

Data Transfer HW 1

Hossein Dehghanipour - 9532250

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1 Question 1

1.1 A

$$P_{tx} = 10$$

$$Att = -20db$$

$$P_{rx} = ?$$

$$att = 10 * \log_{10} \left(\frac{P_{rx}}{P_{tx}} \right) \Rightarrow -20 = 10 * \log_{10}(\alpha) \Rightarrow \alpha = 10^{-2}$$

$$\alpha = \left(\frac{P_{rx}}{P_{tx}} \right) \Rightarrow \left(\frac{P_{rx}}{10} \right) = \frac{1}{100} \Rightarrow P_{rx} = \frac{1}{10} watt \Rightarrow P_{rx} = 10^2 mW$$

1.2 B

$$-10 = \log_{10} \alpha \Rightarrow -1 = \log_{10} \alpha \Rightarrow \alpha = 10^{-1}$$

$$\alpha_1 + \alpha_2 = 2 * 10^{-1} W \Rightarrow \text{Total Power} = 200mW$$

2 Question 2

$$TotalAttenuation = -12 + 35 - 10 = 13db$$

$$+13 = 10 * \log_{10} \left(\frac{P_{rx}}{4} \right) \Rightarrow 10^{1.3} = \left(\frac{P_{rx}}{4} \right) \Rightarrow P_{rx} = 79.8$$

3 Question 3

3.1 A

$$Nyquist : C = 2 * W * m$$

$$m = \log_2 M$$

$$M = 32 \Rightarrow C = 2 * 10K * \log_2 32 \Rightarrow C = 2 * 10K * 5 = 100kb/s$$

$$C = 10^5$$

3.2 B

$$C = BW * \log_2 \left(1 + \frac{S}{N}\right) \Rightarrow 100K = 10K * \log_2 \left(1 + \frac{S}{N}\right) \Rightarrow 10 = \log_2 \left(1 + \frac{S}{N}\right) \Rightarrow 2^{10} = 1 + \left(\frac{S}{N}\right) \Rightarrow \left(\frac{S}{N}\right) = 1023$$

$$SNR = 10 * \log_{10} \left(\frac{S}{N}\right) \Rightarrow SNR = 10 * \log_{10} 1023 \Rightarrow SNR \approx 30db$$

3.3 C

$$C_{new} = 2 * C_{old} \Rightarrow C_{new} = 2 * 100kb = 200kb = 2 * 10^5 b$$

$$2 * 10^5 = 10^4 * \log_2 \left(1 + \frac{S}{N}\right) \Rightarrow 20 = \log_2 \left(1 + \frac{S}{N}\right) \Rightarrow \frac{S}{N} + 1 = 2^{20} \Rightarrow \frac{S}{N} = 2^{20} - 1$$

$$SNR = 10 * \log_{10} \frac{S}{N} \Rightarrow SNR = 10 * \log_{10} 2^{20} - 1 \approx 60db \Rightarrow SNR \approx 60db$$

4 Question 4

$$N = 10mW$$

$$P_{tx} = 20dbmW \Rightarrow 10 \log_{10} 2 = 20 \Rightarrow \log_{10} S = 2 \Rightarrow P_{tx} = 10^2 mW$$

$$-5 = 10 \log_{\frac{P_{rx}}{100}} 10 \Rightarrow \left(\frac{-1}{2}\right) = \log_{P_{rx}} 100 \Rightarrow 10^{-5} = \frac{P_{rx}}{10^2} \Rightarrow P_{rx} = 10^{1.5} = S$$

$$C = BW * \log_2 \left(1 + \frac{S}{N}\right) \Rightarrow C = 2 * 10^6 * \log_2 (1 + 10^{0.5}) \Rightarrow C = 2 * 10^6 * \log_2 (3.16 + 1) \Rightarrow C = 2 * 10^6 * \log_2 (4.16) \approx 4MHz$$

5 Question 5

$$\log_{10} \left(\frac{E_b}{N_0}\right) = 4.2db$$

$$E_b = S * T_b = \frac{S}{R} \Rightarrow \left(\frac{E_b}{N_0}\right) = \left(\frac{S}{RN_0}\right) = \left(\frac{S}{RKT}\right)$$

$$\Rightarrow 10 \log_{10} \left(\frac{E_b}{N_0}\right) = 10 \log_{10} (S) - 10 \log_{10} (RKT) \Rightarrow 10 \log_{10} (S) = 10 \log_{10} (RKT) + 10 \log_{10} \left(\frac{E_b}{N_0}\right) \Rightarrow$$

$$10 \log_{10} (S) = 10 \log_{10} (RKT) + 4.2 \Rightarrow 10 \log_{10} (S) = 10 \log_{10} (270 * 3600 * 1.38 * 10^{-23}) + 4.2 \Rightarrow$$

$$10 \log_{10} (S) = -164.67 \Rightarrow \log_{10} (S) = -16.467 \Rightarrow S = 10^{-16.46} \approx 10^{-16}$$

6 Question 6

T_s : Sampling Time

T_x : TDM Sampling Time

n : Number of Samples

Sampling Rate : $\frac{1}{T_x}$

$$T_x = \frac{T_s}{n} \implies T_x = \frac{0.5\mu s}{120} \implies \text{Sampling Rate} = 240Mb/s$$

$$BW_{TDM} = \frac{1}{2T_x} \implies BW_{TDM} = 120MHz$$

7 Question 7

$$10 \text{ Channels} + 9 \text{ Guard Band} : \implies 10 * (4)KHz + 9 * (0.5)KHz = 40 + 4.5 = 44.5KHz$$

8 Question 8

8.1 A

$$\text{In FSK} : F_g > 0 \implies f_s - \frac{R}{2} > 0 \implies f_s - 1000 > 0 \implies f_s > 1000$$

$$\text{I Assume that} : f_s = 1200 \implies f_g = 200$$

$$BW = 1200 + 1000 = 2200$$

8.2 B

$$\text{In ASK} : BW = 2f_0 = R = 2kHz$$

8.3 C

$$\text{Both FSK and PSK are calculated with the same formula} \implies BW = 2f_0 = R = 2kHz$$

9 Question 9

$$10\log_{10}\left(\frac{E_b}{N_0}\right) = 10\log_{10}\frac{S}{N} + 10\log_{10}W - 10\log_{10}R \implies 18 = 15 + 10\log_{10}\frac{S}{R} \implies 3 = 10\log_{10}\frac{W}{R} \implies \left(\frac{W}{R}\right) = 10^{0.3} \implies B = \left(\frac{R}{W}\right) = \frac{1}{10^{0.3}} \approx 0.5$$
