Communication Systems
Lab – 5 Report

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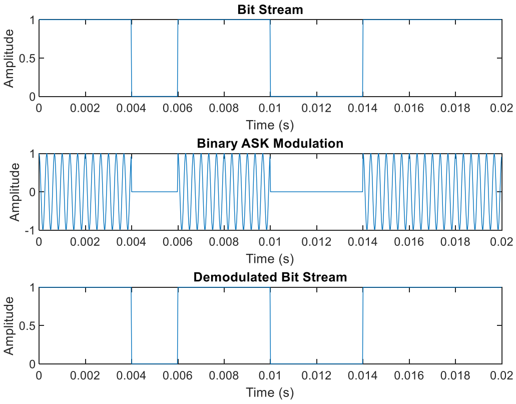
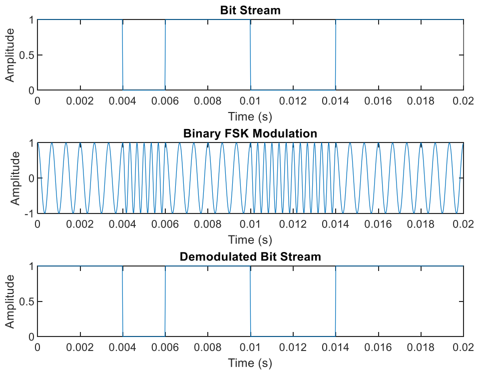
Figure 1



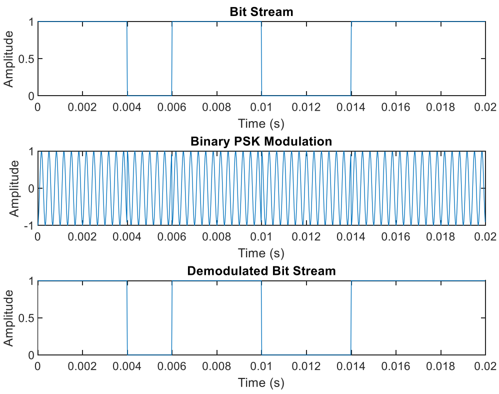
In this figure we see binary ASK modulation and demodulation results. Modulator produces $A\cos(2\pi f_c t)$ when bit is one, and 0 when bit is 0. Also, demodulator works well.

Figure 2



As seen in the figure, binary FSK modulator produces $A\cos(2\pi(3k)t)$ when bit is 0, and $A\cos(2\pi(1.5k)t)$ when bit is 1. Also, demodulator works well.

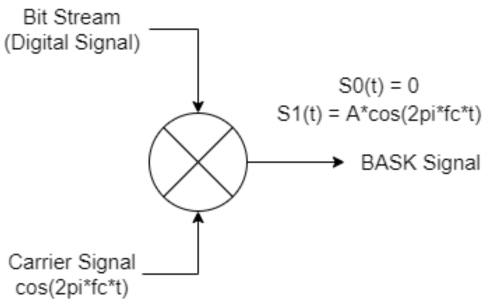
Figure 3



We can clearly see phase differences at bit changes because binary PSK modulator produces $Acos(2\pi f_c t)$ when bit is 0, and $Acos(2\pi f_c t + \pi)$ when bit is 1. Also, demodulator works well.

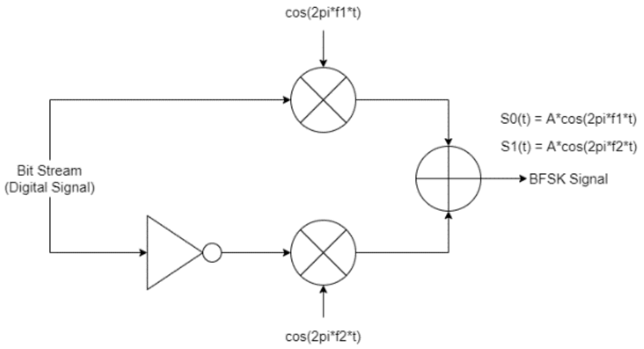
Questions

Q1.



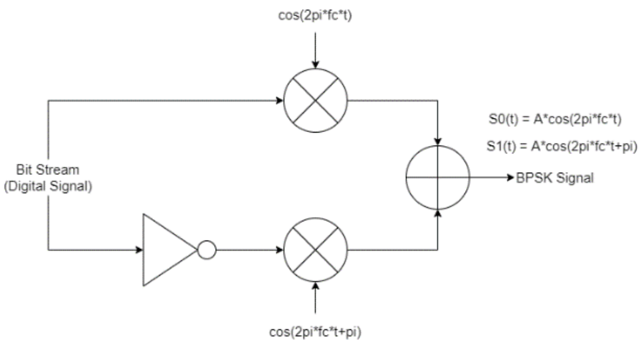
$$BASK = \begin{cases} Acos(2\pi f_c t) & ,(Bit\ Stream) = 1\ => S_1(t) \\ 0 & ,(Bit\ Stream) = 0\ => S_0(t) \end{cases}$$

As seen in the figure and the equations above, BASK modulator directly multiplies the carrier signal with digital signal which results in 0 when bit is 0, and $A\cos(2\pi f_c t)$ when bit is 1.



$$BFSK = \begin{cases} Acos(2\pi f_1 t) & ,(Bit\ Stream) = 1 => S_1(t) \\ Acos(2\pi f_2 t) & ,(Bit\ Stream) = 0 => S_0(t) \end{cases}$$

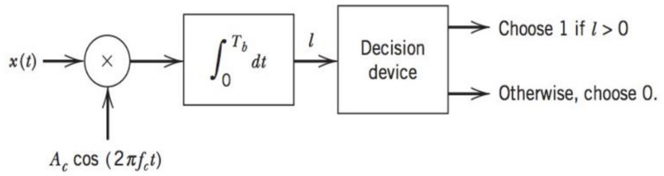
BFSK modulator results in two different symbols with same amplitude but different dedicated frequencies (f1 and f2). Simply, the modulator runs f1 carrier multiplier when bit is 1 and f2 carrier multiplier when bit is 0 thanks to the inverter gate.



$$BPSK = \begin{cases} Acos(2\pi f_c t) & ,(Bit\ Stream) = 1 => S_1(t) \\ Acos(2\pi f_c t + \pi) & ,(Bit\ Stream) = 0 => S_0(t) \end{cases}$$

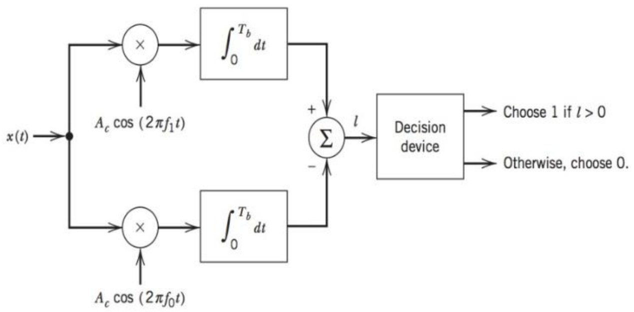
BPSK modulator creates two sinusoidal signals with same amplitude but with pi phase difference which is actually negative of the signal. Simply, similar mechanism to BFSK, the modulator runs in phase carrier multiplier when bit is 1 and pi phase different carrier multiplier when bit is 0 thanks to the inverter gate.

Q2.



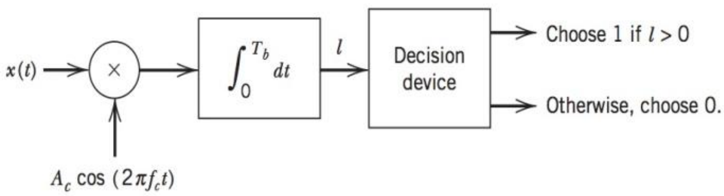
$$BASK\ Demod = \begin{cases} 1 \quad , \int_0^{T_b} x(t) S_1(t) > \ 0 => S_1(t) \\ 0 \quad , \qquad Otherwise \ => S_0(t) \end{cases}$$

For BASK demodulator, we can use coherent receiver and decision device to demodulate signal. We do not need to do this process for both symbols because on of our symbol is zero. It would be a redundant process to subtract zero from something. Simply, we are multiplying the signal with symbol 1 and take integral for one bit time to find if it is S1 or not. If the value after integral is greater than 1, we know that it is S1, otherwise S0.



$$BFSK\ Demod = \begin{cases} 1 \ , \int_0^{T_b} x(t)\ [\mathrm{S}_1(\mathrm{t}) - \mathrm{S}_0(\mathrm{t})]\, dt > \ 0 => S_1(t) \\ 0 \qquad\qquad\qquad\qquad , \quad Otherwise \ => S_0(t) \end{cases}$$

For BFSK demodulator, we use coherent receiver to compare the correlation of the symbols. If the correlation of symbol 0 is greater, I becomes lesser than 0 which results in 0 output from decision device and vice versa. This circuit simply multiplies the input signal by both symbols separately than takes integral to find out their correlation. After subtraction process, decision device decides the bit according to the value of l.



$$BASK\ Demod = \begin{cases} 0 \quad , \int_0^{T_b} x(t) S_0(t) > \ 0 => S_0(t) \\ 1 \quad , \qquad Otherwise \ => S_1(t) \end{cases}$$

For BFSK demodulator, we again use coherent receiver. However, similar to the BASK demodulator, we do not need to check the correlation of both symbols. This is because, one signal is negative of the other one. So, the modulator multiplies the input signal with S0(t) and takes integral to find the correlation of it. Then, decision device decides according to the value of I.

Q3.

If we compare the modulation systems, we can say that BASK is the worst one because its error probability is high, and SNR and noise immunity of it are worse than others. On the other hand, BFSK and BPSK has better error probability and SNR values. If we compare constellation diagram of BFSK and PFSK, we can say that BPSK would perform better behavior to the noise. Overall, BPSK is the best one according to the error probability, but it has greater bandwidth than BASK. However, BASK is the worst according to error probability and SNR.