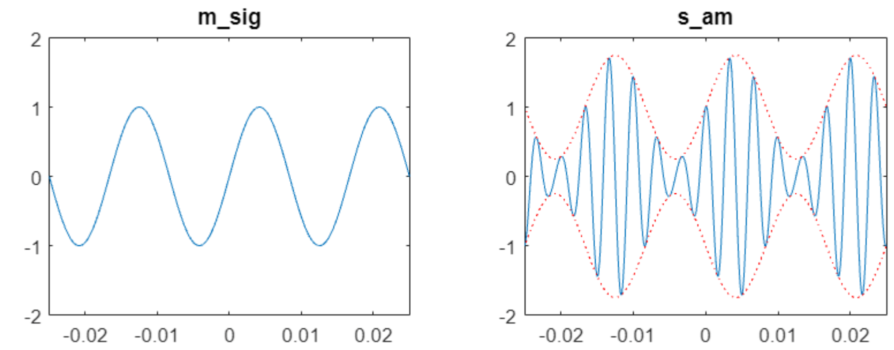
Assignment 3 - 190117

1. Assuming:

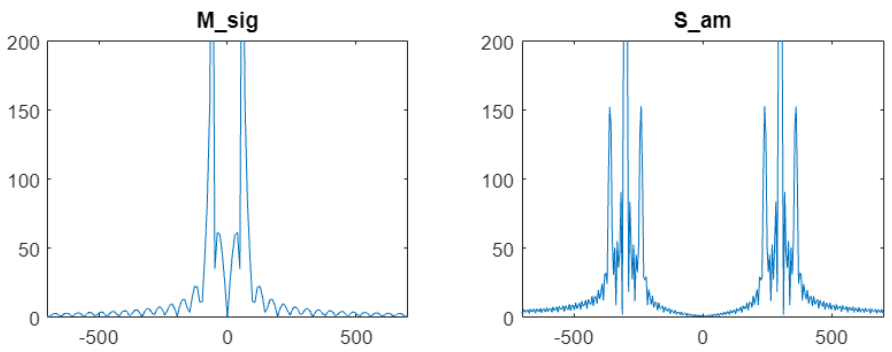
```
m_sig = sin(2*pi*60*t)
```

Updated CODE is attached with the assignment

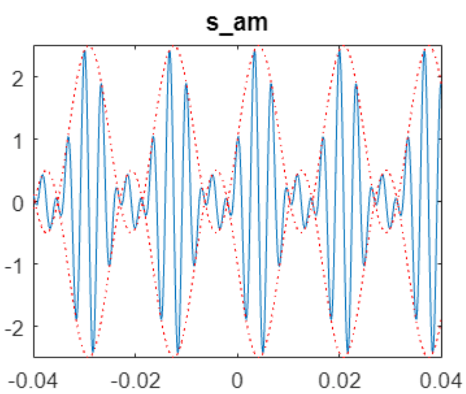
(a) For `ka = 0.75` and `fc = 300`, the following is the plot of time domain representation of an AM modulated signal:



(b) For `ka = 0.75` and `fc = 300`, the following is the plot of frequency domain representation of an AM modulated signal:



(c) Now changing the modulation index to `ka = 1.5`, we get the following time domain plot:

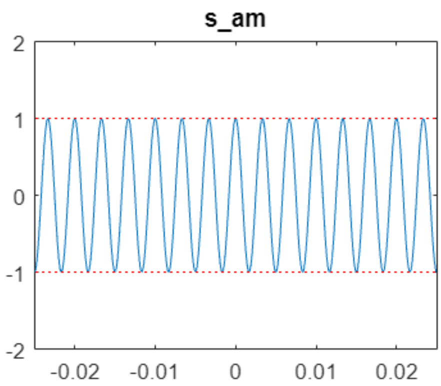


The modulation index indicates by how much the modulated variable varies around its unmodulated level. Amplitude modulation index is defined as:

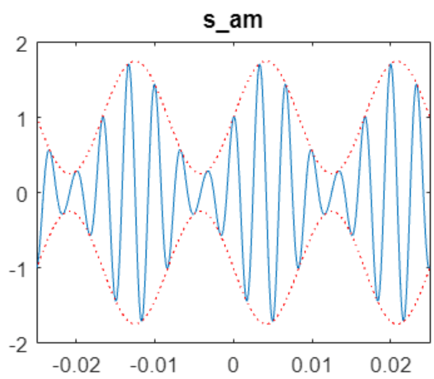
$$\mathbf{ka} = \frac{\mathbf{M}}{\mathbf{A}}$$

where M and A are modulation amplitude and carrier amplitude respectively. If `ka = 0.75`, this means carrier amplitude varies by 75% above (and below) its unmodulated level, as shown in part (a). Now for `ka = 1.5`, the above plot is shown. Here, negative excursions beyond zero entail a reversal of the carrier phase. So, we observe how the modulated amplitude varies with change in modulation index.

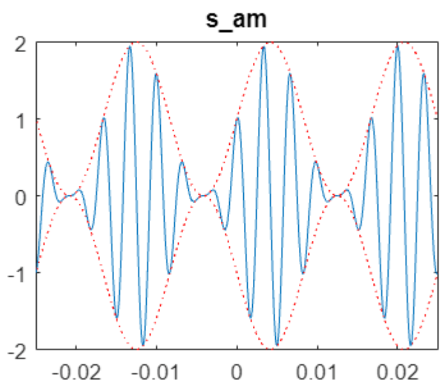
With the following plots we can visualize the variation for different values of ka.



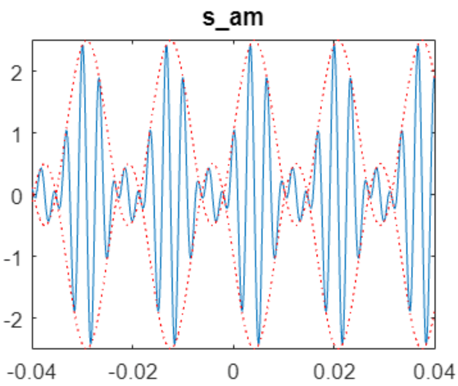
`ka = 0`



`ka = 0.75`



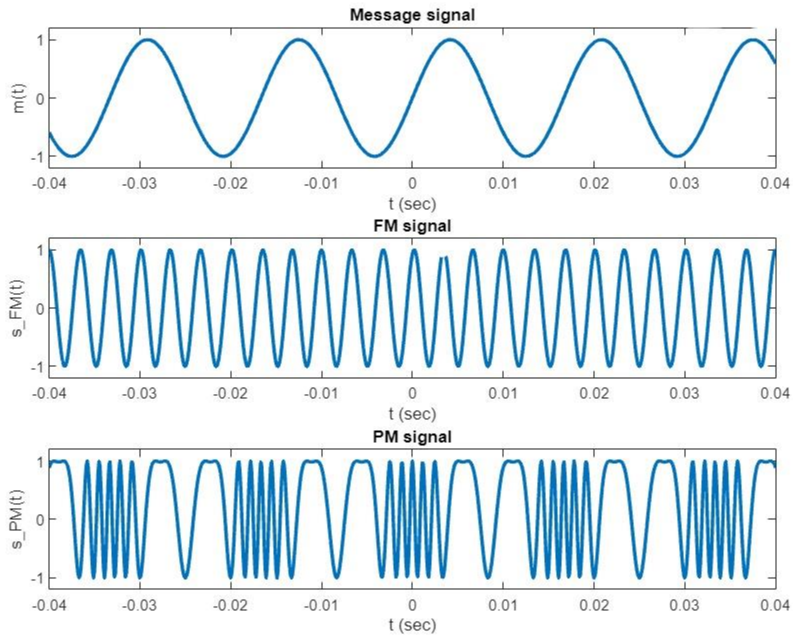
`ka = 1`



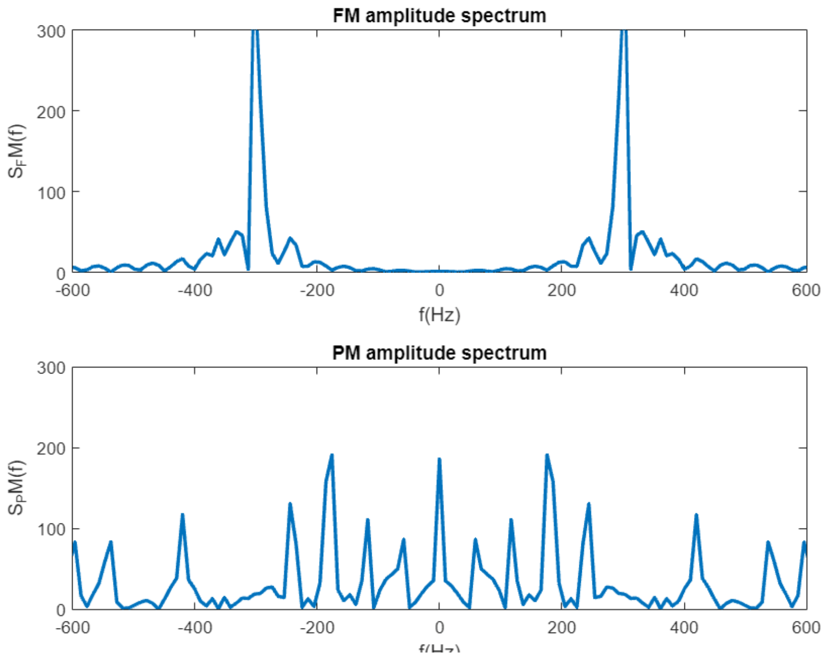
`ka = 1.5`

2. Updated code is attached with this assignment.

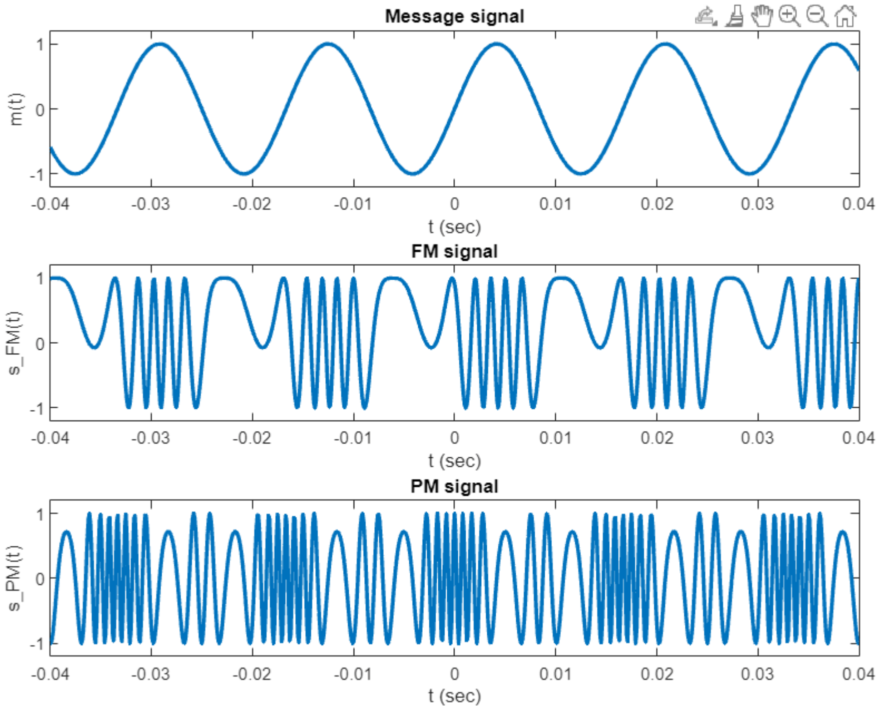
(a) For `kf = 80, kp = pi and fc = 300`, following is the plot of time domain representation of a FM and PM modulated signal:

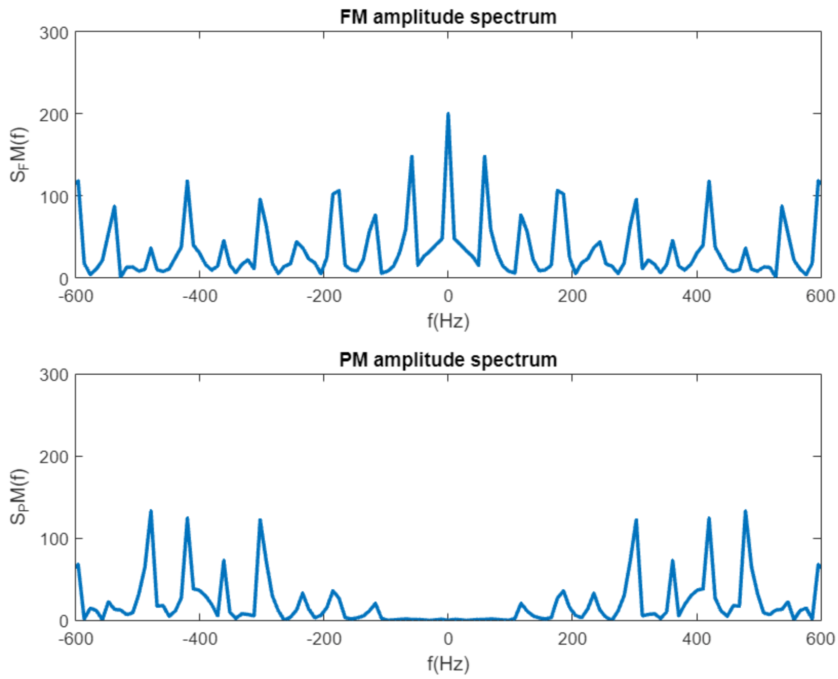


(b) For `kf = 80, kp = pi and fc = 300`, following is the plot of frequency domain representation of a FM and PM modulated signal:



(c) Changing the modulation indices `kf = 800*pi` and `kp = 5`:





As in amplitude modulation, the modulation index indicates by how much the modulated variable varies around its unmodulated level. Change in `kf` relates to variations in the carrier frequency while change in `kp` relates to the variations in the phase of the carrier signal.

3. Bit pattern $\Rightarrow$ 01100

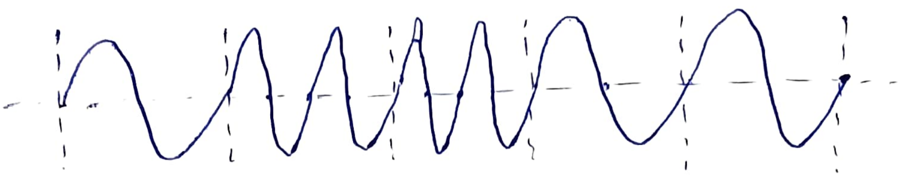
(i) ASK $\rightarrow$ $S(t) = \begin{cases} A\cos(2\pi f_c t) & \text{binary 1} \\ 0 & \text{binary 0} \end{cases}$

0 1 1 0 0

(ii) BFSK $\rightarrow$ $S(t) = \begin{cases} A\cos(2\pi f_1 t) & \text{binary 1} \\ A\cos(2\pi f_2 t) & \text{binary 0} \end{cases}$

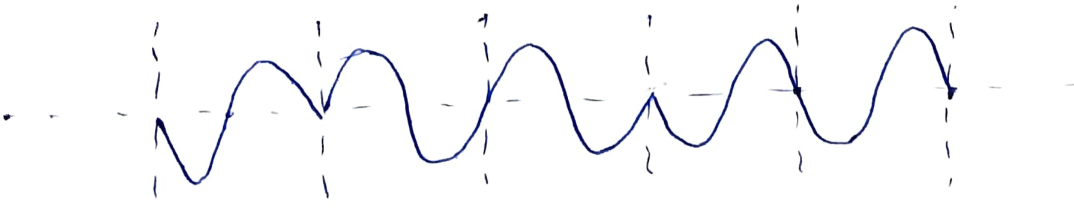
$(f_1 > f_2)$

0 1 1 0 0



(iii) BPSK $\rightarrow$ $S(t) = \begin{cases} A\cos(2\pi f_c t + \pi) & \text{binary 1} \\ A\cos(2\pi f_c t) & \text{binary 0} \end{cases}$

0 1 1 0 0



4. $$\frac{E_b}{N_0} = \left(\frac{S}{N}\right)\left(\frac{B}{R}\right)$$

$$\Rightarrow \frac{E_b}{N_0} = \frac{S}{N} \times 1 \Rightarrow \frac{S}{N} = \frac{E_b}{N_0}$$

From the figure; ~~[illegible]~~ at $BER = 10^{-6}$,

for ASK, $\left(\frac{S}{N}\right)_{dB} = \left(\frac{E_b}{N_0}\right)_{dB} = 13.5\ dB$

for FSK, $\left(\frac{S}{N}\right)_{dB} = \left(\frac{E_b}{N_0}\right)_{dB} = 13.5\ dB$

for PSK, $\left(\frac{S}{N}\right)_{dB} = \left(\frac{E_b}{N_0}\right)_{dB} \sim 10.5\ dB$

5. Delta Modulation :