ECEN 220 - Signals and Systems
Lab 2: Fourier Series

1) First, let us consider the Fourier Series and demonstrate its convergence properties with increasing number of harmonics.
   Consider a periodic signal with a period of $T_0 = 3$, where on each cycle
   $$x(t) = e^{-t}, \quad 0 \leq t \leq 3$$
   a) Plot $x(t)$ over a time interval of $0 \leq t \leq 3$.
   b) Compute the exponential FS coefficients a_k by numerical integration. Use the `quad` command. Since we cannot consider the exact FS with infinite terms, we will consider $2K + 1$ terms, ie
   $$\hat{x}(t) = \sum_{k=-K}^{K} a_k e^{jk\omega_0 t}$$
   Generate a plot of the $\hat{x}(t)$ as approximated by $K = 1, 5, 10, 30$ terms, superimposed on top of the true $x(t)$. Plot only one period, i.e., $0 \leq t \leq 3$.
   Hint: The `quad` command takes as its first argument the function handle of the integrand. For example, to compute
   $$g = \int_0^{1000} t^{z-1} e^{-t} dt$$
   for $z = 0.5$, one would enter
   ```
   z=0.5;
   F = @(t)(t.^(z-1)).*exp(-t);
   g = quad(F,0,1000)
   ```
   c) For the $K = 10$ case also plot the magnitude and the phase of the FS coefficients. Use the `stem` command.

2) Consider another periodic signal, with a period $T_0 = \pi$ where for each cycle
   $$x(t) = \sin(t)e^{-t}, \quad 0 \leq t \leq \pi$$
   Verify Parceval's identity by computing the average power of $x(t)$, P_x, by numerical integration and also by summing up the power in each FS coefficient.

Hand in the published Matlab code.