



**SHRI ANGALAMMAN COLLEGE OF ENGINEERING & TECHNOLOGY**  
(An ISO 9001:2008 Certified Institution)  
SIRUGANOOR, TRICHY-621105.



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**  
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EC1403 SATELLITE COMMUNICATION

## **UNIT 1 OVERVIEW OF SATELLITE SYSTEMS, ORBITS AND LAUNCHING METHODS**

### *2 Marks Questions*

1. What is a satellite?
2. How is frequency planning and frequency allocation done for the entire world?
3. List out the frequency bands used for satellite services?
4. Write down some satellite services?
5. What are active & passive satellites?
6. Why satellite frequency spectrum is in microwaves?
7. What is an orbit? Discuss its significance.
8. What are the different types of orbit?
9. Distinguish between stationary and non-stationary orbits.
10. What do you understand by polar orbiting satellites?
11. Distinguish between prograde & retrograde orbits?
12. Write down Kepler's laws of planetary motion?
13. Define period of satellite.
14. Write the equation of motion.
15. Write about the following: INTELSAT & U.S. DOMSATS
16. What are orbital perturbations?
17. What is atmospheric drag?
18. Write information on: Calendars, universal time, Julian dates & sidereal time
19. Define the following: Sub satellite point, Inclination, Mean anomaly & True anomaly
20. What are orbital elements?
21. Explain apogee, perigee & line of apsides?
22. What is geocentric equatorial & top centric Horizon co-ordinate system?
23. Why are transformations between coordinate systems required?
24. What is meant by earth station referred to the IJK frame?
25. What are the orbital parameters required to determine a satellite's orbit?

### *16 Marks Questions*

1. a. How are frequency allocations for satellite services done?  
b. Discuss about various satellite services
2. a. Derive Kepler's laws of planetary motion  
b. Write notes on: Intelsat, U.S.Domsat, polar orbiting satellites

3. a. Describe the various orbital elements and orbital parameters with suitable diagram  
b. Write down the applications and advantages of satellite communication
4. a. Explain Orbital perturbations.  
b. The semi major axis and the semi minor axis of an elliptical satellite orbit are 20000Km and 16000Km respectively. Determine the apogee and the perigee distances.
5. a. What are the active and passive satellites? Explain in detail about various types of orbit and their relative merits and demerits.  
b. Write the applications of satellite communication and write your comment on the future trend in satellite communication.
6. a. Derive the expressions for the six orbital elements using the Newton's laws. What is their significance?  
b. How are the satellites positions estimated using the sub-satellite points?
7. a. Explain the need for satellite communication.  
b. What are the different types of satellite orbits? Discuss their merits and demerits.  
c. A low orbiting satellite has an 8-hour prograde orbit. How long during each orbit will an earth station be able to communicate with it above an elevation angle of 15°?
8. a. Discuss about frequency allocations for satellite services.  
b. What are the effects of a non-spherical earth on the orbital mechanics of satellite?  
c. Calculate the radius of a circular orbit for which the period is 1day.

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### *Problems*

1. a. Calculate radius of a circular orbit for period of revolution 1day.  
b. Calculate the apogee and perigee heights for the orbital parameter  $e=0.0011501$ ; assume a mean radius of earth as 6371km.
2. A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12h. Given that  $e=0.002$ , calc. the semi major axis. the earth's equatorial radius is 6378.1414km.
3. Calculate the average length of the civil year in the Gregorian calendar?
4. Determine which of the following years are leap years: a) 1987 b) 1988 c) 2000 d) 2100
5. Calculate the time in days, hrs, min, & sec for the epoch day 324095616765.
6. Find the Julian day for 13 h UT on 18 Dec 2000.
7. Find the time in Julian centuries from the reference time Jan 0.5,1900 to 13 h UT on 18 Dec 2000.

8. Calculate the time of perigee for the passage for the NASA elements given in the table 2.1.
9. Given that the mean anomaly is 205 deg & the  $e=0.0025$ , calculate the eccentric anomaly.
10. Calculate the magnitude of the position vector in the PQW frame for the orbit specified below. Calculate the position vector in the IJK frame & its magnitude. Confirm that it remains unchanged from the value obtained in the PQW frame.
11. Find the GST for 13 h UT on Dec 18, 2000.
12. Find the LST for Thunder Bay, longitude 89.26 deg W for 13 h UT on Dec 18, 2000.
13. The IJK range vector components for certain sat. at GST=240deg are as given below. Calculate the corresponding range & the look angles for an earth station the coordinates for which are – latitude 48.42 deg N ,longitude 89.26 deg W, height above mean sea level 200m.

## UNIT 2

### 2 Marks Questions

1. What are antenna look angles? why are they required?
2. Give the expression for range, elevation & azimuth angles.
3. Illustrate the limits of the visibility and coverage angle.
4. What is polar mounting antenna?
5. What are near geostationary orbits?
6. What is earth eclipse of satellite? Write down the effects & remedial solution?
7. What do you understand by sun-transit outage?
8. List out the various launch vehicles, launch sites and launching orbits.
9. Draw the diagram depicting a launch mission?
10. Why different stages of firing the rocket is necessary?
11. List out the various subsystems of communication satellite, their function and important parameters?
12. What are the constituents of satellite pay load? Write down their uses.
13. What do you understand by power supply subsystem? List out the different batteries used.
14. What is attitude control? What is the need? What are the different types?
15. What are the two main techniques of satellite attitude control?
16. What is spin stabilization?
17. What do you mean by momentum wheel stabilization?
18. What is station keeping? Why is required?
19. What is meant by spin-stabilization?
20. Why 3-axis stabilization is preferred over body stabilization?
21. What do you understand by propulsion subsystems?
22. Write about TT&C subsystem?
23. What is thermal control subsystem? Why is it required?
24. What are transponders?
25. Why are spot beam antennas preferred?
26. Write about frequency reuse concept and orthogonal polarization?
27. Where are TWTA's used?
28. Write about Morelos spacecraft?
29. What are ANIK satellites?
30. Write about Tiros-N satellite?

## 16 Marks Questions

1. a. i. Discuss about near Geostationary orbits.
  - ii. Determine the limits of visibility for an earth station situated at mean sea level, at latitude  $48.42'$  north and longitude  $89.26$  degrees west. Assume a minimum angle of elevation of  $5'$
  - iii. Discuss about sun transit outage.
  - iv. Determine the angle of tilt required for a polar mount used with an earth station at attitude  $49'$  north. Assume a spherical earth of mean radius  $6371\text{Km}$  and ignore earth station altitude.

or

- b. i. Discuss in detail about attitude control of a satellite.
  - ii. What is the advantage of the TWTA used aboard satellites compared to other types of high power amplifiers? What are the main disadvantages of TWTA?
  - iii. What is thermal control? Why is it required?
2. a. What are look angles and derive the expressions for azimuth, elevation and range?

or

- b. With a neat diagram, explain the attitude and orbit control system present in the space segment.
3. a. In detail, explain the following subsystems of spacecraft:
  - i. Attitude and Orbit control.
  - ii. Telemetry, Tracking and Command.

or

- b. Derive the expression for received power, (C/N) ratio and link power budget equation for satellite downlink with a neat sketch.
4. a. i. Draw the block diagram of a satellite telemetry unit and explain the function.
  - ii. Explain in detail the various propagation factors and polarization effect of space segment.

or

b. Discuss about Morelos, Anik and Tiros satellites

5. a. Describe the 3-axes stabilization technique

Or

b. Explain how station keeping is performed

6. a. Discuss about the i. Power supply ii. Transponder iii. Antenna and iv.

Thermal control subsystems

or

b. Describe the momentum wheel stabilization technique

7. a. Obtain the expressions for look angles and range

Or

b. Discuss about the various subsystems present in a spacecraft

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### UNIT 3 EARTH SEGMENT

#### 2 Marks Questions

1. Differentiate between TVRO, MATV & CATV systems?
2. What are indoor and outdoor muffs? Draw a block diagram showing a home terminal of DBA TV receiving system?
3. Reason for why is a LNA required in outdoor unit?
4. Reason for why a conversion from FM to AM modulation required in indoor unit?
5. Draw a block diagram for MATV system?
6. Draw a block diagram for CATV system?
7. Draw the block diagram of a transmit –receive earth station?
8. Why are the redundant units required in satellite systems including earth stations?
9. Clarify earth stations according to service requirements?
10. Why is Cassegrain antenna popular for large earth stations

#### SPACE LINKS

1. What are the link budget calculations?
2. What is EIRP in link budget calculation?
3. What do you understand by system noise?

4. Classify the antenna noise broadly.
5. What is antenna noise temperature?
6. Write generalized expression for system noise temperature when many number of amplifier stages are in cascade?
7. What would be the noise factor of a lossy network at room temperature?
8. Give expression for overall system noise temperature in terms of power loss?
9. Obtain few steps the CNR of a satellite link-uplink?
10. What is saturation flux density?
11. What are input and output back off? Where do they become significant? Draw relevant graphs?
12. Write the downlink CNR equation?
13. What are the effects of rain in up and down links?
14. Write down the overall link equations considers the up and down link CNR's
15. What is intermodulation noise? Where does it occur? What is its effect?
16. For a given satellite and signal transmission, what are the earth station parameters affecting the C/N ratio
17. Write the relationship between noise power and noise bandwidth

### 16 Marks Questions

1. Write notes on: TVRO, CCTV and MATV
2. i. Describe the features of a Transmit-Receive Earth Station with neat diagram
  - ii. A Satellite TV signal occupies the full transponder bandwidth of 36 MHz, and it must provide a C/N ratio of 22dB at the destination earth station. Given that the total transmission losses are 200dB and the destination earth station G/T ratio is 31 dB/K, calculate the satellite EIRP required.
3. i. Derive the expression for complete Link equation
  - ii. A satellite downlink at 12 GHz operates with a transmit power of 6W and an antenna gain of 48.2 dB. Calculate the EIRP in dBW
4. Discuss about the following:  
Transmission losses, Overall system noise temperature, Input and output back-off in TWTA
5. Describe: i. Effects of rain ii. Up and downlink rain-fade margins iii. Intermodulation Noise
6. i. With the aid of a block diagram, describe the functioning of the indoor receiving unit of a satellite TV/FM receiving system intended for home reception
  - ii. In most satellite TV receivers, the first IF band is converted to a second, fixed IF. Why is this second frequency conversion required?
  - iii. Discuss about antenna misalignment losses with relevant figures
7. i. An antenna has noise temperature of 35 K and is matched into a receiver which has a noise temperature of 100 K. Calculate the noise power density and the noise power for a bandwidth of 36MHz.
  - ii. What is input back-off? Describe it. Also substantiate the reason behind employing it
8. i. Derive the Link power budget equation

- ii. The range between a ground station and a satellite is 42,000km. Calculate the free space loss at a frequency of 6 GHz.
  - iii. A LNA is connected to a receiver which has a noise figure of 12dB. The gain of LNA is 30dB and its noise temperature is 120K. Calculate the overall noise temperature referred to the LNA input.
9. i. Discuss briefly the downlink attenuation
- ii. With suitable diagrams explain the concept of rain depolarization
10. i. Explain with suitable diagram the working of various antenna systems used in earth station
- ii. Discuss the operations of different units in TVRO terminal
11. i. A satellite circuit has the following parameters:  
 Uplink: Saturation flux density:  $-68 \text{ dBW/m}^2$ ; Input back-off: 11 dB; Satellite G/T: -12 dBK  
 Downlink: satellite saturation EIRP: 26.5 dBW; Output Back-off: 6 dB; Transmission path loss: 203 dB; Earth station G/T: 41dB/K.  
 Calculate the carrier-to-noise density ratio for uplink and downlink and the combined value.
- ii. With block diagram explain T1-terrestrial interface module
12. With block diagram explain the function of an earth station
- ii. The required  $E_b/N_0$  ratio for a digital satellite link is 9.6dB, and the bit rate is 1.544 Mbps. Calculate the required C/N<sub>0</sub> ratio.
13. With a neat sketch, explain the power budget for a satellite link considering back-off, rain fade margin and intermodulation
14. i. How does the system noise temperature affect the performance? Derive the expression for overall system noise temperature at the receiving station
- ii. From the calculation of system noise temperature, prove that the C/N ratio is directly proportional to the G/T ratio.

#### UNIT 4

#### 2 Marks Questions

1. Define multiplexing
2. What is multiple access? what are the types?
3. Distinguish between multiple access and multiplexing?
4. What is FDMA?
5. Distinguish between pre-assigned and demand-assigned FDMA satellite access.
6. Give the need for polling method in demand-assigned FDMA
7. What is spade system?
8. Compare centrally controlled and distributed control random access techniques.
9. What is spread spectrum communication?
10. What is TDMA?
11. Give the structure of TDMA?
12. Mention the two basic problems in satellite digital transmission
13. Mention the advantages of TDMA technique over FDMA technique
14. What are the major limitations of TDMA technique?
15. What is satellite switched TDMA?
16. What is CDMA?
17. Why is CDMA advantageous?

18. What do you know about DSSS CDMA?
19. What is CDMA throughput?
20. What are the different network layers?
21. What is TCP/IP protocol? Why it is preferred in satellite links?
22. How can TCP be enhanced over satellite channels?
23. What is split TCP connections?
24. Explain the concept of encryption in satellite-access
25. What are the limitations of FDMA satellite access?

### 16 Marks Questions

1. i. Explain the multiplexing and modulation schemes with FDMA technique with block Diagram  
ii. Describe the frequency HOPP Spread Spectrum Technique with neat diagram
2. i. Draw the structure of TDMA multiple-access technique and explain  
ii. Distinguish between FDMA, TDMA and CDMA techniques.
3. i. Explain the voice and data-multiplexing in satellite system.  
ii. What is CDMA? In what way it is superior to TDMA? Mention the potential application of CDMA.
4. i. Discuss the type of modulation and multiplexing techniques involved in the transmission of voice and data signals  
ii. In what way the spread spectrum communication technique improves the performance of satellite links.
5. i. Explain the functioning of a TDMA satellite system and a clear picture of the TDMA frame format used. Diagrams are necessary  
ii. Write detailed notes on digital video broadcasting.
6. i. With a neat block diagram explain the functioning of a SPADE system  
ii. Explain the TDMA burst and frame structure of satellite system. Draw the necessary diagrams.
7. i. Discuss in detail about direct sequence spread spectrum.



- ii. In a TDMA network the reference burst and the preamble each requires 560 bits and the nominal guard interval between bursts is equivalent to 129 bits. Given that there are eight traffic bursts and one reference burst per frame and the total frame length is equivalent to 40800 bits, calculate the frame efficiency.
- iii. Distinguish between pre-assigned and demand-assigned traffic in relation to a satellite communications network.

8. Explain FDMA in detail
9. Explain TDMA in detail
10. Explain CDMA with example

## UNIT 5

### *2 Marks Questions*

1. What is watershed ?
2. What are the Segments of GPS?
3. What are the two intentional errors that have been introduced by US Military Corps in NAVASTAR GPS ?
4. What is the difference between spatial and non spatial data?
5. What is the difference between raster and Vector data?
6. What are the different types filters?
7. Compare High pass and Low pass filters.
8. What is meant by Raster data?
9. What is meant by Vector data?
10. Compare Raster and Vector data.
11. Difference b/w Supervised and Unsupervised Classification?
12. What are the 2 cases where GIS can be employed in Urban applications?
13. What do you mean by Integrated Watershed Management?
14. What are the Watershed projects in India?
15. What are the different scales used to represent map?
16. What is PRIS (Panchayat Resources Information System) ?
17. What is meant by Urban analysis?
18. What is the difference urban fringe and residential area?
19. Define urban sprawl.
20. What are the applications of remote sensing?
21. What are the applications of GIS?

### *16 Marks Questions*

1. List the different interpretation keys . Explain?
2. Explain 4 different filters and their advantages
3. Explain the 3 segments of GPS
4. What are the components of GIS? Explain
5. What is Resource Information System? Explain one case in detail.
6. Explain the use of RS and GIS in urban application with one example.
7. What is watershed? How does it can be managed using RS and GIS