Radio Engineering Exam

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1. Consider a wireless LAN system with the following system specifications:

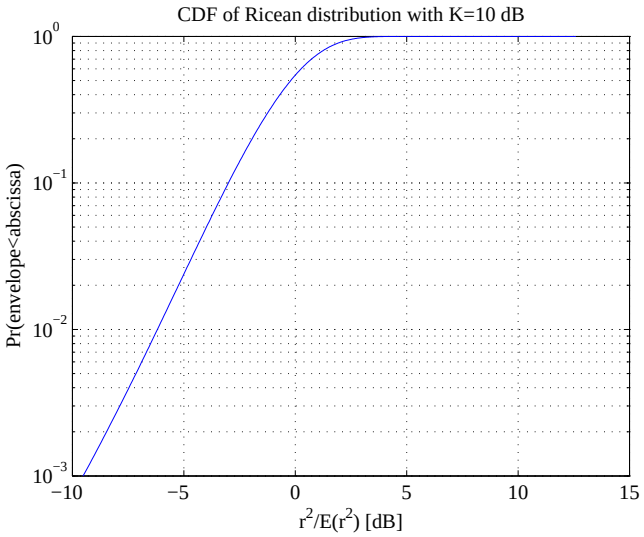
   - $f_c = 5$GHz
   - $B = 20$ MHz
   - $G_{TX} = 2$dB
   - $G_{RX} = 2$dB
   - Fading margin = 16 dB
   - Pathloss = 90 dB
   - $P_{TX} = 20$dBm
   - TX losses: 3 dB
   - Required SNR: 5 dB

   (a) What is the maximum permitted value of the receiver noise figure?

   (b) What is the equivalent input noise temperature of such a receiver?

2. Consider the Extended Typical Urban (ETU) channel model specified in 3GPP TS 36.101:

Excess tap delay [ns]	**Relative power [dB]**
0	-1.0
50	-1.0
120	-1.0
200	0.0
230	0.0
500	0.0
1600	-3.0
2300	-5.0
5000	-7.0



(a) Calculate the average delay, the RMS delay spread, and the approximate coherence bandwidth.

(b) Assuming an LTE system with 5MHz bandwidth, would you say that the system narrowband or wideband. What if the system bandwidth was 1.25MHz?

3. A mobile receiver is known to produce acceptable bit error rates at SNR above 7dB.

   (a) What mean SNR is required in a Rayleigh channel for acceptable error rates to be achievable 99.9% of the time?

   (b) If the mobile is operating in a Rice channel with Rice factor $K = 10$, what mean SNR is required (use the cdf of a Ricean distribution for $K = 10$ from the Figure above).

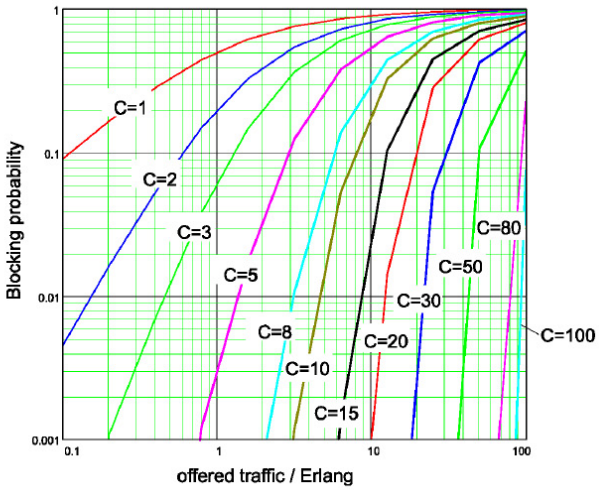
   (c) Comment on both results

4. Assume that a system needs a $C/I = 10$dB to work at an acceptable quality. Further assume that the path loss decays with a path loss exponent on $\eta = 3.5$ and the system requires a fading margin of 5 dB.

   (a) Compute the necessary reuse distance and the minimum cluster size

Erlang-B

Relation between blocking probability and offered traffic for different number of available speech channels in a cell.



(b) Assume that the operator has 5 MHz spectrum and that each channel has a bandwidth of 200kHz. How man channels per cell are there available?

(c) Assume an Erlang-B system with a blocking probability of 10 %. What is the offered traffic in Erlang (Use the Figure above)?

(d) The city of Nice has a population density of 5000 people per km^2. Assuming that every person generates a traffic of 2 milli-Erlang, what is the required cell radius (assume that each cell covers a surface of $A = r^2\pi$).

5. (a) What are the main technical challenges of a wireless communication system compared to a wired system?

(b) What are the different physical propagation mechanisms radio waves undergo?

(c) Explain the difference between shadow fading and multipath fading?

(d) Channel modeling can be classified in several methods. Describe each of these methods briefly.

(e) What is the model commonly used to model shadow fading effects in a cellular system?

(f) What assumptions are made by modeling a radio channel as a WSS-US process.

(g) What distribution is normally used for modeling multipath propagation with a steady line-of-sight component?

(h) What is the coherence time and the Doppler spread of a channel? What is their relationship?

(i) State the three advantages of MIMO systems. What are the requirements on the MIMO channel in order to exploit these advantages.

(j) Briefly explain the principle of diversity and cite some diversity techniques.

(k) What is the difference between macroscopic diversity and microscopic diversity?

(l) Explain the difference between mutual coupling and correlation in MIMO channels.