SET	$\bar{V}_1$	$\bar{V}_2'$	$\bar{I}_1$	$\bar{I}_2'$	$\bar{I}_\varphi$
1	--	$479.3\angle 0.0026^\circ$	$0.166\angle -73.2^\circ$	0	$0.166\angle -73.2^\circ$
2	--	$474.3\angle -2.14^\circ$	$2.43\angle -5.85^\circ$	$2.37\angle -2.14^\circ$	$0.165\angle -74.3^\circ$
3	--	$1\angle 0^\circ$	0	0	0
4	--	$0.7\angle -44.4^\circ$	$0.7\angle -44.4^\circ$	$0.7\angle -44.4^\circ$	0
5	$1.85\angle 21.9^\circ$	--	$1\angle -45^\circ$	$1\angle -45^\circ$	0
6	--	$0.989\angle -2.27^\circ$	$1\angle -3.76^\circ$	$0.989\angle -2.27^\circ$	$0.0283\angle -69.3^\circ$
7	--	$0.983\angle -0.6^\circ$	$0.517\angle -46.9^\circ$	$0.491\angle -45.6^\circ$	$0.0283\angle -69.3^\circ$
8	--	$115.1\angle -3.87^\circ$	$18.29\angle -33.4^\circ$	$15.65\angle -3.87^\circ$	$9.03\angle -92.3^\circ$
9	$5400\angle -2.1^\circ$	--	$20\angle -37^\circ$	$20\angle -37^\circ$	0
10	--	$2330\angle -0.83^\circ$	$20.8\angle -37.7^\circ$	$20.8\angle -37.7^\circ$	0
11	--	$230\angle -47.1^\circ$	$259.4\angle -44.6^\circ$	$23\angle -47.1^\circ$	$236.4\angle -44.4^\circ$
12	--	0	$496\angle -75.1^\circ$	0	$496\angle -75.1^\circ$

HOMEWORK #1
SOLUTIONS

- CASE ① -
- NO LOAD -

$$\bar{Z}_1 = R_1 + j\omega L_1 = 1 + j\,3.77 = 3.9 \angle 75.14^\circ\ \Omega$$

$$\bar{Z}_\phi = R_f // j\omega L_m = 10000 // j\,3016$$

$$\bar{Z}_\phi = 2,887.5 \angle 73.22^\circ\ \Omega$$

$$\bar{V}_2 = 480 \times \frac{2887.5 \angle 73.22^\circ}{(1 + j\,3.77) + (833.61 + j\,2764.5)}$$

$$\bar{V}_2 = 479.3 \angle -0.0026^\circ\ V$$

$$\bar{I}_1 = \frac{\bar{V}_1}{\bar{Z}_{eq}} = \frac{480}{2891.37 \angle 73.22^\circ} = 0.166 \angle -73.2^\circ\ A$$

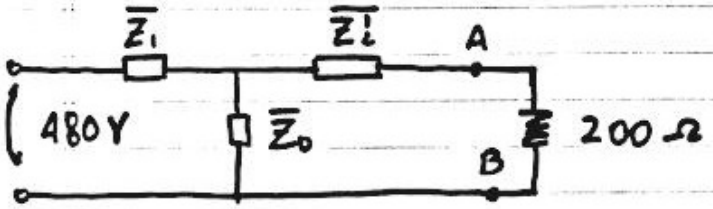
$$\bar{Z}_{eq} = \bar{Z}_1 + \bar{Z}_\phi$$

$$\bar{I}_1 = \bar{I}_\phi \quad \text{since } \bar{I}_2 = \phi$$

CASE ②

$R_L' = 200\ \Omega \qquad X_L' = \emptyset$

$\bar{Z}_1 = 3.9 \angle 75.14^\circ = \bar{Z}_2'$



$\bar{Z}_{eq} = \bar{Z}_1 + \bar{Z}_\emptyset \,//\, \bar{Z}_2'$ (UP TO AB)

$$\underline{\bar{V}_2'} = 480 \times \frac{200}{200 + \bar{Z}_{eq}} = \underline{474.9 \angle -2.13^\circ}\ V$$

$$\underline{\bar{I}_2'} = \frac{\bar{V}_2'}{R_2} = \frac{474.9 \angle -2.13^\circ}{200} = \underline{2.37 \angle -2.13^\circ}\ A$$

$$\underline{\bar{I}_1} = \frac{480}{197.77 \angle 5.85^\circ} = \underline{2.427 \angle -5.85^\circ}\ A$$

$\bar{Z}_{eq}' = \bar{Z}_1 + \bar{Z}_\emptyset \,//\, \bar{Z}_2 = 197.77 \angle 5.85^\circ$

$\underline{I_\emptyset} = \bar{I}_1 - \bar{I}_2 = \underline{0.165 \angle -74^\circ}\ A$

CASE ④

$\bar{Z}_\phi \rightarrow$ OPEN CIRCUIT

$R_1 = 0.02 + j\,0.99\ \Omega$

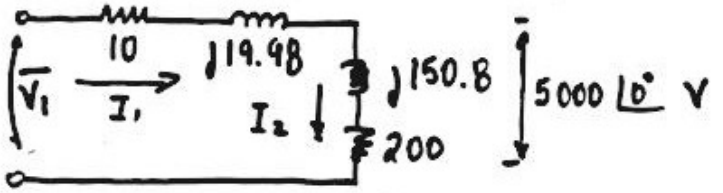
$R'_L = 1\ \Omega$

$$\bar{V}_2 = 1\angle 0^\circ \times \frac{1}{1.427\angle 44.4^\circ} = 0.7\angle 44.4^\circ \text{ V}$$

$$\bar{I}_1 = \frac{1}{1.427\angle 44.4^\circ} = 0.7\angle 44.4^\circ \text{ A}$$

$\bar{I}_1 = \bar{I}_2$

CASE ⑨

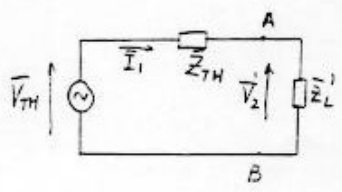


$$\bar{I}_2 = \frac{5000\angle 0^\circ}{Z'_L} = 20\angle -37.01^\circ \text{ A} = \bar{I}_1$$

$$\bar{V}_1 = \bar{I}(Z_1 + Z'_L) = 5403\angle 2.1^\circ \text{ V}$$

(a) (21

2. THE THEVENIN EQUIVALENT CIRCUIT IS:



$\bar{Z}_L' = R_L' + j\omega L_L'$

$V_{TH} = I_\phi (Z_\phi)$

$Z_\phi = R_f // j\omega L$

$$\bar{V}_{TH} = \frac{R_f // j\omega L_m}{R_f // j\omega L_m + R_1 + j\omega L_1}\,\bar{V}_1$$

$$\bar{Z}_{TH} = R_2' + j\omega L_2' + (R_f // j\omega L_m) // (R_1 + j\omega L_1)$$

SET	$\bar{V}_{TH}$	$\bar{Z}_{TH}$	$\bar{V}_2'$	$R_{L\,MAX.P}'$
1 1	$479.4\angle 0^\circ$	$7.79\angle 75.14^\circ$	$479.3\angle 0.0026^\circ$	$7.79\,\Omega$
2 2	$479.4\angle 0^\circ$	$7.79\angle 75.14^\circ$	$474.3\angle -3.14^\circ$	$7.79\,\Omega$
3 6	$1.0\angle 0^\circ$	$1\angle 88.9^\circ$	$0.7\angle -44.4^\circ$	$1\,\Omega$
4 4	$5400\angle 2.1^\circ$	$22.34\angle 63.41^\circ$	$5000\angle 0^\circ$	$22.34\,\Omega$

SET 1: $R_1 = 1\,\Omega$, $\omega L_1 = 3.77\,\Omega$, $R_f = 10\,\Omega$, $\omega L_m = 3016\,\Omega$

$R_2' = 1\,\Omega$, $\omega L_2' = 3.77\Omega$, $R_L' = \infty$, $\omega L_L' = \infty$

$$R_f // j\omega L_m = \frac{3.016\times 10^3\angle 90^\circ}{1.0445\times 10^2\angle 16.78^\circ} = 2887.5\angle 73.22^\circ\,\Omega$$

$$= 833.6 + j2768.6\,\Omega$$

$$\bar{V}_{TH} = \frac{2887.5\angle 73.22^\circ}{834.6 + j2768.37}\times 480\angle 0^\circ$$

$$= \frac{2887.5\angle 73.22^\circ}{2842.4\angle 73.22^\circ}\times 480\angle 0^\circ \cong 479.4\angle 0^\circ\,V$$

$$\bar{Z}_{TH} = 1 + j3.77 + \frac{2887.5\angle 73.22^\circ \times 3.4\angle 75.14^\circ}{2891.4\angle 73.22^\circ}$$

$$\cong 1 + j3.77 + 3.89\angle 75.14^\circ = 1 + j3.77 + 0.998 + j3.76$$

$$= 1.998 + j7.53 = 7.79\angle 75.14^\circ\,\Omega$$

SET 2 : SAME AS FOR SET 1, BUT DIFFERENT $\bar{Z}_L$

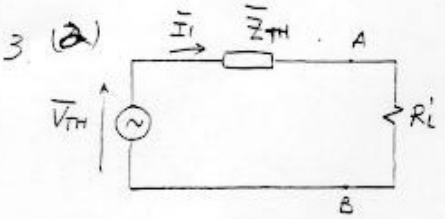
SET 4 : $R_1 = 0.02\,\Omega$, $\omega L_1 = 1\,\Omega$, $R_f = \infty$, $\omega L_m = \infty$, $R_2' = 0$, $\omega L_2' = 0$, $R_L' = 1\,\Omega$, $\omega L_L' = 0$

$\bar{V}_{TH} = \bar{V}_1 = 1.0 \angle 0^\circ$ V; $\bar{Z}_{TH} = 0.02 + j1 \cong 1 \angle 88.4^\circ\,\Omega$

SET 9 : $R_1 = 10\,\Omega$, $\omega L_1 = 19.98\,\Omega$, $R_f = \infty$, $\omega L_m = \infty$, $R_2' = 0$, $\omega L_2' = 0$, $R_L' = 200\,\Omega$, $\omega L_L' = 150.8\,\Omega$

$\bar{V}_{TH} = \bar{V}_1 = 5400 \angle 2.1^\circ$; $\bar{Z}_{TH} = 10 + j19.98 = 22.34 \angle 63.41^\circ\,\Omega$

3 (a)



POWER DELIVERED TO R_L' IS

$P_L = I_1^2 R_L'$

AND $\bar{I}_1 = \dfrac{\bar{V}_{TH}}{\bar{Z}_{TH} + R_L'} = \dfrac{\bar{V}_{TH}}{(R_{TH} + R_L') + jX_{TH}}$

$\therefore P_L = \dfrac{V_{TH}^2 R_L'}{(R_{TH} + R_L')^2 + X_{TH}^2}$; P_L IS MAX WHEN $\dfrac{dP_L}{dR_L'} = 0$,

$$\frac{dP_L}{dR_L'} = \frac{V_{TH}^2 [(R_{TH} + R_L')^2 + X_{TH}^2] - V_{TH}^2 R_L' 2(R_{TH} + R_L')}{[(R_{TH} + R_L')^2 + X_{TH}^2]^2} = 0$$

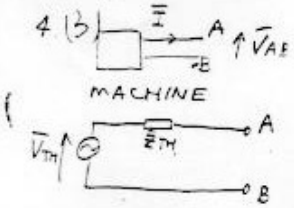
OR. $(R_{TH} + R_L')^2 + X_{TH}^2 = 2R_L'(R_{TH} + R_L')$

OR. $R_{TH}^2 + 2R_{TH}R_L' + (R_L')^2 + X_{TH}^2 = 2R_{TH}R_L' + 2(R_L')^2$

OR. $(R_L')^2 = R_{TH}^2 + X_{TH}^2 = Z_{TH}^2$; $R_L' = Z_{TH}$

FOR EACH SET OF PARAMETERS, POWER DELIVERED TO R_L' IS MAXIMUM WHEN R_L' IS EQUAL TO THE MACHINES OF THE THEVENIN EQUIVALENT IMPEDANCE $\bar{Z}_{TH}$ SEEN BY R_L'

4 (b)



$\bar{V}_{TH} = \bar{V}_{AB}$ WHEN TERMINALS AB ARE OPEN-CIRCUITED.

$\bar{Z}_{TH} = \dfrac{\bar{V}_{TH}}{\bar{I}_{SC}}$ WHERE $\bar{I}_{SC} = \bar{I}$ WHEN TERMINAL AB ARE SHORTED

$\therefore \bar{V}_{TH} = 100 \angle 0^\circ$ V; $\bar{Z}_{TH} = \dfrac{100}{50} \angle 90^\circ = 2 \angle 90^\circ\,\Omega$

Matlab Code for case 11

```
clear all
w = 377;
R1 = .3;
L1 = .003;
Rf = 1;
Lm = .0425;
R2 = .2;
L2 = .003;
RL = 10;
LL = 0;
V1 = 440;

Z1 = R1 + i * w * L1;
Z2 = R2 + i * w * L2;
ZL = RL + i * w * LL;
Xm = i * w * Lm;
Zf = Rf * Xm / (Rf + Xm);
Z2L = Z2 + ZL;
Z2Lf = Z2L * Zf / (Z2L + Zf);

I1 = V1 / (Z1 + Z2Lf);
I2 = (V1 - I1 * Z1) / Z2L;
V2 = I2 * ZL;

If = (V1 - I1 * Z1) / Rf;

fprintf('I1 = %6.2f /_ %6.2f\n', abs(I1), angle(I1)*180/pi);
fprintf('I2 = %6.2f /_ %6.2f\n', abs(I2), angle(I2)*180/pi);
fprintf('V2 = %6.2f /_ %6.2f\n', abs(V2), angle(V2)*180/pi);
fprintf('If = %6.2f /_ %6.2f\n', abs(If), angle(If)*180/pi);


% Results:
%------------------------
% I1 = 259.35 /_ -44.61
% I2 = 22.99 /_ -47.13
% V2 = 229.89 /_ -47.13
% If = 235.93 /_ -40.80
```