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Internal Assessment Test 5 – Feb. 2022

Sub:	Satellite communication					Sub Code:	18EC732	Branch:	ECE
Date:	8-2-2022	Duration:	90 Minutes	Max Marks:	50	Sem / Sec:	7/A,B,C,D,E		OBE

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1	Explain the orbital effects on satellite performance.	[10]	CO1	L1,L2
2	Explain basic principles of orbiting satellites.	[10]	CO1	L2
3	Explain briefly the following: i) Orbital Perturbation ii) Sun Transit Outrage and Earth Eclipse of satellite	[10]	CO1	L1,L2
4	Explain solar energy driven power supply system of a satellite. Also explain With neat sketches explain the working of solar cell.	[10]	CO2	L1, L2
5	With a neat figure explain VSAT.	[10]	CO2	L2
6	Explain with a neat block diagram Satellite cable TV.	[10]	CO3	L2
7	Describe the different types of satellite orbits.	[10]	CO2	L2

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1. The motion of the satellite has significant effects on its performance. These include the Doppler shift, effect due to variation in the orbital distance, effect of solar eclipse and sun's transit outrage.

Doppler Shift

As the satellite is moving with respect to the Earth station terminal, the frequency of the satellite transmitter also varies with respect to the receiver on the Earth station terminal. If the frequency transmitted by the satellite is *fT*, then the received frequency *f*R.

$$\left(\frac{f_R - f_T}{f_T}\right) = \left(\frac{\Delta f}{f_T}\right) = \left(\frac{v_T}{v_P}\right)$$

Where,

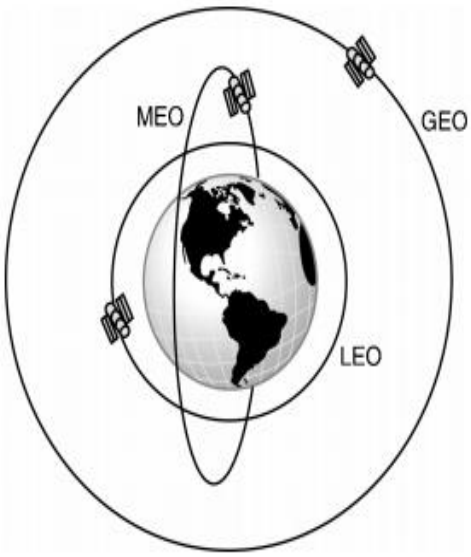
vT is the component of the satellite transmitter velocity vector directed towards the Earth station receiver

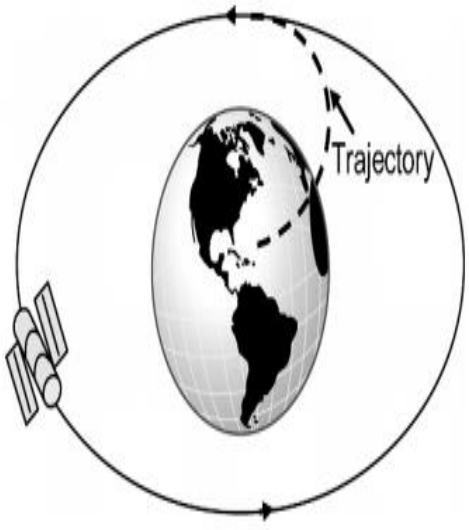
vP is the phase velocity of light in free space (3 × 108 m/s)

2. **TRAJECTORY**- Path traced by the moving body.

ORBIT-Trajectory that is periodically repeated.

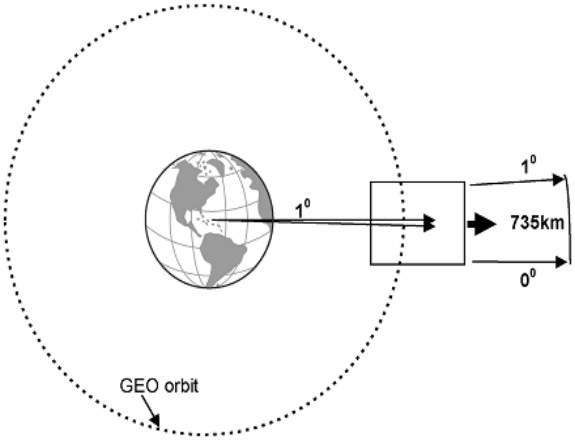
Ex: Motion of different planets of the solar system around the sun and the motion of artificial satellites around Earth





3. The satellite, once placed in its orbit, experiences various perturbing torques that cause variations in its orbital parameters with time.

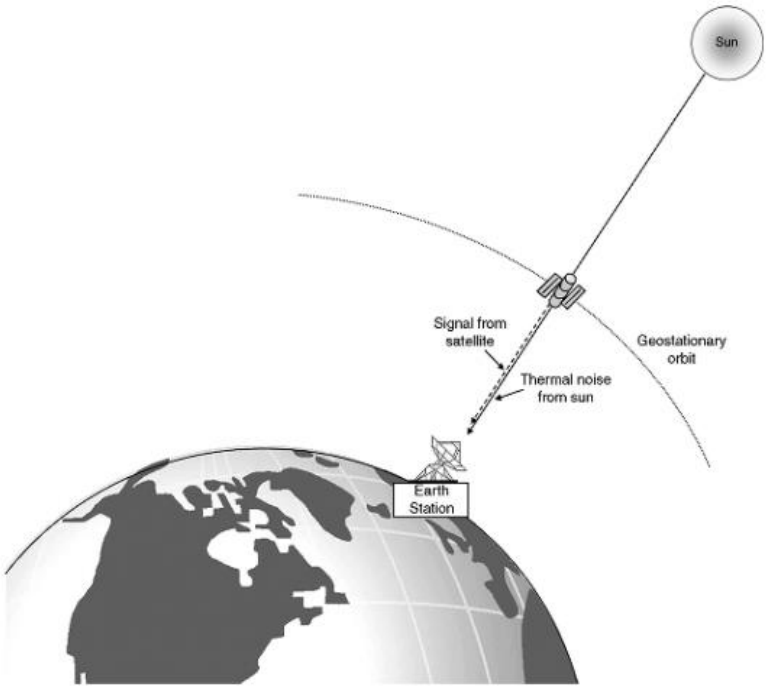
These include gravitational forces from other bodies like solar and lunar attraction, magnetic field interaction, solar radiation pressure, asymmetry of Earth's gravitational field etc. Due to these factors, the satellite orbit tends to drift and its orientation also changes and hence the true orbit of the satellite is different from that defined using Kepler's laws.



- The Earth is not a perfect sphere and is flattened at the poles. The equatorial diameter is about 20–40 km more than the average polar diameter.
- The equatorial radius of the Earth is not constant. In addition, the average density of Earth is not uniform.
- All of this results in a non-uniform gravitational field around the Earth which in turn results in variation in gravitational force acting on the satellite due to the Earth.
  The effect of variation in the gravitational field of the Earth on the satellite is more predominant for geostationary satellites than for satellites orbiting in low Earth orbits
- The satellite is also subjected to the gravitational pulls of the sun and the moon.
- The Earth's orbit around the sun is an ellipse whose plane is inclined at an angle of 7◦ with respect to the equatorial plane of the sun.
- The moon revolves around the Earth with an inclination of around 5◦ to the equatorial plane of the Earth.
  Hence, the satellite in orbit is subjected to a variety of out-of-plane forces which change the inclination on the satellite's orbit.
- As the perturbed orbit is not an ellipse anymore, the satellite does not return to the same point in space after one revolution.
- The time elapsed between the successive perigee passages is referred to as anomalistic period.
- The anomalistic period (*TA*) is given by equation.

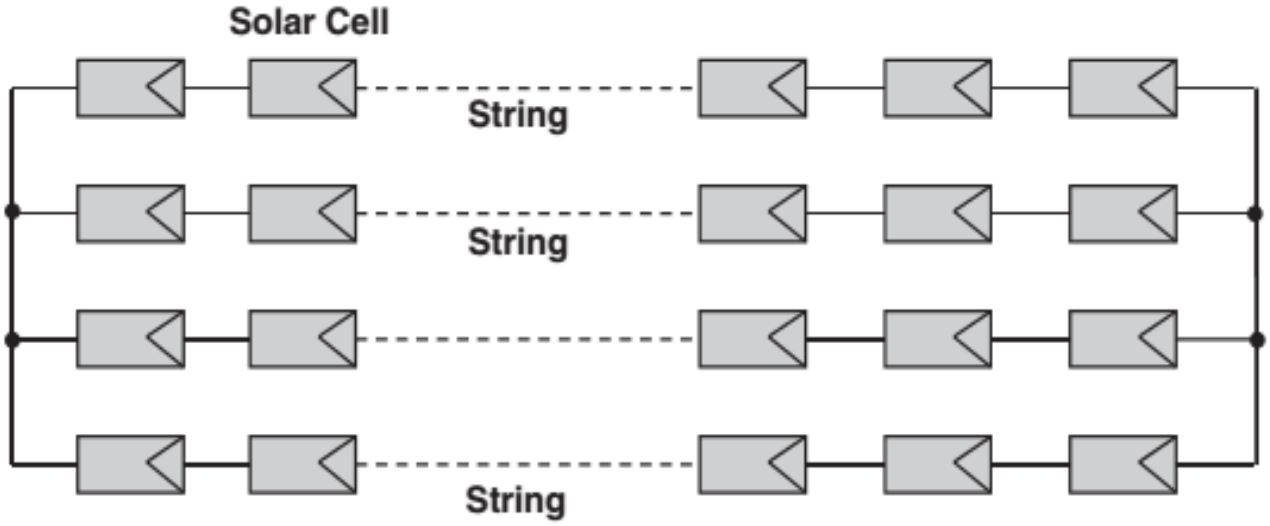
$$t_A = \frac{2\pi}{\omega_{mod}}$$

Sun Transit Outrage



- The Earth station antenna will receive signals from the satellite as well as the microwave radiation emitted by the sun.
- This might cause temporary outrage if the magnitude of the solar radiation exceeds the fade margin of the receiver.
  The traffic of the satellite may be shifted to other satellites during such periods.

4. Power systems for satellite applications have been developed based on the use of solar energy, chemical energy and nuclear energy. Heat generators make use of heat energy in solar radiation to generate electricity. This mode of generating power is completely renewable and efficient if the satellite remains exposed to solar radiation. Heat generators, however, are very large and heavy and are thus appropriate only for large satellites. Solar panel is nothing but a series and parallel connection of a large number of solar cells.The voltage output and the current delivering capability of an individual solar cell are very small for it to be of any use as an electrical power input to any satellite subsystem. The series–parallel arrangement is employed to get the desired output voltage with the required power delivery capability. A large surface area is therefore needed in order to produce the required amount of power.



- The operational principle of the basic solar cell is based on the photovoltaic effect.
- There is generation of an open circuit voltage across a P–N junction when it is exposed to light, which is the solar radiation in the case of a solar cell. This open circuit voltage leads to flow of electric current through a load resistance connected across it, as shown in Figure.

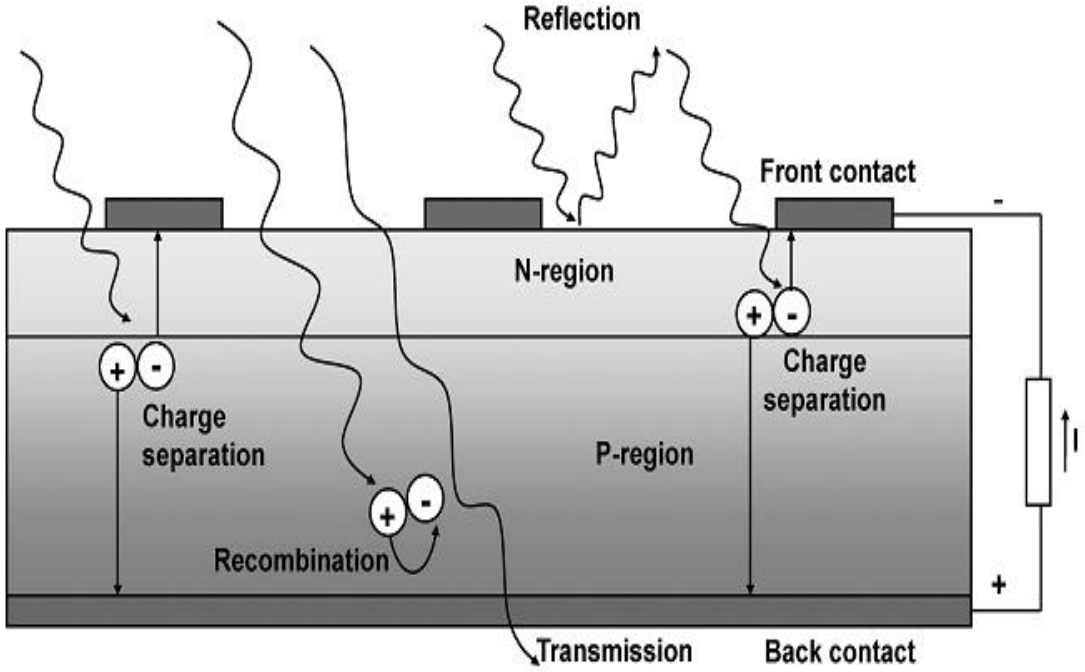


Fig: Principle of operation of a solar cell

5. Cable TV refers to the use of coaxial and fibre optic cables to connect each house through a point-to-multipoint distribution network to the head end distribution station.

Cable TV, originally referred to as CATV (community antenna television) stood for a single head end serving a particular community, like various houses in a large building. The head ends receive programming channels from either a local broadcasting link or through satellites. The use of satellites to carry the programming channels to the cable systems head ends is referred to as satellite–cable television

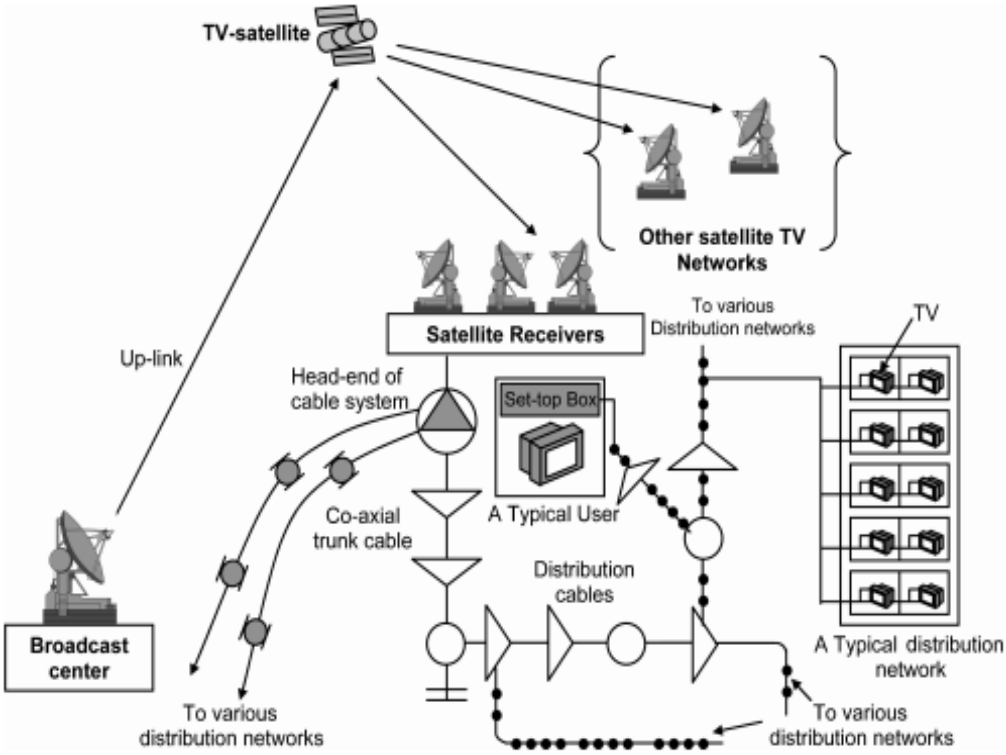


Fig: Satellite cable television

- The head end in this case consists of various receive-only Earth stations with the capability of receiving telecast from two to six satellites.
- These Earth stations either have multiple receiving antennas or, a single dish antenna with multiple feeds, with each feed so aligned as to receive telecast from a different satellite.
- The transmission from the satellite is either in the analogue format (mainly in the C band) or in the digital format (mainly in the Ku band).
- In analogue format of transmission, each receiver is tuned to a different transponder channel and the signals from various receivers are multiplexed for transmission to the users.
- The channels received in the digital format can be transmitted either digitally or in the analogue form.

6. VSAT networks come in various topologies, but the most commonly used topologies are star topology for both unidirectional and bidirectional networks and mesh topology for bidirectional networks.

- Unidirectional star networks are those in which the information is transmitted only in one direction from the hub station to the remote terminals.
- The Broadcast satellite service (BSS), makes use of this topology.
- Bidirectional star networks allow the transmission of information in both the directions, but in this case the information cannot be transmitted directly from one VSAT terminal to another but is routed through the hub station.

  The information from station A to station B (shown by regular line) has to first go to the central hub station and from there it is routed to station B. The same holds for transmission from station B to station A (shown by the dotted line).

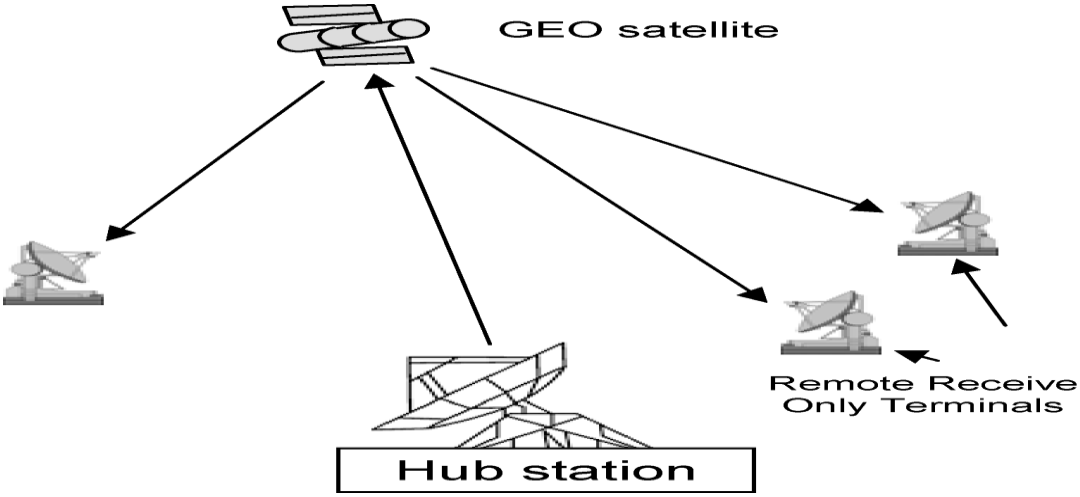
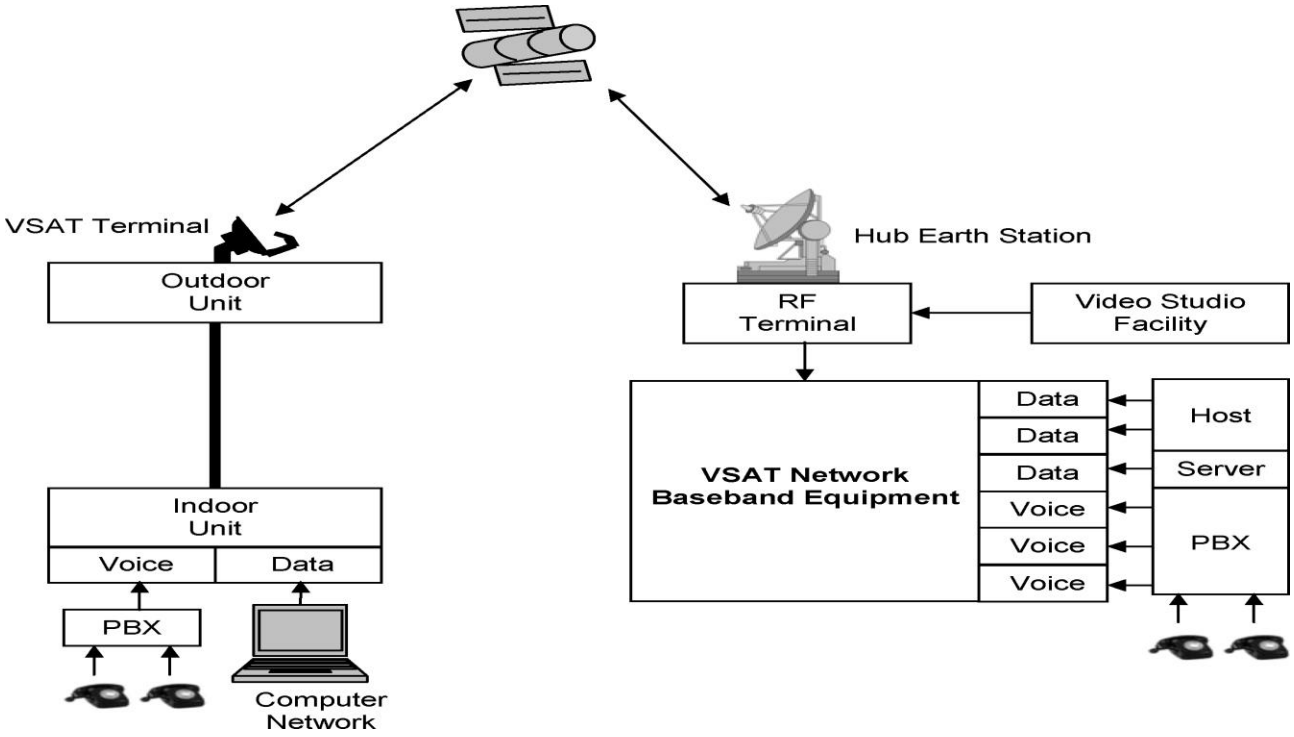
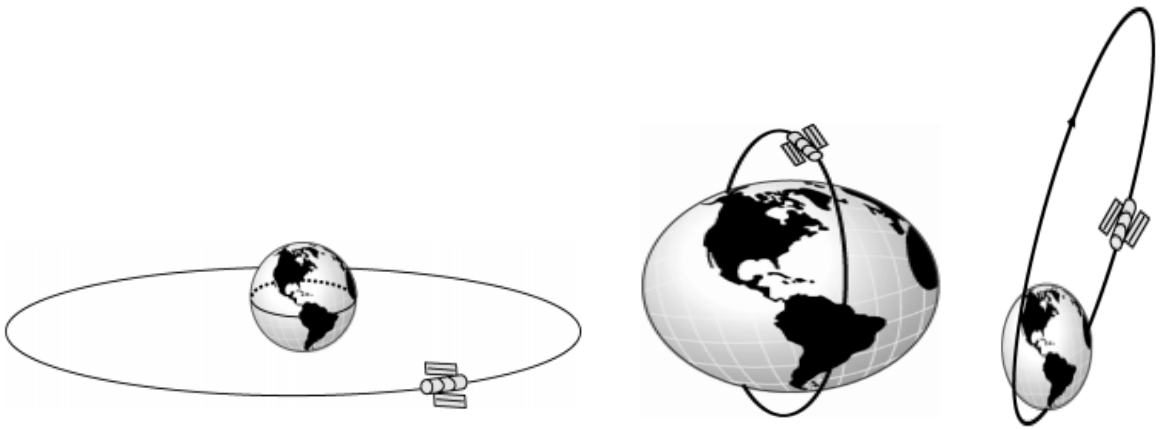


Fig: Unidirectional star networks



7. The satellite orbits can be classified on the basis of: Orientation of the orbital plane, Eccentricity and Distance from Earth

The orbital plane of the satellite can have various orientations with respect to the equatorial plane of Earth. The angle between the two planes is called the angle of inclination of the satellite. On this basis, the orbits can be classified as **equatorial orbits, polar orbits and inclined orbits.**



Orbit Types: Distance from Earth