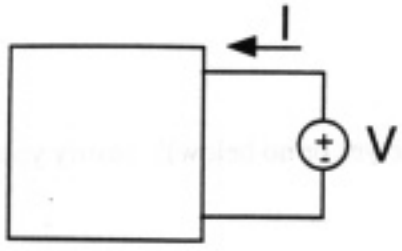
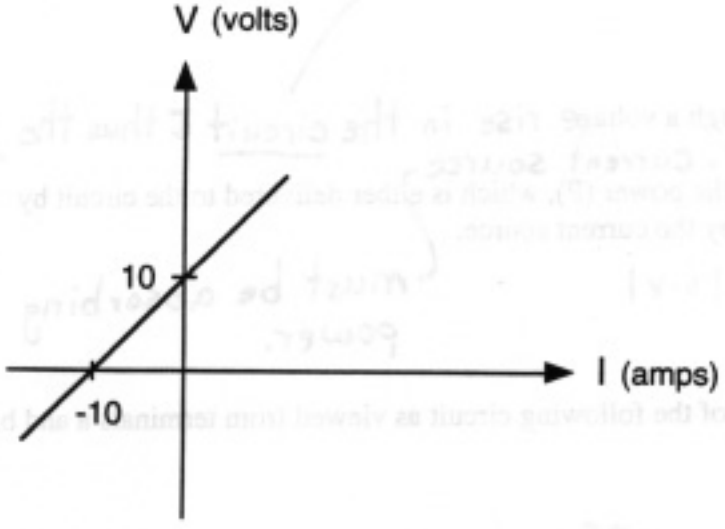
EECS 210 F99
Midterm #1 Solutions

1.

(7 pts.) (a) Consider the following circuit connected to an external voltage source as shown.



The relationship between V and I is plotted below.



Draw the Thevenin equivalent for this circuit in the space provided below.

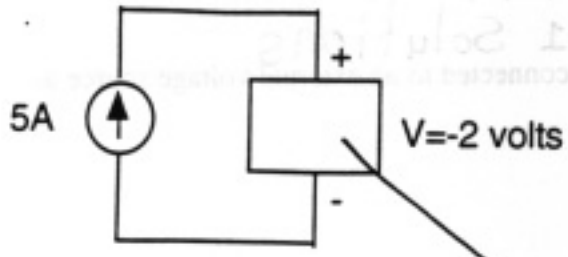
V_{oc}=10 V and I_{sc}= - 10 A.
Thus V_T = 10 V and R_T = 1 Ω.

$V_T = V_{oc}$

$R_T = \frac{-V_{oc}}{I_{sc}}$

total

(6 pts) 1(b) Consider the ideal current source connected to a circuit as shown below. The voltage drop across the circuit terminals is –2 volts as indicated.



Is the current source delivering power to the circuit(circle yes or no below)? Justify your answer using one sentence.

6 pts. total

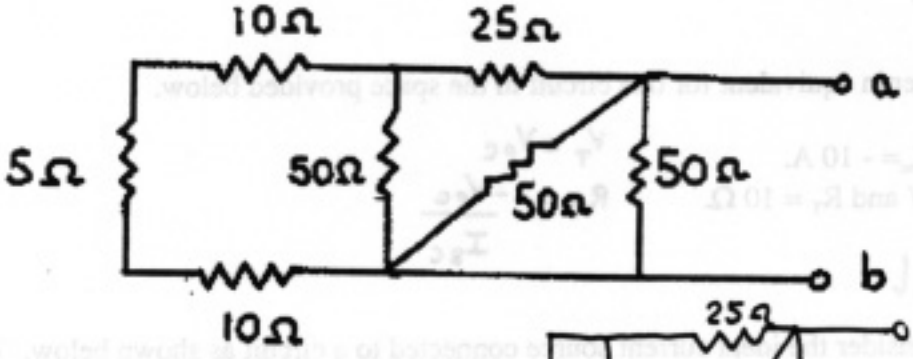
(2 pts.) YES (NO)

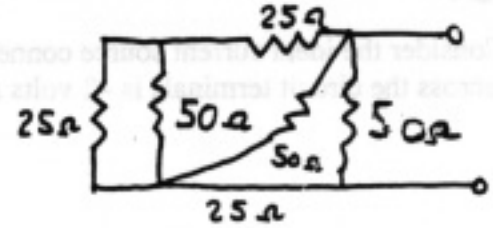
(3 pts.) Justification sentence:
Positive charge is flowing through a voltage rise in the circuit & thus the circuit is generating power. ∴ current source must be absorbing power.

Compute the absolute value of the power (P), which is either delivered to the circuit by the current source or absorbed by the current source.

(1 pt.)P = 10 W. $P = |i \cdot v|$

(7 pts.) 1(c) Find the resistance of the following circuit as viewed from terminals a and b.





R = 15.625Ω

$$\frac{1}{41.66} + \frac{1}{50} + \frac{1}{50} = \frac{1}{R}$$

2. Consider a periodic sawtooth signal which has the following Fourier series representation, where t is in seconds.

$$x(t) = \sum_{n=1}^{\infty} (-1)^{n+1} \frac{\sin(nt)}{n}$$

(2pts) (a) Find its period.

Period = 2π s

(2 pts) (b) Find the frequency of the sawtooth signal in Hz and rad/s.

Frequency = $1/(2\pi)$ Hz.

1 rad/s

(2 pts) (c) Find the frequency of the fourth harmonic in Hz.

Fourth Harmonic Frequency = $2/\pi$ Hz

(14 pts) (d) If x(t) as given above is the input to a linear time-invariant system, the output (y(t)) is

$$y(t) = \cos(3t) + \sin(2t + \frac{\pi}{4})$$

Note filter only passes 2nd & 3rd harmonic terms

Find the output (y(t)) of this system when the input is

$4\sin(t + \frac{\pi}{6}) + \cos(2t)$

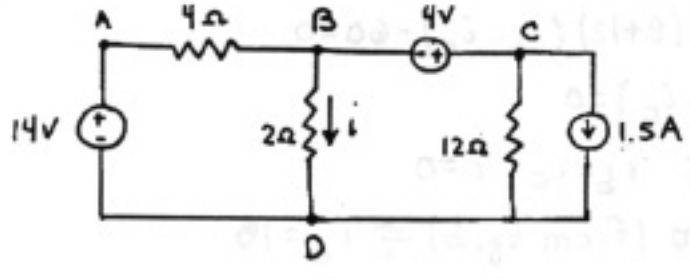
$|H(3/2\pi)| = 2$

$\angle H(3/2\pi) = \frac{\pi}{4} + \pi$

$\therefore$ y(t) = $2\cos(2t + \frac{5\pi}{4})$

3. Consider the following circuit, which is to be solved using node analysis.

(3 pts.) (a) List the essential nodes of the above circuit diagram.



Essential nodes are B, C, D.

(14 pts.) (b) Choose node D as the ground and write the required node equations in the space below.

node A: $v_A = 14\ V$

supernode BC $\quad \frac{v_A - v_B}{4} - \frac{v_B}{2} - \frac{v_C}{12} - 1.5 = 0$

supernode BC: $v_C - v_B = 4\ V$

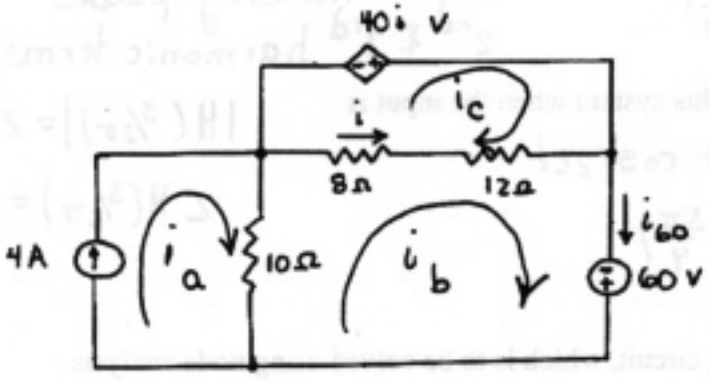
$\therefore\ 3(14 - v_B) - 6v_B - (4 + v_B) - 18 = 0 \rightleftharpoons v_B = 2\ V$

(3 pts.) (c) Use your node equations to find the value of i.

$i = v_B/2$

i = 1 A.

4. Consider the circuit shown below.



(3 pts.) (a) Draw and label the mesh currents on the above figure.

(14 Pts.) (b) Write the mesh equations in the space provided below.

Eq. a $\quad i_a = 4$

Eq. b $\quad 10(i_b - i_a) + (8+12)(i_b - i_c) - 60 = 0$

Eq. c $\quad -40i - 20(i_b - i_c) = 0$

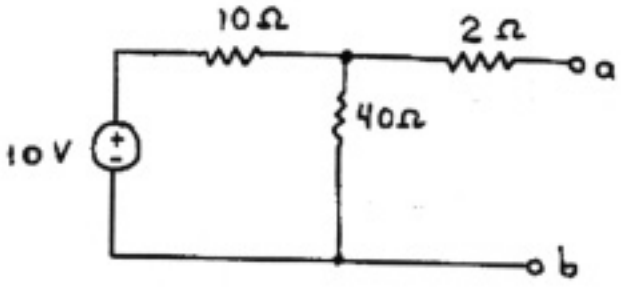
Eq. d $\quad i = i_b - i_c \rightleftharpoons i_b = i_c,\ i = 0$

$i_{60} = i_B,\ 10 i_b = 100$ (from Eq. b) $\rightleftharpoons i_b = 10$

(3 Pts.) (c) Solve the mesh equation to find the current i_{60}.

$I_{60} = 10$ A.

5. Consider the following circuit.



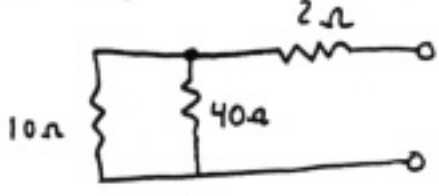
(15 pts.) Compute the Thevenin equivalent voltage and resistance.

$V_T = 8$ V.

$R_T = 10\,\Omega$.

$V_{oc} = \frac{40}{40+10} \times 10V = 8V$ (Voltage divider)

$V_T = V_{oc}$



$\leftarrow R_T$

$R_T = (10 \| 40) + 2$

$= 8 + 2 = 10\Omega$

(5 pts.) (b) Draw the Norton equivalent circuit in the space provided below.

$i_{th} = V_T / R_{Th} = .8$ A