

EE 115 Lab 2

To detect the envelope of $x(t) = A(a_{mod}m_n(t) + 1)\cos(2\pi f_c t)$, we need a diode, a capacitor and a resistor. Assume that the diode has a resistance R_s when the voltage across the diode is positive (however small), and the diode has a resistance R_0 when the voltage across the diode is negative. The resistor has the resistance R_l which satisfies $R_0 \gg R_l \gg R_s$. The capacitor has the capacitance C . *Answer the following questions and/or perform the following tasks. Also discuss your findings.*

- 1) If $f_c = 10\text{MHz}$, what is a proper range of $R_s C$?
- 2) If $m(t)$ has a bandwidth B equal to 10kHz , what is a proper range of $R_l C$?
- 3) If $R_s = 10^{-3}\text{ Ohm}$ and $R_l = 5\text{ Ohm}$, how do you choose C to meet the above conditions?
- 4) Sketch the equivalent circuit (of the envelope detector) when the capacitor is in charging mode, and the equivalent circuit when the capacitor is in discharging mode.
- 5) Let the input voltage be $v_i(t) = u_1(t)$ (the unit step function). Compute and plot the corresponding output voltage $v_o(t)$ of the circuit in the charging mode. How is $v_o(t)$ affected by the value of $R_s C$?
- 6) If the output voltage is initially at $v_o(0) = V$, Compute and plot the free response of the output voltage $v_o(t)$ in the discharging mode. How is $v_o(t)$ affected by the value of $R_l C$?
- 7) Assume $A = 1$, $a_{mod} = 0.5$ and $m_n(t) = \text{sinc}(20 \times 10^3 t) = \frac{\sin(\pi 20 \times 10^3 t)}{\pi 20 \times 10^3 t}$. Compute and plot the envelope of $x(t)$ for $-0.5 \times 10^{-3} < t < 0.5 \times 10^{-3}$.
- 8) Now let $f_c = 80 \times 10^3$. Compute and plot $x(t)$ for $-0.5 \times 10^{-3} < t < 0.5 \times 10^{-3}$ and compare it with its envelope.

Hint: Should we use $R_s C \ll \frac{1}{f_c} \ll R_l C \ll \frac{1}{B}$? why? To plot a signal, you need to choose a (proper) sampling rate. To do that, you need to determine an *exact or approximate* highest frequency f_{max} of the signal and choose a sampling rate larger than $2f_{max}$.