Basic Electrical Technology

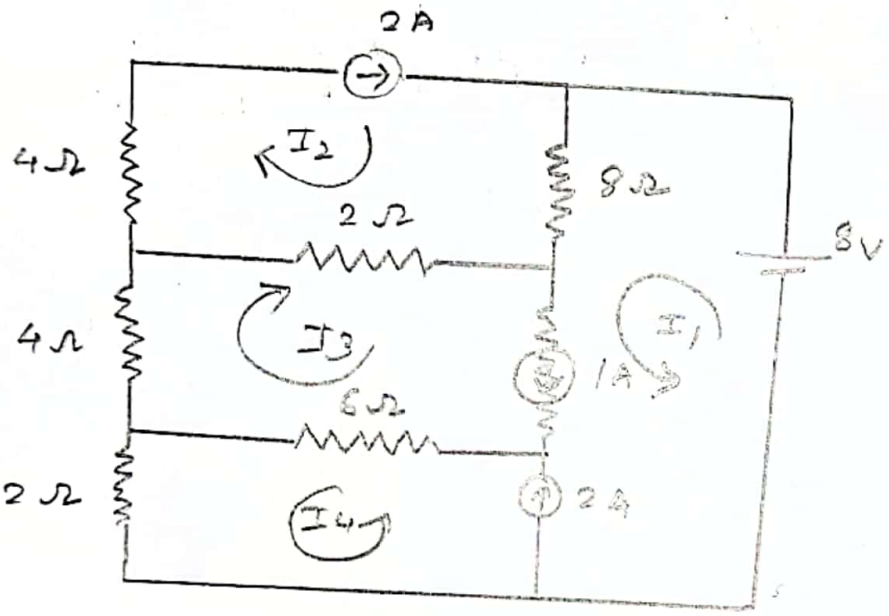
Rutvik. A. Barbhai
Section c.
Reg No. 22580522 2
Basic Electrical Technology
B. Tech compuser science and Engineering

Q1) For the circuit in fig 1. Find the following.

A) The power supplied/absorbed by the 8V source is 80.32W

B) The power absorbed by the 8Ω resistor is 32 W

c) The voltage across the 6Ω resistor is 15.18 V



A1) MESH 1

$8 - 8 + 16 - 8(I_2 + I_2) = 0$

$I_1 + I_2 = 2$ —— (1)

MESH 2

$-28 - 8(I_2 + I_1) - 4I_2 - 2(I_2 - I_3) = 0$

$\Rightarrow -14 - 7I_2 - 4I_1 + I_3 = 0$

$4I_1 + 7I_2 - I_3 = -14$ - (2)

MESH 3

$-12 - 12I_3 + 2I_2 - 6I_4 = 0$

$I_2 - 6I_3 - 3I_4 = 6$ — (3)

MESH 4

$-16 - 8I_4 - 6I_3 = 0$

$3I_3 + 4I_4 = -8$ — (4)

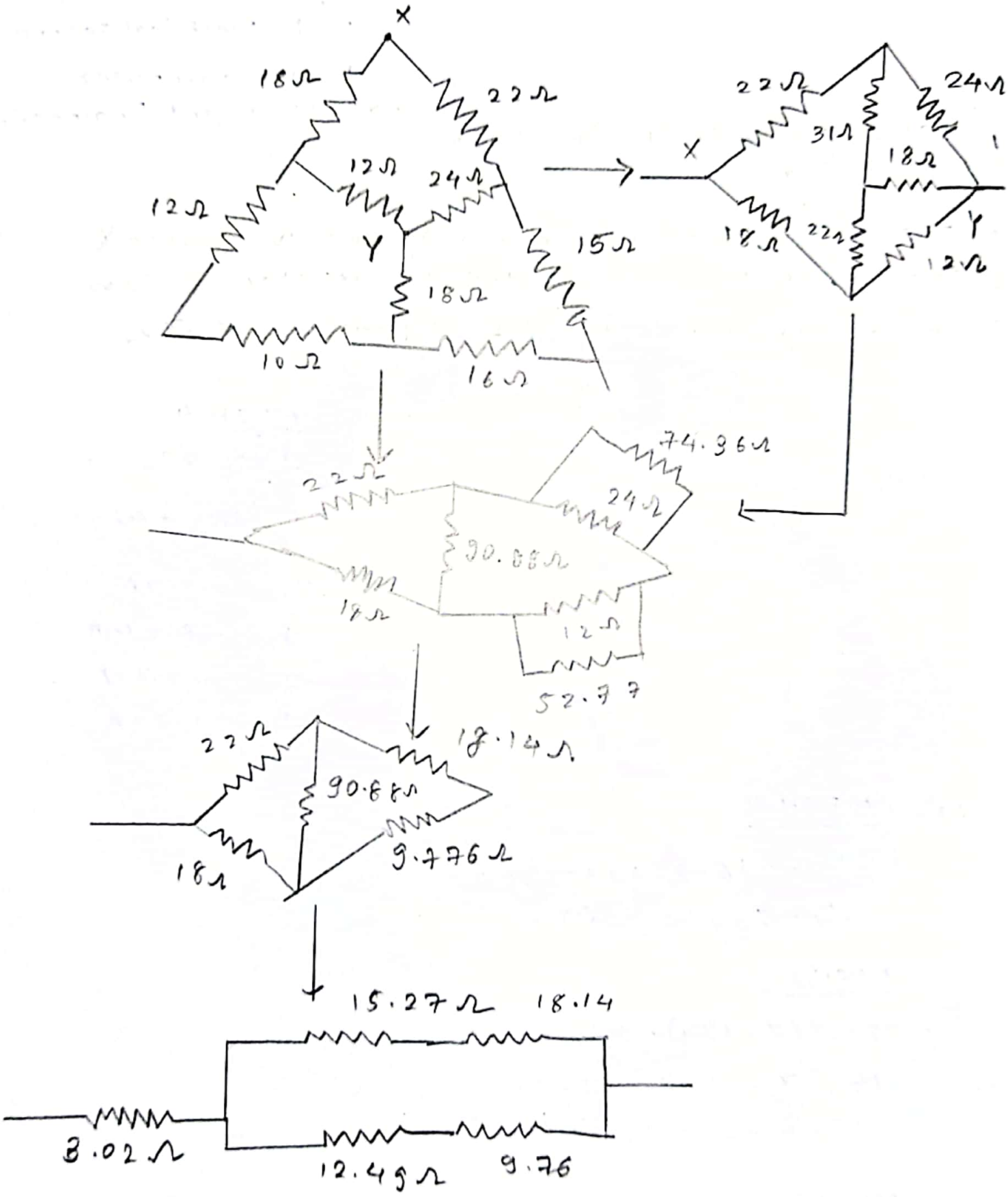
$I_1 = 10.04A$

$I_2 = -8.04A$

$I_3 = -2.14A$

$I_4 = 0.39A$

Q2) The equivalent Resistance between terminals x and Y of the circuit in Figure is



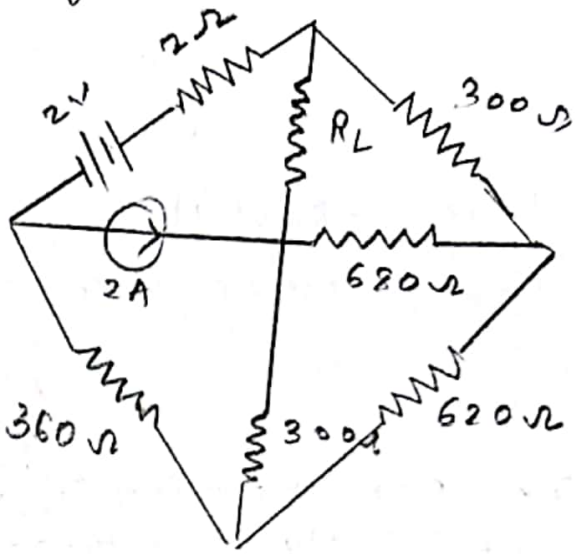
$Req = 16.381\Omega$

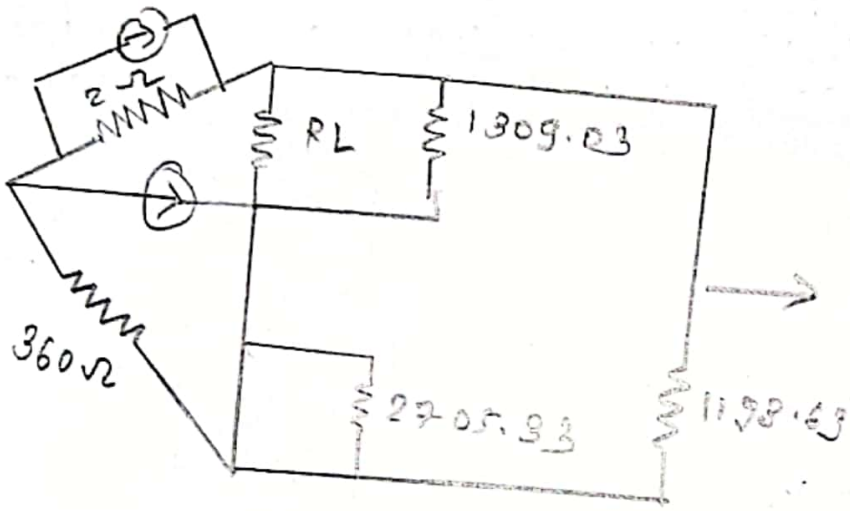
Q2) b. For the circuit shown in figure 3 Find the Thevenin parameter to determine the following; w.r.t

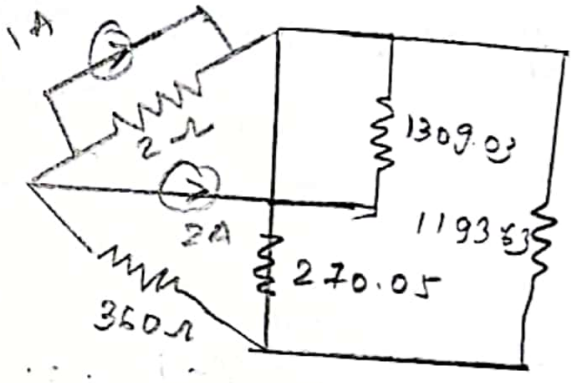
A) Thevenin's voltage (V_{TH}) is?

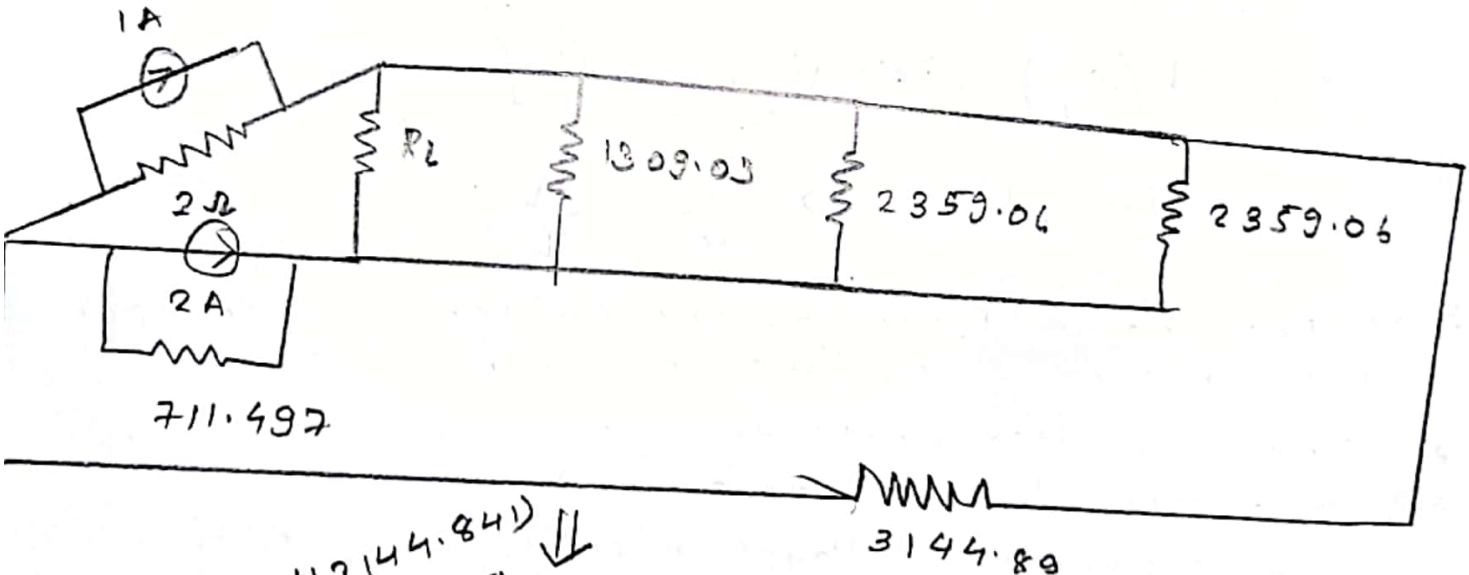
B) Thevenin's resistance (R_{TH}) is?

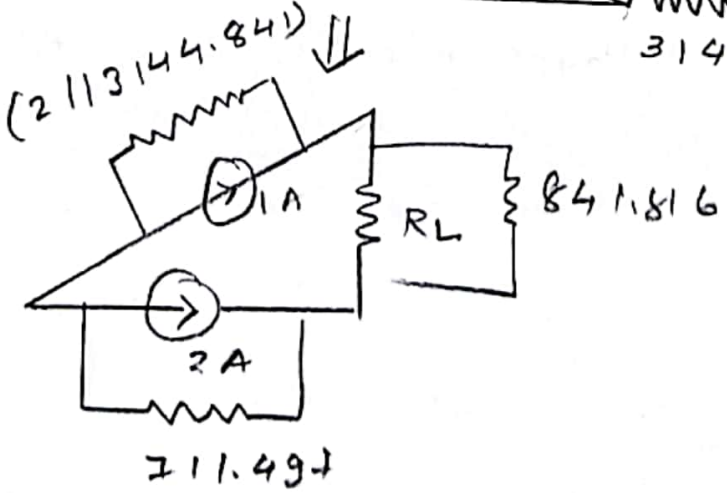
c) power dissipation in R_L Ω resistor is?

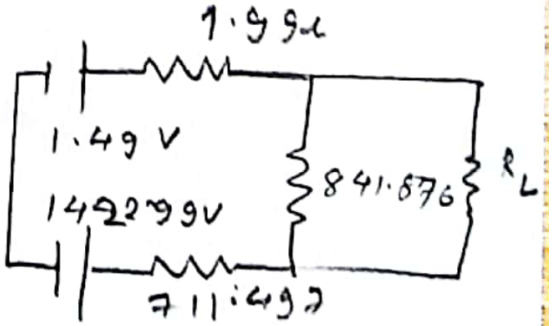


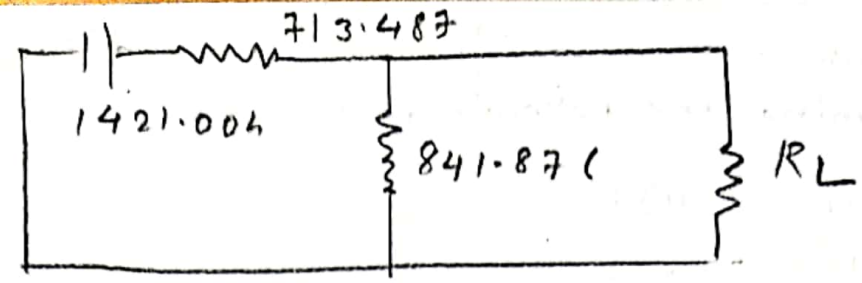












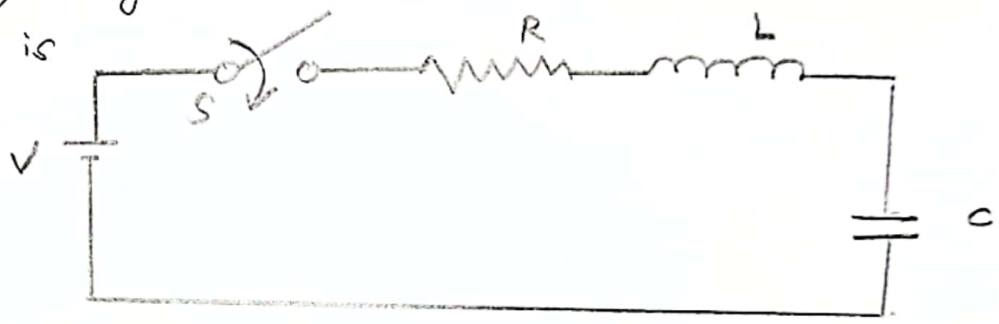
$R_{TH} = 386.191\Omega$

$V_{TH} = 1421.004$

$$P_{TH} = \left(\frac{1421.004}{386.191 + R_L}\right)^2 R_L$$

$$= \frac{2.01 \times 10^6 R_L}{386.191 + R_L}$$

Q3) A) For the circuit, assuming switch was open for sufficiently long time and then closed at $t=0$, the $\frac{di}{dt}$ at $t=0+$ is



$$V = L\left(\frac{di}{dt}\right) + iR + V_c$$

$$V = L\left(\frac{di}{dt}\right) + iR + V\left[1 - e^{-t/RC}\right] \quad (\to 0)$$

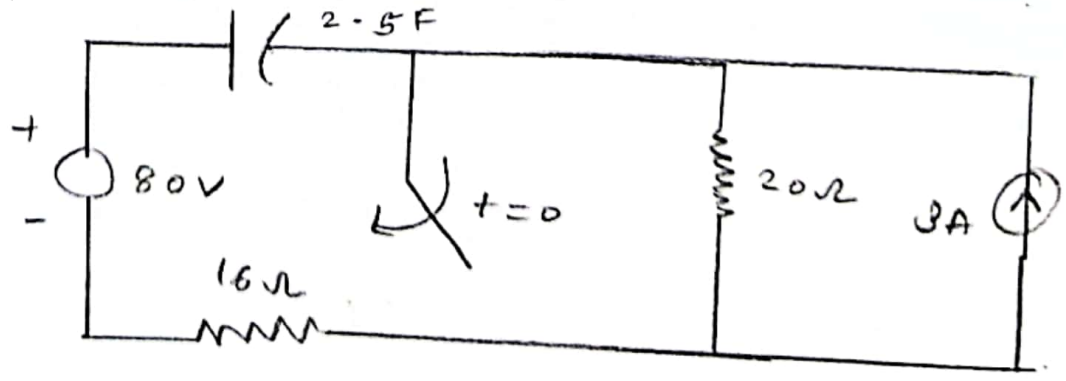
$$0 = L\left(\frac{di}{dt}\right) + iR \Rightarrow \frac{di}{dt} = -\frac{V}{L}$$

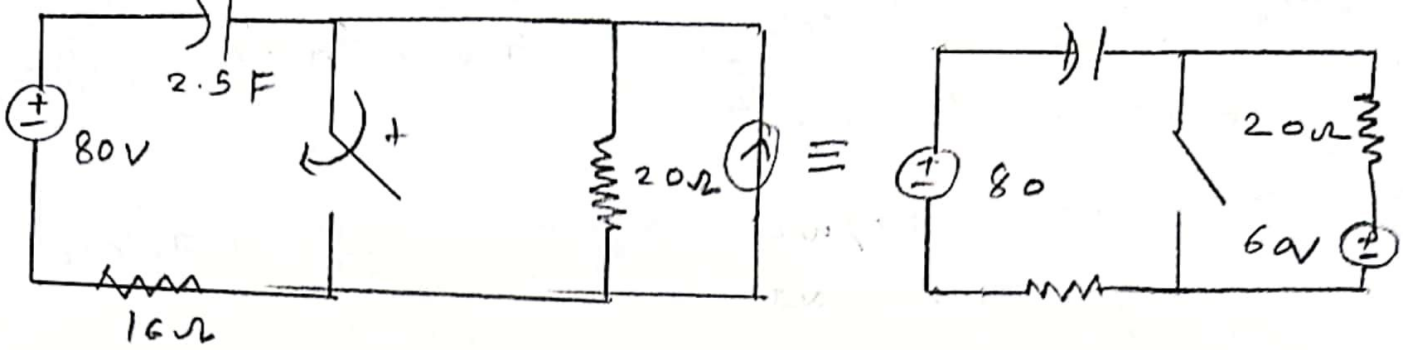
Q3 b) For the in Figure 5, the switch was in open position for a long time, and then operated

A) The capacitor voltage at $t=0$ is?

B) The capacitor at $t=\infty$ is?

C) The capacitor voltages because x V at time?





Ans 1) at $t=0$, capacitor is a wire $\Rightarrow V_c = 20V$

2) at $t=\infty$ capacitor is open ckt $\Rightarrow V_c = 80V$

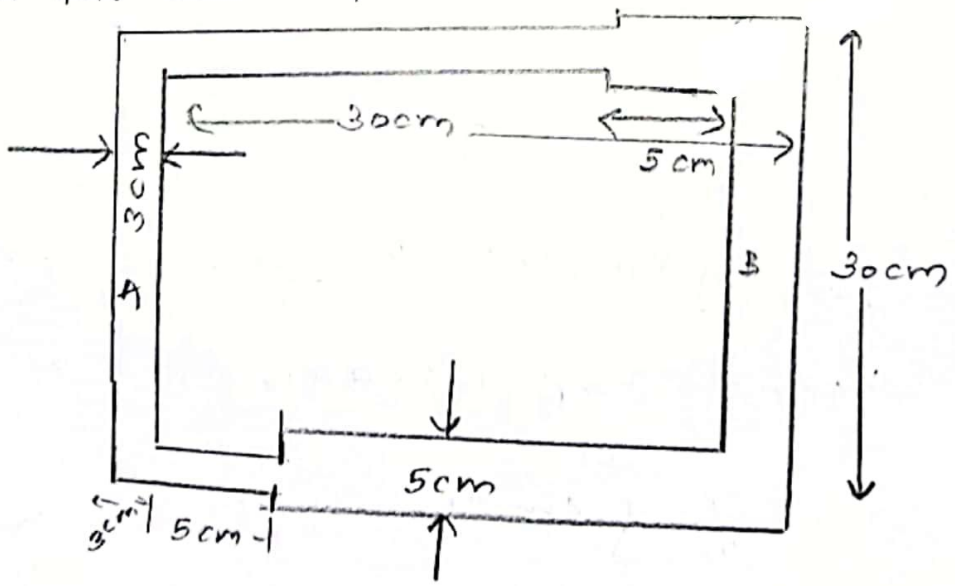
3) $xV = V\left[1 - e^{-t/Rc}\right]$

$$\frac{-t}{Rc} = \ln(1-x)$$

$$t = -40 \ln(1-x)$$

Q4) A core, having square-section, is shown. It is made of two ferromagnetic materials, A and B with a relative permeability of 600 and 1200 resp.

Ans A) A coil of Y turns in wound on the core. The current required in the coil to produce a flux of X Wb is



Ans A) $l_A = 22 + 1.5 + 1.5 + 1.5 + 5 + 1.5 + 17 = 50cm = 0.5m$

$l_B = 20 + 2.5 + 2.5 + \sqrt{7} + 2.5 + 17 + 2.5 = 52cm = 0.52m$

$A_A = 9 \times 10^{-4} m^2$ $\quad A_B = 25 \times 10^{-4} m^2$

$$S_A = \frac{l_A}{\mu_0 \mu_A A_A} = \frac{0.5}{600 \times 4\pi \times 10^{-7} \times 9 \times 10^{-4}} = 0.736 \times 10^6 \, AT/Wb$$

$S_B = \frac{0.52}{1200 \times 4\pi \times 10^{-7} \times 25 \times 10^{-4}} = 0.137 \times 10^6$ AT/Wb

$S_{eq} = 0.873 \times 10^6$ AT/Wb $S_{eq} = \frac{0.002}{4\pi \times 10^{-7} \times 9 \times 10^{-4}} = 1.76 \times 10^6$ AT/Wb

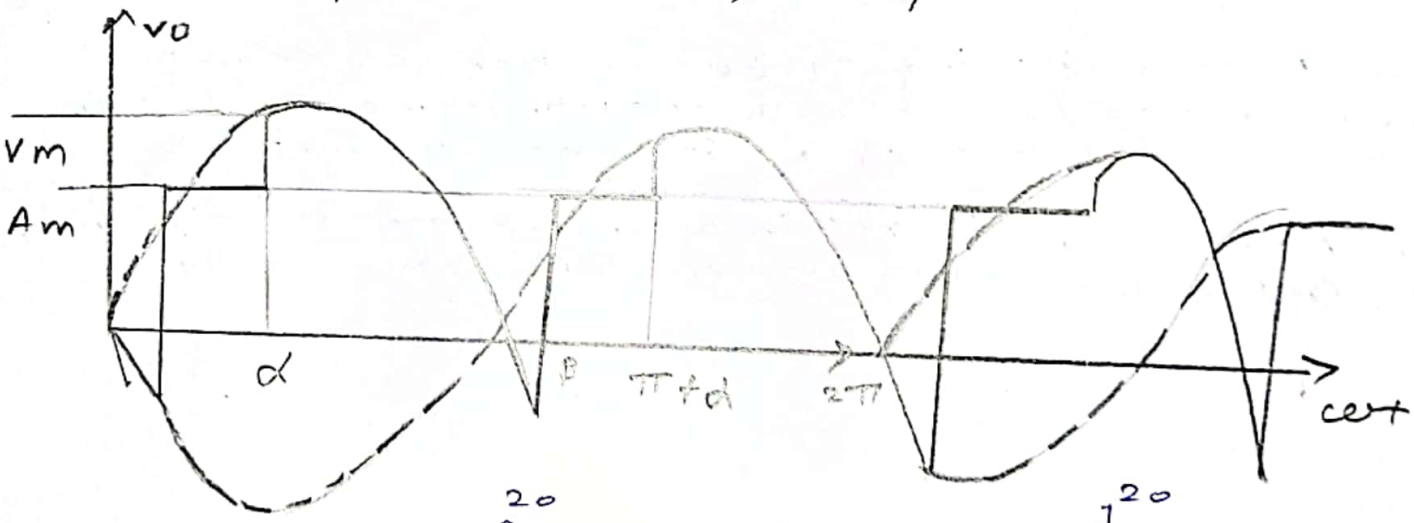
$\phi \times S_{eq} = MMF = NI$

$\left(\frac{0.87 \times 10^6}{y} x\right) A = I$ $S_{eq}' = 2.63 \times 10^6$ AT/Wb

c) coment $S_{eq} = \frac{x}{y}(2.63 \times 10^6)$

Q5) Determine the following

A) Determine the average value of the waveform if $\alpha = 75°$ $\beta = 200°$, $V_m = x$, $A_m = y$



part I $= \frac{1}{40} \int_0^{20} V_m \sin\theta \cdot d\theta = \frac{-V_m}{40} \cos\theta \Big|_0^{20} = \frac{V_m}{40}(\cos 20 - 1)$

$V_{Avg} = -V_m(1.507 \times 10^{-3})V$

part II $V_{avg} = \frac{1}{40} \int_0^{55} A_m \, dt = \frac{A_m 55}{40} = 0.5xy$

part III $V_{avg} = \frac{V_m}{210} \int_0^{105} \sin\theta \cdot d\theta = 5.99 \times 10^{-3} V_m$

$V_{avg} = 0.5y + 4.487 \times 10^{-3} x.$

B) Determine the rms value of the waveform if $\alpha = \frac{\pi}{5}$ rad, $\beta = 200°$, $V_m = x$, $A_m = y$

RMS

part I : $\sqrt{\frac{1}{40}\int_0^{20} V_m^2 \sin^2\theta \, d\theta} = V_m(0.498)$

part II $\sqrt{\frac{1}{110}\int_0^{55} A_m^2 \, d\theta} = \frac{A_m}{\sqrt{2}}$

part III $\sqrt{\frac{1}{210}\int_0^{105} V_m^2 \sin^2\theta \, d\theta} = V_m(0.5)$

$$V_{RMS} = 0.996x + 0.707y$$

Q6) Three circuit A, B and C are connected in parallel across a single phase AC supply

a) A consists of bank of lamps in 1 A at unity power
b) B consists of a coil taking of 20A to power of 0.8
c) C consists of a resistor & capacitor in series, taking a current of 10 A at a power factor of 0.9

Ans 6) A B) $P_A = V_A I_A \Rightarrow V_A = 200V$

as all 3 ckt are in || $V_A = V_B = V_C = V_{Supply} = 200V$

C) $P_{supplied\ to\ A} = V_A I_A = 2000\ W$ $PF_A = 1$

$P_A = 2000$

$P_{supplied\ to\ B} = V_B I_B = 4000\ W$ $PF_B = 0.8$

$P_B = 3200\ W$

$P_{supplied\ to\ C} = V_C I_C = 2000\ W$ $PF_C = 0.9$

$P_C = 1800\ W$

$P_{total} = 7000\ W$

d) $PF = \frac{7}{8} = 0.875$

Q7) 3 similar coils, each having a resistance of 8Ω & an inductive reactance of 8Ω are connected in star across a 415V, 3 phase, 50 Hz supply calculate ① acti—.

Ans 7) $Z = \sqrt{(8)^2+(8)^2}\ \Omega = 8\sqrt{2}\ \Omega = 8+8i$

$\angle 45°$

$$V = \frac{415}{\sqrt{3}} = 239.6V$$

$$I_2 = \frac{V}{Z} = \frac{239.6}{8\sqrt{2}} = 21.172A$$

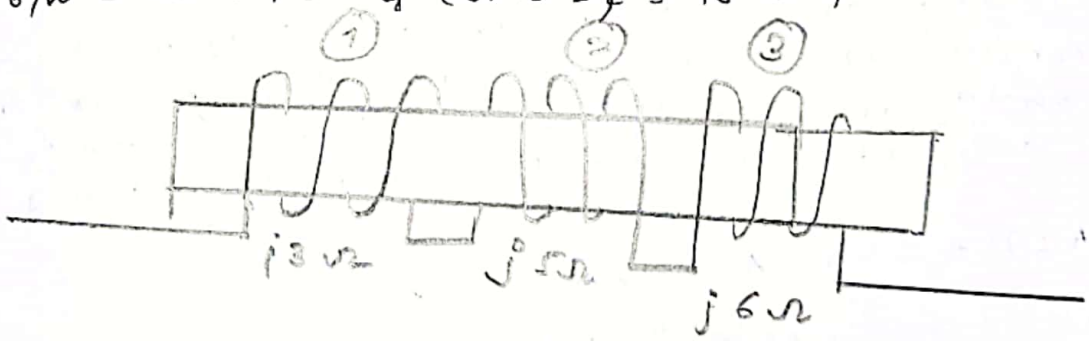
$$PF = \cos\phi = 1/\sqrt{2}$$

Active power $= \sqrt{3}\,VI\cos\phi = 6214.36W$

Reactive power $= \sqrt{3}\,VI\sin\phi = 6214.36W$

Apparent power $= 8788.44.W$

Q8) The following ckt is supplied from a 50Hz source with current enter from RHS. Draw the dotted eqt ckt and determine the eqv inductance if coeff of coupling b/w coils 1 & 2 & coils 2 & 3 is 0.7



Ans 8)

$L_1 = 3/2\pi\times 50 = 9.55mH$

$L_2 = 5/2\pi\times 50 = 15.92mH$

$L_3 = 6/2\pi\times 50 = 19.1mH$

$M_{12} = 8.63\times10^{-3}$ $M_{23} = 12.2\times10^{-3}$ $M_{13} = 5.4\times10^{-3}$

$$L_{eq} = L_1+L_2+L_3-2M_{12}-2M_{23}+2M_{13}$$

$$\boxed{L_{eq} = 13.71mH}$$

Q9) 3 phase star connected balanced load has an impedance of $Z = (8 + j6)\Omega$ per phase. If load is connected to 3-phase 208V

Ans 9) $Z = 8 + 6j = 10\Omega \angle 37°$

$V_L = 208V$

$V_{ph} = \frac{208}{\sqrt{3}}$ $V_m = 120.08V$

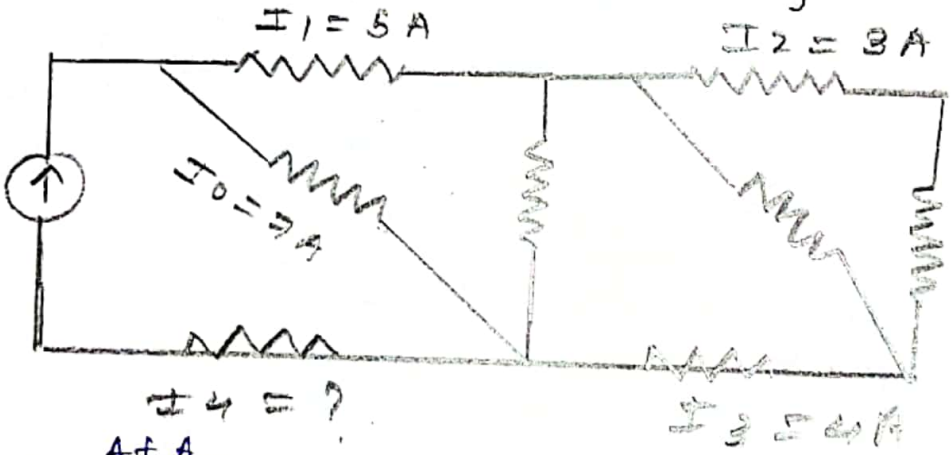
$I_L = 12.008A$

Active power $= \sqrt{3} V I \cos\phi = 1994.576 W$

Reactive power: $\sqrt{3} V I \sin\theta = 1503.02 W$

Apparent power $= 2497.479 W$

Q10) The current I_4 in the following ckt is equal to:-



A10) At A

$I_1 = 3 + 7 = 10A$

At C

$I_2 + 5 + 3 = I_1 \Rightarrow I_2 = 2A$

At B

$7 + 7 + I_4 = I_2 \Rightarrow \boxed{I_4 = -12A}$