

Code: AE22  
Time: 3 Hours

Subject: SATELLITE & SPACE COMMUNICATION  
Max. Marks: 100

DECEMBER 2007
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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.
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**Q.1 Choose the correct or best alternative in the following: (2x10)**

- a. The weight of the satellite, that could be placed in the Geo-stationary orbit by the launch vehicles designed in the late 1960s was around
- |            |             |
|------------|-------------|
| (A) 200 Kg | (B) 500 Kg  |
| (C) 100 Kg | (D) 1000 Kg |
- b. The first country to build a national telecommunication system using GEO satellites was
- |             |            |
|-------------|------------|
| (A) Germany | (B) USSR   |
| (C) Canada  | (D) France |
- c. If the free space loss for a range of 42000 Km between a ground station and a satellite is 200.4 dB, then the frequency of operation is
- |             |              |
|-------------|--------------|
| (A) 3.2 GHz | (B) 5 GHz    |
| (C) 6 GHz   | (D) 7.25 GHz |
- d. If the EIRP of a satellite down link operating at 12 GHz with a transmit power of 6 W is 56 dBW, then the antenna gain would be
- |             |             |
|-------------|-------------|
| (A) 45.2 dB | (B) 44.2 dB |
| (C) 47.2 dB | (D) 48.2 dB |
- e. If the power output of the TWTA of a satellite is 9 dBW operating with an output backoff of 5 dB, then the power output of the TWTA required for full saturated EIRP is
- |             |             |
|-------------|-------------|
| (A) 10 dBW. | (B) 13 dBW. |
| (C) 14 dBW. | (D) 16 dBW. |
- f. In an FM system, when a 1-KHz test tone is used to produce a peak deviation of 5 KHz, the receiver processor gain will be
- |              |              |
|--------------|--------------|
| (A) 26.5 dB. | (B) 22.5 dB. |
| (C) 29.5 dB. | (D) 24.5 dB. |

- g. For a roll off factor of 0.5, the bandwidth for the Bell T1 system with binary transmission becomes
- (A) 2.158 MHz (B) 3.158 MHz  
(C) 6.158 MHz (D) 1.158 MHz
- h. To provide the final output power required to the transmit antenna, the widely used amplifiers in transponders are
- (A) The parametric amplifiers (B) The Klystron amplifiers  
(C) The travelling-wave tube amplifiers (D) The magnetron amplifiers
- i. Most VSAT systems operate in
- (A) C-band (B) X-band  
(C) Ku-band (D) L-band
- j. The code rate of a linear (n,k) block code is
- (A) (k+n) (B) (n/k)  
(C) (k/n) (D) (n-k)

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

- Q.2** a. Which is the orbit preferred for all high capacity communication satellite systems? What are its advantages? With a neat sketch for illustration, briefly, explain Kepler's second Law of planetary motion. (9)
- b. An earth station is located at 30° W longitude and 60°N latitude. Determine the earth station azimuth and elevation angles with respect to geostationary satellite located at 50°W longitude. Assume the orbital radius and earth's radius to be 42164 Km and 6378 Km respectively. (7)
- Q.3** a. Starting from fundamentals, show that the power received by an earth station from a satellite transmitter is given by,  

$$P_r = EIRP + G_r - L_p - L_a - L_{fa} - L_{ra} \text{ dBW}$$
 with usual notations.  
 What do you mean by the expression dBW? (9)
- b. (i) Compute the earth station G/T ratio under the following conditions:  
 Diameter of earth station antenna = 30m;  
 Overall efficiency of antenna = 68%;  
 Frequency of signal to be received = 4150 MHz;  
 System noise temperature at the operating frequency = 79K;  
 Elevation angle when the antenna points at the satellite = 28°;
- (ii) If heavy rain causes the sky temperature to increase so that the system noise temperature rises to 88K, estimate the new value of G/T. (7)
- Q.4** a. What do you mean by 'UPLINK' of a satellite circuit? Derive an expression for the earth station EIRP in dBW for an uplink with clear-sky conditions in terms of the flux density required to saturate the transponder. (8)
- b. The EIRP from a satellite is 49.4 dBW. Calculate (i) the power density at a ground station for which the range is 40,000 Km and (ii) the power delivered to a matched load at the ground station receiver, if the antenna gain is 50 dB. The downlink frequency is 4 GHz. (5)
- c. For the UPLINK the required [C/N] ratio is 20 dB. The operating frequency is 30 GHz, and the bandwidth is 72 MHz. The satellite [G/T] is 14.5 dBK<sup>-1</sup>. Assuming operation with 11 dB input back-off, calculate the saturation flux density. Receiver feeder loss is one decibel. (3)
- Q.5** a. What is the RF channel bandwidth (typical) allocated for FM voice transmissions in the VHF and UHF amateur bands and what type of FM is recommended for this? What are the baseband waveforms used in digital radio transmission called? Why the FM transmitter-receiver link is considered as ideal for carrying the baseband waveforms used in digital radio transmissions? (5)
- b. The baseband bandwidth for a 9.6 Kbps data stream is 4.8 KHz. If the RF signal to be sent is generated using FM, find the

signal-to-noise ratio of the baseband waveform, if the C/N ratio for the signal is 10 dB. Take the peak frequency deviation as 3.6 KHz. (5)

- c. With a sketch for illustration, briefly describe a way in which QPSK modulation can be achieved. (6)

**Q.6** a. What do you mean by '*the transponder*' as applied to a communications satellite? Is this a component of the bus or of the payload? How is satellite service maintained during an eclipse? What do you mean by 'attitude' of a satellite? Why is attitude control necessary. (6)

- b. What are disturbance torques? Name the important ones as applied to Satellite's attitude. (2)

- c. What are the following:  
(i) East-west station-keeping maneuvers  
(ii) North-south station-keeping maneuvers. (8)

**Q.7** a. Distinguish between multiple access and multiplexing. What do you mean by a TDM-TDMA signal? (6)

- b. Briefly describe a TDMA frame. Illustrate by a simplified diagram, a TDMA frame for four transmitting earth stations and briefly explain. (10)

- Q.8** a. Write a note on CDMA, explaining its utility and operating features. (8)
- b. With a sketch for illustration, briefly explain a mesh VSAT network. Furnish also the topology of the above network as viewed from the satellites perspective. (8)
- Q.9** a. What does error control perform? Can ARQ be used in satellite communications? Justify your answer. (4)
- b. Why are cyclic codes widely used in satellite transmission? Write a brief note on the following: (8)
- (i) Hamming codes (ii) BCH codes
- c. Compare decoding to encoding procedure with regard to convolution codes? Support your answer with valid reasons. Name one algorithm that is widely used in practice for convolution decoding. What do you mean by punctured coding? (4)