Assignment: Electrical Circuits (5-Hours)

1. Assignment-1 (Subjective-Problem Solving)

1.1. Calculate the charge,

i. How much charge is represented by 5000 electrons?

ii. Calculate the amount of charge represented by one million protons.

1.2. Calculate Current and Charge

i. The total charge entering a terminal is given by $q = 5t \sin 4\pi t$ mC. Calculate the current at $t = 0.5$ s.

ii. If the charge $q = (10\text{-}10e^{-2t})$ mC, find the current at $t = 0.5$ s.

iii. Determine the total charge entering a terminal between $t = 1$ s and $t = 2$ s. If the current passing the terminal is $i = (3t^2\text{-}t)$ A.

iv. The current flowing through an element is, $i = 2$ A, when $0 < t < 1$ and $i = 2t^2$ A, when $t > 1$. Calculate the charge entering the element from $t = 0$ to $t = 2$ s.

1.3. Calculate voltage

i. An energy source forces a constant current of 2 A for 10 s to flow through a light bulb. If 2.3 kJ is given off in the form of light and heat energy, calculate the voltage drop across the bulb.

ii. To move charge q from point *a* to point *b* requires -30*J*. Find the voltage drop v_{ab} if; (a) $q = 2$ C, (b) $q = -6$ C

1.4. Calculate Power and Energy

i. Find the power delivered to an element at $t = 3$ ms if the current entering its positive terminal is $i = 5 \cos 60\pi t$ A and the voltage is (a) $3i$, (b) $3\, di/dt$.

ii. Find the power delivered to the same element at t = 5 ms if the current remains the same but the voltage is (a) $2i$, (b) $\left(10 + 5\int_0^t i dt\right) V$.

iii. How much energy does a 100-W electric bulb consume in two hours?

iv. A stove element draws 15 A when connected to a 120-V line. How does it take to consume 30 kJ.

1.5. Calculate the power supplied or absorbed by each element in Fig. 1

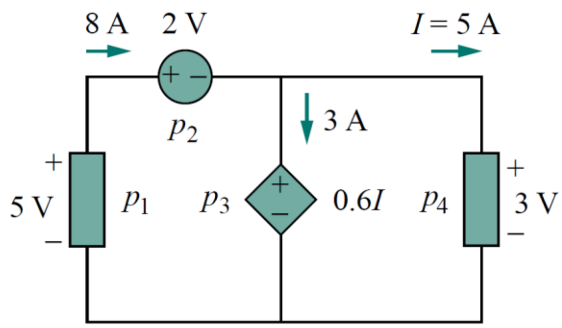

Fig. 1

1.6. Find v_1 and v_2 in the circuit in Fig. 2.

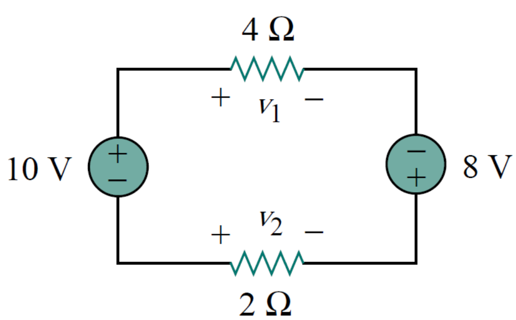

Fig. 2

1.7. Find v_x and v_0 in the circuit of Fig. 3.

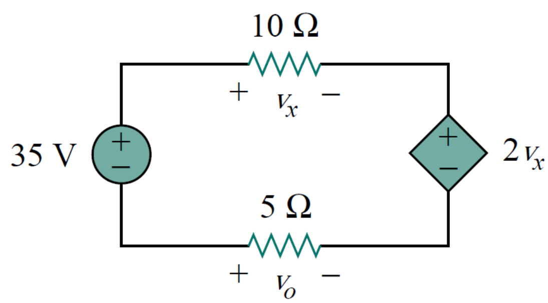

Fig. 3

1.8. Find v_0 and i_0 in the circuit of Fig. 4.

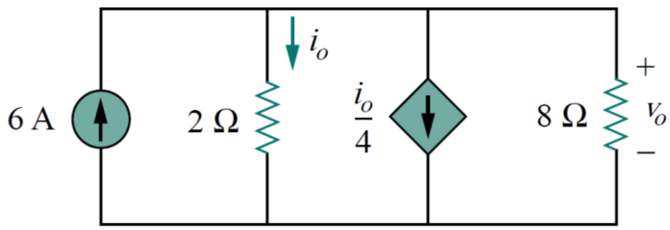

Fig. 4

1.9. Find R_{ab} for the circuit in Fig. 5.

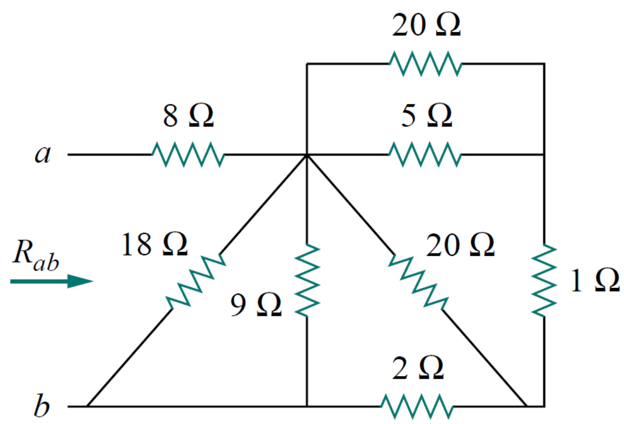

Fig. 5

1.10. Three light bulbs are connected to a 9 V battery as shown in Fig. 6. Calculate: (a) the total current supplied by the battery, (b) the current through each bulb, (c) the resistance of each bulb.

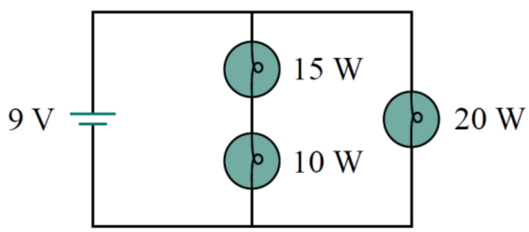

Fig. 6

1.11. Find the voltages at the three non-reference nodes (node1, node2 and node3) in the circuit of Fig. 7.

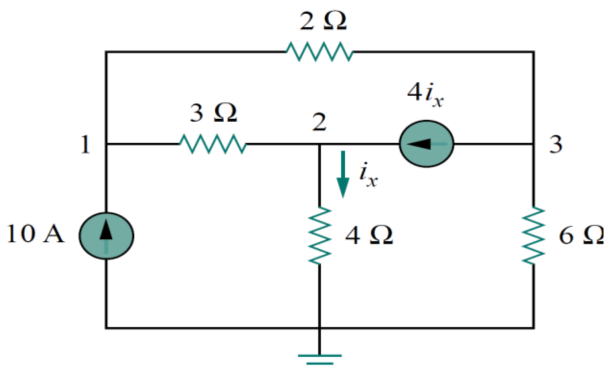

Fig. 7

1.12. Find v and i in the circuit of Fig. 8.

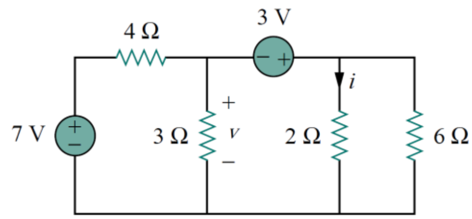

Fig. 8

1.13. Find v_1, v_2 and v_3 in the circuit in Fig. 9.

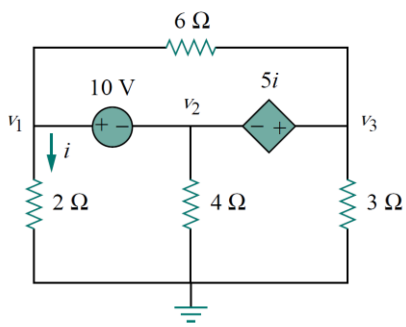

Fig. 9

1.14. Calculate the mesh currents i_1 and i_2 in the circuit of Fig. 10.

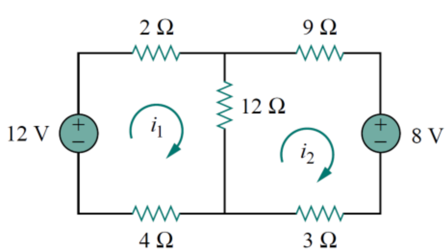

Fig. 10

1.15. Using the mesh analysis, find i_0 in the circuit in Fig. 11.

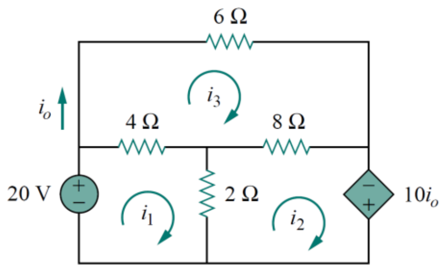

Fig. 11

1.16. Use mesh analysis to determine i_1, i_2 and i_3 in the Fig. 12.

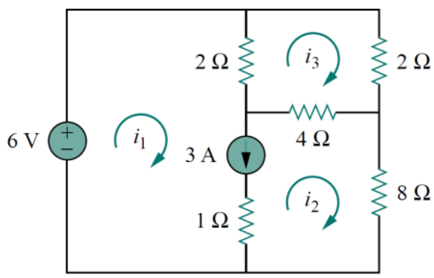

Fig. 12

1.17. The transistor circuit in Fig. 13 has $\beta = 80$ and $V_{BE} = 0.7$ V. Find v_0 and i_0.

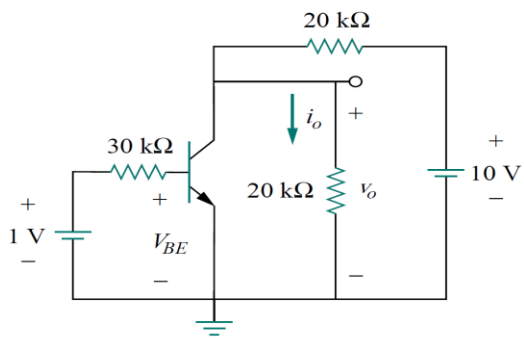

Fig. 13

1.18. Using nodal analysis find v_0 and i_0 in the circuit of Fig. 14.

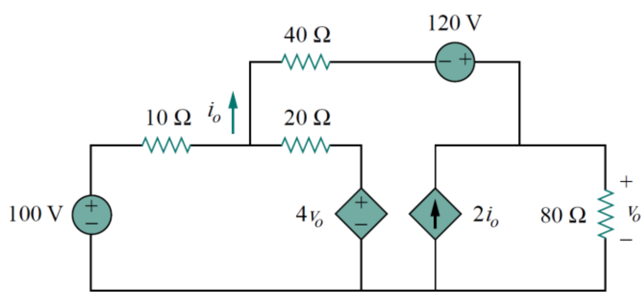

Fig. 14

1.19. Calculate v_0 and i_0 in the circuit in Fig. 15.

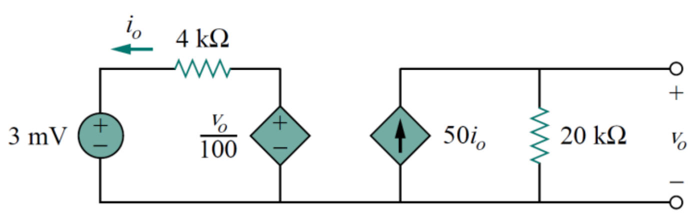

Fig. 15

1.20. For the circuit in Fig. 16, find the gain v_0/v_s.

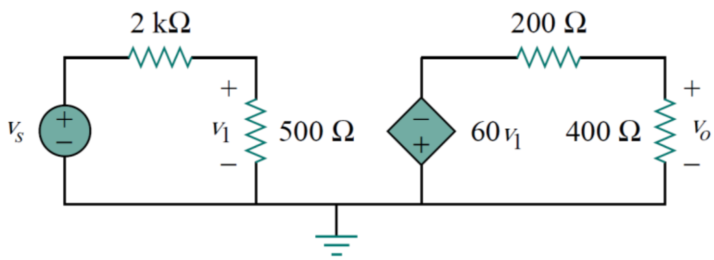

Fig. 16

1.21. Using superposition theorem, find v_0 in the circuit in Fig. 17.

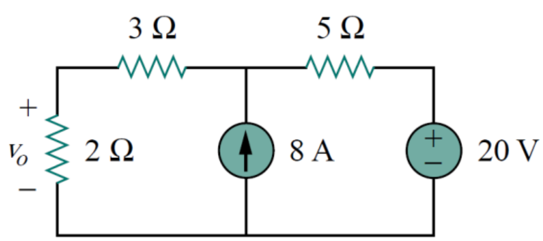

Fig. 17

1.22. Use superposition theorem to find out v_x in the circuit in Fig. 18.

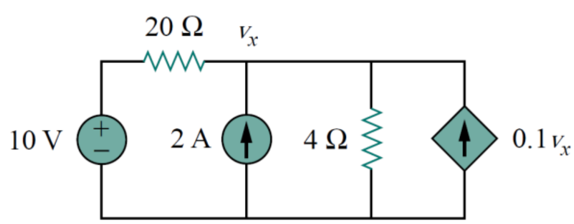

Fig. 18

1.23. Find i in the circuit in Fig. 19 using the superposition principle.

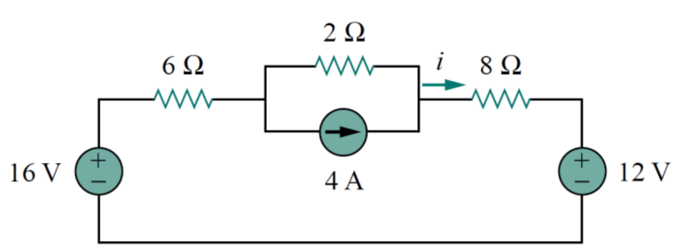

Fig. 19

1.24. Using Thevenin's theorem, find the equivalent circuit to the left of the terminals in the circuit in Fig. 20.

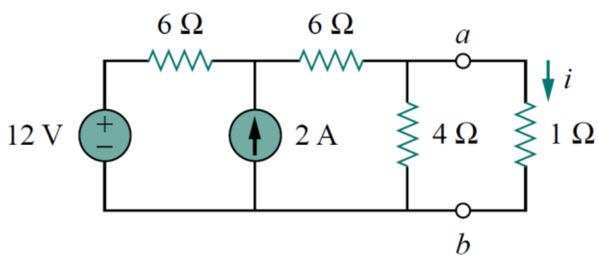

Fig. 20

1.25. Find the Thevenin equivalent circuit of the circuit in Fig. 21 to the left of the terminals.

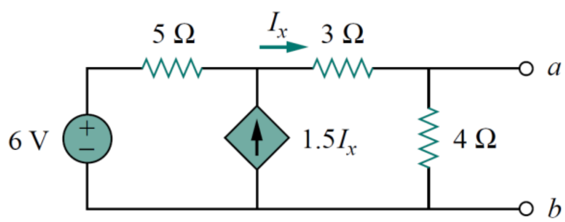

Fig. 21

1.26. Obtain the Thevenin equivalent of the circuit in Fig. 22.

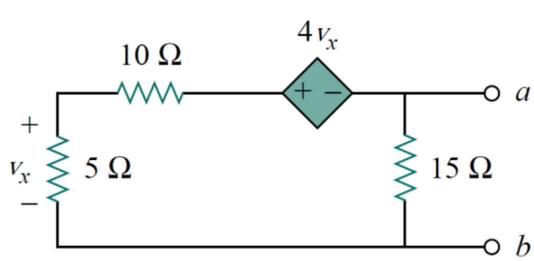

Fig. 22

1.27. Find the Norton equivalent circuit for the circuit in Fig. 23.

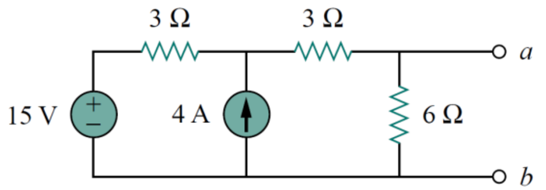

Fig. 23

1.28. Find the Norton equivalent circuit for the circuit in Fig. 24.

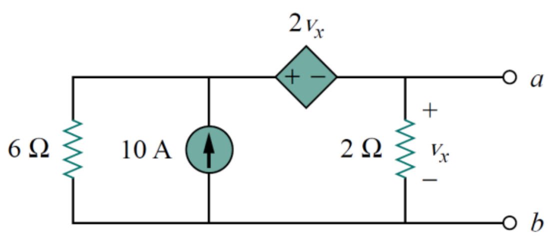

Fig. 24

1.29. A Wheatstone bridge shown in Fig. 25 has $R_1 = R_3 = 1\text{k}\Omega$. R_2 is adjusted until no current is flows through the galvanometer. At that point $R_2 = 3.2\text{k}\Omega$. What is the value of unknown resistance R_x?

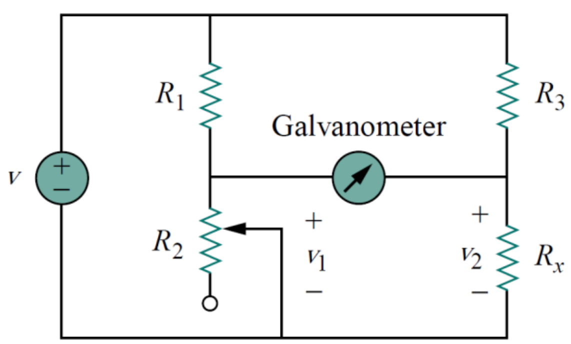

Fig. 25

1.30. Obtain the current through the galvanometer, having resistance of 14Ω, in the Wheatstone bridge shown in the Fig. 26.

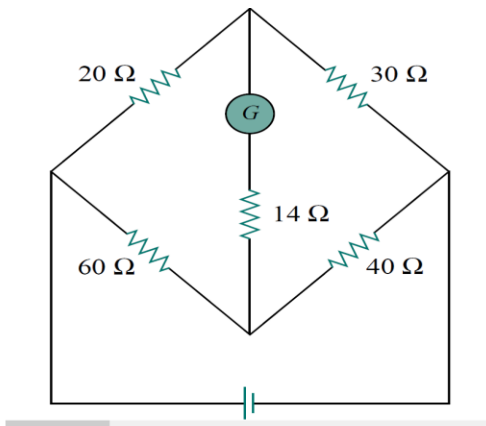

Fig. 26

1.31. Refer to the circuit in Fig. 27. Let $v_C(0) = 30$ V. Determine v_C, v_x and i_o for $t \geq 0$.

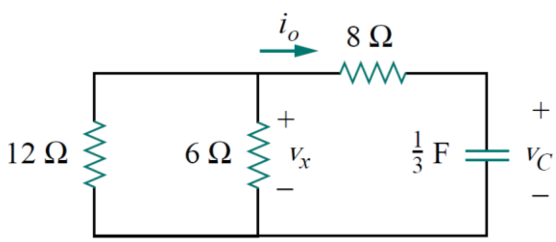

Fig. 27

1.32. If the switch in Fig. 28 opens at $t = 0$, find $v(t)$ for $t \geq 0$ and $w_C(0)$.

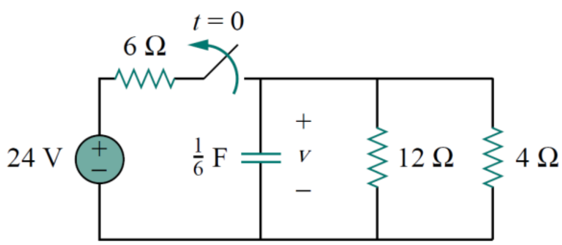

Fig. 28

1.33. Find $v(t)$ for $t > 0$ in the circuit in Fig. 29. Assume the switch has been opened for a long time and is closed at $t = 0$. Calculate $v(t)$ at $t = 0.5$.

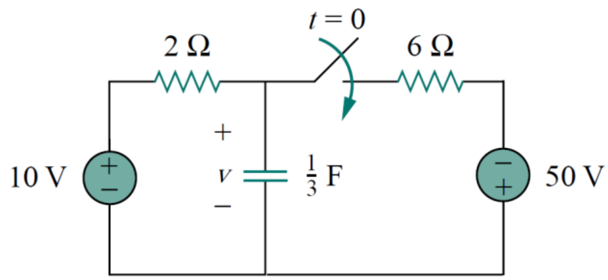

Fig. 29

1.34. The RC circuit in Fig. 30 is designed to operate an alarm which activated when the current through it exceeds 120 μA. If $0 \leq R \leq 6$ kΩ, find the range of the time delay that circuit can cause.

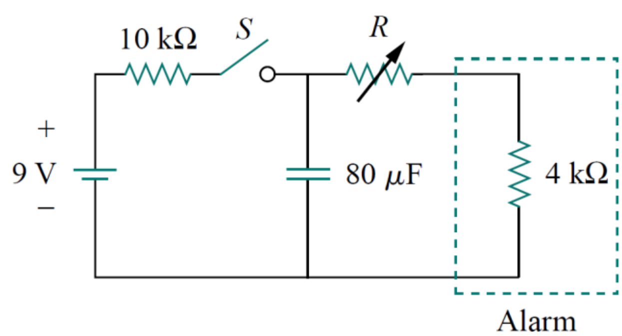

Fig. 30

1.35. Find $v(t)$ and $v_o(t)$ in the op-amp circuit in the Fig. 31

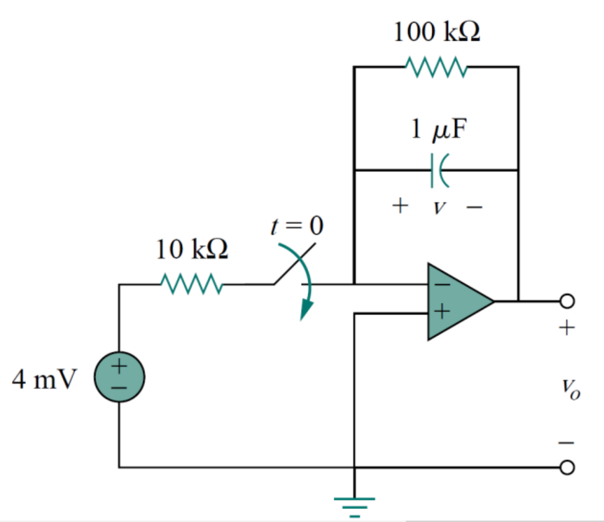

Fig. 31

1.36. Find i and v_x in the circuit in Fig. 32.

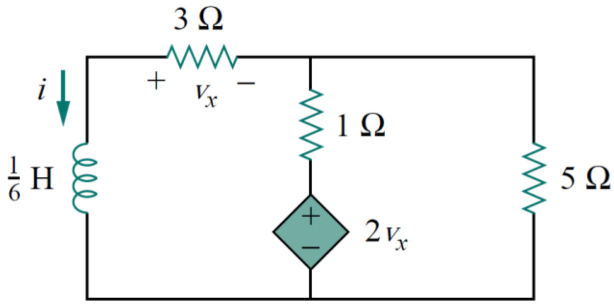

Fig. 32

1.37. For the circuit in Fig. 33, find $i(t)$ for t > 0.

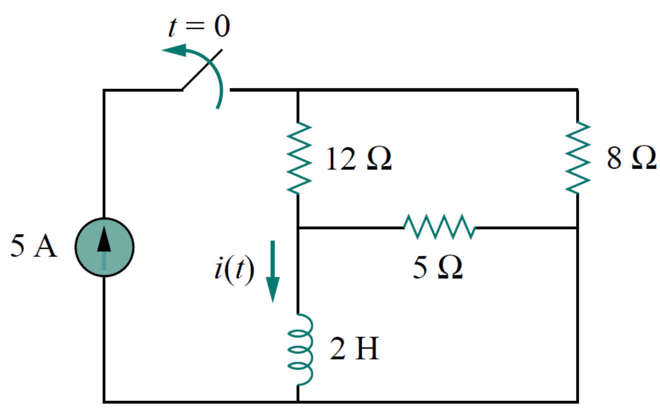

Fig. 33

1.38. The switch in Fig. 34 has been closed for a long time. It opens at $t = 0$. Find $i(t)$ for t > 0.

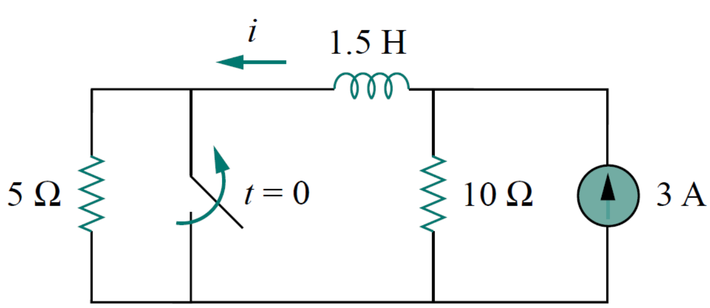

Fig. 34

1.39. The circuit in Fig. 35 is used by a biology student to study “frog kick.” She noticed that the frog kicked a little when the switch was closed but kicked violently for 5 s when the switch was opened. Model the frog as a resistor and calculate its resistance. Assume that it takes 10 mA for the frog to kick violently.

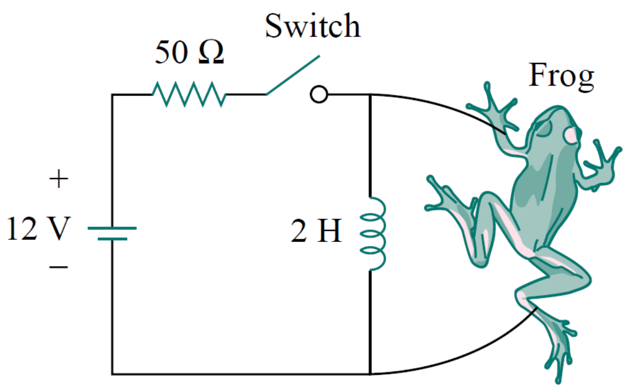

Fig. 35

1.40. The A 120-V dc generator energizes a motor whose coil has an inductance of 50 H and a resistance of 100 Ω. A field discharge resistor of 400 Ω is connected in parallel with the motor to avoid damage to the motor, as shown in Fig. 36. The system is at steady state. Find the current through the discharge resistor 100 ms after the breaker is tripped.

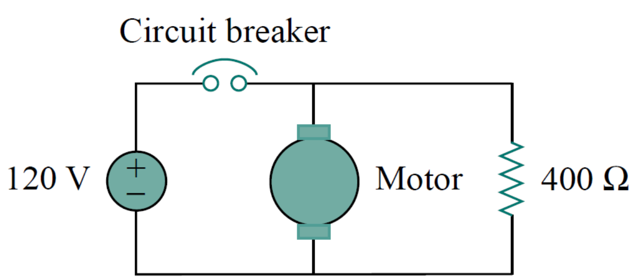

Fig. 36