

**SYED AMMAL ENGINEERING COLLEGE
RAMANATHAPURAM**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING**

EC2045 SATELLITE COMMUNICATION

TWO MARK QUESTIONS WITH ANSWERS

FOR

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UNIT I

SATELLITE ORBITS

1. State Kepler's first law.

It states that the path followed by the satellite around the primary will be an ellipse. An ellipse has two focal points F1 and F2. The center of mass of the two body system, termed the barycenter is always centered on one of the foci.

$$e = \frac{\sqrt{a^2 - b^2}}{a}$$

2. State Kepler's second law.

It states that for equal time intervals, the satellite will sweep out equal areas in its orbital plane, focused at the barycenter.

3. State Kepler's third law.

It states that the square of the periodic time of orbit is perpendicular to the cube of the mean distance between the two bodies.

$$a^3 = \mu / n^2$$

where, n = Mean motion of the satellite in rad/sec.

μ = Earth's geocentric gravitational constant.

4. Define apogee and perigee.

- The point farthest from the earth is known as apogee.
- The point closest from the earth is known as perigee.

5. What is line of apsides?

The line joining the perigee and apogee through the center of the earth is known as line of apsides.

6. Define ascending and descending node.

Ascending node: The point where the orbit crosses the equatorial plane going from south to north.

Descending node: The point where the orbit crosses the equatorial plane

going from north to south.

7. Define inclination.

The angle between the orbital plane and the earth's equatorial plane is known as inclination. It is measured at the ascending node from the equator to the orbit going from east to north.

8. Define mean anomaly and true anomaly.

Mean anomaly: It gives an average value of the angular position of the satellite with reference to the perigee.

True anomaly: It is the angle from perigee to the satellite position, measured at the earth's center.

9. Mention the apogee and perigee height.

$$R_a = a(1+e)$$

$$R_p = a(1-e)$$

$$H_a = r_a - R_p$$

$$H_p = r_p - R_p$$

10. State Newton's First law.

It states that the gravitational force of attraction between two bodies is directly proportional to the product of their masses M and m and inversely proportional to the square of the distance ' r ' between them.

$$F = -GMm/r^2$$

Where, G = Universal gravitational constant

\hat{r} = unit vector.

11. What is meant by azimuth angle?

It is defined as the angle produced by intersection of local horizontal plane and the plane passing through the earth station, the satellite and center of earth.

12. State Newton's second law.

Second law of motion states that the acceleration of the body is directly proportional to the force acting on it and inversely proportional to the mass.

$$F=ma$$

13. Define sub-Satellite point.

The point on the earth vertically under the satellite is called sub-satellite point . The height of the terrain above the reference ellipsoid at the sub-satellite point is denoted by H_{ss} . The height of the satellite above this is denoted by h_{ss} .

Thus the total height is,

$$h= H_{ss}+h_{ss}$$

14. Define sun transit outage.

The sun comes with the beam width of the earth station antenna is known as sun transit outage. During this period, the sun behaves as extremely noisy source and it blanks out all signals from satellite. This effect is known as sun transit outage.

15. Write short notes on station keeping.

It is the process of maintaining the satellite's attitude against different factors that can cause drift with time. Satellites need to have their orbits adjusted from time to time, because, the satellite is initially placed in the correct orbit. But, natural forces induce a progressive drift.

16. Define specific impulse.

The characteristic that is used to describe the propellant performance is called specific impulse ISP. It is defined as,

$$ISP= \frac{\text{Thrust (units of force)}}{\text{Rate of propellant flow}}.$$

17. Write short notes on atmospheric Drag.

The atmospheric drag is significant for near earth satellite below or above 1000km. This drag reduces the velocity at the perigee because of this the satellite does not reach the same apogee height on successive revolution. So that the semi major axis and eccentricity are reduced.

18. Define Prograde orbit and Retrograde orbit.

Prograde orbit: An orbit in which the satellite moves in same direction as the earth rotation. It is also known as the direct orbit.

Retrograde orbit: An orbit in which the satellite moves in counter to direction of earth rotation.

UNIT II

SPACE SEGMENT AND SATELLITE LINK DESIGN

1. Write short notes on attitude control system.

It is the system that achieves and maintains the required attitudes. The main functions of attitude control system include maintaining accurate satellite position throughout the life span of the system.

2. Describe the spin stabilized satellites.

In a spin stabilized satellites, the body of the satellite spins at about 30 to 100 rpm about the axis perpendicular to the orbital plane. The satellites are normally dual spin satellites with a spinning section and a despun section on which antennas are mounted. These are kept stationary with respect to earth by counter rotating the despun section.

3. What are the main functions of a space craft management .

The main functions of a space craft management are given below.

1. To control the orbit and attitude of the satellite.
2. To monitor the status of all the sensors in the satellite.
3. To switch on/off some sections in communication system.

4. Write short notes on telemetry.

The telemetry system is present in the satellite, this subsystem collects data from many/all sensors present in the satellite and retransmit it into the earth station.

5. Write short notes on tracking.

Tracking is nothing but to find the position of the satellite in space. Tracking is very important during the transfer orbit and drift phase of the satellite launch. We know that lots of disturbing forces may change the attitude and orbit of a satellite, so it is necessary to track the satellite and send correction signals.

6. Write the equations of Link-Power Budget.

The power output of the link is power at the receiver. The major source of loss in any ground satellite link is the free space spreading loss.

$$[P_R] = [EIRP] + [G_R] - [LOSSES]$$

$$[LOSSES] = [FSL] + [RFL] + [AML] + [AA] + [PL]$$

Where, FSL=Free Space Spreading Loss(dB)

RFL=Receiver Feeder Loss(dB)

AML=Antenna Misalignment Loss(sB)

AA= Atmospheric Absorption(dB)

PL= Polarization mismatch Law(dB)

7. What is an EIRP?

EIRP means Equivalent Isotropic Radiated Power. It is a measure of radiated or transmitted power of an antenna.

8. What is an intermodulation noise?

Intermodulation distortion in high power amplifier can result in signal products which appear as noise and it is referred to as Intermodulation noise.

9. What is system noise?

Noise temperature is very important concept in receivers. By using this, thermal noise which is generated by active and passive devices in the receiver can be calculated.

The noise power is given by,

$$P_n = kT_n B$$

Where, P_n =Noise power

K =Boltzman's constant

T_n =Noise temperature of source(in Kelvin)

B =Bandwidth in Hz

10. What is antenna loss?

It is added to noise received as radiation and the total antenna noise temperature is the sum of the equivalent noise temperature of all these sources.

11. Define sky noise.

It is a term used to describe the microwave radiation which is present throughout universe and appears to originate from matter in any form, at finite temperature.

12. Define noise factor.

An alternative way of representing amplifier noise is by means of its noise factor. In defining the NF of an amplifier, it is usually taken as 290K. The output noise power in terms of noise factor is given by

$$N_o = FGkT_0$$

13. Define saturation flux density.

The flux density required at the receiving antenna to produce saturation of TWTA is termed the saturation flux density.

14. Define Satellite uplink.

The link through which the earth station transmits the signal and the satellite receives the same is known as uplink. $[C/No]$ equation in the last title carrier to noise ratio can be applied to uplink.

$$[C/No]_u = [EIRP]_u + [G/T]_u - [L]_u - [K]$$

Here, the subscript u is used to denote the uplink.

$[C/No]$ ratio appears at satellite receiver.

$[EIRP]_u$ =Earth station EIRP.

$[G/T]_u$ = satellite receiver G/T

15. Define satellite downlink.

The link through which the satellite transmits the signal and the earth station receives it,

Subscript D is used to indicate the downlink in the following equation.

$$[C/N_0]_D = [EIRP]_D + [G/T]_D - [L]_D - [K].$$

16. Define Carrier to Noise Ratio.

The performance of satellite link is measured by carrier to noise ratio, it is given as CNR or C/N.

C/N in db is given as [C/N]

$$[C/N] = [P_R] - [P_N]$$

$$[C/N_0] = [EIRP] + [G/T] - [L] - [K] \text{ dB. Hz.}$$

17. A transponder require a saturation flux density of -110 dBW/m^2 , operating frequency of 14 GHz. Total loss = 200dB Find [EIRP].

Solution:

$$\text{Here, } [\Psi_s] = -110 \text{ dB}$$

$$F = 14 \text{ GHz}$$

$$[L] = 200 \text{ dB}$$

$$[A] = -(21.45 + 20 \log f) = -44.37$$

$$[EIRP] = [\Psi_s] + [A] + [L]$$

$$[EIRP] = -110 - 44.37 + 200$$

$$[EIRP] = 45.63 \text{ dB.}$$

18. What is noise weighting?

The method used to improve the post detection signal to noise ratio is referred to as noise weighting.

19. Write short notes on body stabilization.

The body stabilization is also known as three axis satellite. The stabilization is achieved by controlling the moment of the satellite along the 3-

axes (i.e) yaw, pitch, roll with respect to the reference.

20. What is meant by Pitch angle?

An angle produced by the movement of a spacecraft about an axis which is perpendicular to its longitudinal axis is known as Pitch angle.

UNIT III

SATELLITE ACCESS

1. What are methods of multiple access techniques?

The methods of multiple access techniques are given below.

FDMA (Frequency division multiple access techniques)

TDMA(Time division multiple access techniques)

CDMA (Code Division Multiple Access)

2. What is CDMA? And its types?

In this method, each signal is associated with a particular code that is used to spread the signal in frequency and time. Its types are:

- Spread spectrum multiple access.
- Pulse address multiple access.

3. What is an TDMA? What are the advantages?

Only one carrier uses the transponder at any one time, and therefore intermodulation products, which results from the non-linear amplification of multiple carriers are absent.

Advantages: The transponder traveling wave tube can be operated at maximum power output.

4. Define multiple access.

Various earth stations may transmit more number of carriers. At that time, a transponder is loaded with more than one number of carriers. This is known as multiple access.

5. What is CBR?

An unmodulated carrier wave is provided during the first part of the carrier and bit-timing recover (CBR) time slot. It is used as a synchronizing signal for local oscillator in the detector circuit. In the remaining part of CBR time slot, the carrier is modulated by a known phase change sequence.

6. What is BCW?

The copy of burst code word (BCW) is stored in all the earth stations. Incoming bits in the burst are compared with the BCW. The receiver detects the group of received bits matched with BCW. Then, accurate time reference for the burst position in frame is provided.

7. What is amplitude modulation?

The modulated signal may be expressed as,

$$am(t) = \{k_a s(t) + 1\} A_c \sin(\omega_c t + \Theta)$$

For special case where the modulating signal is sine wave with angular frequency ω_m and letting $k = m$, above equation becomes

$$am(t) = (m \sin \omega_m t + 1) A_c \sin \omega_c t$$

where, m = modulation index.

8. What are the analog transmission techniques.

The analog transmission techniques are given as,

- Amplitude modulation
- Frequency division multiplexing.
- Frequency modulation.

9. What are the components of encryption?

The symmetric encryption has 5 components. They are,

- Plain text
- Encryption algorithm
- Secret key
- Cipher-text
- Decryption algorithm.

10. What are the types of video signals?

Generally two types of signals are transmitted through the satellite circuits.

- Broadcast quality commercial television.
- Television used for business conferencing.

11. What are the disadvantages of FDMA.

- Sensitive to fading
- Stabilization is difficult.
- Sensitive to random frequency modulation.
- Sensitive to inter modulation distortion.

12. Write short notes on voice.

Voice is a telephone speech signals. Generally bandwidth upto 20 KHz. Telephone handset acting as the acoustic electric transmission converts voice/sound signal to electrical signal.

13. What are the limitations of FDMA-satellite access?

- If the traffic in the downlink is much heavier than that in the uplink, then FDMA is relatively inefficient. So, bandwidth of the uplink channel is not fully used.
- Compared with TDMA, FDMA has less flexibility in reassigning channels.
- Carrier frequency assignments are hardware controlled.

14. Distinguish between pre-assigned and demand-assigned TDMA satellite access.

Preassigned TDMA	Demand assigned TDMA
Example for preassigned TDMA is CSC for the SPADE network. CSC can accommodate upto 49 earth stations in the network and 1 reference station.	In TDMA, re-assigning of channels is more flexible. Different methods are used to provide traffic flexibility.
All bursts are of equal length. Each burst contains 128 bits. The bit rate is 138kb/s,	The burst length may be kept constant and the number of bursts per frame used by the given station is varied when the demand is varied.

15. Mention the merits and demerits of TDMA over FDMA.

In TDMA, only one carrier uses the transponder at any time. So, intermodulation noise is reduced.

16. What is a multiple access technique?

A transponder may be loaded by a number of carriers. These may originate from a number of earth stations. This mode of operation is known as multiple access technique.

17. What is meant by space division multiple access?

The satellite as a whole to be accessed by earth stations widely separated geographically but transmitting on the same frequency i.e. known as frequency reuse. This method of access known as space division multiple access.

18. What is burst code word and burst position acquisition?

Burst code: It is a binary word, a copy of which is stored at each earth station.

Burst position acquisition: A station just entering, or reentering after a long delay to acquire its correct slot position is known as burst position acquisition.

19. Define guard time.

It is necessary to prevent the bursts from overlapping. The guard time will vary from burst to burst depending on the accuracy with which the various bursts can be positioned within each frame.

20. Write short notes on open-loop timing control.

It is a method of transmit timing. In this method, according to burst time plan, a station transmits at a fixed interval. Necessary guard time is allowed to absorb the variations in propagation delay.

UNIT IV

EARTH SEGMENT

1. What are the components of Earth station?

The earth station comprises set of equipment, which is used to make a link with satellite mainly the used components are,

- Transmitters
- Receivers.
- Antennas
- Tracking System.
- Terrestrial interface.
- Primary power.
- Test equipment.

2. Write short notes on MATV.

MATV is a Master Antenna TV System. It is used to provide reception of DBS TV channels to the user group. It consists of one outdoor unit and various indoor units. Each user can independently access all the channels. It has a low signal to noise ratio. The receiver antenna diameter is 2m-3m.

3. Write short notes on CATV.

CATV is a Community Antenna TV system. As in MATV system, it consists of one outdoor unit and separate feeds for each sense of polarization. The channels are then combined by using combiner block. The combined signal is a multiplexed signal which is transmitted through the cable to the users. The signal is retransmitted from a low power VHF TV transmitter.

4. Define Y-factor.

Y-factor is the ratio of output noise measured when the receiver is connected to a hot noise to the output noise measured when connected to the cold source(T_c).

The receiver excess noise T_e is related to the Y-factor by

$$T_e = (T_b - Y T_c) / (Y - 1)$$

5. Define Carrier to Noise Ratio.

The performance of satellite line is measured by carrier to noise ratio, it is given as CNR or C/N.

C/N in db is given as [C/N]

$$[C/N] = [P_R] - [P_N] -$$

$$[C/N_0] = [EIRP] + [G/T] - [L] - [K] \text{ dB. Hz.}$$

6. What is a monopulse?

If the antenna generates different patterns with nulls on the axis, in azimuth and elevation planes, then it is called monopulse tracking method. The monopulse antenna presents a low systematic pointing error or the order of 0.1. The monopulse technique is more complex and highly expensive. Hence it is not used popularly.

7. What are the basic requirements of an earth station antenna?.

The basic requirements of an earth station antenna are listed below.

- The antenna must have a low noise temperature. The ohmic losses of antenna must also be maximum.
- The antenna must be rotated or steered easily so that a tracking system can be employed to point the antenna beam accurately.
- The antenna radiation must have a low side lobe level to reduce interference from unwanted signals and also to minimize interference into other satellites and terrestrial systems.
- The antenna must have a high directive gain.

8. Write short notes on TVRO.

The TVRO is a Receive Only Home TV system. TVRO transmission takes place in Ku- band. Single mesh type reflector may be used which focuses the signal into a single feed horn, which has 2 separate outputs, one for c-band signals and other for ku-band signals.

9. What is a tracking?

The tracking is an important operation of the earth station. The efficiency of earth station depends as to how efficiently it points the antenna beam to the satellite both in the transmit and receive mode.

10. Write a short notes on step by step technique.

The step by step technique is the most popular technique used for tracking. In this technique maximum reception of the received signal is needed and it is performed by moving and checking the beam continuously. This tracking gives a systematic pointing of the order of 0.20_{3db} .

11. A satellite downlink at 12 GHz operates with a transmit power of 6 W and an antenna gain of 48.2 dB. Calculate the EIRP in dBW.

EIRP means Equivalent Isotropic Radiated Power. It is a measure of radiated or transmitted power of an antenna.

$$EIRP = 10 \log 6 + 48.2$$

$$EIRP = 56 \text{ dBW.}$$

12. What is a transponder?

In a communication satellite, the equipment which provides the connecting link between the satellite's transmit and receive antennas is referred to as the transponder.

13. What is meant by input back off of a transponder?

The operating point of TWTA must be shifted closer to the linear portion of the curve to reduce the intermodulation distortion. So, input power is reduced. This is known as input backoff.

14. What is TWTA?

TWTA means travelling wave tube amplifier. The TWTA is widely used in transponder to provide the final output power required to transmit with high power.

15. What is meant by intermodulation distortion?

When multiple carriers are passed through the device with the non-linear transfer characteristic, more serious form of distortion is introduced known as intermodulation distortion.

16. What is polarization interleaving?

Overlap occurs between channels, but these are alternatively polarized left hand circular and right hand circular to reduce interference to acceptable levels. This is referred to as polarization interleaving.

UNIT V**SATELLITE APPLICATIONS**

1. Write short notes on INTELSAT.

INTELSAT stands for International Telecommunication Satellite. In April 6, 1965 first INTELSAT was launched. It is nicknamed as Early Bird. Initially 11 members are made in present; there are more than 155 members and 700 earth stations. INTELSAT-6 uses microprocessor with switching process. These are used for whether, DTH, telex etc.

2. What do INTELSAT, INMARSAT, INSAT stand for?

INTELSAT stands for International Telecommunication Satellite.

INSAT stands for Indian National Satellite system.

INMARSAT stands for International Marine Satellite Organization.

3. What are the satellite mobile services?

The satellite mobile services are

- Mobile Satellite Service.(MSAT)
- Very Small Aperture Terminal(VSAT)
- Direct Broadcast Satellite (DBS)
- Global Positioning System(GPS)
- Microsats
- Orbcomm
- Iridium.

4. What are VSATs?

VSAT is a Very Small Aperture Terminal System. It provides two way communication facilities. Typical user groups include banking and financial institutions, airline, hotel booking agencies and large retail stores with geographically dispersed outlets.

5. Write short notes on INMARSAT.

It stands for International Marine Satellite Organization. It was founded in the year 1979. It provides voice and data service. It is used in marine assessment for disaster management.

6. What are the INMARSAT services?

The INMARSAT services are

- Telephony
- Telex
- Facsimile
- E-mail
- Slow speed data for marine
- Aeronautical
- Landmobile
- Telephony

7. Define LEO.

LEO stands for Low Earth Orbit. It is defined as orbit within the locus extending from the earth surface upto an altitude of 2000 km, the commonly accepted definition for LEO is between 160-200 km above the earth surface.

8. Define MEO.

MEO stands for Medium Earth Orbit. It lies between 8000km and 18000km above the earth surface. MEO satellite ranges for orbital period for about 2 to 12 hrs. Some MEO orbits are in near perfect circles and therefore have constant altitude and travel at a constant speed.

9. Define Satellite Navigational System.

Satellite Navigation are SATNAV system is a system of satellite that provides autonomous geospatial positioning with global coverage. It allows electronic receivers to determine the latitude, longitude and attitude position within a few meters using timing signals transmitted from a line of sight by radio from the satellite.

10. What are the services and features of GSM?

The GSM services are classified into 2.

- Tele services.

- Data services.

Features of GSM:

- Subscriber Identity Module (SIM)
- On the air privacy.

11. What is a direct broadcasting satellite?

Satellite used for direct broadcasting is called DBS. These services include audio, TV, internet services. Satellite and antenna footprint can be made to cover large area of earth.

12. What are the INSAT services?

The INSAT provides 3 main services

- Long distance communication
- TV and Radio broadcasting.
- Meteorology.

13. Write short notes on digital audio broadcast.

The digital audio broadcasting through satellite is used to provide, high quality audio signals to the consumers. In early days, it was called as digital audio broadcast. Now it is commonly termed as

SDARS (Satellite Digital Audio Radio Service)

DARS (digital Audio Radio Service).

14. What are the applications of GPS?

- Mobile communication to provide position updates.
- Spot beam identification.
- Used in ships
- Scientists, surveyors, etc.

15. What is ECEF?

The geocentric equatorial coordinate system is used with the GPS system. It is called as earth centered, earth fixed coordinate system.

16. What is dilution of precision?

Position calculations involve range differences and where the ranges are nearly equal; any error is greatly magnified in the difference. This effect, brought a result of the satellite geometry is known as dilution of precision.

17. What is PDOP?

With the GPS system, dilution of position is taken into account through a factor known as the position dilution of precision.

18. What is a transponder capacity?

- More no. of channels
- High Bandwidth
- Effective Compression technique
- Higher Data Transfer rate

19. What is the difference between a geostationary orbit and a geosynchronous orbit?

In the geostationary orbit, a satellite appears stationary relative to the earth. The satellite follows the same speed as the earth, so it seems to appear stationary from the earth. The earth station antenna needs no tracking facility.

A geosynchronous satellite is a satellite in geosynchronous orbit, with an orbital period the same as the Earth's rotation period. Such a satellite returns to the same position in the sky after each sidereal day, and over the course of a day traces out different paths in the sky.

20. What is the orbital spacing of satellites?

For high power satellites orbital spacing is 9° . This orbital spacing is required to avoid adjacent interference.

21. What is GRAMSAT?

Dedicated satellites launched by ISRO will broadcast the services for the rural development of the nation. These village satellites for empowerment of rural people in India are known as GRAMSAT.