GATE 2026 TEST SERIES

Electric Circuits

Test 1

1. The resistance R of a filament lamp is related to the current by the following equation:

$R = 50 + 1200I$ ohm, where I is the current (A).

What is the value of the resistance(in Ω) ,when a voltage of 240V is applied to the lamp?

Correct Answer: **563** Answer Range: **(560 , 565)** *Not Attempted :* Marks : 2 / 0 (-Ve)

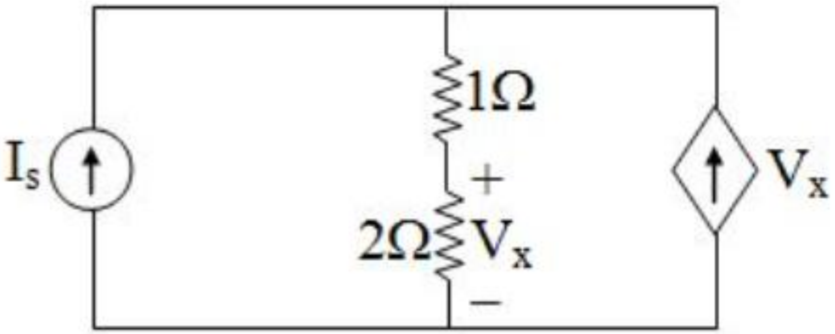
$$V = IR = I(50 + 1200I), \therefore 240 = 50I + 1200I^2$$

$$\text{or } I = \frac{-5 \pm \sqrt{25 + 11{,}520}}{240} = \frac{-5 \pm 107.45}{240}$$

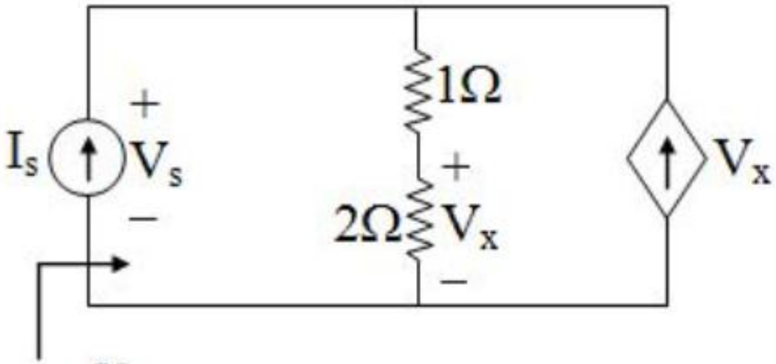
Taking the positive root, $I = \dfrac{102.45}{240} = 0.427\text{A}$,

$$R = \frac{240}{0.427} = 563\Omega$$

2. The equivalent resistance R_{eq} (in Ω) seen by the current source I_s is ____.



Correct Answer: **-3** Answer Range: **(-3 , -3)** *Not Attempted :* Marks : 2 / 0 (-Ve)



$$R_{eq} = \frac{V_s}{I_s}$$

Hence

$$V_s = V_x + \frac{V_x}{2} = \frac{3}{2}V_x$$

$$2[I_s + V_x] = V_x$$

$$2I_s + 2V_x = V_x$$

$$2I_s = -V_x$$

$$V_x = -2I_s$$

So, $V_s = \frac{3}{2}[-2I_S] \Rightarrow R_{eq} = \frac{V_S}{I_s} = -3\Omega$

So, $R_{eq} = -3\Omega$

3. A steady voltage of 100V is applied to a 2-H inductor. What is the value of energy stored after 10sec, given that the current at $t = 0$ was zero?

A) 5kJ

B) 2.5kJ

C) 0.25MJ

D) 1MJ

Correct Answer: **C** *Not Attempted :* ! Marks : 1 / 0.33 (-Ve)

$$i(10) = \frac{1}{L}\int_0^{10} v(t)dt + i(0)$$

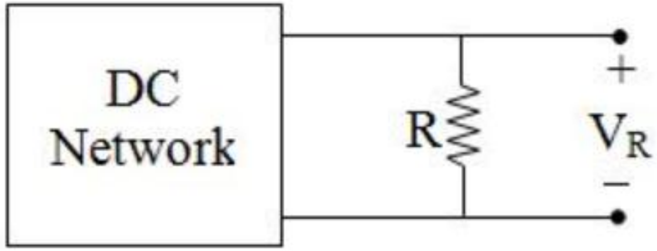
$$= \frac{1}{2}\int_0^{10} 100dt \text{ , since i(0)=0}$$

$$= \frac{1}{2}[100t]_0^{10} = 500A\ .$$

$$W = \frac{1}{2}LI^2$$

$$= \frac{1}{2} \times 2 \times 500^2 = 0.25\text{MJ}\ .$$

4. For circuit shown in figure $V_R = 20V$ when $R = 10\Omega$ and $V_R = 30V$, when $R = 20\Omega$. For $R = 80\Omega$, V_R is ________.



A) 48V

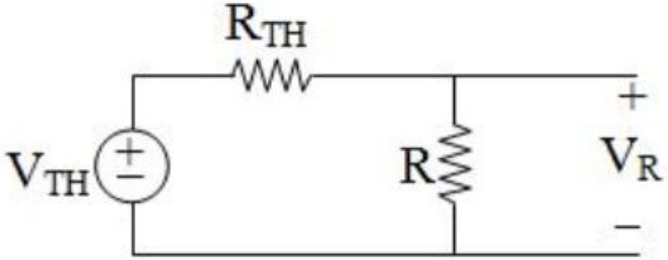
B) 60V

C) 120V

D) 160V

Correct Answer: **A** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

Use thevenin's equivalent



Step - 1

$-V_{TH} + 2\backslash R_{TH} + 20 = 0$

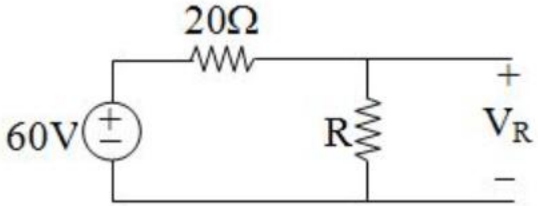
Step - 2

$$-V_{TH} + \frac{3}{2}R_{TH} + 30 = 0$$

$$\text{So, } \frac{R_{TH}}{2} = 10 \rightarrow R_{TH} = 20\Omega$$

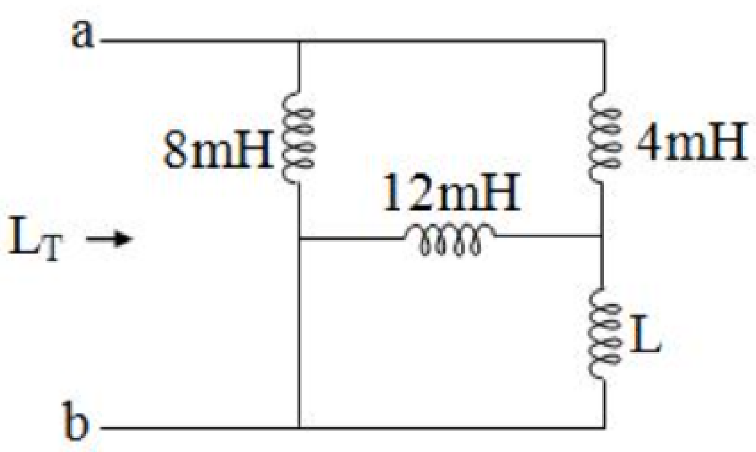
So, $V_{TH} = 60V$

So, if $R = 80\Omega$



$$V_R = 60\left[\frac{80}{20+80}\right] = 48\,\text{Voltage}$$

5. If total inductance seen from terminal a-b in the network is equal to 4mH, then what will be the value of L(in mH)?

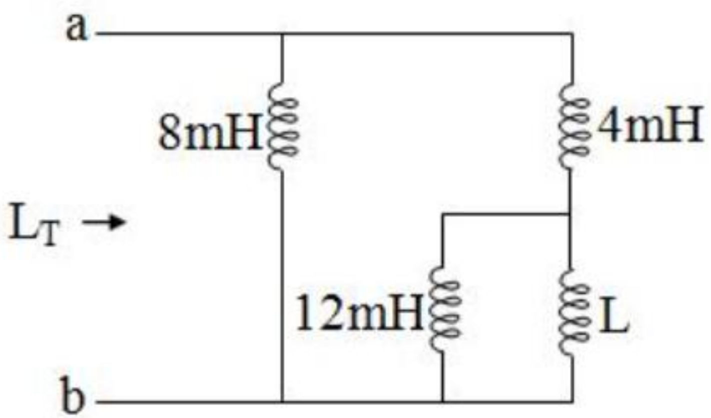


Correct Answer: **6**

Answer Range: **(6 , 6)**

Not Attempted :

Marks : 2 / 0 (-Ve)



$$L_T = [8//[4+12//L]]\text{mH}$$

$$L_T = \left[8//\left[4+\frac{12L}{12+L}\right]\right]\text{mH}$$

$$L_T = \left[8//\left[\frac{48+16L}{12+L}\right]\right]\text{mH}$$

$$L_T = \left[\frac{8\left[\frac{48+16L}{12+L}\right]}{\frac{96+8L+48+16L}{12+L}}\right]\text{mH}$$

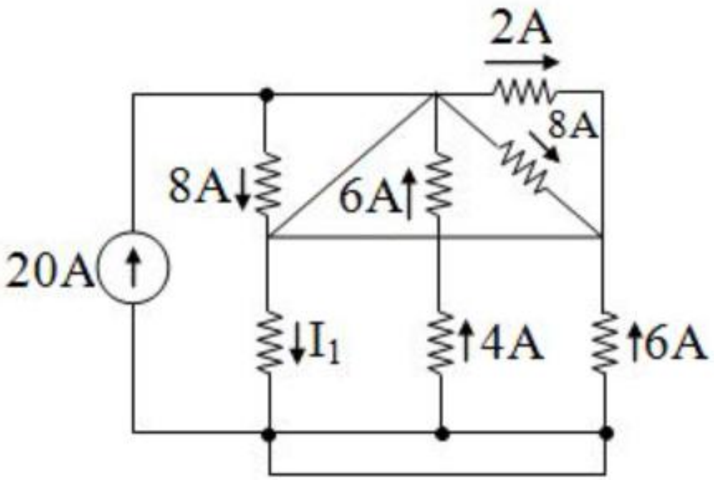
$$4\text{mH} = \left[\frac{8[48+16L]}{8[18+3L]}\right]\text{mH}$$

$$72+12L = 48+16L$$

$$4L = 24$$

$$L = 6\text{mH}$$

6. Value of current I_1 in circuit is



A) 10A

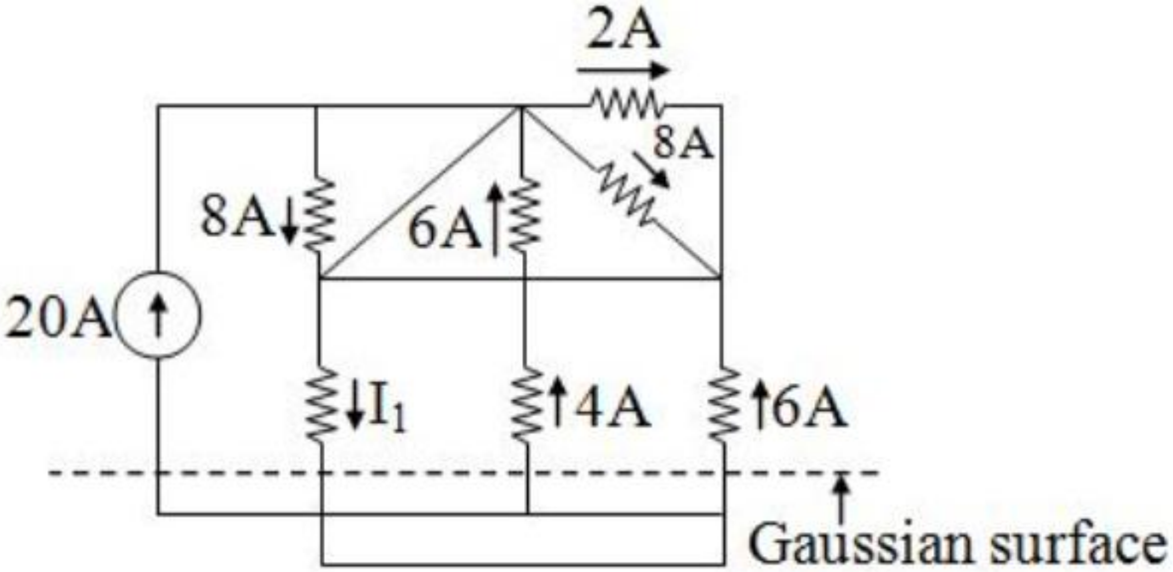
B) 30A

C) 2A

D) 18A

Correct Answer: **B** *Not Attempted :* Marks : 1 / 0.33 (-Ve)

Apply KCL at Gaussian surface.

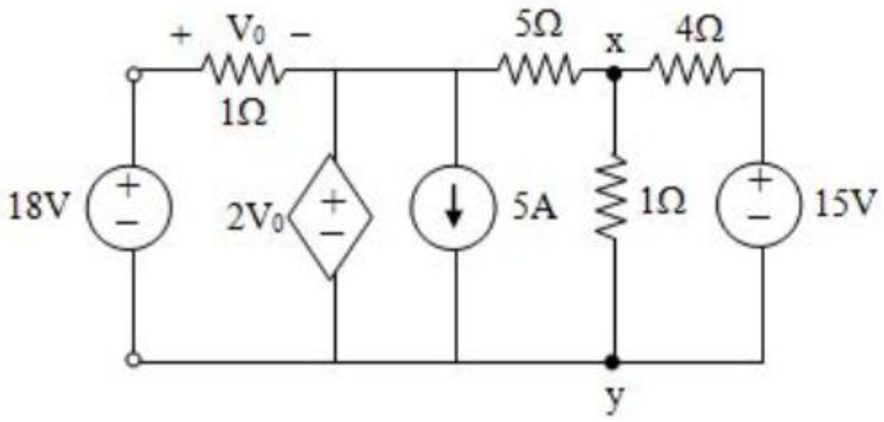


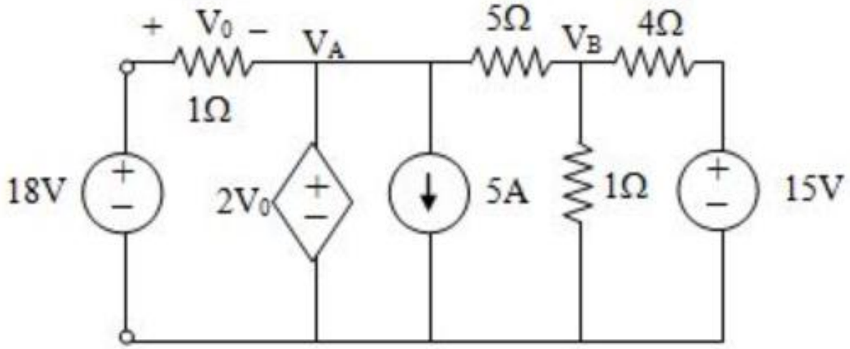
$$I_1 = 20 + 4 + 6$$

$$I_1 = 30A$$

7. What is the value of current (in Amperes) through 1Ω resistor across x-y in the circuit shown in figure?

(rounded off to two decimal places)





$V_A = 18 - V_0$ (but $V_A = 2V_0$)

$2V_0 = 18 - V_0$

$$V_0 = \frac{18}{3} = 6V$$

By applying KCL at node b than

$$\frac{V_B}{1} + \frac{V_B - 15}{4} + \frac{V_B - V_A}{5} = 0$$

$$V_B\left(1 + \frac{1}{4} + \frac{1}{5}\right) = \frac{V_A}{5} + \frac{15}{4} \text{(but } V_A = 18 - 6 = 12V\text{)}$$

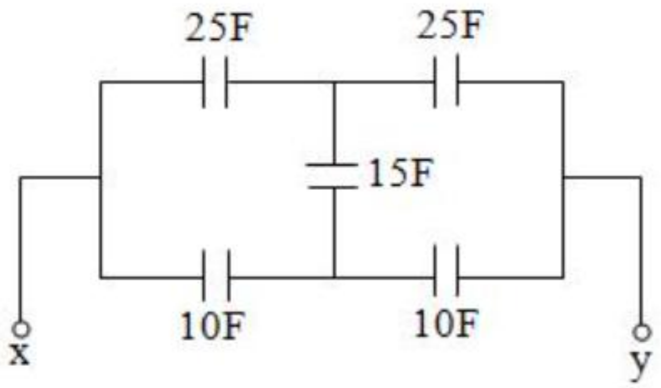
$$V_B\left[\frac{20+5+4}{20}\right] = \frac{12}{5} + \frac{15}{4}$$

$$V_B\left[\frac{29}{20}\right] = \left[\frac{48+75}{20}\right]$$

$V_B = 4.24V$

$\therefore$ so current through 1Ω resistor is $\frac{V_B}{1\Omega} = 4.24A$

8. What is the value of equivalent capacitance between terminals x –y in below figure?



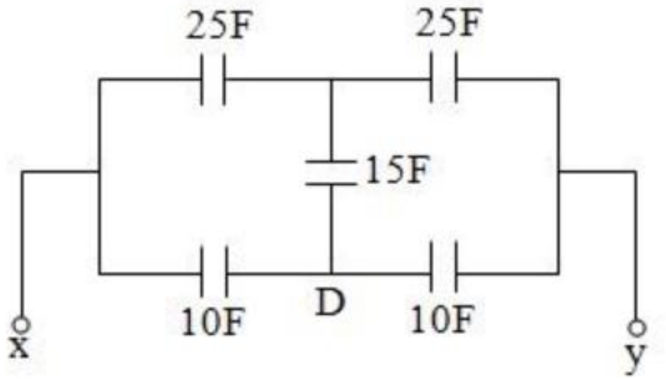
A) 15.5 F

B) 17.5 F

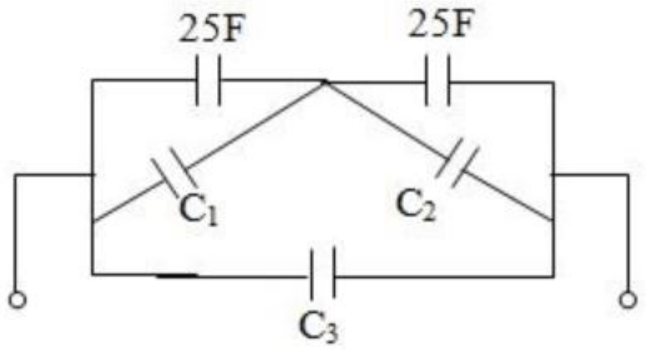
C) 18.5 F

D) 19.5 F

Correct Answer: **B** *Not Attempted :* Marks : 2 / 0.66 (-Ve)



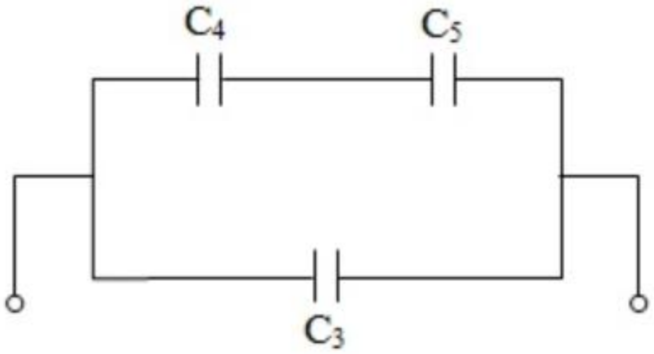
Here star point at "D" has been replaced by equivalent delta having delta branch capacitances C_1, C_2 and C_3



$$C_1 = \frac{10\times 15}{35} = 4.28F$$

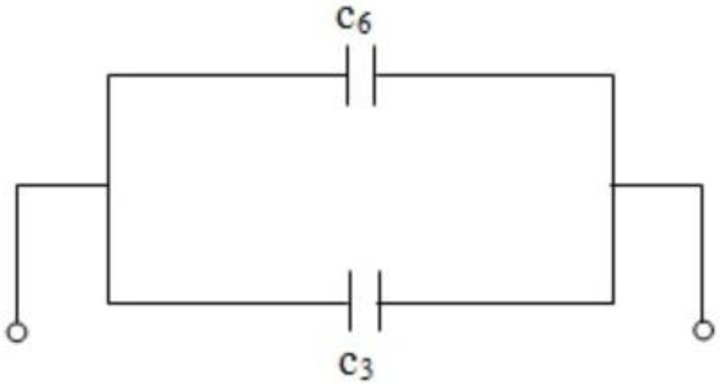
$$C_2 = \frac{15\times 10}{35} = 4.28F$$

$$C_3 = \frac{10\times 10}{35} = 2.86F$$



$C_4 = C_1 + 25 = 29.28F$

$C_5 = C_2 + 25 = 29.28F$



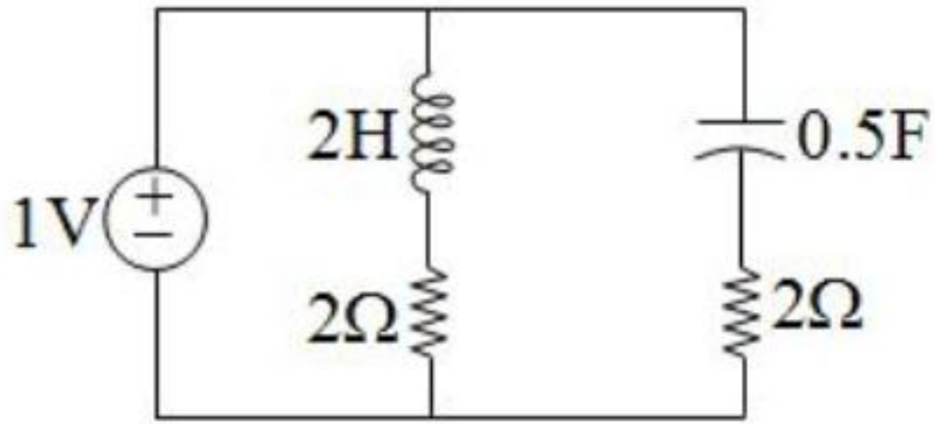
C_6 is formed by series combination of C_4 and C_5

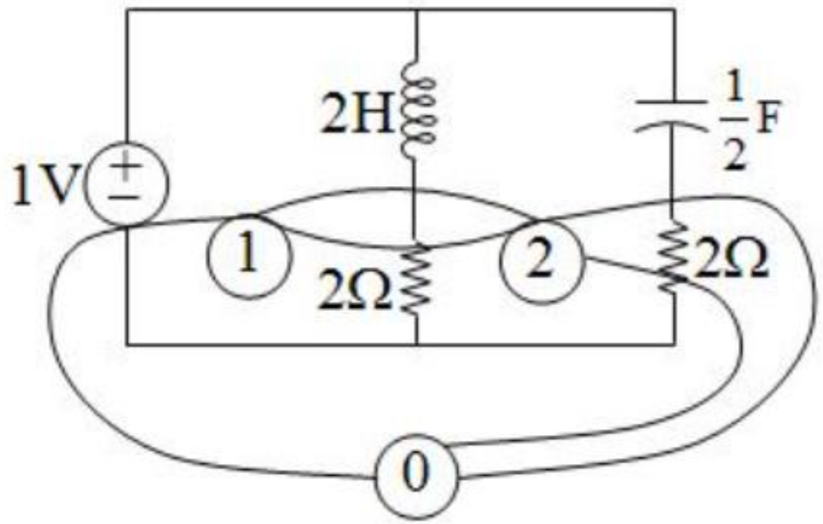
$$C_6 = \frac{(29.28)\times(29.28)}{2\times(29.28)} = 14.64F$$

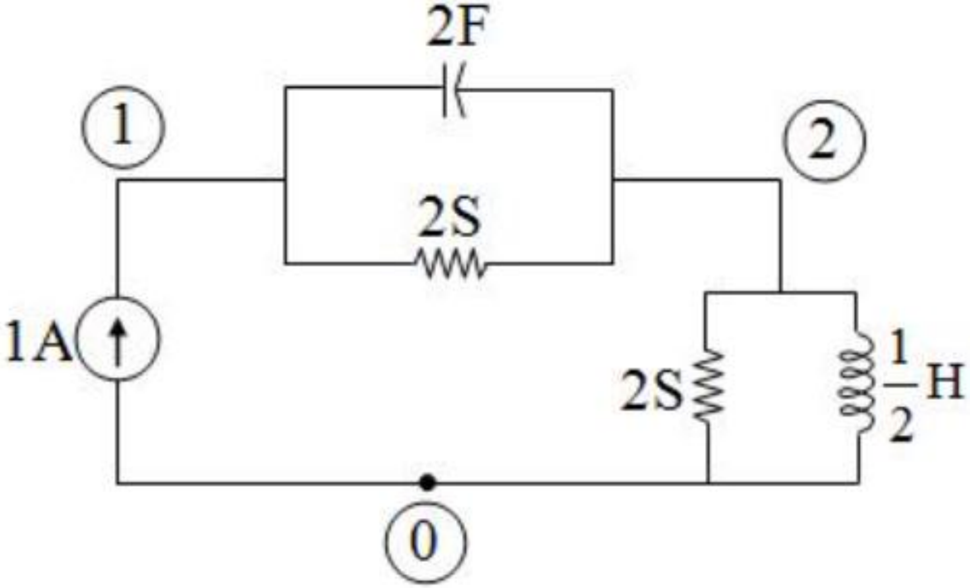
$$\therefore C_{x-y} = C_6 + C_3 = 14.64 + 2.86$$

$$= 17.5F$$

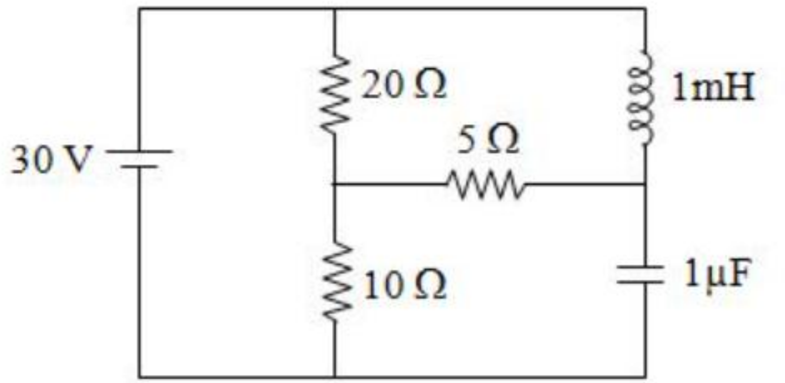
9. The dual of following network shown below is________




2H
1/2 F
1V
2Ω
2Ω
1
2
0


2F
1
2
2S
1A
2S
1/2 H
0

10. The total energy stored in a network will be (in mJ) ________.
(rounded off to two decimal places)



Correct Answer: **1.92**

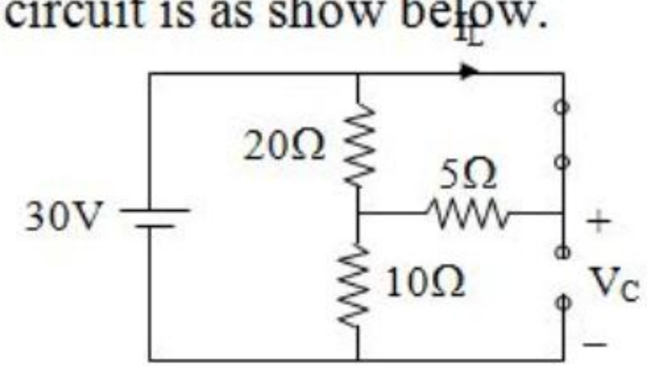
Answer Range: **(1.8 , 2)**

Not Attempted :

Marks : 2 / 0 (-Ve)

It can be assumed that the circuit is in existence for a long time, and has hence reached a steady state. In the steady state there are only 2 energy storing elements.

For DC source inductor acts as a short circuit and capacitor as an open circuit. Hence the circuit is as show below.



$\therefore V_C = 30V$

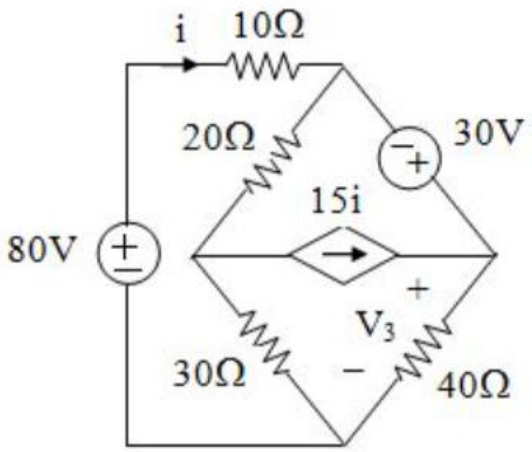
$I_L = 1.714A$

Therefore, energy in inductor $= \frac{1}{2}LI_L^2 = 1.47$ mJ

Energy stored in capacitor $= \frac{1}{2}CV^2 = 0.45$mJ

Total energy = 1.92 mJ

11. The approximate value of voltage V_3 in the circuit given below is



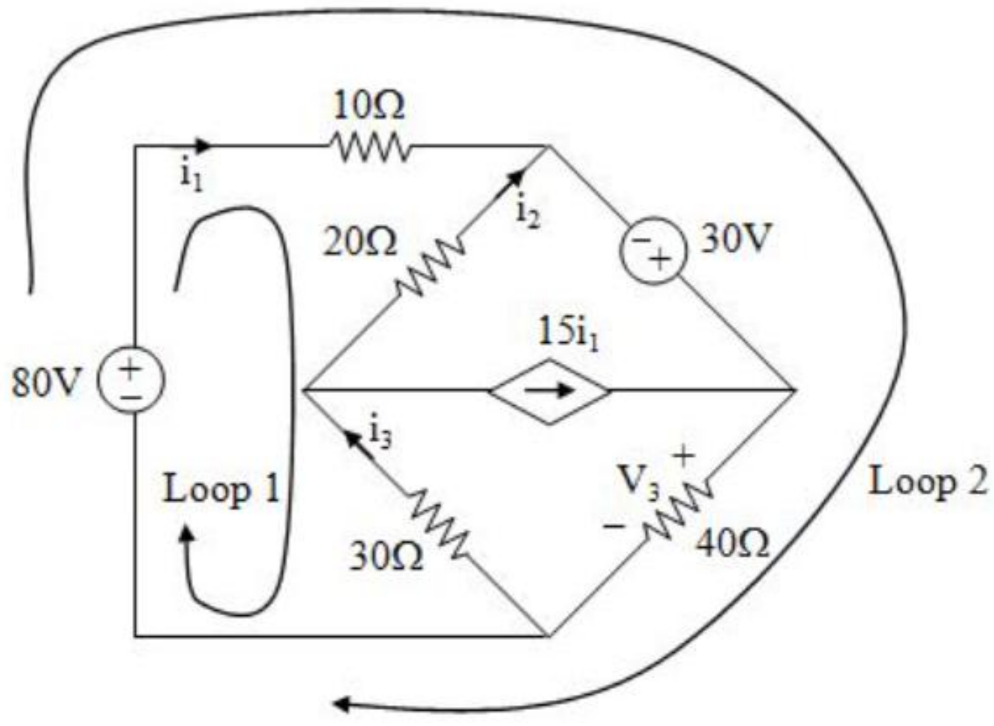
A) 104 V

B) 100 V

C) 108 V

D) 96 V

Correct Answer: **A** *Not Attempted :* Marks : 2 / 0.66 (-Ve)



By solving (1), (2) & (3)

$i_1 = 0.58$ A $\qquad i_2 = -6.68$ A $\qquad i_3 = 2.02$ A

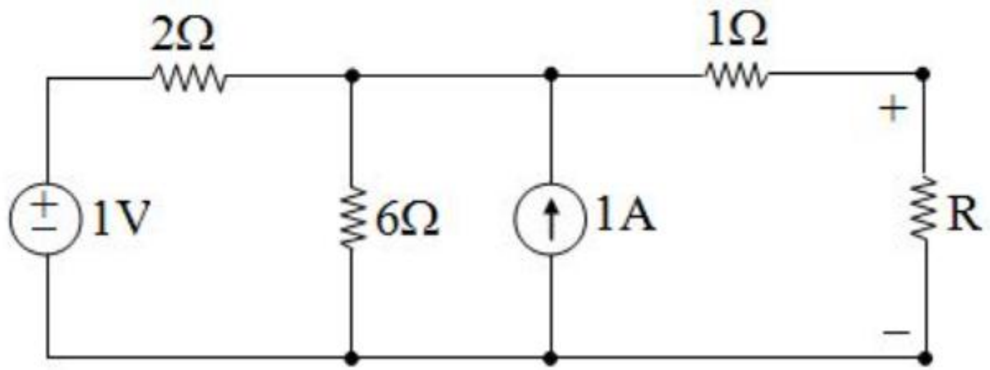
$\therefore V_3 = 40(i_1 + i_3) \approx 104\text{V}$

$\therefore 80 - 10i_1 + 20i_2 + 30i_3 = 0 \qquad \ldots\ldots (1)$

$80 - 10i_1 + 30 - 40(i_1 + i_3) = 0 \qquad \ldots\ldots (2)$

$15i_1 = i_3 - i_2 \qquad \ldots\ldots (3)$

12. Find the maximum power delivered to R in the circuit in figure, when R is set for maximum power transfer?



A) 1W

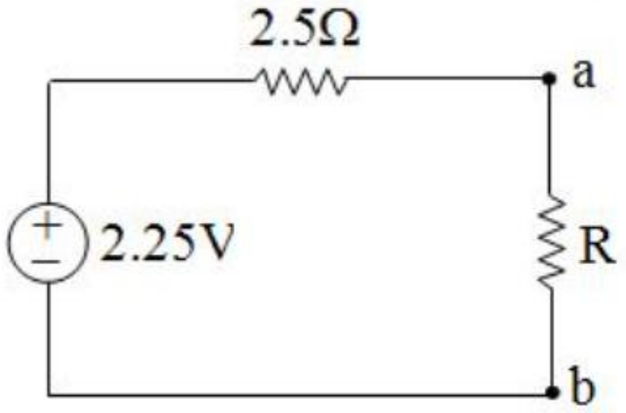
B) 0.5W

C) 2W

D) 2.25W

Correct Answer: **B**   *Not Attempted :*   Marks : 1 / 0.33 (-Ve)

Applying Thevinin theorem, the Thevenin equivalent has Thevenin voltage of 2.25V and a Thevenin resistance of 2.5Ω.

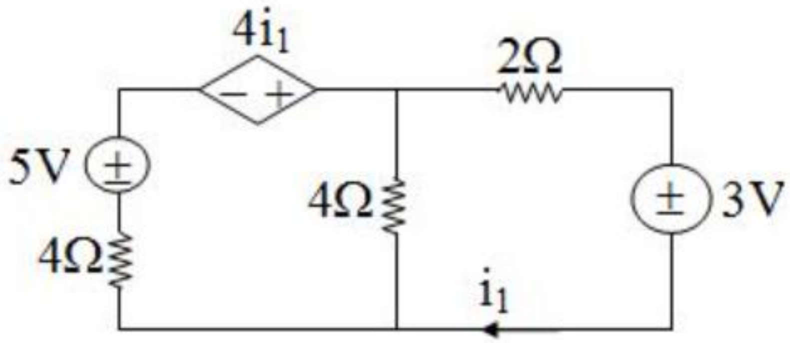


According to the maximum power transfer principle, when $R = R_{Th} = 2.5\Omega$, the load R receives the maximum power.

The maximum power received by the load in this case is

$$P_{Load} = \frac{(V_{Th}/2)^2}{R_{Th}} = \frac{((2.25V)/2)^2}{2.5\Omega} = \frac{81}{160} = 0.50625W .$$

13. Consider the following network



The value of i_1 in amperes is ________

(rounded off to two decimal places)

Correct Answer: **-0.25** Answer Range: **(-0.25 , -0.25)** *Not Attempted :* Marks : 2 / 0 (-Ve)

$$\text{Nodal} \Rightarrow \frac{V-4i-5}{4}+\frac{V-0}{4}+\frac{V-3}{2}=0$$

$$\Rightarrow 4V - 4i_1 = 11 \;\ldots\ldots\ldots\; (1)$$

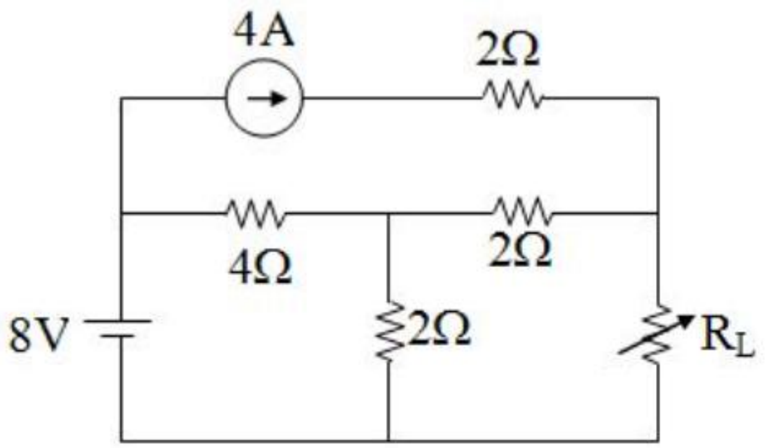
$$\text{By KVL} \Rightarrow V - 2i_1 - 3 = 0$$

$$\Rightarrow V - 2i_1 = 3 \;\ldots\ldots\ldots\; (2)$$

$$\text{Eq. (2) in Eq. (1)} \Rightarrow 4(2i_1 + 3) - 4i_1 = 11$$

$$\Rightarrow i_1 = -\frac{1}{4}\,\text{A} = -0.25\ \text{A}$$

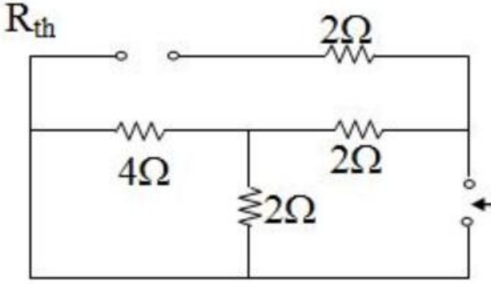
14. Consider the following circuit



The value of maximum power transfer to load resistor 'R_L' in watts is (rounded off to one decimal place)

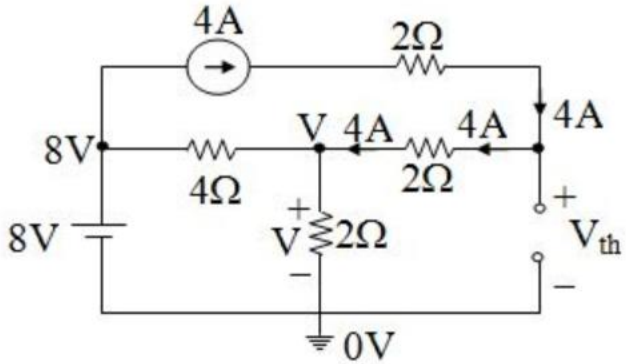
Correct Answer: **19.2** Answer Range: **(19 , 19.5)** *Not Attempted :* Marks : 2 / 0 (-Ve)

R_{th}



$\leftarrow R_L = 2 + 2 \| 4 = \frac{10}{3}\,\Omega$

V_{th}:

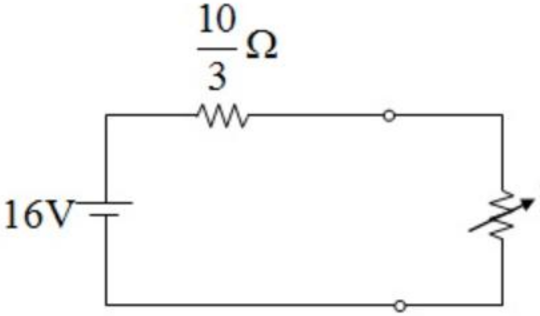


$$\text{Nodal} \Rightarrow \frac{V-8}{4} + \frac{V}{2} - 4 = 0$$

$$\Rightarrow V = 8\text{ V}$$

$$\text{By KVL} \Rightarrow V + 8 - V_{th} = 0$$

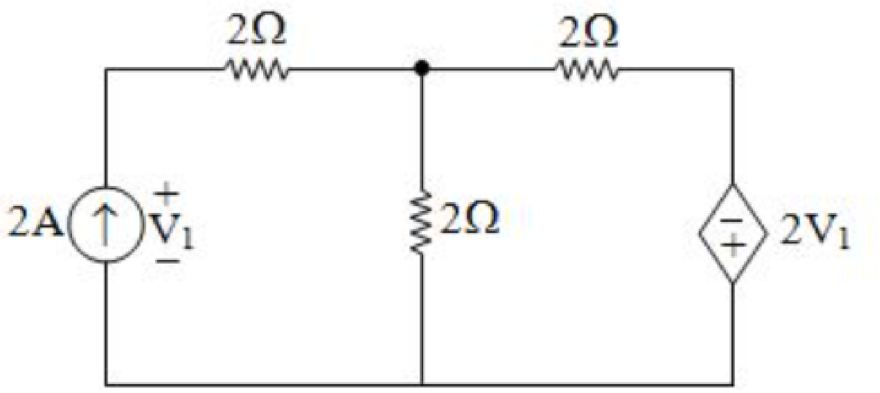
$$\Rightarrow V_{th} = v + 8 = 8 + 8 = 16\text{ V}$$



$R_L = R_s$ for MPT $= \frac{10}{3}\,\Omega$

$$\Rightarrow P_{max} = \frac{V_{th}^2}{4R_{th}}(\text{W}) = \frac{16^2}{4 \times \frac{10}{3}} = 19.2\text{ W}$$

15. In the circuit shown below, the dependent source delivers the power (in Watts) is _______.

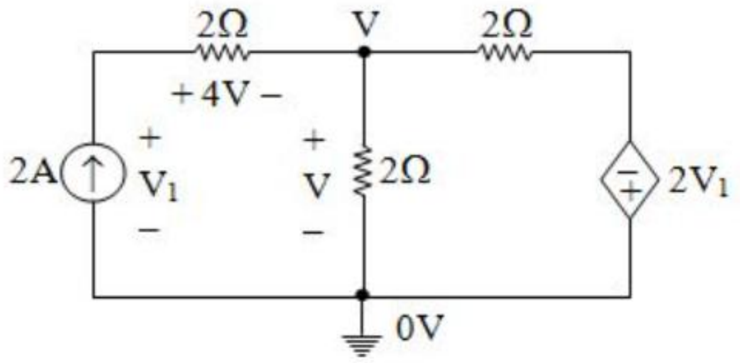


Correct Answer: **15**

Answer Range: **(15 , 15)**

Not Attempted : !

Marks : 1 / 0 (-Ve)



$$\text{Nodal} \Rightarrow -2 + \frac{V}{2} + \frac{V + 2V_1}{2} = 0 \Rightarrow V_1 + V = 2 \rightarrow (1)$$

$$\text{KVL} \Rightarrow V_1 - 4 - V = 0 \Rightarrow V_1 - V = 4 \rightarrow (2)$$

From eqns (1) & (2) $V_1 = 3V$ & $V = -1V$

$$\text{So, } I_{2V_1} = \frac{V + 2V_1}{2} = \frac{-1 + 6}{2} = \frac{5}{2}\text{A}$$

$$\Rightarrow P_{2V_1} = 2 \times 3 \times 5/2$$

$$= 15\text{W (delivered)}$$