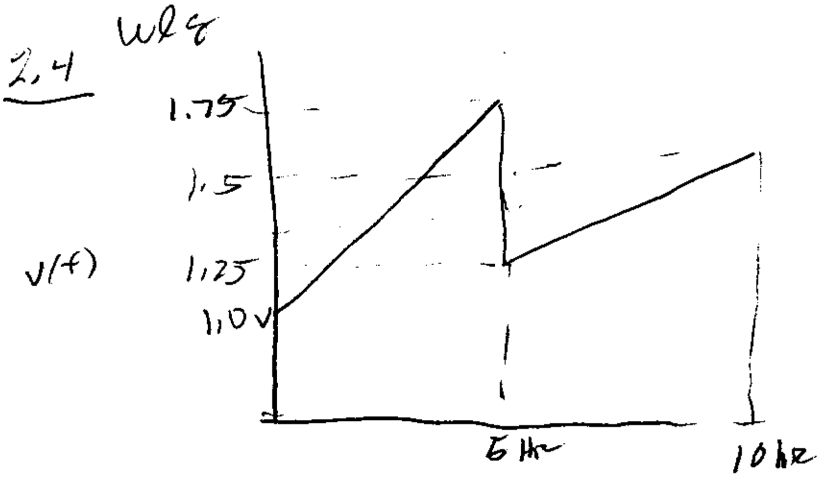
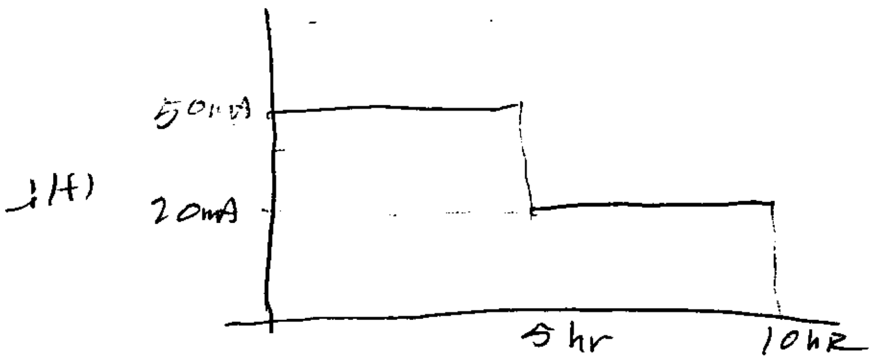
2.4 Wlg





(a) Find Q

since $i = \frac{dq}{dt}$

$$q(t) = \int_{t_0}^{t} i(t)\,dt = \int_{0}^{5\times3.6\times10^3} 50\times10^{-3}\,dt + \int_{5\times3.6\times10^3}^{10\times3.6\times10^3} 20\times10^{-3}\,dt$$

$$q(t) = 50\times5\times3.6 + 20\times5\times3.6$$

$$q(t) = 900 + 360$$

$$q(t)\Big|_{t=10\,hr} = 1260 \text{ Coulombs}$$

2.4 continued

(b) $p = \frac{dw}{dt} \longrightarrow w = \int p(t)\,dt$

For $0 \le t \le 5\,hr$

$$v(t) = a_1 t + b_1 = \frac{0.75}{5 \times 3.6 \times 10^3} t + 1 = \frac{.75t}{18000} + 1$$

$5\,hr \le t \le 10\,hr$

$$v(t) = a_2 t + b_2 = \frac{.25}{5 \times 3.6 \times 10^3} + 1 = \frac{.25t}{18000} + 1$$

$$w(t) = \int_0^{5 \times 3.6 \times 10^3} 50 \times 10^{-3} \left(\frac{0.75t}{18000} + 1 \right) dt + \int_{5 \times 3.6 \times 10^3}^{10 \times 3.6 \times 10^3} 20 \times 10^{-3} \left(\frac{.25t}{18000} + 1 \right) dt$$

$$w(t) = 50 \times 5 \times 3.6 + \frac{.75 (5 \times 3.6 \times 10^3)^2}{36000} \times 50 \times 10^{-3}$$

$$+ 20 \times 5 \times 3.6 + \frac{.25 (5 \times 3.6 \times 10^3)^2}{36000} \times 20 \times 10^{-3}$$

$$W(t) = (900 + 337.5) + (360 + 45)$$

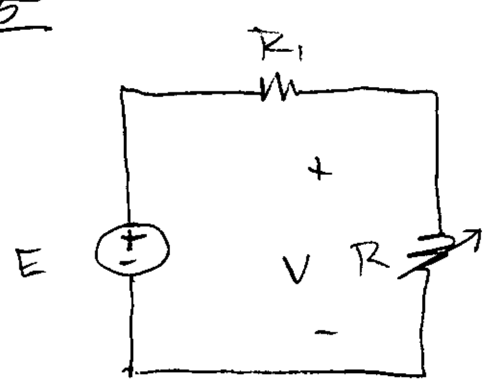
$$W(t)\Big|_{t=10\,hr} = 1642.5\ J$$

2.6 wlg

(a) The load attached to the voltage source; Also, the physics of the voltage source, how it is made, current rating.

(b) The load attached; The physical make-up of the source.

2.15



Find the general expression for power delivered to R.

$$V = \frac{E \times R}{R_1 + R} \qquad P = \frac{V^2}{R} = \frac{E^2 R^2 \times}{(R_1+R)^2}$$

$$P = \frac{E^2 R}{(R_1 + R)^2} \qquad (1)$$

$$\frac{dP}{dR} = \frac{E^2 (R_1 + R)^2 - E^2 R \times 2 \, (R_1 + R)}{[(R_1+R)^2]^2} \qquad (2)$$

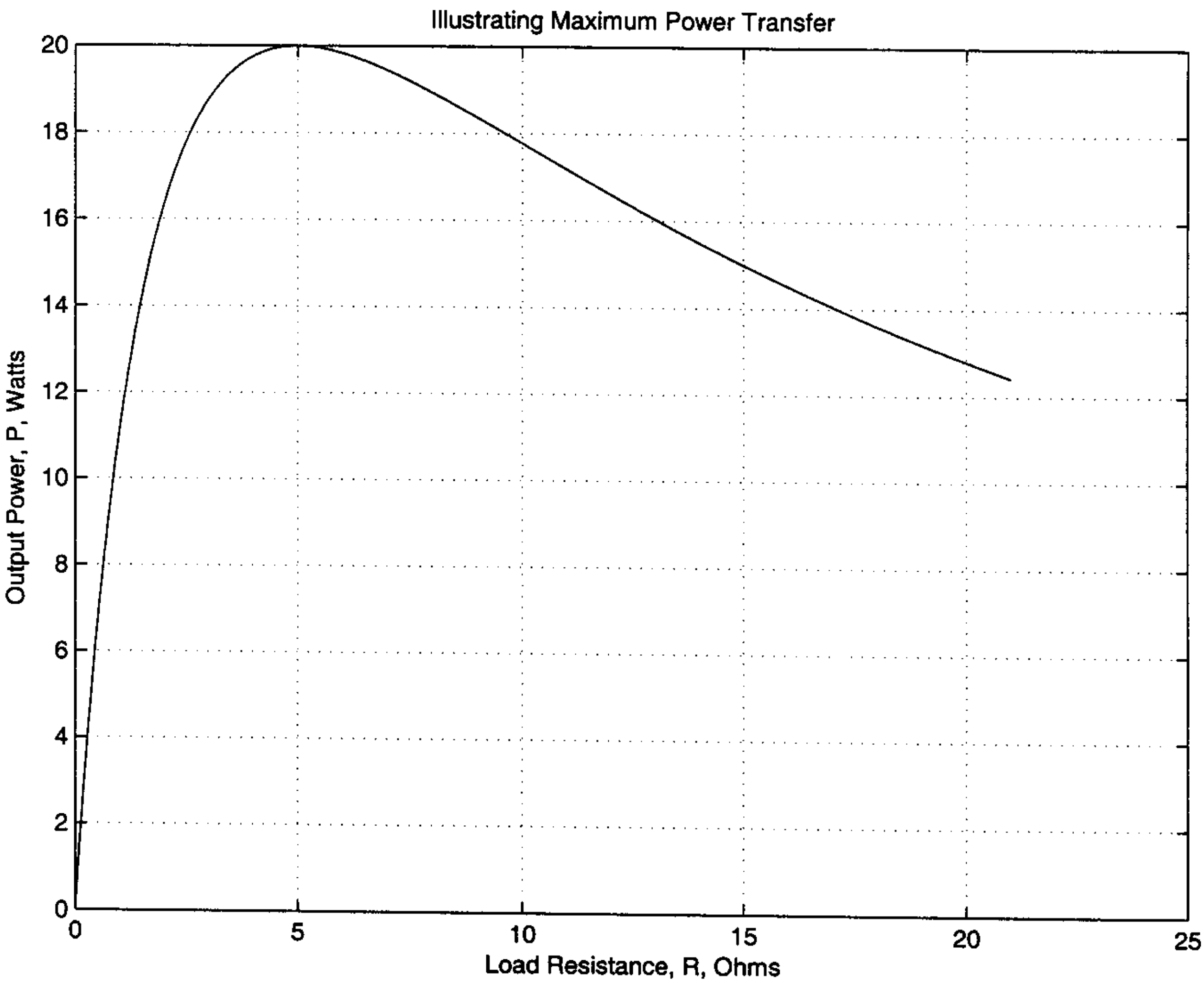
2.15 cont.

Dividing out terms leaves

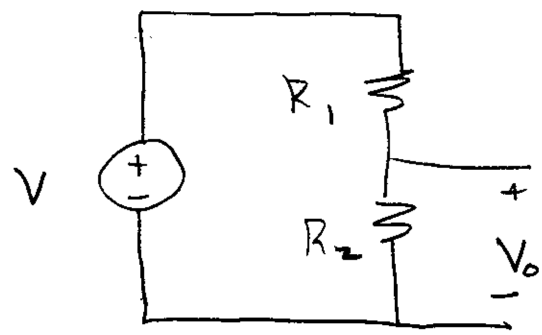
wlg

C:\MATLAB6p5\work\max_power_transfer.m
August 25, 2004

```
%  Making a plot of power across the output resistor of two resistors
%  in parallel.  The supplied voltage is 20 V and the non-load resistor
%  is 5 ohms.  The equation to plot from R = 0 to R = 20 is

%             P = 400*R/(5+R)
% Program under     max_power_transfer.m
% written by: wlg: office computer 8/26/04 for ECE 301


R =  0:.05: 21;

P = (400*R)./((5+R).^2);

plot(R,P)
grid
ylabel('Output Power, P, Watts')
xlabel('Load Resistance, R, Ohms')
title('Illustrating Maximum Power Transfer')
```


Illustrating Maximum Power Transfer
Output Power, P, Watts
Load Resistance, R, Ohms
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25

2.21 wldg



(a) $V = 30\,V$, $R_1 = 10\,k\Omega$, $V_o = 10\,V$

Find R_2 & wattage

$$V_o = \frac{V \times R_2}{R_1 + R_2} = \frac{30 \times R_2}{10k + R_2} = 10$$

$$3R_2 = 10K + R_2$$

$$R_2 = \underline{\underline{5\,K}}$$

$$P_o = \frac{V_o^2}{R_2} = \frac{100}{5K} = 20 \times 10^{-3}$$

$P_o = .02\,W \longrightarrow$ <u>1/8 Watt</u> resistor

(b) $V = 12\,V$, $R_2 = 140\,\Omega$, $V_o = 8.5\,V$

$$V_o = \frac{12 \times 140}{140 + R_1} = 8.5$$

$$1680 = 1190 + 8.5R_1$$

$$8.5R_1 = 490\,\Omega$$

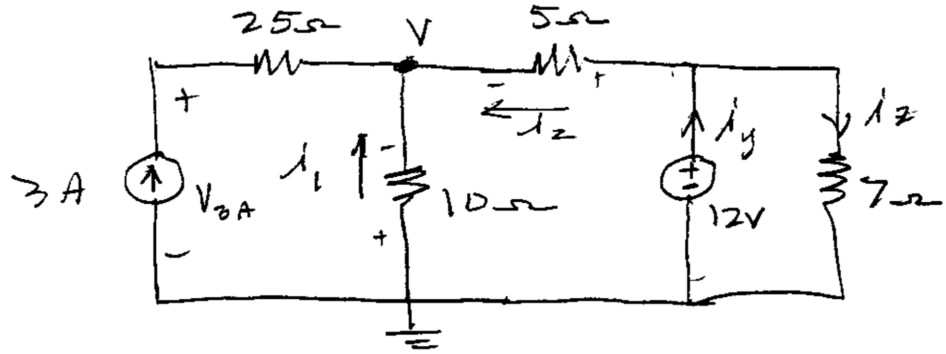
$$R_1 = 57.6\,\Omega$$

$P_2 = \frac{8.5^2}{140} = 0.52\,W \longrightarrow$ 1 W resistor

$P_1 = 0.213\,W \longrightarrow$ 1/4 W resistor

2.24 wlg

Given



(a) Find i_1 and i_2

$$i_1 + i_2 = -3$$

$$-10 i_1 + 5 i_2 = 12$$

solving:

$$i_1 = -1.8\text{ A}, \quad i_2 = -1.2\text{ A}$$

(b) Find the power delivered by the 3 A source and by the 12 V source

$$P_{3A} = 3 \times V_{3A}$$

where $V_{3A} = 3 \times 25 - i_1 \times 10$

$$V_{3A} = 75 + 18 = 93\text{ V}$$

$$P_{3A\,\text{del}} = 93 \times 3 = 279\text{ W}$$

$$P_{12} = i_y \times 12$$

2.24 cont.

$i_{\cancel{z}} = \frac{12}{7}$

$i_2 = -1.2$

$i_y = \frac{12}{7} - 1.2 = 0.514 \text{ A}$

$P_{12} = 0.514 \times 12 = 6.17 \text{ W}$

$P_{3A} = 279 \text{ W}$

Total power develop ;

$$\boxed{P_{\substack{TOTAL \\ dev}} = 279 + 6.17 = 285.2 \text{ W}}$$

$\#$

$P_{disp}7 = \frac{12^2}{7} = 20.57 \text{ W}$

$P_{disp}5 = i_2^2\,5 = (-1.2)^2 5 = 7.2 \text{ W}$

$P_{disp}10 = i_1^2\,10 = (-1.8)^2 10 = 32.4 \text{ W}$

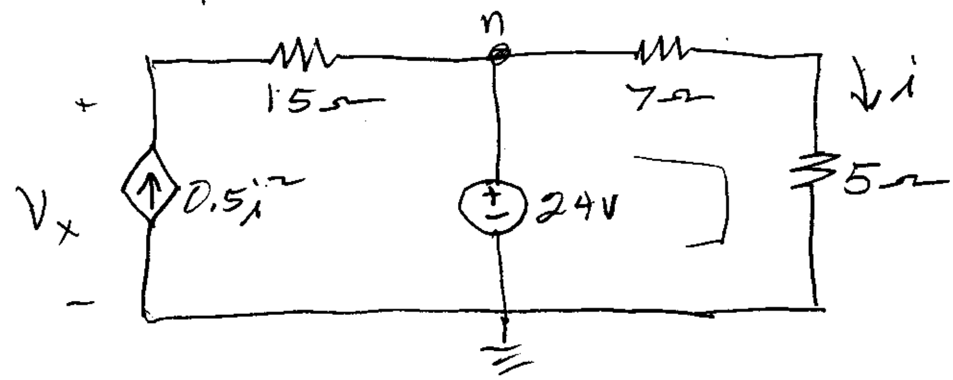
$P_{disp}25 = 3^2\,25 = 225 \text{ W}$

$\Sigma P_{disp} = 285.2 \text{ W}$

check

2.25 wlg

Determine the pwr delivered by the dependent source.



Going around the right mesh using Σ drops = 0, cw (clockwise)

$-24 + 7i + 5i = 0$

$12i = 24$

$i = 2\text{ A}$

must find V_x

$-V_x + 15 \times 0.5i^2 + 24 = 0$

$V_x = 7.5 \times 4 + 24 = 54$

$P_{del_{V_x}} = 54 \times (0.5i^2) = 27 \times 2^2$

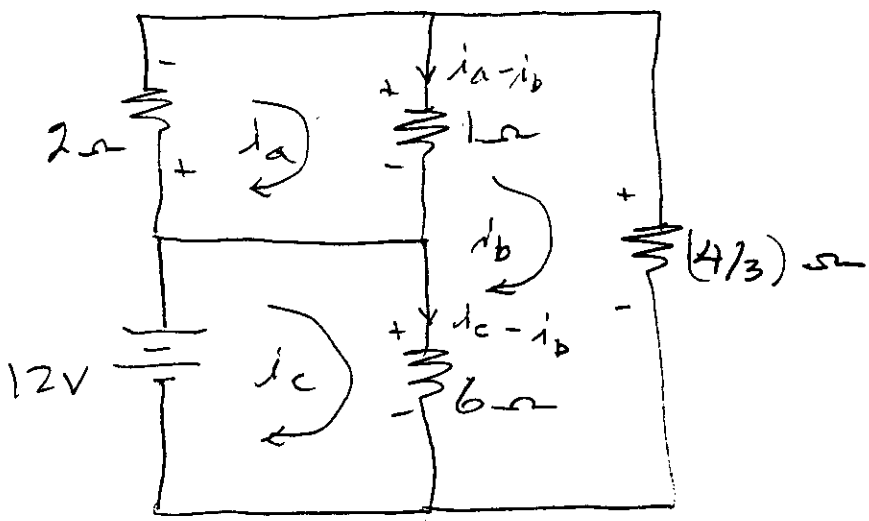
$$\boxed{P_{del_{V_x}} = 108\text{ W}}$$

2.34 wlg

For the circuit below, use KVL and Ohm's Law to find

(a) i_a, i_b, i_c

(b) current through each resistor



For the mesh with $\underline{i_a}$:

$$2 i_a + (i_a - i_b)1 = 0$$

$$\boxed{3 i_a - i_b + 0 i_c = 0}$$

For the mesh with $\underline{i_b}$:

$$(i_a - i_b) \times 1 + (i_c - i_b) 6 - (4/3)(i_b) = 0$$

$$\boxed{i_a - 8.33 i_b + 6 i_c = 0}$$

For the mesh with i_c:

$$(i_c - i_b) 6 - 12 = 0$$

$$\boxed{0 \times i_a - 6 i_b + 6 i_c = 12}$$

2.34 continued

$$\begin{bmatrix} 3 & -1 & 0 \\ 1 & -8.33 & 6 \\ 0 & -6 & 6 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 12 \end{bmatrix}$$

$\boxed{i_a = 2\,A}$, $\boxed{i_b = 6\,A}$, $\boxed{i_c = 8\,A}$

(b)

$\boxed{i_{R_0} = i_a = 2\,A \text{ up}}$

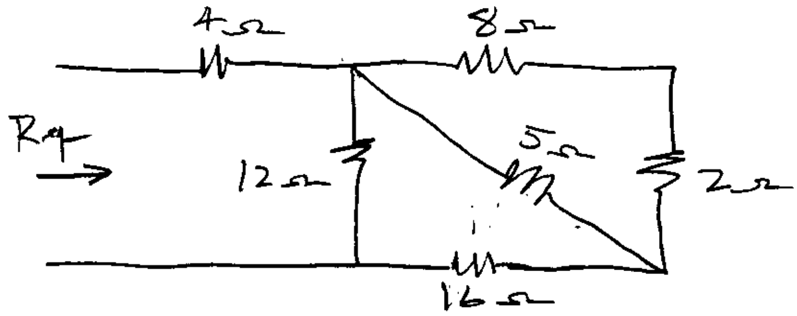
$\boxed{i_{R_1} = \underset{\text{up}}{i_b - i_a} = \underset{\text{up}}{4\,A}}$

$\boxed{i_{R_2} = i_b = \underset{\text{down}}{6\,A}}$

$\boxed{i_{R_3} = \underset{\text{down}}{i_c - i_b} = 8 - 6 = \underset{\text{down}}{2\,A}}$

2,38 wfy

Find the equivalent resistance for the circuit below



$10\,\Omega \parallel 5\,\Omega = \dfrac{10 \times 5}{15} = \dfrac{50}{15}\,\Omega = 3,33\,\Omega$

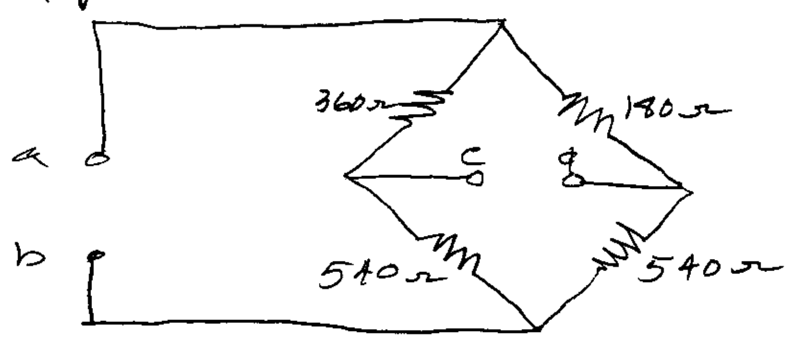
$16\,\Omega + 3,33\,\Omega = 19,33\,\Omega$

$19,33\,\Omega \parallel 12\,\Omega = \dfrac{19,33 \times 12}{19,33 + 12} = 7,4\,\Omega$

$R_{eq} = 4 + 7,4 = 11,4\,\Omega$

$\boxed{R_{eq} = 11,4\,\Omega}$

2.43 Wly



Find R

(a) Looking into a-b if c-d are open

(b) Looking into a-b if c-d are shorted

(c) Looking into c-d if a-b are open

(d) Looking into c-d if a-b are shorted

(a)

$$R_{ab} = (540+360) \parallel (540+180)$$

$$\underset{c\text{-}d\ \text{open}}{R_{ab}} = 900 \parallel 720 = 400\,\Omega$$

(b)

$$\underset{c\text{-}d\ \text{shorted}}{R_{ab}} = 360 \parallel 180 + 540 \parallel 540$$

$$\underset{c\text{-}d\ \text{shorted}}{R_{a\text{-}b}} = 120 + 270 = 390\,\Omega$$

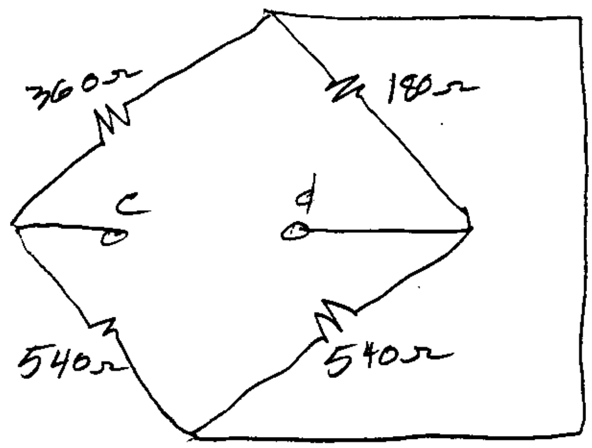
(c)

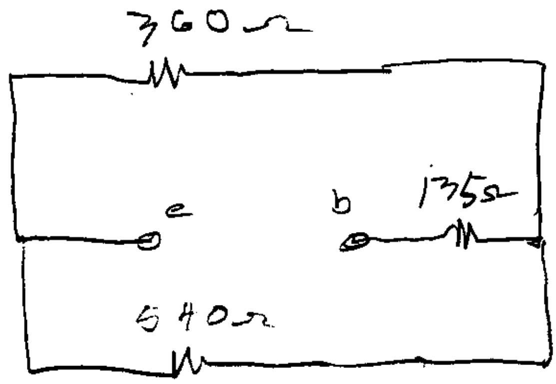
$$\underset{a\text{-}b\ \text{open}}{R_{cd}} = (540+540) \parallel (360+180)$$

$$= 1080 \parallel 540$$

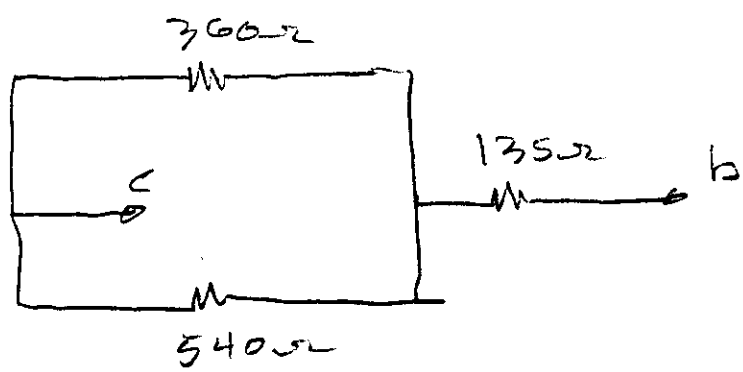
$$\underset{a\text{-}b\ \text{open}}{R_{cd}} = 360\,\Omega$$

2.43 cont





$180 \| 540$
$= 135\Omega$

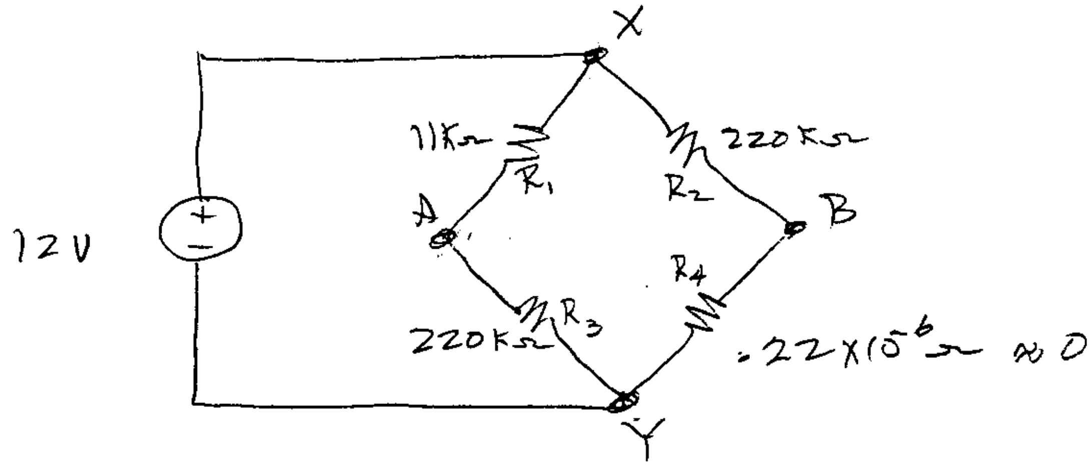


R_{cd} (a–b shorted) $= (360 \| 540) + 135$

$= 351\,\Omega$

2.49 wfg

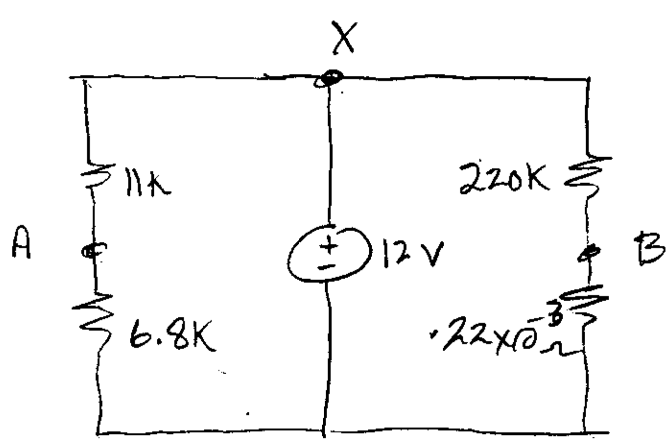
Determine the voltage V_{AB} in the circuit below.



$$V_{XA} = \frac{12 \times 11K}{6.8 + 11K} = 7.42$$

$$V_{XB} = \frac{12 \times 220K}{0 + 220K} = 12V$$

$$\boxed{V_{AB} = V_{XB} - V_{XA} = 12 - 7.42 = 4.58V}$$

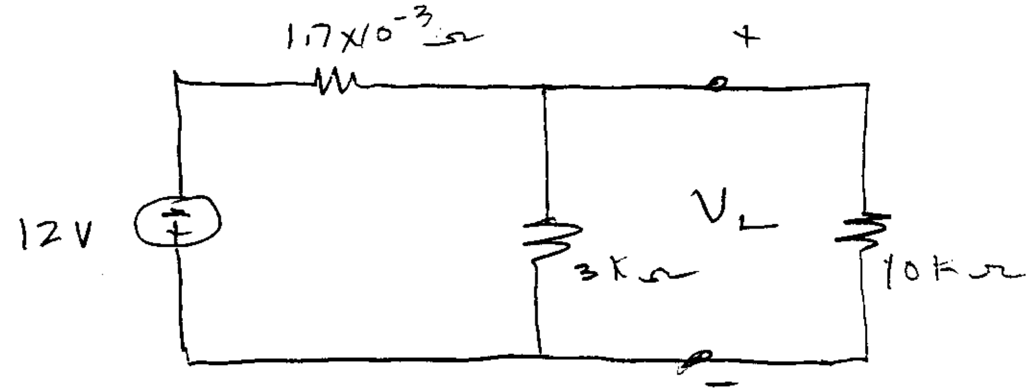


R_3

2.51 wlg

Determine the / voltage across R_3 in the circuit below

absolute value of the voltage across

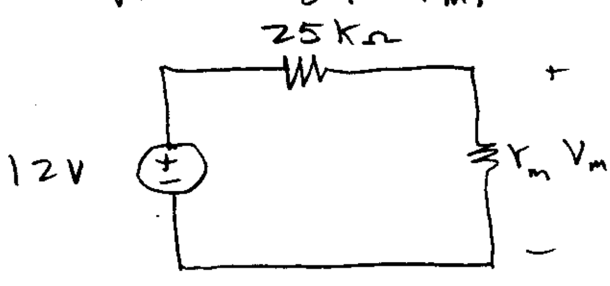


$$R_{LOAD} = 3K \parallel 10K = 2.3K$$

Since $2.3K >>> 1.7\times10^{-3}$ the

$$\boxed{|V_L| = |-12| = 12V}$$

2.61 In the circuit below, the voltage across r_m is 11.81 V. Determine the value of r_m.



$$V_m = \frac{12 \times r_m}{r_m + 25k} = 11.81V$$

So,

$$12\, r_m = 11.81\, r_m + 292.2K$$

$$\boxed{r_m = \frac{292.2K}{0.19} = 1537.9\ K\Omega}$$

	with meter in circuit	without meter in circuit
a	10.15 mA	9.99 mA
b	24.03 mA	23.15 mA
c	27.84 mA	26.67 mA
d	28.29 mA	27.08 mA

Problem 2.65

Solution:

Known quantities:
Schematic of the circuit and geometry of the beam shown in Figure P2.65, characteristics of the mater reads on the bridge.

Find:
The force applied on the beam.

Assumptions:
Gage Factor for Strain gauge is 2

Analysis:

R_1 and R_2 are in series; R_3 and R_4 are in series.

Voltage Division: $V_{R_2} = \dfrac{V_S R_2}{R_1 + R_2} = \dfrac{V_S(R_0 - \Delta R)}{R_0 + \Delta R + R_0 - \Delta R} = \dfrac{V_S(R_0 - \Delta R)}{2R_0}$

Voltage Division: $V_{R_4} = \dfrac{V_S R_4}{R_3 + R_4} = \dfrac{V_S(R_0 - \Delta R)}{R_0 - \Delta R + R_0 + \Delta R} = \dfrac{V_S(R_0 + \Delta R)}{2R_0}$

KVL: $-V_{R_2} - V_{BA} + V_{R_4} = 0$

$$V_{BA} = V_{R_4} - V_{R_2} = \frac{V_S(R_0 + \Delta R)}{2R_0} - \frac{V_S(R_0 - \Delta R)}{2R_0} = \frac{V_S 2\Delta R}{2R_0} = V_S GF\varepsilon = \frac{V_S(2)(6)L}{wh^2 Y}$$

$$F = \frac{V_{BA} wh^2 y}{V_s 12L} = \frac{0.050\,V\,(0.025\,m)(0.100\,m)^2\; 69\times10^9\,\frac{N}{m^2}}{12\,V(12)\,0.3\,m} = 19.97\,kN.$$

Problem 2.66

Solution:

Known quantities:
Schematic of the circuit and geometry of the beam shown in Figure P2.65, characteristics of the mat reads on the bridge.

Find:
The force applied on the beam.