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Homework #3 – Chapter 2

Problem 8: (480 x 640) pixel/image (24 bit/pixel) (60 image/s) = 442.368 Mbps is the necessary data transfer rate. Since this is an ideal channel, we use the theoretical limit imposed by Nyquist: For bandwidth H, using 2-level logic, max rate $r = 2\ H \log_2(2) = 2\ H$.
Thus the required bandwidth is

$$H = (562.368)(10^6)\ s^{-1}\ (1/2) = \mathbf{221.184\ MHz}$$

We seek a band of wavelength about 1.3 microns, which corresponds to a band of frequency of width 281.184 MHz. The center frequency is

$$f = c/\lambda = (2.998)\ (10^8)\ m\ s^{-1} / (1.3)(10^{-6})\ m = 2.306154\ (10^{14})\ Hz$$

A band of 221.184 (10^6) Hz about this frequency, corresponds to a band of

$$B_\lambda = (1.3)(10^{-6})\ m\ (221.184)(10^6)\ s^{-1} / (2.306154\ (10^{14})\ s^{-1}) = (1.246834)(10^{-12})\ m$$

$$B_\lambda = \mathbf{1.2 \times 10^{-6}\ microns}$$

Problem 9:

$$f_1 = c / \lambda_1 = (2.998)\ (10^8)\ m\ s^{-1} / 1(10^{-2})\ m = 2.998\ (10^{10})\ s^{-1}$$

$$f_2 = c / \lambda_2 = (2.998)\ (10^8)\ m\ s^{-1} / 5\ m = 0.5996\ (10^8)\ s^{-1}$$

So the range of frequencies is **60 MHz to 30 GHz**

Problem 15: A hand-sketched drawing and some hand-waving were both helpful, but are not reproduced here. Suppose the satellite aligns with the person on the surface at latitude ϕ and the center of Earth, at time t_0 . The satellite will appear to be positioned straight overhead of the observer. Then, as time passes, the satellite will appear to sink toward the horizon and travel east. At time (t_0 + 6 hours), the satellite will drop below the horizon in the east. At time (t_0 + 18 hours), the satellite will appear above the horizon in the west, and will then rise toward the top of the sky as it travels from west to east. At time (t_0 + 24 hours), the satellite will be in the same location it started, and the cycle will continue.