIBER SOURCES:** Laser- Emission and absorption of radiation
11	2	Einstein relation, Absorption of radiation
12	2	Population inversion
13	2	Optical feedback
14	2	Threshold condition
15	2	Population inversion and threshold
16	2	working of three levels & four level lasers
17	2	Basic idea of solid state
18	2	semiconductors, gas & liquid laser
19	2	Basic concept of Q-switching and mode locking.
20	2	Light Emitting Diode - Structure, Material,
21	2	LED Characteristics, Power & Efficiency, Numerical
22	**3**	**OPTICAL DETECTORS:**Optical detection principles, quantum efficiency
23	3	Responsivity, PIN photo diode
24	3	Avalanche photo diodes, Noise in Detectors
25	3	Photo Diode Materials
26	3	Optical Connectors: Fiber Alignment
27	3	fiber splices, fiber connectors
28	3	expanded beam connectors, fiber couplers& numerical
29	**4**	**OPTICAL FIBER MEASUREMENTS:**Measurements of Fiber Attenuation
30	4	Dispersion, Refractive Index Profile,
31	4	Cut off Wave Length, Numerical Aperture & Diameter
32	4	Optical Time Domain Reflectometry (OTDR) - Field measurement through optical time domain reflectometry
33	4	Laser based systems for measurement of distance
34	4	Laser based systems for measurement of Velocity
35	4	Holography, Numerical
36	**5**	**OPTICAL FIBER SYSTEMS:**Wavelength division multiplexing
37	5	DWDM, active and passive components
38	5	optical sensors, optical amplifiers
39	5	Optical Fiber Applications:public network applications, military
40	5	Optical fiber application in civil and industrial applications, Numerical

TEXT/REFERENCE BOOKS

1.Optical Fiber Communications, G. Keiser, TMH

2.Optical Fiber Communications Principles and Practices, John M. Senior, PHI

3.Optical Communication Systems, J. Gowar, PHI

Teaching and Learning resources:

- **MOOC (NPTEL): -** https://nptel.ac.in/courses/108/106/108106167/

Assessment Methodology:

1. Practical exam using lab instruments.
2. Two Midterm exams where student have to showcase subjective learning.
3. Final Exam (subjective paper) at the end of the semester.

6E 6058

Roll No. _____ [Total No. of Pages : 3]

6E 6058

B.Tech. VI Semester (Main&Back) Examination,April.2019
Electronics & Communication Engg.
6EC6.3A Optical Fiber Communication

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 26

Instructions to Candidates:

*Attempt any **Five questions**, selecting **One question** from **each unit**. All Questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly). Units of quantities used/calculated must be stated clearly.*

Unit - I

1. a) Explain what you mean by a step index and graded index optical fiber. Giving an expression for the possible refractive index profile. Why a graded index fiber with a parabolic index profile is preferred? **(2+2+4)**

   b) A multimode step index fiber with a core diameter of 80 μm and a relative index difference of 1.5% is operating at a wavelength of 0.85 μm. If the core refractive index is 1.48, estimate:

   i) The normalized frequency for fiber.

   ii) The number of guided modes. **(4+4)**

(OR)

1. a) What is Dispersion? Explain and compare the dispersion shifted cable and dispersion flattened cable with neat diagram. **(2+4+2)**

   b) What are the materials require for manufacturing the optical fiber? Describe the modified chemical vapor phase deposition (MCVD) method for preparation of optical fiber. **(3+5)**

Unit - II

2. a) The radiative and non radiative recombination lifetimes of the minority carriers in the active region of a double hetro junctions LED are 60 ns and 100 ns respectively. Determine the total carrier recombination lifetime and the power internally generated within the device when the peak emission wavelength is 0.87 μm at a drive current of 40mA. **(4+4)**

   b) Explain direct bandgap and indirect bandgap semiconductor materials. Which type of material is use for optical fiber? Also explain their applications in optoelectronics. **(4+2+2)**

(OR)

2. a) What is the importance of LASER in optical communication? Drive the rate equation for laser diode. **(4+4)**

b) Describe the common LED structure for optical fiber communication; also give their merits and demerits. **(4+2+2)**

Unit - III

3. a) Explain the following terms of photo diode
   i) Quantum efficiency
   ii) Responsivity **(4+4)**

b) A 60/120 μm graded-index fiber with a numerical aperture of 0.25 and a profile parameter of 1.9 is jointed with a 50/120 μm graded-index fiber with a numerical aperture of 0.20 and a profile parameter of 2.1. If the fiber axes are perfectly aligned and there is no air gap, calculate the insertion loss at the joint in the forward and backward directions. **(4+4)**

(OR)

3. a) A four port multimode fiber FBT coupler has 60 μW optical power launched into port 1. The measured output power at port 2, 3 and 4 are 0.004, 26.0 and 27.5 μW respectively. Determine the excess loss, the insertion losses between the input and the output ports, the crosstalk and the split ratio for the device. **(2+2+2+2)**

b) What is splicing in fiber? Explain different types of techniques use for splicing the optical fiber with neat diagram. **(2+6)**

Unit - IV

4. a) A trigonometric measurement is performed in order to determine the numerical aperture of a step index fiber. The screen is positioned 10 cm from the fiber end face. When illuminated from a wide angled visible source the measured output pattern size is 6.2 cm. calculate numerical aperture of fiber. **(08)**

b) Describe the cut back method for attenuation measurement in the laboratory. Explain its advantage and disadvantages. **(08)**

(OR)

a) What is the need of Optical Time Domain Reflectometry (OTDR) in optical fiber communication? Explain the process of fault location identification with neat graph and diagram. **(3+5)**

b) Explain the working of laser based system for measurement of distance with neat diagram. **(08)**

Unit - V.

5. a) Describe the Wavelength division multiplexing (WDM) and compare with Dense wavelength division multiplexing (DWDM). **(4+4)**

b) What is the object of optical amplifiers? Explain Erbium doped fiber amplifier (EDFA) with neat diagram. **(2+6)**

(OR)

5. a) Explain the Mach-Zehnder interferometric sensor for fiber optics. **(08)**

b) Describe the applications of fiber optics in industries, military and computer drives. **(2+3+3)**