5 Labwork

5.1 Modulation

- Obtain a sawtooth function as the message signal $m(t)$ with $P = 10$ periods and $f_m = 50$Hz fundamental frequency and $A_m = 1$ maximum amplitude value **Hint**: Use *sawtooth(.)* function and first construct a time vector with the given parameters P, f_m and $F_s = 2000$ Hz.

- Obtain a carrier signal using cosine for this time vector with $f_c = 200$ carrier frequency and $A_c = 1$ carrier amplitude.

- Plot the message signal and carrier signal in time domain in the same figure by using *subplot(2xx)*.

- *Report* Express the types of FM signals. What are the conditions to decide the type of the FM signal according to the modulation index β?

- Choose two frequency sensitivity values $k_{f,1}$ and $k_{f,2}$ so that $k_{f,2}$ makes β 1,5 times of the threshold value of β and $k_{f,1}$ makes β 0.5 times of the threshold value of β.

- *Report* What are the types of the FM signals with $k_{f,1}$ and $k_{f,2}$?

- Obtain the modulated signal $[s_1(t), s_2(t)]$ for the frequency sensitivities $k_f = [k_{f,1}, k_{f,2}]$ by using the following equation:

$$s(t) = cos\left(2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m(\tau)d\tau \right) \tag{1}$$

  Hint: Use *cumsum(.)* for the integration.

- Plot the modulated signals $s_1(t)$ and $s_2(t)$ in time domain in one Figure using *subplot(2xx)*

5.2 Magnitude Frequency responses

- Obtain a frequency vector and choose a suitable length N for this frequency vector.

- Obtain the magnitude frequency responses of the message signal and carrier signal.

- Plot these magnitude frequency responses on the same figure by using *subplot(2xx)*.

- Obtain the frequency responses of the $[s_1(t), s_2(t)]$ and plot them on same figure by using *subplot(2xx)*

5.3 Demodulation

- Obtain the demodulated signals for $[s_1(t), s_2(t)]$ by using *fmdemod(.)* with the suitable function inputs.

- Plot these demodulated signal with the original message signal by using *subplot(2xx)* and *hold on*.

- **To get full credit, add title, axis and legend into your figures.**

5.4 Extra questions for Report

Include figures, comments and answers to questions in your reports

- What is the meaning and formula of modulation index β?

- What is the transmission bandwidth of each FM signal type?

- What is the meaning and formula of the frequency deviation?