



Name :

Roll No. :

Invigilator's Signature :

CS/M.TECH (ECE)/SEM-2/MCE-205A/2013

2013

SATELLITE COMMUNICATION

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

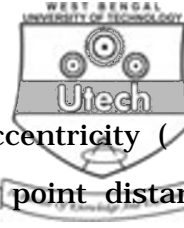
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

i) In a circular geostationary orbit in the equatorial plane

- a) the apogee equals the perigee
- b) the apogee is twice the perigee
- c) the perigee is twice the apogee
- d) none of these.



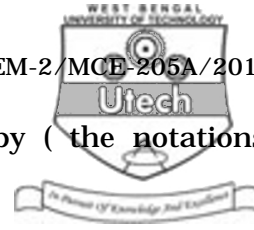
- ii) For an eccentric elliptical orbit with eccentricity (e) and semi-major axis (a), the perigee point distance from the centre of earth having radius (R) is given by
- a) $r_p = a (1 - e) / R$
 - b) $r_p = a (1 - e)$
 - c) $r_p = a (1 + e)$
 - d) $r_p = aR / (1 - e) .$
- iii) Satellite may reuse the same frequency in the same area by
- a) having many small antennas
 - b) overlapping radiation zones
 - c) TDMA
 - d) FDMA.
- iv) The conversion efficiency of solar cell is about
- a) 12% to 15%
 - b) 15% to 20%
 - c) 12% to 25%
 - d) none of these.



- v) For the earth station antennas to be 6 feet in diameter, the satellite frequency bands must be in
- a) 4/6 GHz range
 - b) 12/14 GHz range
 - c) 20/30 GHz range
 - d) Both (a) and (b)
- vi) Earth station figure of merit is defined as
- a) $10 \log (G/T)$
 - b) $10 \log (GT)$
 - c) $20 \log (G/T)$
 - d) None of these.
- vii) A satellite earth station antenna has a gain of 10^6 and a noise temperature of 100°K . The earth station (G/T) in dB/K is
- a) 40 dB/K
 - b) 80 dB/K
 - c) Indeterminate
 - d) Zero.
- viii) A 10 GHz signal was beamed up at a satellite at a distance of about 40,000 km from the earth's surface. The signal undergoes a free space loss of
- a) 10 db
 - b) 50 dB
 - c) 200 dB
 - d) 385 dB.



- ix) The code division multiple access technique is not usually used because
- a) it requires very large bandwidth
 - b) the circuitry required is very complex
 - c) the system becomes too expensive
 - d) its technology has not been completely developed as yet.
- x) The multiple access technique in which full bandwidth is used for full time by all users is
- a) FDMA
 - b) CDMA
 - c) TDMA
 - d) none of these.
- xi) The time duration between the transmissions of traffic bursts in TDMA is
- a) 125 μ sec
 - b) 120 μ sec
 - c) 64 μ sec
 - d) 250 μ sec.



xii) The drop size distribution is given by (the notations have their usual significance)

a) $N(D) = N_0 \exp\left(-\frac{D}{D_m}\right)$

b) $N(D) = N_0 \exp\left(\frac{D}{D_m}\right)$

c) $N(D) = N_0 \exp\left(-\frac{D_m}{D}\right)$

d) $N(D) = N_0 \exp\left(\frac{D_m}{D}\right)$.

xiii) Generally the VSAT network is operated in

- a) FDMA mode
- b) TDMA mode
- c) CDMA mode
- d) None of these.

xiv) The type of configuration used in VSAT system is

- a) Hybrid
- b) Data
- c) Mesh
- d) Star.



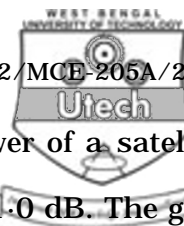
GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. a) What do you mean by apogee and perigee heights ?
Illustrate 'Look angles'. 2
- b) A satellite is in an elliptical orbit with apogee and perigee heights being 4000 km and 500 km respectively. Determine the eccentricity, semi major and semi minor axes. Find also the orbital period of the satellite. Take radius of each as 6370 km. 3
3. Illustrate the following :
 - a) Altitude Control System (ACS)
 - b) Orbit Control System (OCS).
4. Elucidate Telemetry, Tracking, Command and Monitoring (TTC&M) in the context of operation of a communication satellite.
5. Name different antenna systems which are used in satellite communication. State and explain the factors on which the selection of antenna depends. 1 + 4



6. In a satellite communication, the output power of a satellite transponder is 20 W with output back off – 1.0 dB. The gain of the satellite antenna and earth station antennas are 30.0 dB and 59.2 dB respectively. Given, free loss at 4 GHz is 195.0 dB, beam loss is 2.0 dB, atmosphere loss is 0.2 dB and other losses are 0.4 dB. Calculate the power received at earth station.
7. State the purpose of a transponder ? With the help of a diagram, describe the working of a typical single conversion transponder for 6/4 GHz links. 1 + 4

GROUP – C

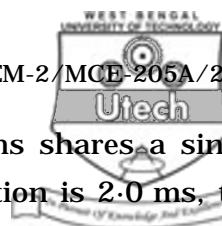
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Develop Friis transmission equation regarding power received by antenna. Also, deduce the relation between C/N and G/T ratio. 2 + 3
- b) An antenna is matched into a receiver. The noise temperature of the antenna and the receiver are 40 K and 100 K respectively. If the receiver band width is 36 MHz, determine its noise power.
- $(k = 1.38 \times 10^{-23} \text{ J/K }) .$ 2



- c) Determine the value of overall carrier to noise ratio in a satellite link where a signal is transmitted to a satellite transponder with a carrier to noise ratio of 15 dB and transponder transmits it with the said ratio of 20 dB. 5
- d) What do you understand by multiple accesses in the context of satellite communication ? What are the various techniques used for this purpose ? 2 + 1
9. a) Distinguish between pre-assigned and demand-assigned techniques, stating the relative advantages and disadvantages. 3
- b) Briefly describe the operational principles of a frequency division multiple access (FDMA) system. What is the significance of guard band ? 5 + 2
- c) Develop the expression for the required carrier to noise ratio in FDMA system in both SCPC and MCPC types. 5
10. a) Illustrate the functional principle of a time division multiple access (TDMA) system. How one can distinguish between time division multiplexing (TDM) and TDMA ? Why TDMA is used with digital signals only ? 3 + 1 + 1
- b) Define TDMA frame. What are the constituents of a TDMA frame structure ? Briefly describe the purpose of each constituent part of a TDMA frame. 1 + 1 + 3



- c) A TDMA network of five earth stations shares a single transponder equally. The frame duration is 2.0 ms, the preamble time per station is 20 μ s and guard bands of 5 μ s are used between bursts. Transmission bursts are QPSK at 30 Mbaud. Calculate the number of 64 Kbps voice channels that each TDMA earth station can transmit. Taking bits are being sent as 500 bursts/s, find how guard time per burst is affected when the fractional channel is ignored. 3 + 2
11. a) Illustrate, (i) Spade system, (ii) Code Divison Multiple Access (CDMA) and (iii) Space Domain Multiple Access (SDMA). 5
- b) Three identical large earth stations shared a single 36 MHz band width transponder using FDMA with the three earth stations transmitting signals of band width 15 MHz, 10 MHz and 5 MHz respectively. The three earth station accesses are changed to TDMA with a frame length of 1.0 ms, a preamble time of 10 μ s and a guard time of 2 μ s. There is no reference burst in TDMA frame. The signals are transmitted using QPSK. Find out the burst symbol rate on the link. Find also the burst duration for each earth station. 4 + 1
- c) Write down the general expression for attenuation involving rain rate and path length in air. Find the specific attenuation at 10 GHz, if the rain fall rate is 40 mm/hour and linear vertical polarization is used.
(Given, $a_v = 0.00887$, $b_v = 1.264$ at 10 GHz)

1 + 2



- d) A 12 GHz direct broadcast satellite link was found to experience 4 dB rain attenuation at an elevation angle of 45° for 0.01% of the time in an average year. What will be the rain attenuation measured at the same time percentage for the same site if the elevation angle were 10° ? 2
12. a) Write down the key equation in the link power budget, stating the meanings of all notations used. Describe briefly how attenuation and depolarization are quantified. 1 + 4
- b) Satellite A radiates an EIRP of 35 dB W on the downlink to an earth station whose antenna gain is 50 dB. Transmission from another satellite B located in the vicinity of the first satellite produces interference in the desired downlink. If the EIRP of the interfering satellite is 30 dB W, determine carrier to interference ratio (C/I), assuming that the path loss on the downlink channel for both the satellites are the same and angular separation of both the satellites from the earth station is 4° . 2
- c) In case of uplink, EIRP values of earth stations A and B are 80 dB W and 75 dB W respectively. The transmit antenna gains in the two cases are 50 dB each. If the gain of the receiving antenna of the satellite is 20 dB in the direction of earth station A and 15 dB in the direction of earth station B, calculate carrier to interference ratio at the satellite due to interference caused by earth station B. Assume, viewing angle of the satellite from the two earth stations is 4° . 3
- d) Illustrate Mobile Satellite Communication System (MSAT). 5



13. a) Explain the important features of VSAT system. 5
- b) Using the following data in relation to communication between VSAT and satellite, calculate $(C/N)_{uplink}$ and $(C/N)_{downlink}$ and hence $(C/N)_{overall}$.
- i) Transmit power of VSAT = 2 W
 - ii) Uplink frequency = 14 GHz
 - iii) Diameter of transmit antenna = 2 m
 - iv) Efficiency of transmit antenna = 68%
 - v) Altitude of satellite = 20,000 km
 - vi) Other losses = - 5 dB
 - vii) Temperature = 500 K
 - viii) Satellite transmit power = 1 W/channel
 - ix) Downlink frequency = 12 GHz
 - x) Satellite antenna gain = 28 dB
 - xi) Other losses = - 2 dB. 10

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