Acropolis Technical Campus, Indore, 452020, (M.P.)

ELECTRONICS AND COMMUNICATION ENGINEERING

Course Plan

(UG)

Optical Communication

Course Code	**EC 7003**	Session: July-Dec 2018	Semester: VII
Tutor	Sneha Nagar	Revision date :	Branch: ECE
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1. Scheme of the Semester Containing the Course

Subject wise distribution of marks and corresponding credits (Grading System w.e.f-2013-14)

S.No.	Subject Code	Subject Name & Title	Maximum Marks Allotted							Credits Allotted Subject wise			Total Credits	Remark
			Theory Slot			Practical Slot			Total Marks					
			End Sem.	Mid Sem. MST (Two tests average)	Quiz, Assig-nment	End Sem	Term work			Period per week				
							Lab work & sessional	Assignment/ quiz		L	T	P		
1	EC-7003	**Optical Communication**	70	20	10	30	10	10	150	3	1	2	06	

2. Course Overview

The objective of this course is to introduce the students to the fundamental basics and understanding of fiber optical communication. This includes the properties of optical fibers and how are they used to establish optical links for communication systems. Students will be able to design an optical link by choosing various parameters and components.

We will begin with the basic principles of optical transmission and the operation of components used in optical networks. We will then describe the design and performance issues of optical communication links and systems.

3. Course Learning Objectives (CLO)

Student will

CLO1: Acquire awareness about optical communication fundamentals.

CLO2: Understand the Ray theory transmission in optical fiber,

CLO3: Understand the principal of LEDs, and semiconductor lasers,.

CLO4: Use analog link to analyze and predict the behavior of optical fiber networks.

CLO5: Use digital link to analyze and predict the behavior of optical fiber networks.

CLO6: Study and identified the different losses in optical fiber communication.

4. Course Outcomes (CO)

At the end of the course, student would be able to demonstrate the knowledge and ability to

CO1: Characterize the application of Optical Devices.

CO2: Demonstrate operation of optical fiber cable.

CO3: Analyze and investigate the operation of optical Components.

CO4: Compare the performance of optical Circuits.

CO5: Analyze various optical losses.

Course Outcome (CO)	CO Statement
CO.7003.1	Characterize the application of optical Devices.
CO.7003.2	Demonstrate operation of optical fiber
CO.7003.3	Analyze and investigate the operation of optical Components.
CO.7003.4	Compare the performance of optical fiber communication.
CO.7003.5	Analyze various optical losses.

5. Mapping Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

(Copy of programme related, PO and PSO are to be attached with this course plan)

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO.7003.1	3	3	3	2	2	3	3	-	1	3	2	1	3	2	3
CO.7003.2	3	3	1	2	1	3	2	-	2	2	2	3	2	2	3
CO.7034.3	3	3	3	2	2	3	2	-	2	3	2	3	3	3	2
CO.7034.4	3	1	2	2	3	2	3	-	3	3	3	2	2	3	2
CO.7003.5	3	1	3	2	1	2	2	-	2	2	1	2	1	1	3

Enter correlation level 1, 2, 3 as defined below-

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High) and if there is no correlation, put "---".

6. Topic delivery details of "Content beyond the Syllabus" for the attainment of POs and PSOs.

Sr. No.	Content Beyond syllabus to be taught	Satisfying PO	Satisfying PSO
1.	Ray theory transmission	a,b,c,h,k,j	1,2
2.	Electromagnetic spectrum	a,b,c,h,k,j	1
3.	Law's of Physics.	a,b,c,d,g,h,i	1,3
4.	Semiconductor's.	a,b,c,h,k,f	1,4,5

7. Distribution of Course Work as per University Scheme

(Slot / Contact Type	Ingredients (per student)	Distribution of periods @ 1hr		Distribution of Marks Max. Marks As per University scheme		
		Number of hours per week	Per Sem (12 weeks)	End Sem	Internal	
					MST / LWS	Q/A
Theory Slot	Lecture (L)	3	36	70	25	5
	Tutorial (T)	3	36			
Practical Slot	Practical Work (P)	6	72	30	25	5

Internal Assessments are based on scheme provided by the university.

(3.a) No. of Theory Lectures Necessary for the course:

(3.b) No. of Theory Lectures Unit wise:

UNIT	I	II	III	IV	V	TOTAL
Assigned No. of Lectures per Unit →	7	8	7	6	7	35
Actual Taken	8 (6)	8 (10)	7 (9)	7	6 (10)	36

8. Time Schedules: Total expected periods from 17/07/2018 to 03/11/2018 as per Academic Calendar, excluding sports week, holidays etc.

Ingredients	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Max. Available	Needed	Excess / Short
Available	13	15	15	15	15	0			
Theory (L)	13			15	15				
Tutorials (T)			15	15					
Practical (P)	26			30	30				

9. Prerequisite(s)

a. Student should have familiarity with optical fiber communication.

b. Student should have Knowledge of Basics of Physical laws (reflection,refraction).

c. Student should have Knowledge of Electromagnetic field theory

10. Post Requisites

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a. The Student will understand different types of optical component and their application in industries.

11. University Syllabus

Theory

Unit-I

Overview of Optical Fiber Communications (OFC): Motivation, optical spectral bands, key elements of optical fiber systems. Optical fibers: basic optical laws and definitions, optical fiber modes and configurations, mode theory for circular waveguides, single mode fibers, graded-index fiber structure, fiber materials, photonic crystal fibers, fiber fabrication, fiber optic cables.

Unit-II

Optical sources: Light emitting diodes (LED): structures, materials, quantum efficiency, LED power, modulation of an LED. Laser diodes: modes, threshold conditions, laser diode rate equations, external quantum efficiency, resonant frequencies, structure and radiation patterns, single mode lasers, modulation of laser diodes. Power launching and coupling: source to fiber power launching, fiber to fiber joints, LED coupling to single mode fibers, fiber splicing, optical fiber connectors.

Unit-III

Photo detectors: pin photo detector, avalanche photodiodes, photo detector noise, detector response time, avalanche multiplication noise. Signal degradation in optical fibers: Attenuation: units, absorption, scattering losses, bending losses, core and cladding losses. Signal distortion in fibers: overview of distortion origins, modal delay, factors contributing to delay, group delay, material dispersion, waveguide dispersion, polarization-mode dispersion. Characteristics of single mode fibers: refractive index profiles, cutoff wavelength, dispersion calculations, mode field diameter, bending loss calculation. Specialty fibers.

Unit-IV

Optical receivers: fundamental receiver operation, digital receiver performance, eye diagrams, coherent detection: homodyne and heterodyne, burst mode receiver, analog receivers. Digital links: point to point links, link power budget, rise time budget, power penalties. Analog links: overview of analog links, carrier to noise ratio, multi channel transmission techniques.

Unit-V

Optical technologies Wavelength division multiplexing (WDM) concepts: operational principles of WDM, passive optical star coupler, isolators, circulators, active optical components: MEMS technology, variable optical attenuators, tunable optical filters, dynamic gain equalizers, polarization controller, chromatic dispersion compensators. Optical amplifiers: basic applications and types of optical amplifiers, Erbium Doped Fiber Amplifiers (EDFA): amplification mechanism, architecture, power conversion efficiency and gain. Amplifier noise, optical SNR, system applications. Performance Measurement and monitoring: measurement standards, basic test equipment, optical power measurements, optical fiber characterization, eye diagram tests, optical time-domain reflectometer, optical performance monitoring.

Tutorials: All the Numerical Part of the Syllabus will be cover in Tutorial.

Practicals:

Exp. No.	Title of the experiment
1	To study and perform the Setting of Optical Fiber Analog link.
2	To Study and perform the Setting of Optical Fiber Digital link.
3	To measure losses in Optical Fiber
4	To measure the Numerical Aperture (NA) of the Optical fiber
5	To study and plot characteristics of Fiber Optic LED and Photo detector
6	To Study and plot Eye Pattern.
7	To Study and perform Time Division Multiplexing

12. Books prescribed by the University

a. Optical fiber Communications : Principles and practice by John M.Senior, 3rd Edition, 2010, Pearson education

b. Optical Fiber Communication by Gerd Keiser, 5th Edition, 2013, Tata McGraw Hills

c. Fiber Optic Communications Technology by Djafar K Mynbaev & Lowell L Scheiner, 3rd Edition, 2008, Pearson Education.
d. J. Gowar, Optical communication systems by J. Gowar, 2nd Edition, 2001, Prentice-Hall of India.
e. Fiber-Optic Communication Systems by Govind P. Agrawal, 3rd Edition, 2007, Wiley India.

Additional books prescribed by the Tutor

1. Khare: Fiber Optics and Optoelectronics, Oxford University Press.
2. Ghatak and Thyagrajan: Fiber Optics and Lasers, Macmillan India Ltd.
3. Gupta: Optoelectronic Devices and Systems, PHI Learning.
4. Sterling: Introduction to Fiber Optics, Cengage Learning.
5. M. Kulkarni: Microwave & Radar Engineering, 3/e, Umesh Publication

e- Resources / Software requirement if any; and its availability

a. http://nptel.ac.in/

13. List of Lab experiments with COs

Exp. No.	Title of the experiment	CO(s)
1	Measuring Equipment	1,3
2	Modes of optical fibers	4
3	Analog links.	2
4	Digital link	5
5	Light emitting diode	1,3
6	Semiconductor laser	3,4
7	Optical Component	3,4
8	Optical losses	3
9	Total internal reflection	3,4
10	Optical detectors	3,4
11		5

14. Course / Lecture and Tutorial Schedule

Lr. No.	Unit No.	Topic to Cover / Content	Aim (CO)	Refererence no. [page to page].	No. of Student present	Completion Date
1-2	U1	**Overview of Optical Fiber Communications** (OFC): - Motivation, optical spectral bands and key elements of optical fiber systems.	1,2	a[124-130]	15	7/9/18
3			2,3	a[121-137]		
4					20	12/9/18
5		- Optical fibers: basic optical laws and definitions	2	a[137-147]	17	14/9/18
6		- optical fiber modes and configurations	3	a[490-500]		
7		- mode theory for circular waveguides,	3	5[37]	18	17/9/18
8		- single mode fibers, graded-index fiber structure,				
9		- fiber materials, photonic crystal fibers, fiber fabrication, fiber optic cables			20	19/9/18
		- Tutorials			20	18/9/18

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	U2	**Optical sources:**				
10		Light emitting diodes (LED): structures, materials, quantum	2	a[162]	10	25/9/18
11		efficiency,	3,5	a[163]	15	26/9/18
12		LED power, modulation of an LED.	3,5	a[167]		
13		Laser diodes: modes, threshold conditions,	3,5	a[166]	18	28/9/18
14		laser diode rate equations, external quantum efficiency, resonant	3,5	a[174]		1/10/18
15		frequencies,			20	3/10/18
		structure and radiation patterns, single	4,5	5[380]		
16		mode lasers,	3,5	5[108-110]	15	4/10/18
		modulation of laser diodes.				5/10/18
		Power launching and coupling: source to fiber power launching, fiber to fiber joints,			20	9/10/18
		LED coupling to single mode fibers, fiber splicing, optical fiber connectors.				9/10/18
		Tutorial			15	12/10/18
	U3	**Optical Detector**				
		Photo detectors: pin photo detector, avalanche photodiodes,			12	8/10/18
17-18		photo detector noise, detector	3,4	5[212]	8	9/10/18
		response time, avalanche				
19		multiplication noise.	3,4	5[214]		
20-21		Signal degradation in optical fibers:	3,4	5[287-300]	8	9/10/18
22		Attenuation: units, absorption,	3,4	6[223]		
		scattering losses, bending losses, core and cladding losses.			15	10/10/18
		Signal distortion in fibers: overview of distortion origins, modal delay, factors contributing to delay, group delay,			17	12/10/18 15/10/18
		material dispersion, waveguide dispersion, polarization-mode dispersion.			17	15/10/18
		Characteristics of single mode fibers: refractive index profiles, cutoff wavelength, dispersion calculations, mode field diameter, bending loss calculation. Specialty fibers.			10	16/10/18
		Tutorial			10	16/10/18

23-24 25 26 27	U4	**Optical receivers:** fundamental receiver operation, digital receiver performance, eye diagrams, coherent detection: homodyne and heterodyne, burst mode receiver, Analog receivers. Digital links: point to point links, link power budget, rise time budget, power penalties. Analog links: overview of analog links, carrier to noise ratio, multi channel transmission techniques. **Tutorial**	3,4 3,4 3,4 3,4 3,4	5[145] 5[170] 5[400] 5[475] 6[161]	10 15 15 10 8 10 8	16/10/18 17/10/18 17/10/18 22/10/18 23/10/18 22/10/18 23/10/18
28 29-30 31 32 33 34 35 36	U5	**Optical technologies** Wavelength division multiplexing (WDM) concepts: operational principles of WDM, passive optical star coupler, isolators, circulators, active optical components: MEMS technology, variable optical attenuators, tunable optical filters, dynamic gain equalizers, polarization controller, chromatic dispersion compensators. Optical amplifiers: basic applications and types of optical amplifiers, Erbium Doped Fiber Amplifiers (EDFA): amplification mechanism, architecture, power conversion efficiency and gain. Amplifier noise, optical SNR, system applications. Performance Measurement and monitoring: measurement standards, basic test equipment, optical power measurements, optical fiber characterization, eye diagram tests, optical time-domain reflectometer, optical performance monitoring Tutorial	5 5 5 5 5 5	5[320-321] 5[317] 5[318] 5[326] 5[526] 5[530]	12 12. 12 15 10 10 10 10 12 12	24/10/18 24/10/18 26/10/18 27/10/18 29/10/18 29/10/18 30/10/18 30/10/18 31/10/18 31/10/18
		Revision and Test 1				12/9/18
		Revision and Test 2				14/11/18

		Revision and Test 3				—
		Total				44

15. Evaluation and Assessment scheme: As per format no.....

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