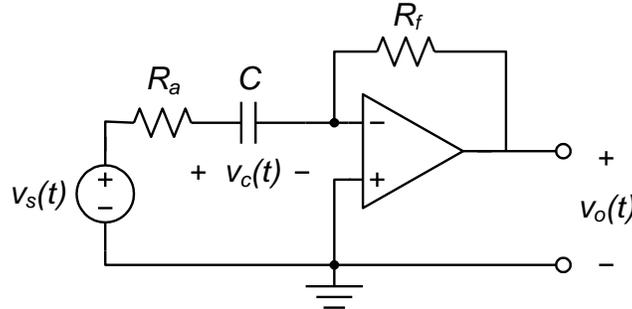


- P1** For the op amp circuit below, let  $R_A = 10 \text{ k}\Omega$ ,  $R_f = 20 \text{ k}\Omega$ ,  $C = 20 \text{ }\mu\text{F}$ , and  $v_s = 4 u(t)$ . Find  $v_o(t)$  for  $t \geq 0$ . *Hint*: “nice” numbers in answer include a 4 and a 5 for  $v_c$  and -8 for  $v_o$ .



- P2** Use LTspice to plot  $v_o(t)$  of the above circuit from 0 to 1 s. You need only attach the schematic diagram and the output voltage plot. For full credit, make them look professional: neatly-organized and fit them on one page.  
*Hint*: you can check your answer by plotting P1’s answer in Matlab  
*Hint*: use walkthrough #2 and #3 for help. Use an ideal opamp (called “opamp” at the end of the opamp list). Trouble with error simulating opamp? Read the handout.  
*Hint*: Make the  $4u(t)$  source using a voltage pulse source. Set  $V_{\text{initial}} = 0$ ,  $V_{\text{on}} = 4$ , and leave the other parameters blank to simulate the circuit turning on to 4V at  $t=0$ . Simulate and print just the first second.

- P3** A simple relaxation oscillator circuit is shown below. The neon lamp fires when its voltage reaches 75 V and turns off when its voltage drops to 30 V, and can be modeled by a  $120\Omega$  resistor when it is lit (essentially it is arcing electrons across its electrodes like miniature lightning) and looks like an open when the voltage is not sufficient to cause arcing (ie when it not lit).
- (a) For how long is the lamp on each time the capacitor discharges?  
 Hint 1: redraw the circuit starting at time  $t=0$  while the capacitor is discharging and lighting the lamp. Replace the neon lamp with its model when it is lit.  
 Hint 2: At  $t=0$  the voltage across the capacitor must be just enough to start the neon bulb arcing.  
 Hint 3: Answer is between 0.5 and 1 ms.
- (b) What is the time interval between light flashes while the lamp charges?  
 Hint 1: redraw the circuit starting at  $t=0$  when the capacitor is just starting to charge again after it was just discharged – this is not starting at 0V.  
 Hint 2: Answer is between 15 and 20 s.

