EE40 Homework #1 Solutions

1) 18 bit A/D. signal range from $-250\mu V$ to $250\mu V$
1 bit for +/-. 17 remaining bits divide up the 0 to $250\mu V$ range

voltage resolution $= \left(\frac{250\mu V}{2^{17}-1}\right) = \frac{250\cdot10^{-6}\,V}{131071} = 1.9\cdot10^{-9}\,V$

1.9nV resolution

2) a) $I = 32\mu A$ $\quad A = 10\mu m^2$ $\quad I = \frac{dQ}{dt} \rightarrow$ charge/time

i) avg. # e^-/sec = (amount of charge/time) / (amount of charge/e^-)

$= I\,C/s \,/\, (1.6\cdot10^{-19}\,C/e^-)$

$= 32\mu / (1.6\cdot10^{-19})$

$= 2\cdot10^{14}\ e^-/sec$

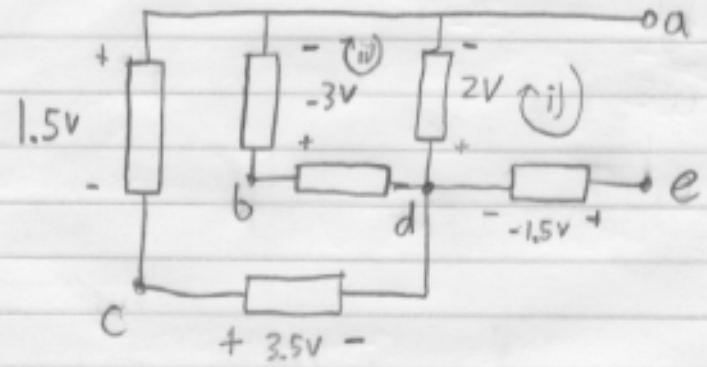
ii) current density = current/Area

$= I/A = (32\mu A)/(10\mu m^2) =$

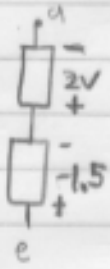
$= 32\cdot10^{-6}\,A / (10(10^{-4})^2\,cm^2)$

$= 320\ A/cm^2$

2) b)



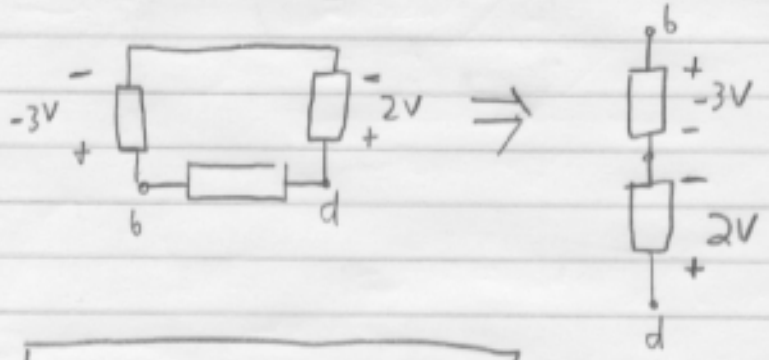
i) V_{ae} =



$V_{ae} = V_a - V_e = (-2V) + (1.5V) =$

$\boxed{V_{ae} = -0.5\,V}$

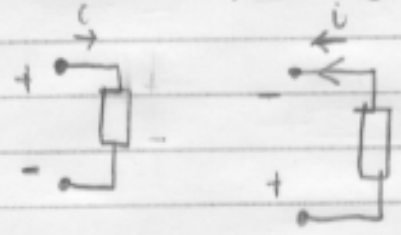
ii) V_{bd} - look at the center of the circuit



$\boxed{V_{bd} = (-3V) - (2V) = -5V}$

$\boxed{V_{bd} = -5\,V}$

3) Remember the passive sign convention



$p>0$ - power is delivered to the box
$p<0$ - power is extracted from the box

a) elements a, c, e, f are following the passive sign convention
b, d do not

b)

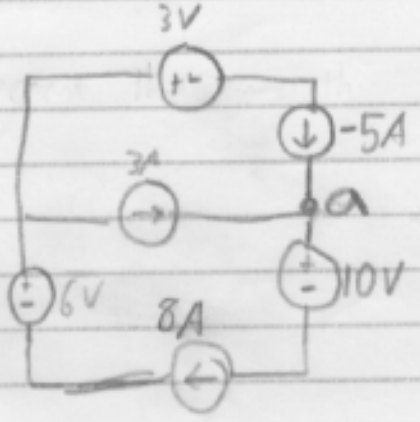
element	passive sign convention	V	I	V·i
a	yes	-8	7	(-8)(7)
b		-2	-7	(-2)(-7)
c	yes	10	15	(10)(15)
d		10	5	(10)(5)
e	yes	-6	3	(-6)(3)
f	yes	-4	3	(-4)(3)

element	power
a	-56
b	-14
c	150
d	-50
e	-18
f	-12

Total Power Delivered - 150 Watts

Total Power Absorbed - 150 Watts

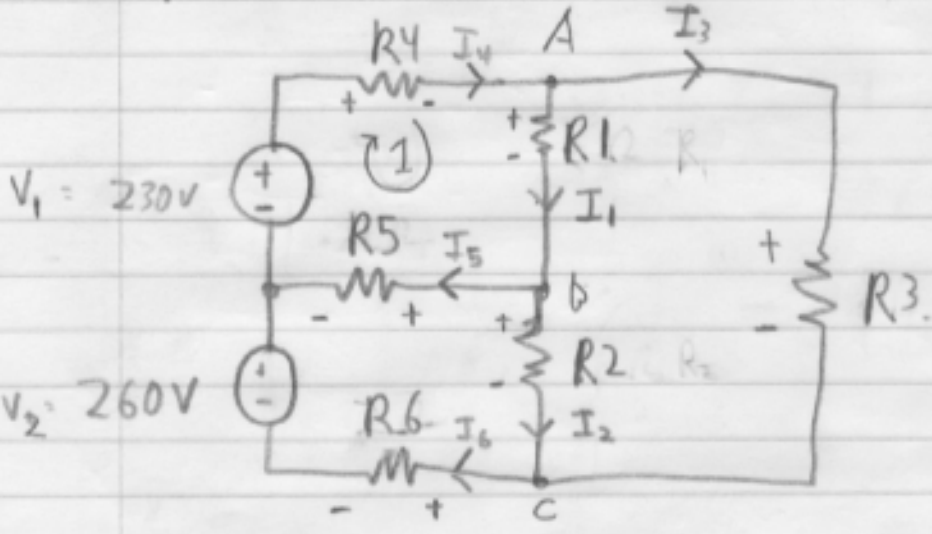
4) This connection is invalid. Look at point a. 8 amps are leaving the point, and (3+(-5)) amps are going into point a. Therefore, there is a contradiction because a wire cannot absorb charge.



KCL at point a.

$0 \neq 3-5-8$

5) $i_1 = 20A \quad i_2 = 15A$



$V = RI \quad P = IV = I^2R$

$I_1 = 20A \quad I_2 = 15A \quad \underset{@\ B}{KCL} \Rightarrow 0 = I_1 - I_2 - I_5 \Rightarrow I_5 = 5A$

KVL Loop 1 $\quad 0 = -230V + I_4R_4 + I_1R_1 + I_5R_5 \Rightarrow I_4 = 25A$

KCL at point A. $\quad 0 = I_4 - I_3 - I_1 \Rightarrow I_3 = 5A$

KCL at point C $\quad 0 = I_3 + I_2 - I_6 \Rightarrow I_6 = 20A$

Power supplied by $V_1 = P_{V_1} = V_1 \cdot I_4 = (230)(25) = 5750\ W$

" " $V_2 = P_{V_2} = V_2 \cdot I_6 = (260)(20) = 5200\ W$

" absorbed " $R_1 = I_1^2 R_1 = 3200\ W$

" " " $R_2 = I_2^2 R_2 = 3600\ W$

$R_3 = $ " $= 2000\ W$

$R_4 = $ " $= 1250\ W$

$R_5 = $ " $= 100\ W$

$R_6 = $ " $= 800\ W$

Total Power absorbed = 10950 W

" Power supplied = 10950 W

Note: Power absorbed should always equal power supplied