

Data Transfer HW 1

Hossein Dehghanipour - 9532250

May 1, 2020

Contents

1	Question 1	1
1.1	A	1
1.2	B	1
2	Question 2	1
3	Question 3	1
3.1	A	1
3.2	B	2
3.3	C	2
4	Question 4	2
5	Question 5	2
6	Question 6	3
7	Question 7	3
8	Question 8	3
8.1	A	3
8.2	B	3
8.3	C	3
9	Question 9	3

1 Question 1

1.1 A

$$P_{tx} = 10$$

$$Att = -20db$$

$$P_{rx} = ?$$

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

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

1.2 B

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

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

2 Question 2

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

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

3 Question 3

3.1 A

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

$$m = \log_2 M$$

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

$$C = 10^5$$

3.2 B

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

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

3.3 C

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

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

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

4 Question 4

$$N = 10mW$$

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

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

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

5 Question 5

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

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

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

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

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

6 Question 6

7 Question 7

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

8 Question 8

8.1 A

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

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

$$BW = 1200 + 1000 = 2200$$

8.2 B

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

8.3 C

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

9 Question 9

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

$$\left(\frac{W}{R} \right) = 10^{0.3} \implies B = \left(\frac{R}{W} \right) = \frac{1}{10^{0.3}} \approx 0.5$$
