ECT413	OPTICAL FIBER COMMUNICATION	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to introduce the concepts of light transmission through optical fibers and introduce the working of optical components.

Prerequisite: Basic concepts of Solid State Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the working and classification of optical fibers in terms of propagation modes
CO 2	Solve problems of transmission characteristics and losses in optical fiber
CO 3	Explain the constructional features and the characteristics of optical sources and detectors
CO4	Describe the operations of optical amplifiers
CO5	Understand the concept of WDM, FSO and LiFi

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	1									1
CO 2	3	3	2									1
CO 3	3	3	2									1
CO 4	3	3	1									1
CO 5	3	3	2									1

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	: 10marks
Continuous Assessment Test(2numbers)	: 25 marks
Assignment/Quiz/Course project	: 15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Know the classification and working of optical fiber with different modes of signal propagation

1. Illustrate the types of optical fibers with refractive index profiles.
2. Define Photonic Crystal Fibers and list the types.
3. What is the necessity of cladding for an optical fiber?

Course Outcome 2 (CO2): Understand the transmission characteristics and losses in optical fiber

1. Describe the various attenuation losses incurred by light signal while transmitting through a fiber.
2. What is meant by group velocity dispersion?
3. An optical fiber has an attenuation coefficient of 0.5dB/km at 1310nm. Find the optical power at 25km if 500μW of optical power is launched into the fiber.

Course Outcome 3 (CO3): Describe the constructional features and the characteristics of optical sources and detectors

1. What is a heterojunction? How it increases the radiance and efficiency of LEDs?
2. Draw the basic block diagram of an optical receiver and explain.

Course Outcome 4 (CO4): Describe the performance of optical amplifiers

1. What are salient features of semiconductor optical amplifiers?
2. Explain the amplification mechanism with energy level diagram in an EDFA.

Course Outcome 5 (CO5): Know the concept of WDM, FSO and LiFi

1. What are the underlying principles of the WDM techniques?
2. Explain in detail diffraction gratings.
3. Write a note on optical Add / Drop multiplexers.

SYLLABUS

Module 1:

Optical fiber Communications: The general system, Advantages of optical fiber communication, Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity

Fibres: Types and refractive index profiles, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fibre materials, photonic crystal fibre, index guiding PCF, photonic band-gap fibres, fibre cables.

Module 2:

Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber.

Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers.

Module 3:

Optical sources:LEDs and LDs, structures, characteristics**,**modulators using LEDs and LDs. coupling with fibres, noise in Laser diodes, Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications

Optical detectors: Types and characteristics, structure and workingof PIN and AP, noise in detectors, comparison of performance.Optical receivers, Ideal photo receiver and quantum limit ofdetection.

Module 4:

Optical Amplifiers:basic concept, applications, types, doped fibre amplifiers, EDFA, basic theory, structure and working, Semiconductor laser amplifier, Raman amplifiers, TDFA, amplifier configurations, performance comparison.

Module 5:

The WDM concept, WDM standards, WDM components, couplers, splitters, Add/ Drop multiplexers, gratings, tunable filters. Introduction to free space optics, LiFi technology and VLC. Optical Time Domain Reflectometer (OTDR) – fault detection length and refractive index measurements.

Text Books

1. Gerd Keiser, Optical Fiber Communications, 5/e, McGraw Hill, 2013.
2. Mishra and Ugale, Fibre optic Communication, Wiley, 2013.

Reference Books

1. Chakrabarthi, Optical Fibre Communication, McGraw Hill, 2015.
2. Hebbar, Optical fibre communication, Elsevier, 2014
3. John M Senior- Optical communications, 3/e, Pearson, 2009.
4. Joseph C. Palais, Fibre Optic Communications, 5/e Pearson, 2013.
5. Keiser, Optical Communication Essentials (SIE), 1/e McGraw Hill Education New Delhi, 2008.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Optical fiber Communications**	**(8)**
1.1	The general system, Advantages of optical fiber communication	1
1.2	Optical fiber waveguides: Ray theory transmission	1
1.3	Modes in planar guide, Phase and group velocity	1
1.4	Fibres: Types and refractive index profiles, Step index fibers, Graded index fibers, Single mode fibers	2
1.5	Cutoff wavelength, Mode field diameter, effective refractive index	1
1.6	Fibre materials, photonic crystal fibre, index guiding PCF, photonic band-gap fibres, fibre cables.	2
2	**Transmission characteristics of optical fiber:**	**(7)**
2.1	Attenuation, Material absorption losses	1
2.2	Linear scattering losses	1
2.3	Nonlinear scattering losses, Fiber bend loss	1
2.4	Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber	2
2.5	Optical Fiber Connectors: Fiber alignment and joint loss	1
2.6	Fiber splices, Fiber connectors, Fiber couplers	1
3	**Optical sources and detectors:**	**(8)**
3.1	LEDs and LDs, structures, characteristics, modulators using LEDs and LDs	2
3.2	coupling with fibres, noise in Laser diodes	1
3.3	Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications	1
3.4	Optical detectors: Types and characteristics, structure and working of PIN and AP	2
3.5	noise in detectors, comparison of performance	1
3.6	Optical receivers, Ideal photo receiver and quantum limit of detection.	1
4	**Optical Amplifiers:**	**(6)**
4.1	basic concept, applications, types	1
4.2	doped fibre amplifiers, EDFA, basic theory, structure and working	2
4.3	Semiconductor laser amplifier	1
4.4	Raman amplifiers, TDFA	1
4.5	amplifier configurations, performance comparison	1
5	**The WDM concept**	**(6)**
5.1	WDM standards, WDM components	1
5.2	couplers, splitters, Add/ Drop multiplexers	1
5.3	gratings, tunable filters	1
5.4	Introduction to free space optics, LiFi technology and VLC	1

5.5	Optical Time Domain Reflectometer (OTDR) – fault detection length and refractive index measurements.	2
	Total	**35**

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT413

Program: Electronics and Communication Engineering

Course Name: Optical Fiber Communication

Max.Marks: 100 Duration: 3Hours

PART- A

Answer ALL Questions. Each Carries 3 mark.

1. Define acceptance angle and critical angle. K1
2. What is the necessity of cladding for an optical fiber? K3
3. What is meant by group velocity dispersion? K2
4. Explain intermodal dispersion? K2
5. Differentiate between spontaneous and stimulated emission. K1
6. Draw the three key transition process involved in LASER action. K1
7. Compare EDFA and TDFA. K2
8. What is the principle of Raman amplifiers? K2
9. Define FSO concept. List the advantages. K2
10. Write short note on LiFi technology. K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module – I

11. a)	With block diagram explain a general light wave system. What are the advantages of optical communication?	7	CO1	K2
11. b)	i) Define Photonic Crystal Fibers . ii) Consider an optical fiber of 50 μm diameter, core index n1 = 1.5, and cladding index n2 = 1.49 for operation at λ = 1.31 μm. How many modes does this fiber support?	7	CO1	K2
	OR			
12.a)	Illustrate the types of optical fibers with refractive index profiles.	6	CO1	K2
12.b)	Explain the following : (i) Acceptance angle (ii) Numerical aperture	8	CO1	K2

	If for a given optical fiber the refractive index of cladding and core are 1.45 and 1.47 respectively, calculate the numerical aperture and angle of acceptance in air.			

Module – II

13. a)	Explain macro bending and micro bending losses with a neat diagram.	10	CO2	K2
13. b)	An optical fiber has an attenuation coefficient of 0.5dB/km at 1310nm. Find the optical power at 25km if 500μW of optical power is launched into the fiber.	4	CO2	K3
	OR			
14.a)	Describe the various attenuation losses incurred by light signal while transmitting through a fiber.	9	CO2	K2
14.b)	Given an optical fiber of 50 μm diameter, core index of 1.5, and cladding index 1.49 for operation at $\lambda = 1.31$ μm, What would be the pulse spread due to modal dispersion over a distance of 10 km?	5	CO2	K2

Module-III

15 a)	With neat sketch explain the working of pin photodiode and APD	10	CO3	K2
15 b)	What is meant by responsivity? How it is related to quantum efficiency?	4	CO3	K3
	OR			
16a	What is a heterojunction? How it increases the radiance and efficiency of LEDs?	7	CO3	K3
16b	Draw the basic block diagram of an optical receiver and explain.	7	CO3	K2

Module-IV

17 a)	Explain the amplification mechanism with energy level diagram in an EDFA.	8	CO4	K2
17 b)	Compare the performance of different optical amplifiers	6	CO4	K2
	OR			
18 a)	Explain the working of semiconductor optical amplifiers. What are salient features of semiconductor optical amplifiers?	7	CO4	K2
18 b)	What are different amplifier configurations? Explain the basic working principle of optical amplifiers.	7	CO4	K2

Module-V

19 a)	With neat sketch explain WDM scheme.	7	CO5	K2
19 b)	Illustrate the working principle of diffraction gratings.	7	CO5	K2
	OR			
20 a)	Explain with block diagram the working of optical add / drop multiplexer. Explain why it is required in optical communication system.	7	CO5	K2
20 b)	How does an OTDR works? Explain the fault detection and refractive index measurement.	7	CO5	K2

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