EECS/CSE 70A Spring 2018 **Midterm Exam #1** Name:________________________

May 2nd, 2018, 12:00 pm to 12:50 pm ID no.:________________________

PROBLEM 1: (10 points) BITCOIN MINING

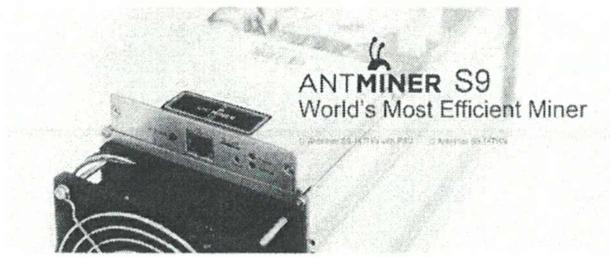
What is the hourly profit or loss if you spend money only on electricity with the Antminer S9 to mine bitcoin? Show your work!

Hourly income (mining)=¢ 36 (2)

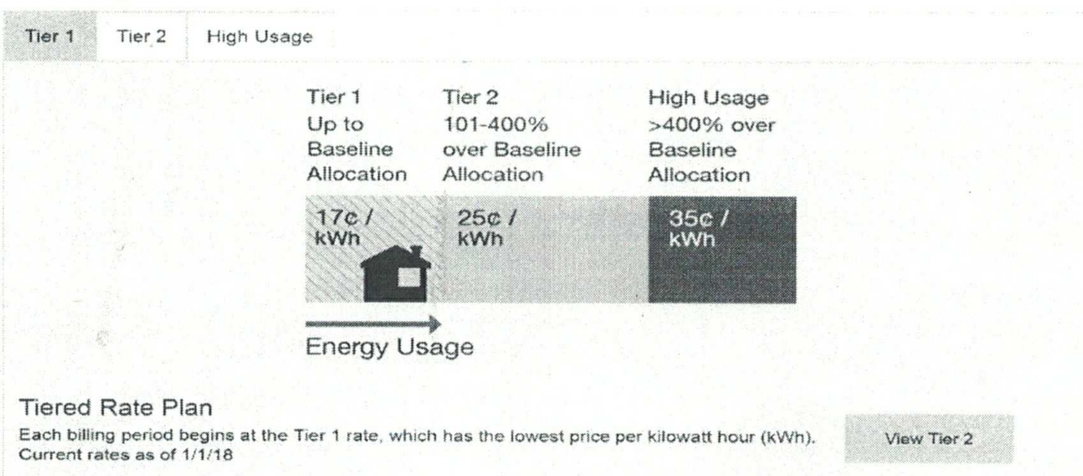
Hourly cost (electricity) = ¢ 22.1 (2)

Hourly profit/loss (circle profit or loss) = ¢ 13.9 (2)

- Hash Rate13TH/s (this is a measure of the number of hash "computations" per second the S9 can perform). Recall T=tera=10^12
- **Power Consumption 1300W**



- Assume **Bitcoin Value of 10000$**
Shown below is the Southern California Edison rate for electricity, current as of 5/1/2018. Assume your household is frugal with electricity usage, so you are in Tier 1.



I will calculate the number of hashes it takes to mine 1 bitcoin for you: The global hash rate (the combined computational capability of all active mining computers in the world) as of 5/1/2018 is 28,791,021,184 GH/s. # hashes to mine 1 bitcoin = global hash rate times ten minutes /25 = (28,791,021,184 * 10^9 H/s) * (60 sec/min) 10 min /12.5 = (2.9 * 6/1.25) * 10^(10+9+1+1-1) = approx. 1.3 * 10^21.

<u>**So:**</u> 1.3 * 10^21 hashes earns one bitcoin. Use this to determine how many bitcoins per second the Antminer S9 mines, based on its hash rate of 13 TH/s. (H=hash T=Tera)

The electricity cost should be calculated based on the Antminer S9 power consumption of 1300 W.

PROBLEM 1:

Hourly income:

Antminer Processing speed $= 13 \frac{TH}{s} = 13 \times 10^{12} \frac{H}{s}$

1 bitcoin $= 1.3 \times 10^{21}$ H

Antminer bitcoin earning rate $= \frac{13 \times 10^{12}}{1.3 \times 10^{21}} \frac{\text{bitcoin}}{s} = 10^{-8} \frac{\text{bitcoin}}{s}$ (2)

Bitcoin earned per hour $= 10^{-8} \times 60 \times 60 = 3.6 \times 10^{-5}$ (2)

Hourly income $= 3.6 \times 10^{-5} \times 10^{4}$ \$ $= 3.6 \times 10^{-5} \times 10^{6}$ ¢ $= 36$¢

Hourly Cost

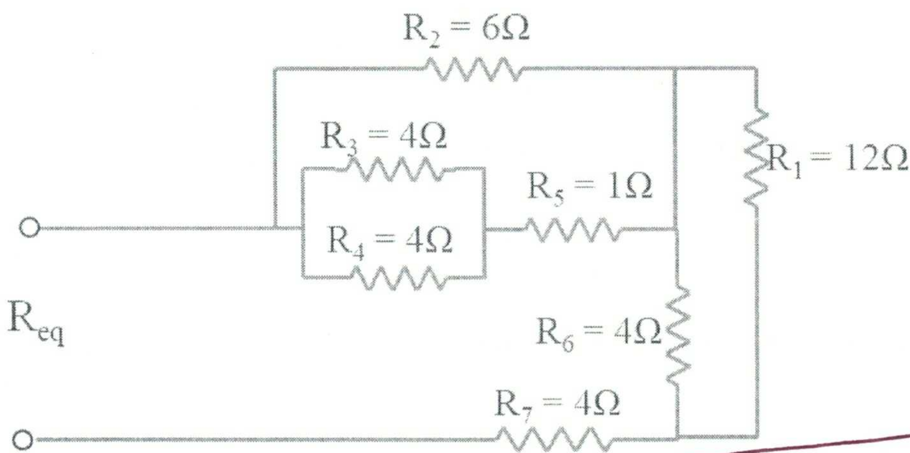
$= 1.3$ KW $\times \frac{17¢}{KWH} = 22.1 \frac{¢}{\text{hour}}$

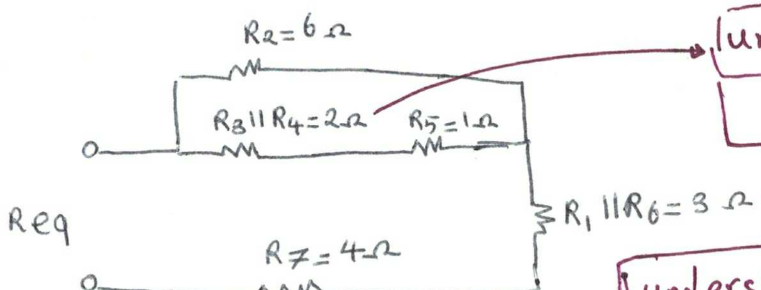
Hourly Cost $= 22.1$¢

Hourly Profit $= 36¢ - 22.1¢ = 13.9¢$

PROBLEM 2: (10 points)

Find R_{eq}:



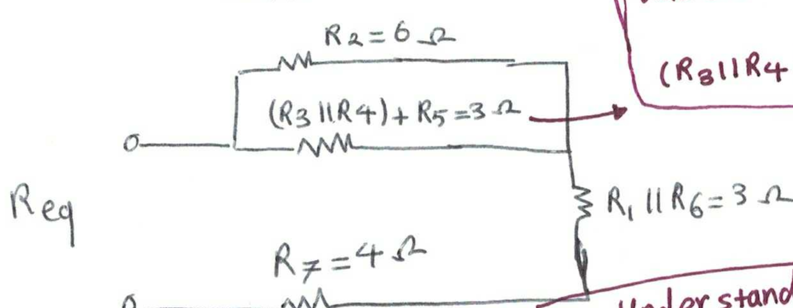


understanding R_3 is Parrallel wit R_4 (2)

" R_1 is " " R_6 (2)

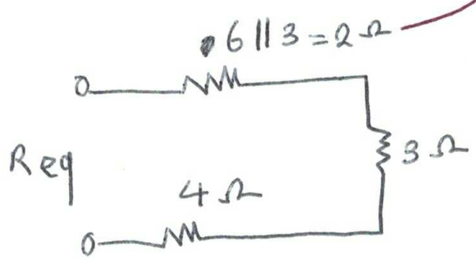
understanding $R_3 || R_4$ is in series with R_5

$(R_3||R_4)+R_5 = 3\,\Omega$ (2)



understanding R_2 is in Parrallel with $[(R_3||R_4)+R_5]$

$R_2 || [(R_3||R_4)+R_5] = 2\,\Omega$ (2)

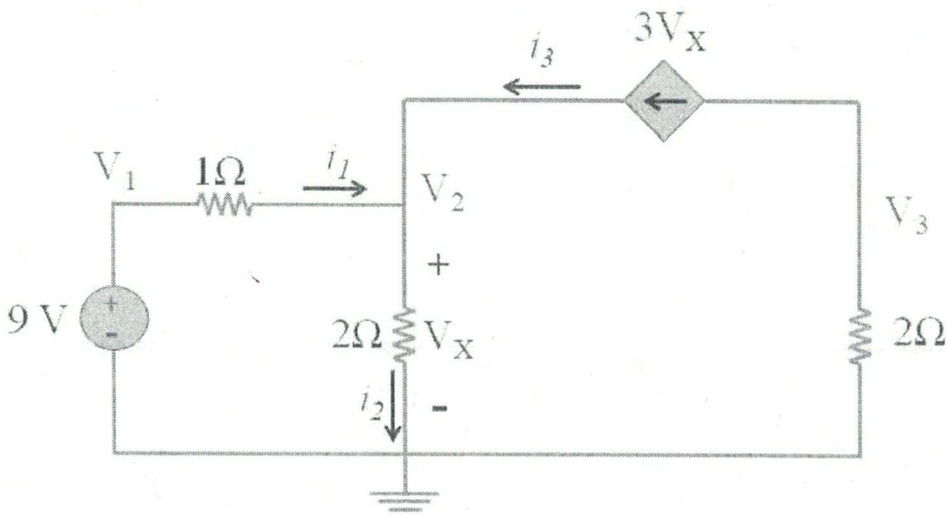


$R_{eq} = 3_\Omega + 3_\Omega + 4_\Omega = 9\,\Omega$

Final Answer (2)

PROBLEM 3: (40 points)

Use nodal analysis to find V_1 through V_3 and i_1 through i_3:



a) What is the value of V_1 (2pts)

V_1= 9V (2)

b) KCL Equations (20pts)

Write KCL @ Node V_2 to find an equation in terms of the unknown nodal voltages of V_1 through V_3 (10pts)

(1)

$i_1 + i_3 = i_2 \rightarrow \frac{V_1 - V_2}{1} + 3V_x = \frac{V_2}{2}$

$V_x = V_2 \Rightarrow \frac{V_1 - V_2}{1} + 3V_2 = \frac{V_2}{2} \rightarrow V_1 + 1.5V_2 = 0$

understanding $V_x = V_2$ (2)

or $9 + 1.5V_2 = 0$

or $V_2 = -6V$

(7)

Write KCL @ Node V_3 to find an equation in terms of the unknown nodal voltages of V_1 through V_3 (10pts)

$$3V_x + \frac{V_3}{2} = 0 \rightarrow 3V_2 + \frac{V_3}{2} = 0 \quad (10)$$

$$\Rightarrow V_3 = -6V_2 = +36V$$

c) Solve V_1 to V_3 (3pts)

V_1	9V	(1)
V_2	-6V	(1)
V_3	+36V	(1)

d) Find expressions for currents i_1, i_2 and i_3 in terms of V_1 through V_3 (12pts)

i_1	$\frac{V_1 - V_2}{1}$	(4)
i_2	$\frac{V_2}{2}$	(4)
i_3	$3V_2$ or $-\frac{V_3}{2}$	(4)

$$i_1 = \frac{V_1 - V_2}{1} \qquad i_2 = \frac{V_2}{2}$$

$$i_3 = 3V_2 \text{ or } i_3 = -\frac{V_3}{2}$$

e) Solve i_1 through i_3 (3pts)

i_1	15 A	①
i_2	-3 A	①
i_3	-18 A	①

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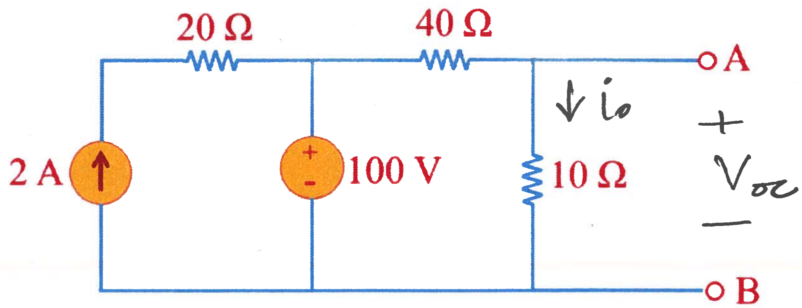
Professor Peter Burke

PROBLEM 4: [redacted] points) 30

Find the Thevenin equivalent circuit at terminals AB by finding V_{oc} and I_{sc}.

$V_{oc} \equiv V_{ab}$(open) $I_{sc} \equiv I_{ab}$ (short a to b)



(10)	V_{oc}	20 V
(10)	I_{sc}	2.5 A
(4)	V_{Th}	20 V
(6)	R_{Th}	8 Ω

* Method 1 for V_{oc} (voltage divider):

$$V_{oc} = 100 \cdot \frac{10}{50} = 20V$$ [8]

* Method 2 for V_{oc} (KVL): [2]

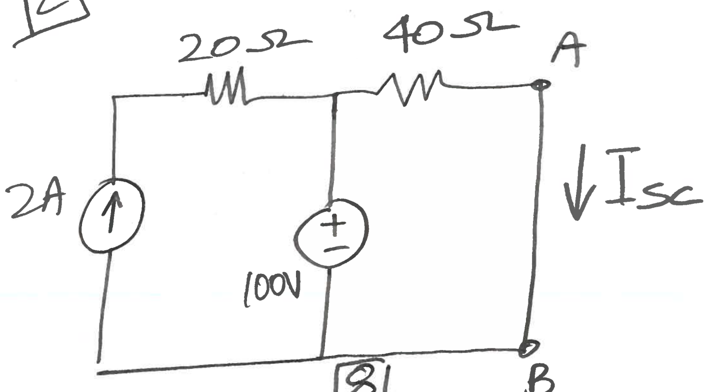
$-100 + 50 i_o = 0 \Rightarrow i_o = 2A$ [6]

[2] $V_{oc} = 10 \cdot i_o = 20V$ [2]

(10)

Method 3: nodal analysis, [2] for each eqn.

$V_{Th} = V_{oc} = 20$ [2] [2] (4)



[8]

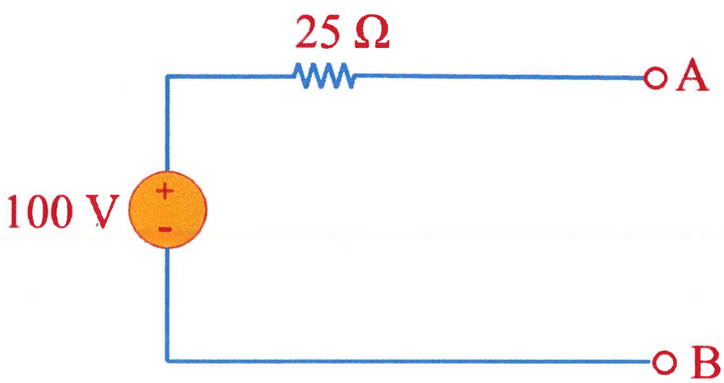
$-100 + 40 I_{sc} = 0 \Rightarrow I_{sc} = 2.5A$ [2] (10)

$$R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{20}{2.5} = 8Ω$$ [4] [2] (6)

or 40||10

PROBLEM 5: (10 points)

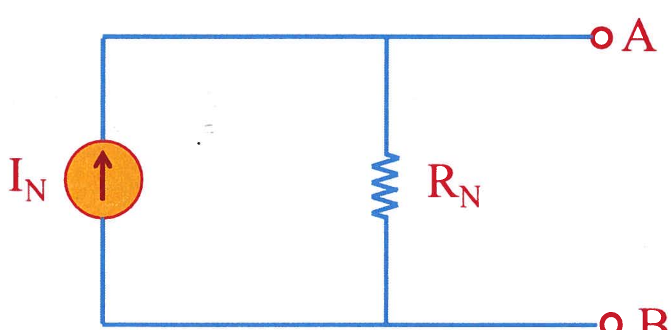
Find the Norton equivalent circuit at terminals AB by using the given Thevenin circuit [redacted]



I_N	4 A
R_N	25 Ω

$R_N = R_{th}$

$I_N = V_{th}/R_{th}$



$$I_N = \frac{V_{Th}}{R_{Th}} = \frac{100}{25} = 4A$$ [4] [2] } (6)

$$R_N = R_{Th} = 25\Omega$$ } (4)