DA-2

1. In this question you are asked to analyze the performance of the TV system using frequency modulation. The uplink station delivers a signal to the satellite which conforms to the following specification:

Transponder and satellite characteristics	
Transponder bandwidth	25 MHz
$(C/N)_{up}$ in 20 MHz noise bandwidth	24 dB
Saturated output power	200 W
Downlink frequency	12.5 GHz
Downlink antenna gain, on axis	39.0 dB
Atmospheric clear air loss	0.4 dB
All other losses	0.5 dB
Receive Station parameters	
Antenna diameter	18 inches
Aperture efficiency	70 %
Antenna noise temperature (clear air)	40 K
Receiver noise temperature	90 K

   (a) The uplink master station transmits a NTSC video signal with a baseband bandwidth of 4.2 MHz to one transponder on the satellite using FM. The transponder is operated with 1 dB of output back-off and the FM signal occupies a bandwidth of 24 MHz. For an earth station with a high gain LNA, at a distance of 38,000 km from the satellite, on the – 4 dB contour of the satellite antenna beam. Find:
      (i) The power at the input to the earth station LNA.
      (ii) The downlink $(C/N)_{dn}$ in a noise bandwidth of 24 MHz.
      (iii) The overall $(C/N)_o$ in the earth station receiver.

2. This problem examines the design and performance of a digital satellite communication link using a geostationary satellite with bent-pipe transponders, used to distribute digital TV signals from one central (hub) earth station to many receiving stations throughout the United States. The link uses QPSK digital transmission at 20 Msps with half rate forward error correction. The half rate FEC gives a coding gain of 5.5 dB.
   The design requires that an overall C/N ratio of 9.5 dB be met in the earth station receiver to ensure that noise in the video signal on the TV screen is held to an

acceptable level. The uplink transmitter power and the receiving antenna gain and diameter must be determined. The available link margins for each of the systems must be found and the performance of the system analyzed when rain attenuation occurs in the satellite – earth paths. The system is specified in Table 1.

Design uplink and downlink for cleaer air and during rain.

Table 1. System and Satellite Specification

Ku-band satellite parameters		
Total RF output power		3.2 kW
Antenna gain, on axis, Ku-band (transmit and receive)		31 dB
Receive system noise temperature		500 K
Transponder saturated output power:	Ku-band	80 W
Transponder bandwidth:	Ku-band	54 MHz
Earth station receiver IF noise bandwidth		20 MHz
Minimum permitted overall C/N in receiver		9.5 dB
Transponder HPA output back-off		1 dB
Transmitting Ku-band earth station		
Antenna diameter		5 m
Aperture efficiency		68 %
Uplink frequency		14.15 GHz
Required C/N in Ku band transponder		30 dB
Miscellaneous uplink losses		0.3 dB
Location: -2 dB contour of satellite receiving antenna		
Receiving Ku-band earth station		
Downlink frequency		11.45 GHz.
Receiver IF bandwidth		20 MHz
Aperture efficiency		68 %
Antenna noise temperature		30 K
LNA noise temperature		110 K
Required overall $(C/N)_o$ in clear air		17 dB
Miscellaneous downlink losses		0.2 dB
Location: -3 dB contour of satellite transmitting antenna		
Rain Attenuation and Propagation Factors at Ku-band		
Clear air attenuation		
Uplink	14.15 GHz	0.7 dB
Downlink	11.45 GHz	0.5 dB
Rain attenuation		
Uplink	0.01 % of year	6.0 dB
Downlink	0.01 % of year	5.0 dB