

**Subject: SATELLITE & SPACE COMMUNICATION**  
**Max. Marks: 100**

- **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)**

- The eccentricity ( $e$ ) of an elliptical orbit with apogee ( $r_a$ ) and perigee ( $r_p$ ) respectively:  

(A) $e = r_a / r_p$	(B) $e = r_p / r_a$
(C) $e = (r_a + r_p) / (r_a - r_p)$	(D) $e = (r_a + r_p) / (r_p - r_a)$
- Satellite capacity depends on  

(A) weight that can be placed on orbit
(B) panel area available for energy dissipation
(C) transmitter power
(D) all of the above
- Satellite may reuse the same frequency in the same area by  

(A) having many small areas
(B) overlapping radiation zones
(C) Multiple Access techniques
(D) any of above
- The satellite orbit almost invariably used with remote sensing satellite is the  

(A) geostationary orbit	(B) geosynchronous orbit
(C) sun synchronous orbit	(D) Molniya orbit
- The location of a geostationary satellite is always given in terms of  

(A) a certain longitude	(B) a certain latitude
(C) longitude and latitude	(D) distance from earth's surface
- The multiple satellite access techniques suitable only for digital transmission is the  

(A) TDMA	(B) FDMA
(C) CDMA	(D) both (A) and (B)
- The minimum number geostationary satellite needed for uninterrupted global coverage is  

(A) 3	(B) 4
(C) 1	(D) 2
- In a circular geostationary orbit in the equatorial plane  

(A) the apogee equals to the perigee
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- (B) the apogee is twice the perigee
- (C) the apogee is half the perigee
- (D) none of above

i. Earth station figure of merit is defined as

- (A)  $10 \log (G/T)$
- (B)  $10 \ln (G/T)$
- (C)  $10 \log (GT)$
- (D)  $20 \log (G/T)$

j. When the orbit eccentricity (e) is greater than zero but less than 1, the orbit is

- (A) an ellipse
- (B) a circle
- (C) a parabola
- (D) a hyperbola

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

- Q.2** a. Explain how the location of a satellite in an orbit is carried out with respect to earth? What are prograde and retrograde orbits? Also explain the ascending nodes, descending nodes, right ascension of the ascending nodes and mean anomaly. (8)
- b. The semimajor axis and the semi minor axis of an elliptical satellite orbit are 20,000 km and 16,000 km respectively. Determine the apogee and the perigee distance. (8)
- Q.3** a. Explain what is meant by rainrate and how this is related to specific attenuation. Explain effective path length in connection with rain attenuation. (6)
- b. What are the various ionospheric effects and atmospheric losses that may affect the satellite link performance? Explain as to how these interference effects are taken into account in the satellite link design? (6)
- c. Three gain blocks are connected in cascade arrangement. It is given that Gain  $G_1 = 10^6$  and its associated equivalent noise temperature  $T_{e1} = 100^\circ \text{K}$ ,  $G_2 = 10^4$  and  $T_{e2} = 60^\circ \text{K}$ ,  $G_3 = 10^3$  and  $T_{e3} = 20^\circ \text{K}$ . Determine the equivalent noise temperature of the cascade arrangement. (4)
- Q.4** a. Explain what is meant by (i) antenna noise temperature (ii) amplifier noise temperature (iii) system noise temperature referred to input. (6)
- b. In a certain satellite communication link, the uplink carrier to noise ratio  $(C/N)_u$  is 25dB where as the downlink carrier to noise ratio  $(C/N)_d$  is 20dB. Find the link carrier to noise ratio  $(C/N)$ . (5)
- c. The carrier power to the earth station transmit antenna is 500 watts. If the satellite TWTA's input back-off is 1dB, determine the carrier EIRP required to saturate the satellite TWTA if the transmit antenna gain is 60dB. (5)
- Q.5** a. What is meant by "threshold" in FM detector? Explain FM improvement and derive the S/N ratio for SCPC signals. (6)
- b. What is meant by error rate performance of a system? Derive the expression for bit error rate for

- b. What is meant by error rate performance of a system. Derive the expression for bit error rate for BPSK and QPSK system. (6)
- c. A satellite link achieves a C/N ratio in the receiver under clear air condition of 14 dB (14dB = power ratio of 25). The receiver has a RRC filter with a noise bandwidth of 1.0 MHz and a roll off factor of 0.3, with ideal correlation detection BPSK and QPSK demodulators. What are the bit rate, symbol rate, occupied bandwidth of the link and BER when the link is operated:  
 (i) with BPSK modulation and  
 (ii) with QPSK modulation?  
 (given that  $Q(7.07) = 7.8 \times 10^{-11}$  and  $Q(5) = 2.8 \times 10^{-7}$ ) (4)

- Q.6** a. What is meant by station keeping of a satellite? Explain its significance and also the methods to achieve it. What are N-S and E-W station keeping? (8)
- b. What is satellite stabilization? Explain the importance of stabilization. Also explain the spin stabilization and three axis body stabilization of satellite. (8)

- Q.7** Explain the function of any four of the following in TDMA system  
 (i) reference burst  
 (ii) burst code word  
 (iii) carrier and bit time recovery  
 (iv) preamble in traffic burst  
 (v) synchronization of burst  
 (vi) burst time plan (16)

- Q.8** a. Describe how convolution coding is achieved. State some of the main advantages and disadvantages of this type of code compared with block codes. (6)
- b. What is spectral efficiency of a satellite communication link? Describe the performance of spectral efficiency with respect to energy per bit for power limited and for bandlimited link. (6)
- c. Calculate the code rate and the number of errors that can be corrected with a BCH (63, 36) code. (4)

- Q.9** a. What is the concept behind majority of VSAT systems? With a neat schematic diagram briefly explain the mode of a satellite in Broadcast Satellite System. (5)
- b. Explain Mesh and Star architecture used in VSAT network. Give advantages and disadvantages of these architectures. (5)
- c. Which are the major types of multiple access schemes that are used in satellite system? Why has a TDM approach been adopted for most downlink applications for digital VSAT and Internet applications to small terminals? (6)