

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.		
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.		
Excellent knowledge and understanding of the main concepts and key theories. All aspects have been covered in excellent detail	40	35
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence		
Your work shows evidence of some logical, analytical thinking and synthesis. Your work also shows that, you can analyse new and abstract data and situations without guidance.	20	8
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.		
A good application of a range of methods, materials, tools and techniques.	40	26
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
		69
		%

Assignment Mark Overall (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to one-week late

Over one week late

HND Electrical and Electronic Engineering
Module: Electrical Principles Theory (M2X0003)

Lecturer: Dr Rabya Kadhim

Student Name: Gauvain Jay Chartier-Roberts

Student ID: CHA16832389

69%

Task 1

See attached files for all circuit diagrams and relevant workings

Section A

- $V_{th} = 2.93 - j26.34 \text{ V}$
- $Z_{th} = 1.76 - j3.80 \Omega$
- $I_n = 6 - j2 \text{ A}$



Section B – Thevanin equivalent circuit

- Current in $Z_4 = 2.04 - j1.23 \text{ A}$
- Power delivered to $Z_4 = 19.95 \text{ W}$

- Current in $Z_5 = 0.88 - j1.96 \text{ A}$
- Power delivered to $Z_5 = 23.10 \text{ W}$

Section C – Norton equivalent circuit

- Current in $Z_4 = 1.21 + j2.04 \text{ A}$ (*polar* = $2.37 < 59.28^\circ$)
- Power delivered to $Z_4 = 19.95 \text{ W}$

- Current in $Z_5 = 0.82 - j1.95 \text{ A}$ (*polar* = $2.12 < 67.19^\circ$)
- Power delivered to $Z_5 = 22.50 \text{ W}$

With respect to the power delivered to both Z_4 and Z_5 , whether using the Thevanin or Norton equivalent circuits, the same value for the power calculation is achieved (in the case of Z_5 , the small discrepancy is likely down to rounding errors during the calculations). We can therefore use either a Thevanin or Norton equivalent circuit to calculate the power delivered to any attached load.

Task 2

See attached files for all appropriate circuit diagrams and workings

Circuit A

- $V_{th} = 4 \text{ V}$
- $R_{th} = 10.4 \text{ } \Omega$

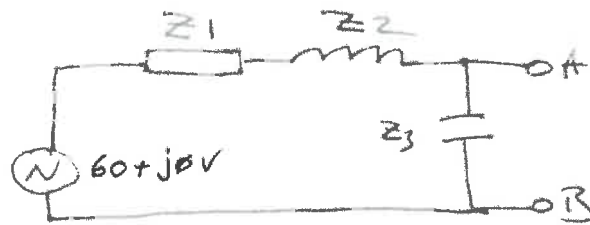
Circuit B

- $V_{th} = 6 \text{ V}$
- $R_{th} = 4.8 \text{ } \Omega$

Combined circuit

- $R_{th} = 3.284 \text{ } \Omega$
- $I \text{ in loop} = 0.132 \text{ A}$
- Voltage over EF = 5.366 V
- For max power transfer RL must equal R_{th} , therefore $R_L = 3.284 \text{ } \Omega$
- Total power dissipated in the circuit = 4.384 W
- Power delivered to $R_L = 2.192 \text{ W}$

Task 1



$$Z_1 = 9 + j0 \Omega$$

$$Z_2 = 0 + j3 \Omega$$

$$Z_3 = 0 - j4 \Omega$$

a) $V_{Th} = V_{\text{across AB}}$ i.e. $V_{\text{across } Z_3}$

$$V_{Z_3} = \frac{Z_3}{Z_1 + Z_2 + Z_3} \times V$$

$$= \frac{0 - j4}{(9 + j0) + (0 + j3) + (0 - j4)} \times 60 + j0$$

$$= \frac{(0 - j4)(60 + j0)}{9 - j}$$

$$= \frac{0 - 240j}{9 - j} \times \frac{9 + j}{9 + j}$$

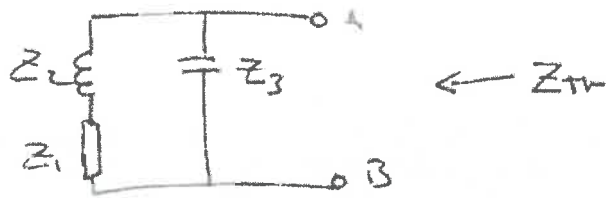
$$= \frac{0 - j2160 + 0 - 240 \times -1}{81 + j9 - j9 - j^2}$$

$$= \frac{240 - j2160}{82}$$

$$\therefore V_{Th} = 2.93 - j26.34 \text{ V}$$

(10)

Z_{th} - Short the source and look in from AB



$$Z_{th} = \frac{Z_3 \times (Z_1 + Z_2)}{Z_1 + Z_2 + Z_3}$$

$$= \frac{0 - j4(9 + j0 + 0 + j3)}{0 - j4 + 9 + j0 + 0 + j3} \Rightarrow \frac{(0 - j4)(9 + j3)}{9 - j}$$

$$= \frac{0 - j36 + 0 + 12}{9 - j} \times \frac{9 + j}{9 + j}$$

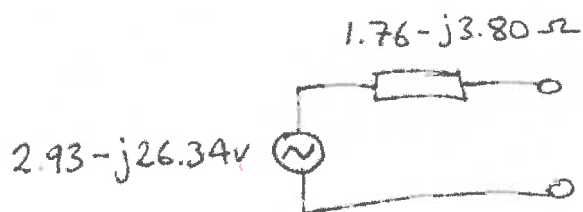
$$= \frac{(12 - j36)(9 + j)}{82} \Rightarrow \frac{108 + j12 - j324 - j^2 36}{82}$$

$$= \frac{144 - j312}{82}$$

$$Z_{th} = 1.76 - j3.80 \, \Omega$$

(10)

Thevenin equivalent circuit:



(4)

Task 1a cont. Norton equivalent circuit

$$I_N = \frac{V_{TH}}{Z_{TH}}$$

$$\therefore I_N = \frac{2.93 - j26.34}{1.76 - j3.80} \times \frac{1.76 + j3.80}{1.76 + j3.80}$$

$$= \frac{(2.93 - j26.34)(1.76 + j3.80)}{(1.76 - j3.80)(1.76 + j3.80)}$$

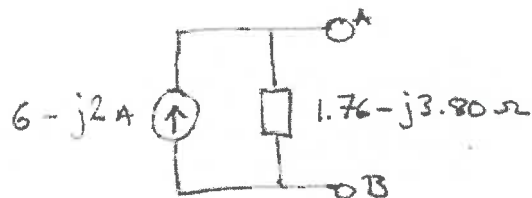
$$= \frac{5.16 + j11.13 - j46.36 - j^2 100.09}{3.09 + 14.44}$$

$$= \frac{105.25 - j35.23}{17.53}$$

$$I_N = 6 - j2 \text{ A} \quad (4)$$

$$Z_N \approx Z_{TH} \quad (3)$$

$\therefore$ The Norton equivalent circuit



(4)

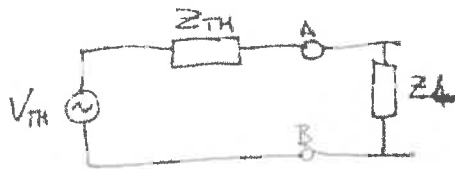
Task 1 B

Use V_{TH} ($2.93 - j26.34V$) and R_{TH} ($1.76 - j3.80\Omega$) to find I and

Power in a) $Z_4 = 5 - j5\Omega$

b) $Z_5 = 10 + j0\Omega$

a)



$$I = \frac{V_{TH}}{Z_{TH} + Z_L}$$

$$I = \frac{2.93 - j26.34}{1.76 - j3.8 + 5 - j5} \Rightarrow \frac{2.93 - j26.34}{6.76 - j8.8} \times \frac{6.76 + j8.8}{6.76 + j8.8}$$

$$= \frac{19.80 + j25.78 - j178.06 - j^2 231.79}{45.69 + 77.44}$$

$$= \frac{251.59 - j152.28}{123.13}$$

$$I_{Z4} = 2.04 - j1.23 \text{ A in the circuit}$$

②
Power!

Task 1 B

$$b) I = \frac{2.93 - j26.34}{1.76 - j3.8 + 10 + j0} \Rightarrow \frac{2.93 - j26.34}{11.76 - j3.8} \times \frac{11.76 + j3.8}{11.76 + j3.8}$$

$$= \frac{34.46 + j11.13 - j309.75 - j^2 100.09}{138.29 + 14.44}$$

$$= \frac{134.55 - j298.62}{152.73}$$

$$I_{Z5} = 0.88 - j1.96 \text{ A in the circuit}$$

③

Task 1 B cont.

$$\begin{aligned} I \text{ in } Z_4 &= 2.04 - j1.23 \text{ A} \rightarrow \frac{\text{In Polar}}{2.38 \angle 31.09^\circ} \\ I \text{ in } Z_5 &= 0.88 - j1.96 \text{ A} \rightarrow 2.15 \angle 65.82^\circ \end{aligned}$$

$$\text{Power in } Z_4 = I^2 Z_4$$

$$Z_4 \text{ in Polar} = 7.07 \angle 45^\circ \Omega$$

$$I_{\text{rms}} = \frac{2.38}{\sqrt{2}} = 1.68 \text{ A}$$

$$\begin{aligned} \therefore Z_4 \text{ power} &= 1.68^2 \times 7.07 \\ &= 19.95 \text{ W} \end{aligned}$$

$$\text{Power in } Z_5 = I^2 Z_5$$

$$Z_5 \text{ in Polar} = 10 \angle 0^\circ$$

$$I_{\text{rms}} = \frac{2.15}{\sqrt{2}} = 1.52 \text{ A}$$

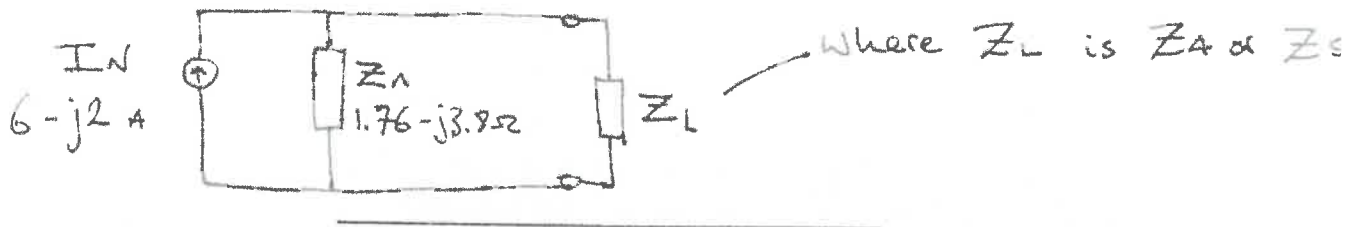
$$\begin{aligned} \therefore Z_5 \text{ Power} &= 1.52^2 \times 10 \\ &= 23.10 \text{ W} \end{aligned}$$

Task 1 c

Use I_N and $Z_N (Z_{Th})$ to find I and power in

a) $Z_4 = 5 - j5 \Omega \rightarrow \text{Polar} = 7.07 \angle 45^\circ$

b) $Z_5 = 10 + j0 \Omega \rightarrow \text{Polar} = 10 \angle 0^\circ$



a) Current divider $I_{Z_4} = \frac{Z_N}{Z_4 + Z_N} \times I_N$

~~First find total:~~
First find total: $Z_T \Omega = \frac{Z_4 \times Z_N}{Z_4 + Z_N} = \frac{(1.76 - j3.8)(5 - j5)}{(1.76 - j3.8) + (5 - j5)}$ (2)

$\therefore Z_T = 2.25 + j1.43 \Omega$

So, $I_{Z_4} = \frac{(2.25 + j1.43)}{5 - j5} \times (6 - j2)$
 $= \frac{16.36 + j4.08}{5 - j5} \times \frac{5 + j5}{5 + j5} = \frac{60.6 + j102.2}{50}$

$I_{Z_4} = 1.21 + j2.04 A$ Polar = $2.37 \angle 59.28^\circ$ +

Power in ~~Z_4~~ $Z_4 = I^2 Z_4$

$I_{RMS} = \frac{2.37}{\sqrt{2}} = 1.68 A$

$\therefore \text{Power in } Z_4 = 1.68^2 \times 7.07$

$= 19.95 W$

Task 1c

$$b) Z_5 = 10 + j0 \Omega \quad \text{Polar} = 10 \angle 0^\circ$$

$$\text{Find } I_{Z5} = \frac{Z_5 // Z_N}{Z_5} \times I_N$$

$$\text{Total } Z_T = \frac{Z_5 \times Z_N}{Z_5 + Z_N} = \frac{(1.76 - j3.8)(10 + j0)}{(1.76 - j3.8) + (10 + j0)}$$

$$Z_T = 2.22 - j2.51 \Omega$$

$$\therefore I_{Z5} = \frac{(2.22 - j2.51)(6 - j2)}{10 + j0} \quad \checkmark$$

$$= \frac{8.3 - j19.5}{10 + j0} \times \frac{10 - j0}{10 - j0} = \frac{83 - j195 + j^2}{100}$$

$$\boxed{I_{Z5} = 0.82 - j1.95 \text{ A}} \quad \text{Polar} = 2.12 \angle 67.19^\circ \text{ (2)}$$

$$\text{Power in } Z_5 = I^2 Z_5$$

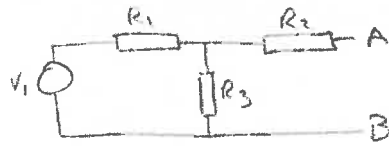
$$I_{\text{rms}} = \frac{2.12}{\sqrt{2}} = 1.50 \text{ A}$$

$$\therefore \text{Power in } Z_5 = 1.50^2 \times 10$$

$$\boxed{= 22.5 \text{ W}} \quad \times$$

Task 2

Circuit A



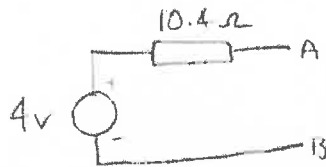
$$\begin{aligned} V_1 &= 10\text{V} \\ R_1 &= 6\Omega \\ R_2 &= 8\Omega \\ R_3 &= 4\Omega \end{aligned}$$

$$\text{Total } R_{\text{th}} = R_2 + \left(\frac{R_1 \times R_3}{R_1 + R_3} \right) = 8 + \frac{24}{10} = \underline{10.4\Omega}$$

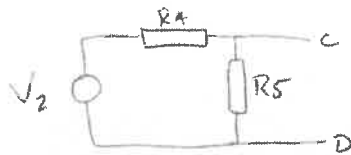
V_{th} = voltage across R_3

$$\therefore V_{\text{th}} = \frac{V_1}{R_1 + R_3} \times R_3 = \frac{10}{10} \times 4 = \underline{4\text{V}}$$

Circuit A equivalent:



Circuit B



$$\begin{aligned} V_2 &= 15\text{V} \\ R_4 &= 12\ \Omega \\ R_5 &= 8\ \Omega \end{aligned}$$

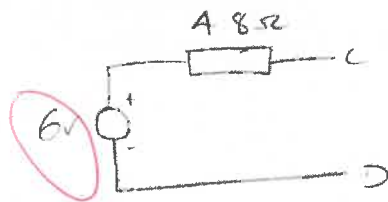
$$\text{Total Resistance } R_{Th} = \frac{R_4 \times R_5}{R_4 + R_5} = \frac{96}{20} = \underline{4.8\ \Omega} \quad \checkmark$$

V_{Th} = voltage across R_5

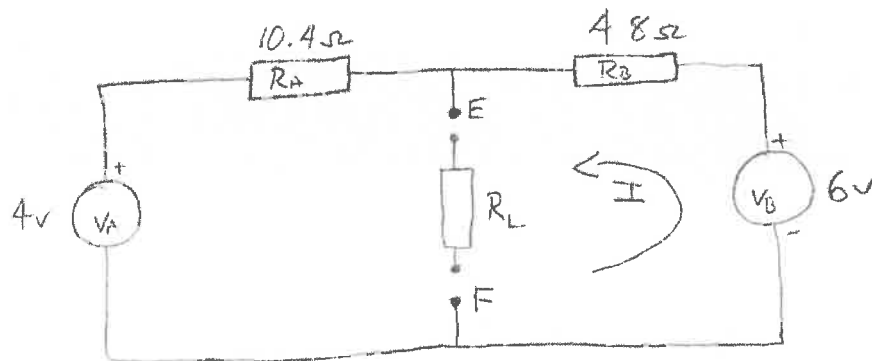
$$\therefore V_{Th} = \frac{V_2}{R_4 + R_5} \times R_5 = \frac{15}{20} \times 8 = \underline{6\text{V}} \quad \times$$

~~4.8~~

Circuit B equivalent:



Combined Thevenin equivalent for circuits A & B



① Find $R_{Th} = \frac{R_A \times R_B}{R_A + R_B} = \frac{49.92}{15.20} = \underline{3.284 \Omega}$ ✓

② Find I in the loop

$I = \frac{V}{R} = \frac{6-4}{10.4+4.8} = \frac{2}{15.2} = \underline{0.132 A}$ ✓

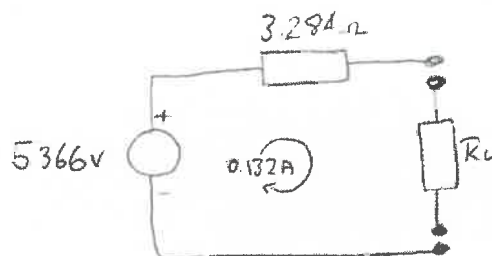
with error corrected

③ Voltage over EF = voltage drop over R_A or R_B

$\therefore 6 - (0.132 \times 4.8) = \underline{5.366 V}$ ✓

⑥

Equivalent circuit:



For max power transfer R_L must equal R_{TH}

$$\therefore R_L = \underline{3.284 \Omega} \quad \checkmark$$

Total power dissipated in the circuit:

$$\begin{aligned} \frac{V^2}{R} &= \frac{(5.366)^2}{3.284 + 3.284} = \frac{28.794}{6.568} \\ &= \underline{4.384 \text{ W}} \end{aligned}$$

Power delivered to R_L :

$$\frac{4.384}{2} = \underline{2.192 \text{ W}} \quad \checkmark$$

(8)