Code: A-22   **Subject: SATELLITE & SPACE COMMUNICATION**
Time: 3 Hours   **June 2006**   **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 first geostationary satellite, Early Bird, began to provide telephone service across the Atlantic ocean, fulfilling clarke's vision on satellite communication in the year

   (A) 1960   **(B)** 1959
   (C) 1969   **(D)** 1965

b.   A remote sensing satellite is launched in

   (A) Circular orbit.   **(B)** Polar orbit.
   (C) Geo Synchronous orbit.   **(D)** Geo Stationary orbit.

c.   The gain of a 10 m^2 aperture at a frequency of 11 GHz is

   (A) 51.2 dB   **(B)** 52.3 dB
   (C) 48.9 dB   **(D)** 54.2 dB

d.   The free space region of the earth's atmosphere begins from a height of about

   (A) 90 km from the earth's surface.
   (B) 300 km from the earth's surface.
   (C) 450 km from the earth's surface.
   (D) 600 km from the earth's surface.

e.   When a signal is transmitted through a link using pre-emphasis and de-emphasis at the source and the destination respectively, the transfer function of the system will be

   (A) 0.5   **(B)** 2
   (C) 1   **(D)** 2.5

f.   The microwave device that can provide amplification over a very wide bandwidth is

   (A) Klystron   **(B)** reflex klystron
   (C) TWT   **(D)** Magnetron.

g.   If the bit rate for a TDMA circuit that uses QPSK modulation is 60.25 Mb/s, then the IF bandwidth required with a roll off factor of 0.2 is

> (A) 35.15 MHz   (B) 36.15 MHz
> (C) 29.12 MHz   (D) 40 MHz

h. If the coding gain for a CDMA receiver is 27.2 dB, then the value of the chip rate for a bit rate of 9.6 kbps is

> (A) 9.6 kcps   (B) 9.5 mcps
> (C) 5 mcps   (D) 10 mcps

i. If the generator matrix for a (6,3) block code is $G = \begin{bmatrix} 100\,011 \\ 010\,101 \\ 001\,110 \end{bmatrix}$, then the code word for the message block (1, 1, 0) is

> (A) [110110]   (B) [110111]
> (C) [000010]   (D) [110101]

j. Most VSAT systems operate with transmitter powers of

> (A) 6 or 8 watts   (B) 10 or 15 watts
> (C) 8 or 10 watts   (D) 1 or 2 watts

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

Q.2 a. Why satellites are considered as a good place to locate a repeater? Signals reaching a satellite from an earth station and signals received on earth stations from a satellite are always very weak, why is it so? Starting from basic principles, deduce the equation for the period of the satellites orbit, T, if the orbit is circular.
(12)

b. A satellite is in an elliptical orbit with a perigee of 1000 km and an apogee of 4000 km. If the mean earth radius is 6378.14 km, find the eccentricity of the orbit.   **(4)**

Q.3 a. It is said that, " weight is the most critical factor in the design of any satellite", give your comments. Which are the other factors that influence the link design? Mention three important features of DBS-TV satellites. Derive necessary equations, that demonstrates how the CNR in the home DBS-TV receiver deteriorates when rain is in the path between the satellite and the receiving antenna.   **(13)**

b. A satellite at a distance of 40000 km from a point on earth's surface radiates a power of 10 W from an antenna with a gain of 17 dB in the direction of the observer. Calculate the flux density at the receiving point in decibels.   **(3)**

Q.4 a. List the impairments (propagation) introduced, when a signal travelling between an earth

station and a satellite pass through the earth's atmosphere including the ionosphere. Mention also the physical cause for the said impairment. **(14)**

    b. Illustrate by a sketch the different layers in the earth's atmosphere. **(2)**

Q.5   a. What is the type of modulation used in analog satellite systems? Support your answer with proper reasoning. What is the disadvantage of the method commonly used? What is the meaning of "unweighted S/N improvement" for the modulation method used? **(6)**

    b. Write a note on SCPC FM links. **(5)**

    c. A baseband signal of maximum frequency equal to 3.4 KHz is used in a SCPC-FM satellite link. A subjective improvement in baseband SNR of 7 dB is provided by de-emphasis. If the CNR of the receiver is 13 dB, calculate the baseband SNR ratio for the voice channel. If the FM demodulator has one FM threshold at 6 dB, estimate the link margin for this system. Take the RF channel bandwidth of the link as 45 KHz. **(5)**

Q.6   a. What is a transponder? Briefly explain the following units of a transponder:

        (i)   The wideband receiver.
        (ii)   The input de-multiplexer.
        (iii)   Power amplifier.
        (iv)   Antenna Subsystem. **(14)**

    b. For a typical C-band communications satellite, how many transponders can be accommodated? **(2)**

Q.7   a. What is 'Multiple Access'? What are the factors influenced by the multiple access technique? Which multiple access technique is widely used as a method of sharing the bandwidth of satellite transponders? What do you mean by pre-assigned access? **(7)**

    b. A C-band transponder has an output spectrum for downlink signals in the frequency range 3705-3741 MHz. If the transponder carries two un-modulated carriers at 3718 and 3728 MHz with equal magnitudes at the input to the HPA, compute the third-order inter-modulation products in the output of the HPA. **(4)**

    c. For what type of signals, is the TDMA technique best suited? Justify your answer. What is satellite-switched TDMA? **(5)**

Q.8 a. Give the meaning of the following:

(i) Error control.   (ii) Half rate FEC.   **(4)**

b. State Shannon-Hartley law and illustrate the ratio of $\log_2\left(\dfrac{H}{B}\right)$ plotted against E_b/N_o in decibels for the case when H<B and when the link is operating at a bit rate of H bps, by a neat sketch.   **(6)**

c. With a neat sketch for illustration, briefly explain a rate 1/2 convolutional encoder.   **(6)**

Q.9 a. What the acronym VSAT stand for? What is the underlying concept behind most VSAT systems? With a neat schematic, briefly explain the mode of a satellite in the BSS.   **(8)**

b. Briefly explain about the choice of the multiple access scheme and Access Control that concerns VSAT systems design.   **(8)**