Preview Test: ENGG1300 Semester One Final Examination 2020

Test Information

Description

ENGG1300 Introduction to Electrical Systems

Semester One 2020 - Final Examination

This is an open book exam – all materials permitted.

Instructions

This exam consists of 60 marks in total. Answer all questions. Questions will consist of short answer, numeric input and multiple choice. All answers must be provided within the blackboard test.

It is strongly recommended that you:

- Read each exam question carefully, then solve the problem with full working on paper, and then enter the answer.
- Save your answers regularly.
- Maintain rounding to at least 4-significant figures to ensure your provided numeric answers are within +/-2% of the correct answer.

When answers require you to enter algebraic expressions:

- Please ensure your expression is correct based on the BODMAS precedence of operations. Carefully ensure brackets are in the correct location.
- Use '*' to indicate multiplication
- Use '/' to indicate division
- Use '^' or the superscript character to indicate an exponent

If you experience a technical error during the exam, you should do the following:

- Contact the Library AskUs service for advice.
- Request an email from AskUs documenting the advice provided so you can forward it to your course coordinator.
- Inform the course coordinator at p.terrill@uq.edu.au.

Timed Test

This test has a time limit of 2 hours and 30 minutes.This test will save and submit automatically when the time expires.
Warnings appear when **half the time**, **5 minutes**, **1 minute**, and **30 seconds** remain.
[The timer does not appear when previewing this test]

Multiple Attempts

Not allowed. This test can only be taken once.

Force Completion

This test can be saved and resumed at any point until time has expired. The timer will continue to run if you leave the test.

QUESTION 1

0 points Save Answer

This is an open book exam. You will have access to your own notes, course texts and other materials. The normal academic integrity rules apply.

- You cannot cut-and-paste material other than your own work as answers.
- You are not permitted to consult any other person, whether directly, online, or through any other means about any aspect of this assessment during the period that this assessment is available.

If it is found that you have given or sought outside assistance with this assessment then that will be deemed to be cheating and will result in disciplinary action. By undertaking this online assessment you are deemed to have acknowledged UQ's Academic Integrity Pledge and to have made the following declaration:

"I certify that my submitted answers are entirely my own work and that I have neither given nor received any unauthorised assistance on this assessment item"

- ◯ Agree
- ◯ Disagree

QUESTION 2

0 points Save Answer

Please use this space to specify any assumptions you have made in completing the exam and which questions those assumptions relate to. You may also include queries you may have made with respect to a particular question, should you have been able to 'raise your hand' in an examination room.

QUESTION 3

0 points Save Answer

Here is a pdf copy of the exam questions: ENGG1300 Semester One Final Examination 2020_pdf_download.pdf

It is suggested that you download these at the start of the exam to allow you to more quickly review the exam questions; and so that you can continue working on solving problems in the event that you have any intermittent internet problems.

Please make sure that you allow adequate time to enter all answers electronically into the blackboard test.

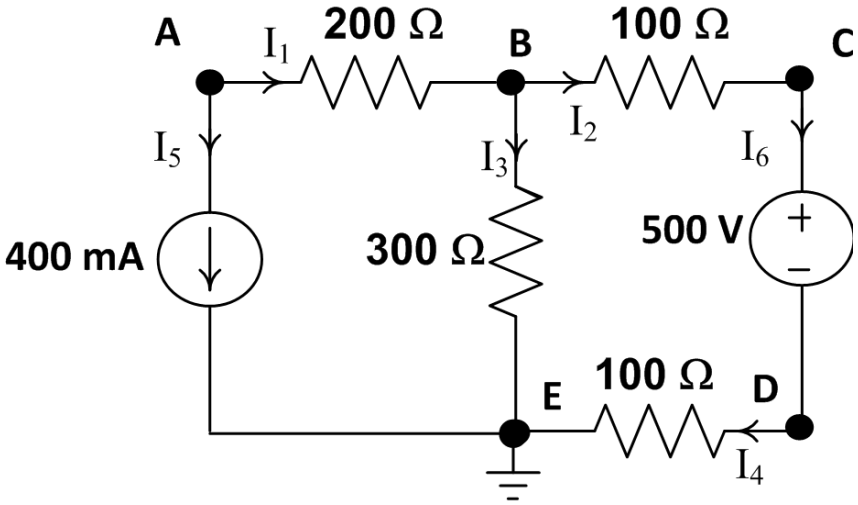
QUESTION 4

1 points | Save Answer

All questions in section 1 relate to the circuit below. This circuit will be shown at the start of each question. It is suggested that you first read each question; then carefully solve the circuit; and then enter your answers.

Consider the circuit shown below.

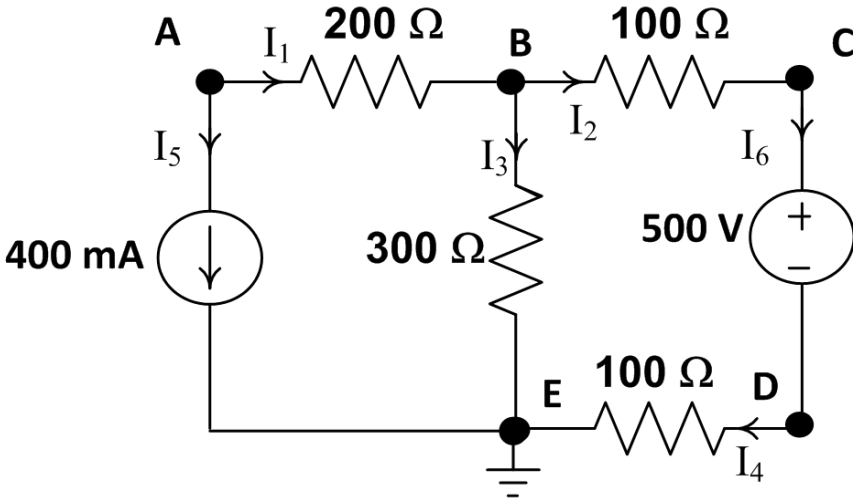
Write an ohm's law equation for the 200Ω resistor in terms of the relevant resistor value, branch current(s) and node voltage(s).



QUESTION 5

1 points | Save Answer

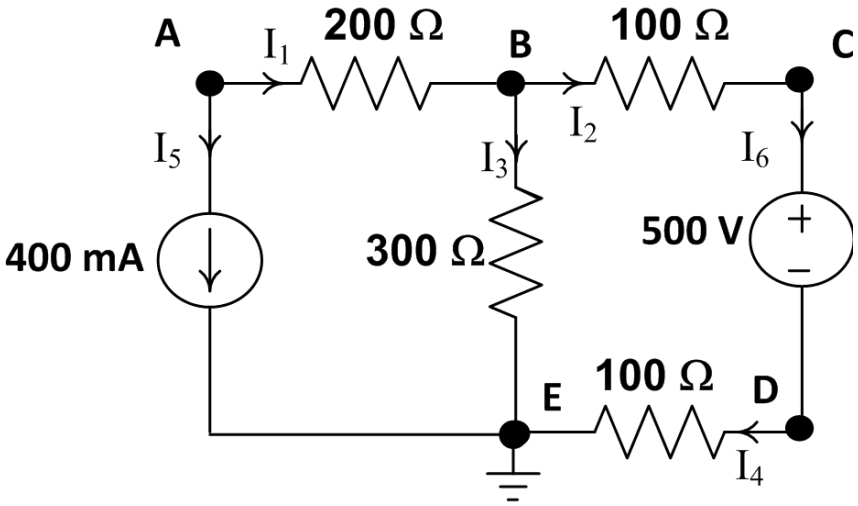
Consider the circuit shown below. Write a Kirchhoff's current law equation at node E in terms of the relevant branch currents.



QUESTION 6

1 points | Save Answer

Consider the circuit shown below. Write a Kirchhoff's current law equation at node B in terms of node voltage(s) and resistor value(s).

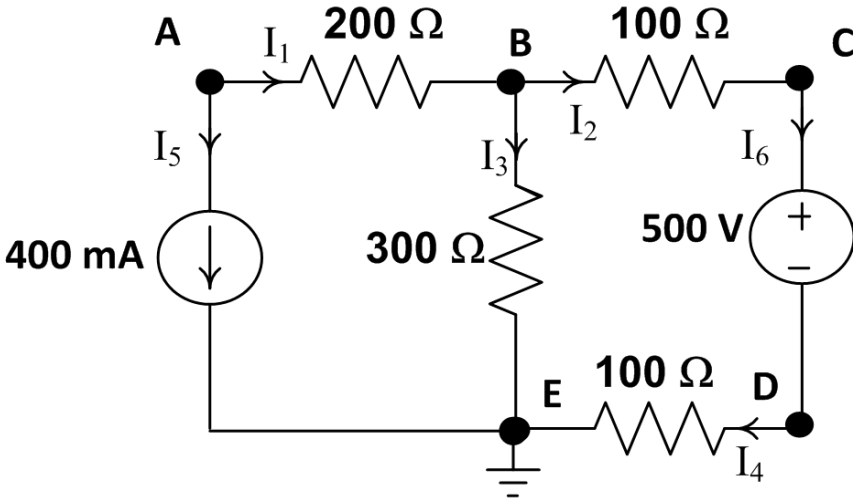


QUESTION 7

1 points | Save Answer

Consider the circuit shown below.

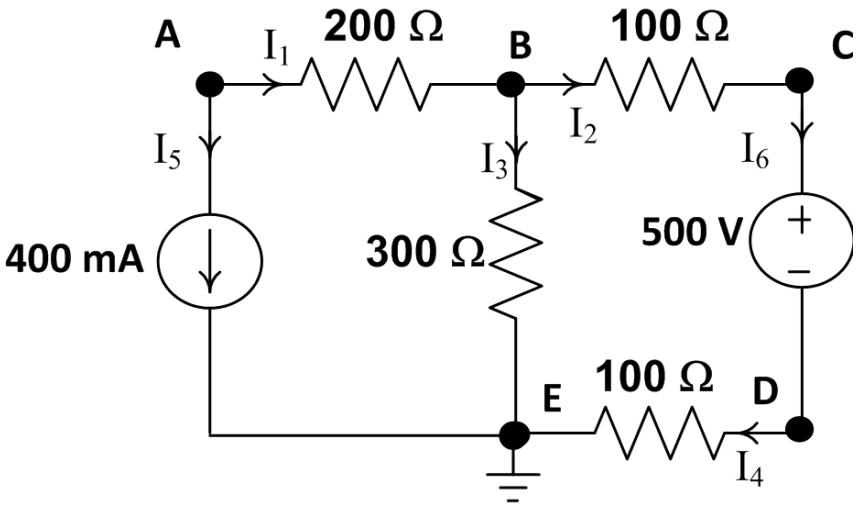
Write a Kirchhoff's voltage law equation for the loop of the circuit that includes the 300 Ω resistor, the two 100 Ω resistors, and the 500V voltage source. Your expression should be in terms of branch current(s) and/or resistor value(s), and/or constants representing the value of voltage or current sources.



QUESTION 8

1 points | Save Answer

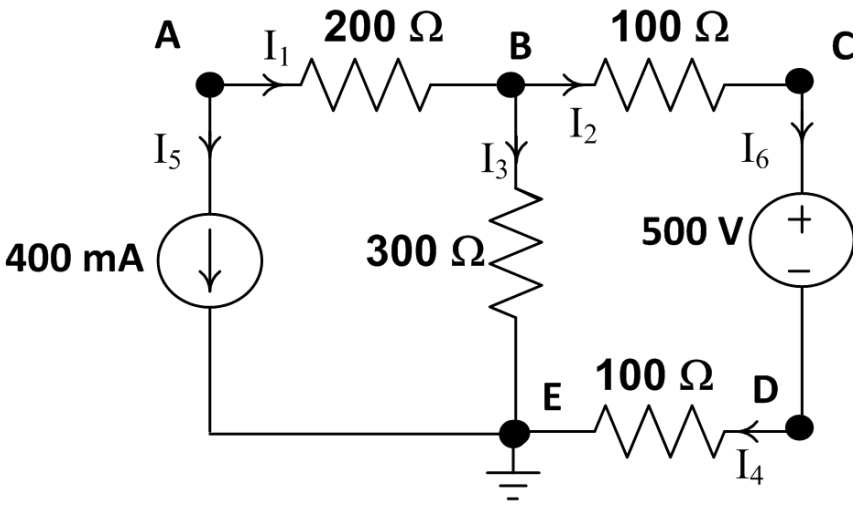
Consider the circuit below.
Solve the circuit to calculate the value of the node voltage V_B. Provide your answer in volts.



QUESTION 9

1 points | Save Answer

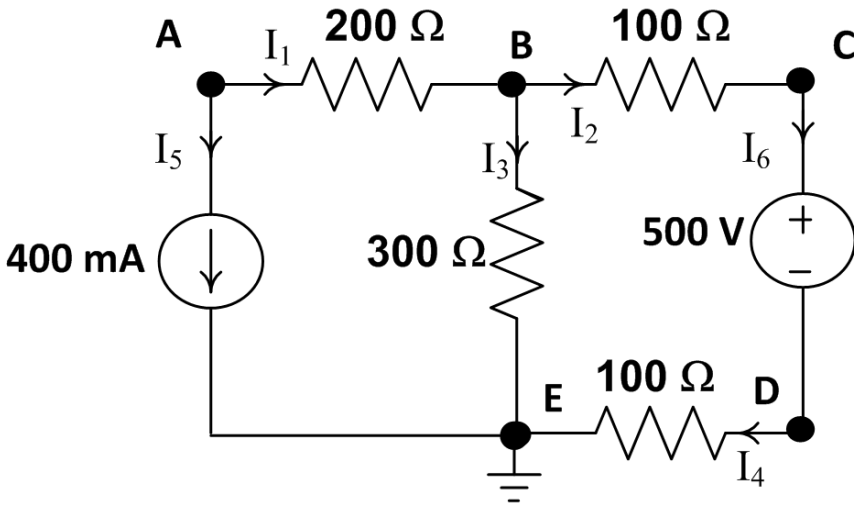
Consider the circuit below.
Solve the circuit to calculate the value of the node voltage V_C. Provide your answer in volts.



QUESTION 10

1 points Save Answer

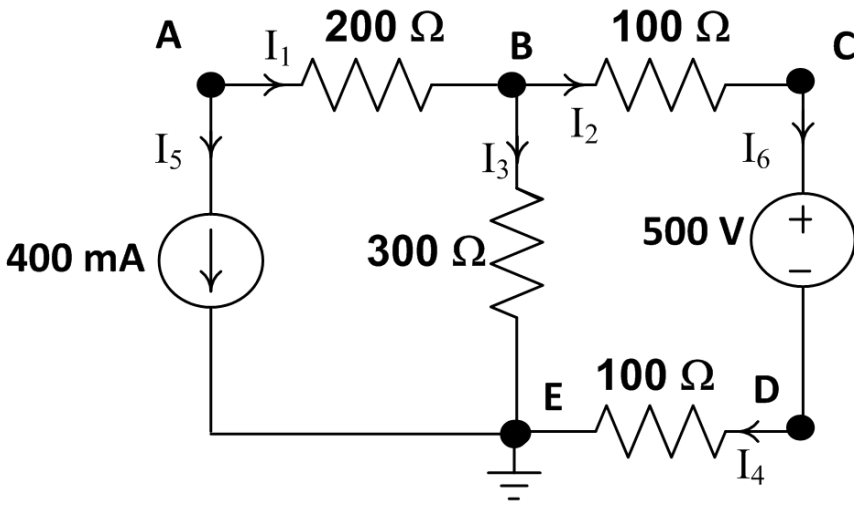
Consider the circuit below.
Solve the circuit to calculate the value of the branch current I_2.
Provide your answer in Amperes.



QUESTION 11

1 points Save Answer

Consider the circuit below.
Solve the circuit to calculate the value of the branch current I_3.
Provide your answer in Amperes.

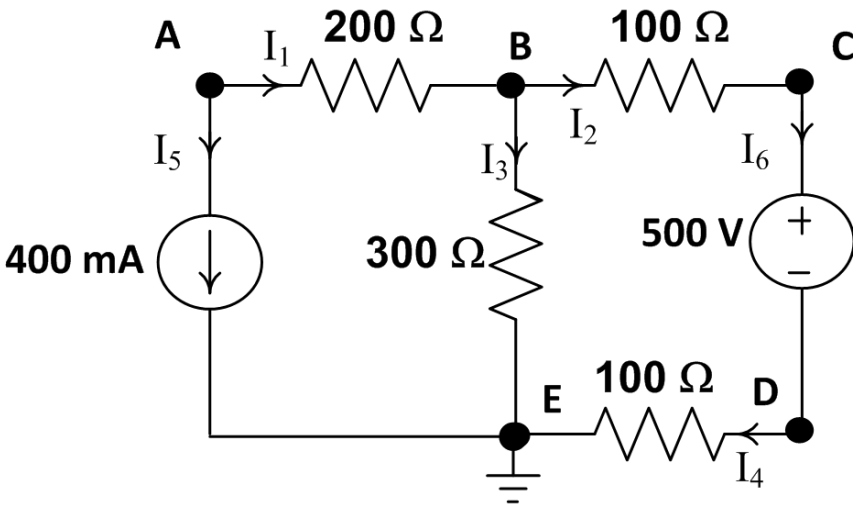


QUESTION 12

1 points | Save Answer

Consider the circuit shown below.

Write an algebraic equation for the power *dissipated* by the current source in terms of the supplied current and node voltage(s).

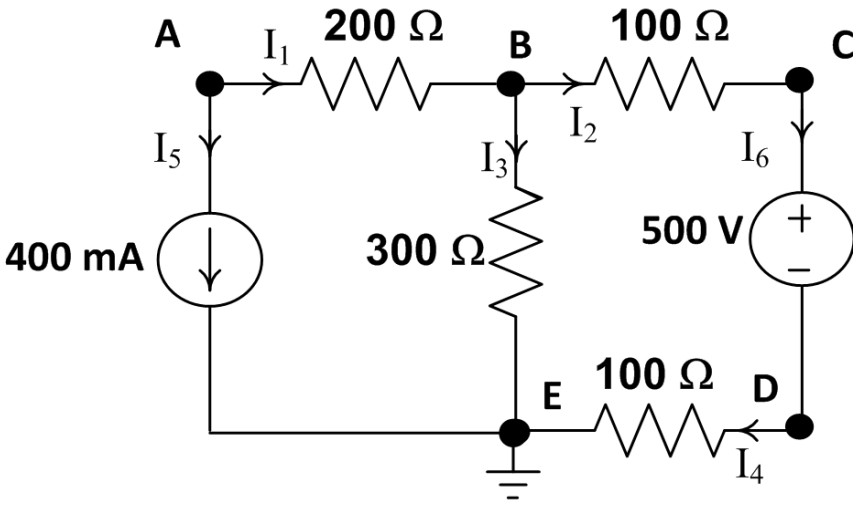


QUESTION 13

1 points | Save Answer

Consider the circuit below.

Solve the circuit to calculate the the value of the power dissipated by the current source (provide your answer in watts).



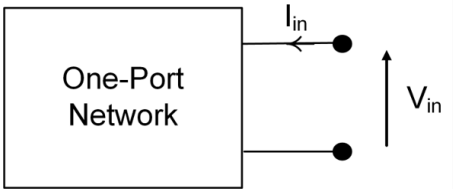
QUESTION 14

1 points Save Answer

All questions in section 2 relate to the figure and table below. This figure and table will be shown at the start of each question. It is suggested that you first read each question; then carefully solve the circuit; and then enter your answers.

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Calculate the Thevenin equivalent circuit of the one port network. What is the value of the Thevenin voltage source? Enter your answer in Volts.



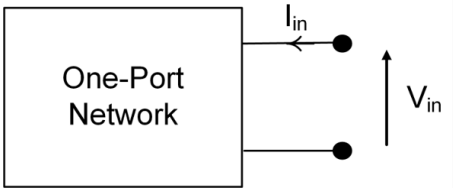
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 15

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Calculate the Thevenin equivalent circuit of the one port network. What is the value of the Thevenin resistance? Enter your answer in Ohms.



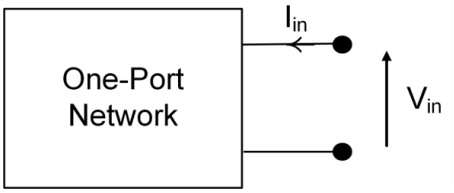
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 16

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Calculate the Norton equivalent circuit of the one port network. What is the value of the Norton Current Source? Enter your answer in milli-amperes.



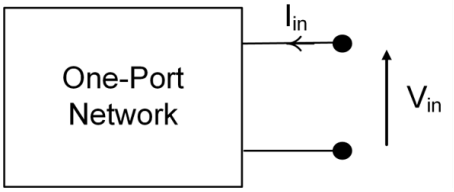
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 17

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Write an algebraic expression for I_{in} if a load resistor is connected across the terminal of the one port-network. Your expression should be in terms of the Thevenin voltage source (V_{TH}), the Thevenin Resistance (R_{TH}) and the load resistor (R). Your answer should NOT include the variable V_{in}.



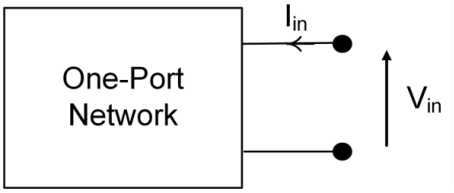
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 18

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Write an algebraic expression for V_{in} if a load resistor is connected across the terminal of the one port-network. Your expression should be in terms of the Norton current source (I_N), the Thevenin Resistance (R_{TH}) and the load resistor (R). Your answer should not include the variable I_{IN}.



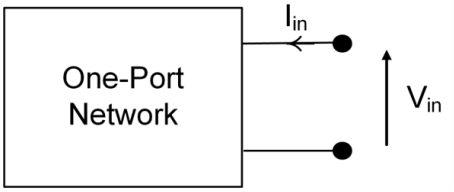
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 19

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Calculate Vin if a 110Ω resistor is connected across the terminal of the one-port network. Enter your answer in Volts



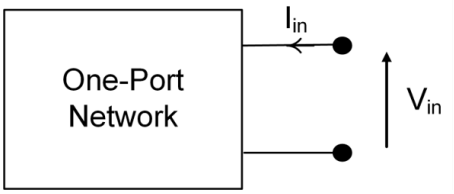
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 20

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

Calculate I_{in} if a 110Ω resistor is connected across the terminal of the one-port network. Enter your answer in milli-amperes.



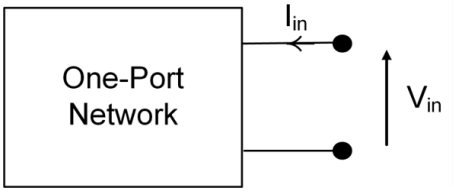
V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 21

1 points Save Answer

Consider the one-port network shown in the figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

A resistor is connected across the terminal of the one-port network. I_{in} is measured as -10mA. What is the value of the resistor? Enter your answer in Ohms.



V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45

QUESTION 22

1 points Save Answer

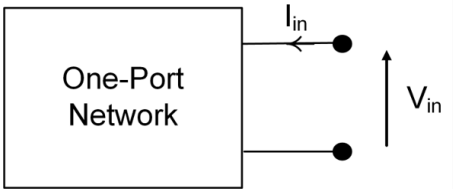
Consider the one-port network shown in the top figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

A light emitting diode (LED) is connected across the terminal of the one-port network as shown in the bottom figure below.

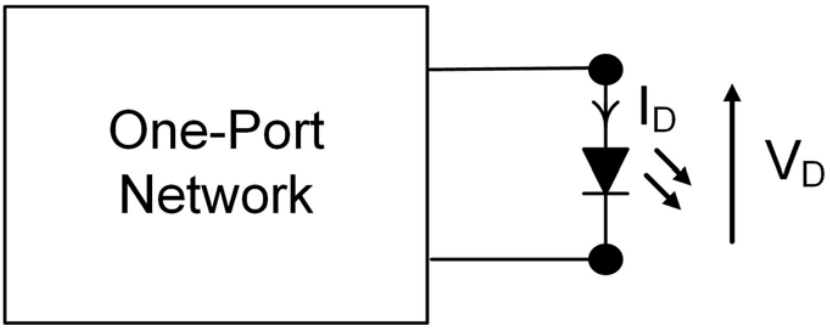
The relationship between the current through the LED (I_D) and the voltage across the LED (V_D) can be modelled by the following piece-wise function:

- I_D = 0 Amperes, for V_D<0.7V
- I_D = 0.0435×V_D - 0.03045 Amperes, for VD≥0.7V

Calculate the value of VD when the LED is connected across the terminal. Enter your answer in volts.



V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45



QUESTION 23

1 points Save Answer

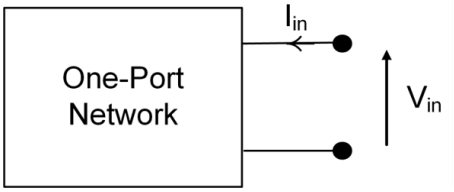
Consider the one-port network shown in the top figure below. The network is known only to consist of independent DC sources and resistors. A number of different components are connected to the port of the network, and the current and voltage are measured, as recorded in in the table.

A light emitting diode (LED) is connected across the terminal of the one-port network as shown in the bottom figure below.

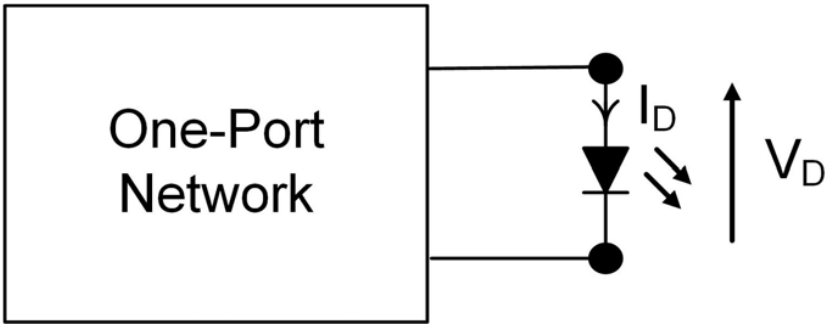
The relationship between the current through the LED (I_D) and the voltage across the LED (V_D) can be modelled by the following piece-wise function:

- I_D = 0 Amperes, for V_D<0.7V
- I_D = 0.0435×V_D - 0.03045 Amperes, for VD≥0.7V

Calculate the value of I_D when the LED is connected across the terminal. Enter your answer in milliamperes.



V_{in} (volts)	I_{in} (milliamps)
3	0
0	-30
-1.5	-45



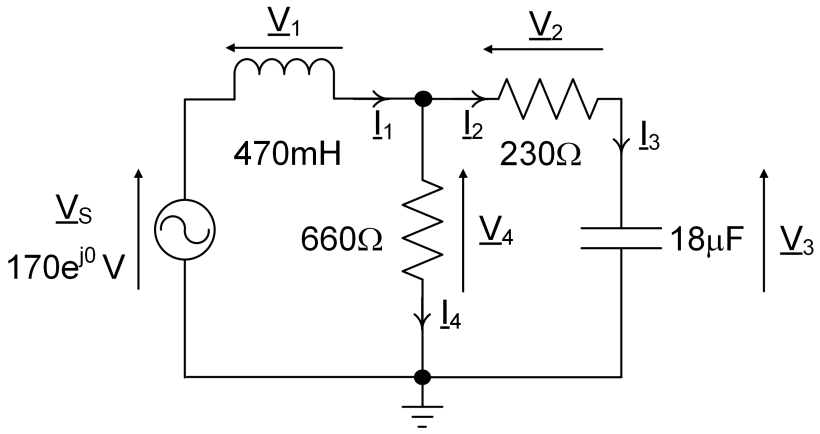
QUESTION 24

1 points Save Answer

All questions in section 3 relate to the circuit below. This circuit will be shown at the start of each question. It is suggested that you first read each question; then carefully solve the circuit; and then enter your answers.

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

What is the impedance of the capacitor (Z_C)? Enter your answer in its rectangular format, i.e. $Z_C = a + jb$ Ohms.

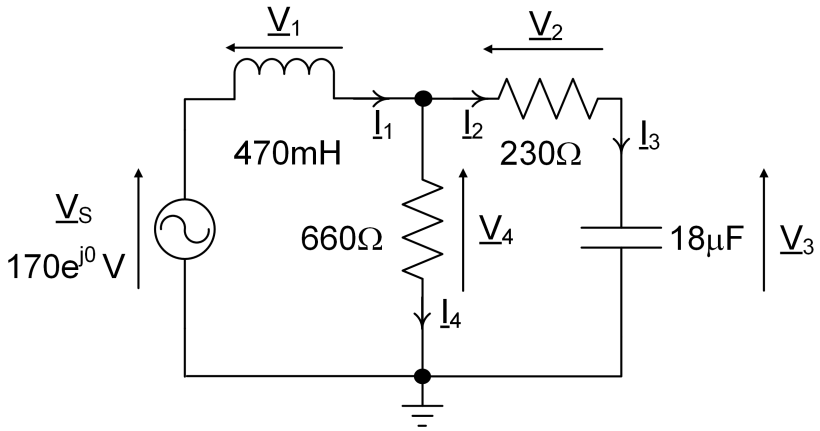


QUESTION 25

1 points Save Answer

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

What is the impedance of the inductor (Z_L)? Enter your answer in its rectangular format, i.e. $Z_L = a + jb$ Ohms.

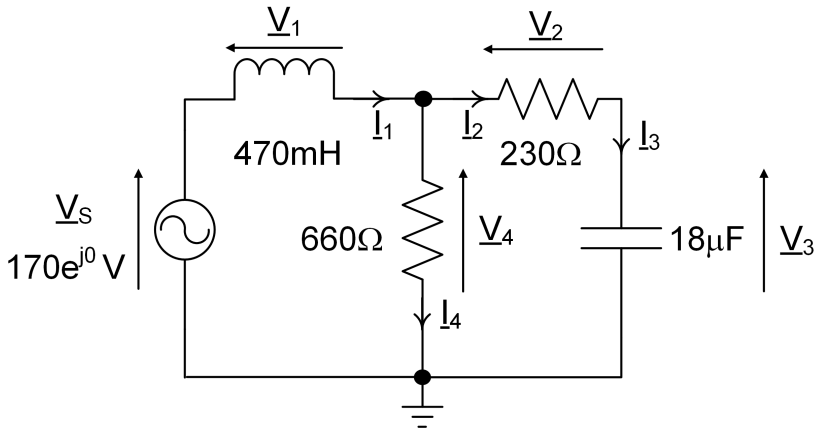


QUESTION 26

1 points Save Answer

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

Write an algebraic expression for the total impedance of the circuit (Z_T) in terms of the impedance of each component (Z_{230}, Z_{660}, ZC, ZL). You can use "||" to represent a parallel combination of components.

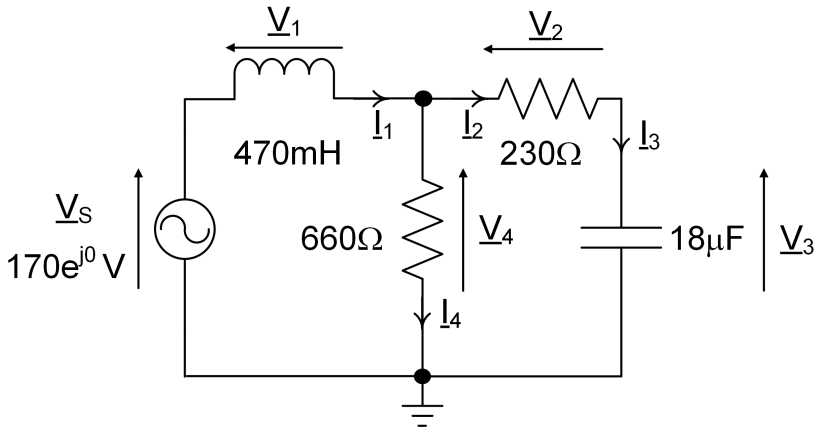


QUESTION 27

1 points Save Answer

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

Calculate the total impedance of the circuit (Z_T). Enter your answer in its rectangular format, i.e. $Z_T = a + jb$ Ohms.



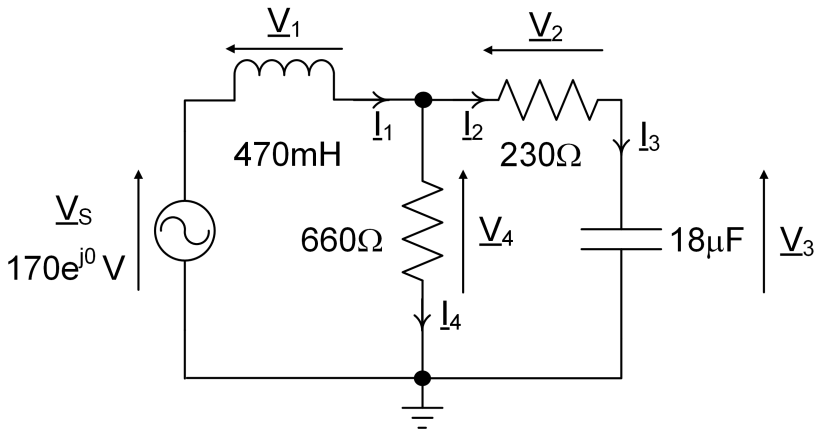
QUESTION 28

3 points Save Answer

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

Solve the circuit in the Figure to calculate the value of the each of the branch currents $\underline{I}_1$, $\underline{I}_2$ and $\underline{I}_4$ as a phasors.

Enter each of your answers in its exponential format, i.e. $\underline{I}_X = ae^{jb}$ Amperes (or $\underline{I}_X$ = ae^(jb) Amperes), with the phase in radians.

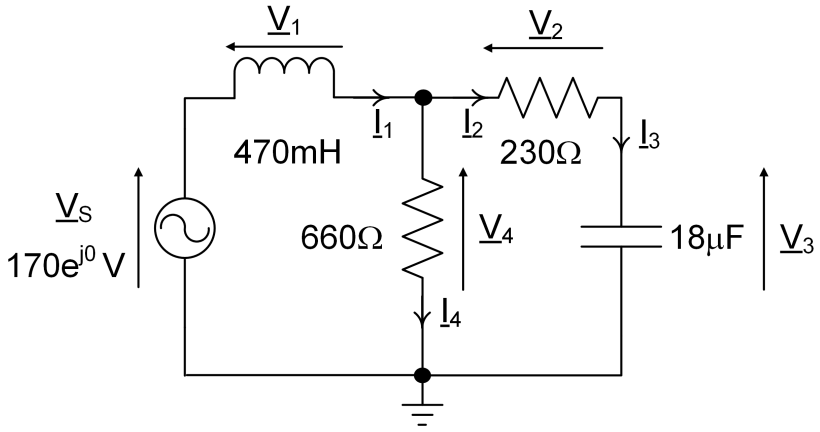


QUESTION 29

1 points Save Answer

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

Write an algebraic expression for the average power supplied by the voltage source. Define any of the branch voltages, branch currents or phase angles you use in your expression that are not explicitly labelled in the figure.

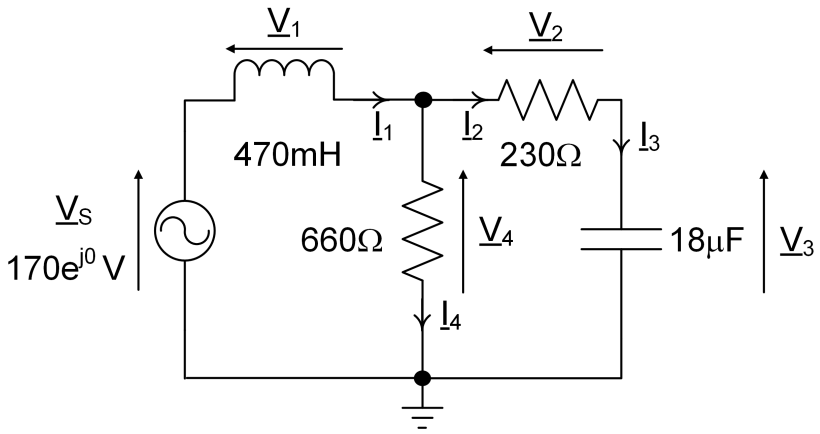


QUESTION 30

1 points Save Answer

Consider the AC circuit shown below. The circuit operates at frequency f =60Hz.

What is the average power supplied by the AC voltage source? Enter your answer in watts.

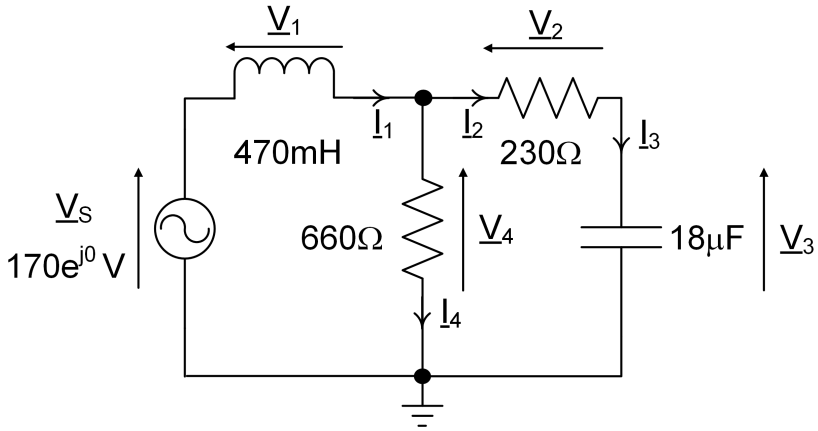


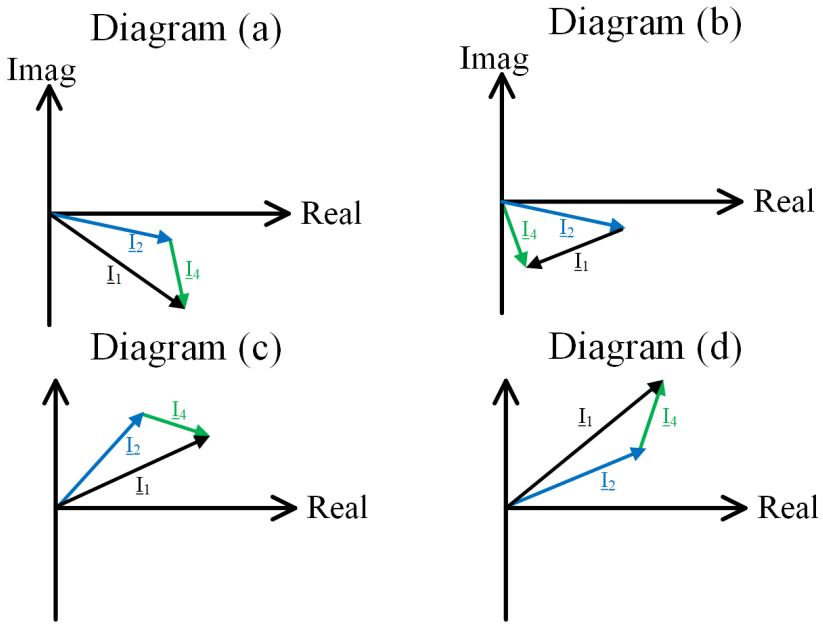
QUESTION 31

1 points Save Answer

Consider the AC circuit shown in the top figure below. The circuit operates at frequency f =60Hz.

Which of the diagrams in the lower figure is a correct conceptual phasor diagram showing that I1 = I2 + I4?





a. Diagram (a)

b. Diagram (b)

c. Diagram (c)

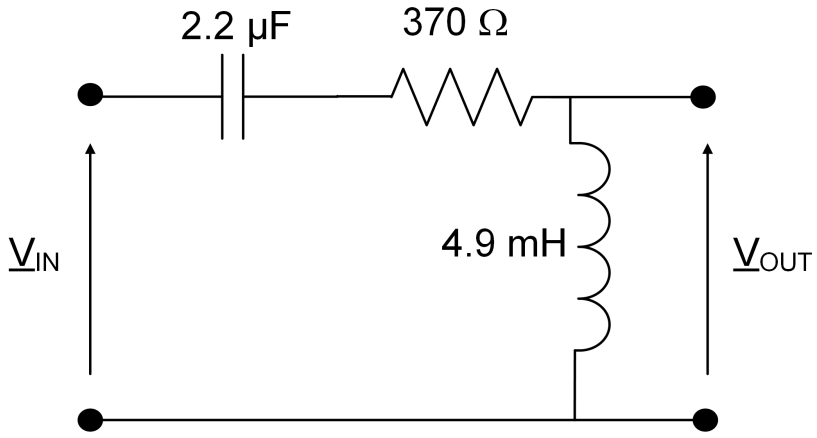
d. Diagram (d)

QUESTION 32

1 points Save Answer

All questions in section 4(a) relate to the filter circuit below. This circuit will be shown at the start of each question. It is suggested that you first read each question; then carefully solve the circuit; and then enter your answers.

Write an algebraic expression for the transfer function of this filter in terms of the component impedances (Z_C, Z_L, and Z_R). You can use "||" to represent a parallel combination of components.

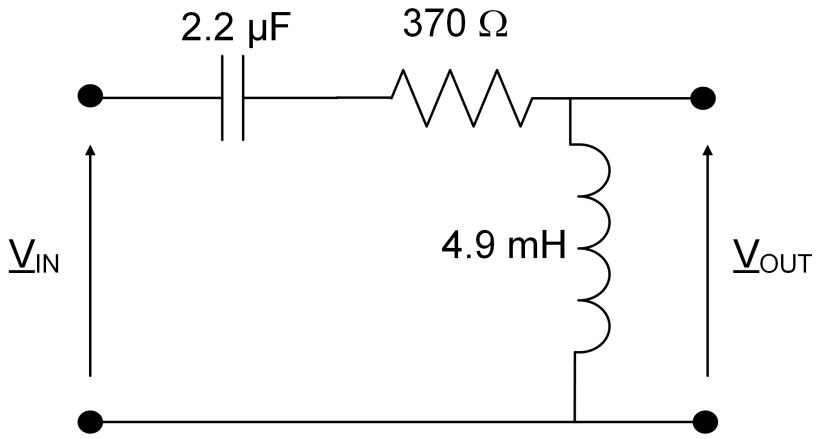


QUESTION 33

1 points Save Answer

Consider the filter circuit below.

Write algebraic expressions for the impedance of the capacitor (Z_C) and the impedance of the inductor (Z_L) in terms of the angular frequency (w) and the component values (C and L respectively). You should not substitute in the numeric component values.



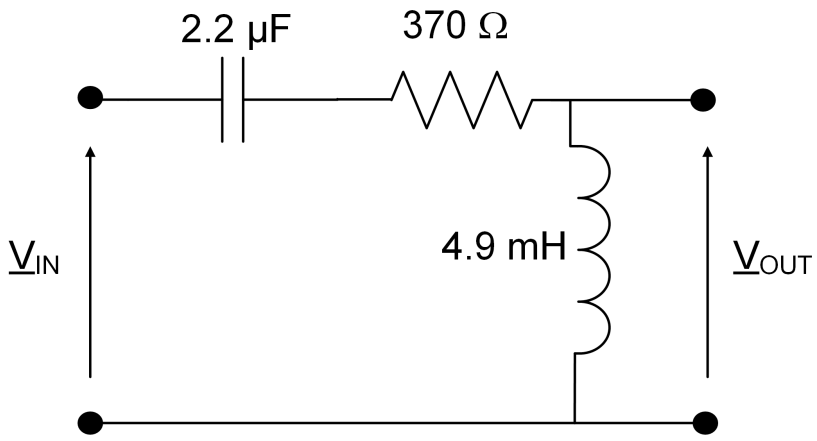
QUESTION 34

2 points Save Answer

Consider the filter circuit below.

Write an expression for the complex transfer function, G(w) of this network. You should simplify the expression such that the numerator is 1.

Do not substitute component values, i.e. the expression should be left in terms of R, C and L representing the values of these components.

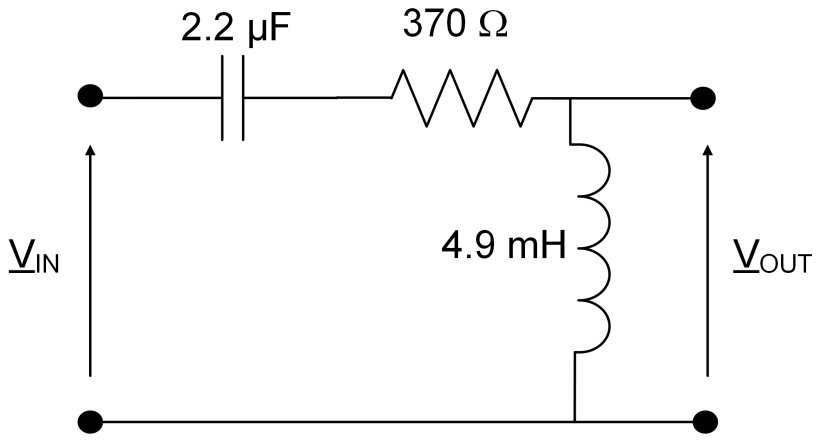


QUESTION 35

1 points Save Answer

Consider the filter circuit below.

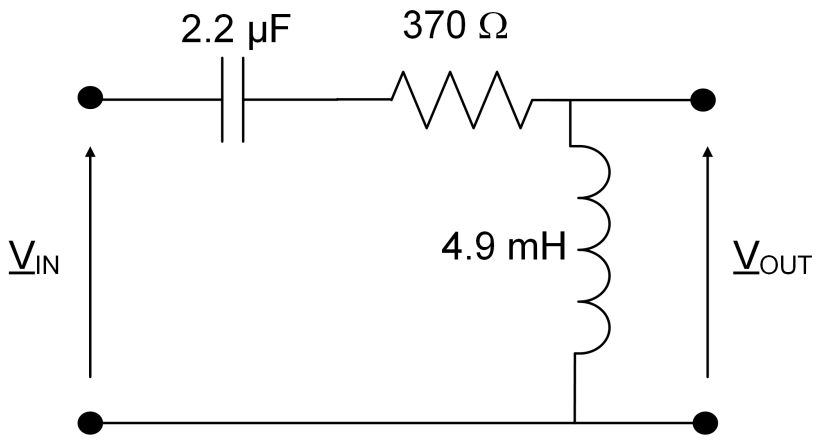
Calculate the phase of the complex transfer function at 10 kHz. Enter your answer in radians.



QUESTION 36

1 points Save Answer

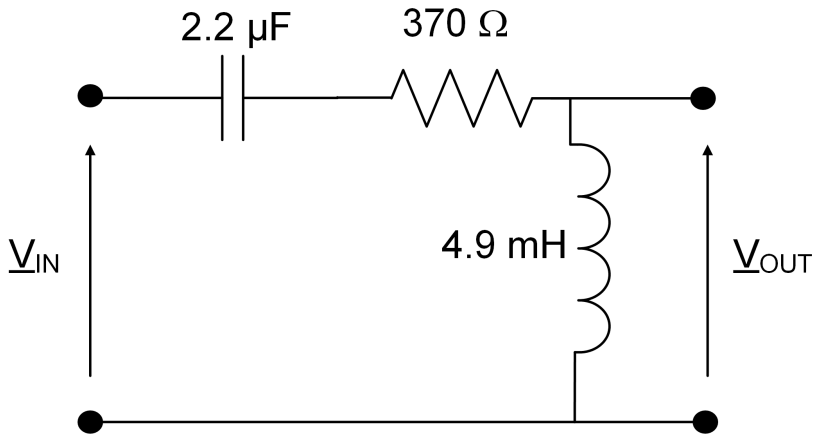
Consider the filter circuit below.
Calculate the gain of the filter at 300Hz. Enter your anser in dB.



QUESTION 37

1 points Save Answer

Consider the filter circuit below.
Calculate the gain of the filter at 3kHz. Enter your anser in dB.

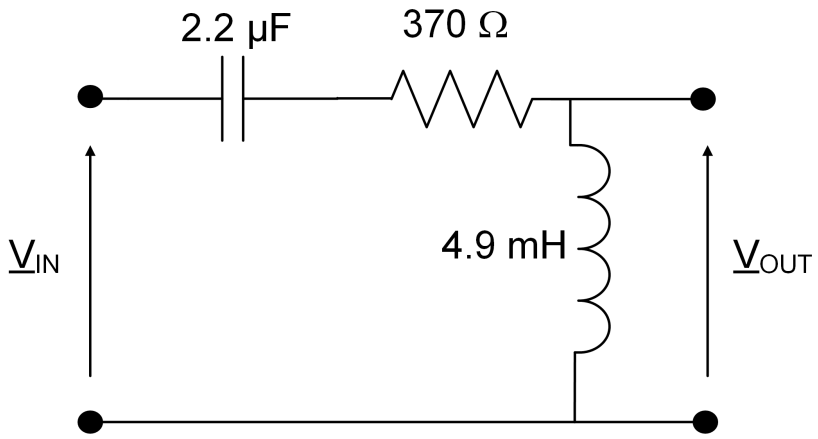


QUESTION 38

1 points Save Answer

Consider the filter circuit below.

You construct the filter circuit, and perform an experiment to measure its cut-off frequency. You observe that the cut-off frequency is approximately 5% higher than the value predicted by a correct theoretical calculation. In 1-2 sentences, explain a likely reason for this difference.



QUESTION 39

2 points Save Answer

In no more than 3-4 short sentences, explain why a fibre optic communications network is able to achieve higher data transmission rates than a traditional “copper wire” communications network.

QUESTION 40

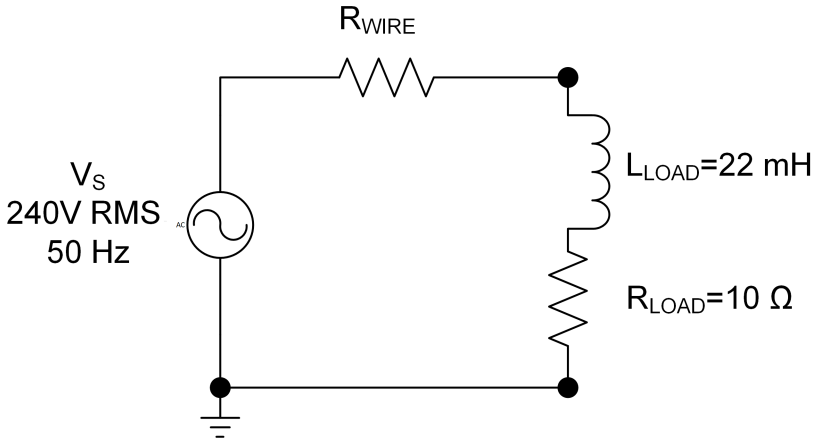
1 points Save Answer

All questions in Section 5(a) relate to the circuit below. This circuit will be shown at the start of each question. It is suggested that you first read each question; then carefully solve the circuit; and then enter your answers.

Consider the figure below which shows the model for an AC power source connected to a pump via a pair of cables. R_{LOAD} + L_{LOAD} represent the pump. R_{WIRE} represents the total resistance of the transmission wire (two cables each 750m long). The electricity cable has the following characteristics:

- Cross-section – circular
- Radius – 1.0 mm
- Material – Copper
- Resistivity – 1.68×10^{-8} Ohm.m

What is the value of the total resistance of the transmission cables, R_{WIRE}? Enter your answer in Ohms.



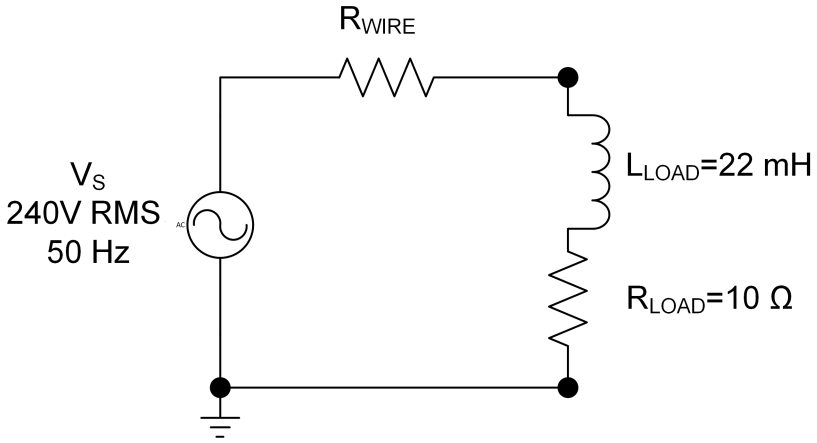
QUESTION 41

1 points Save Answer

Consider the figure below which shows the model for an AC power source connected to a pump via a pair of cables. R_{LOAD} + L_{LOAD} represent the pump. R_{WIRE} represents the total resistance of the transmission wire (two cables each 750m long). The electricity cable has the following characteristics:

- Cross-section – circular
- Radius – 1.0 mm
- Material – Copper
- Resistivity – 1.68×10^{-8} Ohm.m

Calculate the total complex impedance of the system (Z_T, comprised of R_{WIRE}, L_{LOAD} and R_{LOAD}). Write your answer in rectangular format (i.e. Z_T = a + jb Ohms).



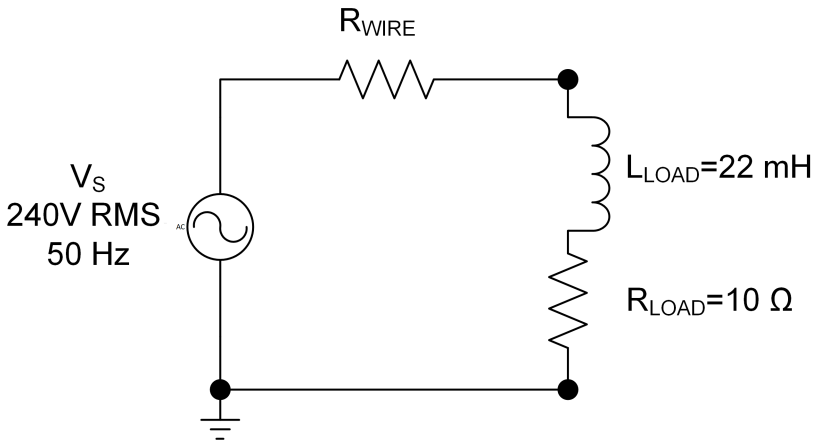
QUESTION 42

1 points Save Answer

Consider the figure below which shows the model for an AC power source connected to a pump via a pair of cables. R_{LOAD} + L_{LOAD} represent the pump. R_{WIRE} represents the total resistance of the transmission wire (two cables each 750m long). The electricity cable has the following characteristics:

- Cross-section – circular
- Radius – 1.0 mm
- Material – Copper
- Resistivity – 1.68×10^{-8} Ohm.m

What is the RMS current that is supplied by the AC voltage source? Enter your answer in the exponential format, i.e. "$I_S = ae^{jb}$ Amperes RMS".



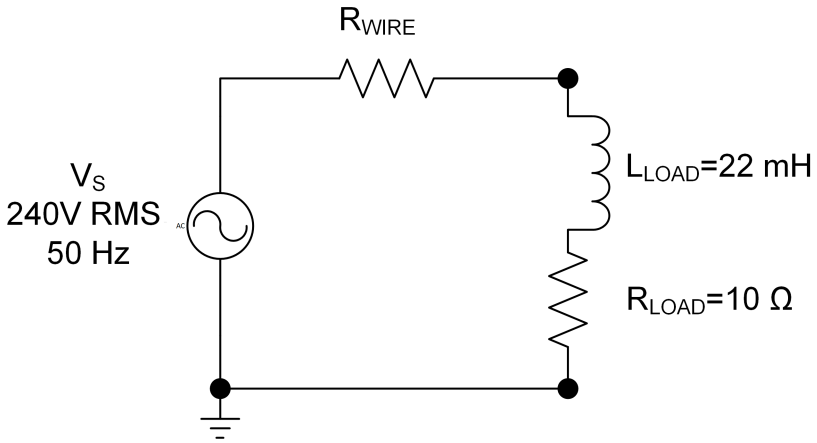
QUESTION 43

1 points Save Answer

Consider the figure below which shows the model for an AC power source connected to a pump via a pair of cables. R_{LOAD} + L_{LOAD} represent the pump. R_{WIRE} represents the total resistance of the transmission wire (two cables each 750m long). The electricity cable has the following characteristics:

- Cross-section – circular
- Radius – 1.0 mm
- Material – Copper
- Resistivity – 1.68×10^{-8} Ohm.m

Write an algebraic expression for the average power (P_{ave}) supplied by the voltage source. Define any terms you use in your expression that are not explicitely shown in the schematic.



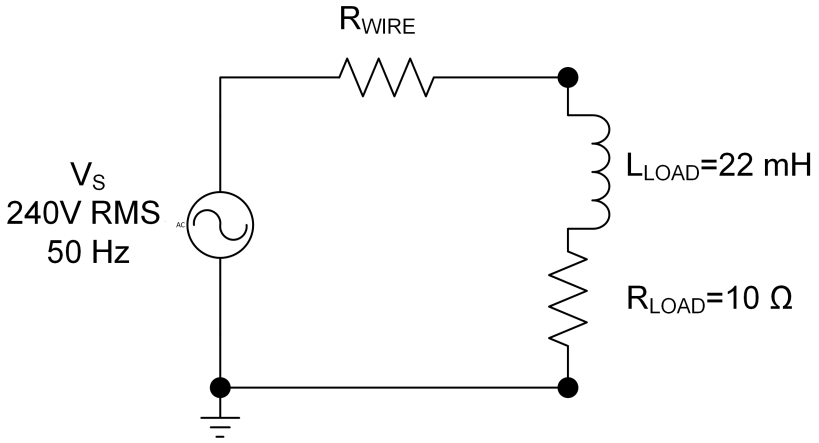
QUESTION 44

1 points Save Answer

Consider the figure below which shows the model for an AC power source connected to a pump via a pair of cables. R_{LOAD} + L_{LOAD} represent the pump. R_{WIRE} represents the total resistance of the transmission wire (two cables each 750m long). An electricity cable has the following characteristics:

- Cross-section – circular
- Radius – 1.0 mm
- Material – Copper
- Resistivity – 1.68×10^{-8} Ohm.m

Calculate the average power supplied by the voltage source V_S. Enter your answer in watts.



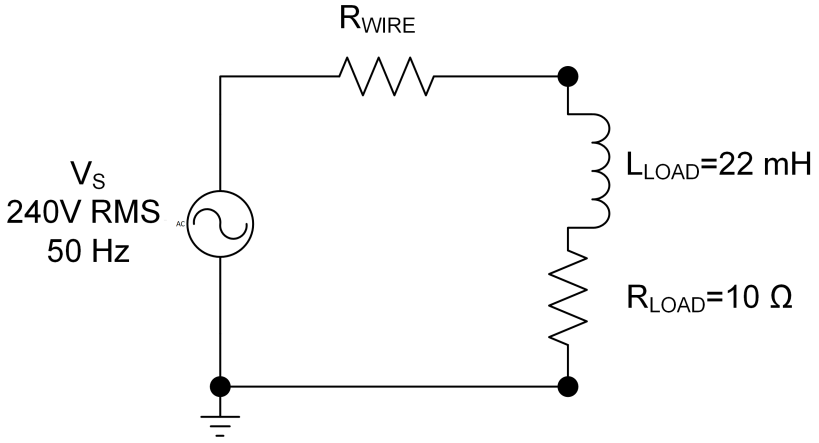
QUESTION 45

2 points Save Answer

Consider the figure below which shows the model for an AC power source connected to a pump via a pair of cables. R_{LOAD} + L_{LOAD} represent the pump. R_{WIRE} represents the total resistance of the transmission wire (two cables each 750m long). An electricity cable has the following characteristics:

- Cross-section – circular
- Radius – 1.0 mm
- Material – Copper
- Resistivity – 1.68×10^{-8} Ohm.m

Calculate the value of a power factor compensation capacitor that would be added in parallel with the pump (i.e. in parallel with R_{LOAD} + L_{LOAD}) to ensure that the power factor of the load is 100% and therefore the power dissipation in R_{WIRE} is minimised. Enter your answer in Micro-Farads (uF).



QUESTION 46

1 points Save Answer

A pole mounted transformer on a suburban street converts 11kV RMS distribution voltages to 240V RMS voltages for supplying domestic power. Calculate and state the turns ratio of this transformer (i.e. Np:Ns).

QUESTION 47

2 points Save Answer

Briefly (in a sentence or two each) describe two technical challenges associated with integrating distributed on-roof solar panels within the existing electricity supply network in Queensland.

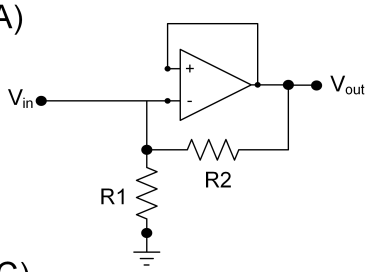
QUESTION 48

2 points Save Answer

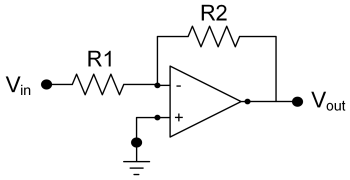
You are required to design an Op-amp Circuit to implement the function: Vout = 0.2Vin.

Consider each of the circuits (A), (B), (C) and (D) in the figure below. State which circuit topology can correctly implement the circuit, and calculate and state values for R1 and R2. Resistor values should be from the E48 series. i.e. "Circuit ('x'), with R1=y Ohms and R2=z Ohms".

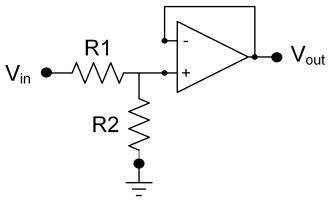
(A)



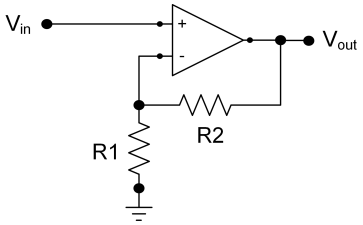
(B)



(C)



(D)



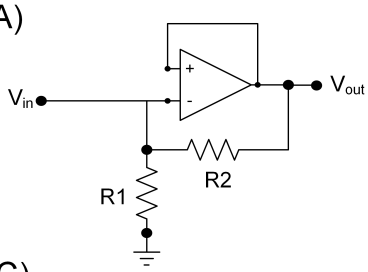
QUESTION 49

2 points Save Answer

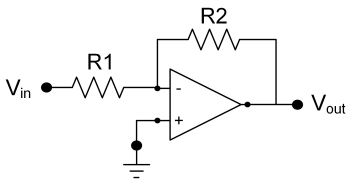
You are required to design an Op-amp Circuit to implement the function: Vout = 12.5Vin.

Consider each of the circuits (A), (B), (C) and (D) in the figure below. State which circuit topology can correctly implement the circuit, and calculate and state values for R1 and R2. Resistor values should be from the E48 series. i.e. "Circuit ('x'), with R1=y Ohms and R2=z Ohms".

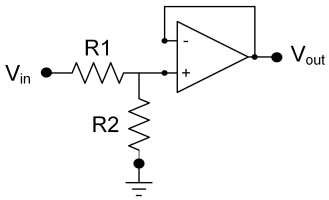
(A)



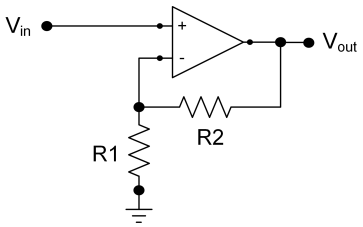
(B)



(C)



(D)

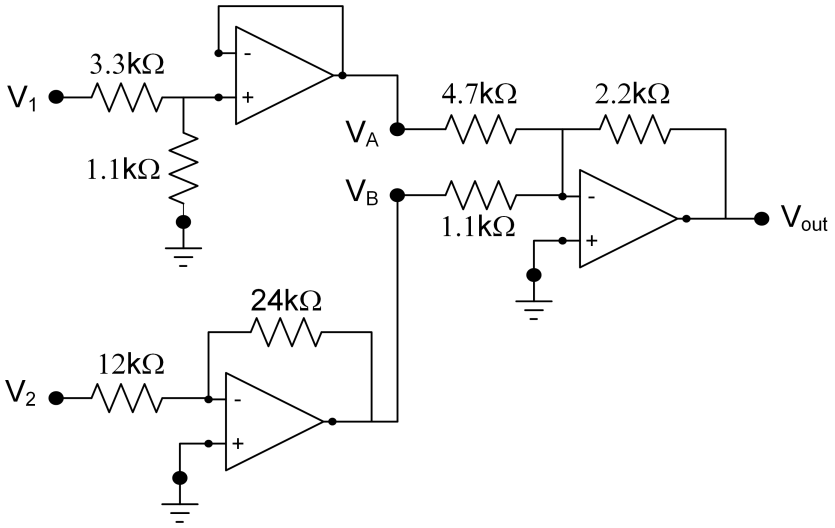


QUESTION 50

1 points Save Answer

All questions in Section 6(b) relate to the circuit below. This circuit will be shown at the start of each question. It is suggested that you first read each question; then carefully solve the circuit; and then enter your answers.

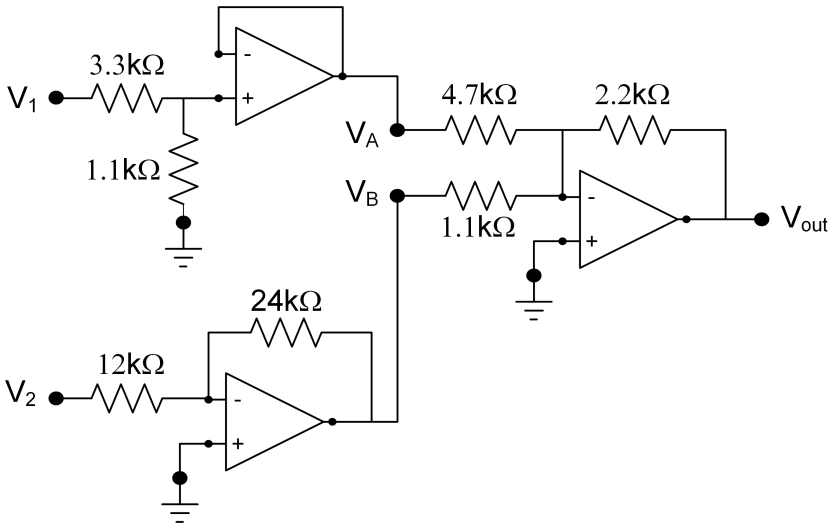
Consider the circuit below. Write an expression for the node voltage V_A as a function of the input voltage V_1.



QUESTION 51

1 points Save Answer

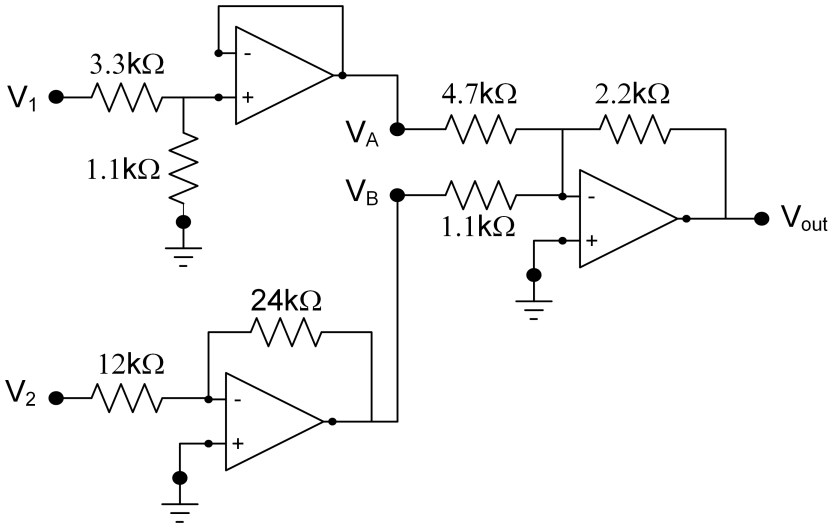
Consider the circuit below. Write an expression for the node voltage V_B as a function of the input voltage V_2.



QUESTION 52

1 points Save Answer

Consider the circuit below. Write an expression for the node voltage V_{out} as a function of the input voltages (V_1 and V_2).



QUESTION 53

2 points Save Answer

In no more than 3-4 short sentences, describe how “proportional control" would operate in the context of a car cruise-control system.

QUESTION 54

1 points Save Answer

In 1-2 sentences, explain one key disadvantage of using proportional control in a car cruise-control system.