Q1. a (4 degrees)
   How many passwords can be constructed from “3” English letters followed by “5” decimal digits.

b. (6 degrees)
   Show that the capacity of the symmetric channel is independent from the source probability.

Q2. a. (5 degrees)
   A binary system send a sequence of 6 binary digits 101100, if the probability of 1’s is quarter as the probability of 0’s, compute the amount of information that the above message convey.

b. (10 degrees)
   A binary system produce Dots half times as Spaces, 25% of the Dots are received in error and 12.5% of the Spaces, find:
   a. The information received for all possible combination of input and output.
   b. The average mutual information received.

Q3. a. (5 degrees)
   Assume that you are encountered with the problem of encoding a source of alphabet consist of 63 letters, how many Binary, Octal, and Hexadecimal digits you need to encode the symbols of this source.

b. (10 degrees)
   a source produce a stream of letters (A, B, C, D) where:
   • P(A) is half as P(C).
   • P(B) is Quarter as P(C)
   • P(D) is equal to the summation of P(A) and P(B).
   Find:
   a. The amount of information that each letter convey.
   b. The entropy of this source.
   c. How can you adjust this source so that you can make it gives the maximum information.
Q4. (15 degrees)
Consider a uniform ternary channel having **error** transmission probability of 0.1, and being used in conjunction with a ternary source which produce three symbols x₁, x₂ and x₃ with the below probabilities:
- P(x₁) is greater than P(x₂) by 0.2.
- P(x₂) is less than 2P(x₃) by 0.1.

a. Give the channel matrix.
b. Find the entropy for the receiver.
c. Find the noise entropy.
d. Find the average mutual information.
e. Find the channel efficiency and redundancy.

Q5. (15 degrees)
A source produce 6 independent symbols x₁, ..., x₆ with the below probabilities:
- P(x₂) greater than 2 P(x₄) by 0.05.
- P(x₃) less than 2 P(x₄) by 0.05.
- P(x₅) equal to the summation of P(x₂) and P(x₃).
- P(x₁) = P(x₆) = half of P(x₄).

Construct Huffman code for the above source code then find the code efficiency.

Q6. (15 degrees)
A ternary source produce 3 symbols A, B and C with the below probabilities:
- The summation of P(A) and P(B) is equal to 0.4.
- The subtraction of P(B) from P(C) is equal to 0.3.

Find the efficiency of the code for the 1ˢᵗ, 2ⁿᵈ extension of this source.

Do well