INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATIONENGINEERING

COURSE DESCRIPTOR

Course Title	**OPTICAL COMMUNICATION**				
Course Code	**AEC018**				
Programme	B.Tech				
Semester	VIII	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. U Soma Naidu , Assistant Professor				
Course Faculty	Mr. U Soma Naidu , Assistant Professor				

I. COURSE OVERVIEW:

The present course covers the concepts and techniques of modern Optical Fiber Communication to vector nature of light, propagation light in a cylindrical dielectric rod, rays and modes, modal analysis of a step indez fiber linearly polarized modes, single mode fibers and graded-index fiber. Optical Communication which are fundamental to all the optical Fiber Communication, Signal degradation and Optical Sources, Optical detectors, optical Amplifier and Optical Networks and Dispersion compensation. The course starts with a detailed overview of Optical Fiber Communication, Nature light, different types of optical fibers, modal analysis, Attenuation-Absorption, scattering losses, bending losses, and core and cladding losses.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEC007	IV	Electromagnetic Theory and Transmission Lines	4
UG	AEC011	V	Antennas and Propagation	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Microwave Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for continuous internal assessment (CIA) and 70 marks for semester end examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lectures, Assignments, Exercises
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	1	Problem related exercises
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Design Exercises
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** An ability to understand the basic concepts in electronics & communication engineering and to apply them to various areas, like electronics, communications, signal processing, VLSI, embedded systems etc., in the design and implementation of complex systems.	2	Lectures and Assignments
PSO 2	**Problem-Solving Skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	-	-
PSO 3	**Successful Career and Entrepreneurship:** An understanding of social awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal Resources as an Entrepreneur.	2	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors. Design optimization of SM fibers, RI profile and cut-off wave length.
II	Interpret various optical source materials, LED structures, quantum efficiency, Laser diodes and different fiber amplifiers.
III	Understand fiber optical receivers such as PIN APD diodes, noise performance in photo detector, receiver operation and configuration.
IV	Analyze fiber slicing and connectors, noise effects on system performance, operational principles WDM and solutions.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Overview Of Optical Fiber Communication, Vector Nature Of light, types of optical fibers, modal analysis.	CLO 1	Understand Basic principles of optical fiber Communications.
		CLO 2	Define light, propagation of light, modes, propagation of light different levels.
		CLO 3	Given the propagation of light in a cylindrical dielectric rod; rays and modes types of optical fibers.

COs	Course Outcome	CLOs	Course Learning Outcome
		CLO 4	Given the Photonic components in optical communication systems.
CO 2	Understand Signal Degradation And Optical Sources, Attenuation-Absorption, Material Dispersion, Optical sources, Principles of operation.	CLO 5	Understand modal analysis of a step index fiber, linearly polarized modes, single mode fibers and graded - index fiber.
		CLO 6	Understand Signal Degradation And Optical Sources, Attenuation- Absorption, scattering losses, bending losses, core.
		CLO 7	Explain cladding losses, optical waveguides; Material Dispersion, Waveguide Dispersion; Optical sources.
		CLO 8	Understand phase noise, switching and modulation characteristics.
CO 3	Understand Optical Detectors, Optical Erectors, Sensitivity And Quantum Efficiency, WDM Concepts And Components	CLO 9	Understand phase noise, switching and modulation characteristics.
		CLO 10	Define Optical detectors: pin detector, avalanche photodiode.
		CLO 11	Understand Principles of operation, concepts of responsively, sensitivity and quantum efficiency, noise in detection.
CO 4	Understand Optical Amplifiers, Basic concepts, semiconductor amplifier, principles of operation, intermediation effects	CLO 12	Explain Multichannel Transmission technique-Multichannel Frequency Modulation Subcarrier multiplexing. WDM Concepts and Components.
		CLO 13	Understand semiconductor amplifier, erbium-doped fiber amplifier, Raman amplifier, Brillion amplifier.
		CLO 14	Understand principles of operation, amplifier noise, signal to noise ratio, gain, gain bandwidth, gain.
CO 5	Understand Optical Networks And Dispersion Compensation, Optical networks, soliton based communication system design.	CLO 15	Explain noise dependencies, inter modulation effects, saturation induced crosstalk, wavelength range of operation.
		CLO 16	Design Optical networks-SONET/SDH, ATM, IP, wavelength routed networks, soliton communication system.
		CLO 17	Understand Fiber soliton, soliton based communication system design, high capacity and WDM soliton.

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X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEC018.01	CLO 1	Understand Basic principles of optical fiber Communications.	PO 1, PO12	2
AEC018.02	CLO 2	Define light, propagation of light, modes, propagation of light different levels.	PO 1, PO 2 PO 4, PO 12	1
AEC018.03	CLO 3	Given the propagation of light in a cylindrical dielectric rod; rays and modes types of optical fibers.	PO 2	1
AEC018.04	CLO 4	Given the Photonic components in optical communication systems .	PO 1, PO 2	2
AEC018.05	CLO 5	Understand modal analysis of a step index fiber, linearly polarized modes, single mode fibers and graded - index fiber.	PO 1	1
AEC018.06	CLO 6	Understand Signal Degradation And Optical Sources, Attenuation- Absorption, scattering losses, bending losses, core.	PO 1	1
AEC018.07	CLO 7	Explain cladding losses, optical waveguides; Material Dispersion, Waveguide Dispersion; Optical sources.	PO 1, PO 4	2
AEC018.08	CLO 8	Explain Semiconductor device fabrication, LED and LASER diode; Principles of operation, concepts of line width.	PO 1	2
AEC018.09	CLO 9	Understand phase noise, switching and modulation characteristics	PO 1, PO 2 PO 4, PO 12	1
AEC018.10	CLO 10	Define Optical detectors: pin detector, avalanche photodiode.	PO 4	2
AEC018.11	CLO 11	Understand Principles of operation, concepts of responsively, sensitivity and quantum efficiency, noise in detection.	PO 4	2
AEC018.12	CLO 12	Explain Multichannel Transmission Technique-Multichannel Frequency Modulation, Subcarrier multiplexing. WDM Concepts and Components.	PO 1, PO 4 PO 12	2
AEC018.13	CLO 13	Understand semiconductor amplifier, erbium-doped fiber amplifier, Raman amplifier, Brillouin amplifier.	PO 1, PO 4 PO 12	2
AEC018.14	CLO 14	Understand principles of operation, amplifier noise, signal to noise ratio, gain, gain	PO 1, PO 4	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		bandwidth, gain.		
AEC018.15	CLO 15	Explain noise dependencies, inter modulation effects, saturation induced crosstalk, wavelength range of operation.	PO 1, PO 12	2
AEC018.16	CLO 16	Design Optical networks-SONET/SDH, ATM, IP, wavelength routed networks, soliton communication system.	PO 1	2
AEC018.17	CLO 17	Understand Fiber soliton, soliton based communication system design, high capacity and WDM soliton.	PO 1, PO 12	1

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)				
	PO 1	PO 2	PO 4	PO 12	PSO 1
CO 1	3	2	2	1	1
CO 2		2			
CO 3	3	2	2	2	1
CO 4	3	2	1		1
CO 5	3	2		2	

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2											1	1		
CLO 2	1	2		1								1			
CLO 3		1													
CLO 4	2	1													
CLO 5	1														
CLO 6	1														
CLO 7	1			2											

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CLO 8	2			3									1		
CLO 9	2	1		2								1	1		
CLO 10		1		2											
CLO 11		2		1											
CLO 12	3	1		1								3			
CLO 13	3			2								3	1		
CLO 14	1			2											
CLO 15	2											2			
CLO 16	1														
CLO 17	1											3			

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XIII. ASSESSMENT METHODOLOGIES–DIRECT:

CIE Exams	PO1,PO2, PO4,PO12, PSO1	SEE Exams	PO1, PO2, PO4, PO12, PSO1	Assignments	PO1, PO2, PO4,PO12, PSO1	Seminars	PO1,PO2, PO4,PO12, PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1,PO2, PO4,PO12, PSO1						

XIV. ASSESSMENT METHODOLOGIES–INDIRECT:

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS:

UNIT - I	OVERVIEW OF OPTICAL FIBRE COMMUNICATION
Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod; rays and modes; different types of optical fibers, modal analysis of a step index fiber, linearly polarized modes, single mode fibers and graded - index fiber.	

UNIT - II	SIGNAL DEGRADATION AND OPTICAL SOURCES
Attenuation- Absorption, scattering losses, bending losses, core and cladding losses; signal distortion in optical waveguides; Material Dispersion, Waveguide Dispersion; Optical sources; Semiconductor device fabrication, LED and LASER diode; Principles of operation, concepts of line width, phase noise, switching and modulation characteristics.	
UNIT - III	**OPTICAL DETECTORS**
Optical detectors: pin detector, avalanche photodiode - Principles of operation, concepts of responsively, sensitivity and quantum efficiency, noise in detection. Multichannel Transmission Technique-Multichannel Frequency Modulation, Subcarrier multiplexing. WDM Concepts and Components.	
UNIT - IV	**OPTICAL AMPLIFIERS**
Basic concepts, semiconductor amplifier, erbium-doped fiber amplifier, Raman amplifier, Brillouin amplifier - principles of operation, amplifier noise, signal to noise ratio, gain, gain bandwidth, gain and noise dependencies, inter modulation effects, saturation induced crosstalk, wavelength range of operation.	
UNIT - V	**OPTICAL NETWORKS AND DISPERSION COMPENSATION**
Optical networks: SONET/SDH, ATM, IP, wavelength routed networks, soliton communication system, fiber soliton, soliton based communication system design, high capacity and WDM soliton.	
Text Books:	
1. Keiser. G, "Optical fiber communications", Tata McGraw-Hill, 4th Edition, New Delhi, 2008. 2. Agrawal. G.P, "Fiber-Optic Communication Systems" John Wiley & Sons, 3rd Edition, 2002. 3. Emmanuel C, Ifeacher, Barrie. W. Jervis, DSP-A Practical Approach, Pearson Education, 2nd Edition, 2002.	
Reference Books:	
1. John Gowar, "Optical Communication Systems", Prentice Hall, 2nd Edition, 1993. 2. Franz, Jain, "Optical communication, Systems and Components", Narosa Publications, 1st Edition New Delhi, 2000. 3. Karminvov, T. Li "Optical Fibre Telecommunications", Vol A & B, Academic Press, 2002.	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Explain the Overview of Optical Fiber Communication.	CLO 1	T1,2.1,29-35
4-7	Propagation of light, propagation of light in a cylindrical dielectric rod; rays and modes.	CLO 1	T1,2.3,40-53

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
8-10	Different types of optical fibers, modal analysis of a step index fiber.	CLO 2	T1,2.4,54-63
11-13	linearly polarized modes, single mode fibers and	CLO 2	T1,2.6,65-67
14-17	Graded - index fiber.	CLO 3	T1,2.6,65-67
18-21	Attenuation-Absorption, scattering losses, bending losses, core and cladding losses.	CLO 5	T1,3.1,90-113
22-26	Signal distortion in optical waveguides; Material Dispersion, Waveguide Dispersion.	CLO 6	T2,2.3,37-43
27-29	Optical sources, Semiconductor device fabrication, LED and LASER diode.	CLO 8	T1,4.1-4.3,134-160
30-33	Principles of operation, concepts of line width, phase noise, switching and modulation characteristics.	CLO 9	T1,4.4-4.6,134-160
34-37	Optical detectors: pin detector, avalanche photodiode - Principles of operation, concepts of responsively, sensitivity and quantum efficiency, noise in detection.	CLO 10	T2,4.1-4.6,133-171 & T1,6.1-6.3,222-238
38-40	Multichannel Transmission Technique-Multichannel Frequency Modulation, Subcarrier multiplexing.	CLO 11	T1,9.3,323-329
41-43	WDM Concepts and Components.	CLO 12	T1,10.1-10.8,340-380
44-47	Basic concepts, semiconductor amplifier, erbium-doped fiber amplifier.	CLO 13	T1,11.1-11.3,392-406
48-52	Raman amplifier, Brillouin amplifier Principles of operation, amplifier noise, signal to noise ratio, gain, and gain bandwidth, gain and noise dependencies.	CLO 14	T1,11.4-11.8,407-414 & T2,6.3-6.4,243-250
53-55	Inter modulation effects, saturation induced crosstalk, wavelength range of operation.	CLO 15	T1,11.4-11.8,415-421
56-60	Optical networks: SONET/SDH, ATM, IP, wavelength routed networks, soliton communication system.	CLO 16	T1,13.1-13.3,453-475
61-65	Fiber soliton, soliton based communication system design, high capacity and WDM soliton.	CLO 17	T1,13.5-13.7,480-500

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Optical Networks	Seminars / NPTEL	PO 1, PO 2, PO 4	PSO 1
2	SONET/SDH, ATM, IP, wavelength routed networks	Seminars / Guest Lectures / NPTEL	PO 2, PO 4, PO 12	PSO 1

Prepared by:

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