Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (ECE-O)/SUPPLE/SEM-8/EC-802/2010

2010

OPTICAL FIBRE COMMUNICATION

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The material for making an efficient LED should be

a) a metal

b) a direct band gap semiconductor

c) an indirect band gap semiconductor

d) an insulator.

ii) A step-index fibre has a core with a refractive index of 1·5 and a cladding with a refractive index of 1·46. Its numerical aperture is

a) 0·156 b) 0·244

c) 0·344 d) 0·486.

iii) Which of the following is an inherent property of an optical signal and cannot be eliminated even in principle ?

a) Thermal noise b) Shot noise

c) Background noise d) Environmental noise.

iv) Which of the following detectors gives amplified output ?

a) P-N photodiode b) P-I-N photodiode

c) Avalanche photodiode d) Photovoltaic detector.

v) Two optical fibres with numerical apertures 0·17 and 0·2 are to be spliced. What will be the loss at the joint in the forward direction ?

a) Zero b) 0·41 dB

c) 1·82 dB d) 2·5 dB.

vi) Rayleigh scattering coefficient τ_R depends on the wavelength λ of the light as

a) $\tau_R \propto \log \lambda$ b) $\tau_R \propto \lambda^4$

c) $\tau_R \propto \lambda$ d) $\tau_R \propto \frac{1}{\lambda^4}$.

vii) Optical bandwidth is always

a) greater than the electrical bandwidth

b) less than the electrical bandwidth

c) equal to the electrical bandwidth

d) square of the electrical bandwidth.

viii) An LED is emitting a mean wavelength of $\lambda = 0{\cdot}90$ μm and its spectral half width, $\Delta\lambda = 18$ nm. Its relative spectral width is

a) 0·02 b) 0·05

c) 0·90 d) 18.

ix) Erbium-doped fibre amplifiers operate at which of the following windows ?

a) Around 1550 nm

b) Around 1300 nm

c) Around 800 nm

d) Around 1550 nm & 1300 nm.

x) The scheme WDM is similar to

a) FDM for *rf* transmission

b) TDM

c) SDM

d) OTDM.

xi) A 1 × 10 coupler has an input signal 0 dBm. The power level at each output port is

a) 0 dBm b) –1 dBm

c) –3 dBm d) –10 dBm.

xii) The responsivity of a given P-I-N diode is 0·5 AW^{-1} for a wavelength of 1 μm. What is the output photocurrent when optical power of 0·2 μW at this wavelength is incident on it ?

a) 1 μA b) 0·1 μA

c) 10 μA d) 1 A.

xiii) Which of the following fibres is suitable for wavelength division multiplexing of signals ?

a) Dispersion-optimized b) Dispersion-shifted

c) Dispersion-flattened d) Any fibre.

xiv) For long-haul high speed link design the source-fibre combination of choice should be

a) LASER-Single mode fibre

b) LED-Single mode fibre

c) LED-Multimode fibre

d) LASER-Multimode fibre.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Define fibre acceptance angle and numerical aperture of a fibre. How are they related ?

3. What do you mean by a drive circuit of an optical source ? Draw two suitable drive circuits for analog modulation of LED & LASER.

4. Draw the injection current *versus* emitted power curves of LED and LASER. Compare them.

5. How does the graded index fibre reduce intermodal dispersion ?

6. Explain the advantages of coherent detection system over the direct detection system.

7. Explain the operation of a WDM MUX based on Mach-Zehnder interferometer.

8. What do you mean by subcarrier multiplexing ? Explain the basic principle of AM/IM subcarrier multiplexing ?

9. Discuss the topology used in FDDI system for high speed data communication.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following questions.

3 × 15 = 45

10. a) What do you mean by coupling efficiency in optical fibre communication ? 3

    b) Why are optical isolators used in fibre optic communication link ? 5

    c) Show that the maximum coupling efficiency (η_c) between a source with Lambertian radiation pattern $I(\theta) = I_0 \cos\theta$ and a fibre is given by $\eta c = (NA)^2$. 7

11. Compare optical direct detection and coherent detection techniques. Describe a simple coherent receiver ASK and derive expression for detected signal current with homodyne detection. 5 + 10

12. a) An 8 km optical fibre link without repeaters uses multimode GIF which has bandwidth-length product of 400 MHz km. Estimate —

        i) total pulse broadening on the link 4

        ii) rms pulse broadening on the link. 4

    b) What is optical power budgeting ? Why is system margin provided ? 7

13. a) What are the different types of coupling losses between two fibres ? 8

    b) Two compatible multimode SI fibres are joined with a small air gap. The fibre axes and end faces are perfectly aligned. Determine the refractive index of the fibre core if the joint is showing a loss of 0·47 dB. 7

14. a) What is the basic difference between a regenerative repeater and an optical amplifier ? 5

    b) Explain the mechanism of amplification in an EDFA with a suitable energy level diagram. 10

15. a) What is an ADD-DROP multiplexer ? With a neat sketch, explain its operation. 7

    b) With a neat sketch, explain the operation of an 8 × 8 star coupler. 8

16. a) Discuss with the aid of a suitable block diagram, a coherent optical fibre communication system. 11

    b) A 2 × 2 directional coupler has an input power level of 100 μW. What is the coupling ratio ? 4

17. Write short notes on any *three* of the following : 3 × 5

    a) Intermodal dispersion

    b) Raman scattering

    c) Fibre optic network for LAN

    d) Eye diagram

    e) Drive circuits.