Paper Code: **EC-701** **Roll No.** | | | | | | | | | | |

B.Tech.

SEVENTH SEMESTER EXAMINATION 2016-17

OPTICAL COMMUNICATION

[Time: 3 hrs.] [Max. Marks: 100]

Note: Attempt ***ALL*** questions. Assume suitable data, if required. All question carry equal marks.

1. Attempt any *two* parts of the following:- **(10x2=20)**

(a) Define normalized frequency for an optical fiber and explain its use in the determination of number of guided modes propagating within a step index fiber. A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.48 and a cladding refractive index of 1.46.Determine (i)The critical angle at the core cladding interface(ii) The NA for the fiber.

(b) Briefly indicate with the aid of suitable diagram the difference between meridional and skew ray path in step index fiber. A graded index fiber with a parabolic 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 wavelength of 1.3μm.

(c) State the requirements that are to be met in selecting materials for optical fibers. Explain with figures and mathematical equation Mode field diameter, spot size and effective refractive index of single mode fiber. Estimate the fiber core diameter for a single mode step Index fiber which has an MFD of 11.6 μm when the normalized frequency is 2.2.

2. Attempt any *four* parts of the following:- **(5x4=20)**

(a) Discuss Rayleigh scattering, Absorption losses, Birefringence phenomenon present in optical Fiber wave guide.

(b) What is intermodal dispersion? Discuss various factors contributing to dispersion.

(c) Two step index fibers exhibit the following parameters.(i)A multimode fiber with a core refractive index of 3% and operating wavelength of 0.8 μm(ii) A 8 μm core diameter single mode fiber with a core refractive index the same as (i), a relative refractive index difference of 0.3% and an operating wavelength of 1.55 μm. Estimate the critical radius of curvature at which large bending losses occurs in both cases.

(d) Discuss any two fiber dispersion measurement techniques.

(e) Explain fiber splices. Discuss various types of misalignment occurs while joining two fibers.

(f) A 2x2 bi-conical tapered fiber coupler has an input optical power level of P_0 = 250 μW. The output powers at other three ports are P_1 =100 μW, P_2 =90 μW and P_3 =6 nW. Calculate Insertion loss between port 0 and 1 and between 0 and 2.Find out Coupling ratio and Return loss too.

3. Attempt any *four* parts of the following:- **(5x4=20)**

(a) Explain the principle of operation of LED and derive the equation for quantum efficiency of LED. Discuss the working of Edge Emitting LEDs . List out various parameters which are needed to be optimized for getting maximum output power from the LED.

(b) A germanium *p–i–n* photodiode with active dimensions of 100 × 50 μm has a quantum efficiency of 55% when operating at a wavelength of 1.3 μm. The measured dark current at this wavelength is 8 nA. Calculate the noise equivalent power and specific detectivity for the device. It may be assumed that dark current is the dominant noise source.

(c) The power generated internally within a double hetero junction LED is 28.4 mW at a drive current of 60mA.Determine the peak emission wavelength from the device when radiative and non radiative live times of the minority carrier in the active region are equal.

(d) Derive Laser Diode Rate equation. Also calculate external quantum efficiency of Laser diode.

(e) What is population Inversion? Discuss the operation of FP Cavity Resonator diode.

(f) Discuss with support of figures Optical and carrier confinement process.

4. Attempt any *two* parts of the following:- **(10x2=20)**

(a) Discuss the significance of Photo detectors. Derive Photo detector noises. What is receiver sensitivity. Explain? What is the role of quantum limit in BER calculation.

(b) A digital fiber optic link has to be designed to transmit at a data rate of 20 Mb/s with a BER of 10^{-9} using NRZ code. The device has the following parameters.

(i) A GaAlAs LED emitting at 850 nm can couple an average 100 μW of optical power into a fiber of 50μm core diameter.
(ii) The fiber is graded index type having α =2.5 dB/Km, t_{mat} = 3ns/km, t_{mod} = 1 ns/Km
(iii) A silicon pin photo diode has been used for receiver with receiver sensitivity =-42 dBm.
(iv) The source rise time is 12 ns
(v) the receiver rise time is 11 ns
(vi) The cable has to be spliced at every Km with a loss of 0.5 dB/splice.
(vii) There are two connectors one at the transmitter and other at the receiver with loss of 1 dB each
(viii) Assume a safety margin of 6 dB estimate the maximum possible link length without repeater and the total rise time of the system.

(c) Determine the signal to noise ratio of Analog Receiver. A germanium photodiode incorporated into an optical fiber receiver working at a wavelength of 1.55 μm has a dark current of 400nA at the operating temperature. When the incident optical power at this wavelength is 10^{-6} W and the responsivity of the device is 0.6 A/W, shot noise dominates in the receiver. Determine the SNR in dB at the receiver when the post- detection bandwidth is 100 MHz.

5. Attempt any *two* parts of the following:- **(10x2=20)**

a) Explain the operational principle and implementation of WDM with diagram.

b) Consider a digital point to point link and analyze it with suitable key parameters and assumptions.

c) What is link Power budget? A silicon photo diode operating at 850 nm requires an input signal of -42 dBm . An LED is used to couple a 50μm average optical power leval into a fiber fly lead with a 50 μm core diameter.Assume that a 1 dB loss occurs at the cable photo detector interface.Find out the possible transmission distance for a cable with an attenuation of 3.5 dB/Km and system margin of 5 dB.