Code: AE-22   **Subject: SATELLITE AND SPACE COMMUNICATION**

JUNE 2007

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.   The bandwidth required for the Bell T1 system, with binary transmission interms of the roll off factor 'ρ' is given by,

   (A) $0.503(1+\rho)MHz$ (B) $0.325(1+\rho)MHz$

   (C) $2.5(1+\rho)MHz$ (D) $0.772(1+\rho)MHz$

b.   The gravitational pull of the SUN and the MOON cause the inclination of the satellite to change at a rate of about

   (A) $0.35°/year$ (B) $0.56°/year$

   (C) $0.85°/year$ (D) $2.3°/year$

c.   An amplifier has a quoted noise figure of 2.5 dB. Its equivalent noise temperature is

   (A) 125 K.   (B) 85 K
   (C) 300 K.   (D) 226 K.

d.   If the gain of a paraboloidal antenna operating at a frequency of 12 GHz with an aperture efficiency of 0.55 is 48.9 dB, then its diameter will be

   (A) 1.58 m.   (B) 3-m.
   (C) 2.15-m.   (D) 5.12-m.

e.   If the power output of the TWTA of a satellite is 8 dBW operating with an output backoff of 6 dB, then the power output of the TWTA required for full saturated EIRP is

   (A) 18 KW.   (B) 18 W.
   (C) 25 W.   (D) 25.3 KW.

f.   To keep bit errors at an acceptable level, the theoretical baseband C/N ratio of a binary digital waveform must atleast be typically

(A) 4.6 dB.   **(B)** 15 dB.
(C) 20 dB.   **(D)** 10 dB.

g. For a roll off factor of unity, the bandwidth for the Bell T1 system with binary transmission becomes

(A) 3.52 MHz   (B) 4.54 MHz
(C) 1.544 MHz   (D) 5.543 MHz

h. The earth will eclipse a geostationary satellite

(A) once a year.   (B) thrice a year.
(C) twice a year.   (D) none of the above.

i. The frame duration in a TDMA network of five earth stations with a preamble time per station of 20 μs is 2 ms. If guard bands of 5 μs are used between bursts, then the data burst duration for each earth station will be

(A) 255 μs (B) 375 μs
(C) 400 μs (D) 195 μs

j. A (7, 4) BCH code can correct upto

(A) two errors   (B) three errors
(C) one error   (D) five errors

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

Q.2   a. Write four points about the first Intelsat satellite. With a neat sketch for illustration, briefly explain the orbital plane coordinate system.
(10)

b. The orbital period of a low earth orbit satellite is 89 min 30.3 seconds. Taking the mean earth's radius as approximately 6378.14 Km, compute the altitude of the orbit above the earth's surface. Also compute the linear velocity of the satellite along its orbit in Km/ second.   **(6)**

Q.3   a. Why noise temperature is considered as a useful concept in communication receivers? Write the schematic of a simplified earth station receiver and write its noise model. Derive the equation for the system noise temperature from the above model.
(10)

b. A satellite receiver operating at 4-GHz has the following gains and noise temperatures:

$T_{in} = 25K$
$T_{RF} = 50K$
$T_{IF} = 1000K$
$T_m = 500K$
$G_{IF} = 30dB$

If the above system has an LNA with a gain of 50 dB, and if a section of lossy waveguide with an attenuation of 2 dB is inserted between the antenna and the RF amplifier, find the system noise temperature referred to the antenna output port. Take the waveguide temperature as 300 K. **(6)**

Q.4 a. Which is the quantity that serves as a measure of the performance of a satellite link? Starting from fundamentals, derive an expression for the above quantity expressed in 'dBHz'. **(8)**

b. An earth station radiates an [EIRP] of 54 dBW of 14 GHz from a 10 metre parabolic antenna. The transmit feeder losses between the high-power amplifier and the antenna are 2.5 dB. Calculate the output of the HPA in watts.
(5)

c. The $\left[\dfrac{C}{N}\right]$ values for a satellite circuit are :

UPLINK: 25 dB and DOWNLINK: 15 dB.

Calculate the overall $\left|\dfrac{C}{N}\right|$ value. **(3)**

Q.5 a. Define the term 'threshold' for an FM demodulator. Where does this occur for a conventional FM demodulator? What is the chief advantage of threshold extension FM demodulator? **(5)**

b. The baseband video bandwidth of a standard NTSC signal is 4.2 MHz. The signal is transmitted over the satellite link in an RF bandwidth of 30 MHz using FM and standard preemphasis and deemphasis. At the receiving earth station, if the $\dfrac{C}{N}$ ratio in clear sky conditions is 15 dB, calculate the baseband $\dfrac{S}{N}$ ratio for the video signal. Take a deemphasis improvement of 9 dB and a subjective improvement factor of 8 dB in the baseband signal-to-noise ratio. Comment on the FM improvement in dB including the subjective weighting specified. **(7)**

c. Distinguish between QPSK and QAM. **(4)**

Q.6 a. How are the equipments carried aboard the satellite classified according to function? Briefly highlight each one of them.
(6)

b. With a sketch for illustration, briefly describe the channelling scheme for the twelve transponders of a typical C-band communications satellite. **(10)**

Q.7 a. What are the advantages of multiple access? What is the basic problem in any multiple access system? **(6)**

b. A large number of satellite telephones can access a single transponder on an LEO satellite using FDMA-DA. The telephones transmit BPSK signals in L-band such that the power level at the input to the transponder is always – 144dBW for any uplink signal. The

transponder's gain and bandwidth are respectively 134 dB and one megahertz. If the maximum permitted output power of the transponder is 5W, compute the maximum number of satellite telephones that can simultaneously access the transponder. Based on your computation, what do you say about the status of the transponder? Take the spacing between center frequencies of the telephone transmitters to be 16 KHz apart, which includes the guard band between each signal. **(10)**

Q.8 a. For what type of satellite communication link, can the demand access (DA) be recommended? Give one example of such a link. What is the main feature of demand access? What is the major difference between a cellular system and a satellite system? What are the types of channel that the DA systems require?
(8)

b. With a sketch for illustration, briefly explain a star VSAT network. Furnish also the topology of the above network as viewed from the satellites perspective. **(8)**

Q.9 a. Which is the fundamental difference between analog and digital signals? In error control coding, what is the quantity that serves as a measure of the number of redundant bits that must be added to detect or correct a given number of errors? Define the term coding gain. It is said that, coding gain must be used with care in satellite links. Give your comments. **(8)**

b. What are the advantages of convolutional codes over block codes? Define the term 'State' of a convolution encoder. What do you mean by the term 'Span' of the encoder? **(4)**

c. Write a brief note on a decoder for convolutional codes. **(4)**