**ELG3175 Deferred Exam Summer 2016**

**Directives**

1. This is a closed book exam
2. Answer all questions
3. Show your work
4. Calculators permitted
5. A list of Fourier Transforms and their properties and trigonmetric identities is provided at the end of the exam

**Question 1 (25 points = 4+3+3+4+7+4)**

A baseband signal is expressed as m(t) = 3cos220t +2cos250t + cos2100t.

1. If we transmit m(t) using conventional AM, find the expression of the AM signal if the modulation index is 0.8, the carrier amplitude is 4V and the carrier frequency is 5kHz.
2. Sketch the spectrum of the AM signal in (a).
3. Find the power of the AM signal in (a).
4. FInd the power efficiency of the AM signal in (a).
5. If we transmit m(t) using FM modulation, find
6. kf so that F = 5.
7. fmax,
8. The bandwidth of the FM signal
9. If we transmit m(t) using USB modulation, what is the bandwidth of the USB signal.

**Question 2 (22 points = 2+3+4+3+3+3+4)**

The signal *m*(*t*) = 3cos(25t)+cos(220t) is sampled where the sampling interval is *Ts* = 10 msec.

* 1. Find *ms*(0), *ms*(*Ts*), *ms*(2*T­s*) and *ms*(3*Ts*).
  2. What is the relationship between the sampling frequency and the Nyquist rate ?
  3. The samples are quantized by the quantizer shown below. Find the quantized samples corresponding to the samples of part (a).
  4. Find the SQNR in dB.
  5. Find the bit rate at the output of the quantizer.
  6. If we transit these bits using 8PAM, find the symbol rate.
  7. Find the bandwidth required to transmit the 8PAM signal if we use a raised cosine pulse shape with rolloff factor of 0.4.



**Question 3 (18 points = 4+3+4+3+4)**

The Hamming (7,4) code can correct one error in one codeword. Its generator matrix is



1. Find all of the codewords
2. Find the minimum distance of the code
3. Find **H**
4. If r = 1 1 0 0 0 0 0, what is the most likely transmitted codeword?
5. How many errors can this code correct?

**Question 4 (20 points= 4+4+5+4+3)**

A memoryless source produces messages at a rate of 400 messages/sec. The messages come from the set {m1, m2, m3, m4, m5, m6, m7} where the transmission probabilities are {0.23, 0.12, 0.31, 0.09, 0.03, 0.21, 0.01}.

1. Which message contains the most informaiton and which message contains the least? Why?
2. Find the entropy of the source
3. Find the Huffmann code for this source
4. Find the efficiency of your Huffmann code.
5. If we use your Huffmann code, what is the bit rate at the output of the source in bps?

**Question 5 (15 points)**

We wish to design an analog to digital converter which then tranmits the data using MPAM modulation. The baseband message m(t) has the following characteristics : -6V < m(t) < 6V, Pm = 3W, Bm = 11 kHz. We want to use a uniform quantizer with SQNR > 53 dB and we want the bandwidth of the PAM signal < 200kHz. We will sample at a rate that is 1.75 times the Nyquist rate and the output of the PCM encoder will be further encoded using a linear (20,12) block error control code. The coded bits are then transmitted using MPAM where the pulse shape is raised cosine with rolloff factor of 0.2. You need to find the minimum number of bits per sample as well as M (the number of distinct amplitudes in the MPAM modulation scheme).







