First Exam	**Department of Telecommunications Engineering**	*Dr. Mohammad Banat*
452 هت – Fall 2011	***Digital Communications***	**Thu. 27 Oct. 2011 @ 8:00-9:00**

1) A QAM signal constellation is defined such that

$$\underline{s}_m = \begin{bmatrix} A_m & B_m \end{bmatrix}^T \text{, where } A_m \in \{-1,1\} \text{ and } B_m \in \{-3,-2,-1,1,2,3\}$$

1.a. Sketch the signal space constellation. ---------- (10)

1.b. What is the average bit energy? ---------- (10)

2.1922

1.c. Write down the signal waveforms as functions of time. ---------- (10)

1.d. Determine the largest possible distance between two signal space points. ---------- (10)

$\sqrt{40}$

1.e. Determine the smallest possible correlation coefficient between two signal space points. ------- (10)

-1

2) A zero-mean analog signal $x(t)$ has a bandwidth of 2500 Hz. The signal is sampled at a rate of 8000 samples/s. The signal is quantized into 8 levels with a step size of 1V.

2.a. Specify the quantization boundaries. ---------- (15)

$\{-4,-3,-2,-1,0,1,2,3,4\}$

2.b. Specify the quantization levels. ---------- (15)

$\{-3.5,-2.5,-1.5,-0.5,0.5,1.5,2.5,3.5\}$

2.c. What is the encoder bit rate?---------- (5)

$3*8,000 = 24,000$ bps

2.d. If each quantization level $\hat{x}_i$ is mapped into a PAM waveform $s_i(t) = \hat{x}_i$ for $0 \le t < T$, sketch the PAM signal space constellation. ---------- (15)