1.19, 1.22, 2.11, 2.22,
2.33, 2.37 & 38, 3.18, 3.21

Engineering II
Electrical Circuit Analysis
Assignment 1 Solutions

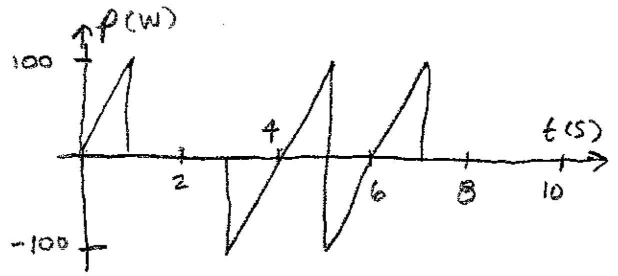
LAM
9.5.05

①

(1.19) v, i @ terminals of device given

ⓐ Sketch $p(t)$ for $0 \le t \le 10$ s

t (s)	v (V)	i (A)	p (W)
$0 \le t \le 1$	5	$20t$	$100t$
$1 \le t \le 2$	0	20	0
$2 \le t \le 3$	0	20	0
$3 \le t \le 4$	-5	$80-20t$	$-400+100t$
$4 \le t \le 5$	-5	$80-20t$	$-400+100t$
$5 \le t \le 6$	5	$-120+20t$	$-600+100t$
$6 \le t \le 7$	5	$-120+20t$	$-600+100t$
$7 \le t \le 10$	0	20	0



ⓑ Calculate area under curve from $0 \to t$ for $t = 1, 6, 10$ s.

$w(1) = \frac{1}{2}(1)(100) = 50$ J
$w(6) = 2 \cdot (\frac{1}{2})(1)(100) - 2(\frac{1}{2})(1)(100) = 0$
$w(10) = 3 \cdot (\frac{1}{2})(1)(100) - 2(\frac{1}{2})(1)(100) = 50$ J

② (1.22) v, i of charging battery given

ⓐ Calculate total q transferred to battery (area under curve $q = \int i\,dt$) (use boxes given)

$$q = \tfrac{1}{2}(5000)(6) + 5000(6) + \tfrac{1}{2}(10000)(6) + 15000(8) + \tfrac{1}{2}(5000)(8) = \boxed{215{,}000\ \text{C}}$$

ⓑ Calculate total energy transferred to the battery $w = \int_{-\infty}^{t} p\,dt = \int_{-\infty}^{t} vi\,dt$

$$v = \begin{cases} 0.2(10^{-3})t + 8 & 0 \le t \le 20\text{ks} \\ 12 & t \ge 20\text{ks} \end{cases}$$

$$i = \begin{cases} 20 - 1.2(10^{-3})t & 0 \le t \le 5\text{ ks} \\ 17 - 0.6(10^{-3})t & 5\text{ks} \le t \le 15\text{ks} \\ 3.2 - 1.6(10^{-3})t & 15\text{ks} \le t \le 20\text{ks} \\ 0 & t \ge 20\text{ks} \end{cases}$$

$\boxed{0 \le t \le 5\text{ks}}$ $p = 160 - 5.6(10^{-3})t - 2.4(10^{-7})t^2$

$$w = \int_0^{5\text{ks}} p\,dt = \left[160t - \frac{5.6(10^{-3})t^2}{2} - \frac{2.4(10^{-7})t^3}{3}\right]_0^{5\text{ks}} = 720\text{ kJ}$$

$\boxed{5\text{ks} \le t \le 15\text{ks}}$ $p = 136 - 1.4(10^{-3})t - 1.2(10^{-7})t^2$

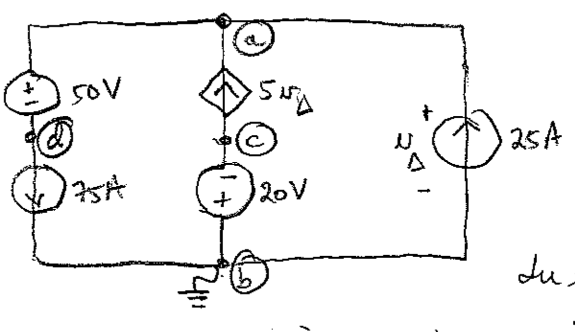
$$w = \int_{5\text{ks}}^{15\text{ks}} p\,dt = \left[136t - \frac{1.4(10^{-3})t^2}{2} - \frac{1.2(10^{-7})t^3}{3}\right]_{5\text{ks}}^{15\text{ks}} = 1090\text{ kJ}$$

$\boxed{15\text{ks} \le t \le 20\text{ks}}$ $p = 256 - 6.4(10^{-3})t - 3.2(10^{-7})t^2$

$$w = \int_{15\text{ks}}^{20\text{ks}} p\,dt = \left[256t - \frac{6.4(10^{-3})t^2}{2} - \frac{3.2(10^{-7})t^3}{3}\right]_{15\text{ks}}^{20\text{ks}} = 226.7\text{ kJ}$$

$$w_{total} = 720 + 1090 + 226.7 \doteq 2036.7\text{ kJ}$$

③ (2.11) Find power developed (supplied)

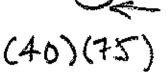


$\sum_a i = 0 = -75 + 5v_\Delta + 25 \Rightarrow v_\Delta = 10$ V

$v_\Delta = v_a - v_b = 10$ V   Let $v_b = 0$ (ground)

In the middle branch, $v_c = -20$V, so the voltage drop across the $5v_\Delta$ current source, $v_a - v_c = 30$ V

In left branch, $v_d = v_a - 50 = -40$ V.

Elements delivering power have  , which are:

75 A current source w/ $p = (40)(75) = 3000$ W,
$5v_\Delta = 50$ A current source w/ $p = (30)(50) = 1500$ W,
& 25 A current source w/ $p = (10)(25) = 250$ W

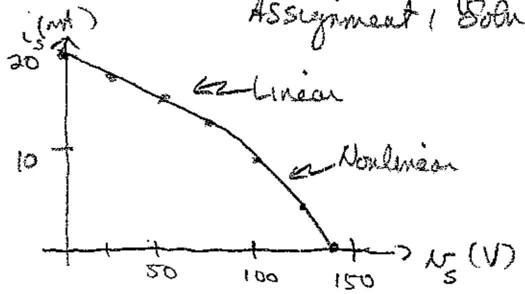
∴ Power supplied = 3000 + 1500 + 250 = 4750 W

Engineering 11
Assignment 1 Solns. Cont.

LAM

(4.) (2.22)

(a) Plot i vs v

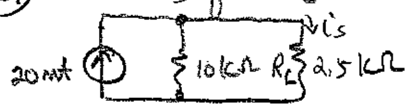


(b) Construct a model for the linear portion

$R = \frac{\Delta v}{\Delta i} = \frac{50}{.005} = 10k\Omega$

(Practical current source is modeled by ideal current source in parallel w/ resistor.)

(c) Find i_s for $R_L = 2.5k\Omega$



By current ÷,
$i_{2.5k} = \frac{10}{10+2.5}(20mA) =$ **16 mA**

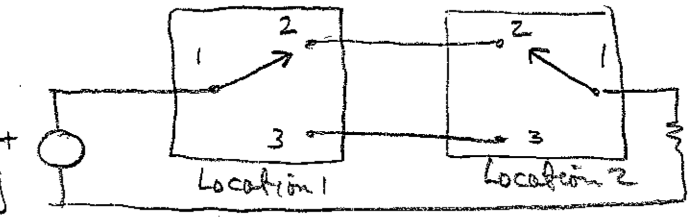
(f) Device is nonlinear & has varying values for R depending on i_s / v_s.

(d)

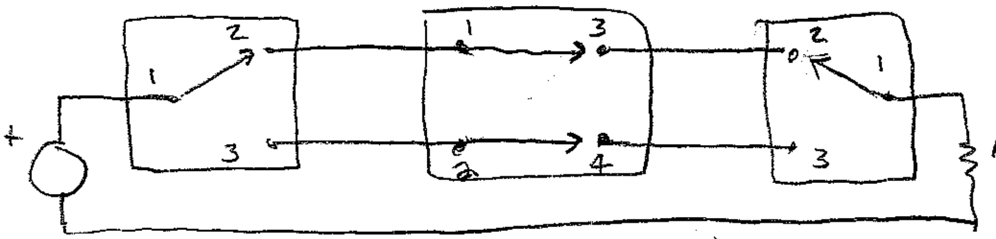
$v_{oc} = (20m)(10k) =$ **200 V**

(e.) Actual $v_{oc} = 140V$ (when $i_s = 0$)

(5.) 2.33

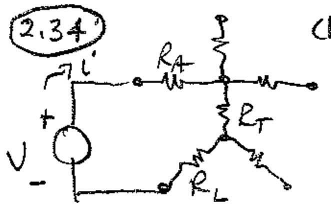


Appliance (on when both S in either position 2 or 3)



(on if path is complete; otherwise off)
Appliance

(6) (2.34) (Fig 2.25)

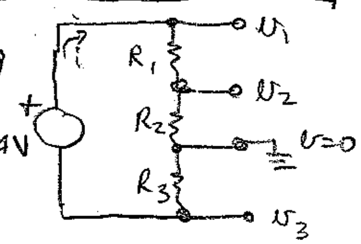


$V = 250V$
$R_A = 400\Omega$
$R_T = 50\Omega$
$R_L = 200\Omega$

so $\Sigma v = 0 = 250 - iR_A - iR_T - iR_L$
$250 = i(400+50+200) = i(650)$
so **$i = 385$ mA** dangerous

(2.38) $R_{space} = 1M\Omega$, $i = 3mA \Rightarrow$
$v = R_{space} i = 3 KV$

(7.) (3.18)



Set $v_1 = 12V$
$v_2 = 6V$
$v_3 = -12V$

$P = 36W \Rightarrow vi = 36 = 24i$ or $i = 3/2$ A

Then
$R_1 = \frac{\Delta v}{i} = \frac{6}{3/2} = 4\Omega$
$R_2 = \frac{\Delta v}{i} = \frac{6}{3/2} = 4\Omega$
$R_3 = \frac{\Delta v}{i} = \frac{12}{3/2} = 8\Omega$

(Δv = drop across given resistor)

(8) (3.21)

v_g (since all in parallel)

$i_g = 8mA$
$v_g = 4V$

$i_1 = 2i_2 = 20i_4$
$i_2 = 10i_3 = 10i_4$
$i_3 = i_4$
i_4

Find Rs: $R_1 = \frac{v_g}{20i_4} = 800\Omega$
$R_2 = v_g/10i_4 = 1.6k\Omega$
$R_3 = R_4 = v_g/i_4 = 16k\Omega$

$\sum_a i = 0 = 8mA - 20i_4 - 10i_4 - i_4 - i_4 \Rightarrow 32i_4 = 8mA$ or $\Rightarrow$
$i_4 = 0.25mA$