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 SUN's track will intersect the position of a geostationary satellite, as seen from an earth station at

(A) one period in the year. **(B)** two periods in the year.
(C) three periods in the year. **(D)** four periods in the year.

b. The SPADE communication signalling channel operates in a

(A) FDMA mode. **(B)** TDMA mode.
(C) CDMA mode. **(D)** DAMA mode.

c. The antenna which is used directly as a radiator aboard satellites to illuminate comparatively large areas of the earth is

(A) a parabolic reflector. **(B)** a turnstile antenna.
(C) a log periodic antenna. **(D)** a horn antenna.

d. The BPSK signal is a

(A) DSB type signal. **(B)** SSB type signal.
(C) DSB SC type signal. **(D)** VSB type signal.

e. For a receiver with a noise figure of 1.5 dB, the equivalent noise temperature is

(A) $110^{\circ}\mathrm{K}$. **(B)** $119^{\circ}\mathrm{K}$.
(C) $116^{\circ}\mathrm{K}$. **(D)** $120^{\circ}\mathrm{K}$.

f. The TDMA guard time specified for Intelsat is

(A) 125 μs. **(B)** 900 ns.
(C) 985 ns. **(D)** 993 ns.

g. In the Intelsat system the frame time is

(A) 150 μs. **(B)** 2 ms.
(C) 5 ms. **(D)** 80 μs.

h. For a satellite operated at an EIRP of 56 dBW and an antenna gain of 50 dB with a transmitter feeder loss of 2 dB, the power output of the TWTA is

(A) 6 dBW. **(B)** 7 dBW.
(C) 10 dBW. **(D)** 8 dBW.

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

Q.2 a. Write the important features of a satellite in geostationary orbit. **(4)**

b. The Virginia Tech earth station is located at 80.438° W longitude and 37.229° N latitude. Calculate the look angles (azimuth and elevation angles) to a geosynchronous satellite whose sub satellite point is located at 121° W longitude. **(5)**

c. Why do losses occur in the earth's atmosphere? Write a note on ionospheric effects. **(1+4)**

Q.3 a. Define the following as applied to a satellite link:
(i) Illumination efficiency of the antenna.
(ii) Path loss.
(iii) Power flux density at the receiving point. **(7)**

b. A receiver operating at 2800 MHz is shown in block diagram form in Figure 1. Calculate its G/T in dBK^{-1} referred to the output port of the antenna. **(7)**

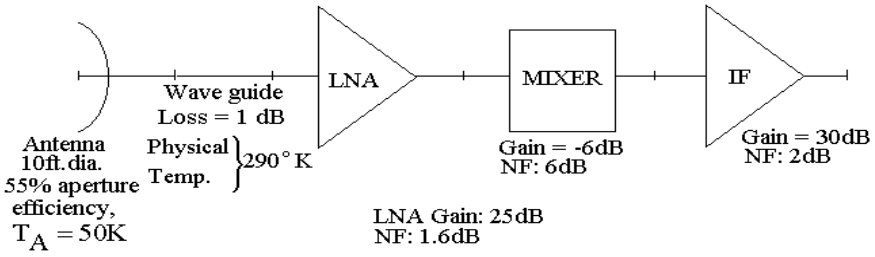

Fig.1

Q.4 a. What is an analog SCPC system? Discuss briefly its features. **(8)**

b. A television signal at baseband extends from 0 to 4.2 MHz. The television signal frequency modulates a 6-GHz transmitter with a peak carrier deviation of 5 MHz. The transmitted signal occupies a bandwidth of 18.4 MHz. The 6-MHz TV signal will be relayed by a satellite whose antenna noise temperature is 290K and whose U.S. standard noise figure is 8 dB. Assume that the transponder bandwidth equals the 18.4 MHz signal bandwidth. Successful operation of this system requires a minimum (C/N) of 10 dB at the satellite receiver input.
(i) Calculate the required carrier power in dBm at the output of the satellite antenna. (i.e. at the input to the transponder)
(ii) Assuming a satellite antenna gain of 17dB and a distance from the transmitting station to the satellite of 3.8×10^7 m, calculate the required earth station EIRP in dBW. **(6)**

Q.5 a. What is TDMA? Mention its advantages and disadvantages. What is the difference between TDM & TDMA? **(9)**

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 Antenna gain : 60dB (at 4 GHz), Antenna gain : 61.3 dB (at 6 GHz) Receiver System temperature : 100 K.

Path Loss 196 dB at 4 GHz and 200 dB at 6 GHz

All the stations operate in a TDMA mode. The original speech signals are sampled at 8 KHz, using 8 bits/sample. The sampled PCM signals are then multiplexed into 40 Mbps streams at each station, using QPSK. Find

(i) The bit rate for each PCM channel.

(ii) The number of speech signals (as PCM channels) that can be sent by each earth station, as a single access.

(iii) The frame time for TDMA without storage.

(5)

Q.6 a. What is a linear block code? Explain quantitatively how errors in code words can be detected by using a parity check matrix H. **(6)**

b. A (7, 4) Hamming code has a generator matrix given by

$$G = \begin{bmatrix} 1000 & 111 \\ 0100 & 110 \\ 0010 & 101 \\ 0001 & 011 \end{bmatrix}$$

(i) Determine all possible code words of this code.

(ii) Owing to errors, the received code word for the message vector 1010 is corrupted in the second bit. Calculate the syndrome and comment on the error detection capability. **(8)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. For a complete satellite circuit show that the combined noise-to-carrier ratio value is given by $\left(\frac{N_o}{C}\right) = \left(\frac{N_o}{C}\right)_U + \left(\frac{N_o}{C}\right)_D$.

Where the sub scripts U & D represents the uplink and downlink. **(9)**

b. A satellite circuit has the following parameters:

	UPLINK	**DOWNLINK**
[EIRP]	54 dBW	34 dBW
$\left[G/T\right]$	0 dB	17 dB
[FSL]	200 dB	198 dB
[RFL]	2 dB	2 dB
[AA]	0.5 dB	0.5 dB
[AML]	0.5 dB	0.5 dB

Where various parameters have usual significance.

Calculate the overall $\left[C/N_o\right]$ value. **(5)**

Q.8 a. What are digital signals? With neat sketches for illustration, briefly explain the following binary waveforms used for encoding digital data:
(i) Unipolar NRZ (ii) Split phase or Manchester. **(5)**

b. Define the following :
(i) FSK (ii) BPSK
Illustrate the formats for the above. **(3)**

c. Explain briefly the BPSK receiver that employs coherent detection, using a block schematic showing the carrier recovery section and the bit timing recovery. **(6)**

Q.9 a. What is the meaning of the term 'attitude' as applied to a satellite? Explain briefly the following with respect to the space segment:
(i) The power supply. (ii) Attitude control. **(9)**

b. A typical TVRO installation for use with C-band satellites has an antenna of diameter 3m with an efficiency of 55%. Calculate its gain and beamwidth. **(5)**

Q.10 a. Explain in detail the operation of the SPADE system of demand assignment. **(10)**

b. One SCPC Voice channel of the SPADE system carries QPSK at a symbol rate of 32,000 symbols per second in a bandwidth of 38 KHz. It achieves a bit error rate of 1×10^{-4}. Without coding, this requires an E_b/N_o of 9.4 dB. The single carrier for this spade channel is radiated by an INTELSAT-V transponder with an EIRP of 0 dBW to an earth station 40,000 Km away. The channel center frequency is 4095 MHz. The tabulated EIRP's for INTELSAT V transponder are about 29 dBW. Why does this single SPADE carrier have a 0-dBW EIRP? **(4)**

Q.11 a. What does VSAT stand for? Write its distinguishing feature. Name the user groups for VSAT. **(5)**

b. Discuss briefly the structure of a VSAT network. **(6)**

c. Comment on the operational configuration module for VSAT system. **(3)**