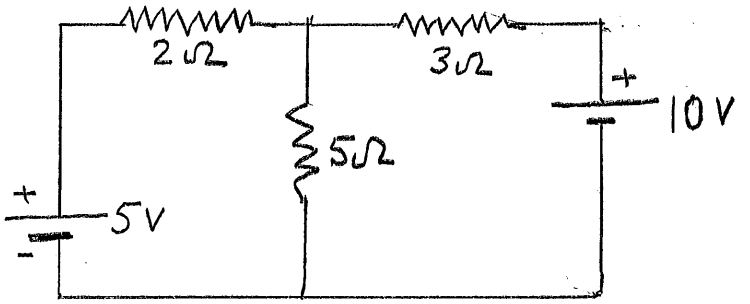
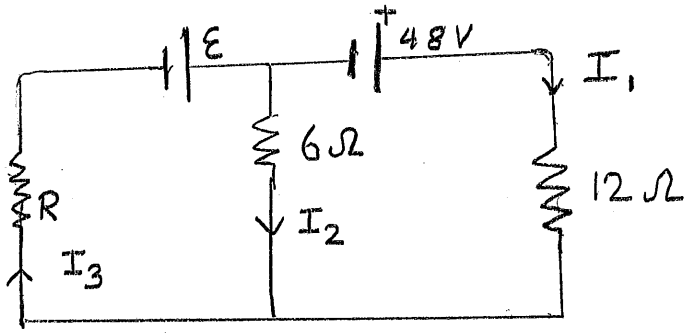
Problems: Week 7

7-1. Write down the physical bases of Kirchhoff's rules for electrical circuits.

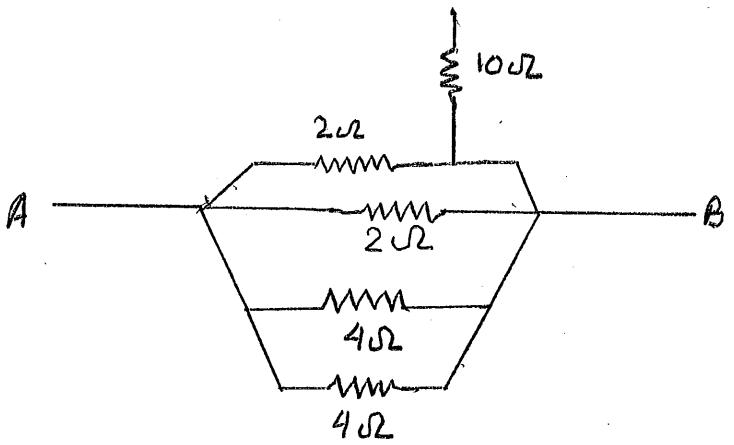
7-2. Calculate the currents in the resistors and the potential drops across them.



7-3. In the circuit shown, $I_1 = 3amp$ and ε and R are not given. Calculate I_2 and I_3.



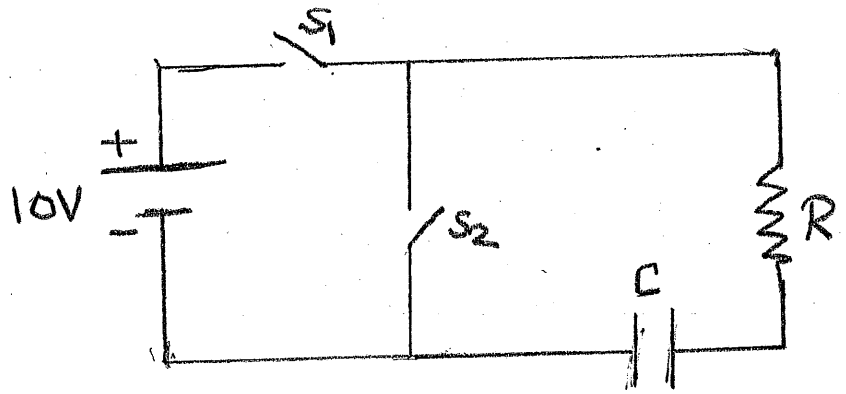
7-4. Calculate R_{AB} and the currents in all the resistors if $V_{AB} = 6V$.



7-5. Show that RC has the dimensions of time.

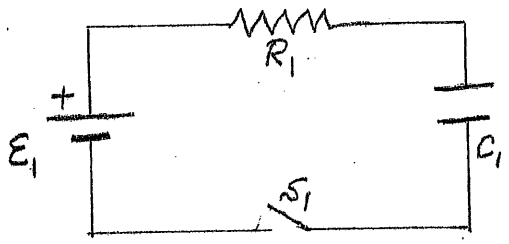
7-6. Why does the characteristic time of an RC circuit depend on both R and C?

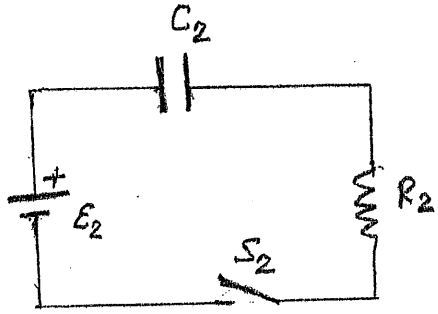
7-7. $R = 10k\Omega$ and $C = 10\mu F$ at t = 0, S_2 is open and S_1 is closed. Calculate potential across C and the current in R at (i) 0.1sec (ii) 0.3sec (iii) t = 1sec.



7-8. A long time later the switch S_1 in the circuit of problem 7-7 is opened and S_2 is closed, now calculate V_C and i at times (i) 0.1sec (ii) 0.3sec and (iii) 1sec after opening the switch. [Indicate direction of current].

7-9. Shown are two circuits





Given

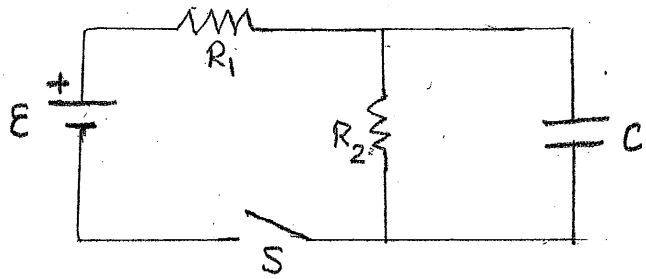
$R_1 = 100k\Omega$ $R_2 = 200k\Omega$

$C_1 = 10\mu F$ $C_2 = 5\mu F$

$\varepsilon_1 = 9V$ $\varepsilon_2 = 9V$

If both switches are closed at t = 0, which capacitor voltage will reach 6V first? Why?

7-10. In the circuit shown, S is closed at t = 0. (i) What is the current in the circuit at t = 0? (ii) What is the potential across C a long time later? (iii) What is the current in the circuit a long time later? Justify your answers.



7-11. How many time constants must elapse before the capacitor in an RC circuit reaches a charge within 1% of its final (equilibrium) value?

7-12. A $1000\mu F$ capacitor is charged to 100V and then allowed to discharge through a heating coil immersed in 0.02kg of water at 20C. What will be the rise in the temperature of water (sp ht of water is 1cal/gm). (neglect the heat capacity of the heater)

7-13. Often you see birds sitting on a high-voltage power line. Typically the Cu wire diameter is 1" and the separation of the bird's feet is about 1.5". If the current in the wire is about 40A, what is the voltage difference across the bird?

7-14. How do you distinguish between an $\underrightarrow{E}$ field and a $\underrightarrow{B}$ field?

7-15. In the presence of a $\underset{\rightarrow}{B} = -B\hat{z}$, a positively charged particle with velocity $\underset{\rightarrow}{v} = v\hat{x}$ at t = 0, will go around on a circle of radius $R = \frac{MV}{qB}$. How much work is done by $\underset{\rightarrow}{B}$ as the particle goes half-way around the circle? Why?