ECA Assignment

Date: 24/11/22
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Name: Shreerang Mhatre
Rollno: 29
Batch: A2
SY B.Tech Electrical & Computer Eng
SUB: ECA Assignment.

Q 1) Derive a proof of maximum power transfer theorem and hence derive formula for maximum power

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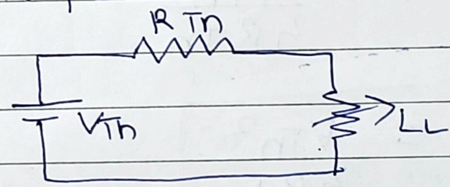

$P_L = I - R_L$

$\therefore \quad I = \dfrac{V_{Th}}{R_{Th} + R_L}$ (by ohm's law)

$\therefore \quad P_L = \left(\dfrac{V_{Th}}{R_{Th} + R_L}\right)^2 \cdot R_L$

$\therefore \quad P_L = V_{Th}^2 \left[\dfrac{R_L}{(R_{Th} + R_L)^2}\right]$ — ①

diff

$\therefore \quad \dfrac{dP_L}{dR_L} = V_{Th}^2 \left[\dfrac{(R_{Th} + R_L)^2 \times [-R_L \times 2(R_{Th} + R_L)]}{(R_{Th} + R_L)^4}\right] = 0$

$\Rightarrow (R_{Th} + R_L)^2 - 2R_L(R_{Th} + R_L) = 0$

$\Rightarrow (R_{Th} + R_L)(R_{Th} + R_L - 2R_L) = 0$

$\Rightarrow (R_{Th} = R_L$

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$\therefore$ for max power

$$\boxed{R_L = R_{Th}.}$$

Now for formula

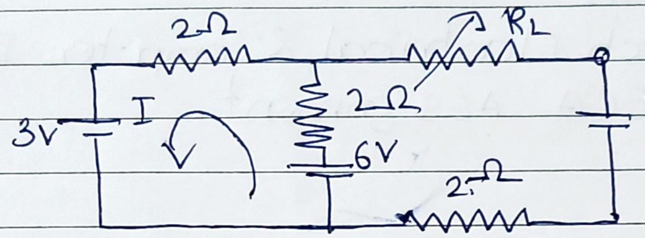
$$P_{Lmax} = V_{Th}^2 \left\{ \frac{R_{Th}}{(R_{Th} + R_{Th})^2} \right\}$$

$$\Rightarrow P_{Lmax} = V_{Th}^2 \left[\frac{R_{Th}}{4 R_{Th}^2} \right]$$

$$\Rightarrow P_{Lmax} = \frac{V_{Th}^2}{4 R_{Th}}$$

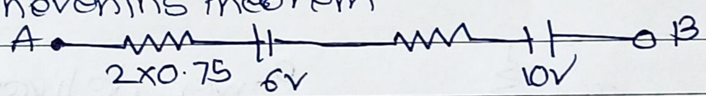
$$\boxed{P_{Lmax} = \frac{V_{Th}^3}{4 R_L}}$$

Q 2) Calculate value of R_L to transfer maximum power to it also calculate value of maximum power.

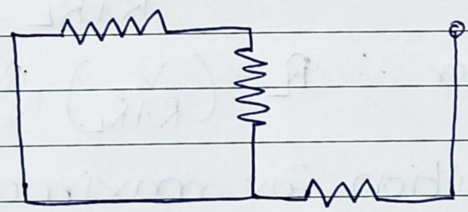


$$I = \frac{6-3}{4} = 0.75\,A$$

by thevenins theorem



$$V_{Th} = (2 \times 0.75) + 10 - 6 = 5.5V$$



$$R_{eq} = (2 \parallel 2) + 2 = 3\,\Omega$$

For maximum power $R_L = R_{eq}$

$$= \left[\frac{V_{Th}}{2R_{eq}}\right]^2 R_{eq} = \frac{5.5^2}{4 \times 3} = 2.52\,W$$

$$\boxed{\begin{array}{l} R_L = 3\,\Omega \\ P_{L\,max} = 2.52\,W \end{array}}$$

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Q 3) In a circuit containing R = 25 ohm, L = 0.23 H and C = 50 µF in series with the voltage of 200 V, the switch is closed at t = 0. Calculate i, di/dt & d^2i/dt^2 at $t = 0^+$.

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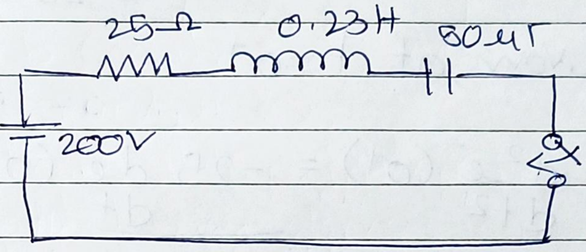

At $t = 0^-$ no current flows through circuit

$$\therefore \boxed{i(0^+) = 0}$$

at $t > 0$: by KVL

$$\Rightarrow 200 - iR - L\frac{di}{dt} - \frac{1}{C}\int_0^t i(t)\,dt = 0$$

$$\Rightarrow 200 - 25i - 0.23\frac{di}{dt} - \frac{10^6}{50}\int_0^t i(t)\,dt = 0$$

$$\Rightarrow 200 - 25i - 0.23\frac{di}{dt} - 20000\int_0^t i(t)\,dt = 0$$

$$\Rightarrow \frac{di}{dt} = \frac{200 - 25i - 2000\int_0^t i(t)\,dt}{0.23} \quad -(1)$$

Now,

$$\frac{di}{dt}(0^+) = \frac{200}{0.23} = 869.56 \text{ A/s}$$

$$\therefore \boxed{\frac{di}{dt}(0^+) = 869.56 \text{ A/s}}$$

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~~Now~~ diff. eqn ①

$$\frac{d^2i}{dt^2} = \frac{-25\frac{di}{dt} - 20000i}{0.23}$$

Now, at $t=0^+$

$$\frac{d^2i}{dt^2}(0^+) = \frac{-25\frac{di}{dt}(0^+) - 20000\,i(0^+)}{0.23}$$

$$= \frac{-25(869.56) - 20000(0)}{0.23}$$

$$\therefore \frac{d^2i}{dt^2} = \frac{-25(869.56)}{0.23}$$

$$\boxed{\frac{d^2i}{dt^2} = 94517 A/s^2}$$