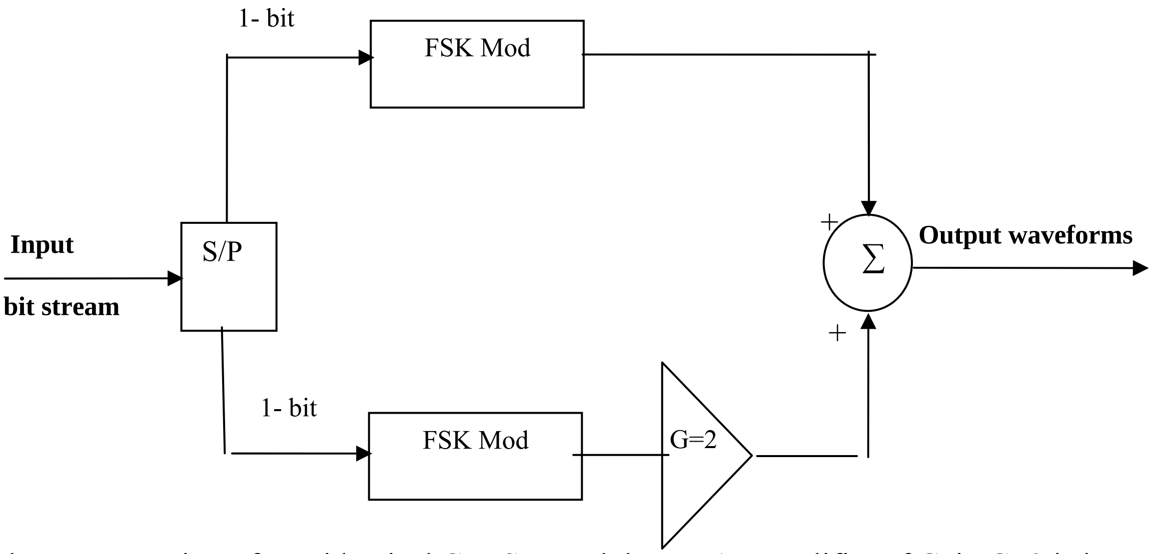
EEG373 (Communication systems II),
Dr. Mohab Mangoud
Assignment (4)

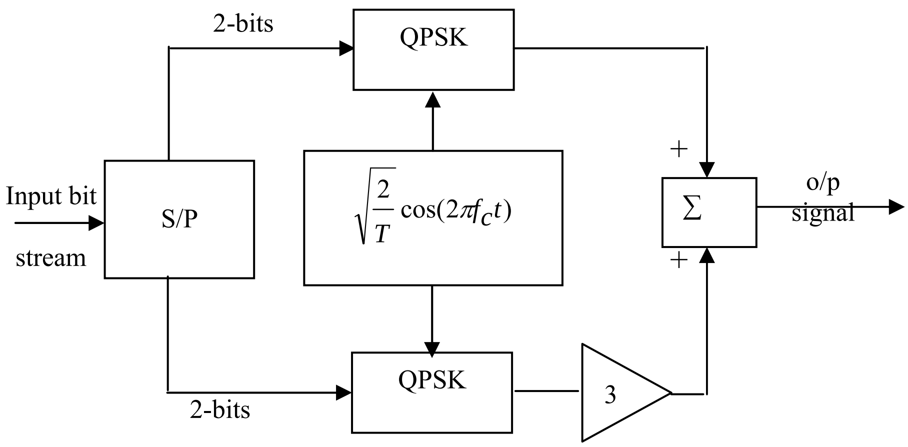
Q1.



The above Tx consists of two identical CBFSK modulators. An amplifier of Gain G=2 is inserted in the lower arm, then the outputs the two arms are added coherently to form the output waveform.

1. Write down expressions for the possible output waveforms.
2. Draw the S.S. and define the D.Rs and D.Bs.
3. Assign a bit scheme for the output signals in S.S.
4. Calculate the average transmitted energy.
5. Calculate the minimum average probability of error.
6. Design a single arm Tx & Rx, such that to achieve minimum energy while holding the same probability of error as in part 4.

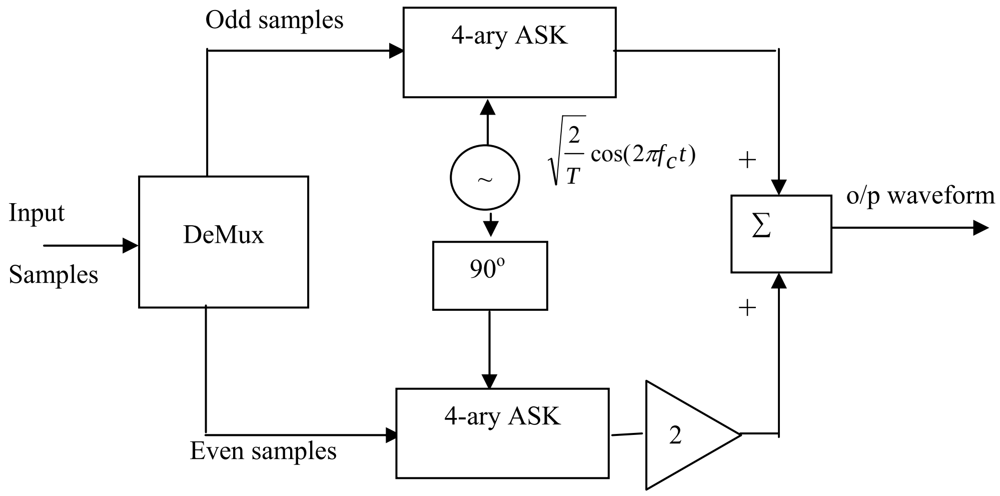
Q2.



The above communication system transmits equally-likely symbols each consists of 4-bits. An amplifier is inserted in the lower arm of Gain G=3 the input bit is in NRZ "L" with amplitudes ± 1 volts for digits 1 and 0, the bit duration is 1 sec. The noise is assumed to be AWGN with PSD = $\frac{N_0}{2}$ = 1 W/Hz.

1. Write down the equations of the possible output signals.
2. Sketch to scale the output signals in S.S. showing the bits assigned to each message point, then define the D.R's and D.B.'s.
3. Find the average energy of the transmitted symbol.
4. Calculate the minimum average probability of error.
5. Suggest an implementation for the receiver.

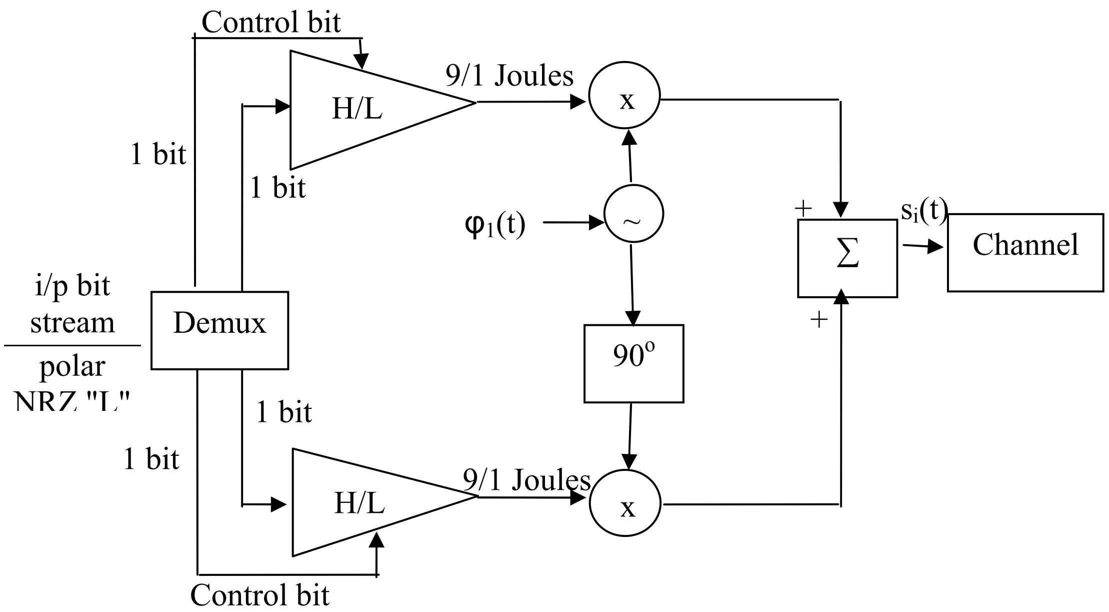
Q3.



The above communication transmitter is used to emit one of 16 equally likely messages over AWGN channel with zero mean and two sided PSD= 1 w/Hz. The quantizers used in the 4-ary ASK modulators are mid-riser with output $\pm\frac{a}{2}$, $\pm\frac{3a}{2}$. An amplifier of gain = 2 is inserted in the lower arm. Assuming the o/p symbol duration T= 2 Sec. a = 2 volts and f_c = 100.25Hz.

1. Write down a close form for the output waveforms.
2. Sketch to scale the output messages in S.S and draw the D.R.s and D.Bs, then assign a bit scheme for each transmitted message.
3. Find the average transmitted energy for the system under consideration.
4. Evaluate the minimum achievable probability of error for the above system.
5. Design an optimum receiver showing each stage of detection.
6. Now, if the amplifier in the lower arm is omitted (Gain=1), find the change in the quantizer step in order to maintain the same average probability of error of part (4).
7. What is the required energy for 16-ary PSK to have same average probability of error of part (4).

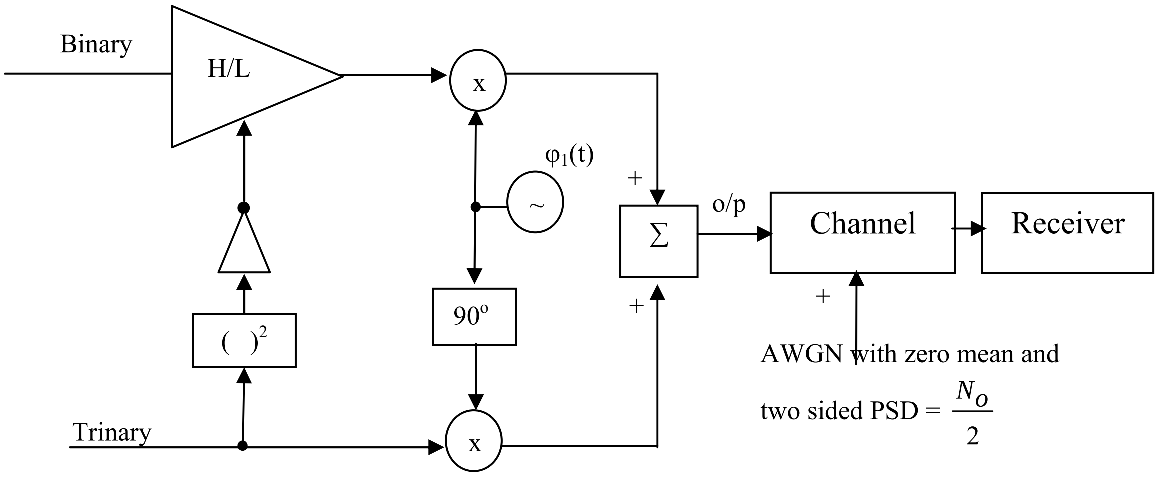
Q4.



The above diagram shows a transmitter for all equally-likely messages in the presence of AWGN with zero mean and two sided PSD $=\frac{N_o}{2}$ W/Hz. The transmitter consists of two identical arms. Each arm consists of an amplifier followed by a multiplier, then the o/p of the two arms are added coherently to formulate the o/p waveform. The state of the amplifier is H when the control bit is "1" and L when the control bit is "0" such that the o/p symbol energy is either 9 or 1 Joules respectively.

1. Determine the ratio H:L
2. Sketch to scale the signals in S.S. for each arm separately and assign a bit scheme for the o/p of each arm.
3. From 2. construct the S.S. for the o/p waveforms and assign a bit scheme for each message.
4. Define the D.Rs then calculate the average probability of error $P_{av}[\epsilon]$, ($\frac{N_o}{2}$=0.25 W/Hz).
5. Design a Rx for the given case showing each stage of detection.
6. Compare the required symbol energy for the equivalent M-ary PSK with the same $P_{av}[\epsilon]$.

Q5.



The illustrated communication system has two arms with two different inputs. The input to the upper arm is an equally likely binary waveforms coded in polar format with amplitudes A & -A for the digits 1 & 0 respectively and bit duration of T_b. An amplifier is inserted in the upper arm with gain either high= H or low=L=1. The state of the amplifier is controlled by the amplitude of the existing bit in the lower arm after squaring it and inverting (the amplifier gain is high when the output of the inverter is +ve otherwise the gain is low). The input to the lower arm is the equally-likely trinary waveforms "1", "0" & "-1" presented by amplitudes ($\frac{\sqrt{3}}{2}.A.H$), (0) & ($-\frac{\sqrt{3}}{2}.A.H$) respectively and bit duration T_b where, H is the high gain of the amplifier.

1. Write down the equations of the possible outputs of the system.
2. Find the ratio H:L so that all the output signals will have the same energy.
3. Sketch to scale the output signals in S.S. and define the D.Bs & D.R.s .
4. Assign a bit scheme for the proposed signals in S.S.
5. Calculate the minimum average probability of error.

$\varphi_1(t) = \sqrt{\frac{2}{T_b}}\cos(2\pi f_c t)$ $\quad$ $0 \le t \le T_b$ $\quad$ $f_c T_b$= Integer $\quad$ $\frac{N_o}{2} = 0.25*10^{-8} w/Hz$

A=2mV $\quad$ T_b=10mSec.