

**Spring 2009**  
**EE 4601: Assignment 7**

- Date Assigned: March 31, 2009.
  - Date Due: April 9, 2009.
1. Consider a set of M-ary orthogonal FSK waveforms. Derive a union bound on the probability of symbol error and express your result as a function of the received  $E_b/N_o$ . Repeat for M-ary biorthogonal FSK waveforms. *use the exact Euclidean distances,  $d_{jk}$ , in this problem and not the upper bound  $d_{jk} \leq d_{\min}$ .*
  2. text problem 6.7
  3. text problem 6.21      N.B. in this problem assume that  $N_o/2 = .2 \times 10^{-13}$  instead of  $N_o/2 = 10^{-20}$
  4. Consider a QAM system on an AWGN channel. Let the maximum symbol rate be  $1/T = 2000$  baud.
    - a) determine the required modulation alphabet size  $M$ , and the  $E_b/N_o$  (in dB) to guarantee a *symbol* error probability of  $P_M = 10^{-5}$  with a bit rate of  $R_b = 4$  kb/s.
    - b) redetermine the above when  $R_b = 8$  kb/s and  $R_b = 16$  kb/s and draw some conclusions.
  5. text problem 6.32 Note: The last sentence of the problem should read "...Fourier transformer...is twice...square-law envelope detector..."