THE UNIVERSITY OF QUEENSLAND

School of Information Technology and Electrical Engineering

Mid-Semester Test

ENGG1300

Introduction to Electrical Systems

Time: **TEN (10)** minutes planning time
NINETY (90) minutes for working

THIS EXAM CONSISTS OF THIRTY (30) MULTIPLE CHOICE QUESTIONS. ANSWER EACH QUESTION ON THE MULTIPLE CHOICE ANSWER SHEET PROVIDED.

During planning time, you are encouraged to review the entire exam and plan the order you will answer questions. You are allowed to complete working and enter your answers during this time.

This examination is closed book – No materials permitted.

No electronic aids are permitted (e.g. laptops, phones).

A casio FX-82 series calculator or a UQ approved calculator (with label) is allowed.

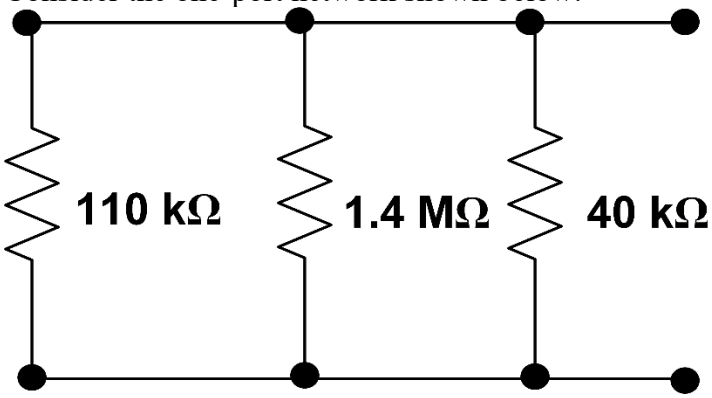
Each question is worth ONE (1) mark each.

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

In a question requiring a numerical answer 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%.

Question 1.

Consider the one-port network shown below.

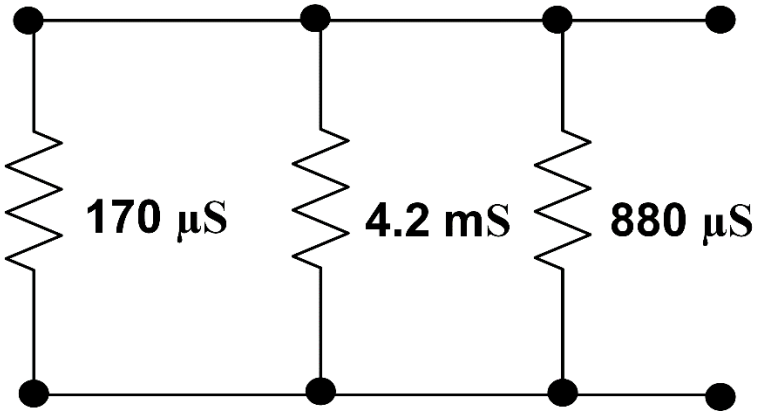


What is the equivalent resistance of this network?

A. 1.54 MΩ
B. 151.4 kΩ
C. 3.481×10^{-5} Ω
D. 28.731 kΩ
E. None of the above.

Question 2.

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

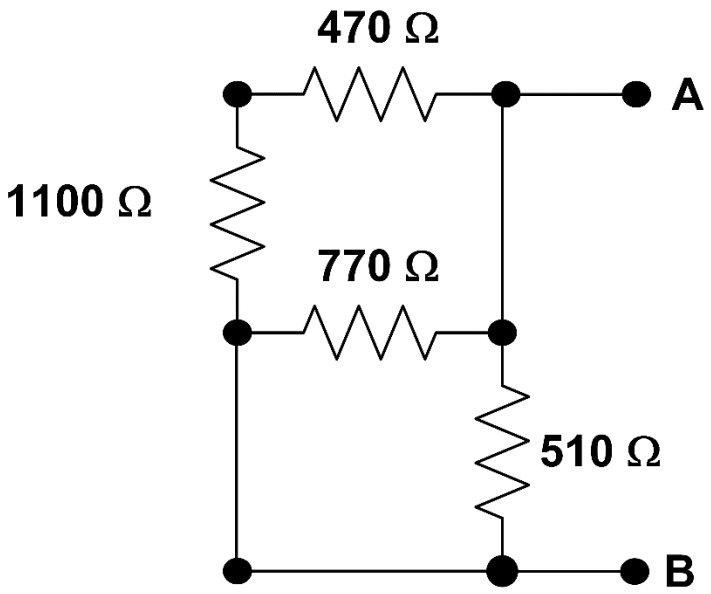


What is the equivalent resistance of this network?

A. 5.25 mΩ
B. 190.5 Ω
C. 7018.7 Ω
D. 0.1424 mΩ
E. None of the above.

Question 3.

Consider the one-port network shown below.



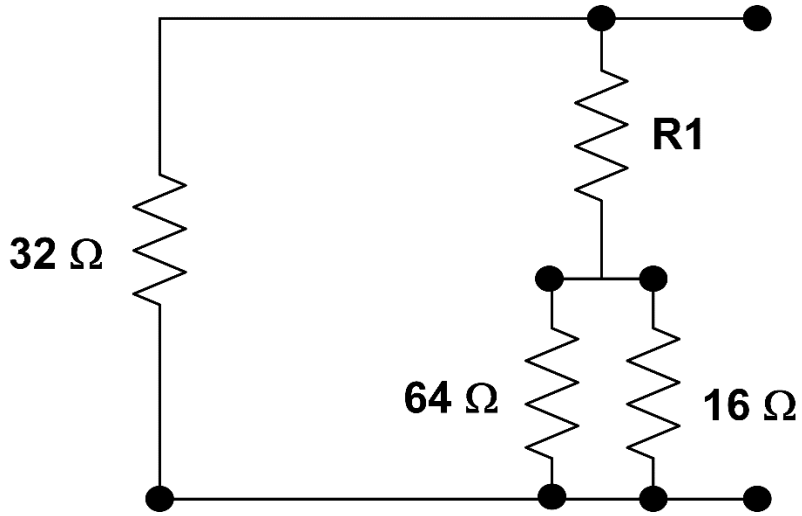
What is the equivalent resistance of this network?

A. 510.0 Ω
B. 1570 Ω
C. 256.6 Ω
D. 158.8 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 12.61Ω. What is the value of the resistor R1?

A. 4.3 Ω
B. 664 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 current?

A. Joules
B. Amperes
C. Coulombs.second^{-1}
D. Both (A) and (B) are units of current
E. Both (B) and (C) are units of current.

Questions (6)−(17) 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.

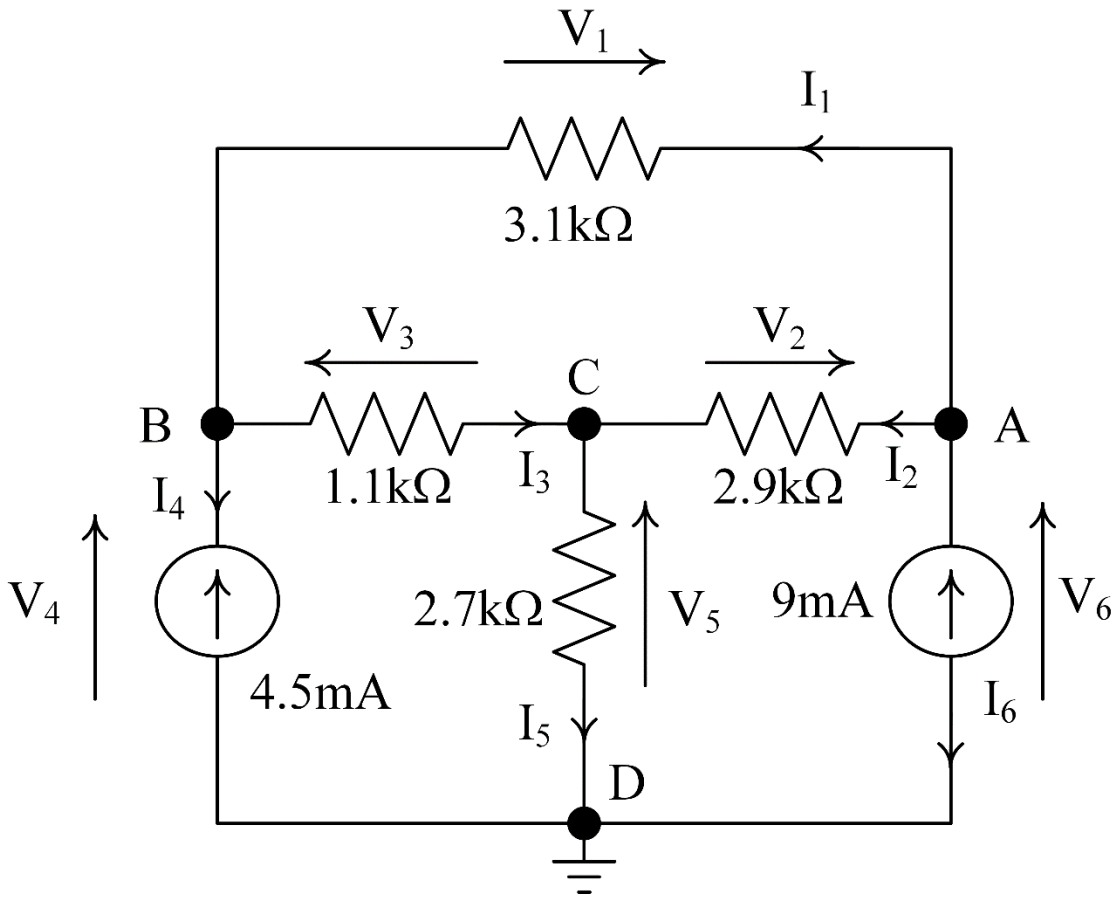


Figure 1: Circuit Schematic for Question (6)-(17)

Space for working

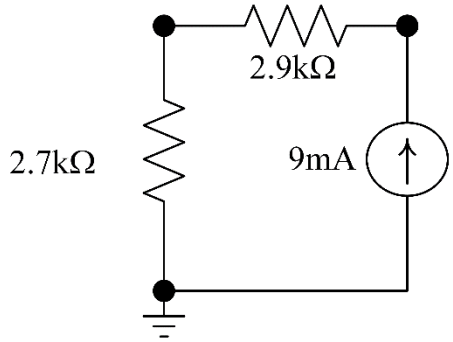
Space for working

Question 6

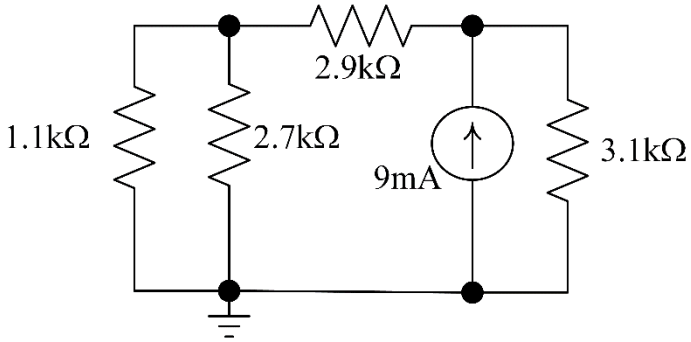
One way to solve linear circuits is the method of *superposition*. When using the method of superposition, which of the following schematics in the figure below is a correct representation of the circuit when the 4.5mA current source is set to zero?

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

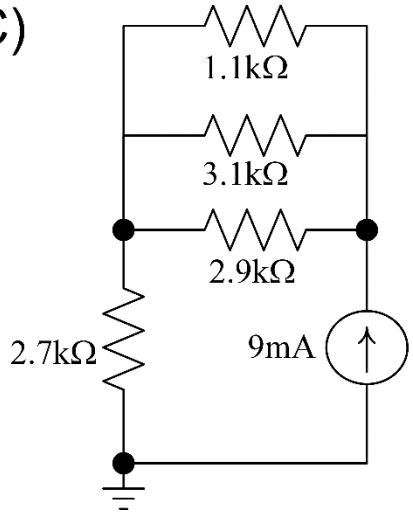
(A)



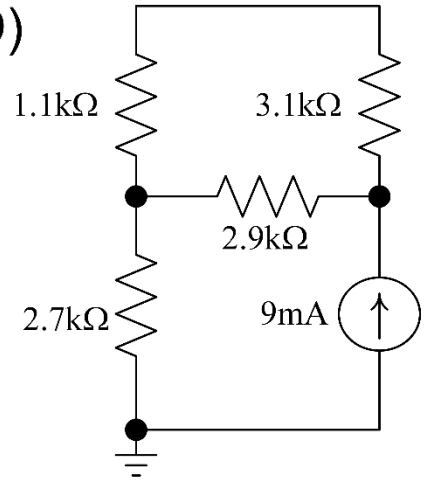
(B)



(C)



(D)



Question 7

When using the method of superposition, what is the value of the voltage V_5 when the 9mA current source is set to zero?

A. 12.15 V
B. -12.15 V
C. 4.65 V
D. -4.65 V
E. None of the above

Question 8

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

A. $1100I_3 + 3100I_1 + 2900I_2 = 0$

B. $1100I_3 + 3100I_1 = 2900I_2$

C. $3100I_1 + 2900I_2 = 1100I_3$

D. $1100I_3 + 2900I_2 = 3100I_1$

E. None of the above.

Question 9

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

A. $\frac{V_B - V_C}{1100} + \frac{V_A - V_C}{2900} + \frac{V_D - V_C}{2700} = 0$

B. $\frac{V_C - V_B}{1100} + \frac{V_A - V_C}{2900} + \frac{V_D - V_C}{2700} = 0$

C. $\frac{V_B - V_C}{1100} + \frac{V_C - V_A}{2900} + \frac{V_D - V_C}{2700} = 0$

D. $\frac{V_B - V_C}{1100} + \frac{V_C - V_A}{2900} + \frac{V_C - V_D}{2700} = 0$

E. None of the above.

Question 10

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

A. $I_4 + I_6 - I_5 = 0$

B. $I_4 - I_6 + I_5 = 0$

C $-I_4 + I_6 + I_5 = 0$

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 Kirchhoff's Current Law Equation at node D

Question 11

In the circuit shown in Figure 1, what is the value of current I_4?

A. 4.5 mA

B. -4.5 mA

C. 9.0 mA

D. -9.0 mA

E. None of the above.

Question 12

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

A. 4.50 mA
B. -4.50 mA
C. 13.5 mA
D. -13.5 mA
E. None of the above.

Question 13

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

A. -22.4 V
B. -2.46 V
C. 14.7 V
D. 36.5V
E. None of the above

Question 14

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

A. -26.7 V
B. -5.37 V
C. 17.5 V
D. 40.2 V
E. None of the above.

Question 15

In the circuit shown in Figure 1, what is the value of branch current I_3?

A. -10.6 mA
B. -2.37 mA
C. 1.20 mA
D. 7.52 mA
E. None of the above.

Question 16

In the circuit shown in Figure 1, what is the value of the power **supplied** by the 9mA current source?

A. -475.4 mW
B. 485.2 mW
C. -127.1 mW
D. 127.1 mW
E. None of the above

Question 17

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 1.1kΩ, 2.7kΩ, 2.9kΩ and 3.1kΩ resistors)?

A. 0 W
B. 89.34 mW
C. 686.3 mW
D. 1256 mW
E. None of the above.

Questions (18)−(20) all involve analysis of the one−port network shown below in Figure 2. In particular, you will be asked to calculate the Thevenin and Norton equivalent circuits.

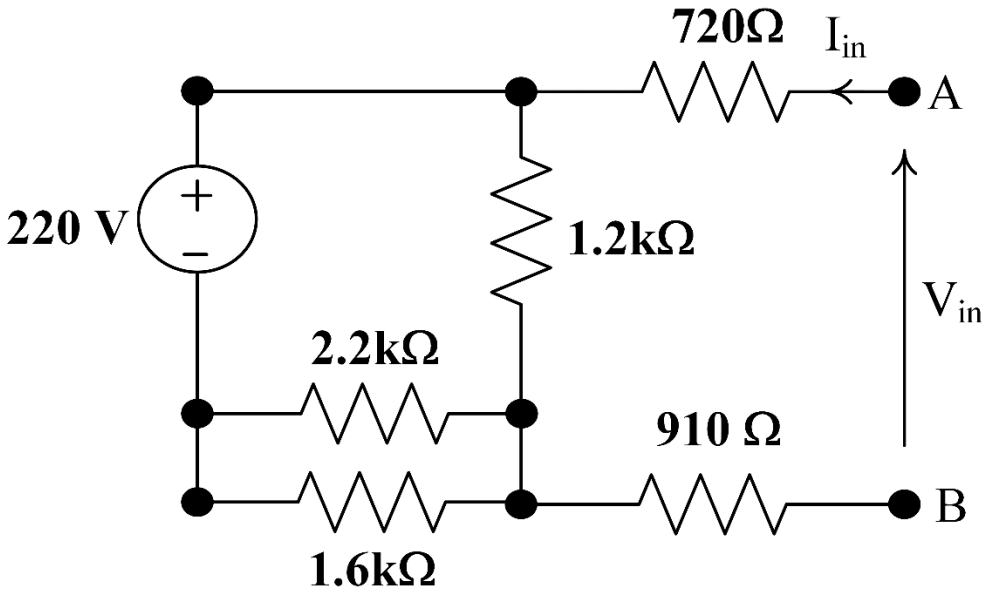


Figure 2: Circuit Schematic for Question's (18)-(20)

Space for working

Question 18

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. 220.0 V
B. 124.1 V
C. 56.92 V
D. 3.19 V
E. None of the above.

Question 19

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. 720 Ω
B. 1630 Ω
C. 2153 Ω
D. 2830 Ω
E. None of the above.

Question 20

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. -57.7 mA
B. 57.7 mA
C. -305.6 mA
D. 305.6 mA
E. None of the above.

Space for working

For Questions (21)-(24), 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.

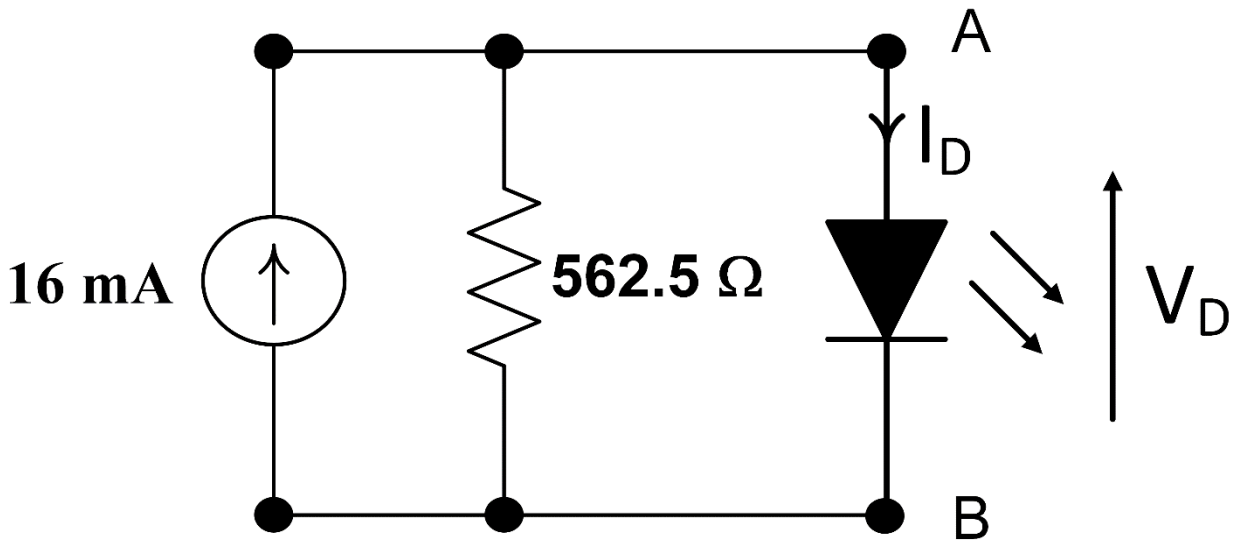


Figure 3: Circuit Schematic for Questions (21)-(24)

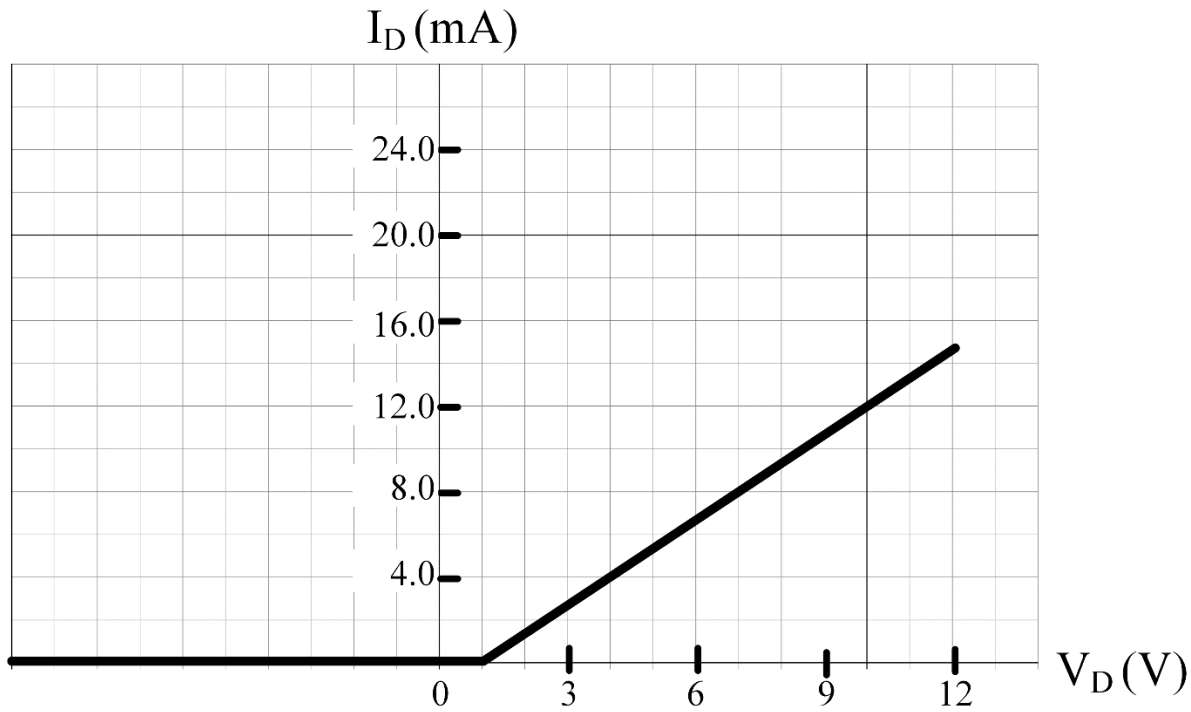


Figure 4: The I-V characteristics of the LED described in questions (21)-(24)

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 V_D?

A. 3.5 V
B. 5.5 V
C. 7.5 V
D. 9.5 V
E. V_D is less than 1.5 V or greater than 11.5 V.

Question 22

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. 6 mA
B. 7 mA
C. 8 mA
D. 9 mA
E. I_D is less than 5mA or greater than 10 mA.

Question 23

With respect to the schematic in figure 3, what percentage of the power supplied by the current source is dissipated by the LED? Choose the closest answer.

A. 0 %
B. 22.5%
C. 37.5 %
D. 75.0%
E. 100%

Question 24

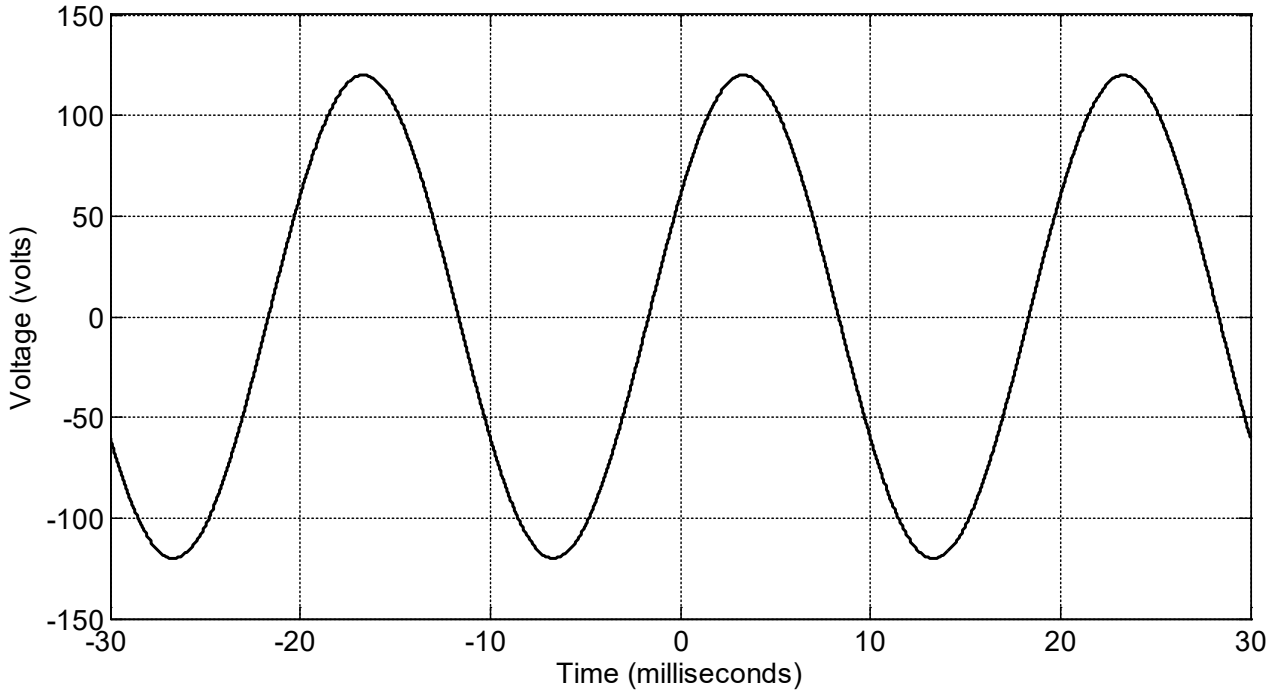
In a particular application, you need to ensure that the current through the diode, I_D is set to 4mA. You are able to modify the circuit in Figure 3 by replacing the resistor with another value in order to achieve this desired current (however the current source should remain the same, and you should use an identical LED). What value resistor should you choose?

A. 650 Ω
B. 550 Ω
C. 450 Ω
D. 350 Ω
E. The resistor needs to be selected to be less than 250Ω or greater than 750Ω.

Space for working

Question 25

A sinusoidal voltage is displayed in the figure below.



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

A. $Vs(t) = 120Cos(50t + 0.003)$
B. $Vs(t) = 240Sin(50t - 0.003)$
C. $Vs(t) = 240Cos(315t + 1.0)$
D. $Vs(t) = 120Cos(315t - 1.0)$
E. $Vs(t) = 240Sin(315t - 1.0)$

Space for working

Question 26.

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. $i(t) = L \int v(t)\, dt$

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

E. None of the above

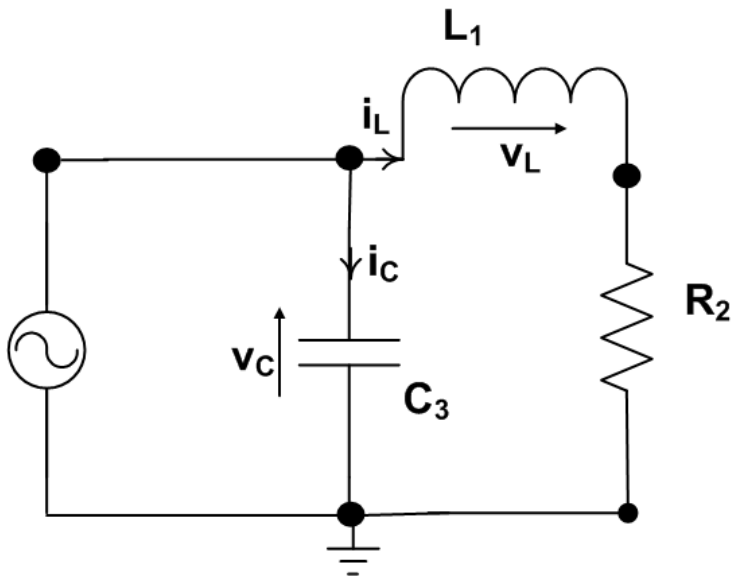
Question 27.

A practical capacitor does not allow an instantaneous step change in its:

A. Voltage
B. Current
C. Magnetic Field
D. Both (A) and (B)
E. Both (B) and (C)

Question 28.

In the circuit shown below, $L_1 = 6$ H, $R_2 = 42\ \Omega$, $C_3 = 27\ \mu$F.

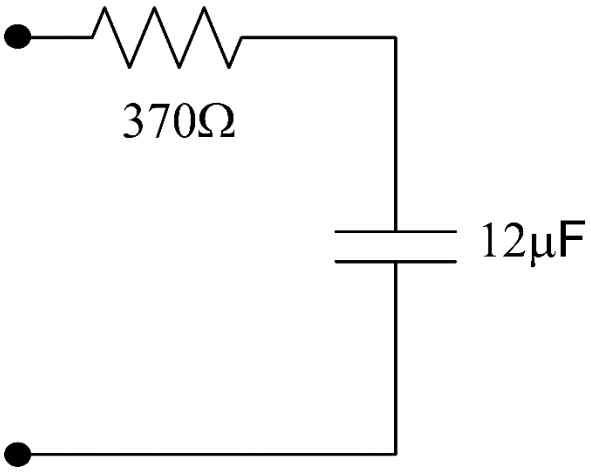


At a particular instant of time, $v_C = -12$V, $i_C = 4$ A, $v_L = 14$V, $i_L = -6$A.
At that instant of time, how much energy is stored in the inductor?

A. 48J
B. 432 J
C. 588 J
D. 108 J
E. None of the above.

Question 29.

Consider the one-port network shown below.



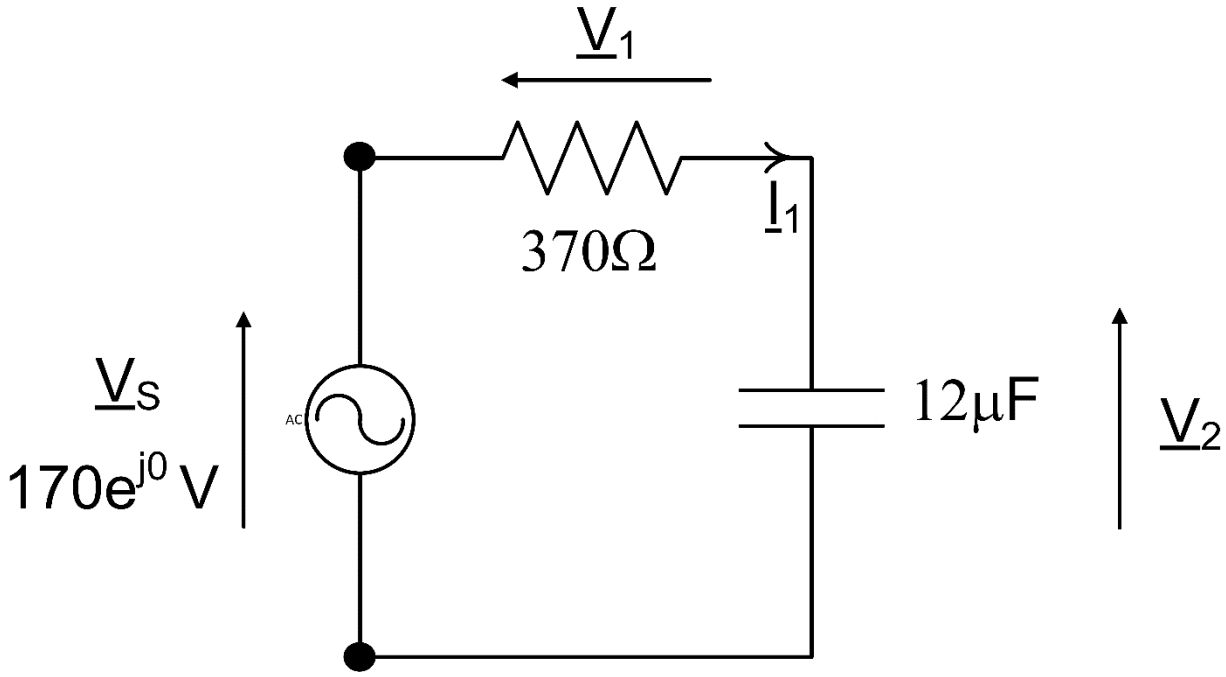
If the frequency of operation is 100Hz, what is the equivalent impedance of this network?

A. $370 + j7.54\times10^{-3}\ \Omega$
B. $370 - j12\times10^{-6}\ \Omega$
C. $370 - j132.6\Omega$
D. $370.0000012\ \Omega$
E. None of the above

Space for working

Question 30.

Refer to the circuit in the figure below.



The frequency of the AC voltage source is 100Hz. What is the value of the phasor voltage across the capacitor ($\underline{V}_2$)?

A. $5.51e^{j0}$V
B. $57.36e^{-j1.23}$V
C. $0.58e^{-j0.34}$V
D. $153e^{j0.64}$V
E. None of the above.

Space for working

Space for working