**Question 1 (30 pts)**

**Set the sampling rate as 10 kHz.**

1) Case 1: Generate a sinusoidal message signal with peak amplitude 1 V, and frequency 10 Hz. Set FM constant $K_f = 200\pi$ and carrier frequency 300 Hz. Generate the FM signal using the following code piece

```
m_intg = ts*cumsum(m); % Numerical Integration
s = A*cos(2*pi*fc*t + kf*m_intg); % FM signal
```

Plot the FM signal in both time and frequency domain as in Figure 1 and Figure 2 respectively. Comment on your results.

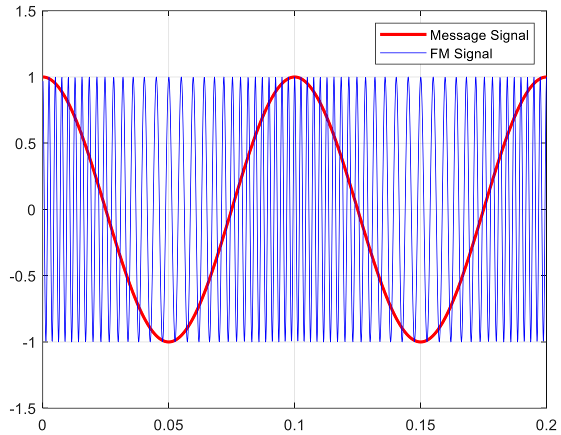


*Figure 1*

Indicate the important frequencies ($f_{max}, f_{min}, \Delta f$) in FM signal given in Figure 1.

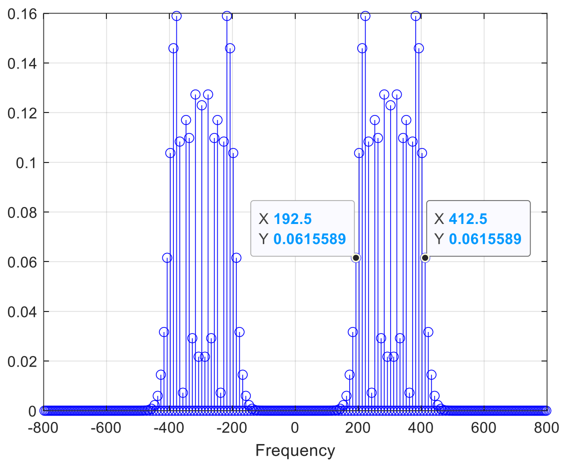


*Figure 2*

What is the FM transmission bandwidth in Figure 2. Compare the transmission bandwidth with the one obtained using Carson's rule ($W = 2(\Delta f + B)$)?

2) Then, perform FM demodulation using the below codepiece

s_der = diff([s(1) s])/ts/kf; % Numerical differantiator

mrec = envelope(s_der);

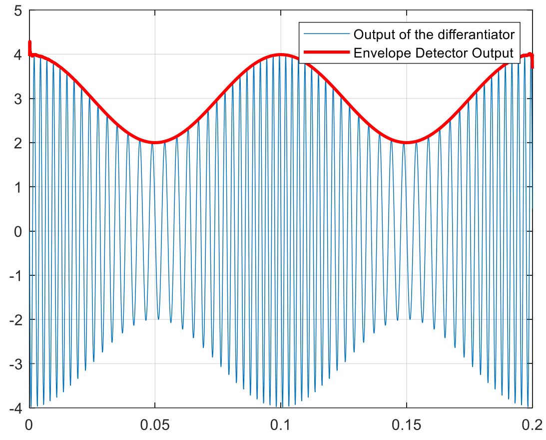


*Figure 3*

**Question 2 (40 pts)**

Based on the results obtained in Question 1.

1) **Case 2:** Double the message peak amplitude as 2 V's and keep the message frequency 10 Hz, repeat the results in Question 1, what is the transmission bandwidth of the FM signal?

2) **Case 3:** Keep the message peak amplitude as 1 V's and double the message frequency 20 Hz, repeat the results in Question 1, what is the transmission bandwidth of the FM signal?

   Create a table and compare your results in Case 1, Case 2 and Case 3.