Registration Number :

B.E. / B.Tech. (Full Time) ARREAR EXAMINATION – APRIL/MAY 2014
ELECTRONICS AND COMMUNICATION ENGINEERING BRANCH
SEVENTH SEMESTER – (REGULATIONS R 2004/2008)
EC 473/EC 9402 – OPTICAL COMMUNICATION

Duration : 3 Hours Max. Marks = 100

Answer **ALL** the questions.

PART- A (10 x 2 = 20 marks)

1. What do you understand by a mode and how can it be compared with a ray.
2. What are the transmission parameters that characterize the performance of Unguided optical communication systems.
3. How does the source spectral width affect the information carrying capacity of a fiber.
4. What are the two broad classification of fiber non-linearities ?
5. Differentiate between direct and indirect band gap materials.
6. Compare the spectrum of a Laser Source and an LED source.
7. Discuss the impact of increasing the mean avalanche gain M of an APD on the Signal-to-Noise Ratio of the receiver.
8. Draw the structure of a transimpedance preamplifier and highlight its merits.
9. What characteristics of the optical fiber enables WDM implementation.
10. What are the limitations of Semiconductor Optical Amplifiers in comparison to Erbium Doped Fiber Amplifiers.

PART – B (5 x 16 = 80 marks)

11. (i) A data transmission system uses a GaAlAs laser diode that has peak emission at 1500 nm and a spectral width of 10 nm. The rise time of the laser transmitter output is 2 ns. The transmission distance is 10 Km over a step index fiber with core index $n_1 = 1.49$ and relative index difference $\Delta = 1$ %. The fiber has a 800 MHz.Km optical bandwidth distance product, the mode mixing factor $q = 0.7$, $D_{mat} = 20$ ps / nm.Km and $V [d^2(Vb) / dV^2] = 0.1$. The receiver is configured with a *pin* photodiode detector biased with a 4MΩ bias resistor and a transimpedance preamplifier front end with a 100 KΩ feedback resistor and open loop gain of 400. It may be assumed that $R_f << R_T$, and that the total capacitance is 6 pF. Determine the total system rise time and estimate the maximum bit rate that can be transmitted without significant errors using this link for the NRZ and the RZ data formats. (10)

(ii) A 1550 nm single - mode digital fiber optic link needs to operate at 622 Mbps over 80 Km without amplifiers. A single – mode InGaAsP laser launches an average optical power of 13 dBm into the fiber. The fiber has a loss of 0. 35 dB / km, and there is a splice with a loss of 0.1 dB every kilometer. The coupling loss at the receiver is 0. 5 dB, and the receiver uses an InGaAs APD with a sensitivity of - 39 dBm. Excess-noise penalties are predicted to be 1.5 dB. Set up an optical power budget for this link and find the system margin. (6)

12a. Discuss the light attenuation mechanisms in a fiber.
Two step index fibers exhibit the following parameters:
MMF : Core RI = 1.500, $\Delta = 3$ %, $\lambda = 0.82$ μm
SMF : Core RI = 1.500, $\Delta = 0.3$ %, $\lambda = 1.55$ μm, Core dia.= 8 μm
Comment on their Critical Bending Radii ?

'OR'

12b. What is the necessity to go for Graded Index configuration in MultiMode fibers ? Compare the refractive index profiles of a Step Index Fiber and a Graded Index Fiber with suitable mathematical expressions and profile diagrams.
Consider a graded index fiber having a parabolic refractive index profile, 25 μm core radius, $n_1 = 1.48$ and $n_2 = 1.46$. If $\lambda = 1320$ nm, what is the value of V and how many modes propagate in the fiber ? Compare this with the number of modes for a Step Index configuration. What percent of optical power flows in the cladding for the step index fiber ? For same values of λ, n_1 and n_2, calculate the core radius of the step index fiber for Single Mode operation. Is this fiber still Single Mode at 820 nm ?

13a. Explain in detail the signal dispersion mechanisms affecting the information carrying capacity of Standard Single Mode Fibers. A typical dispersion shifted single mode optical fiber that has a zero-dispersion wavelength at 1550 nm with a dispersion slope of $S_0 = 0.070$ ps / (nm^2 . km). Compare the dispersion at 1500 nm obtained for this fiber with that of a standard non-dispersion shifted single mode fiber having a zero-dispersion wavelength at 1310 nm with a dispersion slope of $S_0 = 0.090$ ps / (nm^2 . km).

'OR'

13b. Explain in detail how dispersion compensation can be achieved using Chirped Fiber Gratings d Dispersion Compensating fibers, with suitable illustrations. Discuss the merits and demerits of both the compensation techniques.

14a. With suitable energy band diagram and refractive index profile, explain the operation of a Double heterostructure LED. Compare the beamwidths of Surface emitting LEDs and Edge emitting LEDs. Consider an LED having a minority carrier lifetime of 5 ns. Find the 3-dB optical bandwidth and the 3-dB electrical bandwidth.

'OR'

14b. Explain the principle of operation of a Laser diode and derive an expression for the lasing threshold current density. Find the external quantum efficiency for a $Ga_{1-x}Al_xAs$ laser diode (with x = 0. 03) which has an optical power versus drive current re;lationship of 0 . 5 mW / mA.

15a. What are the services that may be offered by second generation optical WDM networks. Discuss the pros & cons of the Broadcast & select WDM network architecture in comparison to the Wavelength routing architecture, with suitable illustrations.

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15b. Explain the salient aspects of the SONET multiplexing standard with respect to the Frame format and the Protocol layers.

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