GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10) &
ELECTRONICS AND COMMUNICATION ENGINEERING (11)
OPTICAL COMMUNICATION
SUBJECT CODE: 2161005
B.E. 6th SEMESTER

Type of course: NA

Prerequisite: Semiconductor Physics, Electromagnetic, Mode theory of waveguide

Rationale: To introduce the students to various optical fiber modes, configurations and various signal degradation factors associated with optical fiber and to study about various optical sources and optical detectors and their use in the optical communication system, optical amplifiers, fiber network elements, basic optical components, and techniques of fiber optic measurement.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Overview of Optical fiber Communications :** Electromagnetic spectrum, Optical Spectral bands, Evolution of fiber optic system, Multiplexing Techniques, Elements of an optical fiber transmission link with the functional description of each block, WDM concepts, transmission widows, advantages of optical fiber link over conventional copper systems, applications of fiber optic transmission systems.	3	6
2	**Optical fibers : Structures, Waveguiding and Fabrication** : Optical laws and definitions, optical fiber modes and configurations, Mode theory, Step Index and Graded Index (GI) fibers ,single mode and graded index fibers, Derivation for numerical aperture, V number and modes supported by step index fiber, mode field ,Numerical aperture and modes supported by GI fibers, fiber materials, linearly Polarized modes fiber fabrication techniques, and mechanical properties of fibers, fiber optic cables.	7	13
3	**Signal Degradation in Optical Fibers :** Attenuation, signal distortion in optical waveguides, pulse broadening in graded index fiber, Characteristics of Single Mode Fibers, mode coupling,International Standards for optical transmission fibers.	5	10
4	**Optical Sources :** Semiconductor Physics background, Light emitting diode (LEDs)-structures, materials, Figure of merits, characteristics & Modulation.	6	12

	Laser Diodes -Modes & threshold conditions, Diode Rate equations, resonant frequencies, structures, characteristics and figure of merits, single mode lasers, Modulation of laser diodes, Spectral width , temperature effects, and Light source linearity.			
5	**Power Launching and Coupling :** Source to fiber power launching, Lensing schemes, fiber-to-fiber joints, LED coupling to single mode fibers, fiber splicing, Optical fiber connectors.	4	8
6	**Photodetectors :** Principles of operation, types, characteristics, figure of merits of detectors photodiode materials, photodetector noise, detector response time,temperature effects on gain, comparison of photodetectors.	4	8
7	**Optical Receiver Operation :** Receiver operation, Preamplifier types, receiver performance and sensitivity, Eye diagrams, Coherent detection, Specification of receivers.	5	10
8	**Transmission Systems :** Point –to-point link –system considerations, Link power budget and rise time budget methods for design of optical link, BER calculation	3	6
9	**Optical Amplifiers :** Semiconductor optical Amplifier, EDFA, Raman Amplifier, Wideband Optical Amplifiers	3	6
10	**Advances in Optical Fiber Systems :** Principles of WDM, DWDM, Telecommunications & broadband application, SONET/SDH, MUX, Analog & Digital broadband, optical switching.	5	10
11	**Overview of Optical Components :** Optical couplers, Tunable sources and Filters ,optical MUX/DEMUX, Arrayed waveguide grating, optical add drop multiplexer (OADM), optical cirulators, attenuators, optical cross connects, wavelength converter, Mach-Zender Interferometer	3	6
12	**Fiber Optical Measurements :** Test Equipments, OTDR , Set ups for Measurement of Attenuation, Dispersion, NA and EYE pattern .	3	6

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**10**	**15**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Optical Fiber Communications by Gerd Keiser, 4th Edition (Mc Graw Hill)
2. Optical Fiber Communication by John M. Senior (PHI/Pearson)
3. Fiber optical communication Technology by Djafar Mymbaev & Lowell L, Scheiner. (Pearson)
4. Fiber optic Communication Systems by G. Agrawal (John Wiley and sons)

Course Outcome: After learning the course the students will be able
1. To comprehend the basic elements of optical fiber transmission link, fiber modes and structure configurations.
2. To visualize the significance of the different kind of losses, signal distortion in optical wave guides , signal degradation factors and dispersion management techniques in optical system performance.
3. To compare the various optical source materials, LED structures, quantum efficiency as well as structures and figure of merit of Laser diodes.
4. To analyze the fiber optil receiver operation and configuration.
5. To analyze and integrate fiber optical network components in variety of networking schemes, SONET/ SDH and operational principles WDM.
6. To analyze the system performance of optical transmitters,,receivers and optical amplifiers.
7. To analyze and deign optical fiber link with encapsulation of different system components.
8. To be familiar with different optical Components like Optical couplers, Tunable sources and Filters ,optical MUX/DEMUX, Arrayed waveguide grating, optical add drop multiplexer (OADM), optical cirulators, attenuators, optical cross connects, wavelength converter, Mach-Zender Interferometer.
9. To understand various Fiber Optical Measurement instruments such as OTDR.

List of Experiments:

1. Setting -up of Analog/ Digital Optical communication Link
2. Measurement of attenuation characteristics of an optical fiber
3. Measurement of NA of a multimode fiber
4. Measurement of Mode field diameter of a single mode fiber.
5. Measurement of Dispersion of optical fiber
6. Performance of PAM on fiber optic link
7. Performance of PWM on fiber optic link
8. Performance of PPM on fiber optic link
9. Measurement of attenuation with OTDR
10. Measurement of emission wavelength of LED/LASER source
11. Measurement of Data quality with EYE PATTERN
12. Preparation of optical fiber end and practices on splicing/connectorization.
13. Performance of TDM on fiber optic link
14. Setting -up of voice link on Optical communication Link.
15. Performing Experiments on the VI characteristics of the optical Sources.
16. Performing Experiments on the characteristics of the optical detectors.

Design based Problems (DP)/Open Ended Problem:
Open ended Problem:
1) Calculation of G. I. fiber parameters like Normalized frequency, No. of Guided Modes based on given data.

2) Determining the S.I. fiber parameters based on given data.

3) Calculation and determination of fiber optical sources parameters like LED,LASER based on given data.

4) Analysis of power link budget and various parameters.

5) Determination and calculations of Various photo detectors (PIN,APD) parameters based on given data.
6) Analysis and calculations of various power launching Techniques parameters based on given data.

7) Analysis and calculations of various parameters of fiber optic passive network components.

Major Equipments: Fiber Optical Trainer Kit, Laser Source, Photo Detector, Optical Power Meter, OTDR,WDM trainer setup, splicing and connectorization kits.

List of Open Source Software/learning website:

- http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Optical%20Communication/Course%20Objective.htm

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics as well as posters for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three group task of students should be submitted to GTU.

Visit to BSNL/Reliance Telecommunication may be arranged and the best report with photographs should be uploaded on the department website.