Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech (ECE-NEW)/SEM-2/MCE-201/2011

2011

PHOTONICS AND OPTICAL 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.*

Answer Question No. 1 which is compulsory and
any *four* from the rest.   5 × 14 = 70
Answer should be brief and to the point.

1. Attempt any *seven* questions :   7 × 2 = 14

    a) What do you mean by Group Velocity and Phase
        Velocity ?

    b) What are the different modes obtained in Optical
        fibres ?

    c) Explain Indirect bandgap semiconductor principle in
        brief.

    d) Explain the term 'Population Inversion'.

    e) Comment about the various noise currents in
        Photodetectors.

30002 (M.Tech)   [Turn over
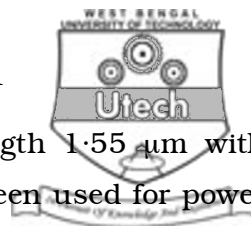
f) A laser source operating at wavelength 1·55 µm with usable spectral band of 80 nm has been used for power coupling to an optical fibre. What will be the optical bandwidth in case of WDM ?

g) What is optical add/drop multiplexer ?

h) What is optical isolator ?

2. a) A step index fibre has a normalized frequeny $v = 26·6$ at a 1300 nm wavelength. If the core radius is 25 µm, find the numerical aperture. 2

b) What do you mean by Dispersion in Optical fibres ? 2

c) Explain Group Velocity Dispersion (GVD). 2

d) Explain Material Dispersion in Optical fibres. 5

e) Obtain the relation of Group Velocity with λ and Phase Index. 3

3. a) Explain the principle of photon emission in Light Emitting Diode (LED). 2

b) Describe the recombination in Heterojunction LED with band diagrams. 4

c) Obtain the LASER diode Rate Equation. 3

d) What do you mean by External Quantum Efficiency of LASER ? 1

e) Describe the operating principle of Liquid Crystal Display. 4

4. a) Explain the operation of PIN diode as a photodetector. 2

   b) An InGaAs PIN photodiode has the following parameters at a wavelength of 1300 nm :

   $I_D = 4$ nA, $\eta = 0\cdot90, R_L = 1000\ \Omega$ and surface leakage current is negligible. The incident optical power is 300 nW ($-$ 35 dBm), and the receiver bandwidth is 20 MHz. Find :

   i) mean-square shot noise current

   ii) mean-square dark current

   iii) mean-square thermal noise current. 6

   c) What do you mean by Raman Effect in Optical amplifiers ? 2

   d) Explain the optical amplification mechanism in Erbium-doped fibre amplifier. 4

5. a) Explain how multiplexing and demultiplexing of four wavelengths can be achieved in WDM using Fibre Bragg Grating and optical circulator. 6

   b) Show that for a 2 × 2 fibre coupler the phase of the driven coupler always lags by 90° behind the phase of the driving fibre. 2
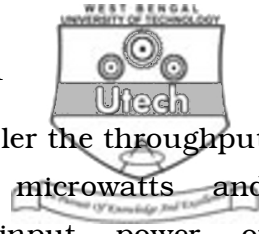
c) In a 2 × 2 biconical tapered fibre coupler the throughput and coupled powers are 230 microwatts and 5 microwatts respectively for input power of 250 microwatts.

   i) What is the coupling ratio ?

   ii) What are insertion losses ?

   iii) Determine the excess loss of the coupler. 2 + 2 + 2

6. a) Give expressions for different losses incurred in fibre optic star network. There is a fibre optic star network containing 50 stations in which station is located at a distance of 500 metres from the star coupler and fibre attenuation is 0·4 dB/km. If excess loss and connector loss in the network be 1·25 dB and 1·0 dB respectively, determine the power margin between the transmitter and the receiver in that star network. 3 + 3

   b) Explain the architecture of a four-fibre bidirectional line switched SONET ring with 5 nodes. How this configuration would be modified in case of failure of an entire node ? 4 + 4

7. Write short notes on any *two* of the following : 2 × 7

   a) Rise time Budget in Digital optical link

   b) Multichannel amplitude and frequency modulation in optical communications

   c) Signal-to-noise ratio in analog optical receiver.

———————