COLUMBIA UNIVERSITY

ELEN E4703 Wireless Communications Prof. Diament

Midterm Exam -- 75 minutes March 19, 2007

CLOSED-BOOK EXAM -- No books, no notes, no scratch paper. CALCULATOR ALLOWED.

1. [20%] Consider an idealized hexagonal model of a cellular system with base stations at the centers of the cells. The cluster size is 13 and we measure the interfering signal level from the nearest co-channel cell to be 28 dB below the weakest in-cell power level. What is the path loss exponent for the environment?

Some possibly relevant formulas: $N = i^2 + ij + j^2$ $D/R = (3N)^{1/2}$ $S/I = (D/R)^n/i_o$

2. [25%] A cell phone used by a truck driver operates at 1.1 GHz and has a short antenna, 2.2 m above the roadway. The base station has an antenna of 16 dB gain installed 13 m above the ground. The truck is 8.8 km from the base station. By how many dB is the received signal weaker than it would have been if the ground were perfectly absorbing rather than reflective?

Some formulas: $G_1A_{e2}/4\pi d^2$ $G_1G_2\lambda^2/(4\pi d)^2$ $G_1G_2h_1^2h_2^2/d^4$ $G_1G_2\lambda^2\sigma/(4\pi)^3d_1^2d_2^2$

3. [20%] A trunked intercom system has 12 channels, of which 8 are currently busy. The traffic intensity averages 0.6 erlangs per user and the entire system can handle up to 7.5 erlangs. The GOS is specified to be a 2% probability of blocking.

If you had tables of the erlb(C, A) and erlc(C, A) functions, how would you determine whether the system can meet the specification of the GOS? Specify the arguments C, A that you would use in the appropriate function.

4. [15%] A novel type of antenna is claimed to produce a uniform radiation intensity within a solid angle of 0.45 steradians in a northerly direction but also radiates backward uniformly within a solid angle of 0.75 steradians in a southerly direction, at half the intensity of the northward radiation. Assume the antenna is lossless. Find the directivity of this antenna.

Recall: $D = (4\pi/P)(dP/d\Omega)_{max}$

5. [20%] In a system for which the lognormal path loss model is valid, the noise floor kTBF is known to be −80 dBm. The statistical average of the power level at the receiver is measured as −45 dBm with a standard deviation of 5.5 dB. What is the maximum signal-to-noise ratio (SNR, in dB) that can be specified at the receiver to ensure that there be no more than a 2% probability that the received signal will drop below the noise threshold?

From tables: $Q(0.02) = 0.492$ $Q(0.98) = 0.164$ $Q(2.054) = 0.02$ $Q(-2.054) = 0.98$