VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI

|| Jai Sri Gurudev ||

Sri Adhichunchanagiri Shikshana Trust ®

BGS INSTITUTE OF TECHNOLOGY

BG Nagara -571448, Mandya District

Department of Electronics and Communication Engineering

Question Bank of

Fiber Optics & Networks (15EC82)

(As per Visvesvaraya Technological University Syllabus)

Complied By:

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Assistant Professor
Dept. of ECE, BGSIT

Programme	Electronics and Communication Engineering	**Degree**	Bachelor of Engineering
Course	Fiber Optics & Networks	**Semester**	8
Course Code	15EC82	**Course Type**	Theory
Total Planned Hours	50	**Credits**	4
CIE	20 Marks	**SIE Marks**	80 Marks
Faculty Name	Mrs. Kavitha B C	**Semester/Section**	8th 'A' & 'B' Sec

Course Outcomes

CO1	Explain the basic principle of optical fiber communication with different modes of Light propagation, types of fibbers and optical material.
CO2	Determine the characteristics, losses and modes of transmission in optical fiber.
CO3	Develop the expression for external quantum of LED and LASER diode.
CO4	Outline the working principles and applications of the optical component
CO5	Explain the different types of optical networks, protocols MAN, LAN and access Networks WDM.

Course Syllabus

Module	Contents	No. of Hours
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
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.	10
3	**Optical sources:** Energy Bands, Direct and Indirect Band gaps, Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External	10

	Quantum Efficiency, Resonant frequencies, Laser Diode structures and Radiation Patterns: Single mode lasers. **Photo detectors:** Physical principles of Photodiodes, Photo detector noise, Detector response time. **Optical Receiver:** Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity, Quantum Limit.	
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.	10
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

Sl. No.	Questions	Marks	Course Outcome	Blooms Taxonomy Level	Appeared in VTU papers
	MODULE 1				
1	Describe block diagram of an optical fiber transmission link and Explain the function of each element in link	08 M	CO1	BT2	Jan 2014
2	Explain what is meant by graded index optical fiber using simple ray theory concept indicate the major advantages of this type of fiber with regarding to multimode propagation.	06 M	CO1	BT2	Jan 2014
3	A graded Index fiber with a parabolic refractive index profile core has a refractive index at the core axis of 1.5 and a relative index difference of 1%. Estimate the maximum possible core diameter which allows single mode operation at a wavelength of 1.3 μm.	06 M	CO1	BT3	Jan 2014
4	Define the terms i) Acceptance angle ii) Numerical aperture. Derive expressions for numerical aperture.	08 M	CO1	BT2	Jan 2015

5	What are the advantages and disadvantage of optical fiber communication?	07 M	CO1	BT2	Jan 2017
6	Derive the expression for Numerical aperture using ray theory.	07 M	CO1	BT2	Jan 2018
7	A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm. The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating in the wavelength of 1μm.	06M	CO1	BT2	Jan 2018
8	Define acceptance angle and critical angle.	05 M	CO1	BT2	Jul 2014
9	With the help of neat diagrams discuss the structure of single mode and multimode step index fibers.	06 M	CO1	BT2	Jul 2016
10	Summarize the inherent advantages of optical fiber over conventional copper cables.	06 M	CO1	BT2	Jul 2017
11	Describe with neat diagram different types of optical fiber waveguides. Using ray theory, explain the propagation of light inside the fiber.	08 M	CO1	BT2	Jul 2017
12	Using Snell's law, derive an expression for Numerical Aperture of a fiber optic cable.	08 M	CO1	BT3	Jul 2018
13	Explain total internal reflection and photonic crystal fiber.	06 M	CO1	BT2	Jul 2018
14	With the neat diagram, discuss the structure of a single mode and multimode step index fiber with advantages for each type.	08 M	CO1	BT2	Jul 2019
15	A silica glass optical fiber has a core refractive index of 1.480 and the cladding refractive index of 1.460. Calculate the critical angle, acceptance angle and Numerical Aperture and the number of guided modes at 1300 mm if core radius is 20 μm.	08 M	CO1	BT3	Jul 2019

MODULE 2					
1	Describe Rayleigh scattering in optical fiber.	06 M	CO2	BT2	Jan 2014
2	Briefly explain intra modal and inter modal dispersion.	06 M	CO2	BT2	Jan 2014
3	Discuss briefly various attenuation mechanism in an optical fiber.	09 M	CO2	BT2	Jan 2015
4	Explain the different types of absorption losses in optical fiber.	06 M	CO2	BT2	Jan 2015
5	Derive an expression for pulse spreading due to material dispersion which is a function of wavelength and time delay.	08 M	CO2	BT2	Jan 2017
6	Explain the different types of bending losses in optical fiber.	06 M	CO2	BT2	Jan 2017

7	In brief explain linear scattering losses.	07 M	CO2	BT2	Jan 2018
8	Discuss different types of non-linear scattering losses.	06 M	CO2	BT2	Jul 2016
9	A step index multimode fiber with a core refractive index of 1500, a relative refractive index difference of 3% and an operating wavelength of 0.82 μm. Estimate the critical radius of curvature at which large bending losses occurs.	05 M	CO2	BT2	Jul 2016
10	Silica has an estimated fictive temperature of 1400 k with an isothermal compressibility of 7x10 11 m2N-1. The refractive index and photo elastic co-efficient for silica are 1.46 and 0.286 respectively. Determine the theorical attenuation in decibels per kilometer due to fundamental Rayleigh scattering in silica at optical wavelength of 0.63 μm. Boltzmann's constant is 1.381x10 -23 JK-1	08 M	CO2	BT3	Jul 2016
11	A 6 km optical link consists of multi mode step index fiber with a core refractive index of 1.5 and a relative refractive index difference of 1%. Estimate the delay between the slowest and fastest mode at the fiber output and also find the rms pulse broadening due to intermodal dispersion on the link.	05 M	CO2	BT3	Jul 2018
12	Explain briefly about chromatic dispersion within an optical fiber.	06 M	CO2	BT2	Jul 2019
13	Describe with aid of suitable diagram, three common techniques used for mechanical splicing of optical fiber.	06 M	CO2	BT2	Jan 2014
14	With aid of simple sketch, outline major categories of fiber couplers.	06 M	CO2	BT2	Jan 2014
15	What are different types of mechanical misalignment?	05 M	CO2	BT2	Jan 2017
16	List out the requirements that a good connector design has to meet.	05 M	CO2	BT2	Jan 2018
17	What is splicing? Explain the fusion splicing with a neat diagram.	08 M	CO2	BT2	Jul 2014

	MODULE 3				
1	Sketch and explain Fabry Perot resonator cavity of laser.	07 M	CO3	BT2	Jan 2014
2	With the help of a schematic diagram, explain the design features of an edge emitting LED.	06 M	CO3	BT2	Jan 2015
3	Define the terms i) Spontaneous emission. ii) Stimulated emission. iii) Quantum efficiency.	08 M	CO3	BT2	Jan 2015
4	With the help of schematic diagram, explain briefly construction and operation of APD.	06 M	CO3	BT2	Jan 2015
5	An InGaAs PIN diode operating at a wavelength of 1300 μm has the following specification. i) Quantum efficiency=90%	05 M	CO3	BT2	Jan 2015

	ii) Dark current I_D=4 Na iii) Load resistor R_L=1k Ω iv) Incident optical power=300 nW v) Receiver Bandwidth=200 MHz Assuming negligible surface leakage current, calculate the mean square value of shot noise, dark current noise and thermal noise currents.				
6	Explain the GaAIAs double hetero junction LED structure.	07 M	CO3	BT2	Jan 2018
7	List the desirable characteristics of the LED and LASER diode as optical sources.	08 M	CO3	BT2	Jul 2014
8	Explain p-i-n photo diode with a neat diagram.	08 M	CO3	BT2	Jul 2014
9	A double hetero junction InGaAsP LED emitting at a peak wavelength of 1310 nm has radioactive and non-radioactive recombination times of 30 and 100 ns, the derive current is 40mA. Find the recombination life time and internal power generated.	06 M	CO3	BT2	Jul 2018
10	Briefly discuss the possible sources of noise in optical fiber receiver.	06 M	CO3	BT1	Jul 2019
11	Briefly explain the operation of double heterostructure Photo diodes.	05 M	CO3	BT1	Jan 2017
12	Explain the operation of front end amplifier.	05 M	CO3	BT1	Jan 2017
13	Draw the cross-section of GaALAs double hetero structure LED energy band diagram and refractive index variation. Explain their importance.	07 M	CO3	BT2	Jan 2017
14	With a schematic diagram, explain the working of an optical receiver.	06 M	CO3	BT2	Jul 2016
15	Explain the term receiver sensitivity. Derive an equation for receiver sensitivity in terms of photo detector noise.	08 M	CO3	BT3	Jan 2016

MODULE 4

1	Explain the operational principle and implementation of WDM with diagrams.	08 M	CO4	BT2	Jan 2014
2	Write a note on MEMS technology.	06 M	CO4	BT2	Jan 2014
3	Explain the operation of isolator	06 M	CO4	BT2	Jan 2014
4	Write basic applications and types of optical amplifiers.	08 M	CO4	BT2	Jan 2014
5	Explain with aid of neat diagram EDFA.	06 M	CO4	BT2	Jan 2014
6	Write a short notes on any two of the following i) Optical isolator	10 M	CO4	BT2	Jan 2015

	ii) Optical circulator iii) Optical add/drop multiplexers.				
7	List out the basic applications of optical amplifiers and describe briefly with the different configurations.	08 M	CO4	BT2	Jan 2015
8	Write short notes on semiconductor optical amplifiers	06 M	CO4	BT2	Jan 2015
9	Derive an expression for difference in length in MZI multiplexer.	09 M	CO4	BT2	Jan 2017
10	Explain in detail the amplification mechanism with energy level diagram in an EDFA.	10 M	CO4	BT2	Jul 2014
11	What is WDM? Explain the advantages of WDM.	04 M	CO4	BT2	Jul 2014
12	With a neat diagram, Explain the working principle of Mach-Zehnder Inter-ferometer multiplexer.	08 M	CO4	BT2	Jul 2017
13	Discuss about chromatic dispersion compensator	08 M	CO4	BT2	Jul 2018
14	Derive an equation for path difference in a 2x2 Mach-20 finder interferometer.	08 M	CO4	BT2	Jul 2018
15	Derive an equation for amplifier gain in semiconductor optical amplifiers.	08 M	CO4	BT3	Jul 2018
16	Explain polarization independent isolator with a neat diagram.	08 M	CO4	BT1	Jul 2019
17	Explain optical circulators and optical add/drop multiplexers in detail.	06 M	CO4	BT1	Jul 2019

	MODULE 5				
1	Explain about synchronous networks with STS frame Structure.	08 M	CO5	BT2	Jul 2019
2	Describe about internal protocol and in evolution over physical layer evolution and traffic flow pattern with relevant diagram.	08 M	CO5	BT2	Jul 2019
3	Explain with neat diagrams, Wavelength convertible routing network architecture.	08 M	CO5	BT2	Jul 2019
4	Write short notes on optical fiber access networks and local area networks.	08 M	CO5	BT2	Jul 2019
5	Explain the following topologies in optical networks. i) Bus ii) Ring iii) Star iv) Mesh topology	04 M	CO5	BT2	
6	Describe the concept of an OXC and a ROADM. Outline how they are utilized in the development of large-scale wavelength division multiplexed networks.	10 M	CO5	BT2	

7	Explain the distinguishing features of optical switching and optical wavelength routing. With the aid of block diagrams outline the optical network hierarchy for the public telecommunications network.	08 M	CO5	BT2	
8	Explain the modularity and scalability features of an optical network. Outline their roles in the development of flexible and physically expanding optical networks.	06 M	CO5	BT2	
9	Define what is ATM and its application in optical networks. Compare the format of an ATM cell with a SONET frame.	09 M	CO5	BT2	
10	Explain the terms protocol and Internet Protocol (IP) and using the OSI reference model discuss the implementation aspects of the IP over: (a) ATM (b) SONET(c) DWDM.	10 M	CO5	BT2	
11	A metropolitan area network (MAN) provides the link between long-haul and access networks. Discuss the basic requirements and functionality of an optical MAN.	04 M	CO5	BT2	
12	Differentiate between static and dynamic routing and wavelength assignments explaining their implementations using a ring topology.	08 M	CO5	BT2	
13	Describe the main features and drawbacks of optical circuit-switched networks.	08 M	CO5	BT2	
14	Discuss the operation of optical packet-switched networks thereby explaining the frame format and also differentiating between the functions of edge and core routers in these networks.	08 M	CO5	BT2	
15.	With neat diagram explain Network Nodes and Switching elements.	07M	CO5	BT2	