# *KFUPM - COMPUTER ENGINEERING DEPARTMENT*

## COE-341 – Data and Computer Communication

## Quiz 05 (Take-Home)- May 9th, 2009 Return May 12th, 2009

**Student Name:**
**Student Number:**

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**Problem 1: (40 points)** One the subject of multi-level Amplitude Shift Keying (ASK) modulation scheme. Consider the 8-level ASK scheme shown in class notes on slide 43. Assume the parameter $d$ = 1 volt, the carrier frequency $f_c$ = 100 Hz, and the symbol duration $T_s$ = 1 msec.

a) (15 points) In a table list (specify) the 8 symbols used by this modulation scheme. Also calculate the energy for each symbol.

b) (15 points) Draw the signal constellation diagram for the modulation scheme. In the plot indicate clearly the axes and the coordinates of the points in the constellation. Use the same grey coding scheme used in the notes, but you **MUST** write the coordinates of the points explicitly.

c) (10 points) Use the table (a) to calculate the average energy per symbol. Assume that all symbols are equally probable. i.e. the occurrence probability of any one of the 8 symbols is 1/8.

**Problem 2: (60 points)** One the subject of multi-level Phase Shift Keying (PSK) modulation scheme. Consider the quadrature PSK scheme shown in class notes on slide 47. The corresponding signal constellation diagram is shown below in Fig P2.1. Assume the amplitude $A = 3.32 \times 10^{-6}$ volts, the carrier frequency $f_c = 2$ MHz, and the symbol duration $T_s = 1$ μsec. Furthermore, assume the transmitter filter constant $r = 1$, and the effective noise temperature for the receiver system is $T = 20{,}000$ degrees Kelvin.

a) (10 points) In a table list (specify) the 8 symbols used by this modulation scheme. Also calculate the energy for each symbol.

b) (20 points) Use the provided table at the end of the quiz to obtain a random sequence of 12 information bits. Using the random sequence and the grid in Fig P2.2, it is required to draw the corresponding $I(t)$ and $Q(t)$ functions for the modulation scheme in a manner similar to that on slide 48 in the class notes. Indicate on the figure any instances where the signal changes phase by 180 degrees.

c) (10 points) Compute the symbol rate for this modulation scheme? Compute the bit rate for this modulation scheme?

d) (20 points) Compute the bandwidth for the QPSK signal? Compute the bandwidth efficiency figure for this system?

e) **(bonus 20 points)** For the given parameters, what is the bit error rate for this transmit/receive system. Utilize the BER curves from the textbook or class notes slide 55.

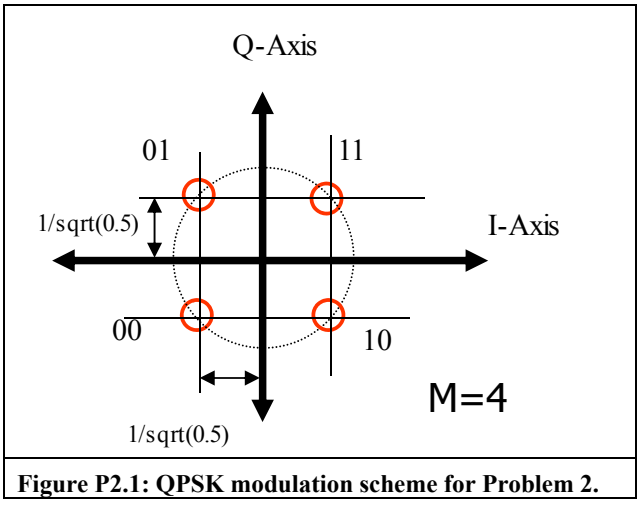


**Figure P2.1: QPSK modulation scheme for Problem 2.**

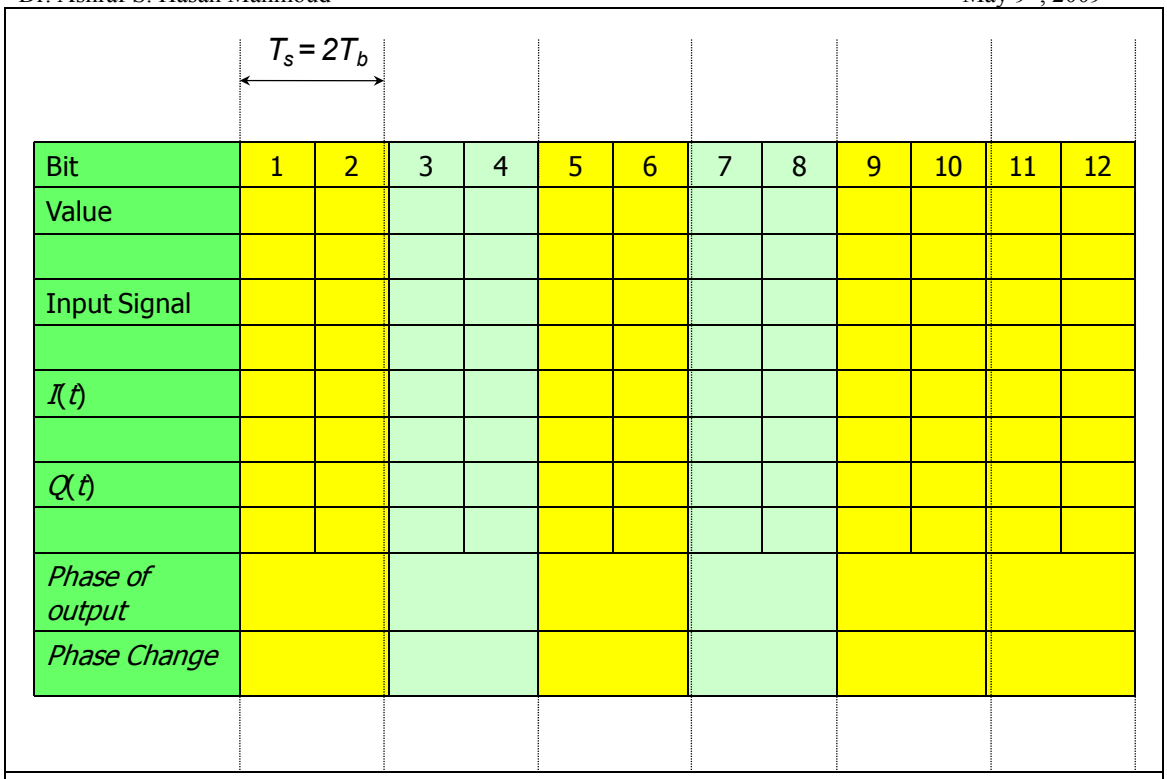


**Figure P2.2: *I*(*t*) and *Q*(*t*) plots and signal phase calculations for part (b).**

**Table 1: Random sequences for information bits.**

| No. | Student ID | Random Sequence of Information bits | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200149430 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 2 | 200273420 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 3 | 200319750 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 4 | 200329250 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 5 | 200345670 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 6 | 200375070 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 7 | 200376230 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 8 | 200421940 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 200426700 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 10 | 200427380 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 11 | 200429300 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 12 | 200440260 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 13 | 200556090 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 14 | 200565230 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 15 | 200574650 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 16 | 200580350 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| 17 | 200581730 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 18 | 200590890 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 19 | 200597610 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 200598750 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 21 | 200683060 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 22 | 200683120 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 23 | 200683820 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 24 | 200804940 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |