Course Code: 20EC0433 **R20**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY :: PUTTUR (AUTONOMOUS)

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QUESTION BANK (DESCRIPTIVE)

Subject with Code: Fiber Optic Communications (20EC0433) **Course & Branch**: B.Tech – ECE

Year &Sem: III-B.Tech & II-Sem **Regulation:** R20

UNIT –I

INTRODCUTION & TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS

1	**a)**	What is meant by optical communication system and discuss the evolution of fiber optic communication system.	[L1] [CO1]	**[5M]**
	b)	Explain the Elements of Optical Communication System with neat sketch.	[L2] [CO1]	**[7M]**
2	**a)**	List out the merits and demerits of optical fiber communication.	[L1] [CO1]	**[4M]**
	b)	List the applications of optical fiber communication.	[L1] [CO1]	**[4M]**
	c)	Write short notes on ray optics theory and What are the advantages and disadvantages of the ray optics?	[L1] [CO1]	**[4M]**
3	**a)**	Describe about the Optical Fiber Structure	[L1] [CO1]	**[4M]**
	b)	Define Total internal reflection and Angle of incidence	[L1] [CO1]	**[4M]**
	c)	What is meant by refractive index of the material?	[L1] [CO1]	**[4M]**
4	**a)**	Derive the expression for i) Critical angle. ii) Numerical aperture.	[L3] [CO1]	**[4M]**
	b)	Derive the expression for i) Acceptance angle ii) Snell's law	[L3] [CO1]	**[4M]**
	c)	A light ray is incident from medium-1 to medium-2. If the refractive indices of medium-1 and medium-2 are 1.6 and 1.36 respectively, then evaluate the angle of refraction for an incident angle of $30^{0.}$	[L4] [CO1]	**[4M]**
5	**a)**	Define skew rays and meridional rays, Write the acceptance angle condition for the skew rays.	[L1] [CO1]	**[4M]**
	b)	Explain the differences between meridional and skew rays.	[L2] [CO1]	**[3M]**
	c)	Describe in detail about (i) Single mode and (ii) Multimode fibers.	[L2] [CO1]	**[5M]**
6	**a)**	Consider multimode fiber that has a core refractive index of 1.488 and core cladding index difference of 2.0%. Calculate numerical aperture, critical angle and acceptance angle.	[L4] [CO1]	**[6M]**
	b)	with neat sketch describe the characteristics of multimode Step index & graded index fibers.	[L2] [CO1]	**[6M]**
7	**a)**	What is attenuation? Explain in detail.	[L2] [CO2]	**[4M]**
	b)	How the attenuation is caused by absorption losses?	[L1] [CO2]	**[4M]**
	c)	What is meant by Scattering losses, Explain the phenomenon of Rayleigh scattering. and Mie scattering	[L2] [CO2]	**[4M]**
8	**a)**	What is meant by bending losses, explain various types of fiber bending losses.	[L2] [CO2]	**[4M]**
	b)	Derive the expressions for fiber Core and Cladding losses.	[L3] [CO2]	**[4M]**
	c)	Explain the effects of signal distortion in optical waveguide	[L2] [CO2]	**[4M]**
9	**a)**	What do you mean by pulse broadening? Explain its effect on information carrying capacity of a fibe.	[L2] [CO2]	**[6M]**
	b)	Define group velocity, Illustrate the impact of group delays in optical communication.	[L2] [CO2]	**[6M]**
10	**a)**	What is meant by dispersion in optical fiber? List the various types of dispersion.	[L1] [CO2]	**[4M]**
	b)	What is meant by chromatic dispersion? and state the two reasons for chromatic dispersion	[L1] [CO2]	**[4M]**
	c)	Discuss in detail the intermodal dispersion with relevant expressions and diagrams.	[L2] [CO2]	**[4M]**

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UNIT –II
FIBER OPTICAL SOURCES AND COUPLING

1	**a)**	Explain in brief about direct and indirect band gap materials in detail.	[L2] [CO3]	**[3M]**
	b)	What is an LED? List the advantages and disadvantages of LED.	[L1] [CO3]	**[4M]**
	c)	What are the various types of LED structures? Explain about double heterostructure with neat diagram?	[L2] [CO3]	**[5M]**
2	**a)**	Explain about planar LED and dome LED with neat diagrams?	[L2] [CO3]	**[6M]**
	b)	A planar LED is fabricated from GaAs which has a refractive index of 3.6.(i) Calculate the optical power emitted into air as a percentage of the internal optical power for the device when the transmission factor at the crystal-air interface is 0.68.(ii) When the optical power generated internally is 60% of the electric power supplied, determine the external power efficiency.	[L3] [CO3]	**[6M]**
3	**a)**	Explain about the surface emitter LED with neat diagram.	[L2] [CO3]	**[6M]**
	b)	Illustrate the working principle of an edge emitter LED with neat diagram.	[L2] [CO3]	**[6M]**
4	**a)**	Explain about super luminescent LED with neat diagram?	[L2] [CO3]	**[4M]**
	b)	Describe about the light source materials in detail.	[L1] [CO3]	**[4M]**
	c)	Derive the expressions of quantum efficiency and LED power.	[L3] [CO3]	**[4M]**
5	**a)**	Discuss about the modulation of LED in detail.	[L2] [CO3]	**[6M]**
	b)	Illustrate about Injection Laser Diode with suitable diagram.	[L2] [CO3]	**[6M]**
6	**a)**	Illustrate the working principle of Distributed feedback LASER diode	[L2] [CO3]	**[6M]**
	b)	Calculate the GaAs optical source with a refractive index of 3.6 is coupled to a silica fiber that has a refractive index is 1.48. If the fiber and the source are in close physical contact then find the Fresnel reflection at the interface and power loss in dB.	[L4] [CO3]	**[6M]**
7	**a)**	Derive the expressions for LASER modes and threshold conditions.	[L3] [CO3]	**[6M]**
	b)	What power is radiated by an LED if its quantum efficiency is 3% and the peak wavelength is 670nm?	[L1] [CO3]	**[6M]**
8	**a)**	Compute the rate equation for LASER diode.	[L3] [CO3]	**[6M]**
	b)	Illustrate about external quantum efficiency of LASER.	[L2] [CO3]	**[6M]**
9	**a)**	Explain in detail the various Characteristics of Light Source.	[L2] [CO3]	**[6M]**
	b)	Explain about resonant frequencies of LASER Diode	[L2] [CO3]	**[6M]**
10	**a)**	Describe about Temperature effects of Laser characteristics.	[L1] [CO3]	**[6M]**
	b)	The Radiative and non-radiative recombination life times of minority carriers in the active region of a double heterojunction LED are 60 nS and 90 nS respectively. Evaluate the total carrier recombination life time and optical power generated internally if the peak emission wavelength is 870 nm and drift current is 40 mA.	[L4] [CO3]	**[6M]**

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UNIT –III
FIBER OPTICAL RECEIVERS

1	**a)**	Explain the principle behind the operation of an PIN Photo diode with its the energy band diagram.	[L2] [CO3]	**[6M]**
	b)	A photo diode has a quantum efficiency of 65% when photons of energy of $1.5x10^{-19}$ J are incident upon it. (i) Find the operating wavelength of the photodiode (ii) Calculate the incident optical power required to obtain a photo current of 2.5 μA when the photodiode is operating as described above.	[L4] [CO3]	**[6M]**
2	**a)**	Explain in detail about the operation of Avalanche Photo Diode using suitable diagram.	[L2] [CO3]	**[6M]**
	b)	A given silicon avalanche photodiode has a quantum efficiency 80% at a wavelength of 0.9μm. Suppose 0.5μW of optical power produces a multiplied photocurrent of 11μA. Calculate the multiplication M.	[L3] [CO3]	**[6M]**
3	**a)**	Illustrate about Photo detector noise and deduce the equation for S/N ratio of an optical fiber.	[L2] [CO3]	**[6M]**
	b)	Compute the expression for Response time of a Photodiode.	[L4] [CO3]	**[6M]**
4	**a)**	Explain about Avalanche multiplication noise in APD diode.	[L3] [CO3]	**[6M]**
	b)	An GaAs Photodetector a pulse of 100 ns emits $6x10^6$ photons at 1300 nm wavelength. Average e-h pair generated are $5.4x10^6$. Calculate the quantum efficiency of the detector.	[L2] [CO3]	**[6M]**
5	**a)**	Summarize the comparisons of photo detectors.	[L4] [CO3]	**[6M]**
	b)	Explain the characteristics of fundamental optical receiver operation.	[L2] [CO3]	**[6M]**
6	**a)**	Analyze photo detector receiver with simple model with its equivalent circuit.	[L4] [CO3]	**[6M]**
	b)	Explain the digital signal transmission for an optical receiver.	[L3] [CO3]	**[6M]**
7	**a)**	What is a preamplifier? Classify them	[L4] [CO3]	**[6M]**
	b)	What are the general applications of Optical Amplifiers.	[L2] [CO3]	**[6M]**
8	**a)**	Explain in detail about any one type of front-end amplifier in detail.	[L3] [CO3]	**[6M]**
	b)	An InGaAs pin photodiode has the following parameters at a wave length of 1300nm I_D =4 nA, η =0.90, R_L=1000Ω,incident power is 300Nw and receiver BW=20MHz. Find various noise associated with optical receiver.	[L3] [CO3]	**[6M]**
9	**a)**	Explain the mechanism of error sources and disturbance in the optical pulse detection with diagram.	[L2] [CO3]	**[6M]**
	b)	Compute the Bandwidth of a photo detector having the parameters as follows: Photo diode capacitance 3 pF, amplifier capacitance 4 pF, load resistance 60 Ω and amplifier input resistance is 1MΩ.	[L2] [CO3]	**[6M]**
10	**a)**	Construct the optical receiver configuration.	[L2] [CO3]	**[6M]**
	b)	Explain about the probability of error in detail.	[L2] [CO3]	**[6M]**

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UNIT –IV
OPTICAL FIBER SYSTEM DESIGN & TECHNOLOGY

1	**a)**	Explain Optical Fiber System Design Specification.	[L2] [CO4]	**[6M]**
	b)	Explain the significance of system consideration in point-to-point fiber links.	[L2] [CO4]	**[6M]**
2	**a)**	List the types of budgets in optical communication system.	[L1] [CO4]	**[4M]**
	b)	Illustrate in detail about Link power budget.	[L2] [CO4]	**[8M]**
3	**a)**	Analyze the system performance using link power budget of digital systems.	[L4] [CO4]	**[6M]**
	b)	A transmitter has an output power of 0.1 mW. It is used with a fiber having NA=0.25, attenuation of 6 dB/km and length of 0.5 km. The link contains two connectors of 2 dB average loss. The receiver has a minimum acceptable power (sensitivity) of -35 dBm. The designer has allowed a 4 dB margin. Calculate the link power budget.	[L4] [CO4]	**[6M]**
4	**a)**	Explain the Rise Time Budget analysis with basic elements.	[L2] [CO4]	**[8M]**
	b)	For a multimode fiber link following parameters are recorded. (i) LED with drive circuit has rise time of 15 ns. (ii) LED spectral width = 40 nm. (iii) Material dispersion related rise time degradation = 21 ns over 6 km link. (iv) Receiver bandwidth = 25 MHz. (v) Modal dispersion rise time = 3.9 nS. Calculate system rise time.	[L4] [CO4]	**[4M]**
5	**a)**	Summarize on system performance using rise time budget of digital systems.	[L2] [CO4]	**[6M]**
	b)	LED spectral width of 20 nm has rise time of 15 ns, t_{mat} is 20ns, t_{rx} is 10ns and t_{mod} is 2.5 ns. Find total system rise time.	[L3] [CO5]	**[6M]**
6	**a)**	Explain about bandwidth budget.	[L2] [CO4]	**[6M]**
	b)	Describe about power budget with examples	[L2] [CO4]	**[6M]**
7	**a)**	What is meant by Receiver Sensitivity? How do you measure and compare receiver sensitivity for different modulation formats and bit rates?	[L1] [CO5]	**[6M]**
	b)	Explain in detail about Receiver Sensitivity	[L2] [CO5]	**[6M]**
8	**a)**	What is a link budget? Does cable type matter to link loss?	[L2] [CO4]	**[4M]**
	b)	Describe about link budget calculations	[L2] [CO4]	**[8M]**
9		Explain the optical multiplexing and de-multiplexing techniques	[L2] [CO5]	**[12M]**
10	**a)**	a) Explain in detail about Optical amplifier with an example.	[L2] [CO5]	**[8M]**
	b)	b) List the applications of Optical amplifier	[L1] [CO4]	**[4M]**

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UNIT –V
OPTICAL NETWORKS

1	**a)**	What is optical Network? Explain the elements of optical network.	[L2] [CO5]	**[7M]**
	b)	List the advantages of optical networks.	[L1] [CO5]	**[5M]**
2		Explain in detail about Optical network topologies.	[L2] [CO5]	**[12M]**
3	**a)**	Illustrate about basic optical networks.	[L2] [CO5]	**[7M]**
	b)	What are the advantages of WDM Networks?	[L1] [CO5]	**[5M]**
4	**a)**	Discuss about broadcast and select single hop network.	[L2] [CO5]	**[6M]**
	b)	Discuss about broadcast and select multi hop network.	[L2] [CO5]	**[6M]**
5		Explain in detail about wave length routed networks.	[L2] [CO5]	**[12M]**
6	**a)**	List the advantages of EDFA.	[L1] [CO6]	**[5M]**
	b)	Explain the Performance of WDM+EDFA systems in optical networks.	[L2] [CO6]	**[7M]**
7	**a)**	Illustrate the basic concept of optical CDMA.	[L2] [CO6]	**[7M]**
	b)	What are the advantages of optical CDMA?	[L1] [CO6]	**[5M]**
8		Illustrate about ultra-high-capacity networks in detail.	[L2] [CO6]	**[12M]**
9	**a)**	Explain in brief about the working principle of WDM.	[L2] [CO5]	**[6M]**
	b)	What are the characteristics of WDM?	[L1] [CO5]	**[6M]**
10	**a)**	Why we need optical networks?	[L3] [CO5]	**[6M]**
	b)	Describe about the optical CDMA network using coded sequence pulse.	[L2] [CO6]	**[6M]**

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