# THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY ISDN 2602

**Laboratory 4: Source and Channel Coding (5%)**

**Answer Sheet**

Please write down your answer here and submit your answer on GitHub by Wednesday (Oct 29th) 23:59

***Part I: Source Coding***

# Task 1 – Length of the bit streams

In this task, we will compare the lengths of the bit streams for four source coding algorithms applied to a black-and-white image: "raw" image encoding, run-length encoding with lengths encoded as 8-bit binary numbers, and run-length encoding with lengths encoded by Huffman coding with one or two dictionaries.

# Check Point:

1. Write down the lengths of the bit streams using “raw” image encoding and the run-length encoding. Is the run-length code better than the raw encoding? **Explain why**.  
     
   The Raw encoding is: 250000, and the Run-Length encoding is 301688. It is not better than the raw encoding because there are various short runs within the image, and when run-length encoding is utilized, it starts a new bit every time a color is changed, with shorter run lengths, every switch is a new run length which for a picture with fine detail, it can be possible each run is only 1-2 pixels but stored as 8 bit runs. The Huffman code is 117374 and 100981.
2. Type “help transpose” in the command window to learn how to perform matrix transpose operation on a matrix in MATLAB. Revise the MATLAB codes so that the image will be rotated along the diagonal. Then, write down and compare the lengths of the bitstreams for these four source coding algorithms before and after the rotation. **Explain why**.

The raw remains the same, but the run-length code becomes 196680, and the Huffman codes become 134892 and 120565. The run-length code decreased because when it is transposed, the run-lengths are longer, and there is a lower frequency of color change. In the Huffman, when it is transposed, the distribution of values and pixel probabilities becomes more equal, which is not ideal for the Huffman code's use in compression.

***Fill in the answers to the blanks and Show your result to the TA.***

# Task 2 – Huffman code

In this task, you will generate the Huffman code for a set of run-lengths, and use it to encode the run- lengths of black or white pixels. You will find that Huffman coding enables us to encode the sequence of run lengths using fewer bits than the standard 8-bit encoding.

# Check point:

1. Find an optimal dictionary to represent these 11 symbols using the symbol probabilities and the Huffman coding algorithm. Once you have found it, replace the value of **dict** defined between the line:

*% % % % Revise the following code to generate a valid and efficient dictionary % % % %*

and

*% % % % Do not change the code below % % % %*

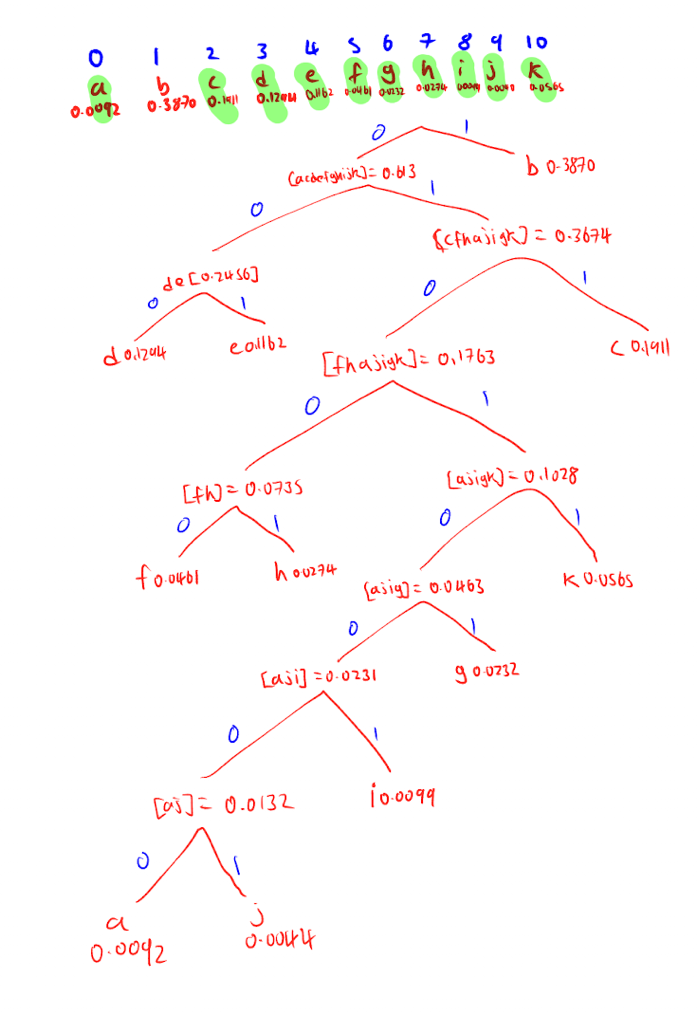
The remaining part of the code uses this dictionary to encode the run lengths, and to measure the length of the resulting bit stream. It also checks whether the dictionary is valid by reconstructing the image from the run lengths encoded by the dictionary using the function **huffman\_encode\_dict**. If your dictionary is correct, the original and reconstructed images should be the same and the **size\_huffman** should be equal to 117374.

dict = {[0 1 0 1 0 0 0 0], [1], [0 1 1], [0 0 0], [0 0 1],...

[0 1 0 0 0], [0 1 0 1 0 1], [0 1 0 0 1], [0 1 0 1 0 0 1], [0 1 0 1 0 0 0 1],[0 1 0 1 1]};

# (Commit the revised codes to GitHub. Show your results to TAs.)

1. Attach the corresponding Huffman tree of the revised optimal dictionary.



***Fill in the answers, commit the revised codes to GitHub***

***and Show your result to the TA.***

***Part II: Channel Coding***

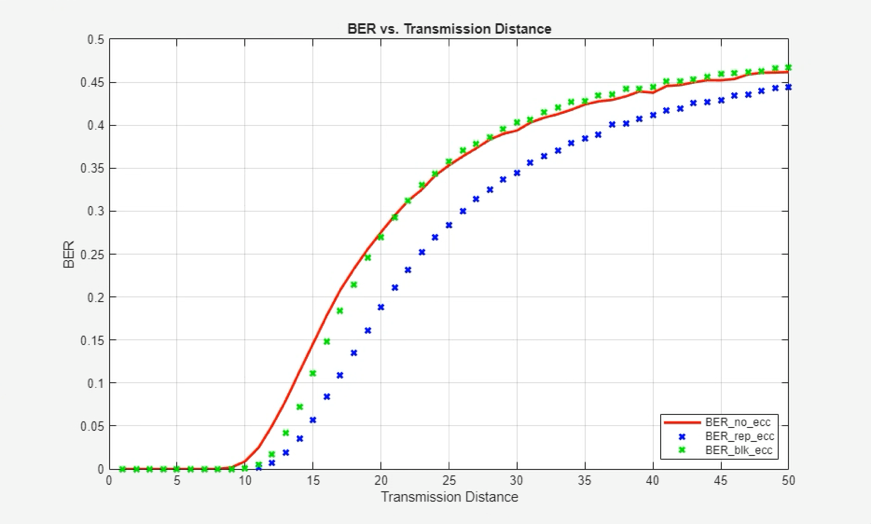


# Task 3 – (n,k) block code decoder and Error Correction Capability

In this task, we will implement the (n,k) block code decoder and compare the error correction capability of the repetition code, hamming block code, and no error correction code.

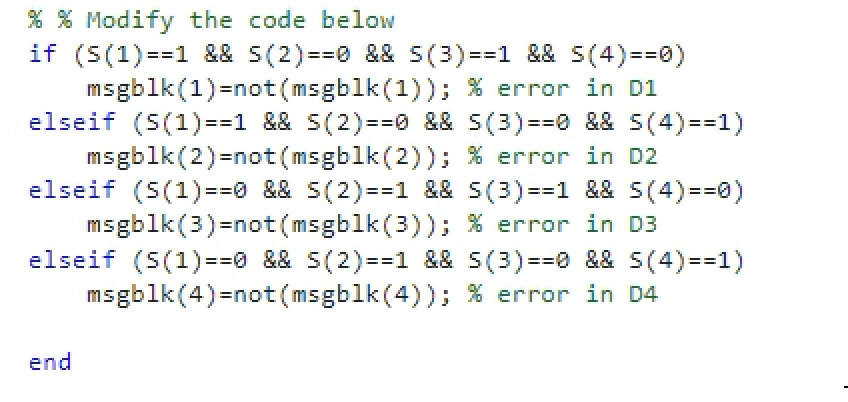
# Check point:

1. Generate a figure with three curves representing the BER performance.



# （Show your results to the TA）

1. Write down/Insert a screenshot of the modified code in “**blk\_decoder.m**”.



**(Commit the revised codes to GitHub. )**

1. Based on your observations, which coding scheme performs the best? **Explain why**.

The Huffman code performs the best as it achieves the most efficient compression while transmitting fewer bits, resulting in lower bit error rates under noisy channel conditions.

***Fill in the answers, commit the revised codes to GitHub***

***and Show your result to the TA.***

**----------------------------------End-----------------------------------**