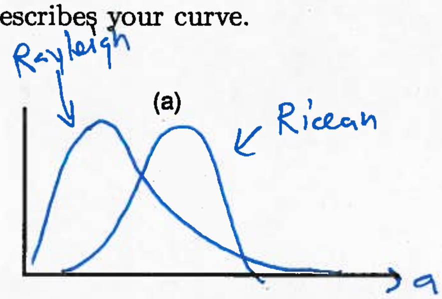
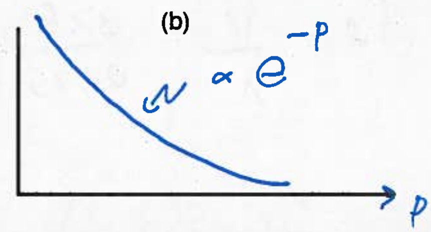
SC/CSE 4215 Mobile Communications Winter 2014
Quiz #1, Thurs. Apr. 3, 2014 Name: ______________________

**1.** (*4 points*)

**a.)** On coordinates (a) sketch the PDFs of the received signal amplitude (not power) of a signal coming through a Rayleigh channel and a signal on a Ricean channel with a very high K-factor [i.e. draw 2 curves on (a)].

**b.)** On coordinates (b) sketch the PDF of the received signal power and indicate what mathematical function best describes your curve.




**2.** (*3 points*) Channel measurements show a two impulse channel response, one at 0-dB and 2 $\mu$s arrival and a second at -1 dB at 2.8 $\mu$s. What is the RMS delay spread?

$p_1 = 1 \quad p_2 = 0.7943 = 10^{-0.1}$

$$\langle t_k \rangle = \frac{1 \times 2 + 0.7943 \times 2.8}{1.7943} = 2.35 \qquad \langle t_k^2 \rangle = \frac{1 * 2^2 + 0.7943 * 2.8^2}{1.7943} = 5.7$$

$$\sigma_d = \sqrt{\langle t_k^2 \rangle - \langle t_k \rangle^2} = 0.4213\ \mu s$$

**3.** (*3 points*) You are designing a receiver in a multipath channel capable of recovering signals with a correlation ($\rho$) of only 0.1 across frequency. If the rms delay spread of your channel is 2.3 ns what is the size of the spectrum that your system should be able to handle?

$$0.1 = \frac{1}{1 + 2\pi\, \Delta f \cdot (2.3n)}$$

$$1 + 2\pi (2.3n) \Delta f = 10$$

$$\Delta f = \frac{9}{2\pi \cdot 2.3n} < 623\,MHz$$

**4.** (*2 points*) You are using a 800-MHz cellular system in a car moving at 135 km/hr. What's the worst case carrier frequency shift that you can expect? Give your answer in Hz.

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{800\times10^6} = 0.375\ m$$

$$v = 135 \times 10^3 \times \frac{1}{60} \times \frac{1}{60} = 37.5\ m/s$$

$$f_d = \frac{v}{\lambda} = \frac{37.5}{0.375} = \underline{100\ Hz}$$

**5.** (*3 points*) You are using a wireless system operating at 500-kbps that experiences a Doppler shift of 200-Hz. Every how many bits will you have to adjust your channel equalizer to make up for temporal changes in the channel?

$$T_{coh} = \frac{9}{16\pi \times 200} = 7.2\ ms$$

adjust every $500 \times 10^3 \times 7.2 \times 10^{-3} = 3600$ bits

$$E = hf, \quad f = c/\lambda, \quad d = v \cdot t$$

$$f_A(a) = \frac{a}{\sigma^2} e^{-a^2/2\sigma^2}, m_A = \sigma\sqrt{\frac{\pi}{2}}, F_A(a) = \int_0^a f_A(\alpha)d\alpha = Pr\{A \le \alpha\}, f_P(p) = \frac{1}{\sigma^2} e^{-p/\sigma^2}$$

$$\sigma_d = \sqrt{\langle t_k^2 \rangle - \langle t_k \rangle^2}, \langle t_k \rangle = \sum_{i=1}^{M} p_i t_i / \sum_{i=1}^{M} p_i, \langle t_k^2 \rangle = \sum_{i=1}^{M} p_i t_i^2 / \sum_{i=1}^{M} p_i$$

$$\rho = \frac{1}{1 + 2\pi(f_2 - f_1)\sigma_d}, B_{coh} = \frac{1}{5\sigma_d}$$

$$f_d = \frac{v}{\lambda}\cos\theta, \rho = \mathrm{J}_0^2(2\pi f_d \tau), T_{coh} = \frac{9}{16\pi f_d}$$

$$Q\ [\mathrm{dB}] = 10\log(Q), \quad \log(A \cdot B/C) = \log(A) + \log(B) - \log(C)$$