CG1108 past year papers

Note Title 4/12/2014

Q.1 (a) Use **Mesh Current Analysis** method to find voltage V_{AB} in Fig. Q.1.a.

AY 12/13

(10 marks)

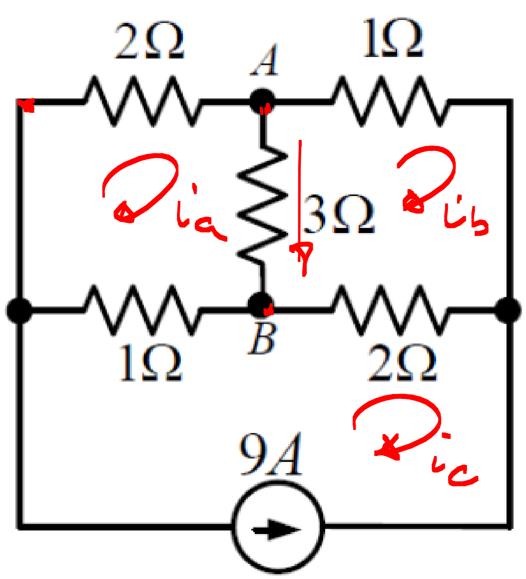

Fig. Q.1.a

$i_c = -9\ A$ ✓

$2i_a + 3(i_a - i_b) + i_a = 0$ — (1)

$i_b + 2\times(i_b - i_c) + 3\times(i_b - i_a) = 0$ — (2)

Find i_a, i_b, i_c.

$V_{AB} = 3\times(i_a - i_b)$ Ans.

Q.1 (a) Determine i_1, i_2, and i_3 in Fig. Q.1.a.

AY 11/12

(10 marks)

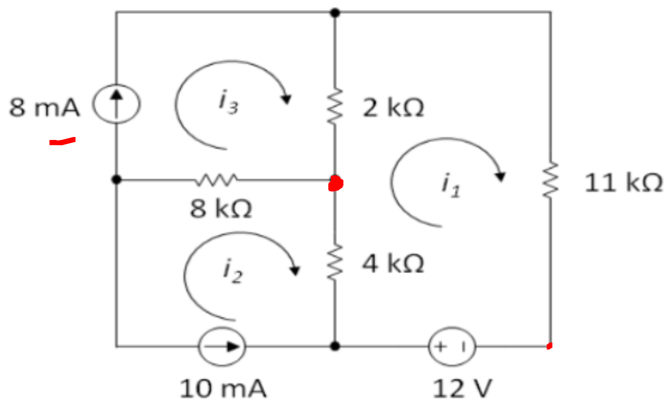

Fig. Q.1.a

$i_3 = 8\ mA$

$i_2 = -10\ mA$

$2000 \times (i_1 - i_3) + 11000 \times i_1 - 12$

$+ 4000 (i_1 - i_2) = 0$

$\Rightarrow i_1$

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Q.1 (b) Use **Node Voltage Analysis** to find the current (i) drawn from the battery in circuit given in Fig. Q.1.b.

How much **power** is delivered (or absorbed) by the current source?

KCL at 'x' : $-i + \frac{15}{1/2} + \frac{15-v}{1/4} = 0 \Rightarrow i$

(10 marks)

KCL at node v :

$\frac{v-15}{1/4} + 3 + \frac{v}{1/2} = 0$

$\Rightarrow v$:

$Power_{3A} = V \times 3$

+ve → abs. by the src

−ve → del.

P.S.C.

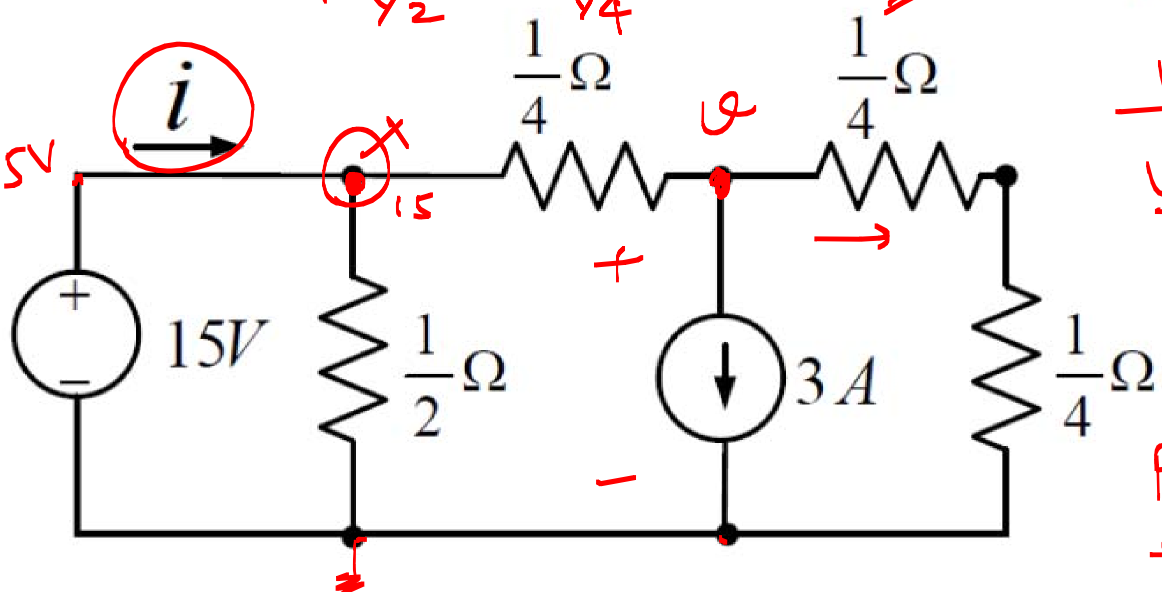

Fig. Q.1.b

Q1. (b) Solve for the voltages at Node 1 and Node 2, as shown in Fig. Q.1.b.

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(10 marks)

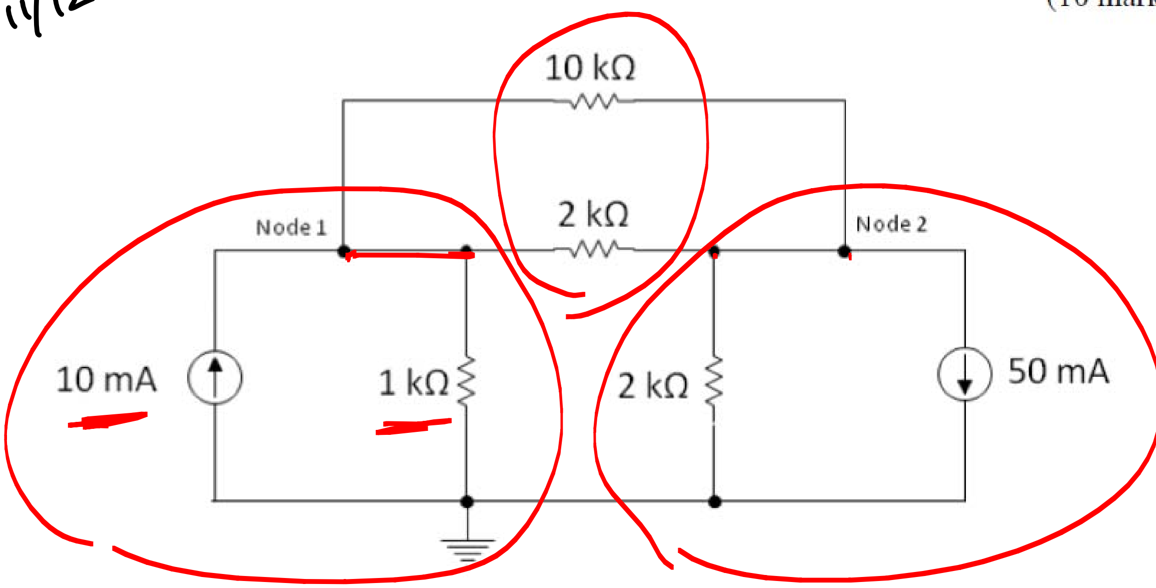
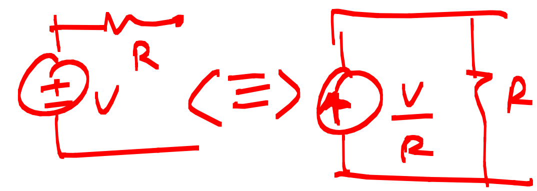
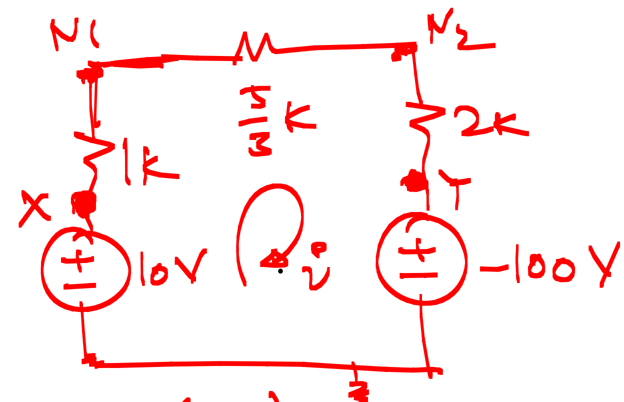


Fig. Q.1.b

Source Conversion





$$10K \| 2K = \frac{10 \times 2}{12} = \frac{5}{3}K$$

$$i = \frac{10-(-100)}{1K+\frac{5}{3}K+2K} = \frac{110}{\frac{14}{3}K} = 23.57\,mA.$$

$V_{N1} = 10 - 1000 \times 23.57 \times 10^{-3} = ?$, $V_{N2} = -100 + 2000 \times 23.57 \times 10^{-3}$ V.

Q1. AY12/13

(c) In circuit shown in Fig. Q.1.c, find the output voltage v_o using **Superposition principle**.

(10 marks)

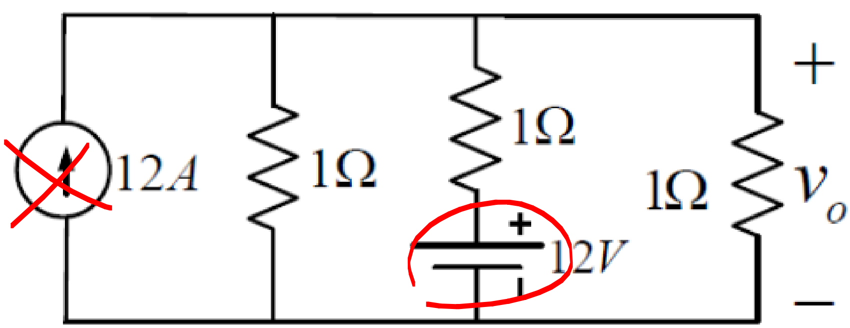
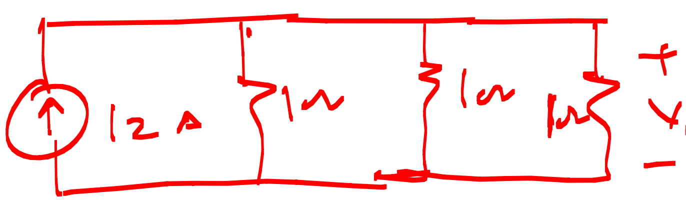


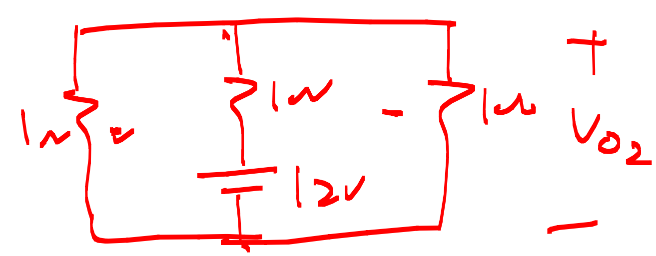
Fig. Q.1.c

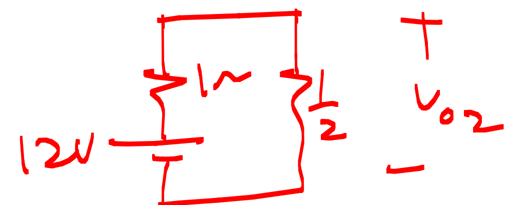
1 Keep the current source
kill the voltage source



$V_{o1} = 12 \times \frac{1}{3} = 4V$

2





$V_{o2} = 12 \times \frac{1/2}{1/2 + 1} = 4V.$

$V_o = V_{o1} + V_{o2} = 8V.$

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Q.2 (a) The Wheatstone bridge circuit, as shown in Fig. Q.2.a, is a resistive circuit that is commonly used in measurement circuits. R_1, R_2, and R_3 are equivalent to 1 kΩ. Determine the unknown resistance R_x when V_{ab} is 10 mV.

(15 marks)

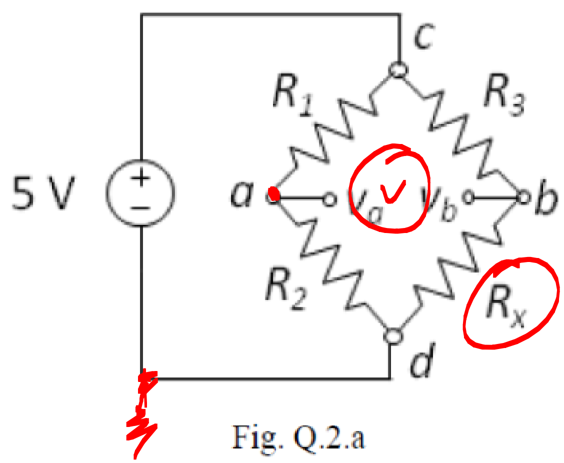

Fig. Q.2.a

$$V_{ab} = V_a - V_b$$

$$= 5 \times \left[\frac{R_2}{R_1 + R_2} - \frac{R_x}{R_3 + R_x} \right]$$

$$10 \times 10^{-3} = 5 \times \left[\frac{1k}{1k + 1k} - \frac{R_x}{R_x + 1k} \right]$$

$$\Rightarrow R_x =$$

Q2 (b) Determine the Thevenin's equivalent for the circuit in Fig. Q.2.b. (15 marks)

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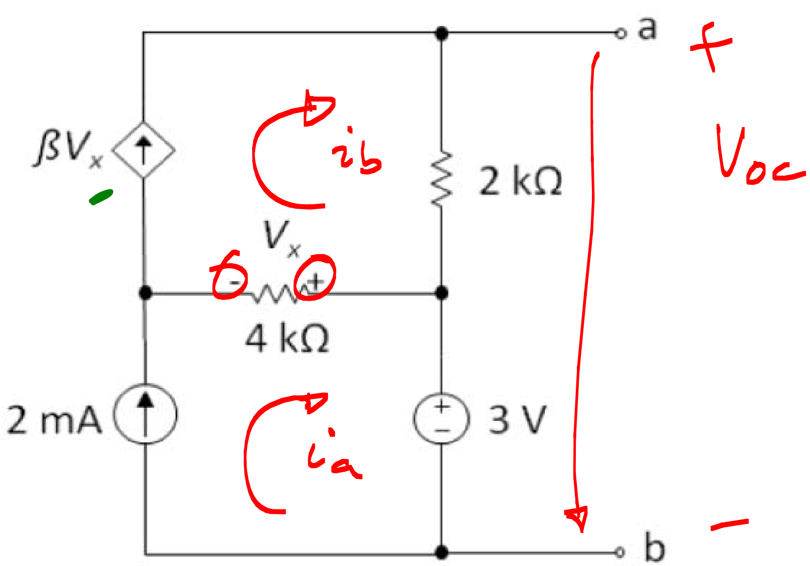
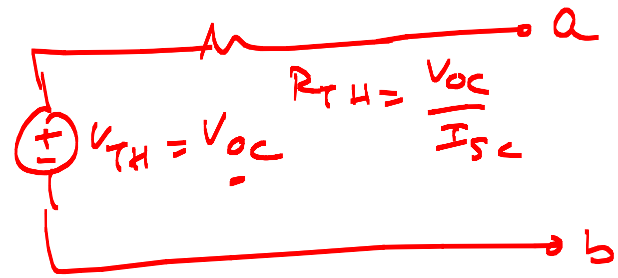


$\beta = 1/2000$

Fig. Q.2.b



$i_a = 2\,mA$.

$i_b = \beta . V_x = \beta \times 4000 \times (i_b - i_a)$

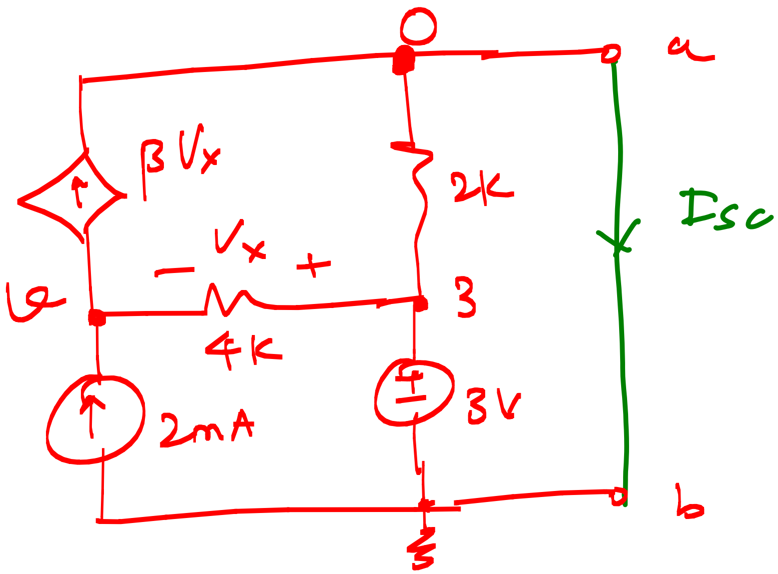
$= \frac{1}{\cancel{2000}} \times \cancel{4000}^{\,2} \times (i_b - 2mA)$

$i_b = 2i_b - 4mA$.

$\Rightarrow i_b = 4mA$.

$V_{oc} = 2000 \times i_b + 3$

$= 2000 \times 4\times10^{-3} + 3 = 11\,V$.



Node voltage analysis

KCL at v:

$$\beta \cdot V_x + \frac{v-3}{4000} - 2mA = 0$$

$$V_x = (3-v)$$

$$\frac{1}{2000}(3-v) + \frac{v-3}{4000} - 2\times10^{-3} = 0$$

$\times 4000$:

$$2(3-v) + v-3 - 2\times 4 = 0$$

$$6 - 2v + v - 3 - 8 = 0 \Rightarrow v = 6-3-8 = -5V.$$

KCL at 'a': $-\beta \cdot V_x + \frac{0-3}{2000} + I_{sc} = 0$

$$-\beta(3-v) + \frac{0-3}{2000} + I_{sc} = 0 \Rightarrow I_{sc}$$

Q1.
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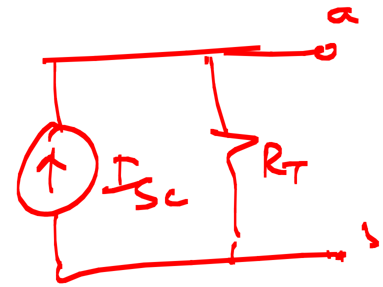
(d) In circuit shown in Fig. Q.1.d, find the **Norton's equivalent** between a and b. Find the **maximum power** that can be drawn from the circuit by the load resistance, R_L.

(10 marks)



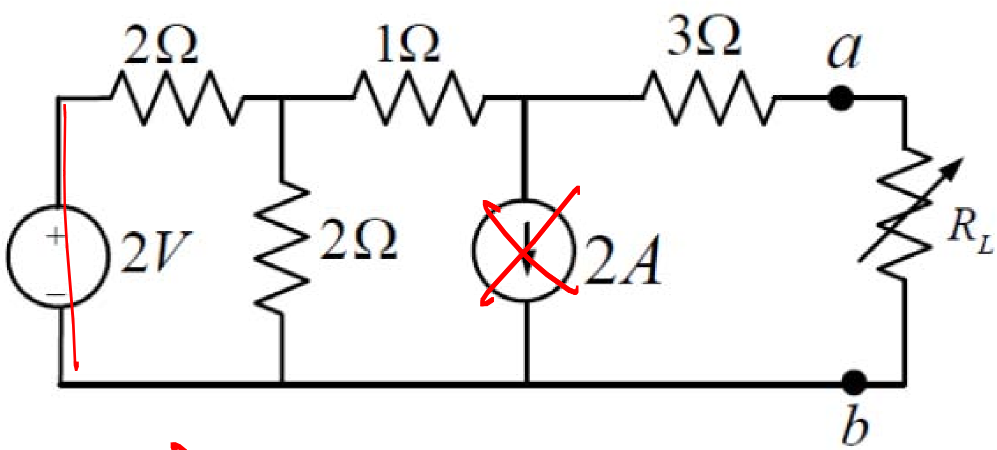
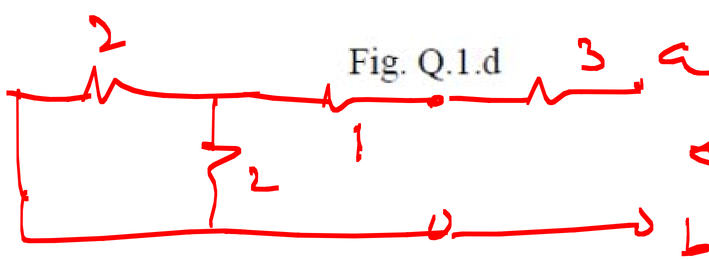


Fig. Q.1.d

R_T can be obtained by killing the ind. sources



$R_T = 3 + 1 + \frac{2}{2} = 5\Omega$.

Q.1.

At 12/13

(e) In circuit shown in Fig. Q.1.e, the current source is AC sinusoidal $i_s(t) = 10\cos 2t$ A. Find the **power dissipated** by the resistor. $\rightarrow P_R = I_{rms}^2 \times R$ $\rightarrow I_s = 10\angle 0^\circ$

(10 marks)

$\omega = 2$ rad/sec

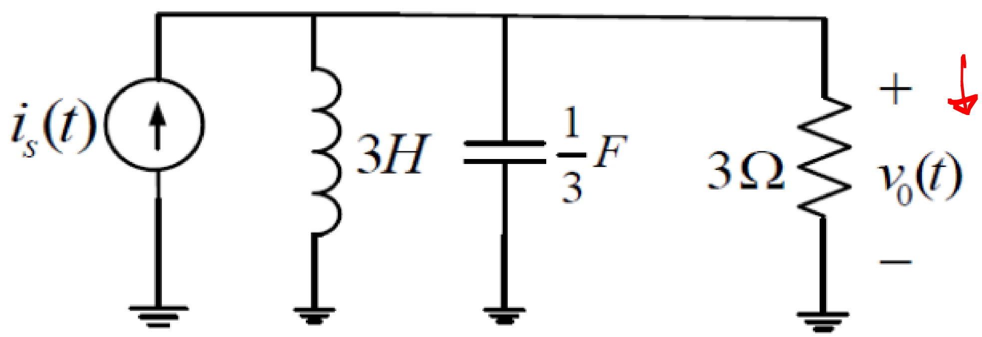


Fig. Q.1.e

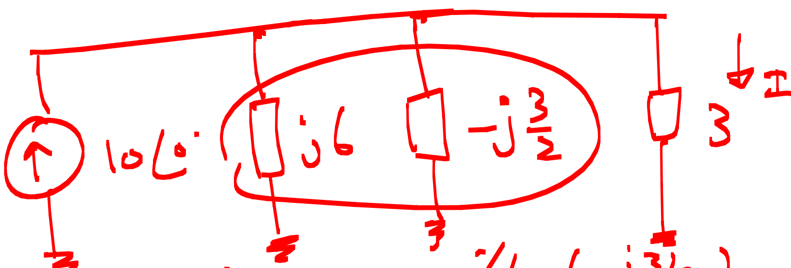
$L = 3H \rightarrow Z_L = j\omega L$

$= j \times 2 \times 3 = j6$

$C = \frac{1}{3}F \Rightarrow Z_C = -j\frac{1}{\omega C}$

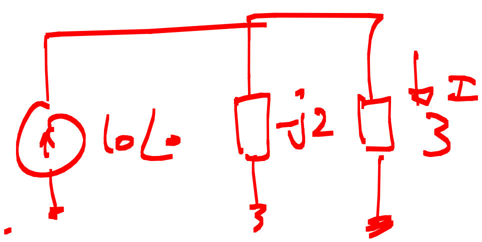
$= -j\frac{1}{2 \times \frac{1}{3}} = -j\frac{3}{2}$

$R = 3 \rightarrow Z_R = 3.$



$\frac{-j \cdot 9}{+9/2} = \frac{\cancel{j}6 \times (-j3/2)}{\cancel{j}(6 - 3/2)} = -j2.$

$\Rightarrow$



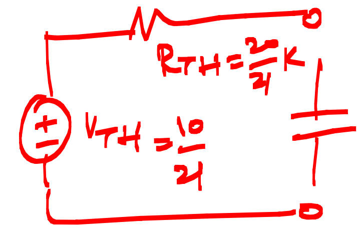
$I = 10\angle 0 \times \frac{-j2}{3 - j2}$

$$I = 5.55 \angle -56.31^\circ$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{5.55}{\sqrt{2}}.$$

$$P_R = I_{rms}^2 \times R = \left(\frac{5.55}{\sqrt{2}}\right)^2 \times 3 = 46.2W.$$

Q.2 The circuit in Figure Q.2 is that of a burglar alarm. The alarm itself is modeled by a $1k\Omega$ resistor. The alarm will not sound until the current in it exceeds $100\,\mu A$. Find the **delay** between switch being closed and the alarm sounding. Assume the capacitor to be initially discharged.



Ap 12/13

(15 marks)

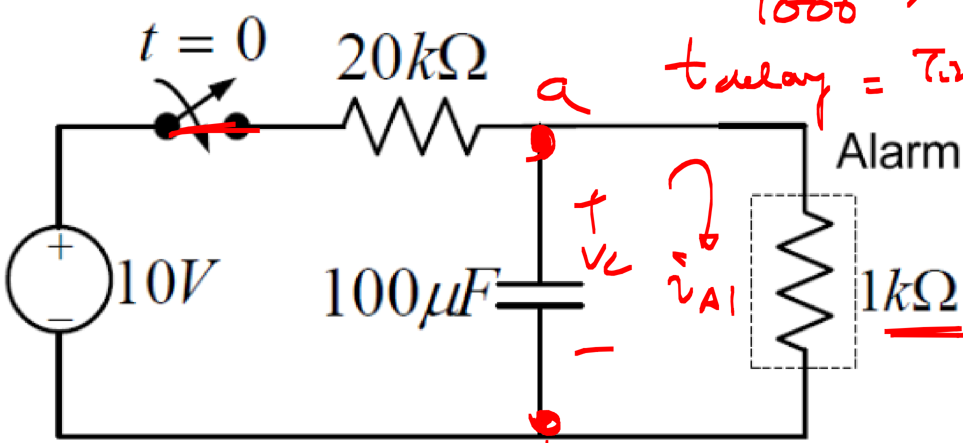


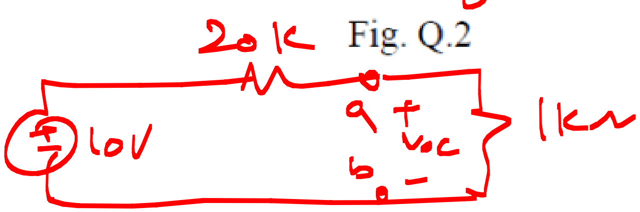
Fig. Q.2

$i_{A1} = \frac{v_c}{1000}$

t_{delay} = Time for v_c to reach $= 1000 \times 100\times10^{-6}$
$= 0.1\,V$.

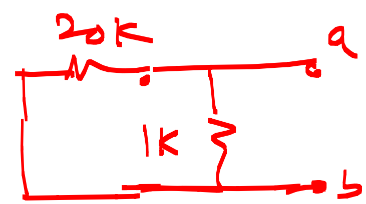
$\tau = R_{TH} \times C = \frac{20}{21}\times10^{3}\times100\times10^{-6}$
$= \frac{2}{21}\,s$.

$v_c(t) = \cancel{v_c(0)}.e^{-t/\tau} + V_{TH}(1-e^{-t/\tau})$, $v_c(0) = 0$



$V_{oc} = 10 \times \frac{1}{20+1}$
$= \frac{10}{21}\,V = V_{TH}$

$R_{TH} =$
$= \frac{20}{21}K$



$$0.1 = \frac{10}{21} \times \left(1 - e^{-t_d \times \frac{21}{2}}\right)$$

$$= \frac{10}{21} - \frac{10}{21} \cdot e^{-t_d \cdot \frac{21}{2}}$$

$$\Rightarrow t_d :$$

Q.3 (a) As shown in Figure 3(a), the CMOS/TTL output of a signal generator is connected to an R-L circuit. The internal resistance of the signal generator is 200Ω.

Sketch and dimension the wave forms of the voltage at the output of the R-L circuit, for two cycles.

(12 marks)

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CMOS / TTL

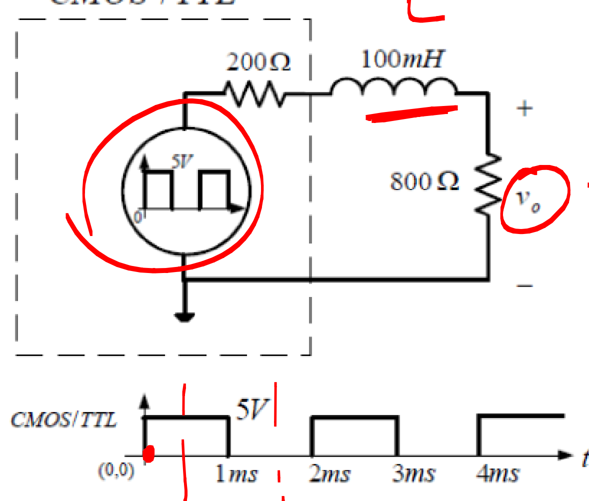
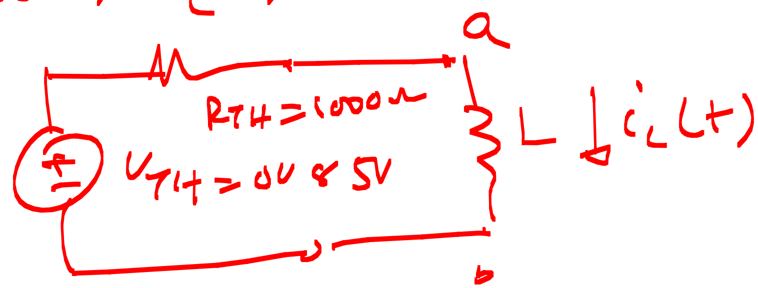


Fig. 3(a)

$v_o(t) = 800 \times i_L(t)$

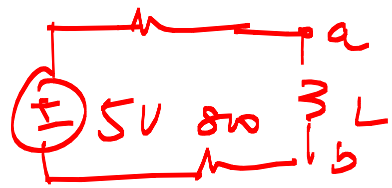
$i_L(t)$



0V, 5V

$v_s = 0$, $v_{TH} = 0$

$v_s = 5V$, $v_{TH} = 5V$



$+ \; v_{oc} = v_s = 5V$

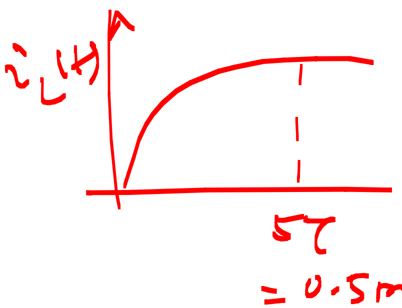
$-$

$R_{TH} = 200 + 800 = 1000\Omega$

$$\tau = \frac{L}{R_{TH}} = \frac{100\times10^{-3}}{1000} = \underline{\underline{0.1\ ms.}}$$

$$i_L(ss) = \frac{V_{TH}}{R_{TH}} = 5\,mA$$

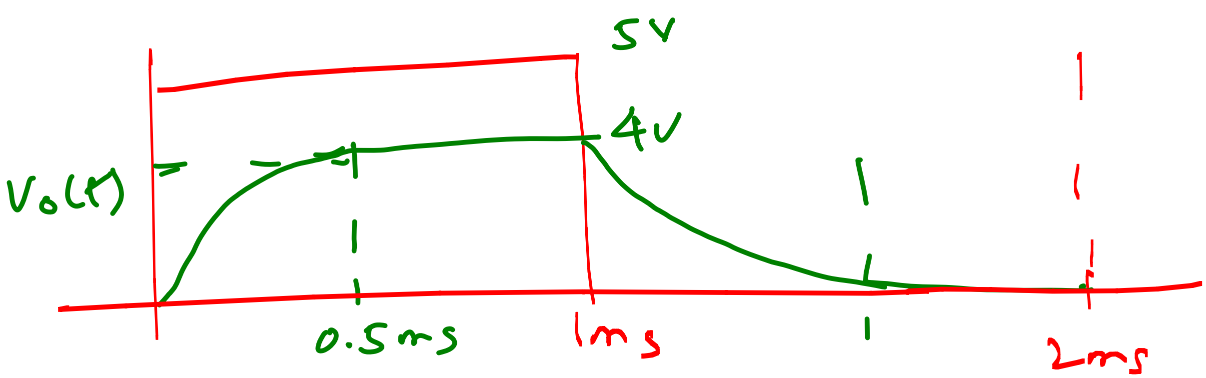
$$V_o(ss) = 5\times10^{-3}\times 800 = 4V$$



$$V_o(t) = i_L(t)\times 800$$

$$= \left[i_L(0)\cdot e^{-t/\tau} + \frac{V_{TH}}{R_{TH}}\left(1-e^{-t/\tau}\right)\right]\times 800$$

$$=$$



Q.3 As shown in Figure Q.3, an AC sinusoidal voltage source is supplying two loads through a step-down ideal transformer. Load-1 is of 110W with a *lagging power factor* of 0.5. Load-2 is of 55W with a *leading power factor* of 0.86.

Find the **current** I_p if there is no capacitor connected to the primary side.

Find the value of the **capacitor** C to be connected at the primary of the transformer so that the source current I_p is in phase with the source voltage.

Draw a **phasor diagram** of the source voltage, primary current, capacitor current and the load currents, after capacitor is connected.

(20 marks)

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$I_p = \frac{N_2}{N_1} \cdot I_s$

$V_2 = \frac{N_2}{N_1} \cdot V_1$

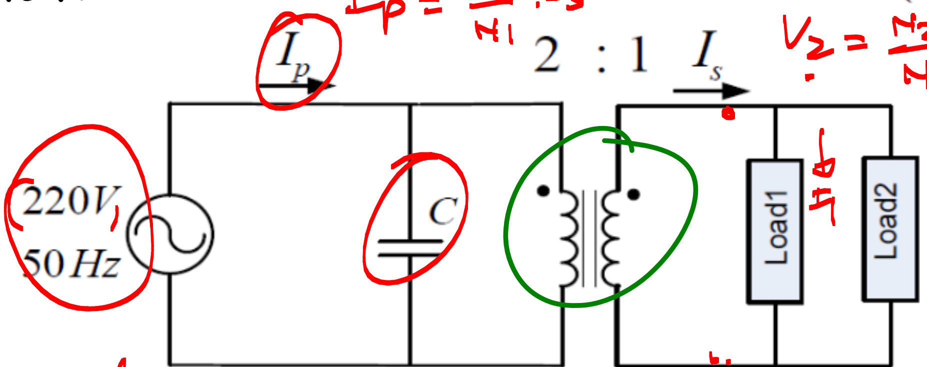


Fig. Q.3

$N_1 : N_2$

$\omega = 2\pi f$
$= 2 \times \pi \times 50$
$= 314$

$Z_L' = \left(\frac{N_1}{N_2}\right)^2 \cdot Z_L$

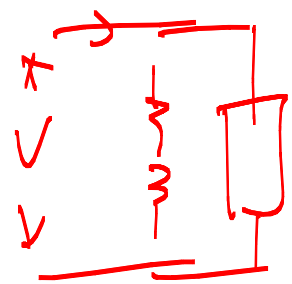
Z_L

AC power

$P = V_{rms} \times I_{rms} \times \cos\phi$ W

p.f. = $\cos\phi$.

ϕ is the phase difference between voltage and current.



$Z = R + jX$
$= \sqrt{R^2 + X^2} \angle \phi$

$\phi = \tan^{-1}\left(\frac{X}{R}\right)$

$I = \frac{V\angle 0}{Z} = \frac{V}{|Z|} \angle -\phi$

Load1 = 110 W, P.f. = 0.5 lagging. $\rightarrow I_1$

Load2 = 55 W, P.f. = 0.86 leading. $\rightarrow I_2$

$V_1 = 220\sqrt{2}\angle 0^\circ$

$V_2 = \left(\frac{N_2}{N_1}\right) \cdot V_1 = \frac{1}{2} \times 220\sqrt{2}\angle 0^\circ = \underline{110\sqrt{2}}\angle 0^\circ$

$V_{rms} = \frac{V_m}{\sqrt{2}}$

$P = V_{rms} \cdot I_{rms} \cdot P.f.$

$110 = 110 \times I_{rms} \times 0.5 \Rightarrow I_{1,rms} = 2A.$

$I_1 = 2\sqrt{2}\angle -\cos^{-1}0.5$

$= 2\sqrt{2}\angle -60^\circ$

$$55 = 110 \times I_{2\,rms} \times 0.86 \Rightarrow I_{2,rms} = 0.581$$

$$I_2 = 0.581\sqrt{2}\,\angle +30^\circ$$

$$I_s = I_1 + I_2 = 2\sqrt{2}\,\angle -60^\circ + 0.581\sqrt{2}\,\angle 30^\circ$$

$$= 2.95\,\angle -43.8^\circ \text{ A.}$$

$$I_p = \frac{1}{2} \times 2.95\,\angle -43.8^\circ = 1.475\,\angle -43.8^\circ \text{ A.}$$

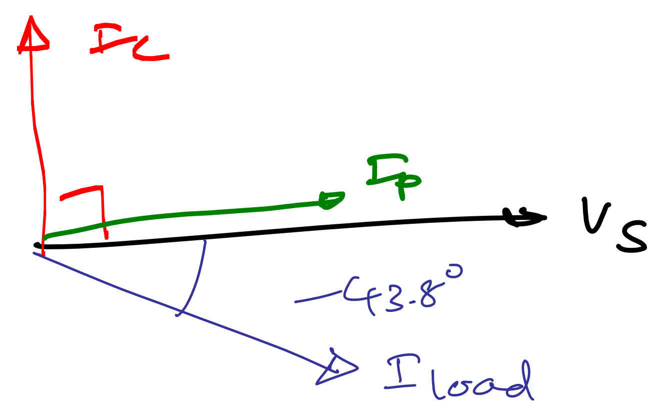
(without capacitor).

$(I_p + I_c)$ to be in phase with V_s.

$$\underline{I_c = j\omega C \cdot V_s} \qquad I_p + I_c = 1.064\left(-j\,1.02 + j\,314 \times C \times 220 \times \sqrt{2}\right) \rightarrow 0$$

$$\Rightarrow C = \frac{1.02}{314 \times 220\sqrt{2}} = 10.44\ \mu\text{F}.$$

Phasor diagram



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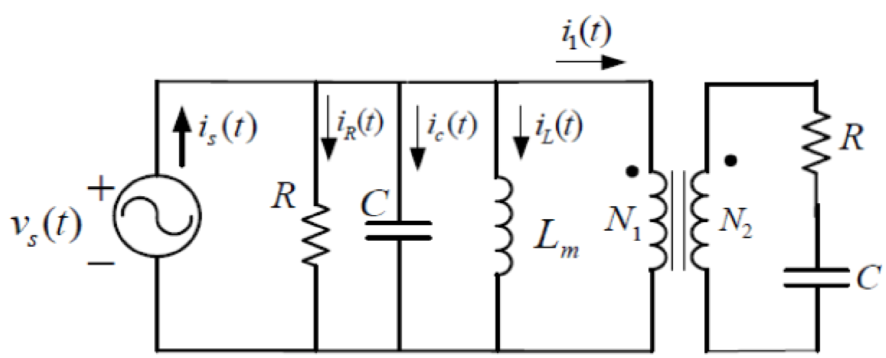
Q.3 (b) As shown in Figure 3(b), a voltage source is supplying an R-C load through a step-up ideal transformer. Also, a capacitive load and an inductive load are connected to primary side of the ideal transformer.

Find currents: $i_s(t), i_R(t), i_c(t), i_L(t), i_1(t)$ as shown in the figure.

Draw the phasor diagram for the source voltage $v_s(t)$ and all the currents: $i_s(t), i_R(t), i_c(t), i_L(t), i_1(t)$.

(13 marks)



$v_s(t) = 300 \cos \omega t$

$\omega = 300\ rad / s$

$L_m = 5mH$

$C = \frac{1}{900} F$

$R = 3\Omega$

$L = 5mH$

$N_1 = 100$

$N_2 = 200$

Fig. 3(b)

Q.4 The magnetic circuit given in Figure Q.4 is made of sheet steel, except for the air g between de. Find the inductance of the coil. Ignore the flux fringing effect.

Given,

$l_{ab} = l_{bg} = l_{gh} = l_{ha} = 0.2$ m

$l_{bc} = l_{fg} = 0.1$ m

$l_{cd} = l_{ef} = 0.099$ m

$\mu_0 = 4\pi \times 10^{-7}$ H/m

μ_r (sheet steel) = 4000

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AY 12/13

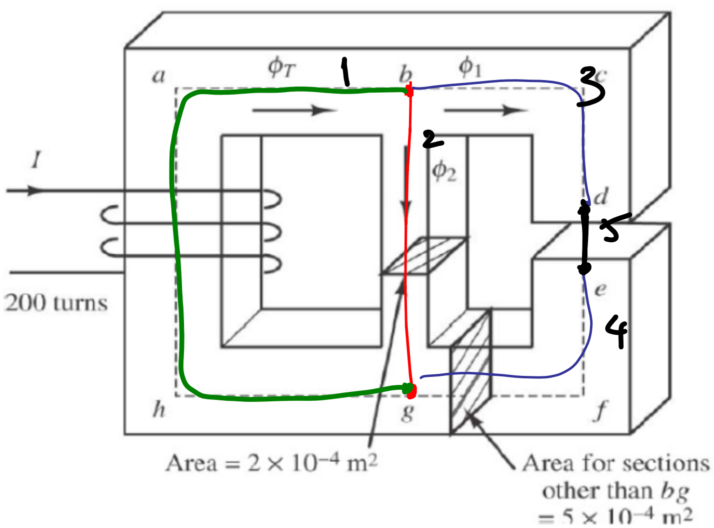
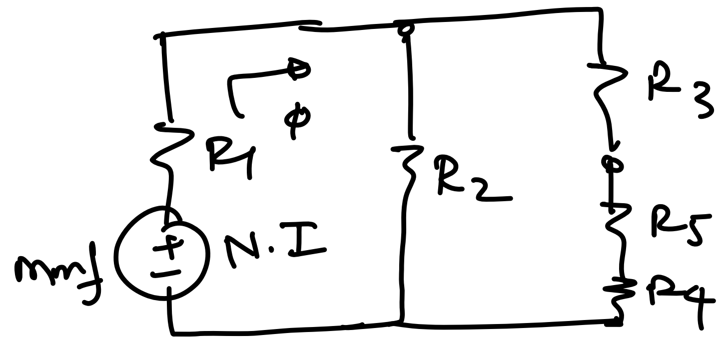
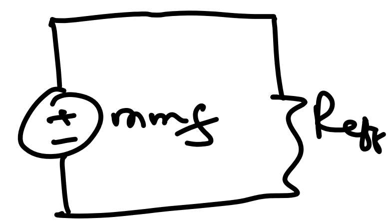


Fig. Q.4



$$R = \frac{l}{\mu A}$$



$$mmf = NI$$

$$R_{eff} = R_1 + R_2 \parallel (R_3 + R_5 + R_4)$$

$$\phi = \frac{NI}{R_{eff}}.$$

$$L = \frac{\lambda}{I} = \frac{N \cdot \phi}{I} = \frac{N \cdot \left(NI/R_{eff} \right)}{I}$$

$$= \frac{N^2 \cdot}{R_{eff}}$$

$N = 200$ turns

CG 1108

1. Node Voltage Analysis Method
2. Mesh Current Analysis Method
3. Super position principle

1. Thevenin / Norton Equivalent

1. maximum power Transfer
2. Nonlinear Element - Graphical Analysis Method.

- L, C
- DC Transients Analysis
- AC steady state Analysis
  Impedance, Phasor
- AC power
- Magnetic Circuits.
- Transformers.
- Diodes and DC power Supply
- DC Motors.