EE 115 Lab 2

To detect the envelope of $u(t) = A(a_{mod}m_n(t) + 1)\cos(2\pi f_c t)$, we need a diode, a capacitor and a resistor. Assume that the diode has a resistance R_s when the voltage across it is positive (however small) and a resistance $R_0 \gg R_s$ when the voltage across it 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:

1) If $f_c = 10$MHz, what is a proper range of R_sC?
2) If $m(t)$ has a bandwidth B equal to 10kHz, what is a proper range of R_lC?
3) If $R_s = 10^{-3}$ Ohm and $R_l = 5$ 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 $v_i(t) = \delta(t)$. Determine the corresponding output voltage (impulse response) $h_c(t)$ of the circuit in the charging mode. How does $h_c(t)$ relate to R_sC? If $v_i(t) = u(t)$ (step function), what would be the output voltage (step response) of the circuit?
6) If the output voltage is initially at $h_d(0) = V$, determine the free response of the output voltage $h_d(t)$ in the discharging mode. How does $h_d(t)$ relate to R_lC?
7) Assume $A = 1$, $a_{mod} = 0.5$ and $m_n(t) = sinc(20 \times 10^3 t) = \frac{\sin(\pi 20 \times 10^3 t)}{\pi 20 \times 10^3 t}$. Plot the envelope of $u(t)$ for $-0.5 \times 10^{-3} < t < 0.5 \times 10^{-3}$.
8) Now let $f_c = 80 \times 10^3$. Plot $u(t)$ for $-0.5 \times 10^{-3} < t < 0.5 \times 10^{-3}$ and compare it with its envelope.