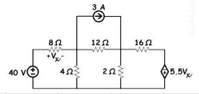
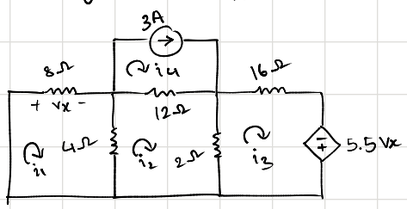
Use the superposition theorem to **determine** the value of V_x for the circuit shown in **Figure 1**. Also, the 8-ohm resistor absorbs power from both independent sources. **Analyze** the circuit and **determine** which independent source in this circuit supplies most of the power to the 8-ohm resistor.



voltage source off



$i_1 = \frac{V_x}{8} \quad i_4 = 3$

loop 1: $V_x + 4i_1 - 4i_2 = 0$

$\Rightarrow V_x + \frac{1}{2}V_x - 4i_2 = 0$

$\Rightarrow \frac{3}{2}V_x - 4i_2 = 0$

loop 2: $i_2(4+12+2) - 4i_1 - 12i_4 - 2i_3 = 0$

$\Rightarrow 18i_2 - \frac{1}{2}V_x - 36 - 2i_3 = 0$

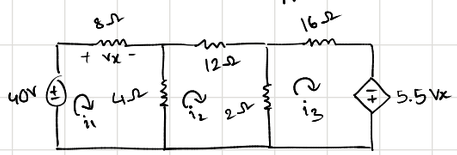
$\Rightarrow -\frac{1}{2}V_x + 18i_2 - 2i_3 = 36$

loop 3: $-5.5V_x + i_3(16+2) - 2i_2 = 0$

$\Rightarrow -5.5V_x - 2i_2 + 18i_3 = 0$

$V_x = 6.48 \quad i_2 = 2.43 \quad i_3 = 2.25$

current source off



$i_1 = \frac{V_x}{8}$

loop 1: $-40 + V_x + 4i_1 - 4i_2 = 0$

$\Rightarrow V_x + \frac{1}{2}V_x - 4i_2 = 40$

$\Rightarrow \frac{3}{2}V_x - 4i_2 = 40$

loop 2: $i_2(4+2+12) - 4i_1 - 2i_3 = 0$

$\Rightarrow -\frac{1}{2}V_x + 18i_2 - 2i_3 = 0$

loop 3: $-5.5V_x - 2i_2 + 18i_3 = 0$

$V_x = 32 \quad i_2 = 2 \quad i_3 = 10$

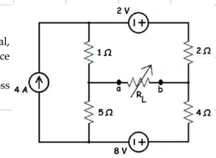
Superposition $V_x = 32 + 6.48 = 38.48$ V

power current source $= \frac{6.48^2}{8} = 5.2488$ W

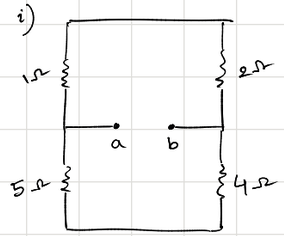
power voltage source $= \frac{32^2}{8} = 128$ W

voltage source supplies most of the power.

For the circuit shown in **Figure 2**, answer the following questions:
i) **Determine** the **Thevenin equivalent** circuit at the **a-b** terminal.
ii) Suppose, your friend suggests that if you connect a **20V-40W** bulb across **a-b** terminal, then you will get maximum bulb intensity. Is he right? If not, then **calculate** the resistance of the bulb that would get maximum intensity.
iii) **Determine** the maximum power delivered to the bulb that would be connected across the **a-b** terminal.

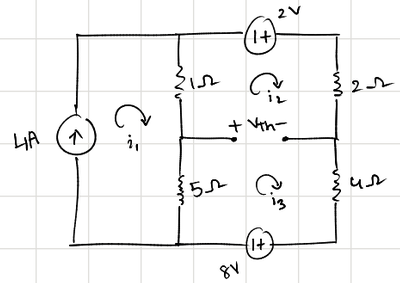


i)



$R_{Th} = (1+2) \,||\, (5+4)$

$= 2.25\ \Omega$



$i_1 = 4 \quad i_3 - i_2 = 0$

loop 2: $-V_{Th} - 2 + i_2(1+2) - i_1 = 0$

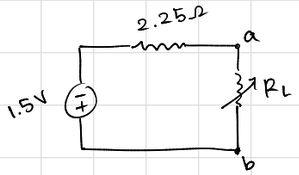
$\Rightarrow -V_{Th} + 3i_2 = 6$

loop 3: $V_{Th} + 8 + i_3(4+5) - 5i_1 = 0$

$\Rightarrow V_{Th} + 8 + 9i_2 - 20 = 0$

$\Rightarrow V_{Th} + 9i_2 = 12$

$V_{Th} = -1.5 \quad i_2 = 1.5$

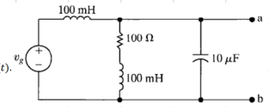


ii) $P = \frac{V^2}{R} \Rightarrow 40 = \frac{20^2}{R} \Rightarrow R = 10\ \Omega$

the resistance of the bulb should be $= R_{Th} = 2.25\ \Omega$

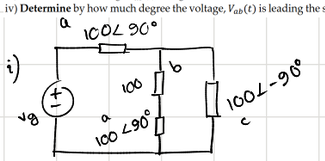
For the circuit shown in **Figure 3**, where $v_g(t) = 247.49 \cos(1000t + \pi/4)$

i) **Determine** the total impedance of the circuit.
ii) **Determine** the current through the 100Ω resistor using the current division rule.
iii) **Determine** the voltage $V_{ab}(t)$ using VDR.
iv) **Determine** by how much degree the voltage, $V_{ab}(t)$ is leading the source voltage, $v_g(t)$.



$v_g = 247.49 \angle 45°$

i)



$$Z = 100\angle 90° + (100 + 100\angle 90°) \,||\, 100\angle -90°$$

$$= 100$$

ii) $$i = \frac{V_g}{Z} = 2.4749 \angle 45°$$

$$i(100\Omega) = i \times \frac{100 \angle -90°}{100 + 100\angle 90° + 100\angle -90°}$$

$$= 2.4749 \angle -45°$$

iii) $$V_{ab} = V_g \times \frac{(100 + 100\angle 90°) \,||\, 100\angle -90°}{100\angle 90° + (100 + 100\angle 90°) \,||\, 100\angle -90°}$$

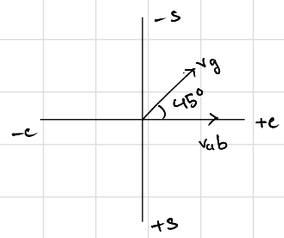
$$= 350.0037$$

$$v_{ab}(t) = 350.0037 \cos(1000t)$$

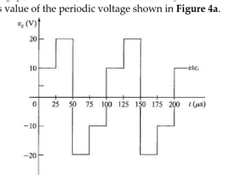
iv) $v_g(t) = 247.49 \cos(1000t + 45°)$

$v_{ab}(t)$ is leading by $360° - 45°$

$= 315°$



i) **Calculate** the rms value of the periodic voltage shown in **Figure 4a**.



$$\int_0^{100} v(t)^2 dt$$

$$= \int_0^{25} 10^2 dt + \int_{25}^{50} 20^2 dt + \int_{50}^{75} 20^2 dt + \int_{75}^{100} 10^2 dt$$

$$= 10^2 \times 25 + 20^2 \times 25 + 20^2 \times 25 + 10^2 \times 25 = 25000$$

$$V_{rms} = \sqrt{\frac{1}{100} \times 25000} = 15.81139$$

ii) Now, **use** this rms value as the maximum amplitude of the sinusoidal voltage source in the circuit shown in Figure 4b. **Determine** $I_0(t)$ and average real power absorbed by the 2-ohm resistor in the circuit. The angular frequency is 100 rad/s in the circuit.

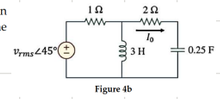
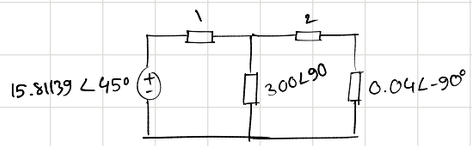


Figure 4b



$$Z = 1 + 300\angle 90° \,||\, (2 + 0.04\angle -90°)$$

$$= 3.000563 \angle -0.5092°$$

$$i = \frac{V}{Z} = 5.26947 \angle 45.509°$$

$$i_o = i \times \frac{300\angle 90°}{300\angle 90° + 2 + 0.04\angle -90°}$$

$$= 5.27\angle 45.89°$$

$$i_o(t) = 5.27 \cos(100t + 45.891°)$$

$$i_{rms} = \frac{i_o}{\sqrt{2}} = \frac{5.27}{\sqrt{2}} = 3.72649$$

$$P_{avg} = i_{rms}^2 \times R = 3.72649^2 \times 2 = 27.7735 \text{ W}$$