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LECTURE # 4

EXAMPLE # 1:

a) Calculate the charge stored on a 3pF capacitor with 20V acr[oss] it.

Sol:-

$q = Cv$

$q = 3\times10^{-12} \times 20 \Rightarrow 60pC$

b) ~~The~~ Find the energy stored in the capacitor.

Sol:-

The energy stored is:

$w = \frac{1}{2} Cv^2$

$= \frac{1}{2} \times (3\times10^{-12}) \times (20)^2$

$w = \frac{1}{2} \times 3\times10^{-12} \times 400 \Rightarrow 600pJ$

EXAMPLE # 2:

The voltage across a 5-μF capacitor is:

$v(t) = 10 \cos(6000t) V$

Calculate the current through it.

Sol:-

By definition, the current is

$i(t) = C\frac{dv}{dt} = 5\times10^{-6} \frac{d}{dt}(10 \cos 6000t)$

$= -5\times10^{-6} \times 10 \sin 6000t \times 6000$

$i(t) \Rightarrow -0.3 \sin 6000t$

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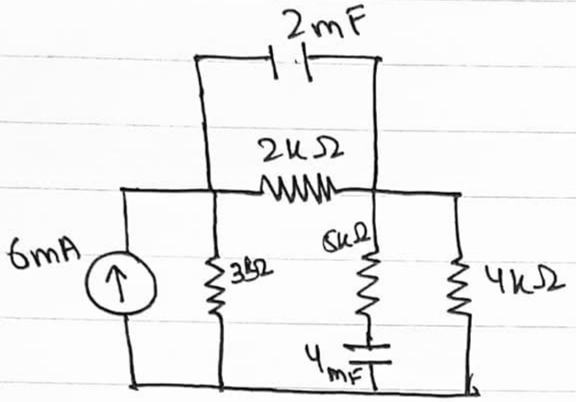
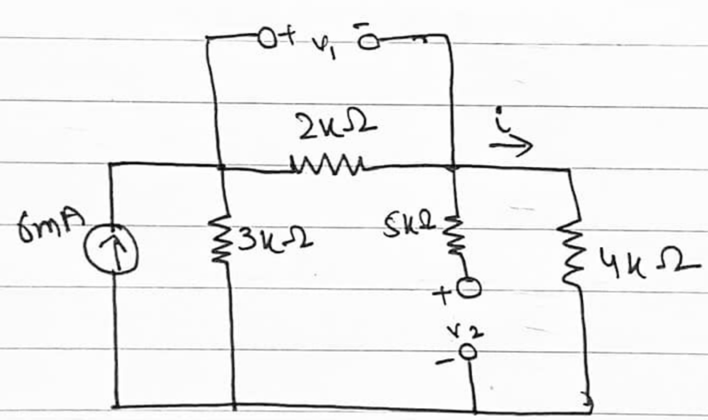
EXAMPLE # 3:-

Obtain the energy stored in the capacitor shown below under the dc conditions:-



Sol:

Under dc conditions, we replace each capacitor with an open circuit, as shown below:-



The current through the series combination of the 2kΩ and 4kΩ resistors is obtained by current division as:

$$i = \frac{3}{3+2+4}(6mA)$$

$$= \frac{3}{9}(6mA) \Rightarrow 2mA$$

Hence, the voltages v_1 and v_2 across the capacitors are:

$$v_1 = 2000i \Rightarrow 4V$$

$$v_2 = 4000\,i = 4000\,(2mA) \Rightarrow 8V.$$

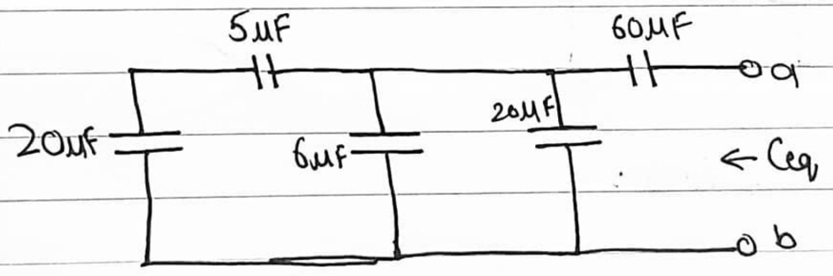
and the energies stored in them are:

$$w_1 = \frac{1}{2} C_1 v_1^2 = \frac{1}{2}(2\times10^{-3})(4)^2 \Rightarrow 16mJ$$

$$w_2 = \frac{1}{2} C_2 v_2^2 = \frac{1}{2}(4\times10^{-3})(8)^2 \Rightarrow 128mJ$$

EXAMPLE #4:-

Find the equivalent capacitance seen between terminals a and b of the circuit shown below:-



Sol:

The 20μF and 5μF capacitors are in series; their equivalent capacitance is:

$$\frac{20\times5}{20+5} = 4\mu F \qquad \therefore \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \text{ for series}$$

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This 4μF capacitor is in parallel with the 6μF and 20μF capacitors; their combined capacitance is:

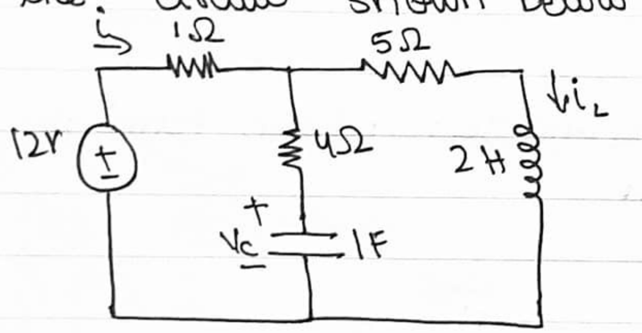
$$4+6+20 = 30\mu F \qquad \therefore C_{eq} = C_1+C_2+\dots+C_n \text{ for parallel}$$

This 30μF capacitor is in series with the 60μF capacitor. Hence, the equivalent capacitance for the entire circuit is:

$$C_{eq} = \frac{30\times 60}{30+60} \Rightarrow 20\mu F$$

<u>EXAMPLE # 5:-</u>

Consider the circuit shown below

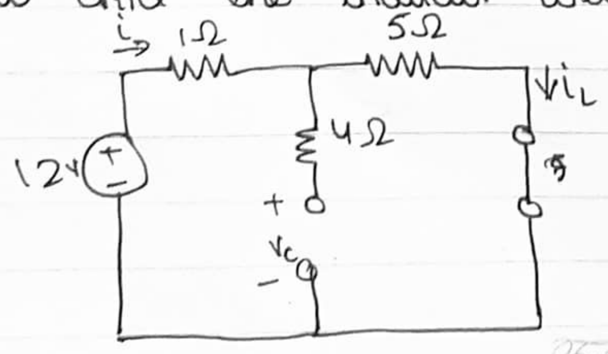


a) Under dc conditions, find:

a) i, v_c and i_L

<u>Sol:-</u>

Under dc conditions, we replace the capacitor with an open circuit and the inductor with a short circuit as shown below:



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$$i = i_L = \frac{12}{1+5} \Rightarrow 2A$$

The voltage V_C is the same as the voltage across 5Ω resistor. Hence,

$$V_C = 5i = 5 \times 2 \Rightarrow 10V$$

b) the energy stored in the capacitor and inductor:-

Sol:-

The energy stored in the capacitor is:

$$W_C = \frac{1}{2} C V_C^2$$

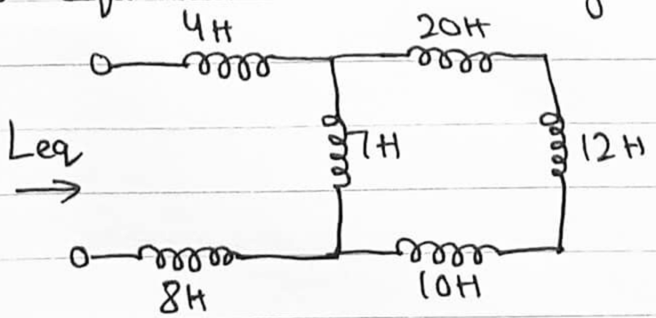
$$= \frac{1}{2}(1)(10)^2 \Rightarrow 50J$$

and than in the inductor is:-

$$W_L = \frac{1}{2} L i_L^2 = \frac{1}{2}(2)(2^2) \Rightarrow 4J$$

EXAMPLE # 6:-

Find the equivalent inductance of the circuit shown below



Sol:-

The 10H, 12H and 20H inductors are in series; thus, combining them gives a 42 H inductance.

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The 42 H inductor is in parallel with the 7 H inductor so that they are combined, to give

$$\frac{7 \times 42}{7+42} \Rightarrow 6 H$$

This 6 H inductor is in series with the 4-H and 8-H inductors. Hence,

$$L_{eq} = 4 + 6 + 8 \Rightarrow 18 H$$