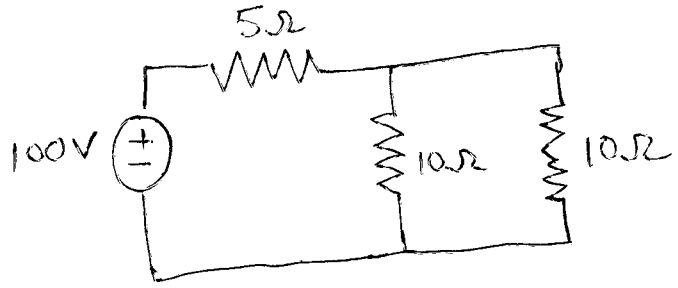
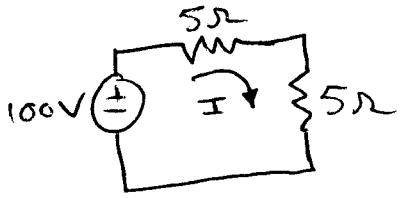
1.b. (5 pts) Determine the power absorbed by the 5Ω resistor in the follwing circuit.



Solution

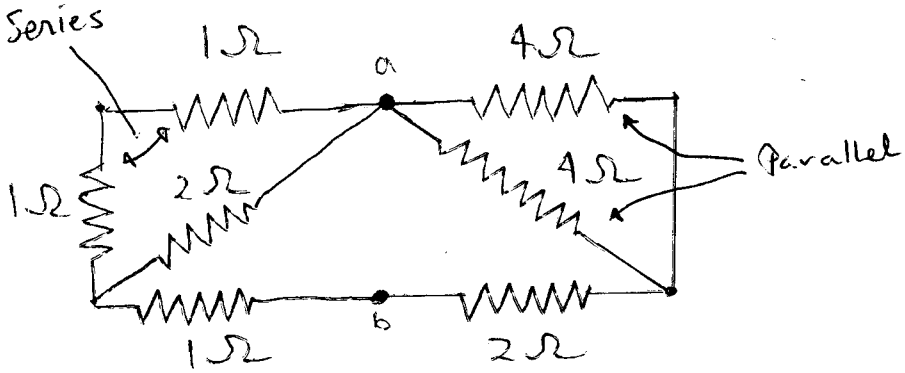


$$I = \frac{100\,V}{10} = 10\,A \qquad P = I^2R = (10)^2 \cdot 5 = 500\,W$$

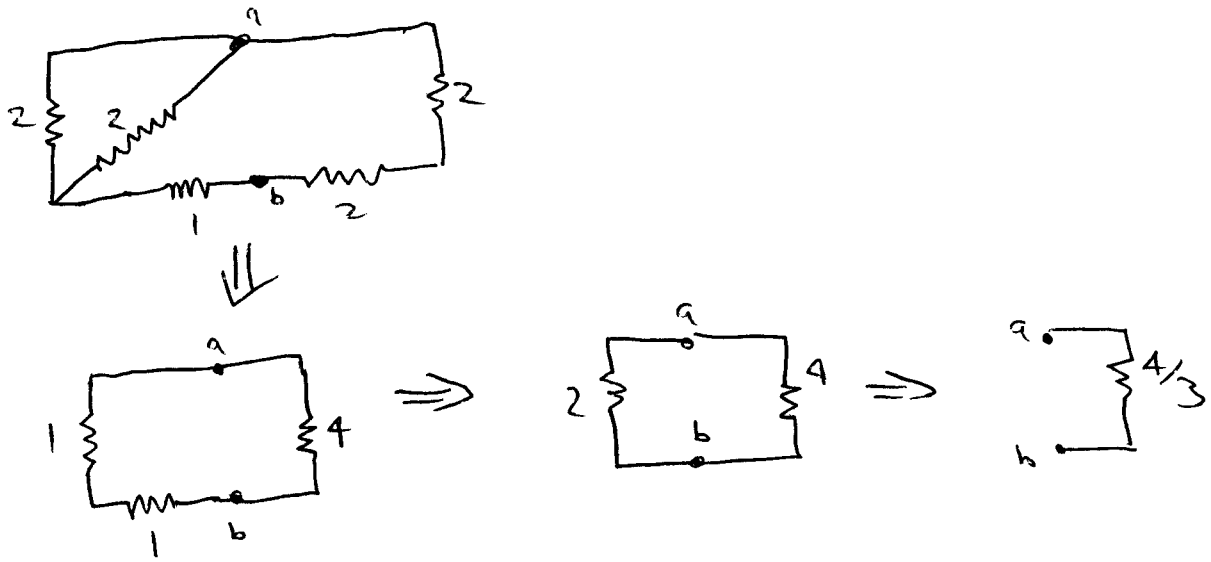
P_2= 500 W (Power absorbed by 5Ω resistor)

Problem: 1 (20 pts)

1.a. (5 pts) Determine the equivalent resistance between terminals a and b for the following circuit.

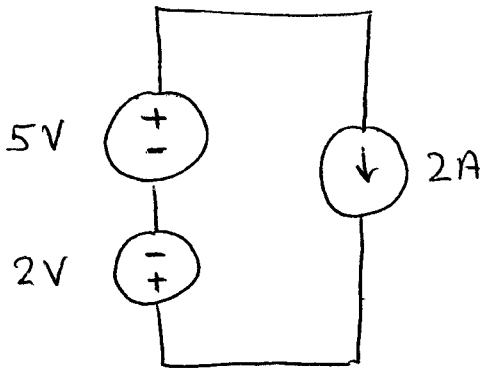


Solution

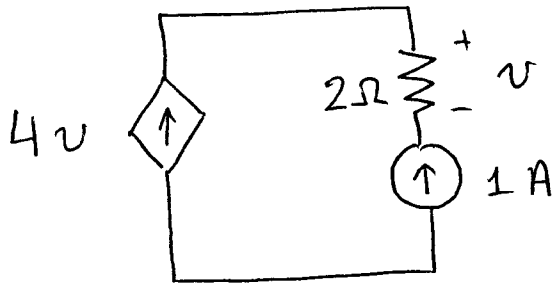


$R_{eq} =$ 4/3 Ω

1.c. (5 pts) State whether the following circuits represent valid or invalid interconnections of sources.



Circuit A



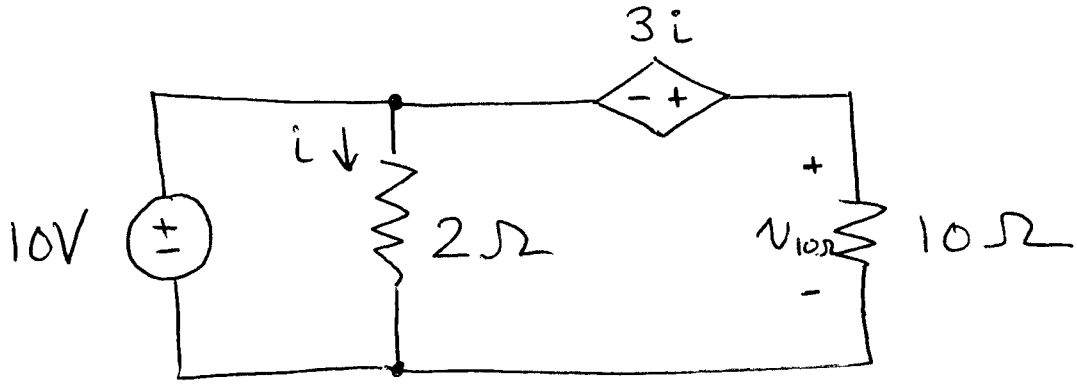
Circuit B

Soln: currents and voltages throughout circuit are consistent. Hence valid.

Soln: Dependent current source is in series with indep. current source so the currents need be the same but of opposite sign. However, using 1A source as reference. $v = -2V$ so that $4v = -8A \neq -1A$

Circuit A is Valid (Valid/Invalid), Circuit B is Invalid (Valid/Invalid)

1.d. (5 pts) For the circuit below, find the voltage $v_{10\Omega}$ across the 10Ω resistor.



Soln: 1) As 2Ω resistor is in parallel w/ 10V source

$i = \frac{10}{2} = 5A$.

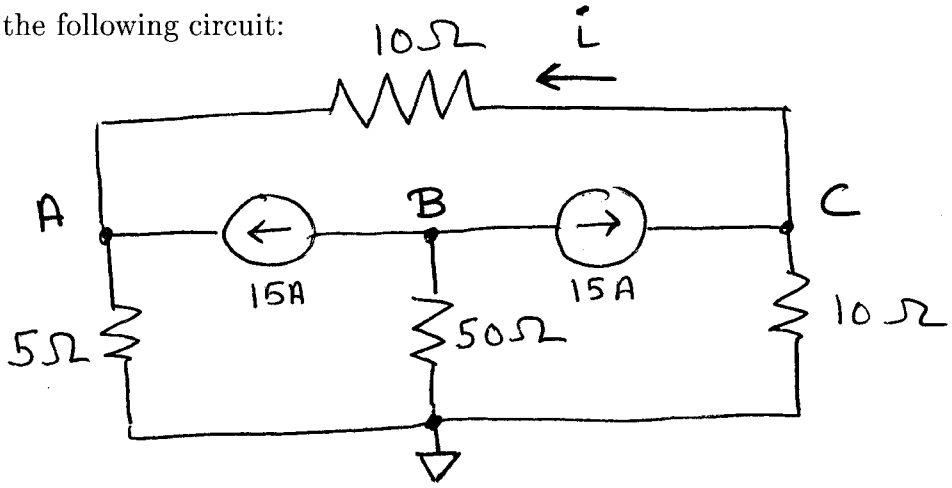
2) Thus dependent voltage source generates $3i = 15V$ and applying KVL around outer loop:

$$-10 - 15 + v_{10\Omega} = 0 \quad \text{or} \quad v_{10\Omega} = 25V$$

$v_{10\Omega}$= 25V

Problem: 2 (20 pts)

Consider the following circuit:



2.a (5 pts): Label the essential nodes on the circuit diagram and choose a reference node.

Solu: (A, B, C as indicated plus reference node at bottom)

2.b (10pts) Write down the node equations and simplify.

Solu: Apply KCL to nodes A, B, C:

$$A: \quad 15 - v_A/5 - \frac{v_A - v_C}{10} = 0 \quad \Rightarrow \quad 3v_A - v_C = 150$$

$$B: \quad -15 - 15 - v_B/50 = 0 \quad \Rightarrow \quad v_B = -50 \cdot 30 = -1500\,V$$

$$C: \quad 15 - v_C/10 - \frac{v_C - v_A}{10} = 0 \quad \Rightarrow \quad v_A - 2v_C = -150$$

2.d (5 pts) Find the current i going through the 10Ω resistor on top of the circuit diagram.

Solu: Multiply equ. A by 2 and subtract the equ. C:

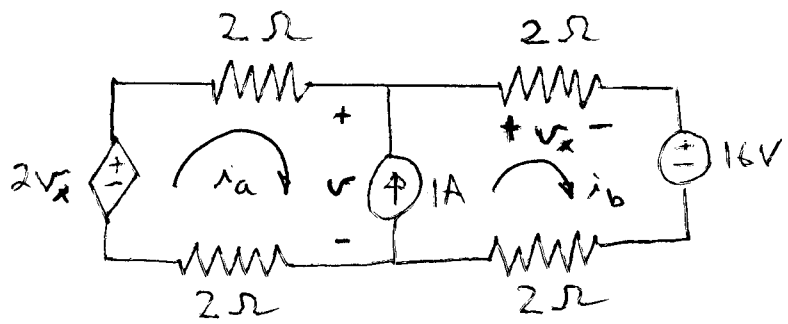
$$\begin{array}{rl} 6v_A - 2v_C &= 300 \\ -\quad v_A - 2v_C &= -150 \\ \hline 5v_A \qquad\quad &= 450 \end{array} \quad \Rightarrow v_A = 90\,V,\ v_C = 120\,V$$

thus: $i = \frac{v_C - v_A}{10} = 3\,A$

$i =$ 3A

Problem: 3 (20 pts) Mesh analysis problem

Consider the following circuit:



3.a (5 pts) Label the mesh currents. Are there any supermeshes? Yes

3.b (10 pts) Write down mesh equations and simplify.

KVL around outer loop (supermesh)

$$-2v_x + 2i_a + 2i_b + 16 + 2i_b + 2i_a = 0$$

$$v_x = 2i_b$$

$$i_b - i_a = 1$$

3.c (5 pts) Solve mesh equations and find voltage v

$$-4i_b + 4i_a + 4i_b + 16 = 0$$

$$4i_a + 16 = 0 \Rightarrow i_a = -4A$$

$$i_b = i_a + 1 = -3A$$

$$v_x = 2i_b = -6V$$

$v_x =$ **-6V**

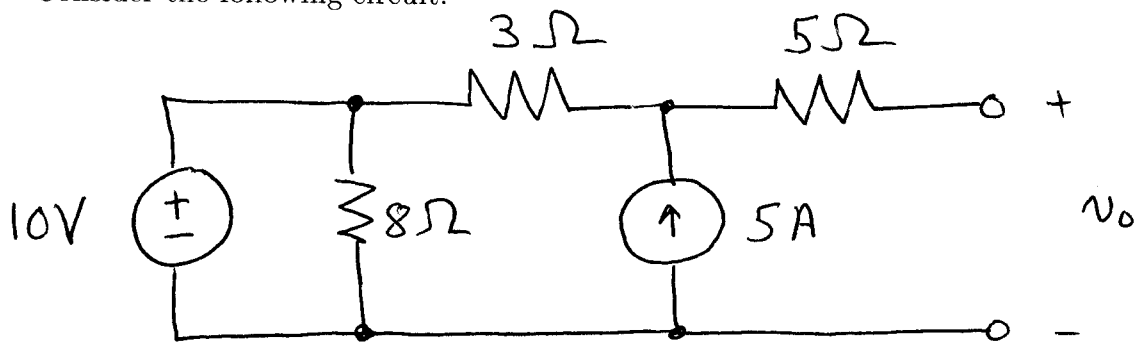
$$v = 2i_b + 16 + 2i_b$$

$$= 4i_b + 16$$

$$= 4(-3) + 16 = 4V$$

Problem: 4 (20 pts)

Consider the following circuit:

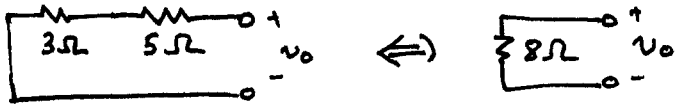


4.a (10 pts) Find the Thevenin equivalent voltage V_{th} and resistance R_{th}.

Solu: · Find $v_{open\ circuit} = v_{th}$: As zero current flows through 5Ω, v_o is the voltage drop across 5A source. Apply KVL around the loop containing 5A source, 10V source and 3Ω resistor to obtain (note 5A flows through 3Ω resistor):

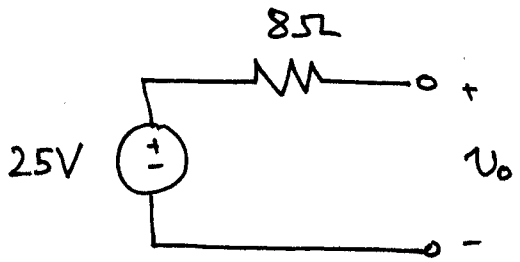
$$-10 - 3(5) + v_o = 0 \Rightarrow v_o = v_{th} = 25\,V$$

· To find R_{th}, turn off the sources to obtain equivalent circuit:



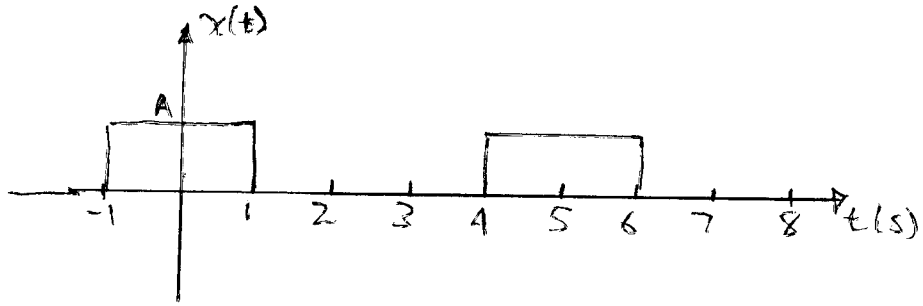
$V_{th} =$ 25V, $R_{th} =$ 8Ω

4.b (10 pts) Draw the Thevenin equivalent circuit.



Problem: 5 (20 pts) Fourier Series problem

Consider the following periodic waveform $x(t)$.



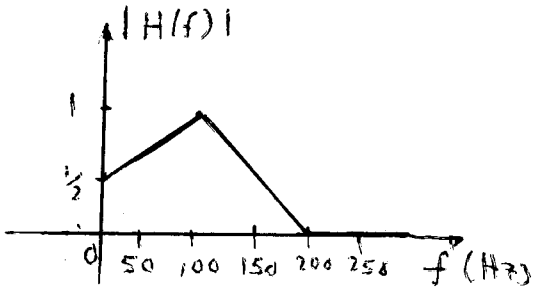
5.a Determine the period T, fundamental frequency f_0 and the second harmonic frequency f_2 of $x(t)$ (6 pts)

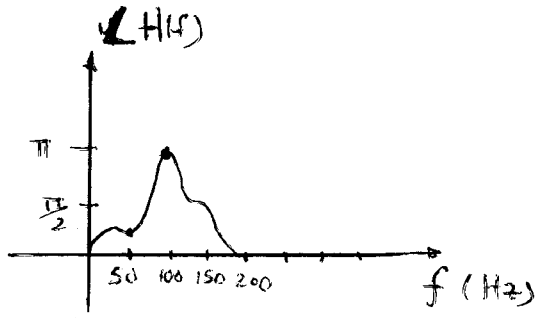
$T =$ 5 s, $f_0 =$ 1/5 Hz, $f_2 =$ 2/5 Hz

5.b The Fourier series representation of $x(t)$ is $x(t) = A_0 + \sum_{n=1}^{\infty} a_n \cos(2\pi n f_0 t) + b_n \sin(2\pi n f_0 t)$. Determine whether each statement is true or false (5 pts):

Statement	True	False
$b_n = 0$ for all n.	X	
$b_n = 0$ only for odd n.		X
$a_n = 0$ for all n		X
$A_0 < 0$		X
The average value of $x(t)$ is $2A/5$.	X	

5.c The signal $x(t) = 10 + 12\cos(2\pi 100t) + 3\sin(2\pi 200t)$ is the input to a linear time invariant system with transfer function (magnitude and phase) shown below. Determine the output $y(t)$ of the system (9 pts.).





$y(t) =$ 5 + 12 cos(2π 100 t + π)