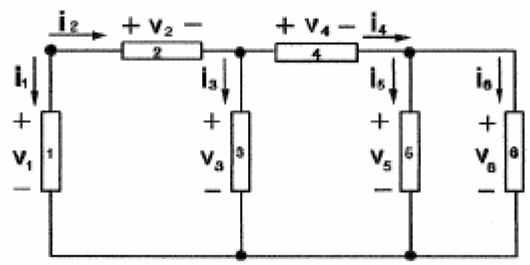
Homework Solutions 1

(1-2) Express the following quantities using the appropriate engineering prefixes

(a) 0.022 volts	= 22 mV
(b) 23 x 10^-9 farads	= 23 nF
(c) 56,000 ohms	= 56 kΩ
(d) 7.52 x 10^5 joules	= 0.752 MJ
(e) 0.000235 henrys	= 0.235 mH

(1-22) Figure P1-22 show an electric circuit with the voltage and a current variable assigned to each of the six devices.

1-22



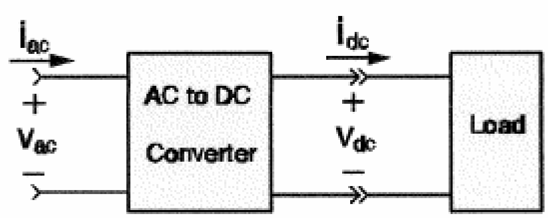
Device No. 1 p = vi = (15 V)x(-1 A) = -15 W, delivering
Device No. 2 i = p/v = (5 W)/(5 V) = 1 A, absorbing
Device No. 3 v = p/i = (5 W)/(0.5 A) = 10 V, absorbing
Device No. 4 p = vi = (4 V)x(0.5 A) = 2 W, absorbing
Device No. 5 v = p/i = (18 W)/(3 A) = 6 V, absorbing
Device No. 6 v = p/i = (-15 W)x(-2.5 A) = 6 V, delivering
total power = $-15 + 5 + 5 + 2 + 18 - 15 = 0$ power balance check

Remember, **p > 0 device is *absorbing* power**
p < 0 device is *delivering* power

Total power of all devices must add to zero, which is also a good way to check over your work. Hence, **the power balance check**.

(1-27) Figure P1-27 states that the AC input is 120 V, the DC output is 24 V, and the efficiency is 82% when the output power is 200W. Find input and output currents.

1-27



$V_{dc} := 24$ $V_{ac} := 120$ $P_{dc} := 200$ $\eta := 0.82$ $P_{ac} := \frac{P_{dc}}{\eta}$ $P_{ac} = 243.902$

$I_{dc} := \frac{P_{dc}}{V_{dc}}$ $I_{ac} := \frac{P_{ac}}{V_{ac}}$ $I_{dc} = 8.333$ $I_{ac} = 2.033$

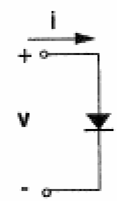
Consider, (DCpower / ACpower) = 0.82, which is the efficiency of the converter. The DC power is given now find the AC power. Since, power is lost due to the converter and the AC voltage is given, the relationship P = VI is used to find the AC current. The DC current is easily found because the DC voltage and power are given.

(2-9) Figure P2-9 shows the circuit symbol for the a class of two-terminal devices called diodes. The i-v relationship for a p-n junction diode is:

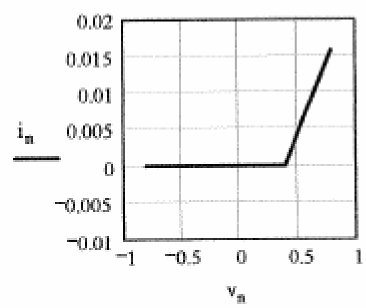
$$i_n := 2\cdot 10^{-16}\cdot\left(\exp\left(40\cdot v_n\right) - 1\right) \quad p_n := v_n\cdot i_n$$

2-9 $v_1 := -0.8$ $v_2 := -0.4$ $v_3 := -0.2$ $v_4 := -0.1$ $v_5 := 0$ $v_6 := 0.1$ $v_7 := 0.2$ $v_8 := 0.4$ $v_9 := 0.8$

(a) $n := 1, 2 .. 9$ $i_n := 2\cdot 10^{-16}\cdot\left(\exp\left(40\cdot v_n\right) - 1\right)$ $p_n := v_n\cdot i_n$



n =	v_n =	i_n =	p_n =
1	-0.8	0	0
2	-0.4	0	0
3	-0.2	0	0
4	-0.1	0	0
5	0	0	0
6	0.1	$1.072\cdot 10^{-14}$	$1.072\cdot 10^{-15}$
7	0.2	$5.96\cdot 10^{-13}$	$1.192\cdot 10^{-13}$
8	0.4	$1.777\cdot 10^{-9}$	$7.109\cdot 10^{-10}$
9	0.8	0.016	0.013



(b) nonlinear, nonbilateral, and passive.

(c) For $v := 5$ $i := 2\cdot 10^{-16}\cdot(\exp(40\cdot v) - 1)$ $p := v\cdot i$ $i = 1.445\times 10^{71}$ $p = 7.226\times 10^{71}$

Model does not apply. These signal levels would vaporize the device & several nearby towns .

(d) For $v := -5$ $i := 2\cdot 10^{-16}\cdot(\exp(40\cdot v) - 1)$ $i = -2\cdot 10^{-16}$ $p := v\cdot i$ $p = 1\times 10^{-15}$

Model applies since these levels are nearly zero.

Remember, *linear* means that the defining characteristic is a straight line through the origin. *Bilateral* means that the i-v characteristic curve about the symmetry,

Let **i = f(v)**, then,

$$\mathbf{f(-v) = -f(v)}$$

hence, the function f(v) symmetry is odd.

A *passive* device is defined as a device that always absorbs power.

(2-10) The resistance of a device is given by

$$R = 0.3T_c + 100$$

where T_c is the device temperature in C. Find the voltage across the device when the current is 1mA and the temperature is 400 C.

$m := 0.3 \quad T_C := 400 \quad i := 10^{-3} \quad R := m \cdot T_C + 100 \quad R = 220 \quad v := i \cdot R \quad v = 0.22$

If $V = RI$, then $V = (0.3T_c + 100) \cdot I$; let $T_c = 400$ and $I = 10^{-3}$,

Therefore, $V = [0.3 \cdot (400) + 100)\,] \cdot (10^{-3}) =$ **0.22 V**