LE/EECS 3213 E Communication Networks Fall 2014
Quiz #3, Thurs. Nov. 13, 2014 Name: ______________________

**1.** (*5 points*)

1.) [1] The power of an input signal is 1-mW (milliwatt). What is this power expressed in dBm?

$10 \log 1 = 0$ dBm

2.) [1] Which cable would you prefer if you wanted the best signal performance, UTP or coax?

coax

3.) [1] For physical media what typically happens to the attenuation as the signal frequency goes up?

it goes up (gets worse)

4.) [1] In an A-to-D what is the name of the block that follows the sampler block?

quantizer

5.) [1] What is the minimum sampling rate needed to convert a 22-kHz into discrete-time such that the signal can be perfectly recovered with a interpolation filter.

44 kHz or k Samples per second

**2.** (*5 points*) Suppose that WDM wavelengths in the 1675-nm band are separated by 0.1 nm. What is the frequency separation in GHz? What is the net data rate achievable if a total of 120 wavelengths are multiplexed?

$$\text{freq. separation} = \frac{v \cdot \Delta\lambda}{\lambda^2} = \frac{2\times10^8 \times 0.1\times10^{-9}}{(1675\times10^{-9})^2}$$

$$= 7.1285\times10^9 \text{ Hz}$$

$$= \boxed{7.1285 \text{ GHz}}$$

net R of ~~128~~ 120 wavelengths $= 120 \times 7.1285$

$= 855.4$ Gbps

**3.** (*5 points*) Suppose that a link between two optical hubs has 20 repeaters. Suppose that the probability that a repeater fails during a year is 0.005 and that repeaters fail independently of each other. What is the probability that the link does not fail at all over 10 years.

$p = 0.005$ failure in one year

$(1-p)$ : no failure of 1 repeater in one year

$(1-p)^{20 \times 10}$ : no failure of 20 repeaters in 10 years

$= 0.367$

$c = 3 \times 10^8$ m/s (in free space), $c = 2 \times 10^8$ m/s (in media), 1 nm $= 10^{-9}$ m, 1 ms $= 10^{-3}$ s, 1 GHz $= 10^9$ Hz

$$\log_x y = \frac{\log_a y}{\log_a x}$$

$$C = W_c \log_2(1 + \text{SNR})$$

$$y = \int_a^b x\text{d}x = \frac{x^2}{2}\Big|_a^b = (b^2 - a^2)/2, y = \int_a^b x^2\text{d}x = \frac{x^3}{3}\Big|_a^b = (b^3 - a^3)/3$$

$$y(t) = a_0 + \sum_{k=1}^{\infty} a_k \cos(2\pi f_0 \cdot k \cdot t) + \sum_{k=1}^{\infty} b_k \sin(2\pi f_0 \cdot k \cdot t)$$

$$f_0 = \frac{1}{T}, a_0 = \frac{1}{T}\int_0^T y(t)\text{d}t, a_k = \frac{2}{T}\int_0^T y(t) \cdot \cos(2\pi f_0 \cdot k \cdot t)\text{d}t, b_k = \frac{2}{T}\int_0^T y(t) \cdot \sin(2\pi f_0 \cdot k \cdot t)\text{d}t$$

$$\text{SNR [dB]} = 10\log(\text{SNR}), \text{SNR [dB]} = 6m - 10\log(3\sigma_x^2/V^2), \sigma_q^2 = \Delta^2/12$$

$$\mathcal{F}\{\text{rect}(t/T)\} = T\text{sinc}(fT) = T\sin(\pi fT)/\pi fT$$

$$\mathcal{F}\{\text{sinc}(t/T)\} = T\text{rect}(fT)$$

$$B = v\Delta\lambda/\lambda^2$$