Ref No:

Sri Krishna Institute of Technology,
Bangalore

COURSE PLAN

Academic Year 2019-2020

Program:	UG
Semester :	8th sem
Course Code:	*15ec82*
Course Title:	FIBER OPTICS AND NETWORKS
Credit / L-T-P:	4
Total Contact Hours:	50
Course Plan Author:	Dr. Devananda S.N

Academic Evaluation and Monitoring Cell

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A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	UG
Semester:	8	Academic Year:	2019-20
Course Title:	FIBER OPTICS AND NETWORKS	Course Code:	*15ec82*
Credit / L-T-P:	4	SEE Duration:	3 Hours
Total Contact Hours:	50	SEE Marks:	80
CIA Marks:	20	Assignment	5
Course Plan Author:	Dr. devananda S.N	Sign ..	
Checked By:	Syada N	Sign ..	
CO Targets	CIA Target :	SEE Target:	

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute.

Module	Content	Teaching Hours	Blooms Learning Levels
1	**Optical fiber Communications:** Historical development, The general system, Advantages of optical fiber communication, Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, Photonic crystal fibers	10	L1,L2
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.	10	L1,L2

	Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers.		
3	**Optical sources:** Energy Bands, Direct and Indirect Bandgaps, Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant frequencies, Laser Diode structures and Radiation Patterns: Single mode lasers. **Photodetectors:** Physical principles of Photodiodes, Photodetector noise, Detector response time. **Optical Receiver:** Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity, Quantum Limit.	10	L1,L2
4	**WDM Concepts and Components:** Overview of WDM: Operational Principles of WDM, WDM standards, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings, Active Optical Components, Tunable light sources, **Optical amplifiers:** Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers. (Text 1	10	L1,L2
5	**Optical Networks:** Optical network evolution and concepts: Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, Public telecommunication network overview. Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching, Optical burst switching networks, Optical network deployment: Long- haul networks, Metropoliton area networks, Access networks, Local area networks.	10	L1,L2

-	**Total**	**50**	

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
	1.Gerd Keiser, Optical Fiber Communication, 5th Edition McGraw Hill Education(India) Private Limited, 2015. ISBN:1-25-900687-5.	3,4	DEPART LIB
	2.John M Senior, Optical Fiber Communications, Principles and Practice, 3rdEdition, Pearson Education, 2010, ISBN:978-81-317-3266-3	1,2,5	DEPART LIB
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
	Joseph C Palais, Fiber Optic Communication , Pearson Education, 2005, ISBN:0130085103		
C	**Concept Videos or Simulation for Understanding**	**-**	**-**
C1			
C2			
C3			
C4			
C5			
D	**Software Tools for Design**	**-**	**-**
	NS2		
E	**Recent Developments for Research**	**-**	**-**
	Networking		
	Splicing, connectors,couplers		
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1	Notes		

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.
Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
1	*15ec82*	*Fiber optic and networks*	Basic of ray theory	8	Fundamental of light propagation	L1

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
5	WDM ,SWITCHING NETWORKING	NETWORKING		L2

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs.

Modules	Course Code.	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Instr Method	Assessment Method	Blooms' Level
1	*15ec82*	Classification and working of optical fiber with different modes of signal propagation.	10	LECTURE/ PPT/ TUTORIAL	Assignment and Slip Test	L2 Understand
2	*15ec82*	Describe the transmission characteristics and losses in optical fiber communication.	10	LECTURE/ PPT/ TUTORIAL	Assignment and Slip Test	L2 Understand
3	*15ec82*	Describe the construction and working principle of optical connectors, multiplexers and amplifiers	10	LECTURE/ PPT/ TUTORIAL	Assignment and Slip Test	L2 Understand
4	*15ec82*	Describe the constructional features and the characteristics of optical sources and detectors.	10	LECTURE/ PPT/ TUTORIAL	Assignment and Slip Test	L2 Understand
5	*15ec82*	Illustrate the networking aspects of optical fiber and describe various standards associated with it.	10	LECTURE/ PPT/ TUTORIAL	Assignment and Slip Test	L2 Understand
-	**-**	**Total**	**50**	**-**	**-**	**L2**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Sensors,photo electronics	CO1	L2
2	Dynamic light scattering, Tunable laser diodes	CO2	L2
3	Multifrequency Lasers, Multimedia MAC protocol	CO3	L2
4	Optical neural networks	CO4	L2
5	Cable Televisison signals, Long distance communication	CO5	L2

3. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes														-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	Level
1	15EC82.1	Understand the basic principle	3	2	1													

		of optical fiber communication with Ray theory.																	
2	15EC82.2	Understand the different modes used in optical fiber communication.	3	2	1														
3	15EC82.3	Understand the transmission characteristics and losses in optical fiber	3	2	1														
4	15EC82.4	Understand the optical fiber joints and connectors used in optical fiber communication.	3	2	1														
5	15EC82.5	Explain the optical sources used in optical fiber communication.	3	2	1														
-	**15EE662.**	Average																	**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																	

4. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Basic of ray theory, and fundamental of light propagation and nature of light	Seminar	2nd week / date feb 22nd	Dr Devananda S.N	List from B4 above

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Optical fiber Communications	10	2	-	-	1	1	2	CO1, CO2	L1
2	Transmission characteristics of optical fiber, Optical Fiber Connectors	10	2	-	-	1	1	2	CO2, CO3	L2
3	Optical sources, Photodetectors and Optical Receiver	10	-	2	-	1	1	2	CO3, CO4	L2
4	WDM Concepts and Components, Optical amplifiers	10	-	2	-	1	1	2	CO3, CO4	L2
5	Optical Networks	10	-	-	4	1	1	2	CO4, CO5	L2
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	15	CO1, CO2, CO3, CO4	L2
3, 4	CIA Exam – 2	15	CO5, CO5, CO5, C05	L2
5	CIA Exam – 3	15	CO5, CO5	L2

1, 2	Assignment - 1	03	CO1, CO2, CO3, CO4	L2
3, 4	Assignment - 2	03	CO5, CO5, CO5, C05	L2
5	Assignment - 3	03	CO5, CO5	L2
1, 2	Seminar - 1	02	CO1, CO2, CO3, CO4	L2
3, 4	Seminar - 2	02	CO5, CO5, CO5, C05	L2
5	Seminar - 3	02	CO5, CO5	L2
1, 2	Quiz - 1		-	-
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-		
	Final CIA Marks		**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:		Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	The student should be able to:	-	**Level**
1		CO1	L2
2		CO2	L2
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
1	**Optical fiber Communications:** Historical development, The general system	CO1	L1
2	Advantages of optical fiber communication	CO1	L2
3	Optical fiber waveguides: Ray theory transmission	CO1	L2
4	Ray theory transmission	CO1	L2
5	Modes in planar guide	CO1	L2
6	Phase and group velocity	CO1	L2
7	Cylindrical fiber: Modes	CO2	L2
8	Step index fibers, Graded index fibers	CO2	L2
9	Single mode fibers, Cutoff wavelength	CO2	L2
10	Mode field diameter, effective refractive index	CO2	L2
11	Fiber Materials, Photonic crystal fibers.	CO2	L2
c	**Application Areas**		
-	Students should be able employ / apply the Module learnings to . . .		
1	Transmit telephone signals,Internet communication	CO1	L2
2	Cable Televisison signals, Long distance communication	CO2	L2
d	**Review Questions**		
1	Using Snell's law derive an expression for numerical aperture of a fiber optic cable.	CO1	L2
2	Explain total internal reflection and photonic crystal fibers.	CO1	L2
3	Derive an expression for pulse spreading due to material desperation.	CO1	L2
4	What are the advantages and disadvantages of OFC.	CO2	L2
5	Derive necessary mathematical condition that the angle of incidence **ɵ(teta)** must satisfy optical skew ray to propagate in the step index fiber.	CO2	L2
6	Explain the different types of absorption loss in optical fiber communication	CO1	L2
7	Derive an expression for NA using ray theory.	CO1	L2
8	In brief discuss the different design approaches for single mode fibers	CO1	L2

9	In brief explain linear scattering losses.	CO1	L2
10	Derive the expression for RMS – Pulse broadening due to inter modal dispersion in step index fiber.	CO1	L2
11	Explain the GaAlAs double – hetero junction LED structure.	CO2	L2
12	Explain the structure of RAPD and its working	CO2	L2
13	Explain lensing schemes for coupling improvement.	CO2	L2
14	Discuss different types of non linear losses	CO2	L2
15	Explain with the help of neat diagram, distributed feedback laser diode.	CO1	L2
16	With appropriate mathematical equations explain single-mode fiber joints	CO1	L2
e	**Experiences**	-	-
1		CO1	L2
2			

Module – 2

Title:		Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	The student should be able to:	-	**Level**
1		CO3	L2
2		CO4	L2
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
12	**Transmission characteristics of optical fiber:** Attenuation	CO3	L2
13	Material absorption losses, Linear scattering losses	CO3	L2
14	Nonlinear scattering losses	CO3	L2
15	Fiber bend loss	CO3	L2
16	Dispersion, Chromatic dispersion	CO3	L2
17	Intermodal dispersion: Multimode step index fiber	CO3	L2
18	**Optical Fiber Connectors:** Fiber alignment and joint loss	CO4	L2
19	Fiber alignment and joint loss	CO4	L2
20	Fiber splices	CO4	L2
21	Fiber connectors	CO4	L2
22	Fiber couplers	CO4	L2
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Sensors, photo electronics	CO3	L2
2	Green house gas measurements, Lasers	CO4	L2
d	**Review Questions**	-	-
17	Explain fiber bending loss with a neat diagram.	CO3	L2
18	Explain GaAs homo junction injection laser with fabriperot cavity and also derive its quantum efficiency of the above laser.	CO3	L3
19	Derive an expression for pulse spreading due to material disperssion which is a function of wavelength and time delay.	CO3	L2
20	Explain different types of bending losses in optical fiber.	CO3	L2
21	Draw the cross section of GaAlAs double hetero structure LED energy band diagram and refrative index variation. Explain their importance.	CO3	L3
22	Derive an expression for Lacing condition and hence for optical gain in lasers.	CO3	L3
23	With proper sketch briefly explain the structure of RPAD photo diode.	CO3	L3
24	Show that optical power coupled into a step index fiber due to an Led with Lambartian distribution is given by $P=P_s(NA)^2$ For $r_s<=a$, with usual notation.	CO3	L3
25	List out the requirement that a good connector design has to meet.	CO3	L3

26	In brief explain basic structure of an optical receiver.	CO3	L3
27	Discuss the features of eye pattern.	CO4	L3
28	Write a short note on "Burst mode receiver".	CO4	L3
29	Explain fusion splicing of optical fibers with appropriate equations.	CO4	L2
30	Illustrate the different types of scattering losses in optical fiber with suitable equations	CO4	L3
31	Explain what is meant by critical bending radius for an optical fiber	CO4	L2
e	**Experiences**	-	-
1		CO3	L2
2			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Code:	15EC82	Sem:	VIII	Marks:	30	Time:	75 minutes
Course:	Fiber Optics and Networks						

-	-	**Note: Answer all questions, each carry equal marks. Module : 1, 2**	**Marks**	**CO**	**Level**
		PART A			
1	a	Derive an expression for pulse spreading due to material desperation.	8	CO1	L2
	b	Derive the expression for RMS – Pulse broadening due to inter modal dispersion in step index fiber.	7	CO1	L2
		OR			
2	a	Explain the GaAlAs double – hetero junction LED structure.	8	CO2	L2
	b	What are the advantages and disadvantages of OFC.	7	CO2	L2
		PART-B			
3	a	List out the requirement that a good connector design has to meet.	8	C03	L2
	b	In brief explain basic structure of an optical receiver.	7	C03	L3
		OR			
4	a	Write a short note on "Burst mode receiver".	8	C04	L3
	b	Explain fusion splicing of optical fibers with appropriate equations.	7	C04	L3

b. Assignment -1

			Model Assignment Questions				
Crs Code:	15EC82		Sem:	8	Marks:	5 / 10	Time:	90 – 120 minutes
Course:		Fiber Optics and Networks					
		Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.					

SNo	**USN**	**Assignment Description**	**Marks**	**CO**	**Level**
1		Using Snell's law derive an expression for numerical aperture of a fiber optic cable.	8	CO1	L2
2		Explain total internal reflection and photonic crystal fibers.	8	CO1	L2
3		Derive an expression for pulse spreading due to material desperation.	6	CO1	L2
4		What are the advantages and disadvantages of OFC.	6	CO2	L2
5		Derive necessary mathematical condition that the angle of incidence **e**(teta) must satisfy optical skew ray to propagate in the step index fiber.	4	CO2	L2

6		Explain the different types of absorption loss in optical fiber communication	7	CO1	L2
7		Derive an expression for NA using ray theory.	7	CO1	L2
8		In brief discuss the different design approaches for single mode fibers	7	CO1	L2
9		In brief explain linear scattering losses.	7	CO1	L2
10		Derive the expression for RMS – Pulse broadening due to inter modal dispersion in step index fiber.	5	CO1	L2
11		Explain the GaAlAs double – hetero junction LED structure.	4	CO2	L2
12		Explain the structure of RAPD and its working	6	CO2	L2
13		Explain lensing schemes for coupling improvement.	6	CO2	L2
14		Discuss different types of non linear losses	6	CO2	L2
15		Explain with the help of neat diagram, distributed feedback laser diode.	6	CO1	L2
16		With appropriate mathematical equations explain single-mode fiber joints	4	CO1	L2
17		Explain fiber bending loss with a neat diagram.	6	CO3	L2
18		Explain GaAs homo junction injection laser with fabriperot cavity and also derive its quantum efficiency of the above laser.	10	CO3	L3
19		Derive an expression for pulse spreading due to material disperssion which is a function of wavelength and time delay.	7	CO3	L2
20		Explain different types of bending losses in optical fiber.	8	CO3	L2
21		Draw the cross section of GaAlAs double hetero structure LED energy band diagram and refrative index variation. Explain their importance.	9	CO3	L3
22		Derive an expression for Lacing condition and hence for optical gain in lasers.	9	CO3	L3
23		With proper sketch briefly explain the structure of RPAD photo diode.	9	CO3	L3
24		Show that optical power coupled into a step index fiber due to an Led with Lambartian distribution is given by $P=P_s(NA)^2$ For $r_s<=a$, with usual notation.	9	CO3	L3
25		List out the requirement that a good connector design has to meet.	9	CO3	L3
26		In brief explain basic structure of an optical receiver.	9	CO3	L3
27		Discuss the features of eye pattern.	8	CO4	L3
28		Write a short note on "Burst mode receiver".	8	CO4	L3
29		Explain fusion splicing of optical fibers with appropriate equations.	4	CO4	L2
30		Illustrate the different types of scattering losses in optical fiber with suitable equations	6	CO4	L3
31		Explain what is meant by critical bending radius for an optical fiber	6	CO4	L2

D2. TEACHING PLAN - 2

Module – 3

Title:		Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1		CO5	L3
2		CO6	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**

23	**Optical sources:** Energy Bands, Direct and Indirect Bandgaps,	CO5	L3
24	Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power,	CO5	L3
25	Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency,	CO5	L3
26	Resonant frequencies, Laser Diode structures and Radiation Patterns: Single mode lasers.	CO5	L3
27	**Photodetectors:** Physical principles of Photodiodes,	CO6	L2
28	Photodetector noise,	CO6	L2
29	Detector response time.	CO6	L2
30	**Optical Receiver:** Optical Receiver Operation:	CO6	L2
31	Error sources,Front End Amplifiers,	CO6	L2
32	Receiver sensitivity, Quantum Limit.	CO6	L2
c	**Application Areas**	**CO**	**Level**
1	Dynamic light scattering, Tunable laser diodes	CO5	L3
2	Organic light detectors, Burst mode receiver	CO6	L3
d	**Review Questions**	-	-
32	Explain the three types of misalignment which occur when joining optical fibers.	CO5	L3
33	Discuss about star coupler and also give its splitting and excess loss.	CO5	L2
34	Derive SNR for analog receiver.	CO5	L2
35	Explain the term receiver sensitivity , derive an equation for receiver sensitivity in terms of photo detector noise.	CO5	L2
36	What are different types of mis alignments.	CO5	L3
37	Explain briefly the various fiber splicing techniques.	CO6	L3
38	With neat diagram explain the operation of transimpedance pre ampliifer equivalent circuit.	CO6	L2
39	Derive an expression for receiver sensitivity and also explain quantum limit.	CO6	L2
40	Derive the expression for rise time budget analysis.	CO6	L2
41	In brief explain multichannel AM technique.	CO6	L2
42	Write a short note on “microwave photonics”	CO6	L2
43	Explain in brief design and operation of polarization – independent isolator.	CO6	L2
e	**Experiences**	-	-
1		CO6	L2
2			

Module – 4

Title:	Data Transmission and Telemetry Measurement of Non – Electrical Quantities	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1		CO7	L2
2		CO8	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
33	**WDM Concepts and Components:** Overview of WDM:	CO7	L2
34	Operational Principles of WDM, WDM standards,	CO7	L2
35	Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators,	CO7	L3
36	Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings,	CO7	L2
37	Active Optical Components, Tunable light sources,	CO7	L2
38	**Optical amplifiers:** Basic application and types Semiconductor optical amplifiers,	CO8	L2

39	types Semiconductor optical amplifiers	CO8	L2
40	Erbium Doped Fiber Amplifiers,	CO8	L2
41	Raman Amplifiers,	CO8	L2
42	Wideband Optical Amplifiers.	CO8	L2
c	**Application Areas**	**CO**	**Level**
1	Multifrequency Lasers, Multimedia MAC protocol	CO7	L2
2	Fourier Domain mode locking	CO8	L2
d	**Review Questions**	-	-
44	Explain the basic sections of an optical receiver with a neat diagram.	CO7	L2
45	Derive an expression for carrier to noise ratio of an analog optical fiber communication.	CO7	L2
46	Explain sub carrier multiplexing technique in detail with a neat diagram.	CO7	L2
47	Explain radio over fiber links.	CO8	L2
48	Discuss how the eye diagram is powerful measurement tool for assessing the data handling capability in digital transmission system.	CO7	L2
49	Explain with block diagram the elements of analog link. List the signal imperments in analog systems.	CO7	L2
50	Explain sub-carrier multiplexing techniques in OFC.	CO8	L2
51	Derive an equation for receiver sensitivity in terms of photo detector noise .	CO7	L2
52	Discuss coherent detection with relevant block diagram.	CO7	L2
53	Discuss subcarrier multiplexing	CO8	L2
54	Explain link power budget with relevant diagram.	CO8	L2
55	Write short note on 1) Chirping 2) Extinction ratio penalty.	CO8	L2
e	**Experiences**	-	-
1		CO7	L2
2			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15EC82	Sem:	8	Marks:	20	Time:	75 minutes
Course:	Fiber Optics and Networks						

-	-	**Note: Answer any 1 question from each part.**	**Marks**	**CO**	**Level**
		Part A			
1	a	Explain the term receiver sensitivity , derive an equation for receiver sensitivity in terms of photo detector noise.	8	CO5	L3
	b	What are different types of mis alignments.	7	CO5	L2
		OR			
2	a	Derive the expression for rise time budget analysis.	8	CO6	L2
	b	In brief explain multichannel AM technique.	7	CO6	L2
		Part B			
3	a	Explain radio over fiber links.	8	CO7	L2
	b	Discuss how the eye diagram is powerful measurement tool for assessing the data handling capability in digital transmission system.	7	CO7	L2
		OR			
4	a	Explain link power budget with relevant diagram.	8	CO8	L2
	b	Write short note on 1) Chirping 2) Extinction ratio penalty.	7	CO8	L2

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EC82	Sem:	8	Marks:	5 / 10	Time:	90 – 120 minutes

Course:	Fiber Optics and Networks				
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.					
SNo	**USN**	**Assignment Description**	**Marks**	**CO**	**Level**
32		Explain the three types of misalignment which occur when joining optical fibers.	8	CO5	L3
33		Discuss about star coupler and also give its splitting and excess loss.	8	CO6	L2
34		Derive SNR for analog receiver.	8	CO6	L2
35		Explain the term receiver sensitivity , derive an equation for receiver sensitivity in terms of photo detector noise.	8	CO6	L2
36		What are different types of mis alignments.	8	CO5	L3
37		Explain briefly the various fiber splicing techniques.	8	CO6	L3
38		With neat diagram explain the operation of transimpedance pre ampliifer equivalent circuit.	8	CO6	L2
39		Derive an expression for receiver sensitivity and also explain quantum limit.	8	CO6	L2
40		Derive the expression for rise time budget analysis.	8	CO6	L2
41		In brief explain multichannel AM technique.	8	CO6	L2
42		Write a short note on “microwave photonics”	5	CO7	L2
43		Explain in brief design and operation of polarization – independent isolator.	7	CO7	L2
44		Explain the basic sections of an optical receiver with a neat diagram.	4	CO7	L2
45		Derive an expression for carrier to noise ratio of an analog optical fiber communication.	8	CO7	L2
46		Explain sub carrier multiplexing technique in detail with a neat diagram.	8	CO8	L2
47		Explain radio over fiber links.	8	CO7	L2
48		Discuss how the eye diagram is powerful measurement tool for assessing the data handling capability in digital transmission system.	8	CO7	L2
49		Explain with block diagram the elements of analog link. List the signal imperments in analog systems.	5	CO8	L2
50		Explain sub-carrier multiplexing techniques in OFC.	5	CO8	L2
51		Derive an equation for receiver sensitivity in terms of photo detector noise .	6	CO8	L2
52		Discuss coherent detection with relevant block diagram.	8	CO7	L2
53		Discuss subcarrier multiplexing	5	CO8	L2
54		Explain link power budget with relevant diagram.	5	CO8	L2
55		Write short note on 1) Chirping 2) Extinction ratio penalty.	6	CO8	L2

D3. TEACHING PLAN - 3

Module – 5

Title:	Divide and Conquer	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1		CO9	L2
2		CO10	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
43	**Optical Networks:** Optical network evolution and concepts:		
44	Optical networking terminology, Optical network node and switching elements,		
45	Wavelength division multiplexed networks, Public telecommunication network	CO9	L2

	overview.		
46	Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode,	CO9	L2
47	OSI reference model, Optical transport network, Internet protocol	CO9	L2
48	Wavelength routing networks: Routing and wavelength assignment, Optical switching networks:	CO9	L2
49	Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching,	CO10	L2
50	Optical burst switching networks, Optical network deployment:	CO10	L2
51	Longhaul networks, Metropoliton area networks,	CO10	L2
52	Access networks, Local area networks.	CO10	L3
c	**Application Areas**	**CO**	**Level**
1	High security features of UOWC	CO9	L2
2	Optical neural networks	CO10	L2
d	**Review Questions**	-	-
52	Explain the operation of a polarization independent isolater with a neat diagram	CO9	L2
53	Discuss about chromatic dispersion compensator.	CO10	L2
54	Derive an equation for amplifier gain in semiconductor optical amplifiers.	CO10	L2
55	Explain ultra fast point to point transmission system using optical TDM.	CO9	L3
56	Breifly explain the rise time budget analysis with its basic elements contribute to system rise time.	CO9	L2
57	With a neat sketch explain WDM scheme.	CO10	L1
58	Derive an expression for difference in length in MZI multiplexers.	CO10	L2
59	Write a note on optical add/drop multiplexers.	CO9	L2
60	Explain in detail the amplification mechanism with energy level diagram in an EDFA.	CO10	L2
61	With suitable diagram describe SONET /SDH optical network function.	CO9	L2
62	Explain the principal of operation of WDM with relevant block diagram.	CO9	L2
63	Discuss the design and operation of a polarization independent isolator made of three miniature optical components.	CO10	L2
64	Explain with the help of relevant diagrams various applications of fiber bragg gratings.	CO10	L2
65	With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	CO10	L2
66	Write short note on high speed light wave links.	CO10	L2
e	**Experiences**	-	-
1		CO10	L2
2		CO9	

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15EC82	Sem:	8	Marks:	30	Time:	75 minutes
Course:	Fiber Optics and Netwoks						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Explain the operation of a polarization independent isolater with a neat diagram	8	CO9	L2
	b	Discuss about chromatic dispersion compensator.	7	CO9	L2
		or			
2	a	Derive an expression for difference in length in MZI multiplexers.	8	CO9	L2
	b	Write a note on optical add/drop multiplexers.	7	CO9	L2
3	a	Explain the principal of operation of WDM with relevant block diagram.	8	CO10	L2
	b	Discuss the design and operation of a polarization independent isolator made of three miniature optical components.	7	CO10	L2

		or			
4	a	With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	8	CO10	L2
	b	Write short note on high speed light wave links.	7	CO10	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EC63	Sem:	6	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	VLSI Design						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
52		Explain the operation of a polarization independent isolater with a neat diagram	8	CO9	L2
53		Discuss about chromatic dispersion compensator.	8	CO10	L2
54		Derive an equation for amplifier gain in semiconductor optical amplifiers.	8	CO10	L2
55		Explain ultra fast point to point transmission system using optical TDM.	8	CO9	L3
56		Breifly explain the rise time budget analysis with its basic elements contribute to system rise time.	6	CO9	L2
57		With a neat sketch explain WDM scheme.	4	CO10	L1
58		Derive an expression for difference in length in MZI multiplexers.	6	CO10	L2
59		Write a note on optical add/drop multiplexers.	8	CO9	L2
60		Explain in detail the amplification mechanism with energy level diagram in an EDFA.	8	CO10	L2
61		With suitable diagram describe SONET /SDH optical network function.	7	CO9	L2
62		Explain the principal of operation of WDM with relevant block diagram.	9	CO9	L2
63		Discuss the design and operation of a polarization independent isolator made of three miniature optical components.	6	CO10	L2
64		Explain with the help of relevant diagrams various applications of fiber bragg gratings.	6	CO10	L2
65		With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	4	CO10	L2
66		Write short note on high speed light wave links.	6	CO10	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Fiber Optics and Networks					Month / Year	JULY /2019
Crs Code:	15EC82	Sem:	8	Marks:	80	Time:	180 minutes

-	Note	Answer any FIVE full questions, choosing ONE full question from each module	Marks	CO	Level
1	a	Explain total internal reflection and photonic crystal fibers.	8	CO1	L2
	b	Derive an expression for pulse spreading due to material desperation.	8	CO1	L2
		or			
2	a	Explain the GaAlAs double – hetero junction LED structure.	9	CO2	L2
	b	Explain the structure of RAPD and its working	7	CO2	L2
3	a	List out the requirement that a good connector design has to meet.	5	CO3	L2
	b	In brief explain basic structure of an optical receiver.	5	CO3	L3

	c	Discuss the features of eye pattern.	6	CO3	L2
		or			
4	a	Explain fusion splicing of optical fibers with appropriate equations.	5	CO4	L2
	b	Illustrate the different types of scattering losses in optical fiber with suitable equations	8	CO4	L2
	c	Explain what is meant by critical bending radius for an optical fiber	3	CO3	L3
5	a	Discuss about star coupler and also give its splitting and excess loss.	6	CO5	L2
	b	Derive SNR for analog receiver.	5	CO5	L2
	c	Explain the term receiver sensitivity , derive an equation for receiver sensitivity in terms of photo detector noise.	5	CO5	L2
		or			
6	a	In brief explain multichannel AM technique.	7	CO6	L2
	b	Write a short note on "microwave photonics"	5	CO6	L2
	c	Explain in brief design and operation of polarization – independent isolator.	4	CO6	L2
7	a	Explain the basic sections of an optical receiver with a neat diagram.	5	CO7	L2
	b	Derive an expression for carrier to noise ratio of an analog optical fiber communication.	6	CO7	L2
	c	Explain sub carrier multiplexing technique in detail with a neat diagram.	5	CO7	L2
		or			
8	a	Discuss subcarrier multiplexing	10	CO8	L2
	b	Explain link power budget with relevant diagram.	6	CO8	L2
9	a	With suitable diagram describe SONET /SDH optical network function.	7	CO9	L2
	b	Explain the principal of operation of WDM with relevant block diagram.	9	CO9	L2
		or			
10	a	Explain with the help of relevant diagrams various applications of fiber bragg gratings.	6	CO10	L2
	b	With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	6	CO10	L2
	c	Write short note on high speed light wave links.	4	CO10	L2

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15EC82	Sem:	8	Marks:	30	Time:	75 minutes
Course:	Fiber Optics and Netwoks						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Explain the operation of a polarization independent isolater with a neat diagram	8	CO9	L2
	b	Discuss about chromatic dispersion compensator.	7	CO9	L2
		or			
2	a	Derive an expression for difference in length in MZI multiplexers.	8	CO9	L2
	b	Write a note on optical add/drop multiplexers.	7	CO9	L2
3	a	Explain the principal of operation of WDM with relevant block diagram.	8	CO10	L2
	b	Discuss the design and operation of a polarization independent isolator made of three miniature optical components.	7	CO10	L2
		or			
4	a	With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	8	CO10	L2
	b	Write short note on high speed light wave links.	7	CO10	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EC63	Sem:	6	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	VLSI Design						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
52		Explain the operation of a polarization independent isolater with a neat diagram	8	CO9	L2
53		Discuss about chromatic dispersion compensator.	8	CO10	L2
54		Derive an equation for amplifier gain in semiconductor optical amplifiers.	8	CO10	L2
55		Explain ultra fast point to point transmission system using optical TDM.	8	CO9	L3
56		Breifly explain the rise time budget analysis with its basic elements contribute to system rise time.	6	CO9	L2
57		With a neat sketch explain WDM scheme.	4	CO10	L1
58		Derive an expression for difference in length in MZI multiplexers.	6	CO10	L2
59		Write a note on optical add/drop multiplexers.	8	CO9	L2
60		Explain in detail the amplification mechanism with energy level diagram in an EDFA.	8	CO10	L2
61		With suitable diagram describe SONET /SDH optical network function.	7	CO9	L2
62		Explain the principal of operation of WDM with relevant block diagram.	9	CO9	L2
63		Discuss the design and operation of a polarization independent isolator made of three miniature optical components.	6	CO10	L2
64		Explain with the help of relevant diagrams various applications of fiber bragg gratings.	6	CO10	L2
65		With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	4	CO10	L2
66		Write short note on high speed light wave links.	6	CO10	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Fiber Optics and Networks					Month / Year	JULY /2019
Crs Code:	15EC82	Sem:	8	Marks:	80	Time:	180 minutes

-	Note	Answer any FIVE full questions, choosing ONE full question from each module	Marks	CO	Level
1	a	Explain total internal reflection and photonic crystal fibers.	8	CO1	L2
	b	Derive an expression for pulse spreading due to material desperation.	8	CO1	L2
		or			
2	a	Explain the GaAlAs double – hetero junction LED structure.	9	CO2	L2
	b	Explain the structure of RAPD and its working	7	CO2	L2
3	a	List out the requirement that a good connector design has to meet.	5	CO3	L2
	b	In brief explain basic structure of an optical receiver.	5	CO3	L3

	c	Discuss the features of eye pattern.	6	CO3	L2
		or			
4	a	Explain fusion splicing of optical fibers with appropriate equations.	5	CO4	L2
	b	Illustrate the different types of scattering losses in optical fiber with suitable equations	8	CO4	L2
	c	Explain what is meant by critical bending radius for an optical fiber	3	CO3	L3
5	a	Discuss about star coupler and also give its splitting and excess loss.	6	CO5	L2
	b	Derive SNR for analog receiver.	5	CO5	L2
	c	Explain the term receiver sensitivity , derive an equation for receiver sensitivity in terms of photo detector noise.	5	CO5	L2
		or			
6	a	In brief explain multichannel AM technique.	7	CO6	L2
	b	Write a short note on "microwave photonics"	5	CO6	L2
	c	Explain in brief design and operation of polarization – independent isolator.	4	CO6	L2
7	a	Explain the basic sections of an optical receiver with a neat diagram.	5	CO7	L2
	b	Derive an expression for carrier to noise ratio of an analog optical fiber communication.	6	CO7	L2
	c	Explain sub carrier multiplexing technique in detail with a neat diagram.	5	CO7	L2
		or			
8	a	Discuss subcarrier multiplexing	10	CO8	L2
	b	Explain link power budget with relevant diagram.	6	CO8	L2
9	a	With suitable diagram describe SONET /SDH optical network function.	7	CO9	L2
	b	Explain the principal of operation of WDM with relevant block diagram.	9	CO9	L2
		or			
10	a	Explain with the help of relevant diagrams various applications of fiber bragg gratings.	6	CO10	L2
	b	With the help of energy level diagram explain the working of Erbiun – Doped Fiber Amplifiers.	6	CO10	L2
	c	Write short note on high speed light wave links.	4	CO10	L2

2. SEE Important Questions

Course:		Fiber Optics and Networks						Month / Year	May/2019	
Crs Code:		15EC82	Sem:	8	Marks:	80		Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.						-	-	
Module	Qno.	Important Question						Marks	CO	Year
1	1	Derive an expression for NA using ray theory.						8	CO1	L2
	2	In brief discuss the different design approaches for single mode fibers						6	CO1	L2
	3	In brief explain linear scattering losses.						6	CO2	L2
	4	Derive the expression for RMS – Pulse broadening due to inter modal dispersion in step index fiber.						4	CO2	L2
	5	Explain the GaAlAs double – hetero junction LED structure.						7	CO1	L2
2	1	Draw the cross section of GaAlAs double hetero structure LED energy band diagram and refrative index variation. Explain their importance.						9	CO3	L3
	2	Derive an expression for Lacing condition and hence for optical gain in lasers.						8	CO4	L3
	3	With proper sketch briefly explain the structure of RPAD photo diode.						8	CO4	L3
	4	Show that optical power coupled into a step index fiber due to an Led with Lambartian distribution is given by $P=P_s(NA)^2$ For $r_s<=a$, with usual notation.						4	CO4	L2
	5	List out the requirement that a good connector design has to meet.						6	CO4	L3

3	1	Explain the term receiver sensitivity , derive an equation for receiver sensitivity in terms of photo detector noise.	8	CO6	L2
	2	What are different types of mis alignments.	8	CO5	L3
	3	Explain briefly the various fiber splicing techniques.	8	CO6	L3
	4	With neat diagram explain the operation of transimpedance pre ampliifer equivalent circuit.	8	CO6	L2
	5	Derive an expression for receiver sensitivity and also explain quantum limit.	8	CO6	L2
4	1	Explain sub-carrier multiplexing techniques in OFC.	8	CO7	L2
	2	Derive an equation for receiver sensitivity in terms of photo detector noise .	8	CO7	L2
	3	Discuss coherent detection with relevant block diagram.	5	CO8	L2
	4	Discuss subcarrier multiplexing	5	CO8	L2
	5	Explain link power budget with relevant diagram.	6	CO8	L2
5	1	Breifly explain the rise time budget analysis with its basic elements contribute to system rise time.	8	CO9	L2
	2	With a neat sketch explain WDM scheme.	8	CO10	L2
	3	Derive an expression for difference in length in MZI multiplexers.	8	CO10	L2
	4	Write a note on optical add/drop multiplexers.	8	CO9	L3
	5	Explain in detail the amplification mechanism with energy level diagram in an EDFA.	6	CO9	L2

Course Outcome Computation

Academic Year:

Odd / Even semester

INTERNAL TEST	**T1**						**T2**					
Course Outcome	**CO1**		**CO2**		**CO3**		**CO4**		**CO5**		**CO6**	
QUESTION NO	**Q1**	**LV**	**Q2**	**LV**	**Q3**	**LV**	**Q1**	**LV**	**Q2**	**LV**	**Q3**	**LV**
MAX MARKS	10	-	10	-	10	-	10	-	10	-	10	-
USN-1	5	2	10				10	3	9	3	4	1
USN-2	5	2	8	3								
USN-3	7	3	7	3	10	3	8	3	8	3	5	2
USN-4					4	1	10	3	8	3	6	2
USN-5	8	3	6	2	9	3	10	3	8	3		
USN-6							10	3	9	3	4	1
Average CO Attainment		2.5		2.75		2.33		3		3		1.5

LV Threshold : 3:>60%, 2:>=50% and <=60%, 1: <=49%
CO1 Computation :(2+2+2+3)/4 = 10/4=2.5

PO Computation

Program Outcome	PO1		PO3		PO3		PO1		PO12		PO12	
Weight of CO - PO	3		1		3		2		2		3	
Course Outcome	CO1		CO2		CO3		CO4		CO5		CO6	
Test/Quiz/Lab	T1						T2					
QUESTION NO	Q1	LV	Q2	LV	Q3	LV	Q1	LV	Q2	LV	Q3	LV
MAX MARKS	10	-	10	-	10	-	10	-	10	-	10	-
USN-1	5	2	10	3			10	3	9	3	4	1
USN-2	5	2	8	3								
USN-3	7	3	7	3	10	3	8	3	8	3	5	2
USN-4					4	1	10	3	8	3	6	2
USN-5	8	3	6	2	9	3	10	3	8	3		
USN-6							10	3	9	3	4	1
Average CO Attainment		2.5		2.75		2.33		3		3		1.5