

MAE 140: Linear Circuits Fall 2012

Solution HW1

PROBLEM 1-13:

a) Current supplied	$I = \frac{P}{U} = \frac{200\text{W}}{12\text{V}} = 16.67\text{ A}$
Time headlight	$t = \frac{100\text{Ah}}{16.67\text{A}} = 6\text{h}$
b) Time headlight and device	$I = \frac{P}{U} = \frac{300\text{W}}{12\text{V}} = 25\text{ A}$
	$t = \frac{100\text{Ah}}{25\text{A}} = 4\text{h}$

PROBLEM 1-14:

Difference in energy consumption between both devices over 1000 h:

$$(100\text{W} - 16\text{W}) * 1000\text{h} = 84\text{ kWh}$$

Cost: $84\text{ kW} * 7.8\text{ cents/kWh} = 655.2\text{ cents} = \$ 6.55$

PROBLEM 1-21

- | | |
|--------------------------------|-----------------------------|
| (a) 12.1 W | power transferred from B->A |
| (b) 1.6 W | power transferred from A->B |
| (c) 1.44 W | power transferred from A->B |
| (d) 0.9 mW = 900 μW | power transferred from A->B |

PROBLEM 2-3

Current through resistor: $P = UI = RI^2 \quad I = \sqrt{P/R} = \sqrt{\frac{10^{-1}}{10^5}} = \sqrt{10^{-6}} = 1\text{ mA}$

PROBLEM 2-5

Resistance $R = \frac{U}{I} = \frac{U^2}{P} = \frac{225\text{V}^2}{0.025\text{W}} = 9\text{ k}\Omega$

PROBLEM 2-12:

Equation that describes linear relation between resistance and temperature:

$$R = m(T - 25\text{degC}) + b$$

Slope m: $m = \frac{5000-340}{25-100} = -\frac{4640}{75} = -62.13$

Resistance at 25 deg C: $b = R(25 \text{ degC}) = 5000\Omega$

$$R = -62.13(T - 25) + 5000\Omega$$

Temperature for $R = 1k\Omega$ $T(1000\Omega) = 89.4 \text{ deg C}$

PROBLEM 2-13

Current i_1 $-i_1 - i_2 = 0$ $i_1 = -i_2 = 5A$

Current i_4 $i_2 + i_3 - i_4 = 0$ $i_4 = -3A$

PROBLEM 2-14

Voltage v_2 $-v_1 + v_2 + v_3 = 0$ $v_2 = -2V$

Voltage v_4 and v_5 $v_5 = 0$ (due to the ground on both sides)
 $-v_3 + v_4 + v_5 = 0$ $v_4 = v_3 = 5V$

PROBLEM 2-15

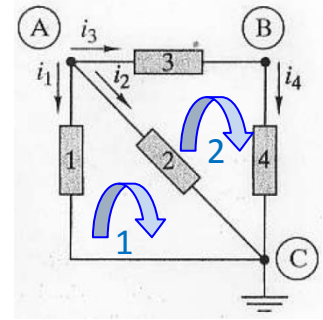
(a) Nodes and loops:

- Nodes:
- Loops:

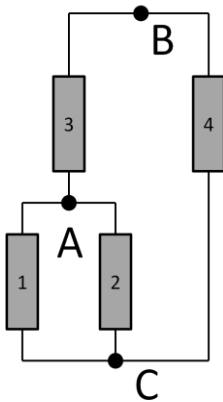
node A, node B and node C

see figure on the right;

also possible is a loop starting at node A going through elements 3-4-1 back to node A.



(b) Elements connected in series or parallel



- In series: element 3 and 4
- In parallel: element 1 is parallel to element 2

(c) KCL and KVL

- KCL:

$$\boxed{A} -i_1 - i_2 - i_3 = 0$$

$$\boxed{B} i_3 - i_4 = 0$$

$$\boxed{C} i_1 + i_2 + i_4 = 0$$

- KVL:

$$\boxed{1} -v_1 + v_2 = 0$$

$$\boxed{2} -i_2 + i_3 + i_4 = 0$$

PROBLEM 2-21Voltage v_6

$$-v_2 - v_4 + v_6 = 0$$

$$v_6 = 15V$$

Voltage v_3

$$-v_3 + v_4 + v_5 = 0$$

$$v_3 = 20V$$

Voltage v_2

$$-v_1 + v_2 + v_3 = 0$$

$$v_1 = 30V$$