ECSE-6961: Fundamentals of Wireless Broadband Networks
Spring 2007, Exam 1

Time: **75 min (strictly enforced)**

Points: **50**

YOUR NAME:

Be brief, but DO NOT omit necessary detail

{Note: Simply copying text directly from the slides or notes will not earn (partial) credit. Brief, clear and consistent explanation will.}

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I. [4 pts] <u>Wireless Technologies</u>

Compare and contrast UWB and Wimax technologies (use a couple of similarities and differences to make your case).

II. [6 pts] Wireless Concepts

Briefly explain

a) What are OFDM, CDMA and MIMO? Why are these concepts important in wireless broadband communications?

b) How is the effect of interference different from the effect of fading on system performance? What methods can be used to mitigate interference?

III. [6 pts] Small Scale Fading:

1. What is flat fading and how is it different from AWGN & large-scale path loss? Why is Rayleigh/Ricean a good statistical model for flat fading?
2. How exactly does multi-path fading lead to frequency-selectivity and ISI in a broadband channel?
3. How exactly does mobility lead to time-selectivity in the channel?

IV. [4 pts] Large-Scale Fading:

1. Explain the difference between path loss and shadowing? What is the impact of shadowing on cell design?
2. Why does the 2-ray path loss model decay as $1/d^4$ and has no frequency dependence whereas the 1-ray LOS path loss model decay as $1/d^2$?

V. [10 pts] <u>Probability:</u> A wireless channel has a BER (bit error rate) of 0.2, i.e. 20%. The transmitter wishes to transmit 15 bytes (= 120 bits) of data to the receiver. What is the expected number of bits that need to be transmitted on the channel for a successful transfer if :

- VI. **[10 pts] Linear Algebra:**

Consider the MIMO channel matrix H: $H = \begin{bmatrix} 7 & 3 \\ 3 & 1 \end{bmatrix}$.

Find its SVD (this decomposes the channel into parallel channels).

VII. [10 pts] [Shadowing, Outage, Modulation Choice:] Consider a WiMAX base station (BS) communicating to a subscriber, with the channel parameters: path loss exponent (α) = 5, Po = −25dB, d0 = 1m, shadowing parameter (σ_s) = 6dB. We assume a transmit power of P_t = 0.1 Watt (20 dBm), a bandwidth of B = 10 MHz. A received SNR of 3 dB is required for coded BPSK demodulation. Consider ambient noise with a typical power spectral density of No = −173dBm/Hz, with an additional receiver noise figure of Nf = 4 dB (noise from all other sources).

$$P_r = P_t P_o \chi \left(\frac{d_o}{d}\right)^{\alpha}$$

- At a distance of 300 meters from the base station, what is the likelihood that the BS can reliably send BPSK? Use the simple empirical shadowing model: