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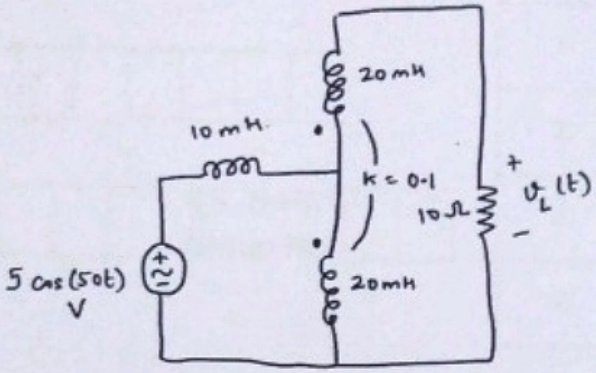
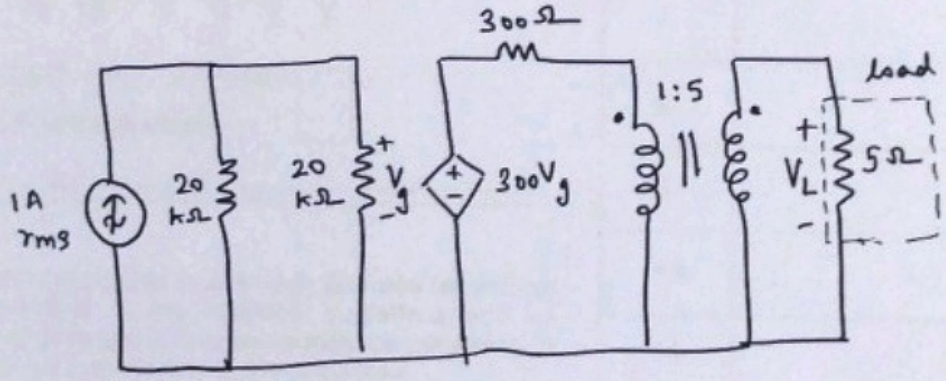
Quiz 3 (30 marks)

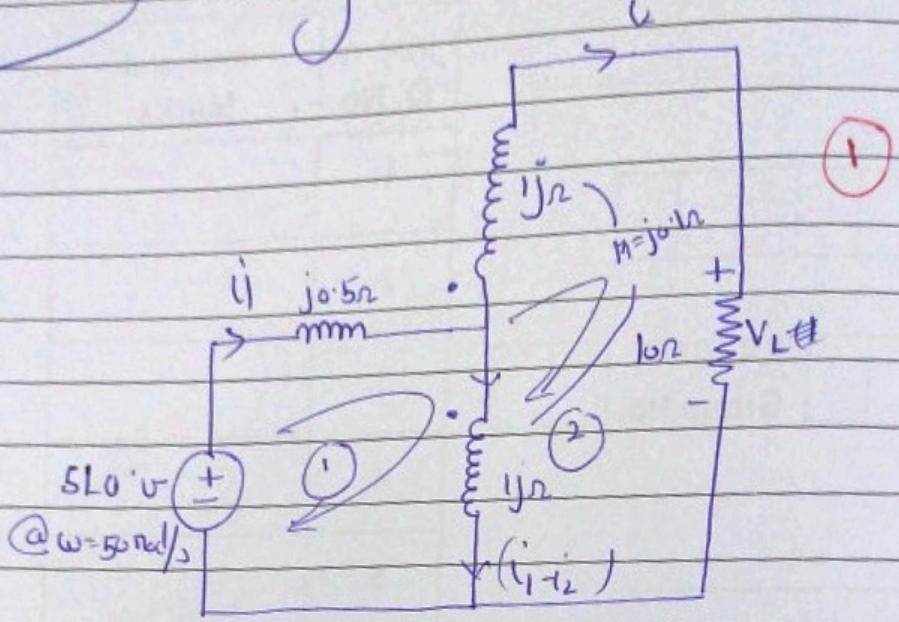
1. **(15 marks)** For the following circuit, write the mesh equations (in phasor domain) and steps required to compute the load voltage V_L. Detailed calculations can be omitted since they are not required.



2. **(15 marks)** In the following circuit, find the time averaged power delivered to the load.



Soln 1) Redrawing circuit in phasor domain-



$X_L = j\omega L$ (M in Ohms)

$X_{20mH} = j \times 50 \times 20 \times 10^{-3}$

$= 1j\Omega$ (2)

$X_{10mH} = j\omega 10 \times 10^{-3}$

$= j \times 50 \times 10 \times 10^{-3}$ (1)

$= j0.5\Omega$

$k = M/\sqrt{L_1 L_2}$

$M = k\sqrt{L_1 L_2}$

$= 0.1 \times \sqrt{40 \times 20 \times 10^{-6}}$

$= 0.1 \times \sqrt{400 \times 10^{-6}}$ (2)

$= 0.1 \times \sqrt{4 \times 10^{-4}}$

$= 2 \times 10^{-3}$

$= 2mH$

$X_{2mH} = j\omega 2 \times 10^{-3} = j \times 50 \times 2 \times 10^{-3} = j0.1\Omega$

Let current in loop ① is i_1 and in loop ② is i_2 :-

⇒ Mesh equation for loop ① :-

$$5\angle 0^\circ - j(0.5)(i_1) - j(1)(i_1 - i_2) - j(0.1)(i_1) = 0 \quad -①$$

⇒ Mesh equation for loop ② :-

$$-10(i_2) + j^1(i_1 - i_2) + j(0.1)(i_2) - j(1)(i_2) - j(0.1)(i_1 - i_2) = 0 \quad -②$$

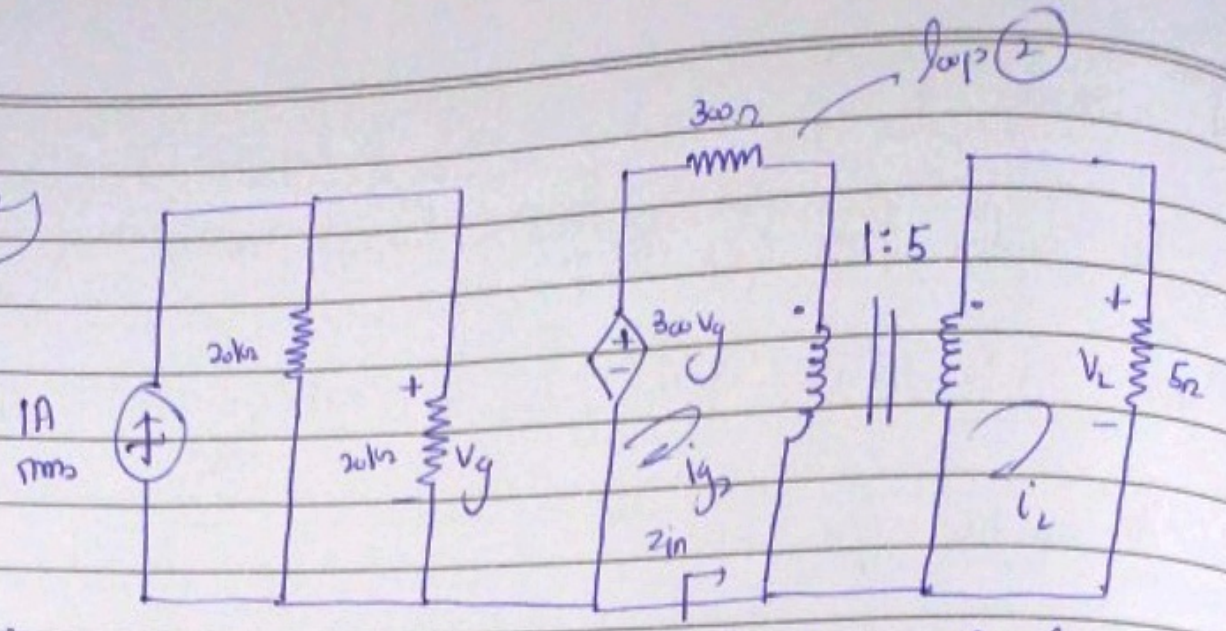
By solving equation ① and ②, we can find i_1 and i_2 :-

$$V_L = i_2 \times (10\Omega) \quad -③, \quad = V_L \angle 0$$

now, from putting the value of i_2 in ③, we can find V_2 and then convert it into time domain.

$$V_L(t) = V_L \cos(50t + 0)\ V\ \Delta -$$

Soln 2)



from, figure we can apply current division to find out the current flowing through 20kΩ resistor

$$i_g = 1A \times \frac{20k\Omega}{40k\Omega}$$

$$= 1A \times 1/2$$

$$= 0.5A \text{ rms}$$ (3)

$$V_g = 0.5A \times 20k\Omega$$

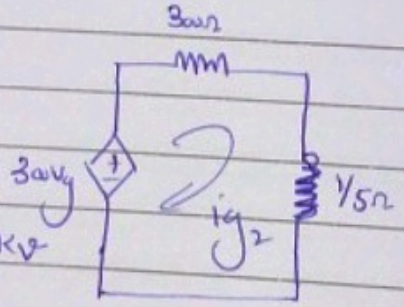
$$= 10V \times 10^3$$

$$= 10kV \text{ rms.}$$

$$a = 5$$

$$Z_{in} = \frac{Z_L}{a^2} = \frac{5}{(5)^2} = 1/5\Omega$$ (3)

⇒ Redrawing loop 2):-



$$i_{g_2} = \frac{3000 \times 10^3}{300 + 1/5} = \frac{3000 \times 10^3}{300.02}$$

$$= 9999.33 \text{ A (rms)}$$ (3)

now, $\frac{i_L}{i_{g_2}} = \frac{1}{5}$

$$\Rightarrow \frac{i_L}{9999.33} = \frac{1}{5}$$ (2)

$$\Rightarrow i_L = \frac{9999.53}{5}$$

$$= 1999.90 \text{ A (rms)}$$

$$P_{load} = (i_L)^2 \times (5\Omega)$$ (3)

$$= (1999.90)^2 \times 5$$

$$= 1,99,98,120.04 \text{ W}$$ D

$$= 19.99 \text{ MW}$$ B