EE160 - Fall 2023 **San José State University**
Homework # 5 **Due: Thu. 10/19/23 11:59 PM**

1. A mixing-diode synchronous detector of DSB-SC signals

   Download MATLAB Simulink model `DSB_SC_mixing_diode_demod_2020.slx`, which is available in Canvas under `Files/Matlab/Amplitude modulation`. This demodulator uses a diode instead of a multiplier and will be used in lab experiment 4.

   (a) Set variable `seed = ID_number` (last four digits of your student ID number) in the command window. Run the model and attach the plots of the time signals.

   (b) Repeat part (a) for a square waveform message signal. You can do this by double clicking on the `Signal Generator` block and choosing `Square` from the pull-down menu in parameter `Waveform`.

   (c) Why does this detector (or demodulator) work? (Hint: Nonlinearity and filtering)

2. Consider the following conventional AM (DSB-LC) signal:

$$u_{\mathrm{AM}}(t) = 10\,\cos(200\pi t) + 5\,\cos(20\pi t)\,\cos(200\pi t).$$

   (a) Plot the signal $u_{\mathrm{AM}}(t)$ over the interval $|t| \le 0.15$ sec.

   (b) Sketch carefully the amplitude spectrum $|U_{\mathrm{AM}}(f)|$ in the range $-120 \le f \le 120$ Hz.

   (c) Find the value of the modulation index a in two different ways:

      i. Expressing the AM signal as

$$u_{\mathrm{AM}}(t) = A_c\,[1 + a\,\cos(20\pi t)]\,\cos(200\pi t).$$

      ii. Using the maximum E_{max} and minimum E_{min} of the envelope from the plot in part (a).

   (d) Is the signal under-modulated or over-modulated?

3. Repeat problem 2 for the signal

$$u_{\mathrm{AM}}(t) = 6\,\cos(200\pi t) + 9\,\cos(20\pi t)\,\cos(200\pi t).$$