Code: A-22 **Subject: SATELLITE & SPACE COMMUNICATION**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x8)

a. The space shuttle flies at a nominal

(A) 150 Km circular orbit. **(B)** 296 Km circular orbit.
(C) 700 Km circular orbit. **(D)** 500 Km circular orbit.

b. For high power applications and in the Ku band the satellite spacing in degrees is around

(A) 5° . **(B)** 2°.
(C) 7°. **(D)** 9°.

c. Certain constraints in the transmitted EIRP of satellites for systems to co-exist will be usually specified by the

(A) CCIR. **(B)** ITU.
(C) IFRB. **(D)** FCC.

d. The maximum data rate that the INTELSAT TDMA traffic burst can carry is

(A) 7.2 Mbps. **(B)** 8.192 Mbs.
(C) 9.52 Mbps. **(D)** 10 Mbps.

e. The EIRP for a satellite down link at 12 GHz operating with a transmit power of 6W and an antenna gain of 48.2 dB is

(A) 80 dBW. **(B)** 60 dBW.
(C) 44.5 dBW. **(D)** 56 dBW.

f. In a spin stabilised satellite, the spin rate is typically in the range of

(A) 20 to 30 rev / min. **(B)** 50 to 100 rev / min..
(C) 100 to 150 rev / min.. **(D)** 150 to 200 rev / min..

g. The process of combining a number of telephony signals in digital form into one baseband signal is known as

(A) PCM. **(B)** FDM.
(C) TDM. **(D)** CDM.

h. Most VSAT systems operate in the

(A) L band. **(B)** C band.
(C) X band. **(D)** Ku band.

PART I
Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. What are the requirements for a spacecraft to achieve synchronous orbit? With a neat sketch for illustration, describe briefly the steps in launching a communications satellite. **(8)**

b. Starting from fundamentals derive the equation for the rain attenuation in dB, if the slant path length of signal through the rain is 'L_s'. **(6)**

Q.3 a. Define the following as applied to a satellite link:
(i) Boresight of the antenna.
(ii) EIRP and
(iii) The Uplink. **(6)**

b. To ensure that the best possible G-to-N ratio is maintained, the noise in the receivers must be reduced as far as possible – why is this dictated? What steps are taken in a practical system to satisfy the above requirement? **(2)**

c. Fig.1 shows a typical receiving system. Deduce the equation for the system noise temperature referred to the input. If the receiver noise figure is 12 dB, the cable loss is 5 dB, the LNA gain is 50 dB, LNA noise temperature is 100 K, and the antenna noise temperature is 35 K, calculate the noise temperature referred to the input. **(6)**

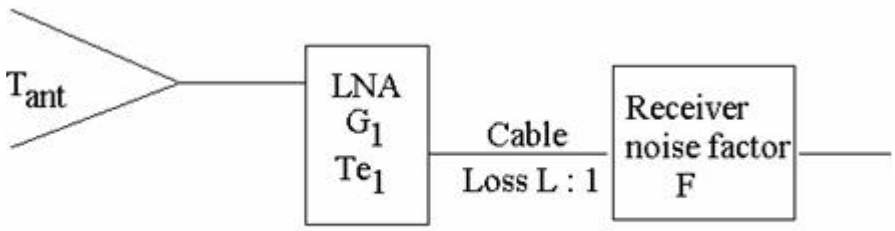

Fig.1

Q.4 a. What is FDM? With a block schematic briefly explain the transmitting and receiving ends of a typical FDM/FM analog system. **(7)**

b. An earth station is to receive 972 multiplexed telephone channels from the INTELSAT V global beam. The rms test-tone deviation specified for the system is 802 KHz and the top base band frequency is 4028 KHz. Using a peaking factor g = 3.16, determine the following:
(i) The number of groups and super groups that are involved.
(ii) The required receiver bandwidth before FM detection.
(iii) The overall (C/T) at the receiver input required for operation at 10-dB (C/N).
(iv) The overall (C/N) required at the receiver input required for a worst channel (S/N) of 50 dB. **(7)**

Q.5 a. What is meant by multiple access of a satellite? Indicate the commonly used multiple access techniques and briefly describe their operating mechanisms. **(8)**

b. Five earth stations share one transponder of a 6/4 GHz satellite. The satellite and earth station characteristics are given below:

Satellite Transponder BW = 36 MHz, Transponder gain = 90 dB (Max)
Input noise temperature = 550 K, Output power = 6.3 W (Max)
4 GHz antenna gain = 20 dB, 6 GHz antenna gain = 22 dB.

Earth Station 4 GHz antenna gain = 60dB, 6 GHz antenna gain = 61.3 dB, R_X System temperature =100 K.

Path Loss At 4 GHz = 196 dB; At 6 GHz = 200 dB

Find the earth station transmitter power and received (C/N) when the system is operated in FDMA with 5 dB input and output backoff. **(6)**

Q.6 a. Define the following:

(i) Capacity of an additive white Gaussian noise channel,
(ii) Spectral efficiency of the communication link,
(iii) Power limited link,
(iv) Bandwidth limited link. **(6)**

b. Write a note on 'ERROR-DETECTION CODING'. **(4)**

c. Alphanumeric characters are transmitted as 7-bit ASCII words, with a single parity bit added, over a link with a transmission rate of 9.6 Kbps.

(i) How many characters are transmitted each second?
(ii) If a typical page of text contains 500 words with an average of five characters per second and a space between words, how long does it take to transmit a page?
(iii) If the bit error rate on the link is 10^{-5}, how many characters per page are detected as having errors? **(4)**

PART II
Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. What are the important factors that contribute to noise in an earth station receiving channel? **(5)**

b. Explain how the calculation of Uplink thermal noise and satellite intermodulation contributions can be carried out by reference to the (C/N) in the transponder. **(5)**

c. The (G/T) ratio for the INTELSAT IV-A global beam is –17.6 dBK^{-1}. An earth station transmits a single carrier with an RF bandwidth of 7.5 MHz and a EIRP of 80.6 dBW at 6 GHz. The receiving earth station has a system noise temperature of 70 K and is to contribute 4210 pW to the system noise budget. Assuming that the transponder is linear, calculate the thermal noise contribution from the transponder if the earth station receiver (C/N) is 18 dB due to thermal noise alone. **(4)**

Q.8 a. What are base band signals? What must be done to the base band digital signal for transmission to and from a satellite? Explain briefly the following binary waveforms used for encoding digital data:
(i) Polar RZ (ii) Alternate mark inversion. **(6)**

b. Define the following binary digital modulation methods:
(i) DPSK (ii) QPSK **(4)**

c. Draw the functional block diagram for carrier recovery in a receiver with coherent detection and briefly explain its operation. **(4)**

Q.9 a. What is a transponder? How many transponders can be accommodated in a typical C-band communication satellite? What do you mean by frequency reuse? **(5)**

b. Assuming the Uplink frequency range as (5.925 to 6.425) MHz, draw a figure which shows the channelling scheme for the transponders of part (a) above and briefly explain its operation. **(9)**

Q.10 a. What is the function of the

(i) burst-code word
(ii) carrier and bit-timing recovery channel

in a TDMA burst? **(7)**

b. Discuss the principle of operation of CDMA. **(7)**

Q.11 a. Describe the operation of a typical VSAT system. **(7)**

b. List some of the short comings of present day VSAT systems. **(3)**

c. Write the syndrome circuit for the (7, 4) cyclic code generated by, $g(X) = 1 + X + X^3$ and briefly explain its operation. **(4)**