Jordan University of Science and Technology
Department of Electrical Engineering
Satellite Communication Systems (EE558) Final Exam

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Q1

a) What are the possible interference modes between satellite circuits?

b) The desired EIRP from a satellite is 40 dBW and the ground station receiving antenna gain is 45 dB in the desired direction and 25 dB toward an interfering satellite with EIRP of 50 dBW. The total losses is 200 dB, and the polarization discrimination is 5 dB. Calculate the desired carrier power, the interference carrier power, and the C/I ratio for a ground station located at the 3 dB contours of both satellites.

Q2

a) Draw the frequency plan for a demand-assigned FDMA SPADE system showing the number of voice channels. What is the bandwidth allocated for each voice channel and show how it is calculated?

b) A satellite downlink has a transponder bandwidth of 36 MHz, a saturation EIRP of 30 dBW, a G/T of 27 dB/K an a total link losses of 196 dB. The transponder is accessed by FDMA carriers each of 45 KHz bandwidth. Calculate the $(C/N)_D$ for a single carrier operation and the number of carriers which can access the transponder if a 3 dB output backoff is employed. Calculate the number of carriers if no backoff is used and the (C/N) for each carrier.

Q3

a) Draw the frame format for a TDMA system showing the contents of the reference burst and the overhead bits in earth station burst.

b) An INTELSAT TDMA frame has the following information: frame period= 2 ms, number of bits per frame = 241664, number of traffic bursts per frame = 40, number of reference bursts per frame = 1, guard interval=200 bits, number of bits in reference burst=584, number of preample bits in each traffic burst=574. Calculate the frame efficiency, the voice channel capacity of the frame, the number of voice channels allocated to each earth station and the size of the buffer memory. Also calculate the reference burst time, traffic burst time, and the guard time.

Q4

a) Draw a complete block diagram for the digital receiver of a direct broadcast satellite (DBS) television.

b) A DBS home receiver has the following parameters: 0.3 m dish antenna with an efficiency of 0.55 and noise temperature of 100 K, A LNB with noise temperature of 150 K, a satellite EIRP of 55 dBW, a transponder bit rate of 40 Mb/s, raised-cosine filter with roll-off factor of 0.2, a QPSK modulation, the range of the link is 40000 Km, the other link losses is 2 dB, a 12 GHz downlink frequency. Calculate the E_b/N_o ratio, the bit error rate, the received power at the input of the LNB, and the transponder bandwidth.

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$EIRP = P_s + G \ dBW$, $G = \eta\left(\frac{\pi D}{\lambda}\right)^2$, $P_N = kTB$

$FSL = 10\log_{10}\left(\frac{4\pi r}{\lambda}\right)^2$, $P_R = EIRP + G_R - losses$

$losses = FSL + RFL + AML + AA + PL$

$T_s = T_1 + \frac{T_2}{G_1} + \frac{T_3}{G_1 G_2} + \dots$, $T_e = (F-1)T_0$

$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots$, $N_0 = kT$

$T_{NW,i} = T_0(L-1)$, $NF = 10\log_{10} F$, $k = 1.38\times10^{-23}$

$EIRP = \Psi_M + A_0 + losses - RFL$, $A_0 = 10\log_{10}\left(\frac{\lambda^2}{4\pi}\right)$

$\frac{C}{N_0} = EIRP + \frac{G}{T} - losses - 10\log_{10} k$

$\frac{C}{N} = \frac{C}{N_0} - 10\log_{10} B_N$, $EIRP = EIRP_s - (BO)$

$P_{HPA} = EIRP - \frac{G}{T} + TFL$, $P_{HPA,sat} = P_{HPA} + BO$

$\frac{C}{N_0} = \frac{E_b}{N_0} + 10\log_{10} R_b$, $BER\Big|_{QPSK} = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$

$T_{rain} = T_0\left(1 - \frac{1}{A}\right)$, $Q(x) = \frac{1}{\sqrt{\pi}} e^{-x^2}$

$$\left(\frac{C}{N_0}\right)_{overall} = \frac{(C/N_0)_U \times \left(\frac{C}{N_0}\right)_D}{(C/N_0)_U + \left(\frac{C}{N_0}\right)_D}$$

$C(\text{at 3dB contour}) = EIRP_1 - 3 + G_B - FSL$

$I(\quad " \quad " \quad) = EIRP_2 - 3 + G_B(\theta) - FSL - Y_D$

$\left(\frac{C}{N}\right)_{REQ} - EIRP_s - \frac{G}{T} + losses + 10\log_{10} k + 10\log_{10} B_{TR} \le -(BO)_0 - \alpha$ (dB)

$10\log_{10} B = 10\log\alpha + 10\log_{10} B_{TR} - 10\log_{10} K$

$M = \underbrace{R_b}_{\text{total E.S}} T_F$, $R_{TDMA} = \underbrace{R_b}_{\text{total E.S}} \frac{T_F}{T_R}$, $\eta_F = 1 - \frac{\text{overhead}}{\text{total bits}}$, $n R_b = \eta_F R_{TDMA}$ (→ voice bit rate)