

Homework 1

Monday, September 30, 2019 12:57 PM

Problems: 1.1, 1.5, 1.14, 1.16, 1.25, 1.29, 1.31

1.1 Use appropriate multiple + submultiple prefixes to express the following quantities

a) 3620 watts (W) = 3.62 kW (kilowatts)

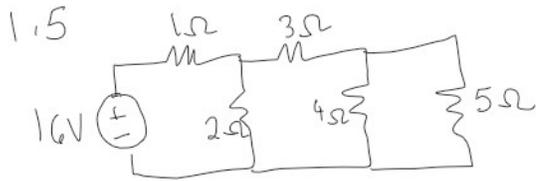
b) 6.00004 amps (A) = 4 mA (microamps)

c) 5.2×10^{-6} ohms (Ω) = 5.2 $\mu\Omega$ (microohms)

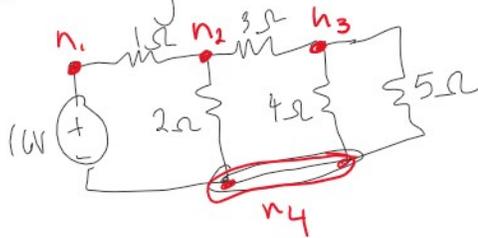
d) 3.9×10^{11} volts (V) = 390 GV

e) 0.02 meters (m) = 2 cm (centimeters)

f) 32×10^5 Volts (V) = 3.2 MV



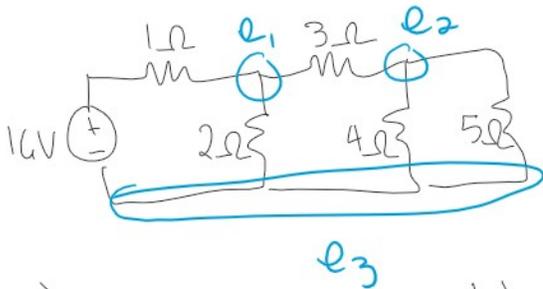
a) Identify and label all distinct nodes



Node: connection between 2 or more elements

b) Which of those are extraordinary nodes?

extraordinary node: node connecting more than 2 elements



c) Identify all combinations of 2 or more circuit elements that are connected in series

$$16V - 1\Omega (C1)$$

$$3\Omega - (4\Omega // 5\Omega) (C2)$$

$$C1 - (2\Omega // C2) (C3)$$

d) Identify all combinations that are connected in parallel

$$4\Omega // 5\Omega (P1)$$

$$2\Omega // (3\Omega + P1) (P2)$$

$$16V // (1\Omega + P2)$$

1.14 Determine the current $i(t)$ flowing through a resistor if the cumulative charge that has flowed through it up to time t is given by

$$a) q_f(t) = 3.6t \text{ mC}$$

$$i(t) = \frac{dq_f}{dt}$$

$$i(t) = \frac{dq_f}{dt} = 3.6 \text{ mA}$$

$$b) q_f(t) = 5 \sin(377t) \text{ mC}$$

$$i(t) = \frac{dq_f}{dt} = 5(377t \cdot \cos(377t)) \mu\text{A} = 1885 \cos(377t) \mu\text{A}$$

$$c) q_f(t) = 0.3[1 - e^{-0.4t}] \text{ pC}$$

$$i(t) = \frac{dq_f}{dt} = 0.12 e^{-0.4t} \text{ pA}$$

$$d) q_f(t) = 0.2t \sin(120\pi t) \text{ nC}$$

$$i(t) = \frac{dq_f}{dt} = 0.2 \sin(120\pi t) + 0.2t \cdot 120\pi \cos(120\pi t) \text{ nA}$$

$$i(t) = \frac{dq}{dt} = 0.2 \sin(120\pi t) + 0.2t \cdot 120 + \cos(120\pi t) \text{ nA}$$

$$= 0.2 \sin(120\pi t) + 24t \cos(120\pi t) \text{ nA}$$

1.16 Determine the net charge ΔQ that flowed through a resistor over the specified time interval for each of the following currents

a) $i(t) = 0.36 \text{ A}$ from $t=0$ to $t=3 \text{ s}$

$$Q = \int_0^3 i(t) dt = \int_0^3 0.36 dt = 0.36(3-0) = 1.08 \text{ A}$$

b) $i(t) = [40t + 8] \text{ mA}$ from $t=1 \text{ s}$ to $t=12 \text{ s}$

$$Q = \int_1^{12} i(t) dt = \int_1^{12} (40t + 8) dt \text{ mA} = 20t^2 + 8t \Big|_1^{12}$$

$$= 20(12^2) + 8(12) - (20(1)^2 + 8(1)) = 2948 \text{ mC} = 2.948 \text{ C}$$

c) $i(t) = 5 \sin(4\pi t) \text{ nA}$ from $t=0$ to $t=0.05 \text{ s}$

$$Q = \int_0^{0.05} i(t) dt = \int_0^{0.05} 5 \sin(4\pi t) dt \text{ nA} = -\frac{5 \cos(4\pi t)}{4\pi} \Big|_0^{0.05}$$

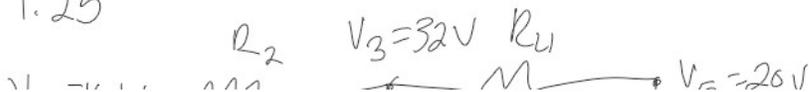
$$= -\frac{5 \cos(4\pi(0.05))}{4\pi} + \frac{5 \cos(0)}{4\pi} = 0.076 \text{ nA}$$

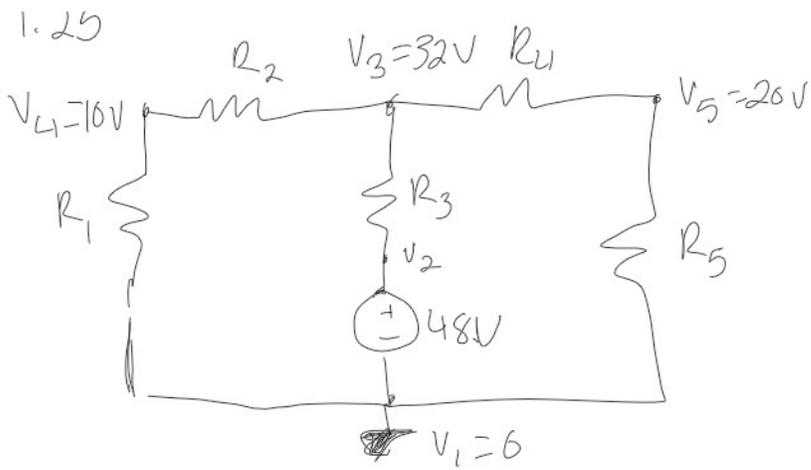
d) $i(t) = 12 e^{-0.3t} \text{ mA}$ from $t=0$ to $t=\infty$

$$Q = \int_0^{\infty} i(t) dt = \int_0^{\infty} 12 e^{-0.3t} dt \text{ mA} = -40 e^{-0.3t} \Big|_0^{\infty}$$

$$= -40 e^{-\infty} + 40 e^0 = 40 \text{ mA}$$

1.25





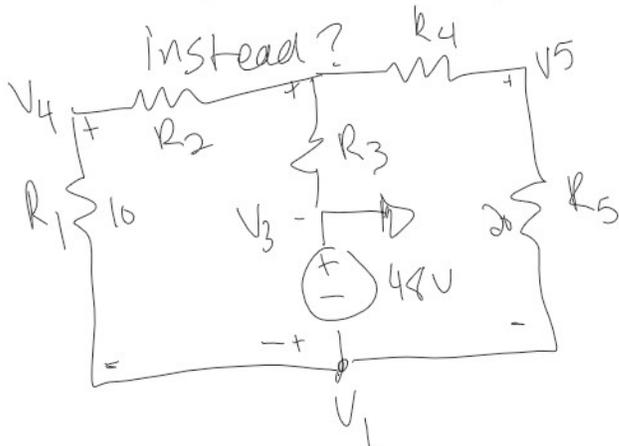
a) What is voltage at node V_2 ?

$V_2 = 48V$

b) What is the voltage difference

$V_{32} = V_3 - V_2 = 32 - 48 = -16V$

c) What are the voltages at node 1, 3, 4, 5 if node 2 is selected as ground node instead?



$V_1 = -48V$

$V_3 = 32 - 48 = -16V$

$V_4 = 10 - 48 = -38V$

$V_5 = 20 - 48 = -28V$

1.29 An electric oven operates at 120V.

If its power rating is 0.6kW, what amount of current does it draw, and

how much energy does it consume in

amount of current does it draw, and how much energy does it consume in 12 min of operation?

$$P = V \cdot I \Rightarrow I = \frac{P}{V} = \frac{6.6 \text{ kW}}{120} = 5 \text{ A}$$

$$W = \int_0^{12 \cdot 60} 0.6 \text{ kW} dt = 0.6 (12 \cdot 60) = 432 \text{ kJ}$$

1.3 The voltage across and current through a certain device are given by:

$$v(t) = 5 \cos(4\pi t) \text{ V} \quad i(t) = 0.1 \cos(4\pi t) \text{ A}$$

Determine:

a) instantaneous power $p(t)$ at $t=0$ + $t=25$ s

$$P = VI \quad t=0 \quad P = 5 \cos(0) \cdot 0.1 \cos(0) = 0.5 \text{ W}$$

$$P = VI \quad t=25 \quad P = 5 \cos(4\pi(25)) \cdot 0.1 \cos(4\pi(25)) = 0.5 \text{ W}$$

b) The average power, P_{av} , defined as the average value of $p(t)$ over a full time period of cosine (0 to 0.5s)

$$p = v(t) \cdot i(t) = 5 \cos(4\pi t) \cdot 0.1 \cos(4\pi t) \\ = 0.5 \cos^2(4\pi t)$$

$$P_{av} = \frac{1}{0.5 - 0} \int_0^{0.5} 0.5 \cos^2(4\pi t) dt$$

$$= 2 \cdot \left(\frac{\sin(8\pi t)}{32\pi} + \frac{t}{4} \Big|_0^{0.5} \right)$$

$$= 2 \cdot \left(0 + \frac{0.5}{4} - 0 - 0 \right) = 2 \cdot \frac{1}{8} = 0.25 \text{ W}$$