EECE 598, Homework 01, SOLUTIONS

1.2 In terms of wavelength, at a central wavelength of 1546 nm a 100-GHz channel spacing is

$$\Delta\lambda = \frac{\lambda^2}{c}\Delta f = \frac{(1546\,nm)^2}{3\times10^8\ m/s}\ 100\times10^9\ s^{-1} = 0.80\,nm$$

The number of wavelength channels fitting into the 1536-to-1556 spectral band then is N = (1556 – 1536 nm)/0.80 nm = 25.

1.3 Three sine waves have the following periods T: 25 μs, 250 ns, 125 ps. Their frequencies are f = 1/T = 40 kHz, 4.0 MHz, and 8 GHz, respectively.

1.6 Three signals have bit rates of R = 64 kb/s, 5 Mb/s, and 10 Gbps. The duration of a bit is T_b = 1/R = 15.6 μs, 200 ns, and 0.1 ns, respectively.

1.7 (a) Convert the following absolute power gains P_2/P_1 to decibel power gains: 10^{-3}, 0.3, 1, 4, 10, 100, 500, 2^n. Answer using Eq. (1.4): -30, -5.2, 0, 6, 10, 20, 27, 3n dB, respectively.

(b) Convert the following decibel power gains to absolute power gains: -30 dB, 0 dB, 13 dB, 30 dB, 10n dB. Answer: 10^{-3}, 1, 20, 1000, 10^n, respectively.

1.8 (a) Convert the following absolute power levels to decibel levels referenced to 1 mW: 1 pW, 1 nW, 1 mW, 10 mW, 50 mW. Answer using Eq. (1.5): -90 dBm, -60 dBm, -30 dBm, 10 dBm, and 17 dBm, respectively.

(b) Find the absolute power levels in units of mW of the following dBm values: -13 dBm, -6 dBm, 6 dBm, 17 dBm. Answer: 50 μW, 250 μW, 4 mW, and 50 mW, respectively.

1.9 (a) 10 log P_A/P_B = 10 log (0.125/1.0) = - 9.0. The attenuation is 9 dB.

(b) An attenuation of 15 dB means the power level drops by a factor of 31.6. Thus the power level at point B would be 32 μW.

1.10 Since the gains given in decibels are additive, the total gain is 15 dB. The signal is amplified by a factor $10^{1.5} = 31.6$.

1.11 A power level of 500 μW in dBm is 10 log (0.5) = -3 dBm. Therefore the power level after 30 km is -3 dBm - 24 dB = - 27 dBm, which is equivalent to 2.0 μW.