30.3 Chapter 3: Noise- and Interference-Limited Systems

1. Consider an RX that consists (in this sequence) of the following components: (i) an antenna connector and feedline with an attenuation of 1.5 dB; (ii) a low-noise amplifier with a noise figure of 4 dB and a gain of 10 dB, and a unit gain mixer with a noise figure of 1 dB. What is the noise figure of the RX?
2. Consider a system with 0.1-mW transmit power, unit gain for the transmit and receive antennas, operating at 50-MHz carrier frequency with 100-kHz bandwidth. The system operates in a suburban environment. What is the receive SNR at a 100-m distance, assuming free-space propagation? How does the SNR change when changing the carrier frequency to 500 MHz and 5 GHz? Why does the 5-GHz system show a significantly lower SNR (assume the RX noise figure is 5 dB independent of frequency)?
3. Consider a GSM uplink. The MS has 100-mW transmit power, and the sensitivity of the BS RX is -105 dBm. The distance between the BS and MS is 500 m. The propagation law follows the free-space law up to a distance of $d_{\mathrm{break}} = 50$ m, and for larger distances the receive power is similar to $(d/d_{\mathrm{break}})^{-4.2}$. Transmit antenna gain is -7 dB; the receive antenna gain is 9 dB. Compute the available fading margin.
4. Consider a wireless LAN system with the following system specifications:
   $f_{\mathrm{c}} = 5$ GHz
   $B = 20$ MHz
   $G_{\mathrm{TX}} = 2$ dB
   $G_{\mathrm{RX}} = 2$ dB
   Fading margin = 16 dB
   Path loss = 90 dB
   $P_{\mathrm{TX}} = 20$ dBm
   TX losses: 3 dB
   Required SNR: 5 dB
   What is the maximum admissible RF noise figure?
5. Consider an environment with propagation exponent $n = 4$. The fading margin between the median and 10% decile, as well as between the median and 90% decile is 10 dB each. Consider a system that needs an 8-dB SIR for proper operation. How far do serving and interfering BSs have to be apart so that the MS has sufficient SIR 90% of the time at the cell boundary? Make a worst case estimate.

30.4 Chapter 4: Propagation Mechanisms

1. Antenna gain is usually given in relation to an isotropic antenna (radiating/receiving equally in all directions). It can be shown that the effective area of such an antenna is $A_{\mathrm{iso}} = \lambda^2/4\pi$. Compute the antenna gain G_{par} of a circular parabolic antenna as a function of its radius r, where the effective area is $A_{\mathrm{e}} = 0.55A$ and A is the physical area of the opening.
2. When communicating with a geostationary satellite from Earth, the distance between TX and RX is approximately 35,000 km. Assume that Friis' law for free-space loss is applicable (ignore any effects from the atmosphere) and that stations have parabolic antennas with gains 60 dB (Earth) and 20 dB (satellite), respectively, at the 11-GHz carrier frequency used.
   (a) Draw the link budget between transmitted power P_{TX} and received power P_{RX}.
   (b) If the satellite RX requires a minimum received power of -120 dBm, what transmit power is required at the Earth station antenna?
3. A system operating at 1 GHz with two 15-m-diameter parabolic antennas at a 90-m distance are to be designed.