Homework 1
due November 1, 23:59

1. Q6, 7, 8 from HW0.
2. **MATLAB:** In this part, you will modulate the bit stream, $s = \{1, 0, 1, 1, 1, 1, 0, 0\}$, with the following modulation schemes.
   (a) BPSK,
   (b) QPSK,
   (c) 4-PAM,
   (d) 16-QAM,
   (e) Binary FSK.

   For each modulation scheme, give the following:
   - The constellation diagram of the modulation scheme,
   - Sinusoidal waveforms to represent the symbols in the constellation diagram (one waveform per symbol),
   - The modulated pulse stream that represents the given bit stream.

   Note:
   - Use MATLAB for coding and plotting.
   - For all symbols, use sinusoidal waveforms with the frequency of 5 Hz and the period for each symbol (symbolling period) as 1 s. Therefore you need to repeat the waveform to produce one symbol.
   - Normalize the waveforms so that the average symbol energy for each constellation is unity.
   - You may need multiple bits per waveform for some of the modulation schemes given above. Notice that you are given a stream of binary symbols (bits) and you can convert them to M-ary symbols easily.
3. (a) Find an orthonormal basis, ρ_i, for the set of the following vectors. Then express s_j, in terms of ρ_i's. $(i, j \in \{1, \ldots, 4\})$.

$$\begin{aligned} s_1 &= (2, -1, -1, -1), \\ s_2 &= (-2, 1, 1, 0), \\ s_3 &= (1, -1, 1, -1), \\ s_4 &= (1, -2, -2, 2). \end{aligned}$$

   (b) Now, find an orthonormal basis, ψ_i, for s_j's by the Gram-Schmidt orthonormalization method. Then express s_j, in terms of ψ_i's.

Report and Submission:

Part 1: The rules for HW0 apply.

Part 2: The MATLAB part of your report should include the plots - all axes have to be labelled and all plots have to be captioned. Avoid huge blank spaces in your report (use subplots in MATLAB if necessary). Explain every figure you have in your report. This part does not need to exceed two pages. Also, you must upload the m-file that includes the code -with necessary comments- that executes this part.

Part 3: You can prepare your answer for this part either handwritten or on computer. Handwritten reports have to be scanned for upload. Make sure your scans are readable.

Upload two documents: a single pdf document as your report, and one m-file for Part 2. There are many free websites where you can convert/edit/crop pdf files.

ALL SUBMISSIONS ARE ON MOODLE. Late submission is penalized with 10% per day.