EC8094 Satellite Communication

EC8094	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

The student should be made to:

- Understand the basics of satellite orbits
- Understand the satellite segment and earth segment
- Analyze the various methods of satellite access
- Understand the applications of satellites
- Understand the basics of satellite Networks

UNIT I SATELLITE ORBITS 9

Kepler"s Laws, Newton"s law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility – eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.

UNIT II SPACE SEGMENT 9

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command-Transponders-The Antenna Subsystem.

UNIT III SATELLITE LINK DESIGN 9

Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.

UNIT IV SATELLITE ACCESS AND CODING METHODS 9

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, DAMA Assignment Methods, compression – encryption, Coding Schemes.

UNIT V SATELLITE APPLICATIONS 9

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. GPS Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH).

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course, the student would be able to:

- Analyze the satellite orbits
- Analyze the earth segment and space segment

- Analyze the satellite Link design
- Design various satellite applications

TEXT BOOKS:

1. Dennis Roddy, “Satellite Communication”, 4th Edition, Mc Graw Hill International, 2006.
2. Timothy,Pratt,Charles,W.Bostain,JeremyE.Allnutt,"SatelliteCommunication”,2nd Edition, Wiley Publications,2002

REFERENCES:

1. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, “Satellite Communication Systems Engineering”, Prentice Hall/Pearson, 2007.
2. N.Agarwal, “Design of Geosynchronous Space Craft”, Prentice Hall, 1986.
3. Bruce R. Elbert, “The Satellite Communication Applications”, Hand Book, Artech House Bostan London, 1997.
4. Tri T. Ha, “Digital Satellite Communication”, II nd edition, 1990.
5. Emanuel Fthenakis, “Manual of Satellite Communications”, Mc Graw Hill Book Co., 1984.
6. Robert G. Winch, “Telecommunication Trans Mission Systems”, Mc Graw-Hill Book Co., 1983.
7. Brian Ackroyd, “World Satellite Communication and earth station Design”, BSP professional Books, 1990.
8. G.B.Bleazard, “Introducing Satellite communications“, NCC Publication, 1985.
9. M.Richharia, “Satellite Communication Systems-Design Principles”, Macmillan 2003.

EC8094 Satellite Communication

On completion of this course, students will be able to

CO 1	Analyze the satellite orbits.
CO 2	Analyze the earth segment and space segment.
CO 3	Analyze the satellite Link design.
CO 4	Design and analyse of various satellite access techniques.
CO 5	Analyse of various satellite coding techniques.
CO 6	Design various satellite applications

UNIT-I

SATELLITE ORBITS

PART A

1. **State Kepler's third Law. (Nov/Dec2015) [Remember]**
   a) Kepler's third law states that the square of the periodic time of orbit is proportional to thecube of the mean distance between the two bodies.
   b) The mean distance is equal to the semi major axis a. For the artificial satellites orbiting the earth, Kepler's third law can be written in the form a3 = μ / n2
   c) Where n is the mean motion of the satellite in radians per second and μ is the earth's geocentric gravitational constant.

2. **Define Apogee and Perigee. (April / May 2015) (Nov/Dec 2019) [Understand]**
   a) **Apogee :** The point on the elliptical orbit, which is the farthest from the center of the earth. Apogee distance ha = a(1+e)
   b) **Perigee :It is the** point on the orbit that is nearest to earth. The perigee distance for aelliptical orbit is given by hp = a(1-e);

   Where e – eccentricity of the orbit. A – semi major Axis.

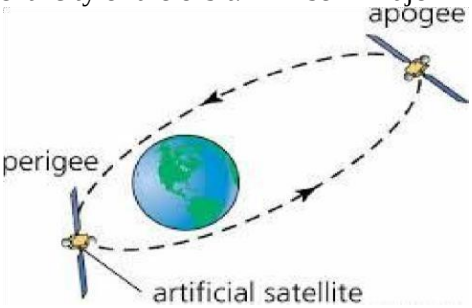


Figure : Apogee and Perigee

3. **Write the equation for total energy of a satellite for a two body system. (Nov/Dec2015) [Apply]**

$$E_{tot} = \frac{1}{2}m_1\dot{\mathbf{x}}_1^2 + \frac{1}{2}m_2\dot{\mathbf{x}}_2^2 + U(\mathbf{r}) = \frac{1}{2}(m_1 + m_2)\dot{\mathbf{R}}^2 + \frac{1}{2}\mu\dot{\mathbf{r}}^2 + U(\mathbf{r})$$

   Where $\mathbf{m}_1$ and $\mathbf{m}_2$ are their masses and **r** their distance

4. **List out the frequency bands used for satellite services. (April / May 2015) [Remember]**

Frequency range,	(GHz) Band designation
0.1–0.3	VHF
0.3–1.0	UHF
1.0–2.0	L
2.0–4.0	S
4.0–8.0	C
8.0–12.0	X

12.0–18.0	Ku
18.0–27.0	K
27.0–40.0	Ka

5. **What are the features of Polar orbiting satellite. (May /June 2014) [Understand]**
   a) Polar orbiting satellites are satellites which orbit the earth in such a way to cover thenorth and south Polar Regions.
   b) They are used for environmental monitoring and search and rescue services.
   c) Since the orbit is lower than the Geostationary satellites, the data resolution is higher.
      - They provide global coverage for climatic studies.

6. **Define right ascension of ascension node. (May /June 2014) [Understand]**
   a) To define completely the position of the orbit in space, the position of the ascendingnode is specified.
   b) However, because the earth spins, while the orbital plane remains stationary, the longitude of the ascending node is not fixed, and it cannot be used as an absolute reference.
   c) However, for an absolute measurement, a fixed reference in space is required. The reference chosen is the first point of Aries, otherwise known as the vernal, or spring,equinox.
   d) The vernal equinox occurs when the sun crosses the equator going from south to north, and an imaginary line drawn from this equatorial crossing through the center of the sun points to the first point of Aries.

7. **Calculate the radius of a circular orbit for which the period is 1 day.(Nov/Dec 2014)Given : 1 day. [Apply]**

$$\omega = \frac{2\pi}{1\ day} = 7.272\ 10^{-5}\ rad/sec$$

$$\text{Using } \mu = 3.986005 \times 10^{14}\ m^3/s^2$$

$$\therefore a = \left[\frac{\mu}{\omega^2}\right]^{1/3} = 42241\ldots\ km$$

8. **What is prograde orbit? (Nov/Dec 2014) [Understand]**
   a) An orbit in which the satellite moves in the same direction as the earth's rotation.
   b) Theprograde orbit is also known as a direct orbit.
   c) The inclination of a prograde orbit always lies between 0°and 90°.
   d) Most satellites are launched in a prograde orbit because the earth's rotational velocity provides part of the orbital velocity.

9. **How is the world divided to facilitate frequency planning for satellite services? (May/June 2013) [Remember]**

The world is divided in to three regions

a) Region1: Europe, Africa,(formerly the Soviet Union)and Mongolia
b) Region 2: North and South America and Greenland
c) Region3: Asia, Australia, and the south- west Pacific

10. What are Julian Dates? (May/June 2013) [Evaluate]

a) Calendar times are expressed in UT, and although the time interval between any twoevents may be measured as the difference in their calendar times, the calendar time notation is not suited to computations where the timing of many events has to be computed.
b) What is required is a reference time to which all events can be related in decimal days.Such a reference time is provided by the Julian zero time reference, which is 12 noononJanuary1intheyear4713 B.C.
c) The important point is that ordinary calendar time are easily converted to Julian dates, measured on a continuous timescale of Julian days.

11. Define orbital Parameters. [Understand]

In order to mention the position of the Earth orbiting satellites some parameters are used and these are termed as orbital parameters. They are

a) Semi Major Axis, Eccentricity, Mean Anomaly, Inclination, Argument of Perigee & Right Ascension of Ascending Node

12. What are the Orbital Perturbations? [Understand]

The Keplerian orbit is ideal; it assumes that the earth is a uniform spherical mass resulting from the satellite motion balancing the gravitational pull of the earth. But in practical Some disturbance and forces are changes the orbital positions.

a) They are the gravitational forces of the sun and the moon and atmospheric drag.
b) The gravitational pulls of sun and moon have negligible effect on low-orbiting satellites, but they do affect satellites in the geostationary orbit.
c) Atmospheric drag, on the other hand, has negligible effect on geostationary satellites but does affect low- orbiting earth satellites below about 1000 km.

13. How to represent the geocentric-equatorial coordinate system? [Apply]

a) The geocentric-equatorial coordinate system is an inertial system of axes, the-reference line being fixed by the fixed stars.
b) The reference line is the line of Aries. This is a very slow rotation.
c) With the origin lying at the center of the earth, as would be used for close in terrestrial satellites, a geocentric system is obtained.
d) Two geocentric coordinate systems are called equatorial or elliptic depending on whether the plane of the elliptic is used as respective reference plane.

14. What is sub satellite point? [Understand]

a) The sub satellite point is the location on the surface of the earth that lies directly

between the satellite and the centre of the earth.

Figure shows the meridian plane which cuts the sub satellite point.

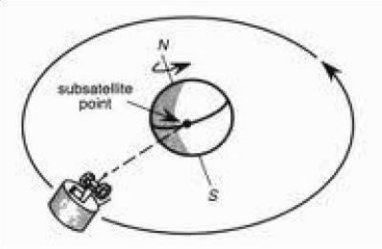


Figure : Sub Satellite Point

15. Define sidereal Day. [Remember]

a) The sidereal day is defined as one complete rotation of the earth relative to the fixedstars.

b) One sidereal day has 24 sidereal hours,1 sidereal hour has 60 sidereal minutes and 1sidereal minutes has 60 sidereal seconds. Generally, a sidereal day has 23h, 56 min.

16. Write the advantages of Geo Stationary orbit. [Understand]

Advantages of Geo Stationary orbit are

a) Tracking equipment avoided

b) Earth stations at constant distance and remain atline of sight

c) Larger coverage area

d) Global coverage with less no. of satellites.

e) Same quality of service at all places

f) No Doppler shift, Cost effective.

17.How the satellites are affected due to Atmospheric drag? [Evaluate]

- For near-earth satellites, below about 1000 km, the effects of atmospheric drag are significant.
- Because the drag is greatest at the perigee, the drag acts to reduce the velocity at this point, with the result that the satellite does not reach the same apogee height on successiverevolutions.
- The result is that the semi major axis and the eccentricity are both reduced. Drag does not noticeably change the other orbital parameters, including perigee height.

18.What are the basic concepts determining the look angles and its ranges? [Remember]

The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles, the following concepts determines the look angle.

- Orbital elements.
- Various measures of time.
- The peri-focal coordinate system, which is based on the orbital plane.
- The geocentric-equatorial coordinate system, which is based on the earth's equatorialplane.

- The topo centric- horizon coordinate system, which is based on the observer's horizonplane.

19. What are Look angles? Define Them. [Understand]

- The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles.
- These are most commonly specified as Azimuth and Elevation angles.

Azimuth Angle:It is defined as horizontal pointing angle of an earth station antenna. **Elevation Angle**:It is the vertical angle formed between direction of travel of an EM wave radiated from and earth station antenna pointing directly towards a satellite and thehorizontal plane.

20. Write the advantages and disadvantages of Satellite Communication. [Understand]

A Satellite is a physical object that revolves around some celestial body. A satellite whichis used for communication purpose is called communication satellites. The advantages and disadvantages are as follows **Advantages:**

- Wide Area of Coverage.
- Point to Multipoint Links whereas many terrestrial links are point to point.
- Mobile Communication can be established.
- Economical when long distance is involved.
- For Geo Stationary Satellite Doppler shift is negligible.

Disadvantages:

- Propagation delay is very high.
- Impedance mismatch + Propagation delay produces echo in telephone systems.
- Echo Suppressors or Echo chancellors are to be added so that complexityIncreases.
- Propagation Delay reduces the efficiency of the data transmission over satellite communication

21. State Kepler's first and third law. (Apr/May 2017, Nov/Dec 2018) [Evaluate]

Kepler's I law:

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

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

Kepler's III Law:

It states that the square of the periodic time of orbit is proportional to the cube of themean 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.

With n in radians per second, the orbital period in second is given by,$P = 2\pi/n$

22. What is the limit of visibility? [Evaluate]

The east and west limits on the geostationary are of a satellite which are visible from any given Station are known as limits of visibility.

23.Define Sub satellite path. [Understand]

This is the path traced out on the earth's surface directly below the satellite.

24.Define Apogee. [Remember]

The point farthest from earth. Apogee height is shown as h_a

25.Define Perigee. [Remember]

The point of closest approach to earth. The perigee height is shown as h_p.

26.Define Line of asides. [Remember]

The line joining the perigee and apogee through the center of the earth.

27.Define Line of nodes. [Remember]

The line joining the ascending and descending nodes through the center of the earth.

28.Define Inclination[Remember]

The angle between the orbital plane and the earth's equatorial plane. It is measured at the ascending node from the equator to the orbit, going from east to north. It will be seen that the greatest latitude, north or south, reached by the sub satellite path is equal to the inclination.

29.Define prograde orbit. [Remember]

An orbit in which the satellite moves in the same direction as the earth's rotation. The prograde orbit is also known as a direct orbit. The inclination of a prograde orbit always lies between 0°and 90°.Most satellites are launched in a prograde orbit because the earth's rotational velocity provides part of the orbital velocity.

30.Define retrograde orbit. [Remember]

An orbit in which the satellite moves in a direction counter to the earth's rotation. The inclination of a retrograde orbit always lies between 90°and 180°.

31.Define Argument of perigee. [Remember]

The angle from ascending node to perigee, measured in the orbital plane at the earth's center in the direction of satellite motion.

32.Define Right ascension of the ascending node. [Remember]

To define completely the position of the orbit in space, the position of the ascending node is specified.

However, because the earth spins, while the orbital plane remains stationary, the longitude of theascending node is not fixed, and it cannot be used as an absolute reference .However, for an absolute measurement, a fixed reference in space is required. The reference chosen is the first point of Aries, otherwise known as the vernal, or spring, equinox. The vernal equinox occurs when the sun crosses the equator going from south to north, and an imaginary line drawn from this equatorial crossing through the center of the sun points to the first point of Aries.

33.Define Mean anomaly. [Remember]

Mean anomaly M gives an average value of the angular position of the satellite withreference to the perigee. For a circular orbit, M gives the angular position of the satellite in the orbit.

34.True anomaly. [Remember]

The true anomaly is the angle from perigee to the satellite position, measured at the earth's center. This gives the true angular position of the satellite in the orbit as a function of time.

35.What are the keplerian elements set? [Remember]

They are six elements. (i). semi major axis a (ii). Eccentricity e (iii). The mean anomalyM_0, (iv). Argument of perigee w, (v).Inclination i (vi) and the right ascension of the ascending node Ω.

36.Write the formula for Apogee and Perigee Heights. [Understand]

Apogee Height $h_a=r_a-R$; where $r_a= a(1+e)$

Perigee Heights $h_p=r_p-R$; where $r_p= a(1-e)$ and R is radius of earth. R=6371 Km.

37.What are polar orbiting satellites? [Remember]

Polar orbiting satellites are satellites which orbit the earth in such a way to cover the north and south Polar Regions .They are used for environmental monitoring and search and rescue services.

38.What are the Orbital Perturbations? [Remember]

The some disturbance forces are changes the orbital positions. They are the gravitational forces of the sun and the moon and atmospheric drag. The gravitational pulls of sun and moon have negligible effect on low-orbiting satellites, but they do affect satellites in the geostationary orbit. Atmospheric drag, on the other hand, has negligible effect on geostationary satellites but does affectlow- orbiting earth satellites below about 1000 km.

39.What is calendar? What are terms involved? [Understand]

A calendar is a time-keeping device in which they year is divided into months, weeks, and days. Calendar days are units of time based on the earth's motion relative to the sun. Of course, it is more convenient to think of the sun moving relative to the earth. This motion is not uniform, and soa fictitious sun, termed the **mean sun**, is introduced.

The mean sun does move at a uniform speed but otherwise requires the same time as the real sun tocomplete

one orbit of the earth, this time being the **tropical year**. A day measured relative to this mean sun is termed a **mean solar day**. Calendar days are mean solar days.

40.Define civil year and Julian calendar. [Evaluate]

A tropicalyearcontains365.2422days.Inordertomakethecalendar year, also referred to as the civil year, more easily usable, it is normally divided into 365 days. The extra 0.2422 of a day is significant, and for example, after 100 years, there would be a discrepancy of 24 days between the calendar year and the tropical year. Julius Caesar made the first attempt to correct the discrepancy by introducing the leap year, in which an extra day is added to February whenever they ear number is divisible by 4. This gave the Julian calendar, in which the civil year was

365.25 days on average, a reason- able approximation to the tropical year.

41.What is Universal time? [Remember]

Universal time coordinated (UTC)is the time used for all civil time–keeping purposes, and it is the time reference which is broadcast by the National Bureau of Standards as a standard for setting clocks. It is based on an atomic time-frequency standard. The fundamental unit for UTC is the mean solar day. In terms of "clock time," the mean solar day is divided into 24 h, an hour into 60min, and a minute into 60s. Thus there are 86,400" clock seconds" in a mean solar day.

42.Compare mean sidereal day and mean solar day. [Apply]

1 mean solar day =1.0027379093 mean sidereal days

= 24 h 3 m 56.55536 s sidereal time

=86,636.55536 mean sidereal seconds

1 mean sidereal day =0.9972695664 mean solar days

=23h56m04.09054smeansolartime

=86,164.09054 mean solar seconds

43.Write down transformation matrix R. [Apply]

$$R=\begin{bmatrix} (\cos\Omega\cos\omega-\sin\Omega\sin\omega\cos i) & (-\cos\Omega\sin\omega-\sin\Omega\cos\omega\cos i) & \sin\omega\sin i \\ (\cos\Omega\cos\Omega+\sin\Omega\sin\omega\cos i) & (-\sin\Omega\sin\omega+\cos\Omega\cos\omega\cos i) & \cos\omega\sin i \end{bmatrix}$$

44.How can you find whether a year is leap year or not? [Apply]

If the number is divisible by 4 without remainder, it is a leap year (or) if the year number ends in 2 zeros and is divisible by 400 without remainder, it is a leap year.

45.Define sidereal Day. [Remember]

The sidereal day is defined as one complete rotation of the earth relative to the fixed stars. One

sidereal day has 24 sidereal hours,1 sidereal hour has 60 sidereal minutes and 1 sidereal minutes has 60 sidereal seconds. Generally, a sidereal day has 23h, 56 min.

46.What is sub satellite point? [Remember]

The sub satellite point is the location on the surface of the earth that lies directly between the satellite and the centre of the earth.

47.Define the term azimuth angle. [Remember]

Azimuth angle is defined as the horizontal pointing angle of an antenna. It is the angle between true (geographic) south or north and the point on the horizon directly below the sun.

48.How affect Atmospheric drag to satellites? [Understands]

For near-earth satellites, below about 1000 km, the effects of atmospheric drag are significant. Because the drag is greatest at the perigee, the drag acts to reduce the velocity at this point, with the resultthatthesatellitedoesnotreachthesameapogeeheightonsuccessiverevolutions. The result is that the semi major axis and the eccentricity are both reduced. Drag does not noticeably change the other orbital parameters, including perigee height.

49.What are the basic concepts needed to determine look angles and its ranges? [Remember]

1. Orbital elements
2. Various measures of time
3. The peri-focal coordinate system, which is based on the orbital plane
4. The geocentric-equatorial coordinate system, which is based on the earth's equatorial plane.
5. The topocentric- horizon coordinate system, which is based on the observer's horizon plane.

50.What are major coordinate transformations needed? [Remember]

- Satellitepositionmeasuredintheperifocalcoordinatesystemistransformedtothegeocentric horizon coordinate system in which the earth's rotation is measured, thus enabling the satellite position and the earth station location to be coordinated.
- The satellite-to-earth station position vector is transformed to the top centric horizon system, which enables the look angles and range to be calculated.

51.What is Julian date? What are the necessary of Julian dates? [Understand]

Calendar times are expressed in UT, and although the time interval between any twoevents may be measured as the difference in their calendar times, the calendar time notation is not suited to computations where the timing of many events has to be computed. What is required is areference time to which all events can be related in decimal days. Such a reference time is provided by the Julian zero time reference, which is 12 noononJanuary1intheyear4713 B.C.!The important point is that ordinary calendar time are easily converted to Julian dates, measured on a continuous timescale of Julian days.

52.Define satellite graveyards. [Remember]

The gravity gradient resulting from the equatorial ellipticity causes the satellites in geostationary orbit to drift to one of two stable points, which coincide with the minor axis of the equatorial ellipse. These two points are separated by 180°on the equator and are at approximately 75°E longitude and 105°W longitude. Satellites in service are prevented from drifting to these points through station-keeping maneuvers. Because old, out-of-service satellites eventually do drift to these points, they are referred to as "satellite graveyards."

53.What is anomalistic period (from perigee to perigee)? [Remember]

The orbital period taking into account the earth's oblations is termed as the anomalistic period. The anomalistic period is $P_A = \frac{2\pi}{n}$ s, where n is radians per sec.

54.What is regression of the nodes? [Remember]

Regression of the nodes is where the nodes appear to slide a long the equator. In effect, the line of nodes, which is in the equatorial plane, rotates about the centre of the earth. Thus Ω, the right ascension of the ascending node shifts its position.

55.What is equatorial ellipticity? [Remember]

In an equatorial bulge, the earth is not perfectly circular in the equatorial plane, it has a small eccentricity of the order of 10^{-5}. This is referred to as the equatorial ellipticity.

56.Distinguish between GEO system and LEO system. (Nov/Dec 2018) [Remember]

S. No.	GEO System	LEO System
1	Geostationary satellites appear fixed as they move at the same angular velocity as the Earth and orbit along a path parallel to Earth's rotation, providing coverage to a specific area.	LEO satellites are much smaller and their orbits are much closer to Earth
2	35786 km	160 to 2000 km
3	3 satellites are required to cover the earth's surface	40 – 80 satellites are required to cover the earth's surface
4	Has an instantaneous ground coverage of 16,000km	Has an instantaneous ground coverage of approx. 6,000km
5	Examples: Intelsat, Interspoutnik, Inmarsat	Examples: Iridium, Globalstar, Teledesic, Skybridge, Orbcomm

57.What are the look angles? [Remember]

The look angles for the ground station antenna are the azimuth and elevation angles required at the

antenna so that it points directly at the satellite.

58.What is information's needed to determine the look angles for the geostationary orbit? [Understand]

The earth-station latitude, denoted here by λ_E The earth-station longitude, denoted here by ϕ_E The longitude of the sub satellite point, ϕss.

59.What conditions are required for an orbit to be geostationary? [Understand]

1. The satellite must travel eastward at the same rotational speed as the earth.
2. The orbit must be circular.
3. The inclination of the orbit must be zero.

60.What factors of disturbance forces affect geostationary orbit? [Understand]

The geostationary orbit cannot be attained because of disturbance forces in space and the effects of the earth's equatorial bulge. The gravitational fields of the sun and the moon produce a shift of about 0.85°/year in inclination.

61.What is Limits of Visibility? [Apply]

There will be east and west limits on the geostationary arc visible from any given earth station. The limits will be set by the geographic coordinates of the earth station and the antenna elevation. The lowest elevation in theory is zero, when the antenna is pointing along the horizontal.

The limiting angle is given by

$$\theta = \arccos \frac{a_E}{a_{GSO}}$$

62.What is Hohmann transfer orbit? [Remember]

An orbital altitude greater than about 200 km is required, it is not economical in terms of launch vehicle power to perform direct injection, and the satellite must be placed into transfer orbit between the initial LEO and the final high-altitude orbit. In most cases, the transfer orbit is selected to minimize the energy required for transfer, and such an orbit is known as a Hohmann transfer orbit.

63.What are the Napier's rules? [Remember]

Special rules, known as Napier's rules, are used to solve the spherical triangle, and these have been modified here to take into account the signed angles B and l_E. Only the result will be stated here. Napier's rules gives angle b as

$b = \arccos(\text{CosB Cos}\lambda_E)$ and angle A as **$A = \text{arcsine}\left\{\frac{\text{SinB}}{\text{Sinb}}\right\}$**

64.Define the Polar Mount Antenna. [Remember]

The home antenna has to be steerable; expense usually precludes the use of separate azimuth and

elevation actuators. Instead, a single actuator is used which moves the antenna in a circular arc. This is known as a polar mount antenna. The antenna pointing can only be accurate for one satellite, and some pointing error must be accepted for satellites on either side of this. With the polar mount antenna, the dish is mounted on an axis termed the polar axis such that the antenna bore sight is normal to this axis.

65.What is sun transit outage? [Understand]

The event which must be allowed for during the equinoxes is the transit of the satellite between earth and sun, such that the sun comes within the beam width of the earth-station antenna. When this happens, the sun appears as an extremely noisy source which completely blanks out the signal from the satellite. This effect is termed sun transit outage, and it lasts for short periods—each day for about 6 days around the equinoxes.

66.What is Space Transportation System (STS)? [Understand]

Satellites Launch vehicles may be classified as expendable or reusable. Typical of the expendable launchers are the U.S. Atlas-Centaur and Delta rockets and the European Space Agency Ariane rocket. Japan, China, and Russia all have their own expendable launch vehicles. Until the tragic mishap with the Space Shuttle in 1986, this was to be the primary transportation system for the United States. As a reusable launch vehicle, was replacing expendable launch vehicles for the United States which are referred to as the Space Transportation System (STS).

67.What are the functionality of STS? [Remember]

The Hohmann elliptical orbit is seen to be tangent to the low- altitude orbit at perigee and to the high-altitude orbit at apogee. At the perigee, in the case of rocket launch, the rocket injects the satellite with the required thrust into the transfer orbit. With the STS, the satellite must carry a perigee kick motor which imparts the required thrust at perigee. At apogee, the apogee kick motor (AKM) changes the velocity of the satellite to place it into a circular orbit in the same plane. Throughout the launch and acquisition phases, a network of ground stations, spread across the earth, is required to perform the tracking, telemetry, and command (TT&C) functions.

68.How to relate Geostationary and Geosynchronous satellites? [Evaluate]

The period for a geostationary satellite is 23 h, 56 min, 4 s, or 86,164 s. The reciprocal of this is 1.00273896 rev/day. But satellites are geosynchronous, in that they rotate in synchronism with the rotation of the earth. However, they are not geostationary. The term geosynchronous satellite is used in many cases instead of geostationary to describe these near-geostationary satellites. It should be noted, however, that in general a geosynchronous satellite does not have to be near-geostationary, and there are a number of geosynchronous satellites that are in highly elliptical orbits with comparatively large inclinations.

69. How do satellite system operators overcome sun transit outage? [Nov/Dec 2021] [Remember]

70. What are the characteristics of geostationary orbit? [Nov/Dec 2021] **[Understand]**

A spacecraft in this orbit appears to an observer on Earth to be stationary in the sky. This particular orbit is used for meteorological and communications satellites. The geostationary orbit is a special case of the geosynchronous orbit, which is **any orbit with a period equal to Earth's rotation period**.

71. Satellite is in an elliptical orbit with eccentricity of 0.6 and perigee altitude 1000 Km. Determine :

a) The semi major axis

b) The period of revolution [NOV/DEC 2020, APR/MAY 2021]

72. Assume a circular orbit: Using Newton's law of gravitation and Newton's second law, determine the acceleration of a satellite. [NOV/DEC 2020, APR/MAY 2021]

PART B

1. (a)Describe the effect of orbit perturbations due to the effect of a non-spherical earth and atmospheric drag.(8) **(APRIL /MAY 2015)(NOV/DEC 2019)** **[Understand]**

   b. Explain what is meant by apogee height and perigee height. A satellite has an apogee of 39,342 km and a perigee of 613Km. Determine the semi major axis and the eccentricity of its orbit(Earth radius = 6371 km).(8) **(APRIL /MAY 2015)** **[Remember]**

2. (a)Describe the method of finding the position vector R of the Earth relative to the IJK frame. (8) **(APRIL /MAY 2015)** **[Remember]**

   b. Explain the launching procedure for putting the GEO satellites in the orbit. (8) **(NOV/DEC 2015)** **[Understand]**

3. What are the orbital parameters? Derive the expression for orbital equation of the satellite starting from Newton's law.(16) **(NOV/DEC 2015)** **[Remember]**

4. (a)Explain about frequency allocations for satellite services.(8)**(MAY/JUNE 2014)** **[Evaluate]**

   (b)Explain about U.S.Domsats. (8)**(MAY/JUNE 2014)** **[Remember]**

5. Explain in detail about orbital elements and orbital perturbations with suitable example. (16) **(MAY/JUNE 2014)** **[Understand]**

6. (a)Explain the three Kepler's law with relevant diagrams (6) **(NOV/DEC 2014)** **[Understand]**

   b. For a particular satellite the eccentricity is 9.5981 x 10^{-3} and the mean anomaly is 204.9779*.The mean motion is 14.2171404 rev/day. The semimajor axis is 7194.9Km. Calculate the true anomaly and the magnitude of the radius vector 5s after epoch. (6) **(NOV/DEC 2014)** **[Apply]**

   a. Write a brief note on Julian dates. (4) **(NOV/DEC 2014)** **[Evaluate]**

7. (a) Explain the orbital perturbations in detail. (8) **(NOV/DEC 2014)** **[Understand]**

   b. Explain the geometry for determining the sub satellite point with a diagram. (8) **(NOV/DEC 2014)** **[Understand]**

8. (a)Describe the method of finding the position vector R of the Earth relative to the IJK frame. (08) **(MAY/JUNE 2013)** **[Remember]**

b. Calculate the magnitude of the position vector in the PQW frame for the orbit with Ω = 300°, ω=60°,i=65°, rp = -6500 km and rq=4000Km. Calculate also the position vector in the IJK frame and its magnitude. Confirm the magnitude. Confirm the magnitude of r vector unchanged in both frames.(8) **(MAY/JUNE 2013)(APRIL /MAY 2015)** **[Apply]**

9. Derive the equation for a satellite orbit. (16) **(NOV/DEC 2017)** **[Apply]**

10. Derive the equations which permi the elevation angle to be calculated. (8) **(NOV/DEC 2017)** **[Apply]**

11. Tabulate the various types of orbits with their merits and demerits. (8) **(NOV/DEC 2017)** **[Understand]**

12. What is meant by the geostationary orbit and also explain the conditions to be required for an orbit to be geostationary.(8) **(NOV/DEC 2019)** **[Understand]**

13. State and explain the Kepler's three laws of motion with suitable diagram.(9) **(NOV/DEC 2019)** **[Understand]**

14. Explain about satellite launch vehicles. (4) **(NOV/DEC 2019)**. **[Remember]**

15. Explain in detail about geocentric-equatorial coordinate system which is based on the earth's equatorial plane. (16) **[Remember]**

16. Explain in detail about topocentric-horizon coordinate system which is based on the observer's horizon plane. (16) **[Understand]**

17. What is meant by polar orbiting and explain in details. (16) **[Understand]**

18. State Kepler's three laws of planetary motion. Illustrate in each case their relevance to artificial satellites orbiting the earth. (16) **[Remember]**

19. What are look angles? Explain how look angles are determined using sub satellite points? Derive the necessary expression for look angles. (16) **[Evaluate]**

20. Give a detailed note on launching vehicles and the procedures employed for launching spacecraft in GEO orbits. (16) **[Understand]**

21. (i) Explain the three laws of Kepler with diagrams. (9) **[Understand]**

(ii) Derive the Kepler's third law for circular orbit using Newtonian laws. (4) **[Nov/Dec 2021]** **[Apply]**

22. (i) How do you find the elevation and azimuth for an earth station to look at geostationary satellite? (10) **[Apply]**

(ii) For a spherical planet of radius 8000 km, assume that stationary orbit occurs at 50000 km. Find the maximum central angular separation between the receiver station and the subsatellite point for the satellite to be visible. (3) **[Nov/Dec 2021]** **[Apply]**

23. (i) A satellite revolves the Earth in the equatorial plane. The velocity of the satellite in its circular orbit is 6 km/s. Find out the duration of time for which the satellite will be visible at a specific point on Earth's equator. (7) **[Apply]**

(ii) For a satellite in elliptical orbit, find:

- An equation that relates eccentric anomaly (E) and true anomaly (φ_0). (4) **[Apply]**
- Eccentric anomaly E for φ_0=0, $\pi/2 = 0, \pi$ (assume eccentricity e = 0. (4) **[Apply]**

[Nov/Dec 2021]

24. Derive the complete expression for Look Angles, along with intermediate angle in satellite communication. Show that intermediate angle is : **[Apply]**

$$\boldsymbol{\alpha = \tan^{-1}\left(\frac{\tan|l_s - l_e|}{sin(L_e)}\right)}$$ **[Apr/May 2021]**

25. Satellite is in a circular orbit around the earth. The altitude of the satellite's orbit above the surface of the earth is 1400 Km. **[Apply]**

i) What are the centripetal and centrifugal accelerations acting on the satellite in its orbit ? Give your answer in m/s^2.

ii) What is the velocity of the satellite in this orbit ? Give your answer in km/s.

iii) What is the orbital period of the satellite in this orbit ? Give your answer in hours, minutes and seconds. (10)

ii) Differentiate between Geosynchronous and Geostationary orbits. **[Remember]** (3)

[Apr/May 2021]

UNIT 1 Assignments

1. Discuss in detail about

a. Major elements in satellite communications

b. Satellite orbits

2. Write the ranges of frequency allocations in satellite communication and explain the applications of satellite communication.
3. Derive the equation for orbital mechanics and explain about Kepler's law.
4. Write the definition of different orbital elements.
5. Discuss in detail about look angle determination (Azimuth and Elevation Angles).

UNIT – 2

SPACE SEGMENT AND SATELLITE LINK DESIGN

PART A

1. Define azimuth angle. (April / May 2015) [Remember]

The coordinates to which the earth station antenna must be pointed to communicate with asatellite are called look angles.

- Azimuth angle is defined as the horizontal pointing angle of an antenna.
- It is the angle between true (geographic) south or north and the point on the horizondirectly

below the sun.

2. **What is a propellant? (April / May 2015)** **[Remember]**
   - Propellant is the chemical mixture burned to produce thrust in rockets and consists of a fuel and an oxidizer.
   - A fuel is a substance that burns when combined with oxygen producing gas forpropulsion. An oxidizer is an agent that releases oxygen for combination with a fuel.
   - The ratio of oxidizer to fuel is called the mixture ratio. Propellants are classified accordingto their state - liquid, solid, or hybrid.

3. **What is meant by station keeping? (Nov/Dec2015)** **[Remember]**
   - It is the process of maintenance of satellite's attitude against different factors that cancause drift with time.
   - Satellites need to have their orbits adjusted from time to time because the satellite initiallyplaced in the correct orbit, natural forces induce a progressive drift.
   - There are two types of station keeping
     1. East – West station keeping : this is the correction along the axis.
     2. North – South Station Keeping : this is to correct the change in inclination.

4. **What are geostationary satellites? (Nov/Dec2015)** **[Understand]**
   - A geostationary orbit is one in which a satellite orbits the earth at exactly the same speedas the earth turns and at the same latitude, specifically zero, the latitude of the equator.
   - A satellite orbiting in a geostationary orbit appears to be hovering in the same spot in thesky, and is directly over the same patch of ground at all times.
   - A Geo Stationary satellite is one which has a visible period of 23 h, 56 min, 4s, or86,164s. The reciprocal of this is 1.00273896 rev/day.

5. **Define Roll, Pitch and Yaw. (May /June 2014)** **[Remember]**
   - The three axes which define a satellite's attitude are its roll, pitch, and yaw (RPY) axes All three axes pass through the center of gravity of the satellite.
   - For an equatorial orbit, movement of the satellite about the roll axis moves the antenna footprint north and south; movement about the pitch axis moves the footprint east and west; and movement about the yaw axis rotates the antenna footprint.

6. **Define input back-off. (May /June 2014)** **[Remember]**
   - In order to reduce the inter modulation distortion, the operating point of the TWT must be shifted closer to the linear portion of the curve, the reduction in input power being referred to as i/p backoff.
   - The saturation flux density for single carrier operation is known input backoff will be specified for multiple carrier operation, referred to the single carrier saturation level.
   - The earth station EIRP will have to be reduced by the specified backoff (Bo), resulting in an uplink value of [EIRP]o =[EIRPs]u-[Bo]i

7. **Write down the parameters which are necessary for determining the look angles for the geostationary orbit. (Nov/Dec 2014) [Remember]**
   - The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles.
   - The following parameters λE, ϕE, ϕss are necessary to determine the look angles.
   - The earth-station latitude, denoted here by λE
   - The earth-station longitude, denoted here by ϕE The longitude of the sub satellitepoint, ϕss.

8. **Define sun transit outage. (Nov/Dec 2014) [Understand]**
   - The event which must be allowed for during the equinoxes is the transit of the satellite between earth and sun, such that the sun comes within the beam width of the earth-stationantenna.
   - When this happens, the sun appears as an extremely noisy source which completely blanks out the signal from the satellite.
   - This effect is termed sun transit outage, and it lasts for short periods—each day for about6 days around the equinoxes.

9. **Distinguish between Geosynchronous and Geostationary orbits. (May/June 2013) [Understand]**
   - Geosynchronous - An orbit around Earth whose orbital period is equal to a sidereal day(23 hours, 56 minutes), irrespective of its inclination.

     Ex: A person on a point on Earth, will see a satellite in this orbit in the same place in thesky at the same time of the day, every day.
   - Geostationary - A geosynchronous orbit around Earth at 35,786 km above the equator, sothat it remains stationary as seen from Earth.

     Ex: A person on any point on Earth, will see a satellite in this orbit stationary w.r.t thisposition, just like a star in the sky.

10. **What are the needs for station keeping? (May/June 2013) [Remember]**
    - Station-keeping maneuvers must be carried out to maintain the satellite within set limitsof its nominal geostationary position.
    - There are a number of perturbing forces that cause an orbit to depart from the ideal keplerian orbit.
    - For the geostationary case, the most important of these are the gravitational fields of themoon and the sun, and the non-spherical shape of the earth, and also solar radiation pressure and reaction of the satellite itself to motor movement within the satellite.

11. **What is meant by payload? [Remember]**
    - The payload refers to the equipment used to provide the service for which the satellitehas been launched.
    - The payload comprises of a repeater and antenna subsystem and performs the primary function of communication

- The repeater have two types

  1.Transparent repeater 2. Regenerative Repeater.

12. What is the temperature control in the satellite? [Remember]

- The need for temperature control is to maintain a constant temperature inside the satellites. Because, the important consideration is that the satellites equipment should operate as nearly as possible in a stable temperature environment.
- Thermal blankets and shields may be used to provide insulation.
- Radiation mirrors are often used to remove heat from communication payload.
- These mirror drum surrounded the communication equipment shelves in each case and provide good radiation paths.

13. Write notes on transponder. [Remember]

- A transponder is the series of interconnected units which forms a single communicationschannel between the receive and transmit antennas in a communications satellite
- It is a single communication channel which is formed by a series of interconnected units.
- A typical transponder bandwidth is 36 MHz, and allowing for a 4-MHz guard band between transponders, 12 such transponders can be accommodated in the 500-MHz bandwidth.

14. Write short notes on attitude control system. [Remember]

- The attitude of a satellite refers to its orientation in space.
- Usually, the attitude-control process takes place aboard the satellite, but it is also possible for control signals to be transmitted from earth, based on attitude data obtained from thesatellite.
- It is the system that achieves & maintains the required attitudes.
- The main functions of attitude control system include maintaining accurate satellite position throughout the life span of the system.

15. Define angle of Tilt. [Remember]

- The angle a rocket makes with the vertical as it curves along its trajectory. The angle at which the dish is tilted relative to the polar mount until the bore sight is pointing at a satellite position due south of the earth station is known as angle of tilt. This is also referred as declination.

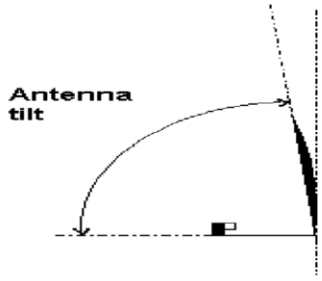


Fig: Tilt Angle

16. Define Momentum Bias. [Remember]

- Spin stabilization may be achieved with cylindrical satellites.
- The satellite is constructed so that it is mechanically balanced about one particular axis and is then set spinning around this axis. For geostationary satellites, the spin axis is adjusted to be parallel to the N-S axis of the earth. In these dual-spin spacecraft, spin stabilization is obtained using spinning flywheels, which are termed as momentum wheels. The average momentum of these wheels is known as momentum bias.

17. Define output backoff. [Remember]

- An input backoff is employed, a corresponding output backoff must be allowed for thesatellite EIRP.
- When the operating point of the Travelling wave tube amplifier (TWTA) is shifted closerto the linear portion in order to reduce intermodulation distortion.
- The corresponding drop in the output power in decibels is known as the output backoff.

18. Write the equations of Link-Power Budget. [Apply]

- 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.[PR] = [EIRP] + [GR] – [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)

19. What is system noise? [Remember]

- 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, Pn=KTnB

  Where, Pn=Noise power , K=Boltzman's constant

  Tn=Noise temperature of source(in Kelvin) B=Bandwidth in Hz

20. Define noise factor. [Remember]

- An alternative way of representing amplifier noise is by means of its noise factor F.
- For defining it, the source is taken at room temperature, denoted by T0.
- The input noise from such a source is KT0 and the output noise from the amplifier is N0,out = FGKT0 Where G -is the available power gain of the amplifier, F - is the noisefactor

21.What is need for station keeping? Or Effects of near geosynchronous orbits? [Remember]

Station-keeping maneuvers must be carried out to maintain the satellite within set limits of its nominal geostationary position. There are a number of perturbing forces that cause an orbit to depart from the ideal keplerian orbit. For the geostationary case, the most important of these are the gravitational fields of the moon and the sun, and the non spherical shape of the earth, and also solar radiation pressure and reaction of the satellite

itself to motor movement within the satellite.

22.Write notes on transponder. **[Remember]**

The transponder is an equipment channel which provide the connecting link between the satellite's transmit and receive antenna, It is a single communication channel which is formed by a series of interconnected units.

23.What is meant by spot beam antenna? [Remember]

Spot beam antenna is a parabolic type of satellite antenna with a high gain and narrow beam. The narrow beam signal send by the antenna covers only a limited graphic area on earth so that only earth stations in a particular intended reception area can properly receive the satellite signal. This antenna is suitable for earth stations handling large traffic of communication.

24.What is meant by frequency reuse? [Remember]

The carrier with opposite senses of polarization may overlap in frequency this technique is known as frequency reuse.

25.Describe the spin stabilized satellites. [Remember]

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

26.Write the formula for GST. [Apply]

GST = 99.6910+ 36000.7689Xt +0.0004Xt +2+UT deg.

27.Write short notes on attitude control system. [Remember]

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

28.What is an polar antenna? [Remember]

A single actuator is used which moves the antenna in a circular arc ie known as polar mount antenna.

29.What is declination? [Remember]

The angle of tilt is often referred to as the declination which must not be confused with the magnetic declination used in correcting compass readings.

30.What is meant by payload? [Remember]

The payload refers to the equipment used to provide the service for which the satellite has been launched.

31.Write short notes on station keeping. [Remember]

It is the process of maintenance of 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 initially placed in the correct orbit, natural forces induce a progressive drift.

32.Define diplexer. [Remember]

The transmit & receives signals are separated in a device known as diplexer.

33.Define input backoff. [Remember]

In order to reduce the inter modulation distortion, the operating point of the TWT must be shiftedcloser to the linear portion of the curve, the reduction in input power being referred to as i/p backoff.

34.What is a Yaw? [Remember]

Yaw is the rotation of a vehicle about its vertical axis.

35.What is an Zero 'g'? [Remember]

Zero 'g' is a state when the gravitational attraction is opposed by equal & opposite inertial forces & the body experiences no mechanical stress.

36.Define angle of Tilt. [Remember]

The angle at which the dish is tilted relative to the polar mount until the bore sight is pointing at a satellite position due south of the earth station is known as angle of tilt $^{\delta}$. This is also referred as declination.

37.What are Horizon detectors? [Remember]

Horizon detectors are infrared sensors which are used to detect the rim i.e. border or edge of the against the background of space for the purpose of attitude control.

38.State the needs for altitude control of a satellite. [Understand]

Two important needs are (i) To ensure that the directional antennas point in the purpose direction.(ii) To make the earth-sensing instruments to cover the required regions in case of earth- environmental satellite.

39.What are RPY axes? [Remember]

RPY stands for Roll, Pitch and Yaw axes. A satellite's attitude is defined by these three axes and movement of the satellite about any one of these axes will change the foot print in the corresponding direction.

40.Define Momentum Bias. [Remember]

In some dual-spin spacecraft, spin stabilization is obtained using spinning flywheels, which are termed as momentum wheels. The average momentum of these wheels is known as momentumbias.

41.What is the temperature control in the satellite? [Remember]

The need for temperature control is to maintain a constant temperature inside the satellites.Because,

the important consideration is that the satellites equipment should operate as nearlyas possible in a stable temperature environment.

42.What is the purpose of wideband receiver? [Understand]

The purpose of wide band receiver is to amplify and frequency converts all the modulated carriers in the 500 MHz band. Frequency conversion shifts the carrier to downlink frequency.

43.Define output backoff. [Understand]

When the operating point of the Travelling wave tube amplifier (TWTA) is shifted closer to the linear portion in order to reduce intermodulation distortion, the corresponding drop in the output power in decibels is known as the output backoff.

44. What does the term 'bus' refer in TT&C ? (Nov/Dec 2019) [Understand]

The term bus refers to the basic satellite structure itself and the subsystems that support the satellite. It also refers to the vehicle as well as the subsystems that provide the power, attitude control, orbit control, thermal control, command and telemetry functions required to service the payload.

45. Write down the formula for reliability of hardware. ? (Nov/Dec 2019) [Apply]

The reliability of a device or subsystem is defined as the ratio of number of surviving components at time t to the number of components at start of test period.

$R=e^{-\lambda t}$, where λ is average failure rate.

Reliability of a device decreases exponentially with time, with zero reliability after infinite time, that is, certain failure.

46. What is a body-stabilized satellite? [Nov/Dec 2021] [Remember]

THREE-AXIS OR BODY STABILIZATION The stabilization is **achieved by controlling the movement of the satellite along the three axes**, i.e. yaw, pitch and roll, with respect to a reference. The system uses reaction wheels or momentum wheels to correct orbit perturbations.

47. Give the differences between bent pipe and base band processing transponders? [Nov/Dec 2021] [Understand]

Bent Pipe Transponders

Bent pipe transponder receives microwave frequency signal. It converts the frequency of input signal to RF frequency and then amplifies it.

Bent pipe transponder is also called as repeater and conventional transponder. It is suitable for both analog and digital signals.

Regenerative Transponders

Regenerative transponder performs the functions of Bent pipe transponder. i.e., frequency translation and amplification. In addition to these two functions, Regenerative transponder also performs the

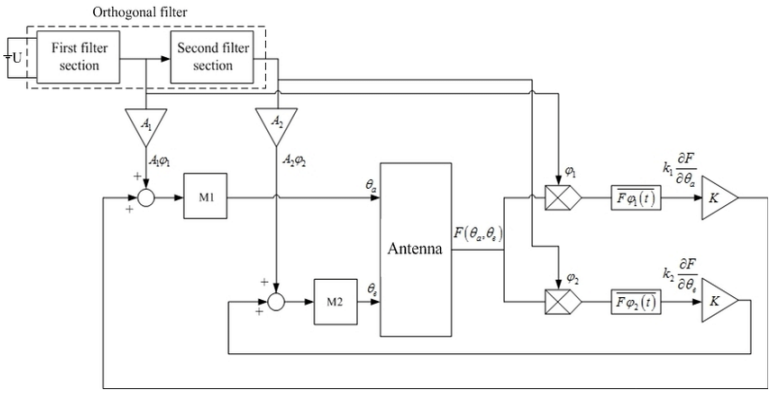
demodulation of RF carrier to baseband, regeneration of signals and modulation.

Regenerative transponder is also called as Processing transponder. It is suitable only for digital signals. The main advantages of Regenerative transponders are improvement in Signal to Noise Ratio (SNR) and have more flexibility in implementation.

48. Define payload and transponder. **[April/May 2021]** **[Understand]**

Payload is the equipment used to provide the service for which the satellite has been launched. Transponder is the equipment which provides the connecting link between the transmitting antennas and receiving antennas of a satellite for communication

49. Draw the block diagram of antenna subsystem. **[April/May 2021]** **[Understand]**



PART B

1. Explain about advanced Trios-N spacecraft and Morelos with a neat sketch. (16)(MAY/JUNE 2014) **(APRIL /MAY 2015)** **[Understand]**
2. Explain in detail about antenna look angles and the polar mount antenna.(16) **(MAY/JUNE 2014)(APRIL /MAY 2015)** **[Remember]**
3. Explain the procedure used to control the altitude control of satellite with necessary diagrams.(16) **(NOV/DEC 2015)** **[Apply]**
4. (a) Determine the angle of tilt required for a polar mount used with an earth station at latitude 49° north. Assume a spherical earth of radius 6371 km, and ignore earth station altitude.(06) **(NOV/DEC 2014)(NOV/DEC 2019)** **[Apply]**

   b. Explain what is meant by satellite attitude, and briefly describe the attitude control with a relevant diagram.(10) **(NOV/DEC 2014)** **[Remember]**
5. (a)Describe with a diagram, satellite eclipse and satellite sun transit around spring and autumn equinoxes.(10) **(NOV/DEC 2014)** **[Apply]**

   (b) What is thermal control? Why it is necessary in a satellite? (6) **(NOV/DEC 2014)(NOV/DEC 2019)** **[Evaluate]**
6. (a)An earth station is located at latitude 12°S and longitude 52° W. Calculate the antenna look angles for a satellite at 70°W.(8) **(MAY/JUNE 2013)** **[Apply]**

b. Show and explain the Earth eclipse of satellite. How this can be overcome by the satellites? (8) **(MAY/JUNE 2013)** **[Understand]**

7. Explain what is meant by satellite attitude, and briefly describe two forms of attitude control. (16) **(NOV/DEC 2019)** **[Remember]**
8. Explain attitude control of satellites. With neat diagrams explain the spinning satellite stabilization and momentum wheel stabilization.(16) **(MAY/JUNE 2013)** **[Understand]**
9. (a)Explain transponders with necessary diagrams.(8) **[Remember]**

   (b)Explain antenna subsystems with necessary diagrams.(8) **[Remember]**
10. Draw the block diagram of TT&C and explain each and individual blocks. (16) **(NOV/DEC 2018)(NOV/DEC 2019)** **[Remember]**
11. How is the performance of a satellite impaired due to external factors? Also suggest suitable methods to overcome the same. (16) **[Evaluate]**
12. In detail, explain the various sub-modules and their functions of a Telemetry , Tracking and Command (TT & C) subsystem. Draw required diagrams. (16) **(NOV/DEC 2018)** **[Remember]**
13. (a) With a neat sketch, explain the various modules of Attitude and orbit control (AOCS) subsystem. (16) **[Remember]** (b)Derive the analytical expression for uplink CNR. (16) **[Remember]**
14. What are the three main systems for tracking satellites? How can tracking systems be affected? What are the main functions of TTCC sub-system? Explain. (16). **(APRIL /MAY 2017)** **[Remember]**
15. What is the principle of Liquid Propulsion system? Explain the specific technologies under the category of electric and ion propulsion. (16) **(NOV/DEC 2018)** **[Remember]**
16. Explain the feature of typical satellite launch vehicles. (16) **(NOV/DEC 2018)** **[Understand]**
17. The thermal control system represents a common denominator for all operating elements of the spacecraft" – Justify. **(NOV/DEC 2018)** **[Evaluate]**
18. "Satellite communication employ electromagnetic waves to carry information between ground and space" – Justify. (13) **(NOV/DEC 2018)** **[Evaluate]**
19. (i) Explain the attitude control system for a three-axis stabilized GEOsatellite.(9) **[Remember]**

    (ii) What is spinning satellite stabilization? Explain with illustration.(4) **[Remember]**

    [Nov/Dec 2021]
20. (i) Explain the orbit control system of a satellite with necessarydiagrams. (9) **[Remember]**

    (ii)Elucidate the illustration about momentum wheel stabilization. (4) **[Nov/Dec 2021]**

21. a) i) Define and explain the terms roll, pitch and yaw. (3) **[Remember]**

ii) Describe the tracking, telemetry and command facilities of a satellite communications system. Are these facilities part of the space segment or part of the ground segment of the system? (10) **[Remember]** **[NOV/DEC 2020, APR/MAY 2021]**

22. b) i) Explain Spin Stabilization and Three-axis Stabilization. (5)

ii) Explain what is meant by thermal control and why this is necessary in a satellite. (4)

iii) Explain what is meant by satellite attitude and briefly describe two forms of attitude control. (4) **[Remember]** **[NOV/DEC 2020, APR/MAY 2021]**

UNIT 2 Assignments

Explain about look angle determination.
What are the functions of different orbital elements? Explain
Explain the physical structure of attitude control.
How the system noise temperature can be calculated? Explain with a neat sketch.

UNIT – 3

Satellite Link Design

PART A

1. **What are the effects of rain over space link? (Nov/Dec2015)** **[Understand]**
   - In Ku band, rainfall is themost significant cause of signal fading.
   - Rainfall results in attenuation of radio waves by scattering and by absorption of energyfrom the wave.
   - Rain attenuation increases with increasing frequency and is worse in the Ku bandcompared with the C band.
   - The rain attenuation for horizontal polarization is considerably greater than for vertical polarization.

2. **Define fade margin. (Nov/Dec2015)** **[Understand]**
   - The amount by which a received signal level may be reduced without causing system performance to fall below a specified threshold value.
   - It is mainly used to describe a communication system such as satellite, for example a system like global star operates at 25-35 dB Fade margin.
   - A design allowance that provides for sufficient system gain or sensitivity to accommodate expected fading, for the purpose of ensuring that the required quality of service ismaintained.
   - The amount by which a received signal level may be reduced without causing system performance to fall below a specified threshold value.

3. State the basic problems in satellite digital transmission. (April / May 2015) [Understand]

The following are the basic problems occurs in satellite digital transmission,

- No coverage of polar region, Long time delay, Echo, Eclipse due to the earth and the sun, Sun Transit outage

4. What are Receiver Feeder losses? (May /June 2014) [Understand]

- Losses at the connection of receiving antenna occurs at couplers, filters and waveguides. This is called receiver feeder loss (RFL). These Losses are added to free space loss (FSL) Similar losses occur at transmitting antenna.
- Transmitter feeder losses are not accounted EIRP.

5. What is the reason for placed LNA at the end of the feeder cable? (May /June 2014) [Understand]

- A Low-noise amplifier (LNA) is an electronic amplifier that amplifies a very low-power signal without significantly degrading its signal-to-noise ratio.
- An amplifier increases the power of both the signal and the noise present at its input
- The receiving horn feeds into a low-noise converter (LNC) or possibly a combination unit consisting of a low-noise amplifier (LNA) followed by a converter.
- Low noise amplifier(LNA) is placed at the end of the feeder cable so that the noise in the cable is reduced by the gain of the LNA.

6. Expand TT & C. (May /June 2014) [Remember]

TT&C - Tracking, Telemetry, and Command : Throughout the launch and acquisition phases, a network of ground stations, spread across the earth, is required to perform the tracking, telemetry, and command (TT&C) functions.

7. A satellite downlink at 12GHz operates with a transmit power of 60W and an antenna gain of 48.2 dB. Calculate the ERP in dBW. (May /June 2014) [Apply]

Given : Downlink frequency = 12 Ghz
Transmit Power =60Watts
Antenna Gain =48.2 dB

Calculation:

EIRP = 10 log 6 + 48.2 = 56 dBW

8. What are the basic requirements of an earth station antenna? [Remember]

- 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.

9. What is outdoor unit? [Remember]

- An outdoor unit consists of a receiving antenna feeding directly into a low-noise amplifier/converter combination.
- A parabolic reflector is generally used, with the receiving horn mounted at the focus.
- A common design is to have the focus directly in front of the reflector, but for better interference rejection an offset feed may be used.
- Comparing the gain of a 3-m dish at 4 GHz with a 1-m dish at 12 GHz, the ratio D/l equals40 in each case, so the gains will be about equal.

10. What is [C/N0] ratio for uplink? [Remember]

- The free-space and other losses are calculated for the uplink frequency.
- The resulting carrier-to-noise density is that which appears at the detector of the satellite receiver.

[C/N0]U=[EIRP]U+[G/T]U-[LOSSES]U-[K].

Uplink Satellite E/S Losses at Uplink frequencies

11. Define output backoff. [Understand]

- An input backoff is employed, a corresponding output backoff must be allowed for thesatellite EIRP.
- When the operating point of the Travelling wave tube amplifier (TWTA) is shifted closerto the linear portion in order to reduce intermodulation distortion.
- The corresponding drop in the output power in decibels is known as the output backoff.

12. What is earth station of a satellite communications system? [Evaluate]

- The earth segment of a satellite communications system consists of the transmit and receive earth stations.
- The simplest of these are the home TV receive-only (TVRO) systems, and the most complex are the terminal stations used for international communications networks.

  Also included in the earth segment are those stations which are on ships at sea, and commercial and military land and aeronautical mobile stations.

13. What is LNB? [Understand]

- The appropriate receiving device at the antenna is called a low-noise block converter (LNB), which contains a low-noise amplifier and a block down converter.
- On the transmit side, there would need to be an up converter and high power amplifier; if the transmit power required is less than about 10W, then it is

  possible to obtain both functions within what is called a block-upconverter (BUC).(or)
- The receiving horn feeds into a low-noise converter (LNC) or possibly a combination unit consisting of a low-noise amplifier (LNA) followed by a converter.
- The combination is referred to as an LNB, for low-noise block.

14. Define Equivalent Isotropic Radiated Power. [Remember]

- A key parameter in link-budget calculations is the equivalent isotropic radiated power(EIRP).

The maximum flux density at distance r from the transmitting antenna ofgin G is ψM=

- An isotropic radiator with an input power equal to GPs would produce same flux density.

Hence EIRP = GPs

[EIRP]=[Ps]+[G] Dbw

15. Define Antenna misalignment losses [Understand]

- When a satellite link is established, the ideal situation is to have the earth station andsatellite antennas aligned for maximum gain.
- There are two possible sources of off-axis loss, one at the satellite and one at the earthstation.
- The off-axis loss at the satellite is taken into account by designing the link for operation on the actual satellite antenna contour.
- The off-axis loss at the earth station is referred to as the antenna pointing loss.

16. Write down the Link-Power Budget Equation [Apply]

- The [EIRP] can be considered as the input power to a transmission link.
- The major source of loss in any ground-satellite link is the free-space spreading loss [FSL], the basic link-power budget equation taking into account this loss only.
- The losses for clear-sky conditions are

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

- The power at the receiver may be calculated as

[PR]=[EIRP]-[LOSSES]+[GR], where the last quantity is the receiver antenna gain.

17. What is [C/N0] ratio for downlink? [Remember]

- The free-space and other losses are calculated for the downlink frequency.
- The resulting carrier-to-noise density is that which appears at the detector of the earthstation receiver. [C/N0]D=[EIRP]D+[G/T]D-[LOSSES]D-[K]-[B].

Down Link Satellite E/S Losses at downlink frequencies

18. What do you meant by rain attenuation? [Remember]

- Rain attenuation makes no sense to determine the attenuation caused by rainfall becausethey will be very punctual events,
- Since rain only causes severe attenuation in situations of heavy rain.
- Thus, even though one satellite transmission may be strongly affected due to rain, its orbit period of nearly 90 minutes minimizes that loss because the same ground station will have several other opportunities to receive VORSat's signals.
- For GEO satellites it becomes mandatory to perform these calculations, once the satellite'sposition in relation to the GS is permanent.

19. What are the advantages of large antenna system? [Remember]

The advantages are

- Large antennas are capable of carrying large volume of traffic is its operation canbe with wideband carriers.
- Large antenna produce narrow beams and large antenna can be easily equippedwith automatic tracking system.
- It is possible to achieve the highest possible aperture efficiency and lowest possiblenoise temperature so that G/T is maximized in large antenna.
- Gain of the large antenna is high since effective aperture area is high and so aperture efficiency is also high.

20. List the corrections added to received power for additional losses. [Understand]

- Corrections must be added to PR for additional losses due to Antenna efficiency – poweris lost in the antenna feed structure, also connections to the receiver.
- Atmospheric absorption due to water and oxygen molecules
- Polarization mismatches of Tx & Rx antennas. Antenna misalignments –ie . bore sights ofTx and Rx antennas not aligned.

21. Examine why noise temperature is a useful concept in communication receivers? [Understand]

Noise temperature is a measure of the noise entering a receiver through antenna. Noise temperature provides a way of determining how much thermal noise is generated by active and passive devices in the receiving system.

Generally, at the receiver side, the noise temperature should be maintained as low as possible.

Front-end amplifier is immersed in liquid helium to maintain its physical temperature around 4°K. it is practical in large earth stations.

23.Define Equivalent Isotropic Radiated Power. [Remember]

A key parameter in link-budget calculations is the equivalent isotropic radiated power(EIRP).

The maximum flux density at distance r from the transmitting antenna of gin G is $\psi = \frac{GPs}{M} \cdot \frac{}{4\pi r^2}$

An isotropic radiator with an input power equal to GPs would produce same flux density.

Hence EIRP= GPs

[EIRP]=[Ps]+[G] Dbw

24.List out transmission losses? [Remember]

Free-space transmission losses, Feeder losses , Antenna misalignment losses, Fixed atmospheric and ionospheric losses.

25.Define Free-space losses (FSL). [Remember]

The free space losses are defined as [FSL]=10 $\log(\frac{4\pi r}{h})^2$.

The received power is given as the sum of the transmitted EIRP plus the receiver antenna gainminus a

third term, which is called free space loss in dB.

$[P_R]=[EIRP]+[G_R]-[FSL]$.

26.Define (receiver) feeder losses. [Remember]

Losses will occur in the connection between the receive antenna and the receiver proper. Such losses will occur in the connecting waveguides, filters, and couplers. These are called as RFL, or [RFL] dB, for receiver feeder losses.

27.Define Antenna misalignment losses [Remember]

When a satellite link is established, the ideal situation is to have the earth station and satellite antennas aligned for maximum gain. There are two possible sources of off-axis loss, one at the satellite and one at the earth station. The off-axis loss at the satellite is taken into account by designing the link for operation on the actual satellite antenna contour. The off-axis loss at the earth station is referred to as the antenna pointing loss.

28.Write down the Link-Power Budget Equation [Apply]

The [EIRP] can be considered as the input power to a transmission link. The major source ofloss in any ground-satellite link is the free-space spreading loss [FSL], the basic link-power budget equation taking into account this loss only. The losses for clear-sky conditions are

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

The power at the receiver may be calculated as **$[P_R]=[EIRP]-[LOSSES]+[G_R]$,** where the lastquantity is the receiver antenna gain.

29.What is system noise? [Remember]

The major source of electrical noise in equipment is that which arises from the random thermal motion of electrons in various resistive and active devices in the receiver. Thermal noise is also generated in the lossy components of antennas, and thermal-like noise is picked up by the antennas as radiation.

The available noise power from a thermal noise source is given by $P_N= kT_NB_N$

30.what is Antenna noise [Remember]

Antennas operating in the receiving mode introduce noise into the satellite circuit. Noise therefore will be introduced by the satellite receive antenna and the ground station receive antenna.

31.How to classify the antenna noise? [Remember]

The antenna noise can be broadly classified into two groups: noise originating from antenna lossesand sky noise.

Sky noise is a term used to describe the microwave radiation which is present throughout theuniverse and which appears to originate from matter in any form at finite temperatures

32.What is [C/N_0] ratio for uplink? **[Apply]**

$[C/N_0]_U=[\ EIRP]_U+[\ G/T]_U-[LOSSES]_U-[K].$

33.What is [C/N_0] ratio for downlink? **[Apply]**

$[C/N_0]_D=[\ EIRP]_D+[\ G/T]_D-[LOSSES]_D-[K]-[B].$

34.Define Noise factor. [Understand]

Amplifier noise is by means of is called as noise factor, F. In defining the noise factor of an amplifier, the source is taken to be at room temperature, denoted by T_0, usually taken as 290 K.The input noise from such a source is kT_0, and the output noise from the amplifier is

$$N_{0,out}= FGkT_0$$

Noise figure =[F]=10 log F.

35.What is [C/N] ratio? [Remember]

A measure of the performance of a satellite link is the ratio of carrier power to noise power at the receiver input. $[C/N]=[P_R]-[P_N]$

i.e. $[C/N_0]=[\ EIRP]+[\ G/T]-[LOSSES]-[K].$

36.Define Saturation flux density [Understand]

The traveling-wave tube amplifier (TWTA) in a satellite transponder exhibits power output saturation. The flux density required at the receiving antenna to produce saturation of the TWTA is termed the saturation flux density. The saturation flux density is a specified quantity in link budget calculations, and knowing it, one can calculate the required EIRP at the earth station.

i.e. $\psi_M = \frac{EIRP}{4\pi r^2}$.

37.Define input backoff. [Understand]

When a number of carriers are present simultaneously in a TWTA, the operating point must be backed off to a linear portion of the transfer characteristic to reduce the effects of inter- modulation distortion. Such multiple carrier operation occurs with frequency- division multiple access (FDMA). The point to be made here is that backoff (BO) must be allowed for in the link-budget calculations.

$$[EIRP]_U=[EIRP_S]_U-[BO]_i$$

38.Define output backoff. [Understand]

$$[EIRP]_D=[EIRP_S]_D-[BO]_o$$

$$[BO]_i=[BO]_o-5\ dB.$$

39.What are the effects of rain? [Remember]

In Ku band, rainfall is the most significant cause of signal fading. Rainfall results in attenuationof radio waves by scattering and by absorption of energy from the wave. Rain attenuation increases with increasing frequency and is worse in the Ku band compared with the C band. Therain attenuation for horizontal polarization is considerably greater than for vertical polarization.

40.What is meant by Uplink rain-fade margin? [Remember]

Rainfall results in attenuation of the signal and an increase in noise temperature, degrading the $[C/N_O]$ at the satellite in two ways. The increase in noise, however, is not usually a major factorfor the uplink. This is so because the satellite antenna is pointed toward a "hot" earth, and this added to the satellite receiver noise temperature tends to mask any additional noise induced by rain attenuation. What is important is that the uplink carrier power at the satellite must be held within close limits for certain modes of operation, and some form of uplink power control is necessary to compensate for rain fades.

41.What is Downlink rain-fade margin? [Remember]

Rainfall introduces attenuation by absorption and scattering of signal energy, and the absorptive attenuation introduces noise. It is a measured parameter which is a function of many factors including the physical temperature of the rain and the scattering effect of the rain cell on the thermal noise incident upon it. At higher rain- fall rates, scattering becomes significant, especially at the higher frequencies. When scattering and absorption are both significant, the total attenuation must be used to calculate the reduction in carrier power and the absorptive attenuationto calculate the increase in noise temperature.

42.What is intermodulation noise? [Remember]

Where a large number of modulated carriers are present, the intermodulation products are not distinguishable separately but instead appear as a type of noise which is termed intermodulation noise.

43.What is meant by DBS service? [Remember]

Planned broadcasting directly to home TV receiver takes place in the Ku-band i.e 12 GHz band. This service is known as direct broadcasting satellite(DBS) service.

44.What is an TWTA? [Remember]

The TWTAS are widely used in transponder to provide the final output power required to thetranstube & its power supplies.

45.What is an OMT? [Remember]

The polarization separation takes place in a device known as an ortho coupler or Orthogonal Mode Transducer.

46.Define sky noise. [Remember]

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

49.Define EIRP. [Remember]

EIRP stands for Equivalent Isotrophic Radiated Power.It is a combination of the output amplifier power, the gain of the transmitting antenna and the losses associated with thatantenna system. It is given by

$EIRP = GP_s$

Where G-Gain of the antenna P_s-

Radiated power

50.Define S/N ratio. [Remember]

The S/N introduced in the preceding section is used to refer to the ratio of signal power to noise power at the receiver output. This is known as S/N ratio.

51.Define CNR. [Remember]

CNR stands for carrier –to-noise ratio. The CNR of a satellite is defined as the ratio of carrierpower to noise power at the receiver input.

52.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. [Apply]

EIRP = 10 log 6 + 48.2 = 56 dBW

3.The range between a ground station and a satellite is 42000 km. Calculate the free space loss a frequency of 6 GHz. [Apply]

[Free space loss] = 32.4 + 20 log 42000 + 20 log 6000 = 200.4 dB

54.Define Saturation flux density. [Remember]

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

55.Write the equations of Link-Power Budget. [Apply]

The power output of the link is power at the receiver. The major sourceof 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)

56.What is an EIRP? [Remember]

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

57.What is an intermodulation noise? [Remember]

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

58.What is system noise? [Remember]

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,

$$P_n=KT_nB$$

Where, P_n=Noise power

K=Boltzman's constant

T_n=Noise temperature of source(in Kelvin)B=Bandwidth in Hz

59.What is antenna loss? [Remember]

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.

60.Define sky noise. [Remember]

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.

61.Define noise factor. [Remember]

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

$N_o = FGkT_0$

62.Define saturation flux density. [Remember]

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

63.Define Satellite uplink. [Remember]

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 lasttitle 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

64.Define satellite downlink. [Remember]

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

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

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

65.Define Carrier to Noise Ratio. [Remember]

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

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

$[P_R]$-$[P_N]$

[C/N0]= [EIRP]+[G/T]-[L]-[K] dB. Hz.

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

Solution:

Here, [Ψs]=-110dB

F=14GHz [L]=200dB

[A]=-(21.45+20logf)=-44.37

[EIRP] =[Ψs]+[A]+[L][EIRP]=-

110-44.37+200[EIRP]=45.63 dB.

67.What is noise weighting? [Remember]

The method used to improve the post detection signal to noise ratio isreferred to as noise

weighting.

68.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. [Apply]

EIRP = 10 log 6 + 48.2 = 56 dBW

69.The range between a ground station and a satellite is 42000 km. Calculate the free space loss a frequency of 6 GHz. [Apply]

[Free space loss] = 32.4 + 20 log 42000 + 20 log 6000 = 200.4 dB

70 .An antenna has a noise temperature of 35 K and it is matched into a receiver which has a noise temperature of 100 K. Calculate the noise power density and the noise power for a BW of 36 MHz. [Apply]

$N_0 = (35 + 100) * 1.38 * 10^{-23} = 1.86 * 10^{-21} J$

$P_N = 1.86 * 10^{-21} * 36 * 10^{6} = 0.067$ PW

73.What is ionospheric scintillation? [Nov/Dec 2021] [Remember]

Ionospheric scintillations are variations in the amplitude, phase, polarization, or angle of arrival of radio waves. They are caused by irregularities in the ionosphere which change with time. The main effect of scintillations is fading of the signal. The fades can be quite severe, and they may last up to several minutes. As with fading caused by atmospheric scintillations, it may be necessary to include a fade margin in the link power-budget calculations to allow for ionospheric scintillation.

74.What is meant by spatial frequency reuse? [Nov/Dec 2021] [Remember]

It is also possible for transponders to operate at the same frequency but to be connected to different spot-beam antennas. These allow the satellite as a whole to be accessed by earth stations widely separated geographically but transmitting on the same frequency. This is termed frequency

reuse. This method of access is referred to as space-division multiple access (SDMA). It should be kept in mind that each spot beam may itself be carrying signals in one of the other multiple-access formats.

75. Explain what is meant by noise factor. **[April/May 2021] [Remember]**

The noise factor, usually of an amplifier, is defined as the ratio of the signal to noise ratio at the input to the signal to noise ratio at the output of the amplifier stage.

76. Calculate the effective area of a 10-ft parabolic reflector antenna at a frequency of (a) 4 GHz (b) 12 GHz. **[April/May 2021] [Apply]**

PART B

11. (a)A satellite TV signal occupies the full transponder bandwidth of 86MHz, and it must provide a C/N ratio of 62dB at the destination earth station. Given that the total transmission losses are 600dB and the destination earth station G/T ration is 81dB/K. calculate the satellite EIRP required.(8)

(MAY/JUNE 2014)(NOV/DEC 2015) **[Apply]**

(b)Discuss about antenna misalignment losses and feeder losses(8) **(NOV/DEC 2014)** **[Remember]**

2.(a)Derive the link - Power budget equation. (8) **(NOV/DEC 2014)** **[Remember]**

b. An LNA is connected to a receiver which has a noise figure of 12 dB. The gain of the LNA is 40dB, and its noise temperature is 120K. Calculate the overall noise temperature referred to the LNA input. (4) **(NOV/DEC 2014)** **[Apply]**

c. A satellite is operated at an EIRP of 56dBW with an output BO of 6dB. The transmitter feeder losses amount to 2dB, and the antenna gain is 50dB. Calculate the power output of the TWTA required for full saturated EIRP. (4) **(NOV/DEC 2014)** **[Apply]**

3. (a)Derive expression for the link power budget of a satellite system.(8)**(MAY/JUNE 2013)** **[Evaluate]**

(b)What is saturation flux density? If the power received by a 1.8 m parabolic antenna at 14 GHz is 250pW, then calculate the saturation flux density. (8)**(MAY/JUNE 2013)** **[Apply]**

4. An antenna has noise temperature of 100 K and is matched into a receiver which has a noise temperature of 400K. Calculate the noise power density and the noise power for a bandwidth of 80MHz.(8) **(MAY/JUNE 2014)(NOV/DEC 2015)** **[Apply]**

5. Explain the following. **(APRIL /MAY 2015)**

I. EIRP. (8) **[Remember]**

II. Transmission Losses.(8) **[Remember]**

6.With a neat diagram, explain the procedure for measuring critical satellite parameters like C/N_0 and G/T. Emphasize on the significance of these parameters. (16) **[Understand]**

7. With a neat sketch, Explain the power budget for a link considering backoff and rain fade margin. **[Understand]**

8. List and explain the steps of Link power budget analysis for downlink.(13)**(NOV/DEC 2018)** **[Understand]**

9.How does the system noise temperature affect the performance? Derive the expression for overall system noise temperature at the receiving earth station. **[Apply]**

10.With suitable mathematics explain the design aspects of uplink. (8) **(APRIL /MAY 2017)**. **[Evaluate]**

11.From the calculation of system noise temperature prove that C/N ratio is directly proportional to G/T ratio.(16) **(APRIL /MAY 2017)** **[Evaluate]**

12.Define EIRP and derive the formula for it in decibels.(4)**(NOV/DEC 2019)** **[Remember]**

13.An uplink operates at 14GHz and the flux density required to saturate the transponder is -120dB(W/m^2).The free space loss is 207dB, and the other propagation losses amount to 2 dB. Calculate the EIRP required for saturation, assuming clear sky conditions. Assume RFL is

negligible.(7) **(NOV/DEC 2019)** **[Apply]**

14. List and explain the factors governing the design of satellite links. (16) **[Remember]**

15.With a neat diagram how measurements on G/T and C/N_0 are made (16) **[Remember]**

16.State the tropospheric effects on space link. Explain the use of Traveling wave tube amplifier in satellite communication systems. (3+10) **(NOV/DEC 2018)** **[Remember]**

17. (i) With the help of transmission theory, derive the link equation for received power from a satellite which takes into account various losses. **[Apply]** (8)

(ii) A satellite at a distance of 42000 km from a point on the earth's surface radiates a power of 10 W from an antenna with a gain of 20dB in the direction of the observer. Find the flux density at the receiving point, and the power received by an earth station antenna at this point with an effective area of 100 m^2. (5) **[Nov/Dec 2021]** **[Apply]**

18. (i) How you can calculate the system noise temperature of a receiver. Derive the noise temperature of a receiver with LNA, mixer, and IF amplifier connected in cascade. Describe the influence of LNA on system noise temperature. (8) **[Evaluate]**

(ii) How do you calculate the system noise temperature if there is an absorptive network at the receiver? (5) **[Nov/Dec 2021]** **[Evaluate]**

19. A C-band earth station has an antenna with a diameter of 9.87 m with an aperture efficiency of 65%. The transmit output power is 102 W at a frequency of 6.1 GHz. The signal is received by a satellite at a distance of 37300 km by an antenna of diameter 0.3939 m with aperture efficiency 65%. The received signal is sent to a transponder with a noise temperature of 450 K, a bandwidth of 36 MHz, and a gain of 110 dB. **[Apply]**

a) Find the path loss at the up-link. (4)

b) What is the power at the output port of the satellite antenna indBW? (4)

c) Find the noise power at the transponder input in dBW. (4)

d) What is the C/N ratio in dB in the transponder? (3)

[Nov/Dec 2021]

20. Certain 6/4 GHz satellite uplink has earth station EIRPis 80 dBW; Earth station satellite distance is 35780 Km; attenuation due to atmospheric factors is 2 dB; satellite antennas aperture efficiency is 0.8; satellite antennas aperture area is 0.5 m_2; satellite receivers effective noise temperature is 190 K; satellite receivers bandwidth is 20 MHz. Determine the link margin for satisfactory quality of service if the threshold value of received carrier to noise ratio is 25 dB. **[Apply]** **[April/May 2021]**

21. A Geostationary satellite transmits 5 W of power with an antenna having a gain of 28 dB. The downlink is operated at 4 GHz and the receive antenna is a dish with diameter of 3.6 m. Compute the EIRP transmitted and the power received by the receiving antenna. Assume the receiver antenna efficiency to be 0.7 and all the other losses to be 2 dB. **[Apply]** **[April/May 2021]**

22. i) Explain what is meant by saturation flux density. The power received by a 1.8 m parabolic antenna at 14 GHz is 250 pW. Calculate the power flux density (a) in W/m_2 and (b) in dBW/m_2 at the antenna. (5) **[Apply]**

ii) Explain what is meant by input backoff. An earth station is required to operate at an [EIRP] of 44

dBW in order to produce saturation of the satellite transponder. If the transponder has to be operated in a 10 dB backoff mode, calculate the new value of [EIRP] required. (5) **[Apply]**

iii) Two amplifiers are connected in cascade, each having a gain of 10 dB and a noise temperature of 200 K. Calculate (a) the overall gain and (b) the effective noise temperature referred to input. (3) **[Apply]** **[April/May 2021]**

UNIT 3 Assignments

1. Discuss in detail about

c. TDMA

d. Satellite Switched TDMA

2. Write about FDMA and the intermodulation technique used in FDMA.
3. What is CDMA and explain the types of CDMA.
4. Draw the general configuration of Earth Station and explain it.
5. What are the main elements of Earth Station Tracking? Explain with neat sketch.

UNIT – 4

SATELLITE ACCESS

PART A

1. List the advantages of CDMA especially where VAST type terminals are involved. (May/June 2013) April/May 2015 [Remember]

The advantages of CDMA are

- Efficient practical utilization of fixed frequency spectrum.
- Flexible allocation of resources.
- Many users of CDMA use the same frequency, TDD or FDD may be used Multipath fading may be substantially reduced because of large signal bandwidth No absolute limit on the number of users, Easy addition of more user
- Impossible for hackers to decipher the code sent
- No sense of handoff when changing cells
- CDMA is compatible with other cellular technologies; this allows for nationwide roaming.

The combination of digital and spread-spectrum modes supports several times asmany signals per unit bandwidth as analog modes.

2. Write about demand assigned TDMA satellite access. (Nov /Dec 2015) [Understand]

 Resource isallocated as needed in response to changing traffic conditions.

- Suitable for bursty or varying traffic conditions.

- More number of earth stations can access the satellite.
- Efficient resource utilization.
- The burst length may be kept constant and the number of bursts per frame used by thegiven station is varied when the demand is varied.

3. What is meant by thin route service? (May/June 2013) (April/May 2015) [Understand]

Trafficcan be broadly classified as heavy route, medium route, and thin route.

- In a thin-route circuit, a transponder channel (36 MHz) may be occupied by a number of single carriers, each associated with its own voice circuit.
- This mode of operation is known as single carrier per channel (SCPC).

4. Define CDMA. (May /June 2014) [Remember]

- In this method, each signal is associated with a particular code that is used to spreadthe signal in frequency & or time.
- Spread spectrum multiple access
- Pulse address multiple access

5. Define the term preamble and post amble. (May /June 2014) (Nov /Dec 2015) [Remember]

- Preamble is the initial position of a traffic burst which carries information similar to that carried in Certain time slots at the beginning of each burst are used to carry timing & synchronizing information. These time slots collectively are referred to as preamble.

6. What is a single access? [Remember]

- A single access means, single modulated carries occupies the whole of the available bandwidth of a transponder.
- Single access operation is used only on heavy traffic routers.
- Example : Telesat Canada - in this satellite each transponder channel being capable of carrying 960 one way voice circuits on an FDM/FM carrier and so it provides heavy route message facilities.

7. What are the disadvantages of FDMA. [Remember]

The following are the advantages of FDMA

Sensitive to fading

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

8. What is meant by multiple access? [Remember]

- A transponder to be loaded by a number of carriers, which may originate from a numberof earth stations geographically separate and each earth station may transmit one or more of the

carriers.

- This is called as multiple access.
- There are different multiple access techniques they are FDMA : Frequency Division Multiple Access TDMA: Time Division Multiple Access CDMA: Code Division Multiple Access

9. What is CBR? [Remember]

- An un modulated 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.

10. What is BCW? [Remember]

- 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.

11. What is amplitude modulation? [Remember]

- The modulated signal may be expressed as,

$$am(t)=\{kas(t)+1\}Ac\sin(\omega ct+1)$$

- For special case where the modulating signal in sine wave with angular frequency cos and letting k=m,above equation becomes $am(t)=(m\sin\omega st+1)Ac\sin$

ωct where, m=modulation index.

12. What is meant by space division multiple access? [Remember]

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

13. What is burst code word and burst position acquisition? [Remember]

- Burst code: It is a binary word, a copy of which is stored at each earth station. Burstposition acquisition:
- A station just entering, or reentering after a long delay to acquire its correct slot position is known as burst position acquisition.

14. Define guard time. [Remember]

- It is necessary to prevent the bursts from overlapping.
- The guard time will vary from burst to burst depending on the accuracy with which thevarious

bursts can be positioned within each frame.

15. What are the limitations of FDMA-satellite access? [Remember]

- 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.

16. What is meant by decoding quenching? [Remember]

- In certain phase detection systems the phase detector must be allowed time to recover from one burst before the next burst is received by it. This is known as decoding quenching.

17. What is meant by digital speech interpolation? [Remember]

- The point is that for a significant fraction of the time the channel is available for other transmissions,& advantages is taken of this in a form of demand assignment known as digital speech interpolation.

Types

- Digital time assignment speech interpolation
- Speech predictive encoded communications

18. Write short notes on open-loop timing control. [Remember]

- 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.

19. What is meant by burst position acquisition & burst position synchronization? (Nov/Dec 2019) [Understand]

- Burst position acquisition & burst position synchronization means when a station just entering, or reentering after a long delay to acquire its correct slot position.

20. Point out the pre-assigned TDMA satellite access. [Understand]

Example for preassigned TDMA is CSC for the SPADE network. CSC can accommodate upto 49 earth stations in the network and 1 reference station. All bursts are of equal length. Each burst contains 128 bots. The bit rate is 128 Kb/s.

21. How does the spread spectrum system differ from conventional communicational communication systems? [Understand]

The spread spectrum system undergo double modulation.

1. First modulation – carrier and message signal.
2. Second modulation – the resultant signal and PN code sequence, which spreads the spectrum over the available bandwidth.

22.What is meant by single access? [Remember]

A transponder channel aboard satellite may be fully loaded by a single transmission from an earth station. This is called as a single access mode of operation.

23.What is meant by multiple access? [Remember]

A transponder to be loaded by a number of carriers, which may originate from a number of earth stations geographically separate and each earth station may transmit one or more of the carriers. This is called as multiple access.

24.What are commonly used methods for multiple access? [Remember]

Frequency-division multiple access(FDMA)and 2. Time-division multiple access (TDMA).

25.How to classify the multiple access based on circuits are assigned to users? [Understand]

1. pre-assigned multiple access Circuits may be pre- assigned, which means they are allocated on a fixed Or partially fixed basis to certain users. These circuits are therefore not available for general use. Pre assignment is simple to implement but is efficient only for circuits with continuous heavy traffic.

2. demand-assigned multiple access (DAMA). All circuits are available to all users and are assigned according to the demand. DAMA results in more efficient overall use of the circuits but is more costl yandcomplicatedtoimplement.

Both FDMA and TDMA can be operated as pre assigned or demand assigned systems. CDMA is a random-access system, there being no control over the timing of the access or of the frequency slots accessed.

26.Define space-division multiple access (SDMA). [Remember]

Above multiple-access methods refer to the way in which a single transponder channel is utilized .A satellite carries a number of transponders, and normally each covers a different frequency channel. This provides a form of FDMA to the whole satellite .It is also possible for transponders to operate at the same frequency but to be connected to different spot-beam antennas. These allow the satellite as a whole to be accessed by earth stations widely separated geographically but transmitting on the same frequency. This is termed frequency reuse. This method of access is referred to as space-division multiple access (SDMA).

27.What is a single mode of operation? [Remember]

A transponder channel aboard a satellite may be fully loaded by a single transmission from an earth station. This is referred to as a single access mode of operation.

28.What is in CDMA? & its types? [Remember]

In this method each signal is associated with a particular code that is used tospread the signal infrequency & or time.

*Spread spectrum multiple access

*Pulse address multiple access

29.What is a thin route service? [Remember]

SCPC systems are widely used on lightly loaded routes, this type of service being referred to as athin route service.

30.What is an important feature of Intelsat SCPC system? [Understand]

The system is that each channel is voice activated. This means that on a two way telephone conversation only one carrier is operative at any one time.

31.What is a TDMA? What are the Advantage? [Remember]

Only one carrier uses the transponder at any one time,& therefore intermodulation products, which results from the nonlinear amplification of multiple carriers are absent. Merits: The transponder traveling wave tube can be operated at maximum power o/p or saturation.

32.What is preamble? [Remember]

Certain time slots at the beginning of each burst are used to carry timing &synchronizing information. These time slots collectively are referred to as preamble.

33.Define guard time. [Remember]

It is necessary to between bursts 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 positionedwithin each frame.

34.What is meant by decoding quenching? [Remember]

In certain phase detection systems the phase detector must be allowed time to recover from one burst before the next burst is received by it. This is known as decoding quenching.

35.What is meant by direct closed loop feedback? [Remember]

The timing positions are reckoned from the last bit of the unique word in the preamble .The loop method is also known as direct closed loop feedback.

36.What is meant by feedback closed loop control? [Remember]

The synchronization information is transmitted back to an earth station from a distant, which is termed

feedback closed loop control.

37.Define frame efficiency. [Remember]

It is a measure of the fraction of frame time used for the transmission of traffic.

38.What are the analog transmission technique. [Remember]

The analog transmission techniques are given as,

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

39.What are the components of encryption? [Remember]

The symmetric encryption has 5 components. They are,

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

40.What are the types of video signals? [Remember]

Generally two types of signals are transmitted through the satellitecircuits.

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

41.What are the disadvantages of FDMA. [Remember]

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

42.Write short notes on voice. [Remember]

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

43.What are the limitations of FDMA-satellite access? [Remember]

- 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.

44.Mention the merits and demerits of TDMA over FDMA. [Remember]

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

45.Distinguish between pre-assigned and demand-assigned TDMA satellite access. [Understand]

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.

46.What is a multiple access technique? [Remember]

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

47.What is meant by space division multiple access? [Remember]

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.

48.What is burst code word and burst position acquisition? [Remember]

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.

49.Define guard time. [Remember]

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.

50.Write short notes on open-loop timing control. [Remember]

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.

51. Mention a few disadvantages of using FDMA in satellite communication. [Nov/Dec 2021] [Remember]

a) Due to the simultaneous transmission of a large number of frequencies, there is a possibility of inter modulation distortion at the transponder.

b) It is suitable only for analog signals.

c) Storage, enhancement of signals is not possible.

d) The large bandwidth requirement for transponders.

e) Guard bands may waste capacity.

f) It requires RF(Radio Frequency) filters to meet stringent adjacent channel rejection specifications. This may increase the cost of the system.

52. How does error control coding impact the cost and size of satellite? [Nov/Dec 2021] [Remember]

The advantage is that a system using ECC does not require a reverse channel to request retransmission of data when an error occurs. The downside is that there is a fixed overhead that is added to the message, thereby requiring a higher forward-channel bandwidth. ECC is therefore applied in situations where retransmissions are costly or impossible, such as one-way communication links and when transmitting to multiple receivers in multicast.

53. Explain the need for a reference burst in a TDMAsystem. **[April/May 2021] [Remember]**

The reference bursts is required at the beginning of each frame to provide timing information for acquisition and synchronization of bursts.

54. What is the use of control bits in the data frame ? **[April/May 2021] [Remember]**

The control field of the data frame consists of 6 bits (of which only the lower 4 are used) that indicate the amount of data in the message. Since up to 8 bytes of data may be sent in one message, the control field may take values ranging from 000000 to 000111.

PART B

1. (a)Discuss satellite links and TCP.(8) **(APRIL /MAY 2015)** **[Remember]**

   (b)Explain direct sequence spread spectrum.(8) **(APRIL /MAY 2015)** **[Remember]**

2. (a)With neat diagrams, explain the TDMA burst and frame structure of satellite system.(12) **(APRIL /MAY 2015)** **[Understand]**

   (b)Compare FDMA, TDMA, and CDMA. (4) **(APRIL /MAY 2015)** **[Understand]**

3. (a)What is a SPADE system? Explain itschanneling scheme and operation. **(MAY/JUNE 2013)**(8)**(NOV/DEC 2015)** **[Remember]**

   (b)Explain pre assigned TDMA and Demand assigned TDMA in detail. **(MAY/JUNE 2013)**(8) **(NOV/DEC 2015)** **[Remember]**

4. (a)Describe the conventional approach and group signal processing of on-board signal processing forFDMA/TDM operation.(8) **(MAY/JUNE 2013)(NOV/DEC 2015)** **[Understand]**

   (b)Describe how signal acquisition and tracking are achieved in a DS/SS system. (8) **(MAY/JUNE 2013)(NOV/DEC 2015)** **[Understand]**

5. (a)Explain the principle behind spectrum spreading and dispreading and how this is used to minimize interference in a CDMA system. Also determine the throughput efficiency of the system. (10) **(MAY/JUNE 2014)** **[Remember]**

   (b)Write short notes on satellite links and TCP.(6) **(MAY/JUNE 2014)** **[Remember]**

6. Describe briefly about on board signal processing for FDMA/TDMA operation.(16) **(MAY /JUNE2014)(APRIL /MAY 2017)** **[Remember]**

7. Explain clearly the pre assigned FDMA with suitable diagrams and show how it differs from demand assigned FDMA. (16) **(NOV/DEC 2014)** **[Remember]**

8. Draw the frame and burst format of TDMA and explain the need for a reference burst in a TDMA system.(16) **(NOV/DEC 2014)** **[Remember]**

9. With a neat block diagram, explain the functioning of a SPADE System.(16) **[Understand]**
10. Describe the ways in which demand assignment may be carried out in FDMA. (16) **[Understand]**
11. Explain the following 1. pre assigned Traffic. 2. Encryption. (16) **[Remember]**
12. For digital video broadcast what type of multiple access is best suited. Justify your answer. (16) **[Remember]**

13. With mathematics briefly explain on capacity of spread spectrum systems. (8) **(APRIL /MAY 2017)** **[Apply]**

14. With a neat block diagram explain the working of a FDMA based satellite network. Analyse its merits and demerits.

15. In detail explain the format structure of TDMA frame. Comment on the significance of each field **[Evaluate]**

16. Write the advantages of CDMA for satellite networking. (9) **(NOV/DEC 2019)** **[Remember]**

17.Explain how carrier recovery is done in TDMA with an example.(9) **(NOV/DEC 2019)** **[Remember]**

18.Describe the concept of multiplexing.(4)**(NOV/DEC 2019)** **[Understand]**

19.Draw the encoder diagram for the following digital signals- Unipolar NRZ, Polar NRZ, Manchester, Polar RZ for the digital data 1010111.(8) **(NOV/DEC 2019)**

20.Explain the concept of compression in satellite links. **[Apply]**

21.Why is CDMA otherwise called spread spectrum communication? How does it differ from FDMA and TDMA? (13) **(NOV/DEC 2018)** **[Remember]**

22."TDMA is a truly digital technology, requiring that all information be converted into bit streams or data packets before transmission to the satellite"-Justify.(13) **(NOV/DEC 2018)** **[Understand]**

23.A video signal of bandwidth 4.2MHz is used to frequency modulate a carrier, the deviation ratio being 2.56. Calculate the peak deviation and the signal bandwidth. (4) **(NOV/DEC 2019)** **[Apply]**

24.Draw the basic arrangement for the detection of the unique word.(4)**(NOV/DEC 2019)** **[Understand]**

25.Describe about the cascading of amplifiers.(7) **(NOV/DEC 2019)** **[Remember]**

26.Write the design aspects and explain the technical features of TDMA frame structure. (16) **(APRIL /MAY 2017)** **[Remember]**

27. Write the features of digital TV broadcast. List the various factors of home receiver unit. **(NOV/DEC 2018)** **[Remember]**

28. Explain the FDMA trasmitter and receiver of T1 channels in satellite communication. (13) **[Nov/Dec 2021]** **[Remember]**

29. Elucidate the MF-TDMA operation in demand assignment multiple access. (13) **[Remember]** **[Nov/Dec 2021]**

30. Distinguish between preassigned and demand-assigned traffic in relation to a satellite communications network. (7) **[Apply]** **[NOV/DEC 2020, APR/MAY 2021]**

31. Given that the IF bandwidth for a 252-channel FM/FDMtelephony carrier is 7.52 MHz and that the required [C/N] ratio at the earth station receiver is 13 dB, calculate (a) the [C/T] ratio and (b) the satellite [EIRP] required if the total losses amount to 200 dB and the earth station [G/T] ratio is 37.5 dB/K. (6) [**Apply]** **[NOV/DEC 2020, APR/MAY 2021]**

UNIT 4 Assignments

Answer the following

1. Differentiate Axi-symmetric and Asymmetric configuration.
2. Distinguish FDMA and TDMA in terms of satellite communication
3. List any five parameters of Earth Station.
4. Write the equation (distance between two points) for position measurement calculation.
5. What is DGPS? Explain.

UNIT – 5

SATELLITE APPLICATIONS

PART A

1. **List the types of maps. (May/June 2013) [Understand]**

Types of map:

- Topographic map - a reference tool, showing the outlines of selected natural and man-made features of the Earth it acts as a frame for other information.
- Topography" refers to the shape of the surface, represented by contours and/orshading, but topographic maps also show roads and other prominent features.
- Thematic map - a tool to communicate geographical concepts such as thedistribution of population densities, climate, movement of goods, land use etc.

2. **How many satellites are in the space for providing GPS data? (May/June 2013) [Remember]** Thereare 4 satellites are needed to cover entire earth.

3. **What are the components of GIS? (May /June 2014) (Nov/Dec 2014) (April / May 2015)** [Remember]

The three components of a Geographical Information System are Computer hardware, Software Modules, Organizational context.

4. **What are the services of GPS? (May /June 2014)** [Remember]

Some important services of Global Positioning System (GPS) are

- Aircraft tracking
- Map making Surveying
- Search and rescue.
- Missile and projectile guidance.

5. **Write the main components of GPS.** [Remember]

- The Control segments, The Space segments, The User segments

6. **What is map?** [Remember]

- A map is defined as the representation of the features of the earth drawn to scale.
  - It is the traditional method of storing, analyzing and presenting spatial data.
- The map is also known as the ‘spatial language’.

7. **Write about Gramsat?** [Remember]

- The Gramsat Programme (GP) is an initiative to provide communication networks at the state level connecting the state capital to districts and blocks.
- The networks provide Computer Connectivity, Data Broadcasting and TV Broadcasting facilities having applications like e-Governance, National

ResourceInformation System (NRIS),

Development Information, Tele-conferencing, Disaster Management, Tele- medicine and Distance Education.

8. Define DTH. [Remember]

- DTH stands for Direct-To-Home television.
- DTH is defined as the reception of satellite programmes with a personal dish in anindividual home.

9. What are the components of DTH. [Remember]

- A DTH network consists of a broadcasting centre,
- Satellites,
- Encoders,
- Multiplexers,
- Modulators and DTH receivers.

10. Write down some applications of GPS. [Remember]

Some important applications of Global Positioning System (GPS) are

- Aircraft tracking
- Map making Surveying
- Search and rescue.
- Missile and projectile guidance.

11. What do you meant by video conferencing? [Remember]

- A videoconference is a live connection between people in separate locations for the purpose of communication, usually involving audio and often text as well as video.
- At its simplest, videoconferencing provides transmission of static images and text between two locations. At its most sophisticated, it provides transmission of full- motion video images and highquality audio between multiple locations.

12. What do you mean by DBS. [Remember]

- Direct broadcast satellite (DBS) refers to satellite television (TV) systems in which the subscribers, or end users, receive signals directly from geostationary satellites.
- Signals are broadcast in digital format at microwave frequencies. DBS is thedescendant of directto-home (DTH) satellite services.

13. What do you meant by DAB. [Remember]

- Digital audio broadcasting (DAB), also known as digital radio and high-definition radio, is audio broadcasting in which analog audio is converted into a digital signal and transmitted on an assigned channel in the AM or (more usually) FM frequencyrange.
- DAB is said to offer compact disc (CD)- quality audio on the FM (frequency modulation) broadcast band and to offer FM-quality audio on the AM (amplitudemodulation) broadcast band.

14. Define LEO ? [Remember]

- LEO means Low Earth Orbit it is relatively low in altitude;
- The altitude range is between 200 and 1200 km above the Earth's surface.

15. Give the Applications of LEO? [Remember]

- Communications satellites - some communications satellites including the Iridiumphone system use LEO.
- Earth monitoring satellites – it use LEO as they are able to see the surface of the Earth more clearly as they are not so far away. They are also able to traverse the surface of the Earth.
- The International Space Station : It is in an LEO that varies between 320 km (199 miles) and 400 km (249 miles) above the Earth's surface. It can often be seen fromthe Earth's surface with the naked eye.

16. Define MEO. [Remember]

- A medium earth orbit (MEO) satellite is one with an orbit within the range from afew hundred miles to a few thousand miles above the earth's surface.
- Satellites of this type orbit higher than low earth orbit (LEO) satellites, but lower than geostationary satellites.

17. Compare LEO,MEO and GEO [Understand]

Parameter	LEO	MEO	GEO
Satellite Height	500-1500 km	5000-12000	35,800 km
Orbital Period	10-40minutes	2-8 hours	24 hours
Number of	40-80	8-20	3
Satellite Life	Short	Long	Long
Number of	High	Low	Least(none)
Cost	Cheap	Very Expensive	Expensive
Propagation Loss	Least	High	Highest

18. What are the INSAT services? [Remember]

The INSAT provides 3 main services Long distancecommunication TV and Radio broadcasting.

- Metrology.

19. What are the services and features of GSM? [Understand]

The GSM services are classified into 2.

- Tele services.
- Data services.

Features of GSM:

a) Subscriber Identity Module (SIM)

b) On the air privacy.

20. Define Satellite Navigational System. [Understand]

- 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.

21. What do you infer about GRAMSAT? [Remember]

ISRO has come up with the concept of dedicated GRAMSAT satellites, keeping in mind the urgent need to eradicate illiteracy in the rural belt which is necessary for the all rounddevelopment of the nation.

This GRAMSAT satellite is carrying six to eight high powered C-band transponders, which together with video compression techniques can disseminate regional and cultural specific audio-visual programmes of relevance in each of the regional languages through rebroadcast mode on an ordinary TV set.

22. Outline the three regions to collect the frequency for satellite services. [Remember]

- Region 1: It covers Europe, Africa and Mangolia
- Region 2: It covers North & south America and Greenland Region 3: It coversAsia, Australia and South west pacific

23.State the uses of watershed analysis? [Understand]

A watershed is an area that drains water and other substances to a common outlet. Watershed analysis is used to drive the topographic features such as watersheds and stream networks. These features are important in characterising the hydrologic process.

24.Write down some applications of GPS. [Remember]

Some important applications of Global Positioning System (GPS) are

1. Aircraft tracking
2. Map making
3. Surveying
4. Search and rescue.
5. Missile and projectile guidance.

25.Define Tone or Hue [Remember]

Tone or Hue refers to the colour or relative brightness of objects on an image.

26.What are the different Technologies used for Urban Planning? [Remember]

1. Rapid Land – Use Assessment.
2. Rapid Land – Information System Development.
3. GIS as an Emerging Tool.

27.Write the main components of GPS. [Remember]

1. The Control segments
2. The Space segments
3. The User segments

28.What are the advantages of Logarithmic contrast enhancement? [Remember]

The advantages of Logarithmic contrast enhancement are

1. It makes the low contrast details more visible by enhancing low contrast edges.
2. It provides a contrast signal to noise ratio.
3. It matches the response of human visual systems to some extent.
4. It usually provides a more equal distribution of gray values.
5. It transforms multiplicative noise into additive noise.

29.Describe briefly the main advantages offered by satellite communication. [Remember]

- Very economical
- Distance insensitive
- It can link many users who are widely separated graphically
- Telephone, data and video services
- Remote sensing like detection of water pollution and monitoring and reporting ofweather condition.

30.How to facilitate frequency planning is done in the world for Satellite Services? How todivide Frequency Allocations for Satellite Services based regions? [Evaluate]

Region1: Europe, Africa,(formerly the Soviet Union)and MongoliaRegion 2: North and South America and Greenland

Region3:Asia, Australia, and the south- west Pacific

31.What are various satellite services allocated depends on frequency bands? How to classifysatellite services? [Remember]

1. Fixed satellite service (FSS)
2. Broadcasting satellite service (BSS)
3. Mobile satellite services
4. Navigational satellite services and
5. Meteorological satellite services

32.Write about Fixed satellite service (FSS). [Remember]

The FSS provides links for existing telephone networks as well as for transmitting television signals to cable companies for distribution over cable systems. The Ku band (12 to 14 GHz)is used for certain FSS. The C band (4to6GHz) is used for FSS.

33.Write about Broadcasting satellite services(BSS) [Remember]

Broadcasting satellite services are intended mainly for direct broadcast to the home, also called as direct broadcast satellite(DBS)service[in Europe it known as direct-to-home (DTH)service]. The Ku band (12 to 14 GHz) is used for DBS

34.What are uses of Mobile satellite services? [Understand]

Mobile satellite services are used for land mobile, maritime mobile, and aeronautical mobile. The L band is used for mobile satellite services. The very high frequency(VHF)band is used for certain mobile.

35.What are the purposes of Navigational satellite services and meteorological services? [Understand]

Navigational satellite services include global positioning systems (GPS), and satellites intended for the meteorological services often provide a search and rescue service. The very high frequency (VHF) band and L band's are used navigational services and for data transfer from weather satellites.

36.Give to frequency ranges of VHF, UHF, L, S, C, X, Ku, K and KaBands. [Remember]

Frequency range, (GHz)	Band designation
0.1–0.3	VHF
0.3–1.0	UHF
1.0–2.0	L
2.0–4.0	S
4.0–8.0	C
8.0–12.0	X
12.0–18.0	Ku
18.0–27.0	K
27.0–40.0	Ka

37.What is INTELSAT? [Remember]

INTELSAT stands for International Telecommunications Satellite. INTELSAT covers three main regions—the Atlantic Ocean Region (AOR), the Indian Ocean Region (IOR),and the Pacific Ocean Region (POR) INTELSAT satellites provide a much wider range of services than those available previously, including such services as Internet, DTH TV, telemedicine, teleeducation, and interactive video and multimedia.

38.What is DOMSAT? [Remember]

Domsat is domestic satellite, which are used to provide various telecommunications services, such as voice, data, and video transmissions, within a country. In the United States, all domsats aresituated in geostationary orbit.

39.What are Low earth orbiting (LEO) satellites? [Remember]

Polar orbiting satellites orbit to cover the north and south Polar Regions of earth. In theory, there are an infinite number of polar orbits, whereas there is only one geostationary orbit. Weather satellites have led to use of relatively low orbits, ranging in altitude between800and900km, compared with36,000 km for the geostationary orbit. These are called as Low earth orbiting (LEOSATS) satellites.

40.Write short notes on INTELSAT. [Remember]

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.

41.What do INTELSAT,INMARSAT,INSAT stand for? [Remember]

INTELSAT stands for International Telecommunication Satellite.INSAT stands for Indian National Satellite system.

INMARSAT stands for International Marine Satellite Organization.

42.What are the satellite mobile services?[Remember]

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.

43.What are VSATs? [Remember]

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.

44.Write short notes on INMARSAT. [Remember]

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.

45.What are the INMARSAT services? [Remember]

The INMARSAT services are

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

- Aeronautical
- Landmobile
- Telephony

46.Define LEO. [Remember]

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.

47.Define MEO. [Remember]

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.

48.Define Satellite Navigational System. [Remember]

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.

49.What are the services and features of GSM?[Remember]

The GSM services are classified into 2.

- Tele services.
- Data services.Features of GSM:
- Subscriber Indentity Module (SIM)
- On the air privacy.

50.What is a direct broadcasting satellite? [Remember]

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.

51.What are the INSAT services? [Remember]

The INSAT provides 3 main services

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

52.Write short notes on digital audio broadcast. [Remember]

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).

53.What are the applications of GPS? [Remember]

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

54.What is ECEF? [Remember]

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

55.What is dilution of precision? [Remember]

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.

56.What is PDOP? [Remember]

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

57.What is a transponder capacity? [Remember]

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

58.What is the difference between a geostationary orbit and a geosynchronous orbit? [Understand]

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 daytraces out different paths in the sky.

59.What is the orbital spacing of satellites? [Remember]

For high power satellites orbital spacing is 9^0. This orbital spacing is required to

avoid adjacent interference.

60. What is GRAMSAT? [Remember]

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

61. What are the two types of networks used in VSAT? [Nov/Dec 2021] [Remember]

A VSAT stands for very small aperture terminal typically with small antenna of 30 cm to 3.8 m in diameter mounted on rooftop of business premises.

VSAT's typically operate at c and Ku band. There are two different configurations of VSAT networks:

1. Star network configuration
2. Mesh network configuration

62. Why an LNBC is needed in a satellite receiver? [Nov/Dec 2021] [Remember]

The LNB is a combination of low-noise amplifier, frequency mixer, local oscillator and intermediate frequency (IF) amplifier. It serves as the RF front end of the satellite receiver, receiving the microwave signal from the satellite collected by the dish, amplifying it, and down converting the block of frequencies to a lower block of intermediate frequencies (IF). This down conversion allows the signal to be carried to the indoor satellite TV receiver using relatively cheap coaxial cable.

63. What is the difference between active and passive satellites ? **[April/May 2021] [Remember]**

Active satellite can generate power for its own operation. It is known as active repeater due to its functionality. Passive Satellite : The passive satellite is a reflector which receives the signal from the transmitting earth station and scatters the signal in all the directions.

64. What does the acronym VSAT stand for ? **[April/May 2021] [Remember]**

A very small aperture terminal (VSAT) is a small-sized earth station used in the transmit/receive of data, voice and video signals over a satellite communication network, excluding broadcast television.

PART B

1. List the characteristics of digital satellite image and explain how image enhancement is carried out. (16) **(APRIL /MAY 2015)** **[Understand]**
2. Explain the types of maps used in GIS based urban applications. (16)**(APRIL /MAY 2015)** **[Remember]**
3. Explain the data input hardware of GIS. (16)**(NOV/DEC 2015)** **[Remember]**
4. Explain the following satellite applications (16)**(NOV/DEC 2015)** **[Understand]**

   (a)Global positioning system. (6)

   (b) Satellite navigation system. (10)
5. Explain in detail about Integration of GIS, remote sensing and urban application. (16)**(MAY/JUNE 2014)** **[Remember]**
6. (a)Explain in detail about elements of interpretation and Interpretation keys characteristics of digital satellite image. (10) **(MAY/JUNE 2014)** **[Remember]**

   (b)With short notes on Resource information system. (6) **(MAY/JUNE 2014)** **[Remember]**

7.(a)Discuss about the key characteristics of digital satellite image. (8) **(NOV/DEC 2014)** **[Remember]**

(b)Write short notes on types of maps. (8) **(NOV/DEC 2014)** **[Understand]**

8.(a)Explain what is meant by remote sensing and also the need of integration of GIS and remote sensing.(12) **(NOV/DEC 2014)** **[Understand]**

(b)State the advantages of GPS. (4) **(NOV/DEC 2014)** **[Remember]**

9.(a)Describe the visual interpretation of satellite images. What are the elements of interpretation? Explain it. (8) **(MAY/JUNE 2013)** **[Remember]**

(b)Explain the various image enhancement schemes. (8) **(MAY/JUNE 2013)** **[Remember]**

10.(a)Explain the significance of integrating GIS and remote sensing. What are their application? (8) **(MAY/JUNE 2013)** **[Remember]**

(b)Write a detailed note on GPS and its application in GIS. (8) **(MAY/JUNE 2013)** **[Remember]**

11. Explain with neat diagram about DTH system (16) **(NOV/DEC 2018)** **[Remember]**
12. Write short notes on (16) **[Remember]**
    a. Gramsat
    b. E mail Service
13. Write short notes on the specialized services offered by satellites for video conferencing e- mail and internet. (16) **[Remember]**
14. In detail explain the various mobile satellite services and their impact on society. (16) **[Remember]**
15. In detail Explain about INMARSAT, LEO, MEO. (16) **[Remember]**

16. What is meant by INMARSAT? What are the objectives of the GRAMSAT program? What are the applications seen for DAB? **(APRIL /MAY 2017)** **[Remember]**

17. With block diagram explain the working principle of DBS-TV receiving system.(8) **(APRIL /MAY 2017)** **[Understand]**

18. Write an overview on VSAT systems. (8) **(APRIL /MAY 2017)** **[Understand]**

19. How are mobile services used in satellite communication systems? (13)**(NOV/DEC 2018)** **[Understand]**

20. State the features to make satellite communication system advantageous in appropriate applications.(4) **(NOV/DEC 2018)** **[Remember]**

21. Write the features of digital TV broadcast. List the various factors of home receiver unit.(9+6) **(NOV/DEC 2018)**. **[Remember]**

22. Describe the architecture of GSM in detail. (9)**(NOV/DEC 2019)** **[Understand]**

23. Write a detailed note on MPEG compression standards.(4) **(NOV/DEC 2019)** **[Remember]**

24. Explain in detail the working of a typical VSAT system.(9) **(NOV/DEC 2019)** **[Understand]**

25. (i) Discuss the position location principle involved in GPS. (7) **[Understand]**

(ii) Explain with diagram the function of single frequency C/A codeGPS receiver. (6)

[Nov/Dec 2021] **[Understand]**

26. (i) Describe the signal processing blocks involved in DTH-TV transmitter and receiver with block diagram. (7) **[Remember]**

(ii)Draw and explain the operation of DBS-TV set top box. (6) **[Nov/Dec 2021]** **[Remember]**

27. (i) Explain the characteristics of a typical VSAT system and Key Components for a VSAT network. (8) **[Remember]** **[April/May 2021]**

(ii) Compare LEOand MEOsatellite. What are the advantage, disadvantage and application of LEOand MEOsatellite? (5) **[Remember]** **[April/May 2021]**

28. i) Explain the working of Global Positioning System. (8) **[Remember]** **[NOV/DEC 2020, APR/MAY 2021]**

ii) Explain the working of Direct Broadcast Satellites in detail. (5) **[Remember]** **[NOV/DEC 2020, APR/MAY 2021]**

UNIT 5 Assignments

1. Explain about SS-TDMA.
2. What is TDMA? Explain the frame structure of TDMA.
3. Explain GPS position location principles.
4. What is the role of GPS C/A codes? Explain with a neat sketch.