Task 1:

(A)

$Z_{internal} = 10 + J10$

$= r + JX$

(a) if pure R used as a load

$R = \sqrt{10^2 + 10^2} = 14.14\ \Omega.$

(b) For complex Load

1. For R var & X var

$\therefore R = r = 10\ \Omega$ & $X = -X = -J10$

2. For R var & X Fixed

let $X = J2$

$\therefore R = \sqrt{10^2 + (10+2)^2} = 15.62\ \Omega$

$\therefore R = 15.62\ \Omega$ & $X = J2$

(B)

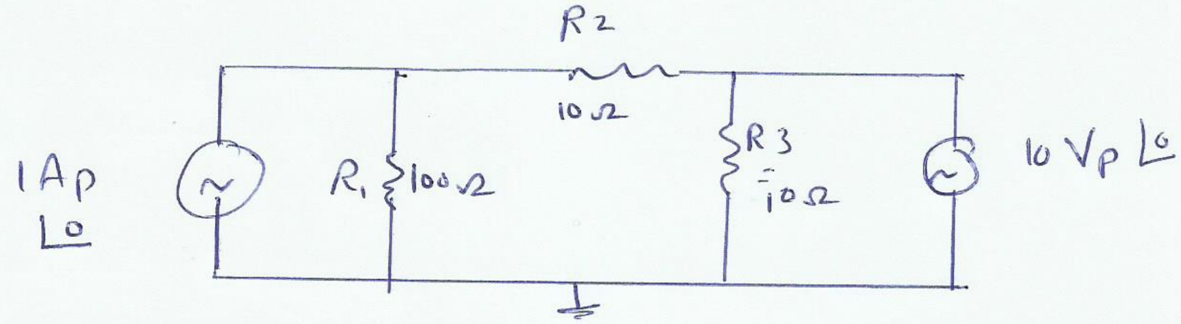
Let $i_s(t) = 1 A_p \angle 0^\circ$

$V_s(t) = 10\ V_p \angle 0^\circ$

$R_1 = 100\,\Omega$

$R_2 = 10\,\Omega$

$R_3 = 10\,\Omega$



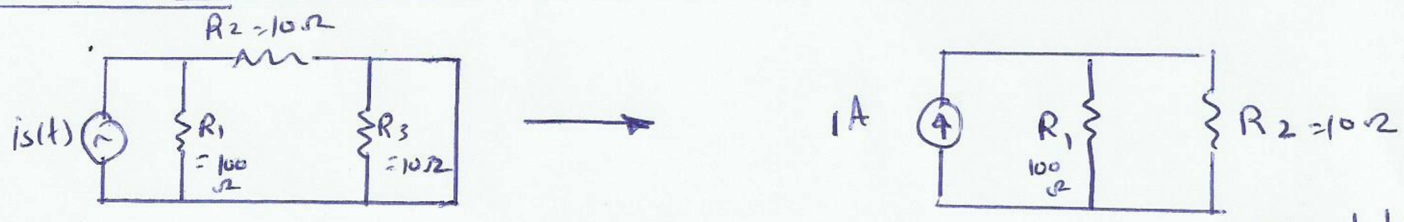
using Simulation

$VR_1 = 12.856\ V_{rms}$

$VR_2 = 5.785\ V_{rms}.$

using Superposition

(1) Short of $V_s(t)$ & use only $i_s(t)$



$\therefore\ i_1 = 1 \times \frac{10}{110} = 91\ mA_{peak} = 64.34\ mA_{rms}$

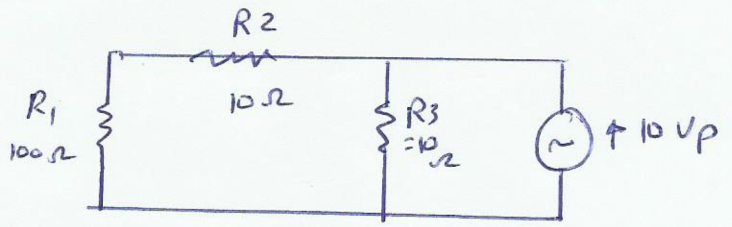
$i_2 = 909\ mA_{peak} = 642.76\ mA_{rms}$

Simulation

64.28 mA

642.8 mA rms

open circuit is(t)



$\therefore V_{R_1} = 10 * \frac{100}{110} = 9.09\ V_{peak} = 6.428\ V_{rms}$

$V_{R_2} = 10 \cdot \frac{10}{110} = 0.909\ V_p = 0.6428\ V_{rms}$

Simulation

$V_{R_1} = 6.428\ V_{rms}$

$V_{R_2} = 0.642\ V_{rms}$

ToTal Voltage.

$V_{R_1} = 6.428 \angle 0 + 642.8\,mA\,(100) = 12.856\ V_{rms}$

$V_{R_2} = \frac{909\,mA}{\sqrt{2}} * 10 - 0.642\,mV_{rms}$

$= 5.786\ V_{rms}$

which are The same like Simulation

Task 2

(a) Simulation File included.

(b). The table "Results" as well as The graph also included in "Excel File".

From Fig $F_r \approx 2500\ Hz$

calculated F_r

not Req in The Exam but just as a check

$$F_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}} = 2640\ Hz$$

(c) $R_d = \dfrac{L}{RC} = \dfrac{12 \times 10^{-3}}{20 \times 300 \times 10^{-9}} = 2\,K\Omega$

(d) $Q_r = \dfrac{\omega_r L}{R} = \dfrac{12 \times 10^{-3} \times 2500}{20} = 1.5$

(e) $Q_r = \dfrac{F_r}{B_W}$

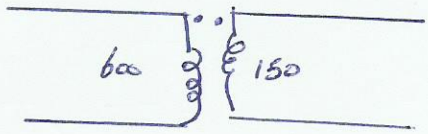
$$\therefore B_W = \frac{F_r}{Q_r} = \frac{2500}{1.5} = 1666\ Hz$$

(F) not selective since

$B_W > 20\%$ of F_r

Task (3)

(A)



This Transformer consists of a Primary winding of 600 Turns
" " " secondary " " 150 "

The V_{sec} will relate to V_{prim} by The Turns ratio as The relation

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$

while The currents will reversaly propor tional and given by

$$\frac{i_S}{i_P} = \frac{N_P}{N_S}$$

The Total power of Primary will equal to secondary For ideal Transformer (No Losses)

$$P_P = P_S$$

$$P_P = i_P V_P = P_S = \cancel{P} i_S V_S$$

$N_1 = 600 = N_P$ $\quad$ & $\quad N_S = N_2 = 150$

$Z_P = 0.25 + J1 \ \Omega$

$Z_S = 0.01 + J0.04 \ \Omega$

$$\text{Turns ratio} = a = \frac{N_P}{N_S} = \frac{600}{150} = 4$$

<u>Z equivalent</u>

(a) R' : Requivalent refered to primary

$$= a^2 R_{sec} = 4^2 \ 0.01 = 0.16 \ \Omega$$

(b) X_L' = equivalent " " "

$$= X_{L\,sec} * a^2 = 4^2 * 0.04 = 0.64 \ \Omega$$

(c) $Z_L' = a^2 Z_{L\,sec}$

$$= a^2 (0.01 + J0.04) = 0.16 + J0.64 \ \Omega$$

(B) بعض س الشرح العام +

<u>mutual inductance</u>

when Two coils are placed close to each other a changing Flux in one coil will cause an induced voltage in The second coil The coils are said To have mutual inductance M

For series inductors

$$L_{total} = L_1 + L_2 + 2M$$

$$V = iR + L\frac{di}{dt}$$

$$= iR + L\frac{di}{dt}$$

$$240 = 5(10+15) + L(10)$$

$$\therefore L = 11.5H \quad = L_x + L_y + 2M$$

$$= 3 + 1.2 + 2M$$

$$\therefore \boxed{M = 3.65\ H}$$

$$K = \frac{M}{\sqrt{L_x L_y}} = \boxed{1.923}$$

(C) Same analysis of A

$$K = \frac{M}{\sqrt{L_1 L_2}} = \frac{0.1}{\sqrt{0.2 \times 0.4}} = 0.353$$

$$f = \frac{75}{\pi} = 23.88$$ ⇐ Simulation File apended

$$\boxed{\begin{array}{l} i_1 = 912.8\ mA\ rms \\ i_2 = 183.137\ mA\ rms \end{array}}$$

Task (4) (M1.2)

(A) Three solution here

\# Simple solution
\# using Mesh
\# " Nodal
\+ Simulation

only one solution Req
(Sim ليس مسموح)

$R_3 = 1\,k\Omega$

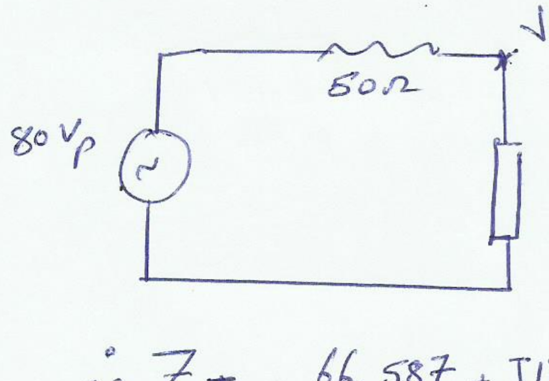
$X_{C2} = -J\dfrac{1}{2\pi fC} = -J3980\ \Omega$

$X_{L2} = J\omega L_2 = J\,2\pi \times 2\times 10^{3} \times 10 \times 10^{-3} = J125.6\ \Omega$

$R_1 = 50\ \Omega$

$$Z_{11} \Rightarrow \frac{1}{Z_{11}} = \left[\frac{1}{1k} + \frac{1}{J125.6} + \frac{1}{-J3980}\right]$$

$$\therefore Z_{11} = 128.79\ \angle 82.6\ \Omega$$



$128.79\ \angle{+82.6}$

$= 16.587 + J127.7\ \Omega$

$$\therefore Z_T = 66.587 + J127.7 = 144.01\ \angle{+62.46}\ \Omega$$

$$i_t = \frac{80\,V}{144.01\ \angle 62.46} = 0.555\ \angle{-62.46} = 0.256 - J0.49\ A_p$$

$V_x = 80 - i_t(50) = 80 - 0.555\angle{-62.46} \times 50$

$= 67.17 + j24.6$

$= 71.532\angle{20.11}$ peak V

$\boxed{V_x = 50.58\ V_{rms}}$

$\therefore$ i_{L_2} "current in 10 mH coil"

مطلوب

$= \dfrac{V_x}{X_{L_2}} = \dfrac{71.532\angle{20.11}}{j125.6} = 0.569\angle{-69.89}$

$= 0.195 - j0.53$ A peak

غير مطلوب

$i_{C_2} = \dfrac{71.532\angle{20.11}}{-j3980} = 1.89\times10^{-3}\angle{110.11}$ A peak

$= -6.498\times10^{-4} + j1.77\times10^{-3}$ A peak

$i_{R_3} = \cancel{\dfrac{71.532\angle{20.11}}{3980\angle{-90}}} = \dfrac{71.532\angle{20.11}}{1000} = 71.532\times10^{-3}\angle{20.11}$

$= 0.0671 + j0.0245$ A peak

$V_{across\ R_3} = V_x = 71.532\angle{20.11}$

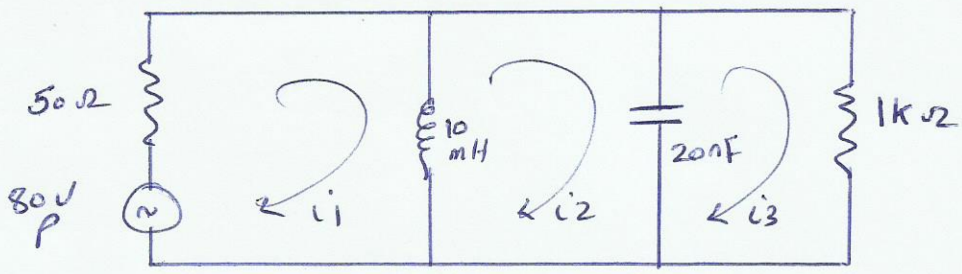
غير مطلوب

Verification $i_t = i_{L_2} + i_{C_2} + i_{R_3}$ "phasor sum"

$= 0.195 - j0.53 - 6.498\times10^{-4} + j1.77\times10^{-3} + 0.0671 + j0.0245$

$= 0.261 - j0.503 \approx i_t \approx 0.256 - j0.49$

Using Mesh



$X_{L_1} = 10 \times 10^{-3} * 2\pi * 2\times 10^{3} = J125.6 \ \Omega$

$X_C = -J \dfrac{1}{2\pi f c} = -J3980 \ \Omega$

Loop 1

$80 = 50 i_1 + (i_1 - i_2) J125.6$

$\boxed{80 = i_1 (50 + J125.6) - i_2 125.6 + 0} \rightarrow (1)$

Loop 2

$\Rightarrow 0 = i_2(J125.6 - J3980) + J3980 i_3 - i_1(J125.6)$

$0 = i_2(-J3855) + J3980 i_3 - i_1 J125.6$

$\boxed{0 = -J125.6 i_1 - J3855 i_2 + J3980 i_3} \rightarrow (2)$

Loop 3

$\boxed{0 = i_3(1000 - J3980) + i_2 J3980} \rightarrow (3)$

by solving (1),(2),(3)

$i_1 = 0.26 - J0.49 = 0.554 \angle -62$ A peak

$i_2 = 0.06 + J0.04 = 0.0721 \angle 33.7$ A peak

$i_3 = 0.07 + J0.02 = 0.0728 \angle 15.94$ A peak

$i_1 = i_{total}$

$= 0.26 - 0.49J = \boxed{0.554 \angle -62}$ A-peak

$i_{L_2} = i_1 - i_2$

$= 0.026 - J0.49 - 0.06 - J0.04 = 0.2 - J0.53 = \boxed{0.566 \angle -69}$ A-peak

$i_C = i_2 - i_3$

$= 0.06 + J0.04 - 0.07 - 0.02 = -0.01 + J0.02$

$= \boxed{0.022 \angle 116.5}$ A-peak

$i_{R_3} = i_3$

$= 0.07 + 0.02J = \boxed{0.728 \angle 15.19}$ A-peak

note That:

Requried

$i_L = 0.566 \angle -69 \approx 0.195 - J0.53$ Apeak

$= 0.402 \angle -69$

Arms

$V_{R_3} = i_{R_3} * 1000 = 71.532 \angle 20$ Vpeak

$= 50.57$ Vrms

Using Nodal — only single Node "V_x"

$$\frac{80 - V_x}{50} = \frac{V_x}{J125.6} + \frac{V_x}{-J3980} + \frac{V_x}{1000}$$

$$\frac{80}{50} = V_x \left[\frac{1}{J125.6} - \frac{1}{J\,3980} + \frac{1}{1000} + \frac{1}{50} \right]$$

$$\therefore V_x = V_{R_3} = 71.54 \angle 20.13 \quad V\,peak$$

$$i_{L2} = \frac{V_x}{J125.6} = \frac{71.74 \angle 20.13}{125.6 \angle 90} = 0.571 \angle -69 \quad A\,peak$$

Summary of Result Compared To Simulation

$i_L = 0.555 \angle -62.46$ peak $= 0.256 - J0.49$ A peak

$= 0.392$ A rms

$i_{L2} = 0.566 \angle -69 = 0.195 - J0.53$ A peak

$= 0.402$ A rms

$i_{C2} = 1.9 \times 10^{-3} \angle 110 = -6.498 \times 10^{-4} + J1.77 \times 10^{-3}$ A peak

$= 1.34 \times 10^{-3}$ A rms.

$i_{R3} = 71.532 \times 10^{-3} \angle 20.11 = 0.0671 + J\,0.0245$ A peak

$= 50.58 \times 10^{-3}$ A rms.

$V_x = V_{R3} = 71.53 \angle 20.11$ V peak $= 50.57$ V rms.

$V_{R_1} = 80 \angle 0 - V_x = 80 - 71.53 \angle 20.11 = 80 - [67.17 + J24.6]$
$= 12.83 - J24.6 = 27.74 \angle -62.45 = 19.6$ V rms.

(هو نفس تمّ Simulation
تقريباً " خطأ Sim)

M1.2 B

$L_1 = 10\,mH \rightarrow X_{L1} = 2\pi \times 1 \times 10^3 \times 10 \times 10^{-3} = \boxed{J62.8\,\Omega}$

$Z_1 = 100 + J62.8\,\Omega = 118.08 \angle 32.12\ \Omega$

$L_2 = 5\,mH \rightarrow X_{L2} = J31.4\,\Omega$

$Z_2 = 200 + J31.4 = 202.44 \angle 8.9\ \Omega$

$L_3 = 15\,mH \rightarrow X_{L3} = J94.2\,\Omega$

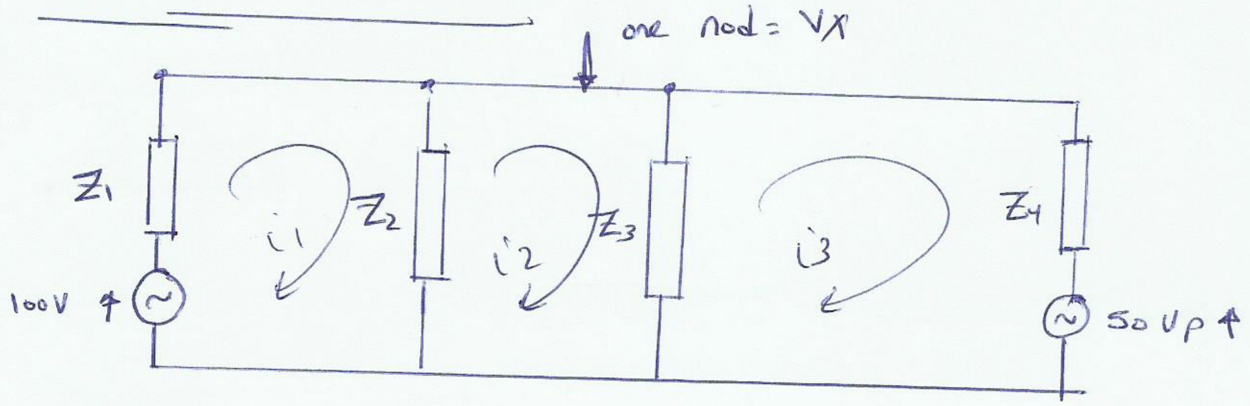
$C_2 = 50\,nF \rightarrow X_{C2} = -J3184\,\Omega$

$Z_3 = X_{L3} + X_{C2} = -J3090 = 3090 \angle -90\ \Omega$

$C_1 = 100\,nF \rightarrow X_{C1} = -J1592\,\Omega$

$Z_4 = 200 - J1592 = 1604 \angle -82.84\ \Omega$

using Mesh



Loop(1)

$100 = i_1(300 + J94.2) - i_2(200 + J31.4) + 0$

Loop(2)

$0 = -i_1(200 + J31.4) + i_2(200 - J3058.6) + J i_3 3090$

Loop(3)

$-50 = 0 + i_2(J3090) + i_3(200 - J4682)$

Soluing 1, 2, 3

Currents

$i_1 = 0.314 - J0.079$ Apeak

$i_2 = 0.012 + J0.028$ Apeak

$i_3 = 0.008 + J0.008$ Apeak

current in (R_1, L_1) Branch $= i_1$

$= 0.314 - J0.079 = 323 \times 10^{-3} \angle -14.12$ Apeak

$= 228.4$ mArms $\approx$ Simulation (228.604 Arms)

current in (R_2, L_2) Branch

$= i_1 - i_2 = 0.314 - J0.079 - [0.012 + J0.028]$

$= 0.302 - J0.106 = 0.320 \angle -19.34$ Apeak

≈ 0.226 Arms $\approx$ Simulation 226 mArms

Current in (C_1, R_3) Branch

$= i_3 = 0.008 + J0.008 = 11.313 \angle 45$ mApeak

≈ 8 mArms $\approx$ Simulation (8.1 mArms)

current in (C_2, L_3) Branch $= i_2 - i_3$

$= 0.012 + J0.028 - [0.008 + J0.008] = 4 \times 10^{-3} + 20 \times 10^{-3} J$

$= 20.39 \times 10^{-3} \angle 78.69 \approx 14.41$ mA rms

$\approx$ Simulation (15.022 Arms)

Voltage across each ~~for~~ component

$R_1 = 100\ \Omega$

$V_{R1} = 100 * 323m \angle{-14.12} = 32.3\ V_p \angle{-14.12} \approx 22.84\ V_{rms}$

$\approx$ Sim (22.86 Vrms)

V_{L1}

$= 323m \angle{-14.12} * \overset{X_L}{j62.8} = 20.28 \angle{75.88}\ V_{peak}$

$= 14.34\ V_{rms} \approx$ Sim (14.55 Vrms)

V_{R2}

$= 200 * 320m \angle{-19.34} = 64 \angle{-19.34}\ V_{peak}$

$= 45.25\ V_{rms} \approx$ Sim (45.2 Vrms)

V_{L2}

$= 320m \angle{-19.34} * \overset{X_{L2}}{31.4 \angle{90}} = 10.048 \angle{70.66}$

$= 7.105\ V_{rms} \approx$ Sim (7.193 Vrms)

V_{C2}

$= 20.39m \angle{78.69} * \overset{X_{C2}}{3184 \angle{-90}} = 64.92 \angle{-11.31}\ V_{peak}$

$\approx 46.2\ V_{rms} \approx$ Sim (47 Vrms).

V_{L3}

$= 20.39 \times 10^{-3} \angle{78.69} * \overset{X_{L3}}{94.2 \angle{90}} = 1.92 \angle{168.69}\ V_{peak}$

$= 1.36\ V_{rms} \approx$ Sim (1.43 Vrms)

V_{C1}

$X_{C1f} = -J1592$

$= 11.313\,m \angle 45 * 1592 \angle -90 = 18 \angle -45$ Vpeak

$= 12.7$ Vrms $\simeq$ Sim (12.725 Vrms)

$V_{R3} =$

$= 11.313 \angle 45 * 200 = 2.262 \angle 45$ Vpeak

$= 1.6$ Vrms $\simeq$ Sim (1.62 V rms)

Using Nodal

one node only Vx

see Fig p(13 -solution)

$$\frac{V_X - 100}{118.08 \angle 32.12} + \frac{V_X}{202.44 \angle 89} + \frac{V_X}{3090 \angle -90} + \frac{V_X - 50}{1604 \angle 82.84}$$

by solving

$V_X = 0.0647 \times 10^3 \angle -10.542$ Vpeak

$= 45.749$ Vrms $\simeq$ Sim(45.761 Vrms)

Current Through each Branch

R_1, L_1

$$= \frac{100 - V_X}{R_1 + JX_{L1}} = 0.314 - 0.79J = 323\,m \angle -14.12 \text{ Apeak}$$

R_2, L_2

$$\frac{V_X}{R_2 + JX_{L_2}} = 0.302 - J0.106 = 0.320 \angle{-19.34} \text{ A peak}$$

C_2, L_3

$$= \frac{V_X}{JX_{L_3} - JX_{C_2}} = 4 \times 10^{-3} + 20 \times 10^{-3} J$$

$$= 20.39 \angle 78.69 \text{ A peak}$$

C_1, R_3

$$= \frac{V_X}{R_3 - JX_{C_1}} = 0.008 + J0.008 = 11.313 \angle 45 \text{ A peak}$$

all other values like Mesh solution

D1.2

Solution Apended

Dr. Michael