Code: A-22   **Subject: SATELLITE & SPACE COMMUNICATION**
Time: 3 Hours

> **December 2005**

                                                                        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.   When the satellite orbit eccentricity is greater than one, the orbit becomes

   (A) elliptical.   **(B)** circular.
   (C) hyperbolic.   **(D)** parabolic.

b.   In the C-band transponder, the uplink frequency is about

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

c.   The typical solar cell arrays generate

   (A) 10 to 20 kW of power.   **(B)** 15 to 30 kW of power.
   (C) 1 to 2 kW of power.   **(D)** None of the above.

d.   For a carrier frequency of 15 GHz, the diameter of the antenna for per dB gain would be

   (A) 4 metres.   **(B)** 6 metres.
   (C) 3.2 metres.   **(D)** 2 metres.

e.   The dominant non-linear device in the transponder of a satellite that may affect the link
     signal performance significantly is

   (A) the klystron   **(B)** the GUNN diode
   (C) The reflex klystron   **(D)** the TWTA

f.   After frequency translation, the next unit of the repeater is

   (A) The antenna   **(B)** The detector
   (C) The LNA   **(D)** The power amplifier

g.   From the surface of the earth, the top of the ionospheric layer during the day time in the
   earth's atmosphere is at a height of around

(A) 200 Km.   **(B)** 400 Km.
(C) 800 Km.   **(D)** 1000 Km.

h. QPSK is phaseshift keying for a

(A) Two symbol waveform.   **(B)** Four symbol waveform.
(C) Eight symbol waveform.   **(D)** Five symbol waveform.

i. The number of full duplex voice circuits that the standard INTELSAT SCPC channelling scheme provides is around

(A) 798.   **(B)** 420.
(C) 399.   **(D)** 300.

j. The SPADE CSC operates in a TDMA mode using a center frequency of

(A) 15.32 MHz below the pilot.   **(B)** 18.045 MHz below the pilot.
(C) 17.031 MHz below the pilot.   **(D)** 22 MHz below the pilot.

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

Q.2 a. Briefly describe the first coordinate system used to describe the earth and a satellite. For a satellite of mass 'm' which is located at a vector distance 'r' from the center of the earth, derive the equation for the angular momentum of the satellite.

(9)

b. Some orbital measurements for a satellite are given below:
Semi major axis   : 42,167.911 Km
Eccentricity   : 0.00033
Mean anomaly   : 28.3866^0
Determine
  (i)   The orbital period in hours, minutes and seconds.
  (ii)   The mean orbital angular velocity in radians per second.
  (iii)   The maximum and minimum distances of the space-craft from the center of the earth during each orbital revolution, comment on the daily range variation.   **(7)**

Q.3 a. Discuss the 'ionospheric effects' on a signal travelling between an earth station and satellite.   **(8)**

b. Calculate the rain attenuation which is exceeded for 0.01% of the time in any year for the data given below:
Altitude of the earth station : 600 m
Antenna elevation angle   : 50 degrees
Rain height   : 3 Km.
Point rain rate   : 10 mm/h
Take the frequency as 12 GHz for which the specific attenuation coefficients are :

$a_h = 0.0188, a_v = 0.0168$, $b_h = 1.217$, $\& b_v = 1.2$.   Give   the   calculations   for   vertical polarisation.   **(8)**

Q.4 a. Explain what is meant by "Satellite Attitude". Briefly describe two forms of attitude control.   **(10)**

   b.   What are the functions of the antennas carried aboard a satellite? Calculate the beamwidth between nulls and the power gain of a 2-m parabolic reflector used at 6 GHz.   **(6)**

Q.5 a. Why do you require accurate bit-timing at the receiver of a digital system? Explain briefly the functional block diagram for bit-timing recovery.   **(9)**

   b.   For the system shown in the Fig.1, calculate the noise temperature referred to the input.   **(7)**

Fig.1
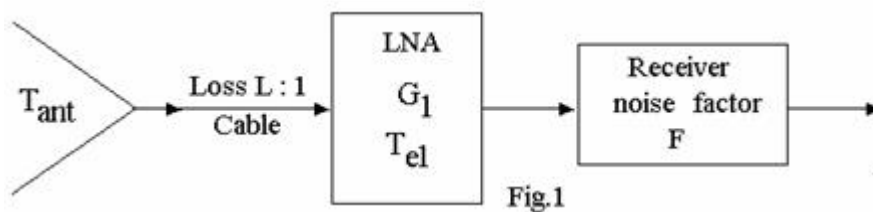
Take F = 12 dB, L = 5 dB, $G_1 = 50dB$, $T_{e_1} = 150K$ and $T_{ant} = 55K$

Q.6 a. Write the digital equivalents of the basic analog modulation schemes and define each one of them. Explain the principle of coherent demodulation of a BPSK signal with a neat schematic.   Comment   on   the   disadvantage   of   this   system,   if any.   **(12)**

   b.   How many of each of the following signals would fit into a one megahertz spectrum allocation?
   (i)   Voice, with a maximum frequency of 4 KHz, modulated using SSBSC AM.
   (ii)   High-fidelity music with a maximum baseband frequency of 15 KHz, using wideband   FM   with   a   maximum   deviation   of   75 KHz.   **(4)**

Q.7 a. Derive the equation for the power delivered to a matched receiver (Applicable to both the 'UPLINK'   and   the   'DOWNLINK'   of   a   satellite   circuit)   in   decibel notation.   **(9)**

   b. A satellite transponder requires a saturation flux density of $110\,dBW/m^2$, operating at a frequency of 14 GHz. Calculate the earth station EIRP required if total losses amount to 200 dB.   **(7)**

Q.8 a.   What is the expansion of 'SPADE' as used in satellite communication? With a neat illustration,   explain   the   channelling   scheme   for   the   SPADE system.   **(10)**

   b.   Explain, what the acronym 'SCPC' stands for. What is the important feature of the Intelsat SCPC system?

(6)

Q.9 a. What are linear block codes? The generator matrix of a (7, 4) Hamming code is given
below.

(i)   Find the code word for the message 1010. Write the parity check ma

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

(ii)   Suppose that the received code vector 'R' for the above message is corrupted in
the second bit. Compute the syndrome. With the computed syndrome what do
you conclude?   **(9)**

b.   A CRT terminal is used to enter alphanumeric data into a computer. The CRT is
connected to the computer through a voice grade telephone line having a usable
bandwidth of 3000 Hz and an output S/N of 10 dB. Assume that the terminal has 128
characters and that the data sent from the terminal consist of independent sequences of
equiprobable characters.

(i)   Find the capacity of the channel.

(ii)   Find the maximum theoretical rate at which data can be transmitted from the
terminal to the computer without errors.   **(7)**