

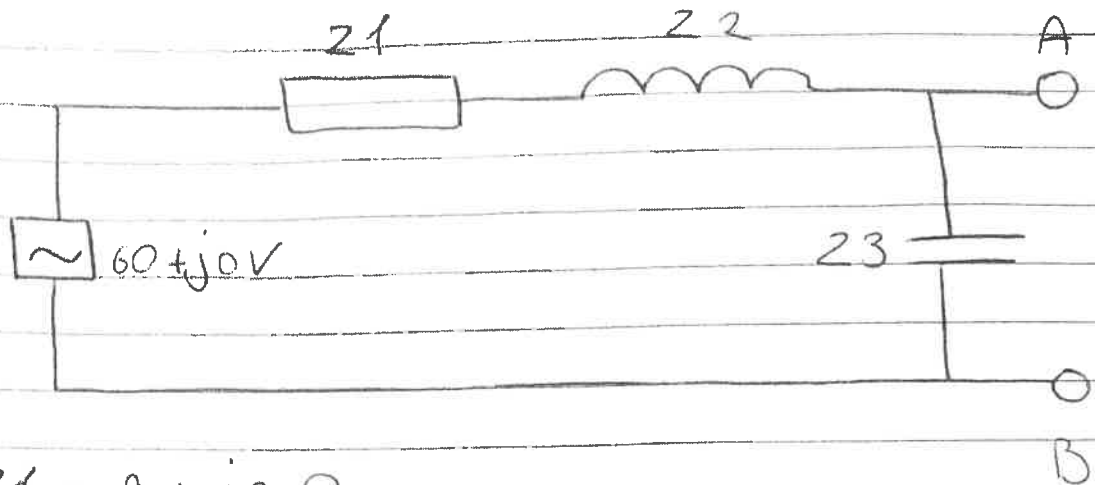
This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed 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.	40	30
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	12
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	28
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
		70 %

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	

Task 1

70%



$$Z1 = 9 + j0 \Omega$$

$$Z2 = 0 + j3 \Omega$$

$$Z3 = 0 - j4 \Omega$$

$$a) V_{th} = \frac{Z3}{Z1 + Z2 + Z3} \cdot V$$

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

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

$$V_{th} = \frac{-j240}{9 - j} \cdot \frac{9 + j}{9 + j}$$

$$V_{th} = \frac{-j2160 - j^2 240}{81 - j^2} = \frac{-j2160 + 240}{82}$$

$$V_{th} = \frac{-j2160}{82} + \frac{240}{82}$$

$$V_{th} = -j26,34 + 2,93$$

✓

10

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

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

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

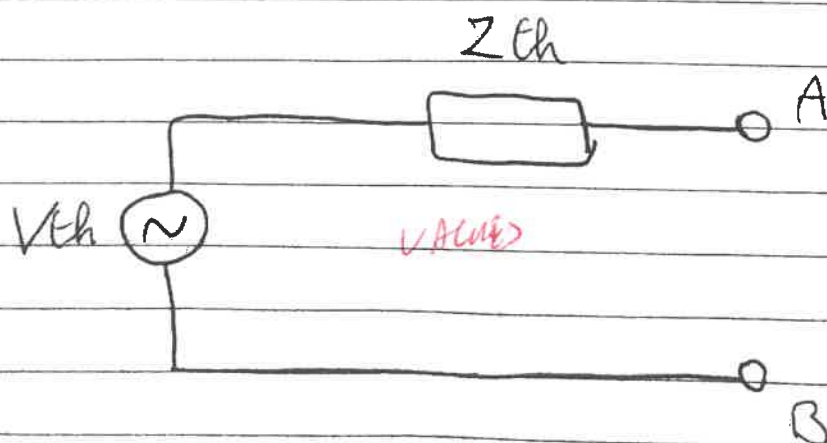
$$= \frac{-j36 - j^2 12}{(9 - j)} \Rightarrow \frac{12 - j36}{9 - j}$$

$$Z_{th} = \frac{12 - j36}{9 - j} \cdot \frac{9 + j}{9 + j} =$$

$$= \frac{108 + j12 - j324 - j^2 36}{82} =$$

$$= \frac{144 - j312}{82} \Rightarrow \frac{144}{82} - j\frac{312}{82}$$

$$Z_{th} = 1,76 - j3,80 \, \Omega \quad \checkmark \quad (10)$$



$$\bullet \quad I_N = \frac{V_{Th}}{R_{Th}} \Rightarrow \frac{2,93 - j 26,34}{1,76 - j 3,80}$$

$$I_N = \frac{2,93 - j 26,34}{1,76 - j 3,80} \cdot \frac{1,76 + j 3,80}{1,76 + j 3,80}$$

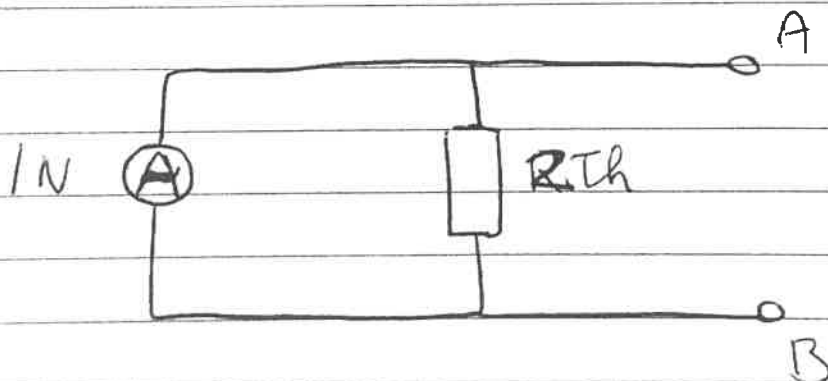
$$I_N = \frac{5,16 + j 11,13 - j 46,36 - j^2 100,089}{3,10 + j 6,67 - j 6,67 - j^2 14,44} =$$

$$= \frac{105,25 - j 35,23}{17,54} \Rightarrow \frac{105,25}{17,54} - j \frac{35,23}{17,54}$$

$$I_N = 6 - j 2 \text{ A}$$

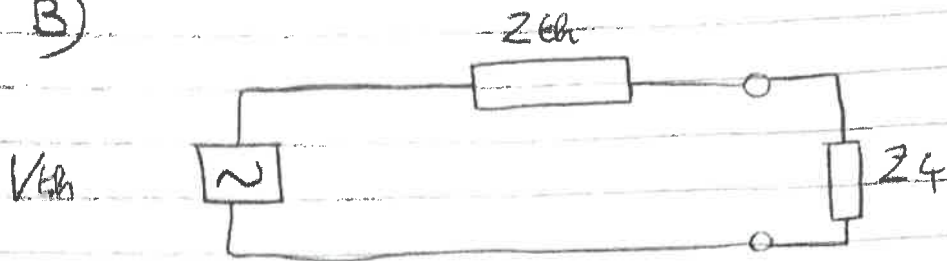


(4)



(3)

B)



$$I_{Z_L} = \frac{V_{th}}{Z_{th} + Z_L} = \frac{2,93 - j 26,34}{(9,76 - j 3,80) + (5 - j 5)}$$

$$= \frac{2,93 - j 26,34}{6,76 - j 8,80} \cdot \frac{6,76 + j 8,80}{6,76 + j 8,80}$$

$$= \frac{19,81 + j 25,78 - j 178,06 - j^2 231,79}{123,14}$$

$$= \frac{251,6 - j 152,28}{123,14}$$

$$= \frac{251,6}{123,14} - j \frac{152,28}{123,14}$$

$$I_{Z_L} = 2,04 - j 1,24$$

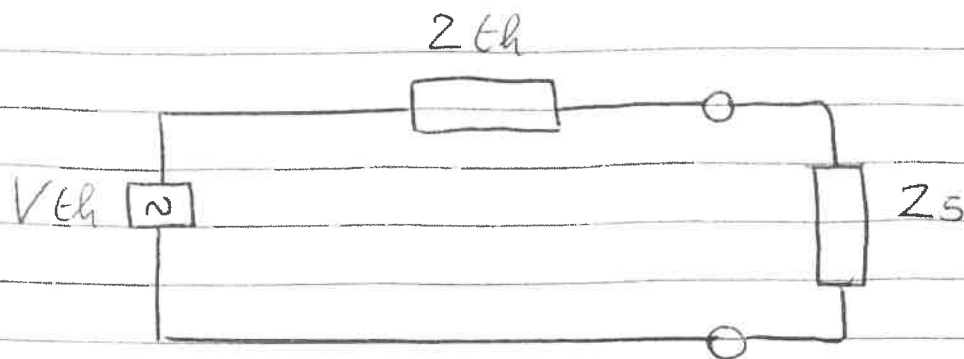
Transform from rectangular to polar form

$$I_{Z_L} = 2,38 \angle -31,29^\circ$$

$$Z_L = 7,07 \angle -45^\circ$$

$$I_{Z_L \text{ RMS}} = \frac{2,38}{\sqrt{2}} = 1,68 \text{ A}$$

$$P_{Z_L} = (I_{Z_L \text{ RMS}})^2 \cdot Z_L = 1,68^2 \cdot 7,07 = 19,95 \text{ W}$$



$$I_{Z5} = \frac{V_{th}}{2\Omega + Z_5} = \frac{2,93 - j 26,34}{(1,76 - j 3,80) + (10 + j 0)}$$

$$I_{Z5} = \frac{2,93 - j 26,34}{11,76 - j 3,80} \cdot \frac{11,76 + j 3,80}{11,76 + j 3,80}$$

$$I_{Z5} = \frac{34,46 + j 11,13 - j 307,76 - j^2 100,09}{132,74}$$

$$= \frac{134,55 - j 298,63}{132,74}$$

$$= \frac{134,55}{132,74} - j \frac{298,63}{132,74}$$

$$I_{Z5} = 0,88 - j 1,95$$

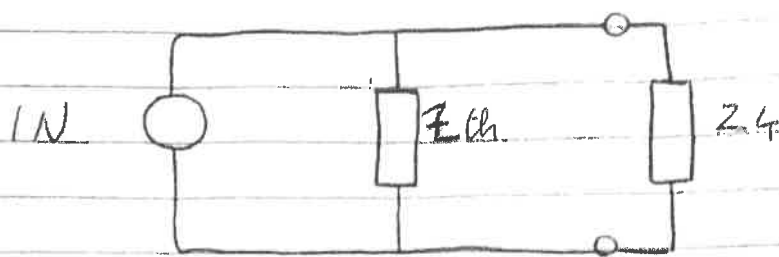
Transform from rectangular ~~to~~ to polar form

$$I_{Z5} = 2,14 \angle -65,71^\circ \quad Z_5 = 10 \angle 0^\circ$$

$$I_{Z5 RMS} = \frac{2,14}{\sqrt{2}} = 1,51 A$$

$$P_{Z5} = (I_{Z5 RMS})^2 \cdot Z_5 = (1,51)^2 \cdot 10 = 22,80 W$$

c)



$$I_4 = 1V \cdot \frac{Z_{LH}}{Z_{LH} + 24} = 6 - j2 \cdot \frac{1,76 - j3,80}{(1,76 - j3,80)(5 - j5)}$$

$$= 6 - j2 \cdot \frac{1,76 - j3,80}{6,76 - j8,80} =$$

$$= \frac{10,36 - j22,8 - j3,52 + j^2 7,6}{6,76 - j8,80} =$$

$$= \frac{2,96 - j26,32}{6,76 - j8,80} \cdot \frac{6,76 + j8,80}{6,76 + j8,80}$$

$$= \frac{20 + j26,05 - j177,92 - j^2 231,62}{123,14}$$

$$= \frac{231,62}{123,14} - j \frac{151,87}{123,14}$$

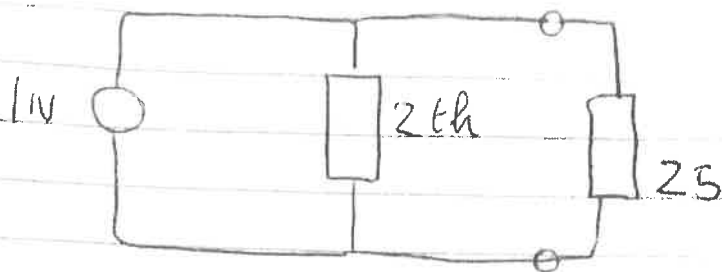
$$I_4 = 2,04 - j1,23$$

Transform from rectangular to polar form

$$I_4 = 2,38 \angle -31,9$$

$$I_4 \text{ RMS} = \frac{2,38}{\sqrt{2}} = 1,68 \text{ A}$$

$$P_4 = (I_4 \text{ RMS})^2 \cdot (24) = (1,68)^2 \cdot 24 = 19,95 \text{ W}$$



$$I_S = 1V \cdot \frac{Z_{LH}}{Z_{LH} + Z_S} = \frac{1,76 - j3,80}{11,76 - j3,80} \cdot 6 - j2 =$$

$$= \frac{10,56 - j3,32 - j22,8 + j^2 7,6}{11,76 - j3,80} =$$

$$= \frac{2,96 - j26,32}{11,76 - j3,80} \cdot \frac{11,76 + j3,80}{11,76 + j3,80}$$

$$= \frac{34,81 + j11,25 - j309,52 - j^2 100,02}{152,74}$$

$$= \frac{134,83}{152,74} - j \frac{298,27}{152,74}$$

$$I_S = 0,88 - j1,95 \quad \checkmark$$

(2)

Transform from rectangular to polar form

$$I_S = 2,14 \angle -65,71 \quad |I_S|_{RMS} = \frac{2,14}{\sqrt{2}} = 1,51 A$$

$$P_S = (I_S)_{RMS}^2 \cdot (Z_S) = (1,51)^2 \cdot 10 = 22,80 W$$

- Conclusion: The results of B and C with respect to the power delivered to Z_4 and Z_5 , using Thevenin or Norton equivalent circuit, is the same. ✓

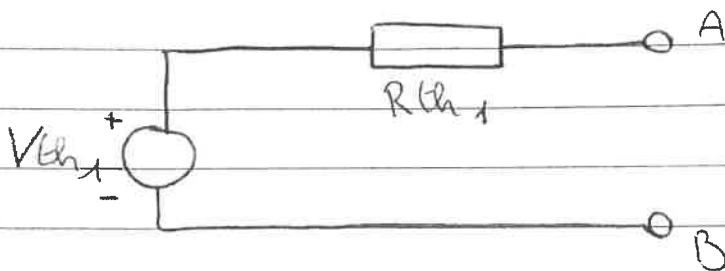
(4).

TASK 2

Thevenin equivalent circuit of A

$$V_{th1} = V_1 \cdot \left(\frac{R_3}{R_3 + R_1} \right) = 10 \cdot \left(\frac{4}{4 + 6} \right) = 4 \text{ V}$$

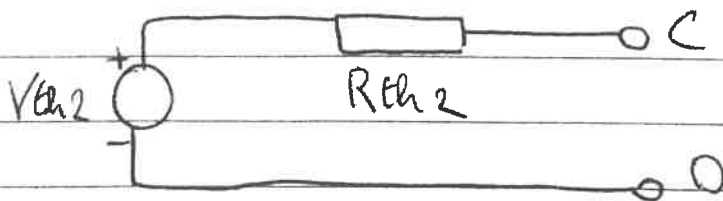
$$R_{th1} = \left(\frac{R_1 \cdot R_3}{R_1 + R_3} \right) + R_2 = \left(\frac{6 \cdot 4}{6 + 4} \right) + 8 = 10,4 \, \Omega$$

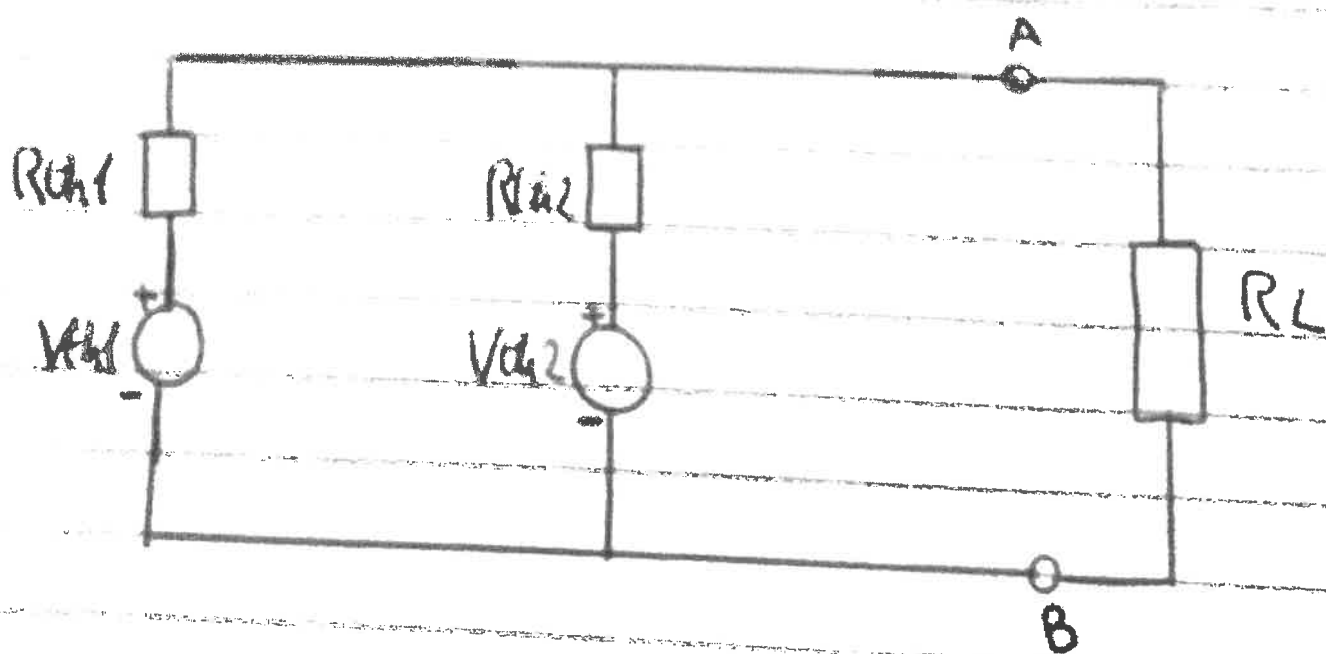
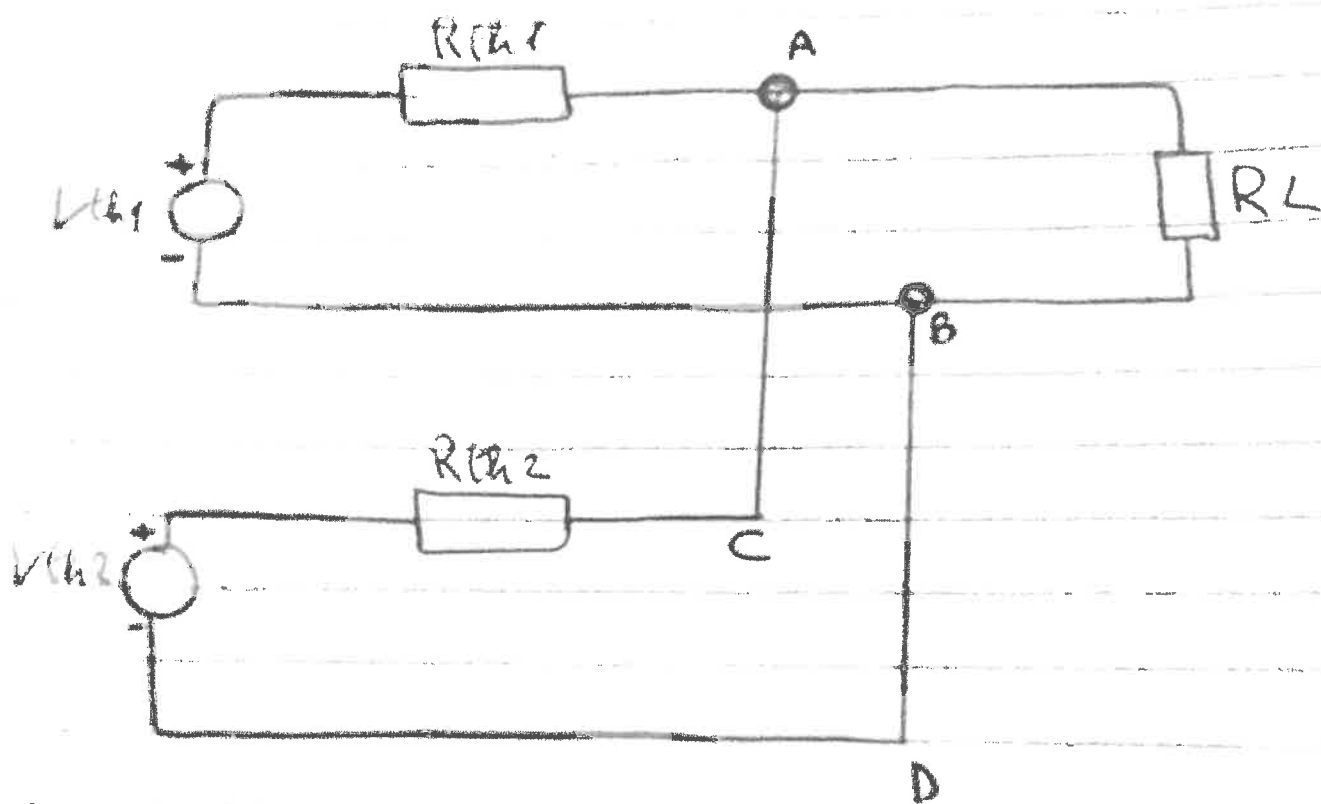


Thevenin equivalent circuit of B with $\begin{cases} R_5 = 8 \, \Omega \\ R_4 = 12 \, \Omega \end{cases}$

$$V_{th2} = V_2 \cdot \left(\frac{R_5}{R_4 + R_5} \right) = 15 \cdot \left(\frac{8}{20} \right) = 6 \text{ V}$$

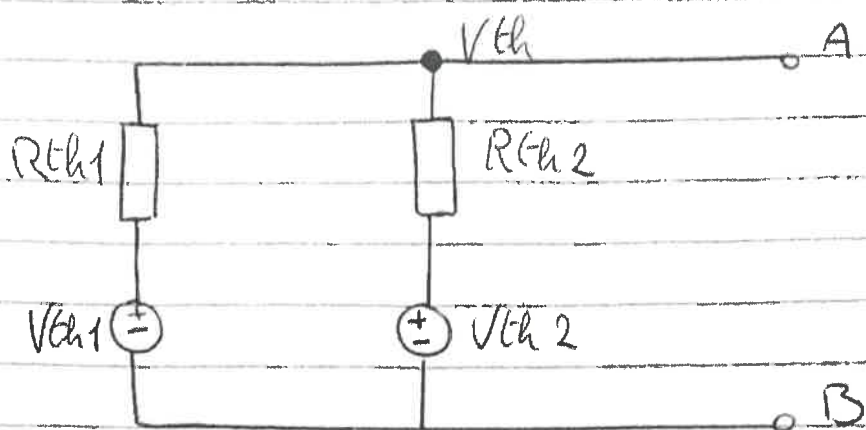
$$R_{th2} = \frac{R_5 \cdot R_4}{R_5 + R_4} = \frac{8 \cdot 12}{8 + 12} = \frac{96}{20} = 4,8 \, \Omega$$





Answer: $I = \dots$

• Thevenin's equivalent of the combination



$$R_{th1} = 10,4 \, \Omega$$

$$R_{th2} = 4,8 \, \Omega$$

$$V_{th1} = 4 \, V$$

$$V_{th2} = 6 \, V$$

• Applying Nodal Analysis:

$$\frac{V_{th} - V_{th1}}{R_{th1}} + \frac{V_{th} - V_{th2}}{R_{th2}} = 0$$

$$V_{th} \left(\frac{1}{R_{th1}} + \frac{1}{R_{th2}} \right) = \frac{V_{th1}}{R_{th1}} + \frac{V_{th2}}{R_{th2}}$$

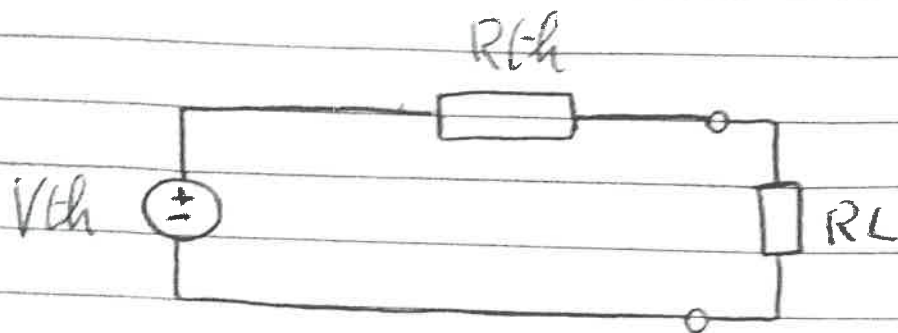
$$V_{th} \left(\frac{1}{10,4} + \frac{1}{4,8} \right) = \frac{4}{10,4} + \frac{6}{4,8}$$

$$V_{th} (0,30) = 1,63$$

with error.

$$V_{th} = \frac{1,63}{0,30} = 5,43 \, V$$

$$R_{th} = \frac{R_{th1} \cdot R_{th2}}{R_{th1} + R_{th2}} = \frac{10,4 \cdot 4,8}{10,4 + 4,8} = 3,28 \, \Omega$$



Maximum power is transferred from source to load when $R_L = R_{th}$ ✓

$$I^2 = \left(\frac{V_{th}}{2 R_{th}} \right)^2 = \left(\frac{5,43}{2 \cdot 3,28} \right)^2 = 0,68 \text{ A}$$

$$P_{MAX} = I^2 \cdot R_L = 0,68 \cdot 3,28 = 2,23 \text{ W} \quad \text{✓} \quad \textcircled{8}$$