Code: AE22 **CCEMBER 2008** **Subject: SATELLITE & SPACE COMMUNICATION**

Time: 3 Hours **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. In which of the following satellite system Doppler shift is absent

(A) Geostationary satellite **(B)** Near earth orbit satellite
(C) Domestic satellite system **(D)** Geosynchronous satellite

b. The multiple access technique that suffers from intermodulation distortion is

(A) TDMA **(B)** FDMA
(C) CDMA **(D)** Packet Access

c. The commonly used analog modulation technique in satellite communication is:

(A) AM **(B)** FM
(C) PAM **(D)** PWM

d. A Geostationary satellite completes one orbit in

(A) one hour **(B)** 5 hours
(C) 24 hours **(D)** 28 hours

e. In C band transponders, the uplink frequency is about

(A) 6 GHz **(B)** 4 GHz
(C) 14 GHz **(D)** 11 GHz

f. The eccentricity of an elliptical orbit with the apogee point at 43,000 km and the perigee point at 7000 km from centre of the earth

(A) 0.72
(B) 0.16
(C) 0.45
(D) indeterminate from given data

g. In a spin stabilized geostationary satellite, the spin axis is

(A) perpendicular to the orbital plane

(B) in the plane of the orbit
(C) inclined at 45º to the orbital plane
(D) none of these

h. Satellite (S_1) and (S_2) are orbiting in two different equatorial circular orbits. The radius of S_1 orbit is four times the radius of S_2 orbit. The orbital period of S_1 orbit will therefore be

(A) 4 times the orbital period of S_2
(B) 8 times the orbital period of S_2
(C) twice the orbital period of S_2
(D) same as the orbital period of S_2

i. With the reference to transponder capacity utilization in case of TDMA and FDMA techniques,

(A) the capacity utilization is almost 100% irrespective of number of accesses in TDMA
(B) the capacity utilization can never be 100% in FDMA
(C) the capacity utilization is 100% in TDMA for single access only
(D) none of these

j. A satellite earth station antenna has a gain of 10^6 and a noise temperature of 100ºK. The earth station will has G/T in dB/K as

(A) 40dB/K **(B)** 80dB/K
(C) indeterminate **(D)** none of these

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. What are the Kepler's Three Laws for planetary motion? Derive the Kepler's Third law with help of Newton's universal law of gravitation and Newton's second Law of motion. **(6)**

b. A satellite is in an elliptical orbit with eccentricity 0.6 and perigee altitude 1000 km. If given the mean earth radius as 6378.14 km and $\mu = 3.986004 \times 10^5$. Determine (i) the semimajor axis; (ii) period of revolution; (iii) apogee radius ; (iv) apogee velocity ; (v) perigee velocity. **(10)**

Q.3 a. Using the expressions for the noise figures and temperatures of two networks in tandem, show that the general microwave receiver overall system temperature Ts can be written as

$$T_s = T_a + (L-1)\,T_o + LT_r + L(F-1)T_o/G_r$$

where T_a is the antenna temperature, L is the loss between the antenna and low noise

amplifier (LNA), T_r is the excess temperature of the LNA, G_r its gain, and F the noise figure of the following down converter. **(8)**

b. Derive the equations for rain attenuation in decibels. **(8)**

Q.4 a. Define EIRP and show that $\left[\frac{C}{N}\right]^{-1}_{\text{overall}} = \left[\frac{C}{N}\right]^{-1}_{\text{uplink}} + \left[\frac{C}{N}\right]^{-1}_{\text{downlink}}$. **(5)**

b. Explain why the Low-noise amplifier of a receiving system is placed at the antenna end of the feeder cable. **(5)**

c. Explain, $\frac{G}{T}$ ratio of satellite receiving system. A satellite receiving system employ a 5 m parabolic antenna operating at 12 GHz. The antenna Noise Temperature is 100 K and the receiver front end noise Temperature is 120 K. Calculate $\frac{G}{T}$. **(6)**

Q.5 a. Compare the OOK and BPSK modulation techniques used in satellite communication. **(8)**

b. Explain analog FM/FDM television transmission through satellite. Write down the expression for S/N ratio calculation for satellite TV links. **(8)**

Q.6 a. What is meant by satellite attitude? Explain the axes used to define a satellite attitude. Differentiate between passive attitude control and active attitude control. **(5)**

b. Describe the east-west and north-south station-keeping maneuvers required in satellite station keeping. What are the angular tolerances in the station keeping that must be achieved? **(5)**

c. Why TWTA are used aboard satellites compared to other types of high power amplifying devices? What are the main disadvantages of the TWTA? **(6)**

Q.7 a. Distinguish between pre-assigned and demand assigned traffic in relation to a satellite communication network. Briefly describe the ways in which demand assignment may be carried out in an FDMA network. **(6)**

b. A TDMA network of five earth stations shares a single transpoder equally. The frame duration is 2ms, the preamble time per station is 20µsec, and guard bands of 5 µsec are used between bursts. Transmission bursts are QPSK at 30 Mbauds. Calculate the number of 64kbps voice channels that each TDMA earth stations can transmit. What will be the increase in guard time for the calculated number of voice channels? **(10)**

Q.8 a. Describe the error detection and error correction techniques used in satellite communication. Also explain why forward error correction normally be used on satellite circuits? **(5)**

b. Compare Linear code and convolutional codes. **(5)**

c. The bit rate for a base band signal is 1.544 Mb/s, and FEC at a code rate of 7/8 is applied before the signal is used to modulate the carrier. Given that the system used the raised cosine filtering with a roll off factor of 0.2, determine the bandwidth required for (i) BPSK and (ii) QPSK. **(6)**

Q.9 a. Explain which Network architecture is implemented for,
(i) Narrow casting
(ii) When there is no normal return channel.
(iii) To setup two way communications over the same satellite for large country with widely dispersed communities without passing through Hub. **(8)**

b. What is window of connection? Illustrate continuous transmission ARQ system for 60 msec window with 10 msec one way delay and 260 msec one way delay. Which will have higher throughput and why? Assume there are no propagation errors. **(8)**