

Course: Digital Transmission Systems	Number: ELEC 462/2	Section: W
Examination: Final	Date: Dec. 10, 1999	Time: # of pages: 3 Hours 3
Instructor: Dr. M.R. Soleymani		
Books and Materials: Allowed		
Calculators: allowed (standard type)		
Special Instructions: Try all questions, Make assumptions if necessary		

1) Two audio signals each with a bandwidth of 22 kHz. are sampled and quantized using a uniform quantizer.

(a) Find the minimum required sampling rate (3 Marks).

(b) Find the minimum number of bits per sample if a quantization Signal-to-Noise Ratio of 90 dB is desired (4 Marks).

(c) Find the minimum channel bandwidth required for transmitting the resulting data stream if the modulation technique used is QPSK with raised cosine filtering with a roll-off factor of 0.4 (6 Marks).

(d) Find the answer to part (c) if, prior to modulation, the data stream is encoded using a (511,439) BCH code (3 Marks).

2)

(a) Calculate the bit rate of a T1 carrier (4 marks).

(b) Repeat part (a) for a system with only 10 voice channels with everything else remaining the same as T1 (3 Marks).

(c) Calculate and compare the efficiency of the two systems (3 Marks).

3) Consider the following pulse:

$$p(t) = \begin{cases} 1 & 0 \leq t < \frac{T}{2} \\ -1 & \frac{T}{2} \leq t < T \\ 0 & \text{elsewhere} \end{cases}$$

(a) Find and sketch the impulse response of the filter matched to this pulse (4 Marks).

(b) In a binary communication system a 1 is represented as $s_1(t) = Ap(t)$

and a 0 is represented as $s_2(t) = -Ap(t)$. Design the optimum receiver for this system if the bits are equally likely and the channel is AWGN (5 Marks).

(c) Find the probability of error in terms of A, T and N_0 where $\frac{N_0}{2}$ is the two-sided power spectral density of the noise (7 Marks).

4) Find the difference between the $\frac{E_b}{N_0}$ requirement of coherent and non-coherent binary FSK schemes for a bit error rate of 10^{-4} (10 Marks).

5) A communication system uses binary PSK and transmits at a rate of 250 kbps with a bit error probability of 10^{-8} .

(a) Find the probability of error if the bit rate is increased to 1 Mbps with everything else remaining unchanged (6 Marks).

(b) Would your answer change if some other modulation technique is used (1 Mark). Justify your answer (2 Marks).

6) Compare the average energy of the 8-ary constellation given in Figure 1 with that of an 8PSK constellation with the same minimum distance between the points (10 Marks).

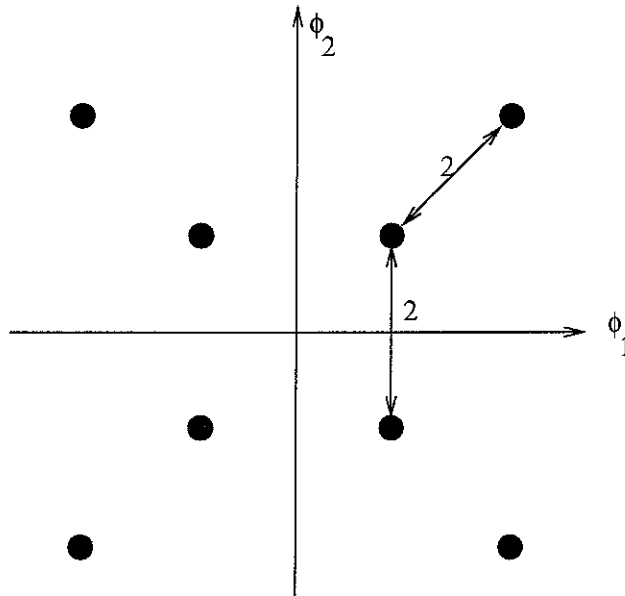


Figure 1

7) A communication system is using 64-QAM modulation. Find the $\frac{E_b}{N_0}$ (in dB) required for a bit error probability of 10^{-4} (8 Marks).

8) Determine the block length and the number of the redundancy symbols for a Reed-Solomon code with $m = 8$ and error correction capability of 8 symbols (4 Marks). Find the rate of the code (2 Marks) and the block-length in bits (1 Mark).

9) A convolutional encoder is described by the following generator sequences:

$$g_1 = (1101),$$

$$g_2 = (1011).$$

- (a) Draw the encoder for this code (4 Marks).
- (b) Draw the state diagram of the code (5 Marks).
- (b) What is the constraint length of the code (2 Marks),
- (c) Find the output of the encoder if the input is 000101000 (3 Marks).