# ECEn 665
# Antennas and Propagation for Wireless Communication

Homework #17
Due Mar. 20, 2023

1. (a) For a single antenna with input impedance $50\,\Omega$ and ohmic resistance $1\,\Omega$, find the radiation efficiency as a transmitter. (b) Considering the same antenna as a receiver in thermal equilibrium with an isotropic thermal noise environment with brightness temperature $290\,$K, find the external noise power in 1 MHz bandwidth in dBm using Eq. (5.43), the loss noise power in dBm using Eq. (5.46), and the isotropic noise response in dBm using Eq. (5.45). (c) From these values, compute the receiving efficiency of the antenna.

2. Numerically simulate a Rayleigh multipath channel. Choose a transmitter location $(x_t, y_t)$, an array of locations $[x_r(t_m), y_r(t_m)]$ modeling a moving receiver, and random coordinates $(x_n, y_n)$ for $N_s$ scatterers. The receiver should at least a few wavelengths in total and a fraction of a wavelength in each time step. Model the electric field intensity at the receiver using $E = \sum_{n=1}^{N_s} R_n e^{-jkr_n}/r_n$ where $R_n$ is a reflection coefficient and $r_n$ is the total path distance from the transmitter to the $n$th scatterer and then to the receiver. For a simple channel model, $R_n = 1$, or the reflection coefficient can be uniformly distributed with magnitude between zero and one.
   (a) Plot the time history of the received power on a dB scale.
   (b) Use the `hist` command to generate the PDF of the received field magnitude as the receiver moves along a line through the propagation environment. Convert the output of the `hist` function to a PDF estimate by rescaling to integrate to one. Plot your simulated PDF overlaid with the expected PDF.
   (c) Create a similar plot for the received power or SNR with noise power equal to unity with your estimated PDF overlaid with the expected PDF. You can compute the variance parameter from the real or imaginary part of your received field samples.