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INSTITUTE OF
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Internal Assesment Test - II

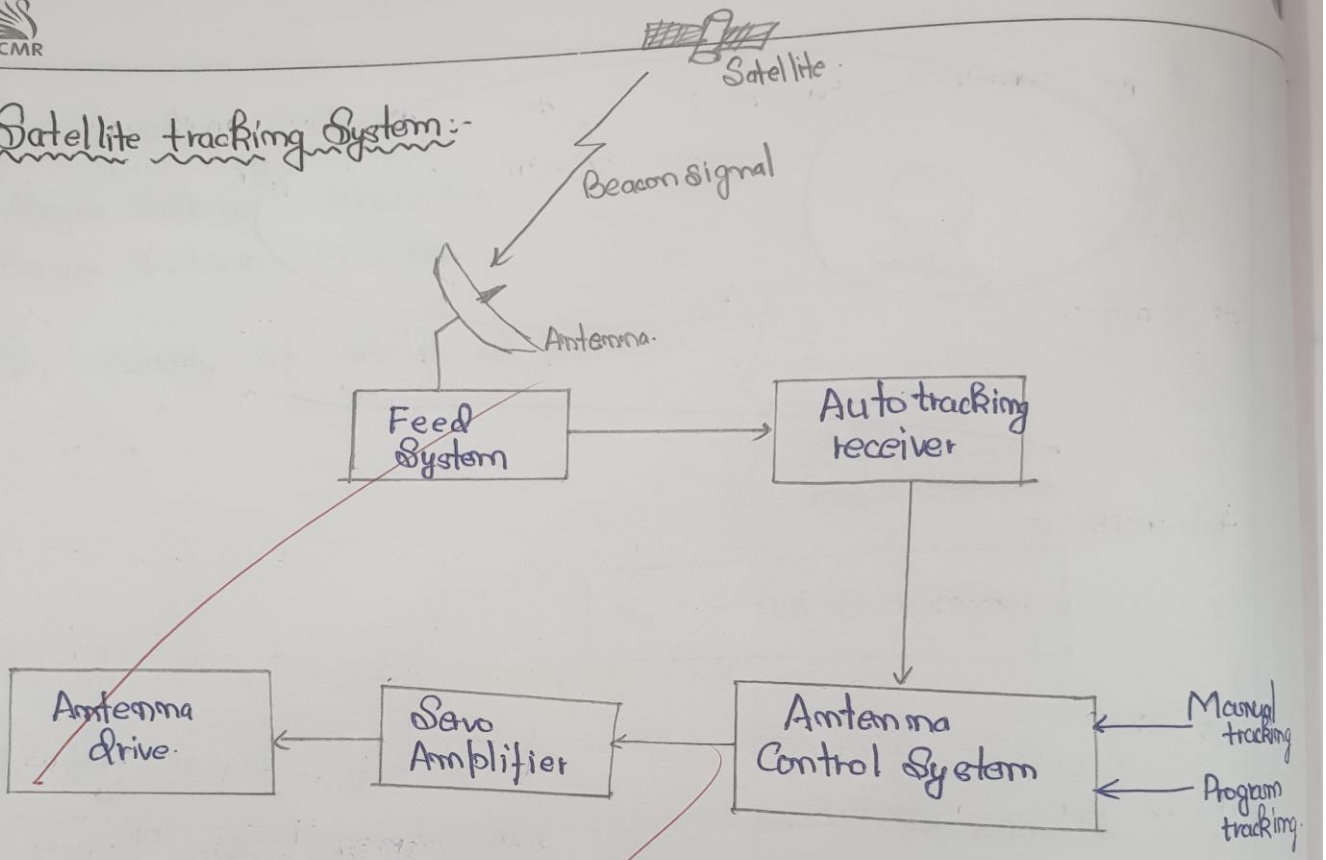
Sub:	Satellite Communication							Code:	15EC755
Date:	15/10/2019	Duration:	90 mins	Max Marks:	50	Sem:	VII	Branch:	ECE-A,B,C,D

Answer Any FIVE FULL Questions

S.No	Questions	Marks	OBE	
			CO	RBT
1.	With neat block diagram write short notes on the tasks performed by Earth station's satellite tracking system.	[10]	CO2	L2
2.	Explain the principle of operation of a solar cell with neat block diagram.	[10]	CO2	L2
3.	Discuss the functions of Tracking, Telemetry and Command subsystem of a spacecraft with a neat block diagram.	[10]	CO3	L2
4.	Discuss earth design consideration and its testing methods.	[10]	CO2	L2
5.	List out various satellite sub-system. Explain any two sub-system in detail.	[10]	CO3	L2
6.	Derive the transmission equation of a satellite link relating the received power level to the transmitted power level.	[10]	CO3	L3
7.	List out various multiple access techniques. Explain any two multiple access techniques in detail.	[10]	CO3	L2
8.	Compute the free-space path loss in decibels for the following conditions: 1. For a path length of 10 km at 4 GHz operating frequency 2. Earth station transmitting antenna EIRP = 50 dBW, satellite receiving antenna gain = 20 dB and received power at satellite = -120 dBW	[10]	CO3	L3

Internal II

1. **Satellite tracking System:-**



* Earth Satellite's tracking system is used to track the exact location of satellite by moving the Earth Station's Antenna in a desired direction.

* Due to perturbations, the orbital parameters of satellite changes so, in order to locate the satellite, we use the Earth station's satellite tracking system.

* The one which is having the small beamwidth need not to be located only the one having the larger beamwidth can be located.

It can be of various types.

(i) Satellite Accquisition
(ii) Manual tracking
(iii) Autotracking
(iv) Program tracking.

(i) Satellite Acquisition:-

It acquires the satellite location by moving the antenna of Earth station either by manual tracking i.e moving it manually or by moving the antenna through programming

(ii) Manual tracking:-

When the autotrack fails then the antenna can be oriented manually.

(iii) Autotracking is the way through which you can continuously track it.

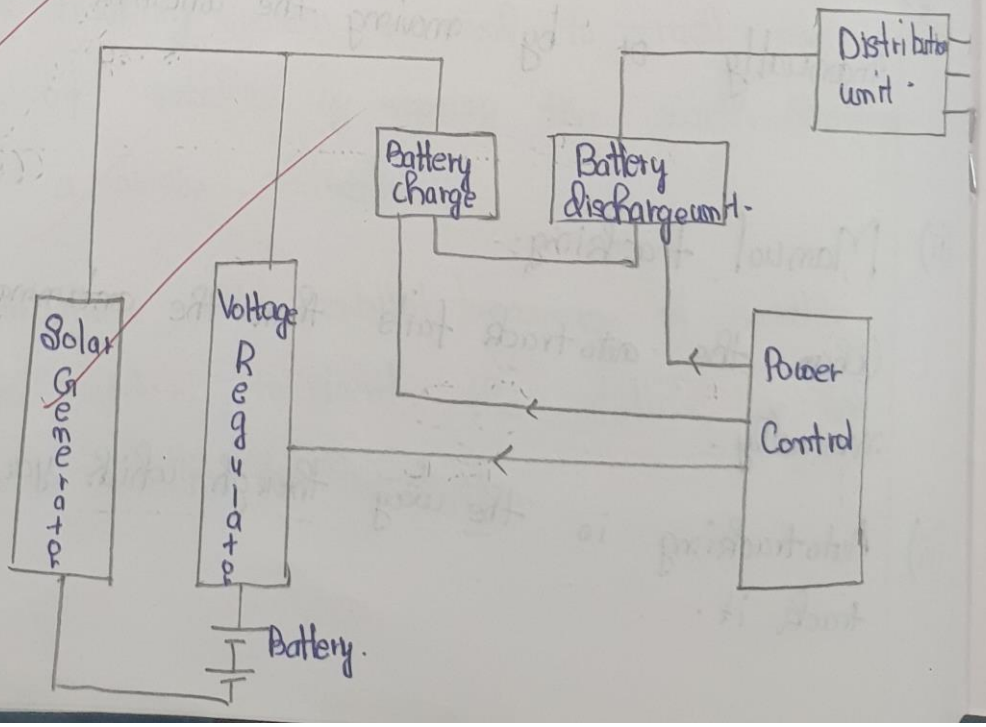
(iv) Program tracking in which it can be controlled by the program written by satellite operator.

* Here first of all the beacon signal from the satellite is being received by Earth Station through autotracking receiving antenna and is fed into the feed system.

* Then it is fed into Antenna Control System where it compares the values & make certain correction.

* Then it is amplified by using Servo Amplifier which is then used by Antenna drive to drive it in desired direction.

(2) Solar Cell:-

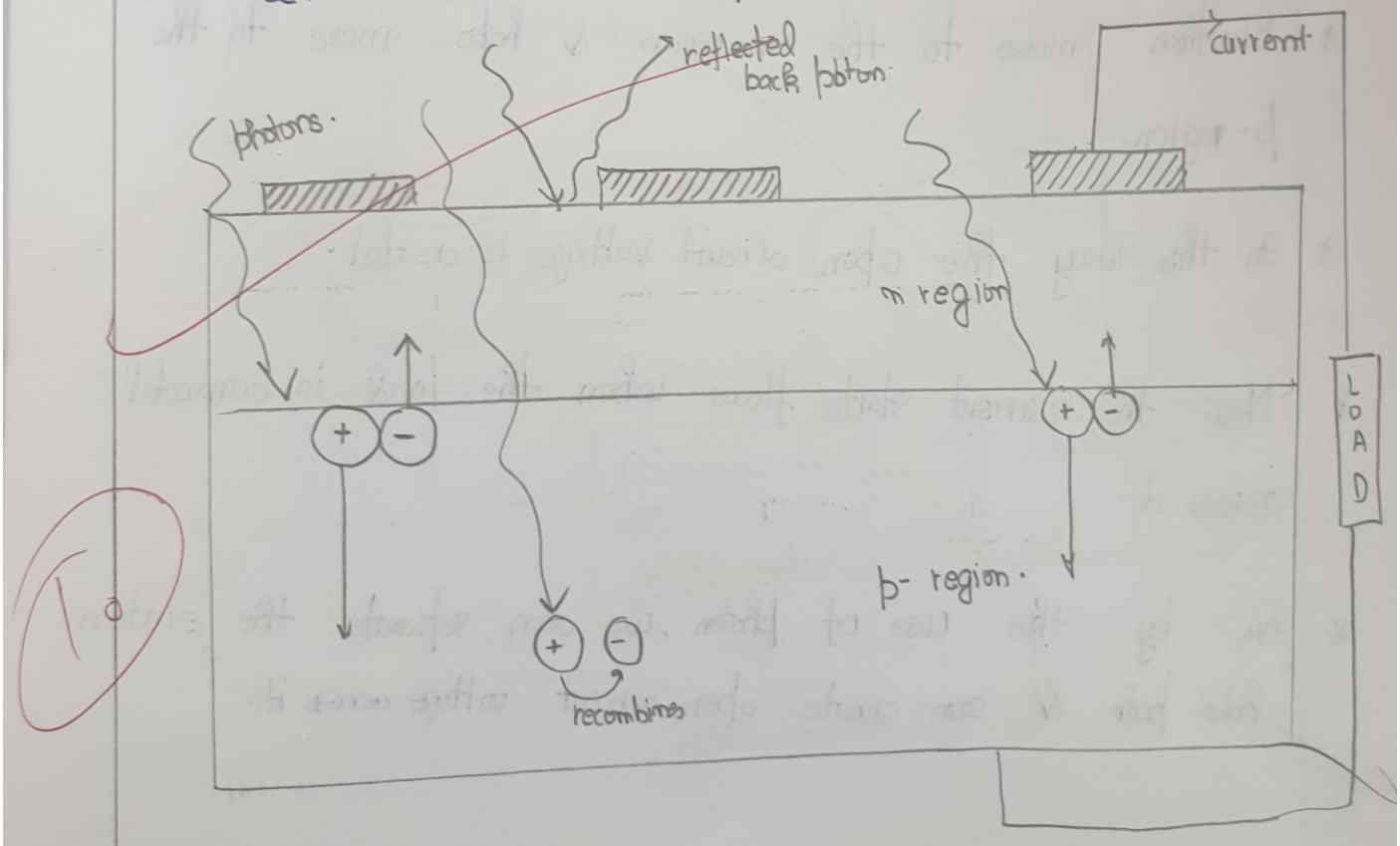


* Solar cell is based on the mechanism of photovoltaic effect.

* In satellites we use solar cell in order to drive the satellite as there the solar energy is in abundance.

* It consists of solar panels, a rechargeble battery, battery charger, controller & regulator to convert AC to Dc.

Solar cell works on the principle of photovoltaic effect.



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* Here as the photons strikes on it an open circuit voltage is created across the P-N junction.

* As photons strikes either electron-hole pair goes for recombin & vanishes

* Or the electron-hole pairs get separated & starts moving towards the positive & negative terminal.

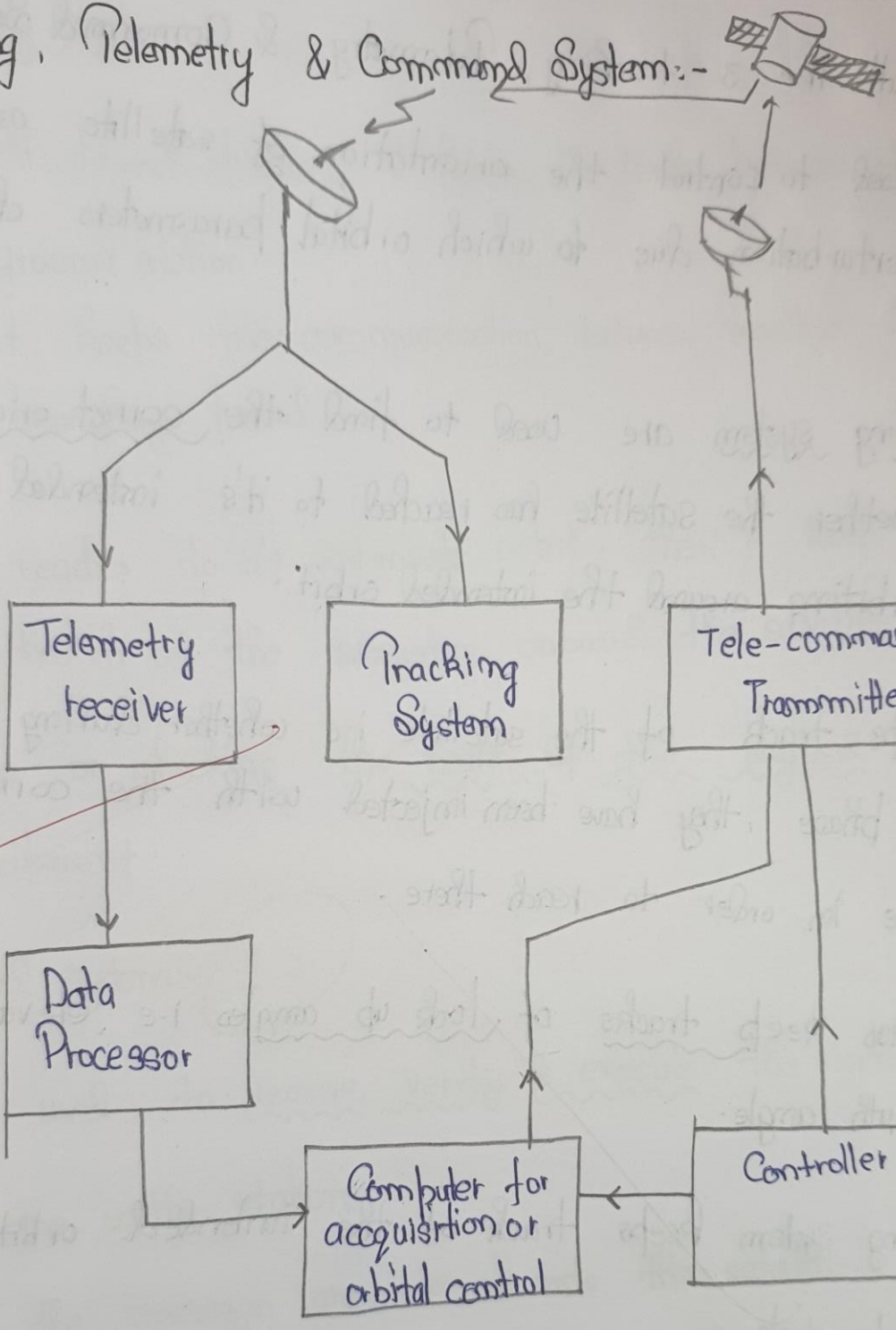
* Electron moves to the n-region & holes move to the p-region.

* In this way the open circuit voltage is created.

* Now the current starts flows when the load is connected across it.

* So, by the use of photon, we can separate the electron hole pair & can create open circuit voltage across it.

3. Tracking, Telemetry & Command System:-



Block diagram.

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* Here all the 3 tracking, Telemetry & Command Subsystem are used to control the orientation of satellite as there are perturbation due to which orbital parameters changes.

* Tracking system are used to find the correct orientation i.e whether the satellite has reached to it's intended orbiting or orbiting around the intended orbit.

* It keeps track of the satellite i.e whether during the launch phase, they have been injected with the correct velocity & angle in order to reach there.

* It also keeps tracks of look up angles i.e. elevation & azimuth angle.

* Tracking system keeps track of the intended orbit & look-up angles.

* Telemetry System:

* During the launch phase, it keeps the link between the satellite & the ground station.
Means it keeps the communication between satellite & ground during launching period.

* Once it reaches to it's intended orbit, then it keep track of the health of the subsystem onboard the satellite.

* It keeps on checking the health of the payload or any other equipment.

* Command system:-

* It is used to receive, verify & execute the signals through the earth stations.

* First all the messages are stored onto the satellite.

* Afterwards it is being received by the earth station where it is being rectified in Telemetry system.

* Then the required commands are transmitted back to the satellite.

7. Multiple access techniques:-

The various types of multiple access techniques are as follows

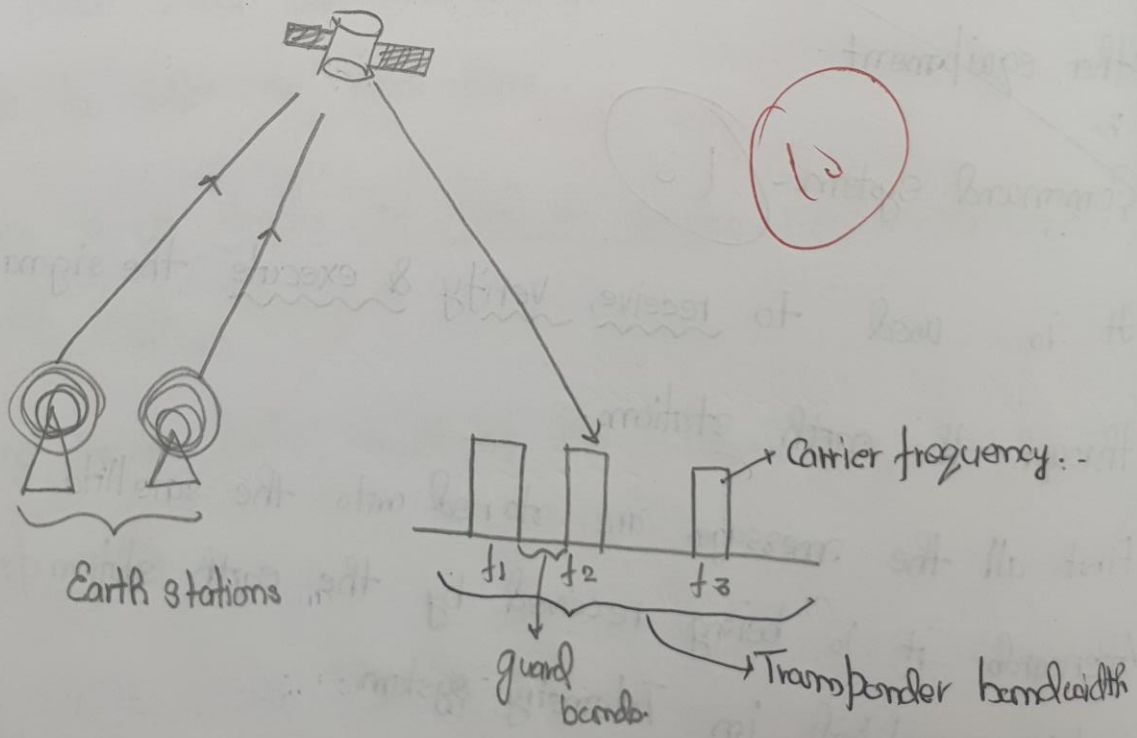
(i) FDMA → Frequency Division Multiple Access

(ii) TDMA → Time Division Multiple Access

(iii) CDMA → Code Division Multiple Access

(iv) SDMA → Space Domain Multiple Access:-

(i) Frequency Division Multiple Access:-



* In Frequency division, the earth station can transmit one or more message signals through the different carries.

* In frequency division, we have different carries for different messages.

* Here there carriers are separated by guard band in order to remove interferences.

* The satellite's transponder keep all those carriers which are ~~present inside in~~ in range of it's bandwidth.

* Then it performs the frequency translation & amplification on the message & again transmitted back to the Earth station.

* Earth station can easily select the desired carrier.

* The advantages are

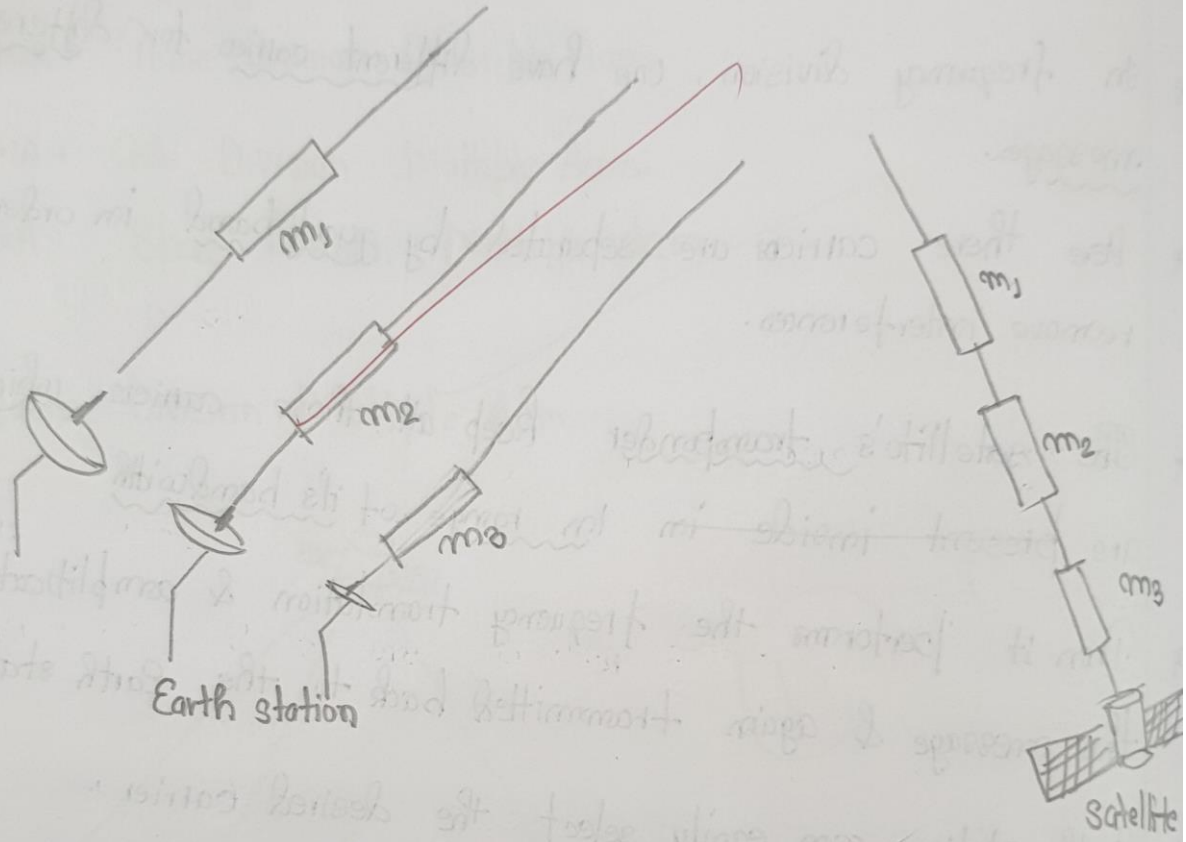
(i) Reduces the time complexity

(ii) Simplifies the design ie cost effective design.

* But the disadvantage is inter modulation due to non-linearities.

* It can be either preassigned or demand assigned.

(ii) Time Division Multiple Access (TDMA)



* Here in TDMA, there is a single carrier by separted by timedivision or time slots.

* Here earth stations will be having single carrier but will be separated by time.

* The earth stations transmit the information in such a way that, it should be synchronized wrt time i.e. it should be closely packed but should not overlap with one another.

* So, in TDMA time synchronization is necessary.

* Then the satellite transponder will start transmitting the signal one by one which can collectively taken by the Earth stations.

* Earth stations will gather all the signals which is being transmitted but will keep only one which is of interest.

* The disadvantage of Time Division Multiple Access is it requires more cost for equipments.

* It can also be preassigned, limited assigned, demand assigned & satellite switched demand.

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⑤ The various satellite subsystems are as followed:-

(i) Attitude & Orbital Control

(ii) Telemetry, Tracking & Command Subsystem

(iii) Payload

(i) Attitude Control

* This the process through control which we compare the antenna axis with the reference plane

* Attitude Control is done during both
  (i) launch phase
  (ii) In orbit

* During the launch phase, it guides the satellite & provides proper orientation against perturbations.

* It provides the constant link or communication of satellite with the ground station.

* It is just like the tracking system during the launch phase.

* But once it gets placed into the intended orbit successfully then it starts orienting the antenna of satellite in the desired direction.

* So, during the launch period, it maintains the link between the earth station & ground.

* And during inorbiting period, it keeps the track of orientation of antenna.

Orbital Control:- (10)

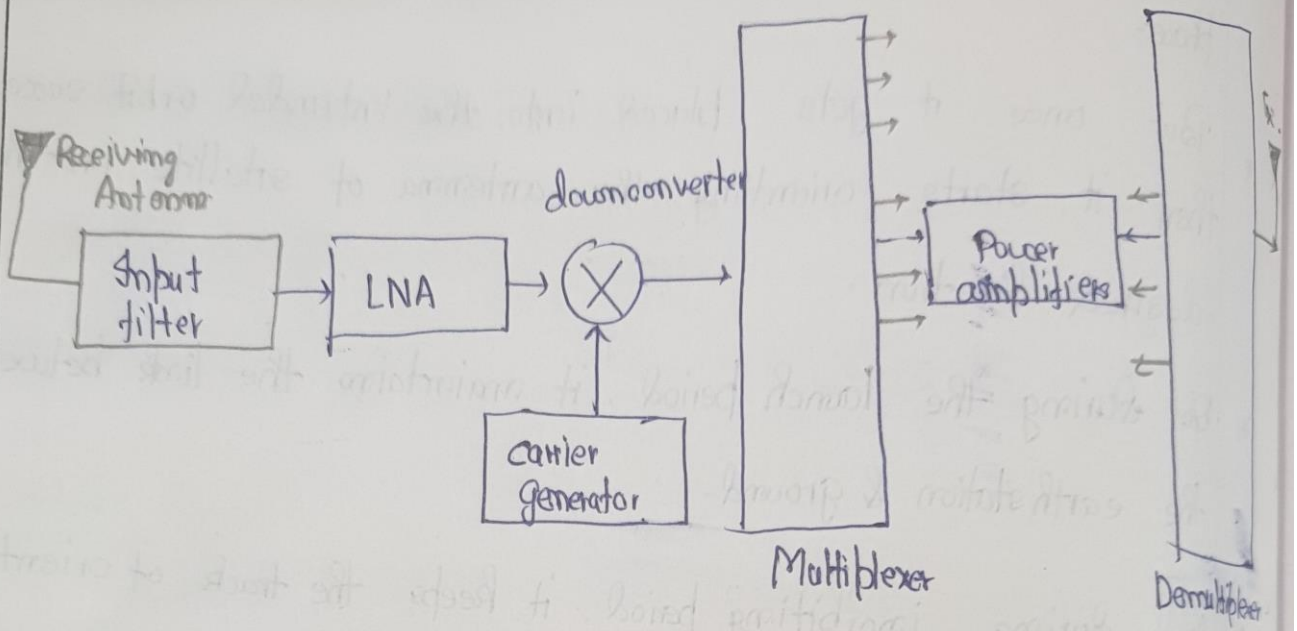
* The orbital parameters of satellite changes due to perturbations.

* Due to this, it gets shifted off from the intended orbit.

* So, in order to avoid this, they ~~using~~ use the firing thrust

* It brings the orbital parameter normal.

(ii) Payload :-



* Payload is like the brain of satellite.
* Payload is used to perform the function for which the satellite is intended.
* First it receives the signal & allows to pass through the input filter.
* Then specific range of frequency is allowed to pass through Low-Noise Amplifier.

Then it is modulated by using carrier & then it is encrypted by using multiplexer & demultiplexer.

* For communication purpose, the transponder is the payload.
* It can either transmit, receive or both.
* In weather forcasting, radiometer is the payload.
It consists of camera & detector for UV & IR rays detection.

4. Earth Design Consideration.
(i) Key performance parameters
(ii) Design Optimization
(iii) Environmental & site consideration.

(i) Key performance parameters.
(i) EIRP (Efficient Istotropic Radiated Power).
* It is formed by combining transmitting antenna & HPA.
* It is given by the product of output power of HPA to the gain of the transmitting antenna.

* It is a number which tells the output power being sent.

$$EIRP = 10\log_{10}(P_T G_T)$$

(ii) Figure of Merit (G/T):-

* It is formed by combining the receiving antenna & LNA.
* It is the ratio of gain of receiving antenna to the Temperature of Noise induced by it.

Design Optimization:-

$$\left(\frac{G}{T}\right) = \frac{C}{No} - EIRP + (Lp + Lm) + K$$

Lp → path loss
Lm → Line margin
K → Boltzmann constant.

* Here either EIRP or Figure of merit can be traded off.

(iii) Environmental Consideration.

* We should reduce the noise generated by solar pressure.

V. good

⑥ . Transmission equation is related to the power received by destination which can be satellite in satellite communication or radio frequency (RF) transmission.

. power gives us the efficiency of transmission

. noise to signal ratio is important to make sure a good communication link.

. Let the power transmitted be P_T (dB) and gain of transmitting antenna G_T (dB) Power flux density is given by

$$P_{RD} = \frac{P_T G_T}{2\pi d^2} \quad \left(\frac{W}{m^2}\right)$$

attenuation $A_T = \frac{G_T \lambda^2}{2\pi}$

$$G_T = A_T \frac{2\pi}{\lambda^2}$$

The transmitted power $P_R = \frac{P_T G_T}{2\pi d^2} A_R$

wkt, $A_R = \frac{G_R \lambda^2}{2\pi}$

$$P_R = \frac{P_T G_T}{2\pi d^2} \frac{G_R \lambda^2}{2\pi} = \frac{P_T G_T G_R}{\left(\frac{2\pi d}{\lambda}\right)^2}$$

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Let $\left(\frac{4\pi d}{\lambda}\right)^2 = L_p$

$$P_R = \frac{P_T G_T G_R}{L_p}$$

Taking log on both sides

$$\log P_R = \log(P_T) + \log(G_T) + \log(G_R) - \log(L_p)$$

$$\log(P_R) = \log(P_T G_T) + \log(G_R) - \log(L_p)$$

$$\therefore P_R = P_T G_T + G_R - L_p$$

where $EIRP = P_T G_T$

$$\boxed{P_R = EIRP + G_R - L_p}$$

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IAT-2

8.

a) 1. given, $R = 10km$

Free space path loss $= -20 \log \left(\frac{2\pi R}{\lambda}\right)$

given, operating frequency $= 4GHz$

$$\lambda = \frac{c}{f}$$

$$\lambda = \frac{3 \times 10^8}{4 \times 10^9}$$

$$\lambda = 0.075m$$

Free space path loss $= -20 \log \left(\frac{2\pi \times 10 \times 10^3}{0.075}\right)$

$= -118.46 dB$

2. Given,

$EIRP = 50 dBW$

$G_R = 20 dB$

$P_R = -120 dBW$

$P_R = EIRP + G_R - L_P$

$L_P = EIRP + G_R - P_R$

$$L_p = 50 + 20 - (-120)$$

$$L_p = 190 \text{ dB}$$

where, L_p – free space path loss.

8.
b) Given,

$$f = 2 \text{ GHz}$$

- We know that the polarization rotation is inversely proportional to the square of frequency.
- The frequencies are different by a factor of 5.
- Therefore, the polarization rotation will differ by a factor of 25.

$$\text{Polarization rotation} = \frac{75^\circ}{25} = 3^\circ$$

The attenuation experienced by co-planar component,

in first case, for $\Delta\psi = 75^\circ$

$$A_R = -20 \log (\cos(75^\circ))$$

$$= 11.7400 \text{ dB}$$

$$L_p = 50 + 20 - (-120)$$

$$L_p = 190 \text{ dB}$$

where, L_p - free space path loss.