

OPTICAL AND SATELLITE COMMUNICATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,** ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

All parts of a question (a,b,etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches. Unnecessary long answers may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (*a*) A step-index fiber has a core index of refraction of $n_1 = 1{\cdot}425$. The cut-off angle for light entering the fiber from air is found to be 8·50°.

   (1) What is the numerical aperture of the fiber ?

   (2) What is the index of refraction of the cladding of this fiber ?

   (3) If the fiber were submersed in water of Refractive Index 1·33, what would be the new numerical aperture and cut-off angle ? 8

   (*b*) A 10 x 10 star coupler is used to distribute the 3-dBm power of a laser diode to 10 fibers. The excess loss ($Loss_{ex}$)

of the coupler is 2 dB. Find the power at each output fiber in dBm and μW. 8

(c) Compare step index single made fiber with step index multimode operations. 4

2. (a) A communication system uses 10 km of fiber that has a 2·5-dB/km loss characteristic. Find the output power if the input power is 400 mW. 4

(b) A system has the following characteristics :

LED power (PL) = 2 mW (3 dBm)

LED to fiber loss (Lsf) = 3 dB

Fiber loss per km (FL) = 0.5 dB/km

Fiber length (L) = 40 km

Connector loss ($Lconn$) = 1 dB (one connector between two 20-m fiber lengths)

Fiber to detector loss (Lfd) = 3 dB

Receiver sensitivity (Ps) = − 36 dBm

Draw the link power budget and find the loss margin. 14

(c) A receiver has sensitivity Ps of − 45 dBm and a BER of 10^{-9}. What is the minimum power that must be incident on the detector ? 2

3. (a) What is the maximum core diameter for a fiber if it is to operate in single mode at a wavelength of 1550 nm if the N.A. is 0·12 ? 4

(b) A 10-km fiber with a BW × length product of 1000 MHz × km (optical bandwidth) is used in a communication system. The rise times of the other components are tc = 10 ns, tL = 2 ns, tph = 3 ns, and trc = 12 ns. Calculate the *electrical* BW for the system. 12

(c) An 8 × 8 star coupler is used in a fiber optic system to connect the signal from one computer to eight terminals. If the power at an input fiber to the star coupler is 0·5 mW, find

(1) the power at each output fiber and

(2) the power division in decibels. 4

4. (a) A 2-km-length multimode fiber has a modal dispersion of 1 ns/km and a chromatic dispersion of 100 ps/km.nm. If it is used with an LED of linewidth 40 nm,

(1) What is the total dispersion ?

(2) Calculate the bandwidth (BW) of the fiber. 8

(b) A 3-km fiber optic system has an input power of 2 mW and a loss characteristic of 2 dB/km. Determine the output power of the fiber optic system. 8

(c) Write short note on Dispersion Shifted Fiber (DSF). 4

Group B

5. (a) Write short note on Code Division Multiple Access. 8

(b) A satellite at a distance of 36,000 km from earth radiates a power of 5 W from an antenna with a gain of 16 dB. Find the power received by an earth station antenna with gain of 45 dB. Operating frequency is 11 GHz. 6

(c) Find the Julian Date for 13 hours Universal Time (UT) on 18 Dec. 2000. 6

6. (a) A satellite is in a 322 km high circular orbit. Determine :

(i) The orbital angular velocity in radians per second

(ii) The orbital period in minutes

(iii) The orbital velocity in meters per second. 8

(*b*) Calculate the radius of a circular orbit for which the period is 1-day. 6

(*c*) A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12 h. Given that the eccentricity is 0·002, calculate the semi-major axis. The earth's equatorial radius is 6378·1414 km. 6

7. (*a*) State and explain all the three Kepler's Laws planetary motion. 15

(*b*) Derive expression for Orbital Velocity of satellite. 5

8. (*a*) Derive Expression for Centrifugal force acting on satellite. 6

(*b*) Determine the angle of tilt required for a polar mount used with an earth station at latitude 49 degrees north. Assume a spherical earth of mean radius 6371 km, and ignore earth station altitude. 8

(*c*) Discuss different types of propagation impairments which affects satellite communication. 6

Group C

9. Answer the following : 10 × 2

(*i*) Why uplink frequency is higher than downlink frequency ?

(*ii*) What are the applications of VSAT network ?

(*iii*) What are Azimuth and elevation angles ?

(*iv*) Define Transponder.

(*v*) What do you understand by orbital perturbations ?

(*vi*) Differentiate between meridional ray and skew ray.

(*vii*) Draw absorption characteristics of pure SiO_2 in optical communication band.

(*viii*) Define LP Modes.

(*ix*) What do you mean by dispersion shifted fiber ?

(*x*) What do you mean by dispersion Flattened fiber ?