Total number of printed pages – 10

B. Tech

CPEC 5401

Seventh Semester Examination – 2006

COMMUNICATION SYSTEMS

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) How do satellites on inclined orbits overcome disadvantages of geostationary satellites ?

   (b) Why do communication satellites use two frequencies – one for uplink and another

P.T.O.

for downlink? Why uplink frequency is always chosen higher than the downlink frequency ?

(c) Define system noise temperature of a communication receiver. How is it related to G/T ratio of a satellite earth station ?

(d) What is multiple access? What is the basic principle of operation of CDMA ?

(e) How does rain affect satellite communication ? Why 6/4 GHz band finds more use than 14/11 GHz band ?

(f) Define numerical aperture. Refractive index of the core of an optical fiber is $n_1 = 1.487$. Refractive index of the cladding changes by 2%. The core diameter is 62.5 μm and the operating wavelength is 1300 nm. Calculate the numerical aperture and the number of modes the fiber will support.

(g) What is population inversion ? Why is it essential for laser operation ? How population inversion is realized ?

(h) Define chromatic dispersion. For a graded index fiber operating at 850 nm, the zero-dispersion slope $S_o = 0.101$ ps / (nm^2km) and zero dispersion wave length $\lambda_o = 1300$ nm. The spectral width of the source is 70 nm. If the fiber is 5 km long, calculate the pulse spreading. Calculate the bit rate per km.

(i) Why semiconductor photodiodes are reverse biased ? List the other advantages of reverse biasing. Why *p-i-n* photodiodes are so popular compared to other photodiodes ?

(j) What is WDM ? How WDM technology is capable of enhancing bit rate to Tbits/s ?

2. (a) List the advantages of geostationary satellites for which it is widely used commercially. What is a subsatellite point ? What are 'look angles' ? How look angles of an earth station are determined ? 5

(b) Given earth's radius = 6378 Kms, and gravitational co-efficient g_o is 3.964×10^{14} m^3/sec^2. Determine the height of geostationary orbit. Calculate the area covered on the earth's surface by a geosynchronous satellite for a minimum elevation angle of 10 degrees. 5

3. (a) Determine the EIRP generated by an earth station transmitter with an output power of 1.2 kw coupled to a parabolic reflector antenna with 15 m diameter and antenna aperture efficiency of 55%. The system carrier frequency is 6.25 GHz and feed

and branch losses equal to 4.5 dB. Determine the uplink space losses assuming the height of the geosynchronous satellite to be 36,000 km. 6

(b) Draw a simplified block schematic diagram of a single conversion transponder for 6/4 GHz band. Describe the function of each subsystem. Which subsystem should be provided with redundancy and why ? 4

4. (a) Following data are available for a satellite receiving system : 5

(i) 2.5 m dia parabolic reflector antenna with 55% efficiency and noise temperature $T_A = 50°k$,

(ii) LNA of 25 dB gain and noise figure = 1.6 dB

(iii) Mixer of - 6 dB gain and NF = 6 dB

(iv) I.F. stage of 30 dB gain and NF = 2 dB

(v) Wave guide loss = 1 dB, physical temp.= 290°k. Calculate its G/T ratio in dBk^{-1} referred to the output port of the antenna.

(b) Bring out the distinguishing features of multiple access techniques – FDMA, TDMA and CDMA. Which one is most versatile and why ? 2.5

(c) Draw a simplified diagram of a large earth station's equipment using FDM/FM/FDMA technology. Describe the system in brief. 2.5

5. (a) Explain, in brief, various factors responsible for attenuation in an optical fiber. Draw the attenuation vrs wavelength curve. 3

(b) Explain, in brief, modal-, chromatic-, wave guide- and polarization mode dispersion. How to improve dispersion performance of an optical fiber ? 4

(c) What are LP modes ? Draw the field configurations and intensity plots of LP_{11} mode. 3

6. (a) Distinguish between spontaneous and stimulated radiation with respect to their properties. Draw the input-output characteristics of a laser diode and explain what mechanisms determine the course of this graph. What must be the slope efficiency of a laser diode ? Why do we need to cool a laser diode ? 2+2+1

(b) List the various sources of noise in a photodiode. Obtain suitable expressions for

them as applicable to *p-i-n* and APD photodiodes. Draw the noise equivalent circuit of a photodiode.

A *p-i-n* photodiode with an input power of 0.1 μw and responsivity R=0.9 A/W operates at 850 nm. It has a bandwidth of 1.5 GHz and connected to a load resistance of 50 kohms. Neglecting dark current noise and 1/f noise current determine the rms value of total noise current. Calculate the SNR. Boltzmann' constant $K_B=1.38\times10^{-23}$ J/K°. Assume T = 300°K. 5

7. (a) Draw an optical communication link showing all components from optical source to photo detector. List all those, which contribute to 'link power budget' and 'link rise-time budget'. 4

(b) Design an optical fiber link for the transmission of 200 Mb/s at a 6.5 km distance. For the design you may use an LED operating at 820 nm with a power output of–10 dBm, a *p-i-n* diode photo detector with a sensitivity of – 45 dB. You may assume suitable values for other data required for designing the optical fiber link. 6

8. (a) Draw the block schematic diagram of a typical WDM network containing tunable sources and various types of optical amplifiers and optical filters. Explain the principle of operation of this network. If the WDM system is operating with a channel spacing of 100 GHz and the network operates at 1550 nm, calculate the channel spacing in nm. 5

(b) Explain the plasma-activated chemical vapour deposition (PCVD) technique of making perform and drawing optical fiber. 5