Department of ICT, MIT, Manipal
Principles of Data Communication [ICT 2156]
Tutorial 4

1. A telephone line is known to have a loss of 20 dB. The input signal power is measured as 0.5 W, and the output noise level is measured as 4.5μW. Using this information, calculate the output signal-to-noise ratio in dB.

2. Show that doubling the transmission frequency or doubling the distance between transmitting antenna and receiving antenna attenuates the power received by 6 dB.

3. The audio power of the human voice is concentrated at about 300 Hz. Antennas of the appropriate size for this frequency are impracticably large, so that to send voice by radio the voice signal must be used to modulate a higher (carrier) frequency for which the natural antenna size is smaller.
   a. What is the length of an antenna one-half wavelength long for sending radio at 300 Hz?
   b. Suppose we would like a half-wave antenna to have a length of 1 meter. What carrier frequency would we use?

4. Suppose a transmitter produces 50 W of power.
   a. Express the transmit power in units of dBm and dBW.
   b. If the transmitter's power is applied to a unity gain antenna with a 900-MHz carrier frequency, what is the received power in dBm at a free space distance of 100 m?
   c. Repeat (b) for a distance of 10 km.
   d. Repeat (c) but assume a receiver antenna gain of 2.

5. A microwave transmitter has an output of 0.1 W at 2 GHz. Assume that this transmitter is used in a microwave communication system where the transmitting and receiving antennas are parabolas, each 1.2 m in diameter.
   a. What is the gain of each antenna in decibels?
   b. Taking into account antenna gain, what is the effective radiated power of the transmitted signal?
   c. If the receiving antenna is located 24 km from the transmitting antenna over a free space path, find the available signal power out of the receiving antenna in dBm units.

6. With no intervening obstacles, the optical line of sight can be expressed as $d = 3.57\sqrt{h}$ where *d* is the distance between an antenna and the horizon in kilometers and *h* is the antenna height in meters. Using a value for the earth's radius of 6370 km, derive this equation. *Hint:* Assume that the antenna is perpendicular to the earth's surface, and note that the line from the top of the antenna to the horizon forms a tangent to the earth's surface at the horizon. Draw a picture showing the antenna, the line of sight, and the earth's radius to help visualize the problem.

7. Determine the height of an antenna for a TV station that must be able to reach customers up to 80 km away.