EE 115 Lab 1

1) In this task, we will examine the average power of a random signal that has its minimum value larger than or equal to -1, and also examine its impact on the power efficiency of the conventional amplitude modulation (AM) signals.
   a) Use the Gaussian-random-number generator to generate a random sequence
   $$m[0], m[1], \cdots, m[N]$$
   where N could be 200 or some other large integer.
   b) Determine the minimum value of the sequence and denote it by $-M_0$.
   c) Compute the normalized sequence $m_n[k] = \frac{1}{M_0} m[k]$ whose minimum value should be now -1.
   d) Compute the average power of $m_n[k]$ by $P_m = \frac{1}{N} \sum_{k=1}^{N} m_n^2[k]$.
   e) If we apply the conventional AM to $m_n(t) = m_n[k] rect(\frac{t-k}{T})$ where $rect(\frac{t}{T})$ is a rectangular pulse of width equal to T, the resulting AM signal is
   $$u_{AM}(t) = A_c(a_{mod} m_n(t) + 1)\cos(2\pi f_c t) \tag{1}$$
   and then its power efficiency is
   $$\eta_{AM} = \frac{a_{mod} P_m}{1 + a_{mod} P_m}. \tag{2}$$
   Plot η_{AM} versus P_m subject to $0 < P_m < 1$ for each of $a_{mod} = 1, 0.75, 0.5$.

2) In this task, we will examine the quality of a simple DC blocker which consists of a capacitor C and a resistor R (in serial connection). We know that the frequency response $H(f)$ of the DC blocker is
$$H(f) = \frac{R}{R + \frac{1}{j2\pi C}} = \frac{j2\pi f}{j2\pi f + \frac{1}{RC}}. \tag{3}$$
   a) Plot $|H(f)|$ versus f within $-50 < f < 50$ in Hz (or some other better choice of range) for each of $RC = 0.01, 0.1, 1, 10$.
   b) Repeat the above but plot $20\log_{10}|H(f)|$ (which is in dB) versus f. Here, to avoid the negative infinity at $f = 0$, you can set the range from -60dB to 0dB.
   c) If we want to remove the DC component from $a_{mod} m_n(t) + 1$ where the spectrum of (real-valued) $m_n(t)$ occupies the band from 20Hz to 5KHz (and also from -5KHz to -20Hz), what should be an acceptable range of the RC values? (Hint: What should be the minimum value of RC such that $0.95 \leq |H(f)| \leq 1$ for $|f| \geq 20$Hz?)