THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

This exam paper must not be removed from the venue

Venue _____
Seat Number _____
Student Number |__|__|__|__|__|__|__|__|
Family Name _____
First Name _____

School of Electrical Engineering & Computer Science
In-semester Two Saturday Examinations, 2024
ENGG1300 Introduction to Electrical Systems

This paper is for St Lucia Campus students.

Examination Duration: 90 minutes

Planning Time: 10 minutes

Exam Conditions:

•No written or printed material permitted
•Casio FX82 series or UQ approved and labelled calculator only
•During planning time - students are encouraged to review and plan responses to the exam questions

Materials Permitted in the Exam Venue:
(No electronic aids are permitted e.g. laptops, phones)

None

Materials to be supplied to Students:
Additional exam materials (e.g. answer booklets, rough paper) will be provided upon request.

1 x Gradescope Bubble Sheet

Instructions to Students:

If you believe there is missing or incorrect information impacting your ability to answer any question, please state this when writing your answer.

This exam consists of thirty (30) multiple choice questions. Answer each question on the multiple choice answer sheet provided.

For each question, choose the one answer which is most correct.

Where "none of the above" is the correct answer option, the associated numerical answer will be different to any of the provided numerical answers by at least +/-5%.

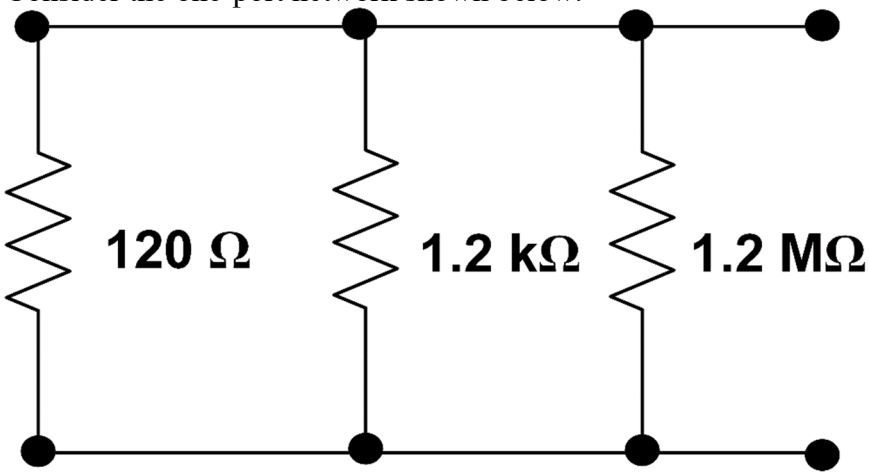
For Examiner Use Only

Question	Mark

Total _____

Question 1.

Consider the one-port network shown below.

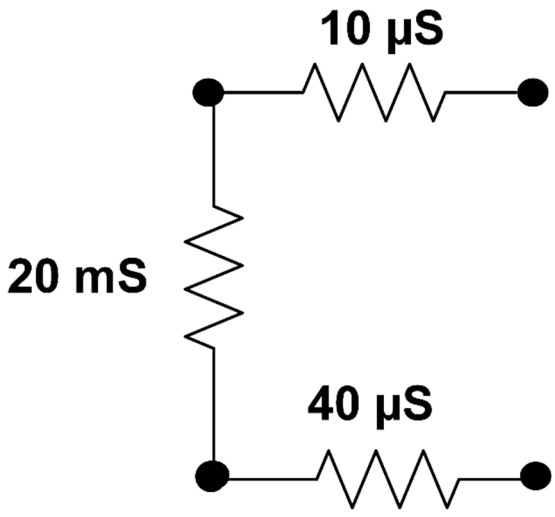


What is the equivalent resistance of this network?

A. 9.167×10^{-5} Ω
B. 109.1 Ω
C. 122.4 Ω
D. 1.201 MΩ
E. None of the above.

Question 2.

Consider the one-port network shown below.
Note that the resistor values are shown as conductances.

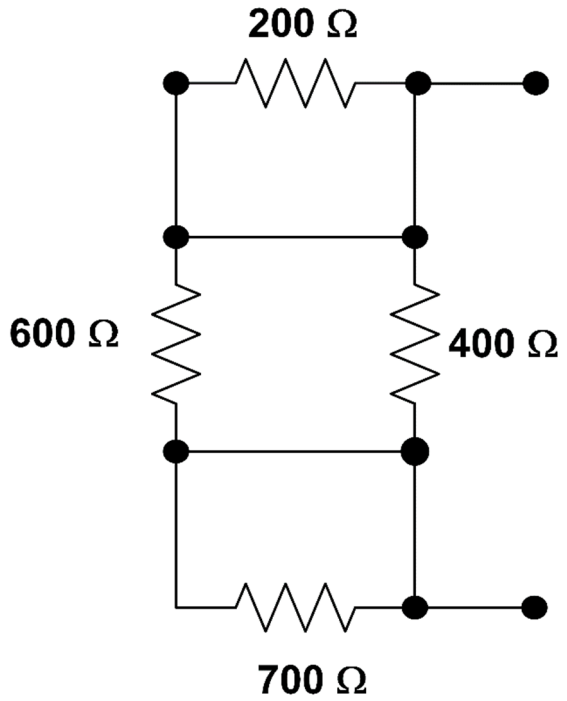


What is the equivalent resistance of this network?

A. 20.005 mΩ
B. 49.875 Ω
C. 125.05 kΩ
D. 7.997×10^{-6} Ω
E. None of the above.

Question 3.

Consider the one-port network shown below.



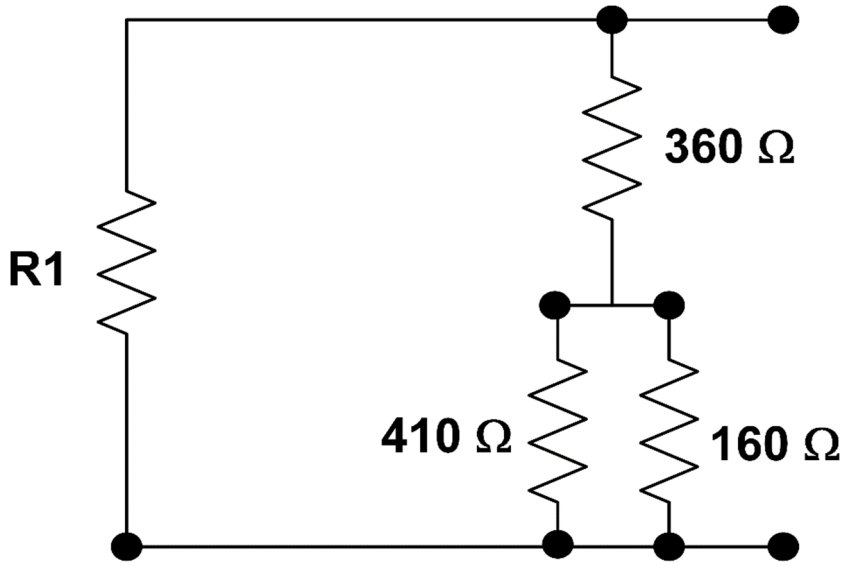
What is the equivalent resistance of this network?

A. 0 Ω
B. 1140 Ω
C. 1900 Ω
D. 240 Ω
E. none of the above.

Space for working

Question 4.

Consider the circuit below.



The equivalent resistance of this network is measured as being 191.21 Ω. What is the value of the resistor R1?

A. 110 Ω
B. 320 Ω
C. A unique value of the resistor R1 **is** able to be calculated with the information provided, but neither (A) or (B) are correct.
D. A unique value of the resistor R1 **is not** able to calculated with the information provided, but there is at least one physical resistor value that satisfies the overall resistance of the network.
E. There is no possible physical resistor value for R1 which satisfies the overall resistance of the network.

Question 5.

Which of the following is a unit of voltage?

A. Volts
B. Amperes
C. $Ohm^{-1}.Coulombs.second^{-1}$
D. Both (A) and (B) are units of voltage.
E. Both (A) and (C) are units of voltage.

Questions (6)−(16) all refer to solution of the circuit below in Figure 1. You are advised to carefully read the questions; then solve the circuit and check your working to make sure it is correct; and finally answer each of the questions.

In all cases be very careful about the sign of the answers.

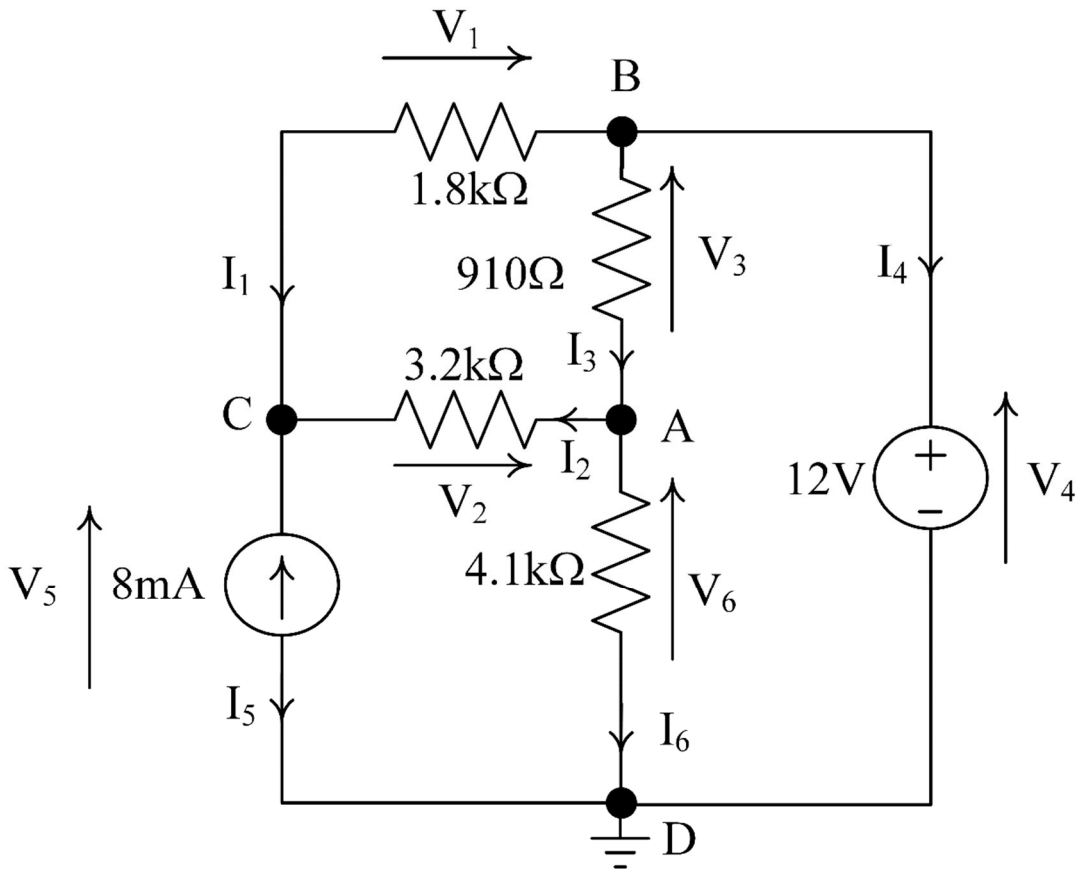


Figure 1: Circuit Schematic for Questions (6)-(16)

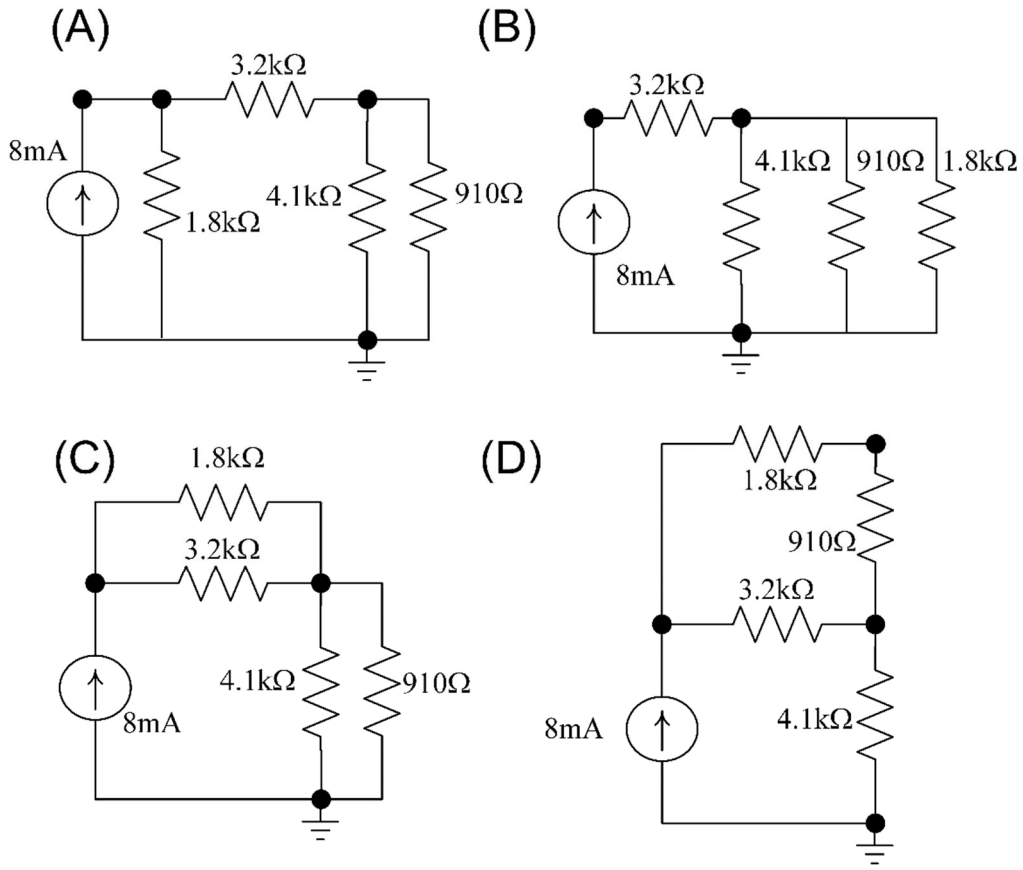
Space for working

Space for working

Question 6

One way to solve linear circuits is the method of *superposition*. When using the method of superposition, which of the following schematics in the figure below is a correct representation of the circuit in Figure 1 when the 12V voltage source is set to zero?

A. Figure (A)
B. Figure (B)
C. Figure (C)
D. Figure (D)
E. None of the above



Question 7

With reference to Figure 1, which of the following is a correct Kirchhoff's Voltage Law Equation?

A. $910I_3 = 1800I_1 + 3200I_2$

B. $3200I_2 = 1800I_1 + 910I_3$

C. $1800I_1 + 910I_3 + 3200I_2 = 0$

D. $1800I_1 = 910I_3 + 3200I_2$

E. None of the above.

Question 8

With reference to Figure 1, which of the following is a correct Kirchhoff's Current Law Equation?

A. $\frac{V_B-V_A}{910}+\frac{V_C-V_A}{3200}+\frac{V_D-V_A}{4100}=0$

B. $\frac{V_B-V_A}{910}+\frac{V_A-V_C}{3200}+\frac{V_A-V_D}{4100}=0$

C. $\frac{V_B-V_A}{910}+\frac{V_A-V_C}{3200}+\frac{V_D-V_A}{4100}=0$

D. $\frac{V_B-V_A}{910}+\frac{V_C-V_A}{3200}+\frac{V_A-V_D}{4100}=0$

E. None of the above.

Question 9

With reference to Figure 1, which of the following is a correct Kirchhoff's Current Law Equation at node D?

A. $I_6 = I_4 + I_5$

B. $I_4 + I_5 + I_6 = 0$

C. $I_5 = I_4 + I_6$

D. It is impossible to write this equation because the current entering the earth connection is unknown.

E. None of answers (A)-(C) are correct, but it is possible to write a correct Kirchoff's Current Law Equation at node D

Question 10

In the circuit shown in Figure 1, what is the value of Current I_5?

A. 11 mA
B. -11 mA
C. 8 mA
D. -8 mA
E. None of the above.

Question 11

In the circuit shown in Figure 1, what is the value of current I_1?

A. 1.54 mA
B. 3.68 mA
C. -1.81 mA
D. -5.16 mA
E. None of the above.

Question 12

In the circuit shown in Figure 1, what is the value of node voltage V_C?

A. 8.78 V
B. 21.3 V
C. -5.71V
D. -12 V
E. None of the above

Question 13

In the circuit shown in Figure 1, what is the value of branch voltage V_2?

A. 9.28 V
B. -9.28 V
C. 12.0 V
D. -12.0 V
E. None of the above.

Question 14

In the circuit shown in Figure 1, what is the value of the power **consumed** by the 8mA current source?

A. -67.1 mW
B. 67.1 mW
C. -170.2 mW
D. 170.2 mW
E. None of the above

Question 15

In the circuit shown in Figure 1, what is the value of the power **consumed** by the 4.1kΩ resistor?

A. 4.67 mW
B. 21.5 mW
C. 69.5 mW
D. 121.9 mW
E. None of the above

Question 16

In the circuit shown in Figure 1, what is the value of the total power **consumed** by all the resistors in the circuit (i.e. including the 910Ω, 1.8kΩ, 3.2kΩ and 4.1kΩ resistors)?

A. 0 W
B. 65.7 mW
C. 108.3 mW
D. 328.4 mW
E. None of the above.

Questions (17)−(19) all involve analysis of the one−port network shown below in Figure 2. In particular, you will be asked to calculate key values corresponding to Thevenin and Norton equivalent circuits.

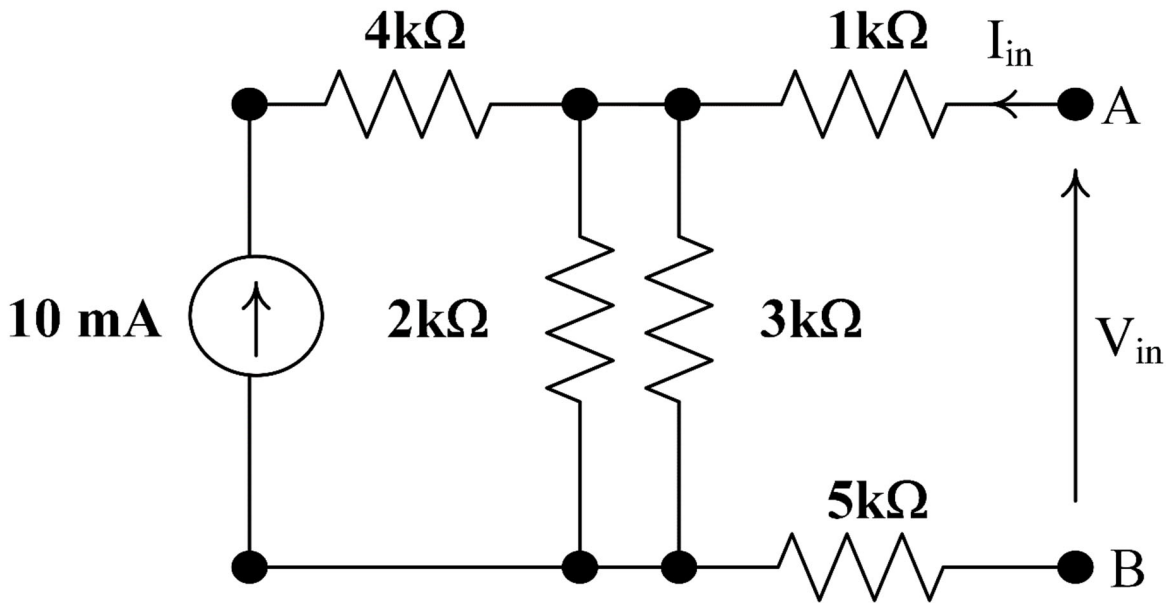


Figure 2: Circuit Schematic for Questions (17)-(19)

Space for working

Question 17

If the one-port network of Figure 2 is replaced by its Thevenin Equivalent Circuit, what is the value of the voltage source in that equivalent circuit, V_T?

A. 12.0 V
B. 52.0 V
C. 200.0V
D. 2.31 mV
E. None of the above.

Question 18

If the one-port network of Figure 2 is replaced by its Thevenin Equivalent Circuit, what is the value of the series resistor in that equivalent circuit, R_T?

A. 923.0 Ω
B. 1200.0 Ω
C. 6923.1 Ω
D. 7200.0 Ω
E. None of the above.

Question 19

If the one-port network of Figure 2 is replaced by its Norton Equivalent Circuit, what is the value of the current source in that equivalent circuit, I_N?

A. 1.667 mA
B. 7.22 mA
C. 10.0 mA
D. 305.6 mA
E. None of the above.

Space for working

For Questions (20)-(23), consider the circuit schematic in Figure 3 below which contains a non-linear light emitting diode (LED). The I-V characteristic curve for the LED is shown in Figure 4.

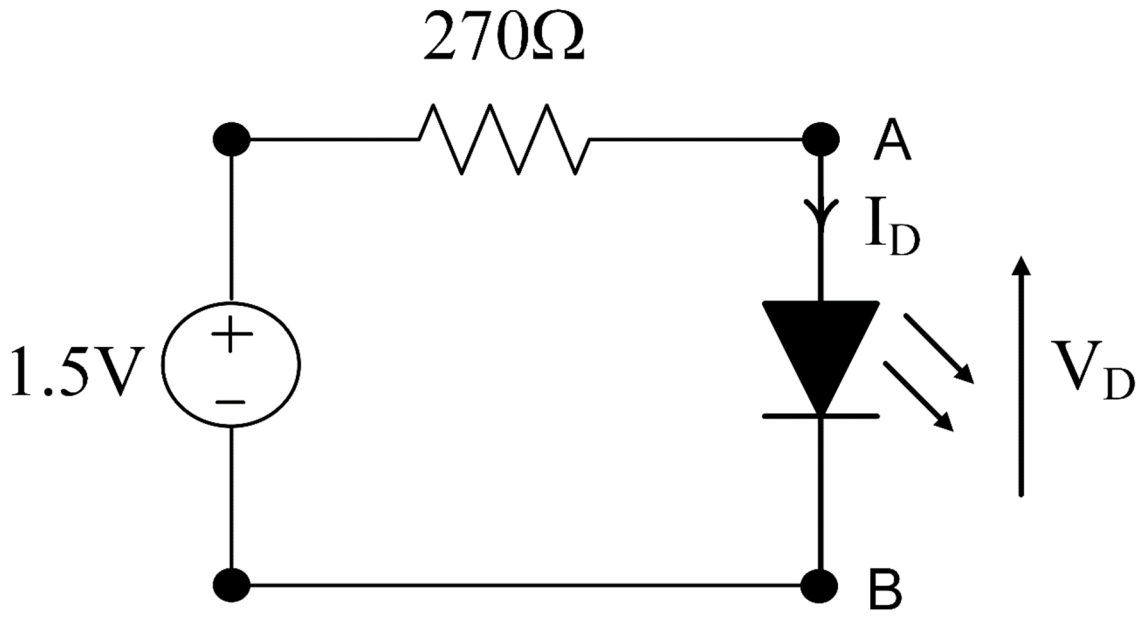


Figure 3: Circuit Schematic for Questions (20)-(23)

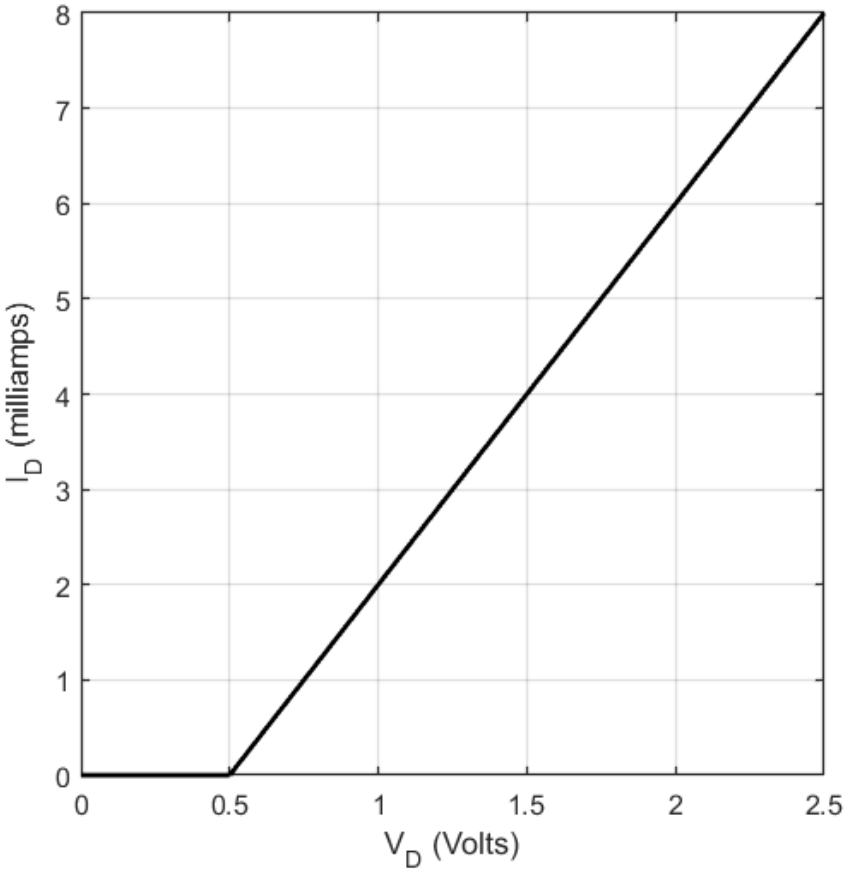


Figure 4: The I-V characteristics of the LED described in questions (20)-(23)

Question 20.

Given the circuit schematic of Figure 3 and the diode I−V characteristic of Figure 4, which of the following is closest to the value of V_D?

A. 0.75 V
B. 1.0 V
C. 1.25 V
D. 1.5 V
E. V_D is either ≤0.5V; or ≥1.75V.

Question 21.

Given the circuit schematic of Figure 3 and the diode I−V characteristic of Figure 4, which of the following is closest to the value of I_D?

A. 1 mA
B. 2 mA
C. 3 mA
D. 4 mA
E. I_D is either ≤0.5mA; or ≥4.5 mA.

Question 22.

With respect to the schematic in Figure 3, and the diode I−V characteristic of Figure 4, what percentage of the power supplied by the voltage source is dissipated by the LED? Choose the closest answer.

A. 0 %
B. 33%
C. 50 %
D. 67%
E. 100%

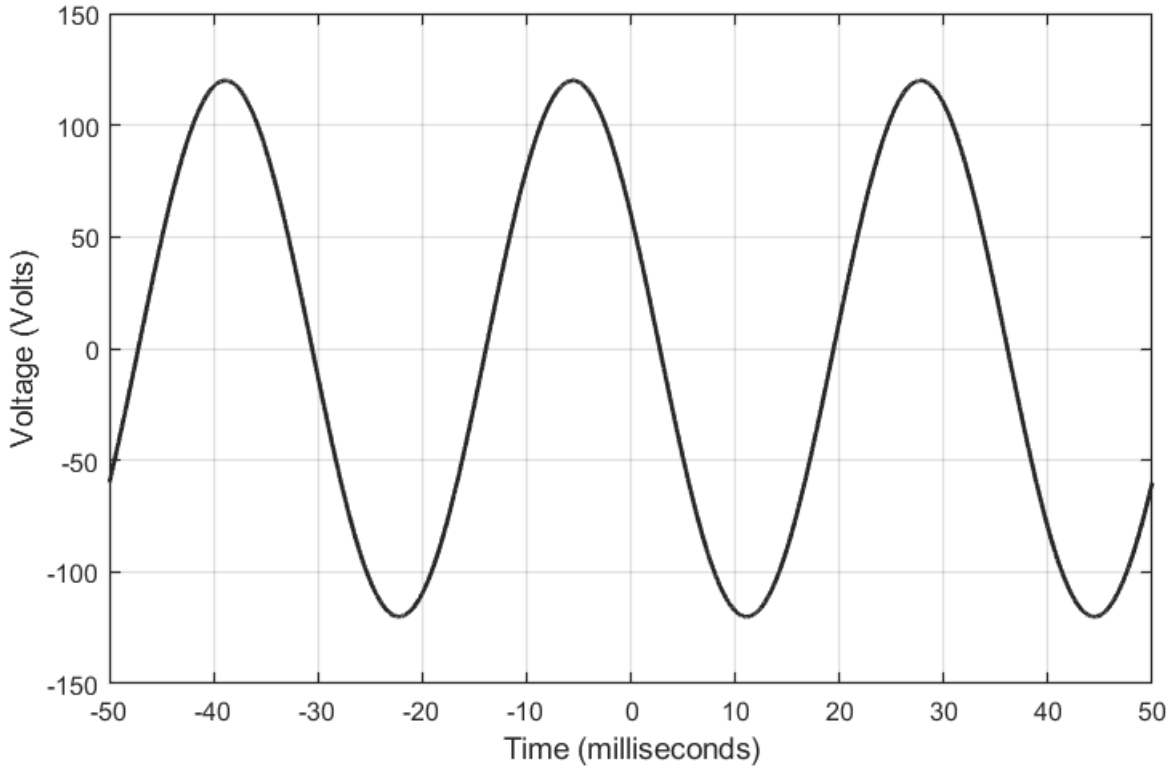
Question 23.

In a particular application, you need to ensure that the current through the diode, I_D is set to 3mA. You are able to modify the circuit in Figure 3 by replacing the voltage source with another value in order to achieve this desired current (however the resistor should remain the same, and you should use an identical LED). What value voltage source should you choose? Choose the closest answer.

A. 1.0 V
B. 1.5 V (No change in voltage source is required)
C. 2.0 V
D. 2.5 V
E. The voltage source should be selected to be to be ≤0.5V; or ≥3.0V

Question 24

A sinusoidal voltage is displayed in the figure below.



Which of the following equations best models the sinusoidal voltage displayed?

A. $Vs(t) = 120Cos(30t - 0.006)$
B. $Vs(t) = 240Cos(30t - 0.006)$
C. $Vs(t) = 240Cos(190t + 1.05)$
D. $Vs(t) = 120Cos(190t + 1.05)$
E. $Vs(t) = 240Cos(30t - 1.05)$

Question 25.

Which of the following expressions correctly models the voltage *v(t)* across an inductor (with inductance L) to the current *i(t)* through the inductor?

A. $v(t) = L \times i(t)$

B. $v(t) = \frac{1}{L} \times i(t)$

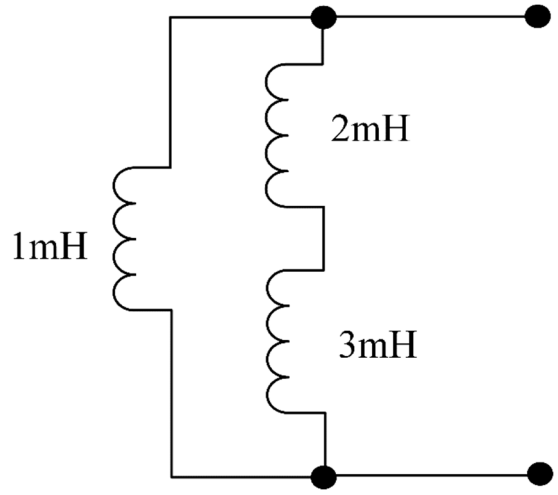
C. $i(t) = \frac{1}{L} \int v(t)\, dt$

D. $i(t) = L \frac{dv(t)}{dt}$

E. None of the above

Question 26.

Consider the one-port network shown below:

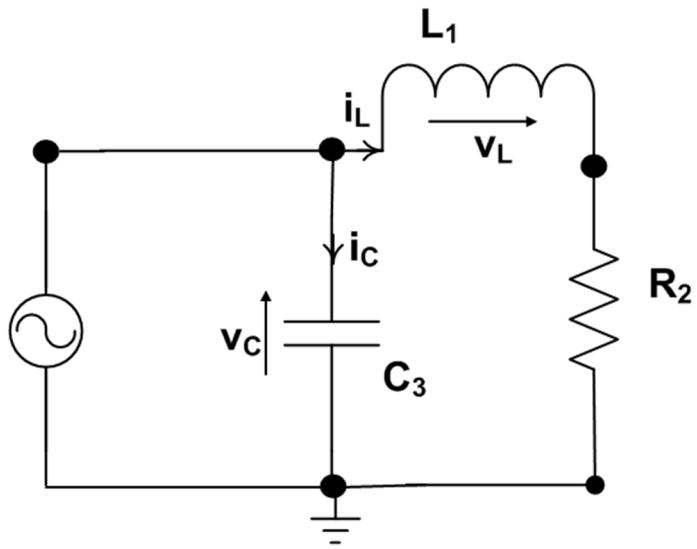


What is the equivalent inductance of this network?

A. 6.00 mH
B. 2.20 mH
C. 0.174 mH
D. 0.833 mH
E. None of the above.

Question 27.

In the circuit shown below, $L_1 = 2mH$, $R_2 = 1.2k\Omega$, $C_3 = 0.1\ \mu F$.

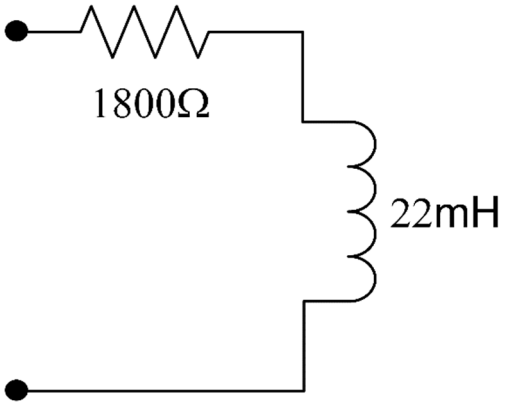


At a particular instant of time, $v_c = 3V$, $i_c = 2A$, $v_L = -4V$, $i_L = -5A$.
At that instant of time, how much energy is stored in the inductor?

A. 25 mJ
B. 16 mJ
C. 20 J
D. -20 J
E. None of the above.

Question 28.

Consider the one-port network shown below.



If the frequency of operation is 5kHz, what is the equivalent impedance of this network?

A. $1800 + j691.2\ \Omega$
B. $1800 + j0.022\ \Omega$
C. $1800 - j1.447\times10^{-3}\ \Omega$
D. $1800.022\ \Omega$
E. None of the above

Space for working

Questions (29)-(30) refer to solution of the circuit below in Figure 5. You are advised to carefully read the questions; then solve the circuit and check your working to make sure it is correct; and finally answer each of the questions.

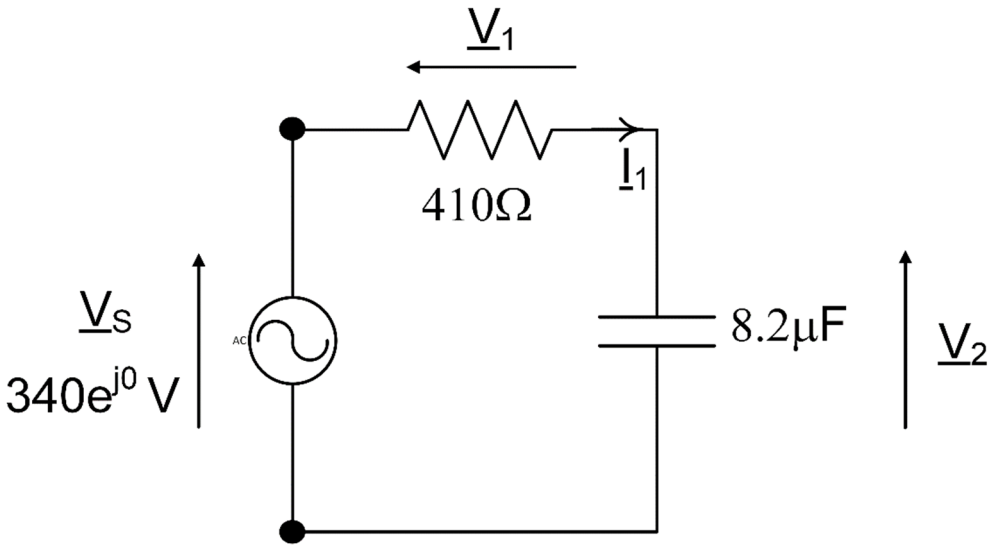


Figure 5: Circuit Schematic for questions (29)-(30)

Question 29.

Refer to the circuit in the Figure 5. The frequency of the AC voltage source is 50Hz. What is the value of the phasor current ($\underline{I_1}$)?

A. $0.829e^{j0}$V
B. $0.829e^{-j6.28\times10^{-6}}$V
C. $0.602e^{j0.75}$A
D. $0.461e^{j0.35}$V
E. None of the above.

Question 30.

Refer to the circuit in the figure 5. The frequency of the AC voltage source is 50Hz. What is the value of the phasor voltage across the capacitor ($\underline{V_2}$)?

A. $5.51e^{j0}$V
B. $47.31e^{-j1.23}$V
C. $174.27e^{-j0.37}$V
D. $233.69e^{-j0.82}$V
E. None of the above.

Space for working

Space for working

END OF EXAMINATION