Batch 1

SET A

SRM Institute of Science and Technology
College of Engineering and Technology
DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

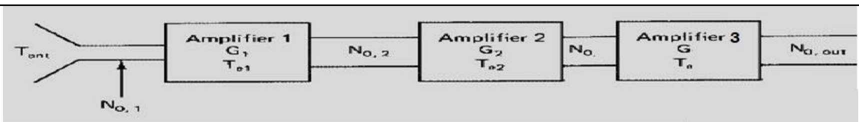
Academic Year: 2022-2023 (EVEN)

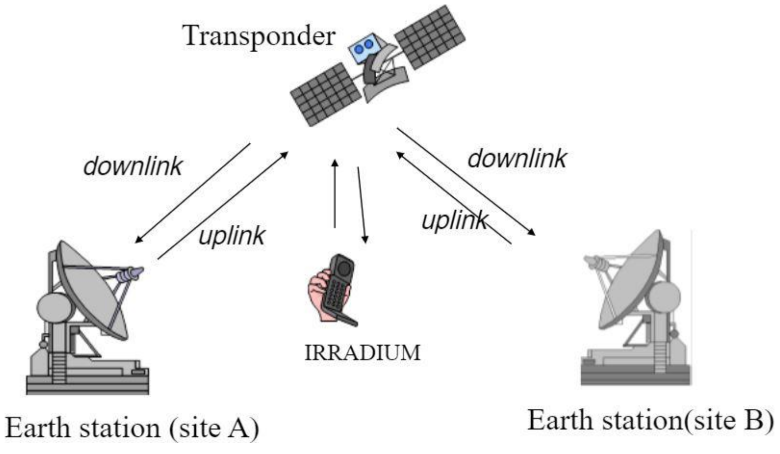
Test: CLA T2 | **Date: 06/04/2023**
Course Code & Title: 18ECE223T Satellite Communication and Broadcasting | **Duration: 2 Periods**
Year & Sem: III & 6th | **Max. Marks: 50**

Course Articulation Matrix with PI:

	18ECE223T- Satellite Communication and Broadcasting	**PROGRAM OUTCOMES**												**PSO**		
S.NO	COURSE OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Demonstrate the principles, concepts and operation of satellite communication systems	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
2	Analyze the satellite orbits, link design, link availability and interference	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
3	Discuss the concepts of Satellite systems in relation to other terrestrial systems	3		2	-	-	-	-	-	-	-	-	-	-	-	-
4	Illustrate the performance of various channel access schemes for satellite communication	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-
5	Explain the applications of satellites and compression standards adopted in satellite communication	-	-	2	-	-	-	3	-	-	-	-	-	-	-	-

Part - A (10 x 1 = 10 Marks) Instructions: Answer all Questions					
Q. No	**Question**	**Marks**	**BL**	**CO**	**PO**
1.	Losses due to connecting wave guides, filters and couplers are classified as **A.** Receiver Feeder Losses (RFL)	**1**	**1**	**CO2**	**3**
2.	Noise generated due to microwave radiation which is present throughout the universe is called **B.** Sky Noise	**1**	**1**	**CO2**	**3**
3.	The main advantage of Forward error correction is **D.** Retransmission avoided	**1**	**2**	**CO2**	**3**
4.	[EIRP] and Saturation Flux density can be equated as **A. $[\Psi_M] + [A_0] + [FSL]$**	**1**	**2**	**CO2**	**4**
5.	Find the downlink output backoff if the input backoff is 11 dB. Assume TWTA operates in linear region. **D.** 6 dB	**1**	**2**	**CO2**	**4**
6.	The equipment used to provide the service for which the satellite has been launched as is called **B.** Payload	**1**	**1**	**CO3**	**1**
7.	In a C band satellite, number of transponders that can be accommodated in a 500 MHz bandwidth are **B.** 12	**1**	**1**	**CO3**	**1**
8.	TV downlink signal receiving C band antenna diameter is **A.** 1.83 m (6 ft)	**1**	**2**	**CO3**	**3**

9.	In satellite subsystems, high power can be achieved with solar panels arranged in the form of ________ solar sails **C.** Rectangular	**1**	**2**	**CO3**	**3**
10.	Choose the modulation used in Television **C.** Vestigial Sideband (VSB)	**1**	**2**	**CO3**	**3**
Part – B **(4 x 4 = 16 Marks)**					
SECTION B1 **Instructions: Answer ANY TWO Questions**					
11	 **$T_S = T_{ant} + T_{e1} + T_{e2} / G_1 + T_{e3}/G_1G_2$**	**4**	**3**	**CO2**	**4**
12	An antenna has noise temperature of 40 K and is matched into a receiver which has a noise temperature of 100 K calculate: a) noise power density and b) the noise power for a bandwidth of 24 MHz. a) $N_O = K*T_N$ $= 1.38 \times 10^{-23} \times (40 + 100)$ **$= 1.932 \times 10^{-21}$ J** b) $P_N = N_O B_N$ $= 1.932 \times 10^{-21} \times 24 \times 10^{6}$ **$= 4.6368 \times 10^{-14}$ W = 0.046 pW**	**4**	**3**	**CO2**	**4**
13	• Rainfall results in attenuation of radio waves by scattering and by absorption of energy from the wave • Rain attenuation is accompanied by noise generation, and both the attenuation and the noise adversely affect satellite circuit performance. • Rain attenuation increases with increasing frequency and is worse in the Ku band com- pared with the C band. Studies have shown (CCIR Report 338-3, 1978) that the rain attenuation for horizontal polarization is considerably greater than for vertical polarization.	**4**	**2**	**CO2**	**3**
SECTION B2 **Instructions: Answer ANY TWO Questions**					
14	• Tracking of the satellite is done by satellite transmit beacon signals which are received at the TT&C earth stations. Tracking is important during the transfer and drift orbital phases of the satellite launch. Once it is on station, the position of a geostationary satellite will tend to be shifted as a result of the various disturbing forces. • To track the satellite's movement and send correction signals as required. Tracking beacons may be transmitted in the telemetry channel, or by pilot carriers at frequencies in one of the main communications channels.	**4**	**3**	**CO3**	**1**
15	• The attitude of a satellite refers to its orientation in space. Much of the equipment carried aboard a satellite is there for the purpose of controlling its attitude. Attitude control is necessary, for example, to ensure that directional antennas point in the proper directions. A number of forces, referred to	**4**	**2**	**CO3**	**3**

	as disturbance torques, can alter the attitude, some examples being the gravitational fields of the earth and the moon, solar radiation, and meteorite impacts. • Passive attitude control - use of mechanisms which stabilize the satellite without putting a drain on the satellite's energy supplies; Examples of passive attitude control are spin stabilization and gravity gradient stabilization. • Active control - Methods used to generate active control torques include momentum wheels, electromagnetic coils, and mass expulsion devices, such as gas jets and ion thrusters.				
16	• The CATV system employs a single outdoor unit, with separate feeds available for each sense of polarization. • All channels are made available simultaneously at the indoor receiver. • Instead of having a separate receiver for each user, all the carriers are demodulated in a common receiver-filter system. • The channels are then combined into a standard multiplexed signal for transmission over cable to the subscribers.	**4**	**2**	**CO3**	**3**
	Part – C **(2 x 12 = 24 Marks)**				
17a (i)	1. Frequency band determination. 2. Satellite communication parameters determination. 3. Earth station parameter determination; both uplink and downlink. 4. Find (C/N) up in the transponder and determine transponder output power from its gain or output backoff. 5. Establish a downlink power and noise budget for the receiving earth station 6. Calculate SNR/BER in the baseband channel. 7. Determine the link margin. 8. Do a comparative analysis of the result vis-à-vis the specification requirements. If needed tweak system parameters to obtain acceptable $(C/N)_0$ /SNR/BER values. 9. Uplink and downlink unavailability estimation. 10. Redesign system by changing some parameters if the link margins are inadequate.  	**8**	**3**	**CO2**	**4**

	Marks split up Steps – 6 Marks Sketch – 2 Marks				
17a (ii)	EIRP can be defined as the power input to one end of the transmission link and the problem to find the power received at the other end. Maximum power flux density at some distance r from transmitting antenna of gain G is $$\varphi_m = GP_s / 4\pi r^2$$ Where, G is Gain of the Transmitting antenna and G is in decibels. Ps is Power of the sender (transmitter) and is calculated in watts. key parameter in link budget calculation denoted as EIRP. An isotropic radiator with input power equal to GP_s would produce the same flux density. $$\mathbf{EIRP = GP_s}$$ This product is known as EIRP. EIRP is often expressed in decibels relative to 1W, or dBW. Let P_s be in watts; then $$\mathbf{[EIRP]=[P_s]+[G]\ dBW}$$	**4**	**3**	**CO2**	**4**
(OR)					
17b (i)	The EIRP can be considered as the input power to a transmission link. Due to the above discussed losses, the power at the receiver that is the output can be considered as a simple calculation of EIRP – losses. **[Losses] = [FSL] + [RFL] + [AML] + [AA] + [PL]** The received power that is PR: **[PR] = [EIRP] + [GR] – [Losses]** Where; [PR]is received power in dB. [EIRP] is equivalent isotropic radiated power in dBW. [GR]is isotropic power gain at the receiver and its value is in dB. [FSL] is free-space transmission loss in dB. [RFL] is receiver feeder loss in dB. [AA] isAtmospheric absorption loss in dB. [AML] is Antenna misalignment loss in dB. [PL] is depolarization loss in dB A measure of a performance of a satellite link is considered as a ratio of carrier power to noise power at the receiver input along with the link budget calculations which are considered to estimate this ratio. This ratio is denotes as C/N and is calculated in decibels. **C/N = [PR] – [PN] □(in decibel)** where: C/N □ carrier to noise ratio PR is Receiver Power PN is Noise Power Thus, the resultant C/N can be calculated with the following	**8**	**3**	**CO2**	**1**

	parameters **[C/N] = [EIRP] + [GR] – [LOSSES] – [k] – [TS] – [B_N]** To complete the calculations, we need to consider the gain is to temperature ratio as well. It is commonly denoted ad G/T. it is denoted as: [G/T] = [GR] – [TS] Thus, the C/N LINK equation could be written as: **[C/N] = [EIRP] + [G/T] - [LOSSES] – [k] – [B_N]** The ratio of carrier to noise power density PR / PN can be the quantity that is actually required. Since PN = k TNBN [**NO = k TN**] then: **[C/N] = [C / NO BN] = [C / N_0] – [BN]** **and therefore,** **[C/No] = [C / N_0] + [BN]** [C/N] is true power ratio in units of decibels, and [BN] is in decibels relative to one hertz or dB Hz. Thus the units for [C/No] are dB Hz. Applying this value to the above equation, we get: **[C/N0] = [EIRP] + [G/T] - [LOSSES] – [k]** **Marks Split up:** Finding PR = 3 marks Finding C/N = 3 marks Finding $(C/N)_0$ = 2 marks				
17b (ii)	[Losses] = [FSL] + [RFL] + [AML] + [AA] + [PL] = 200 + 2.5 + 0 + 0.4 + 0.4 **= 203.5 dB** [PR] = [EIRP] + [GR] – [Losses] = 215 – 203.5 = **11.5 dB**	**4**	**3**	**CO3**	**3**
18a	**Station Keeping:** • Station keeping, which is the term used for maintaining a satellite in its correct orbital position. • The equatorial ellipticity of the earth causes geostationary satellites to drift slowly along the orbit, to one of two stable points, at 75°E and 105°W. • To counter this drift, an oppositely directed velocity component is imparted to the satellite by means of jets, which are pulsed once every 2 or 3 weeks. This results in the satellite drifting back through its nominal station position, coming to a stop, and recommencing the drift along the orbit until the jets are pulsed once again. • These maneuvers are termed east-west station-keeping maneuvers. Satellites in the 6/4-GHz band must be kept within 0.1° of the designated longitude, and in the 14/12-GHz band, within 0.05°	**12**	**3**	**CO3**	**1**

- A satellite which is nominally geostationary also will drift in latitude, the main perturbing forces being the gravitational pull of the sun and the moon. These forces cause the inclination to change at a rate of about 0.85°/year.
- If left uncorrected, the drift would result in a cyclic change in the inclination, going from 0° to 14.67° in 26.6 years and back to zero, at which the cycle is repeated.
- To prevent the shift in inclination from exceeding specified limits, jets may be pulsed at the appropriate time to return the inclination to zero. Counteracting jets must be pulsed when the inclination is at zero to halt the change in inclination. These maneuvers are termed north-south station-keeping maneuvers, and they are much more expensive in fuel than are east-west station-keeping maneuvers. The north-south station-keeping tolerances are the same as those for east-west station keeping, 0.1° in the C band and 0.05° in the Ku band.
- Orbital correction is carried out by command from the TT&C earth station, which monitors the satellite position. East-west and northsouth station-keeping maneuvers are usually carried out using the same thrusters as are used for attitude control

Thermal Control

- Satellites are subject to large thermal gradients, receiving the sun's radiation on one side while the other side faces into space. In addition, thermal radiation from the earth and the earth's albedo, which is the fraction of the radiation falling on earth which is reflected, can be significant for low-altitude earth-orbiting satellites, although it is negligible for geostationary satellites. Equipment in the satellite also generates heat which has to be removed.
- The most important consideration is that the satellite's 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 the communications payload. Mirrored drums surround the communications equipment shelves in each case and provide good radiation paths for the generated heat to escape into the surrounding space.
- In order to maintain constant temperature conditions, heaters may be switched on to make up for the heat reduction which occurs when transponders are switched off. The INTELSAT VI satellite used heaters to maintain propulsion thrusters and line temperatures

Marks Split up:

Station Keeping = 8 marks

Thermal control = 4 Marks

(OR)

18b	**Transponder**	**12**	**3**	**CO3**	**3**

- A transponder is the series of interconnected units which forms a single communications channel between the receive and transmit antennas in a communications satellite.
- The bandwidth allocated for C-band service is 500 MHz, and this is divided into subbands, one for each transponder.
- A typical transponder bandwidth is 36 MHz, and allowing for a 4-MHz guardband between transponders, 12 such transponders can be accommodated in the 500-MHz bandwidth.
- By making use of polarization isolation, this number can be doubled.
- With linear polarization, vertically and horizontally polarized carriers can be separated in this way, and with circular polarization, left-hand circular and right-hand circular polarizations can be separated.
- The carriers with opposite senses of polarization may overlap in frequency, this technique is referred to as frequency reuse.
- Frequency reuse also may be achieved with spot-beam antennas, and these may be combined with polarization reuse to provide an effective bandwidth of 2000 MHz from the actual bandwidth of 500 MHz.
- A transponder may handle one modulated carrier, such as a TV signal, or it may handle a number of separate carriers simultaneously, each modulated by its own telephony or other baseband channel.

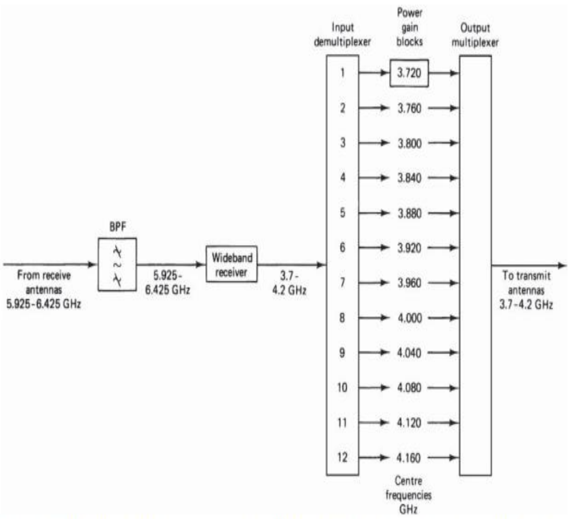


Figure 7.13 Satellite transponder channels. (*Courtesy of CCIR, CCIR Fixed Satellite Services Handbook, final draft 1984.*)

-
- Fig. shows the channeling scheme for the 12 transponders.
- The incoming, or uplink, frequency range is 5.925 to 6.425 GHz. The carriers may be received on one or more antennas, all having the same polarization.
- The input filter passes the full 500-MHz band to the

common receiver.

- There will be many modulated carriers within this 500-MHz passband, and all of these are amplified and frequency converted in the common receiver.
- The frequency conversion shifts the carriers to the downlink frequency band, which is also 500 MHz wide, extending from 3.7 to 4.2 GHz.
- At this point the signals are channelized into frequency bands which represent the individual transponder bandwidths.

Wideband Receiver

- A duplicate receiver is provided so that if one fails, the other is automatically switched in. The combination is referred to as a redundant receiver, meaning that although two are provided, only one is in use at a given time.
- The first stage in the receiver is a low-noise amplifier (LNA). This amplifier adds little noise to the carrier being amplified, and at the same time it provides sufficient amplification for the carrier to override the higher noise level present in the following mixer stage.
- The LNA feeds into a mixer stage, which also requires a local oscillator (LO) signal for the frequency-conversion process. The power drive from the LO to the mixer input is about 10 dBm.
- The oscillator frequency must be highly stable and have low-phase noise. A second amplifier follows the mixer stage to provide an overall receiver gain of about 60 dB.
- Splitting the gain between the preamplifier at 6 GHz and the second amplifier at 4 GHz prevents oscillation, which might occur if all the gain were to be provided at the same frequency.

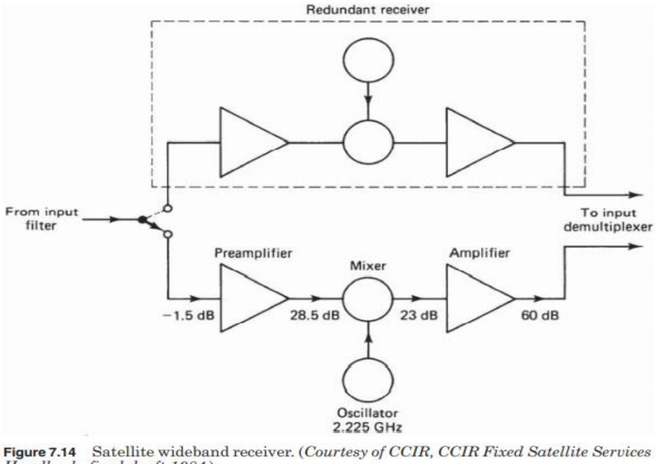


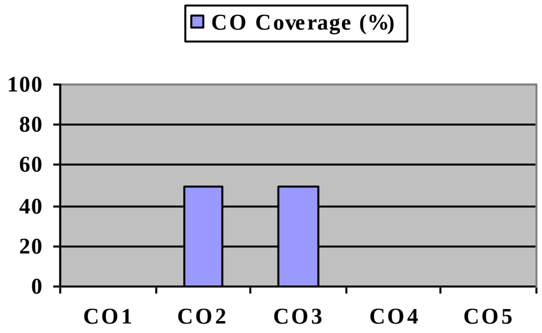
Figure 7.14 Satellite wideband receiver. (*Courtesy of CCIR, CCIR Fixed Satellite Services Handbook, final draft 1984.*)

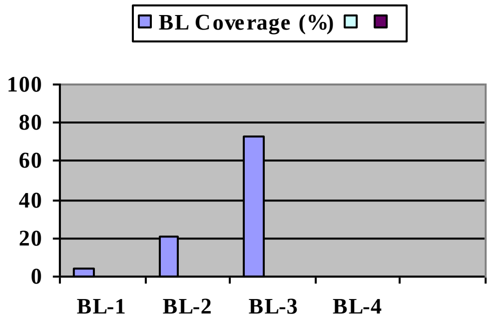
Marks Split up:

Transponder (Diagram & Explanation) = 6 marks

Wideband Receiver (Diagram & Explanation) = 6 marks

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Signature of the Question paper setter

Approved by the Course Coordinator

Approved by t the Academic Advisor