Indian Institute of Technology Dharwad, Karnataka, India

EE 309: Introduction to Communication Systems
Project Components: 1 and 2 (Autumn 2020)

Component 1 Due date: On or before 20th October 2020, 23:59:59 IST
Component 2 Due date: On or before 24th October 2020, 23:59:59 IST

Instructions

1. The first question is Component 1 and the second question is Component 2.
2. For Component 1, provide a short description about the approach you used to design the transmitter and the receiver. This can be hand-written
3. For Component 2, provide a detailed answer to the first part. This can be hand-written.
4. As usual, discussion is allowed. But copying is not allowed. Any kind of copying, like copying of solutions, copying the project code by simply changing variable names, etc. will result in zero marks for this entire project component.

Questions

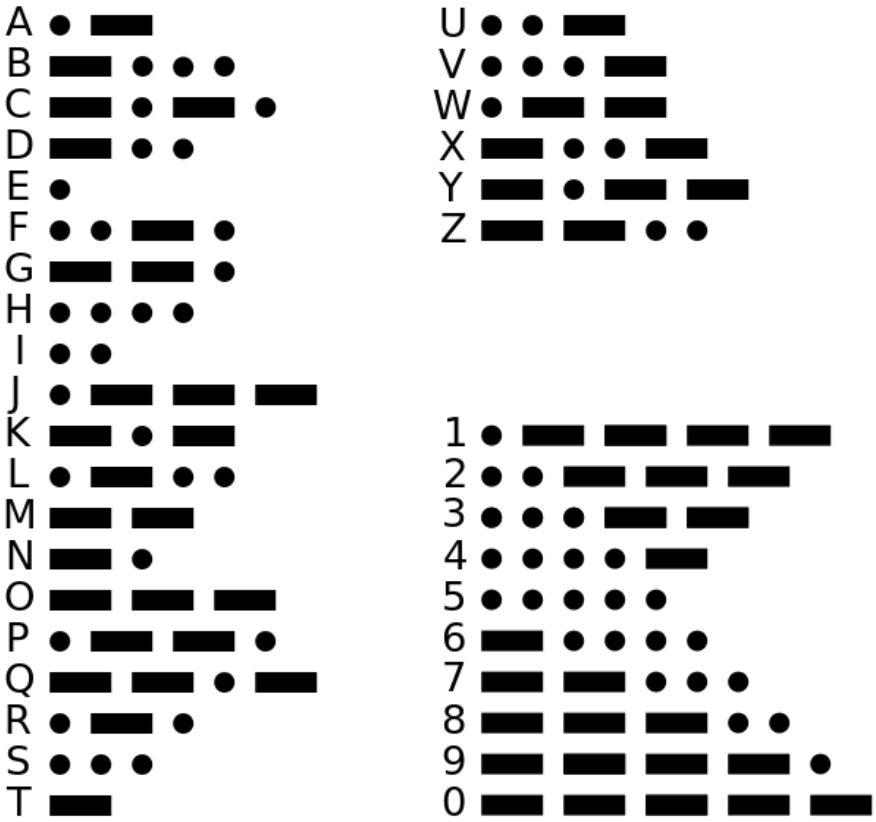
1. (50 points) **Interstellar:** The pilot Cooper has reached the Tesseract and the robot TARS is close to the black hole. TARS wants to send the messages to Cooper using Morse code. Assume that the laws of electro-magnetics work in the same way as on Earth.

   Design a digital communication system for TARS and Cooper using BPSK modulation/demodulation, which incorporates Morse code encoder at the transmitter and the corresponding decoder at the receiver. Note that dot is 1 unit and dash is 3 units. Cooper should be able to decode letters, numbers and words. Plot graphs of letter error rate vs. SNR and word error rate vs. SNR.

   The International Morse Code is given below for your reference.

International Morse Code

1. The length of a dot is one unit.
2. A dash is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.



2. (50 points) **The real ML:** You are exploring the maximum-likelihood (ML) detection rule for binary signalling in a wireless communication channel (with each symbol having the same prior probability). The channel (h) itself is a random number modelled using a complex Gaussian with zero mean and unit variance. You use equal-energy binary signalling as shown in the figure below. The received signal model is $\mathbf{y} = h\mathbf{x} + \mathbf{n}$, where $\mathbf{x} \in \{\mathbf{s_o}, \mathbf{s_1}\}$ is the transmitted signal and n is the noise.
   (a) (15 points) Determine the log-likelihood ratio of the ML detector.
   (b) (35 points) Simulate this system on MATLAB and plot a graph of BER vs. SNR.