Quiz Review Problem. Spring 1997 Problem 5.3.

This problem examines the very simple tuner for an AM radio shown below. Here, the tuner is the parallel inductor and capacitor. The injection of radio signals into the tuner by the antenna is modeled by a current source, while the Norton resistance of the antenna in parallel with the remainder of the radio is modeled by a resistor. (You will learn about antenna modeling in 6.014!) The AM radio band extends from 540 kHz through 1600 kHz. The information transmitted by each radio station is constrained to be within ±5 kHz of its center frequency. (You will learn about AM radio transmission in 6.003!) To prevent frequency overlap of neighboring stations, the center frequency of each station is constrained to be a multiple of 10 kHz. Therefore, the purpose of the tuner is to pass all frequencies within 5 kHz of the center frequency of the selected station, while attenuating all other frequencies.

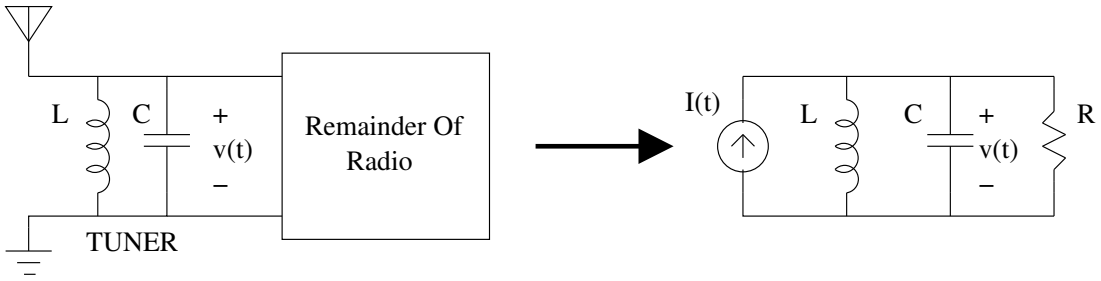
a) Assume that $I(t)=I_0\cos(\omega t)$. Using impedance methods, find *v(t)* where $v(t)=V_0\cos(\omega t+\phi)$, and both V_0 and ϕ are functions of ω . Note that *v(t)* is the output of the tuner, namely the signal that is passed on to the remainder of the radio.
b) For a given combination of I_o, C, L, and R, at twhat frequency is V_o maximized?
c) Assume that L = 365 μH. Over what range of capacitance must C vary so that the frequency of maximum V / I may be tuned over the entire AM band? Note that tuning the frequency of maximum V / I to the center frequency of a particular station tunes in that station.
d) As a compromise between passing all frequencies withi n5 kHz of a center frequency and rejecting all frequencies outside that band, let the design of R be such that

$$\frac{V(1\,MHz \pm 5\,kHz)}{V(1\,MHz)} \approx 0.25$$

when the tuner is tuned to 1 MHz. Given this design criterion, determine R.
e) Given your design for R, determine Q and

$$\frac{V(1\,MHz \pm 10\,kHz)}{V(1\,MHz)}$$

f) Given that the tuner is tuned to 1 MHz, sketch and clearly label the step response of the tuner to a 1μA step, assuming zero initial conditions.



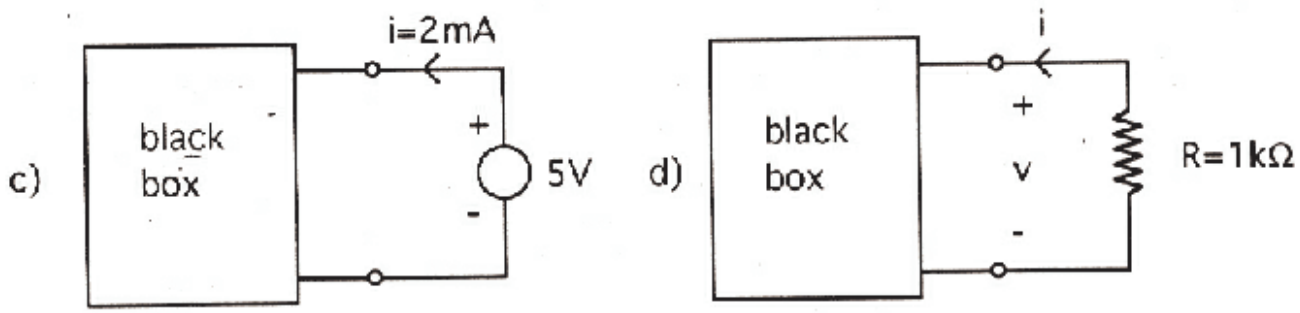
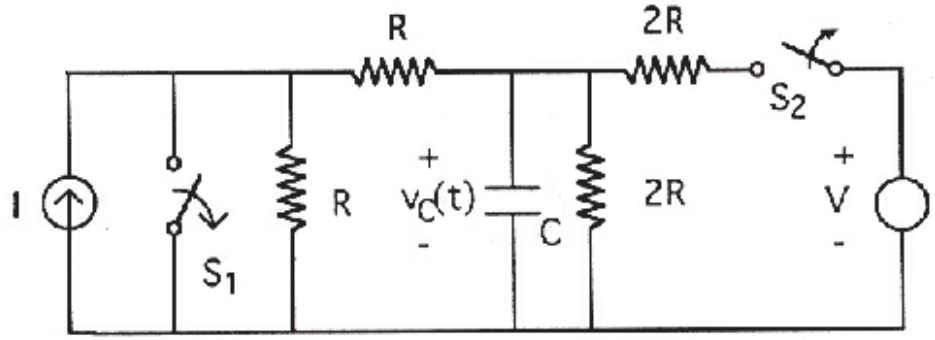


Fig. 1

Problem 2

Find $v_c(t)$ for $t>0$ for the circuit shown in Fig. 2, in which the switches S_1 and S_2 have been closed for a long time before they are opened at $t=0$.



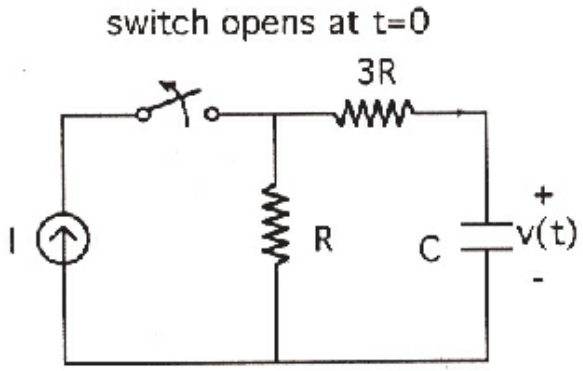
S_1 and S_2 have been closed for a long time before being opened at $t=0$

Fig. 2

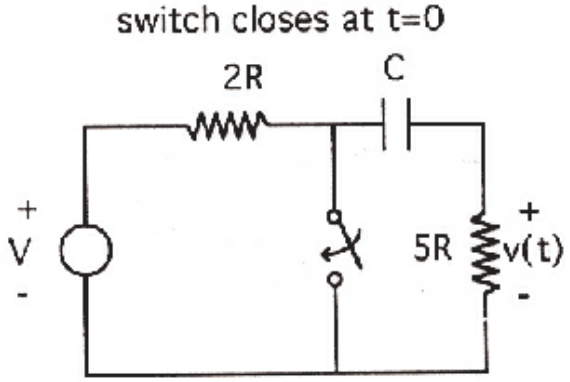
Problem 3

For each of the following circuits, determine the initial value v(0+) (the value just **after** the switch position changed) and the final value v(∞).

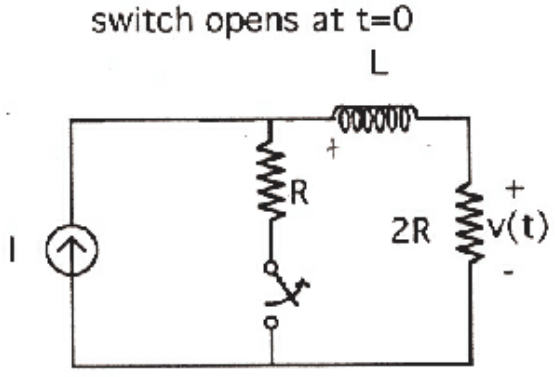
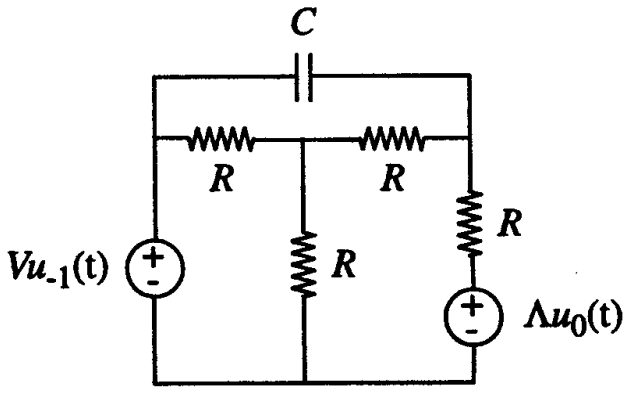
a)



b)



c)



Problem 7.4: Find the value of Λ for which all currents and voltages will be constant for $t > 0$ in the network below. The network is at rest for $t < 0$.