**Week 1 Tutorial**

**Problem 1**

Given an analogue signal has a bandwidth of 2700 Hz, amplitude range of -2.5v to +2.5v, and dynamic range of 13 dB (ratio of peak to mean signal power). The signal is to be converted into binary PCM using uniform quantisation with the aim of that the signal to be reproduced at the receiver output with minimum SQNR of 40 dB.

1. Determine the step size of the uniform quantizer.
2. Determine the quantisation error (in percentage) with respect to the peak signal amplitude.

**Problem 2**

There are 4 analogue signals, each has a bandwidth of 5000 Hz are to be digitised and transmitted over an AWGN channel.

Determine the minimum bit rate of this system if the signal is quantised to 4 bits code per sample.

**Problem 3**

A band-limited signal *m*(*t*) of 3 kHz bandwidth is sampled at rate of 33.33% higher than the Nyquist rate.

The maximum allowable error in the sample amplitude (*i.e.*, the maximum quantization error) is 0.5% of the peak amplitude *mp*. Find the minimum channel bandwidth required to transmit the digitised signal modulated using 4 multilevel signal.

**Problem 4**

Given below is a Huffman coding tree:

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1. Determine the Huffman code for each symbol
2. Determine the average code length
3. Determine the entropy of the source
4. Determine the coding efficiency of this code
5. Suggest a way to improve the efficiency