THE UNIVERSITY OF QUEENSLAND

School of Electrical Engineering and Computer Science

In-Semester Examination

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.

This examination is closed book – No materials permitted.

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

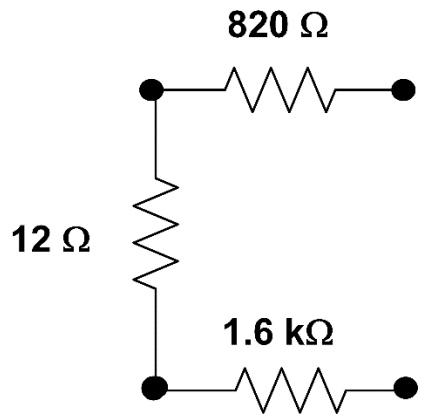
A UQ approved calculator (with label), or a casio FX-82 series calculator is allowed.

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%.

Question 1.

Consider the one-port network shown below:

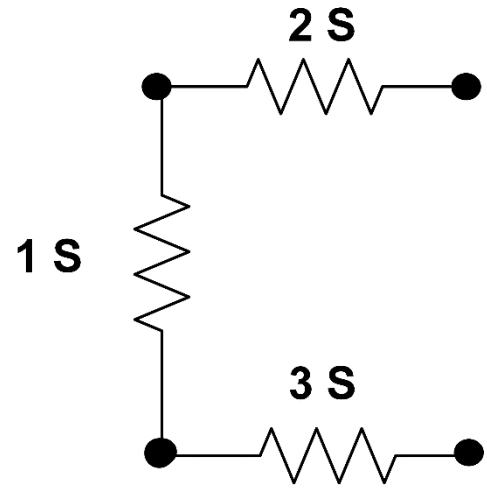


What is the equivalent resistance of this network?

A. 11.7 Ω
B. 833.6 Ω
C. 2432.0 Ω
D. 0.0852 Ω
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. 0.545 Ω
B. 6 Ω
C. 0.167 Ω
D. 1.83 Ω
E. None of the above.

Question 3.

Consider the one-port network shown below.

What is the equivalent resistance of this network?

A. 114.6 Ω
B. 186.7 Ω
C. 252.0 Ω
D. 2430 Ω
E. None of the above.

Question 4.

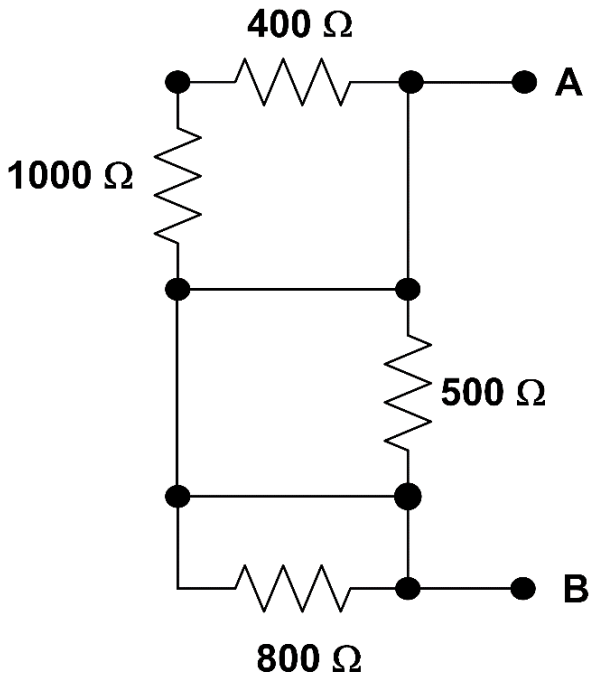
Which of the following is a unit of power?

A. Farad
B. Joule
C. Watt
D. Henry
E. Siemens

Space for working

Question 5.

Consider the one-port network shown below.



What is the equivalent resistance of this network?

A. 2700 Ω
B. 1707.7 Ω
C. 500 Ω
D. 0 Ω
E. None of the above.

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Questions (6)−(17) all refer to solution of the circuit below in Figure 1. First solve this circuit, and then check your working to make sure it is correct before answering the subsequent questions.

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

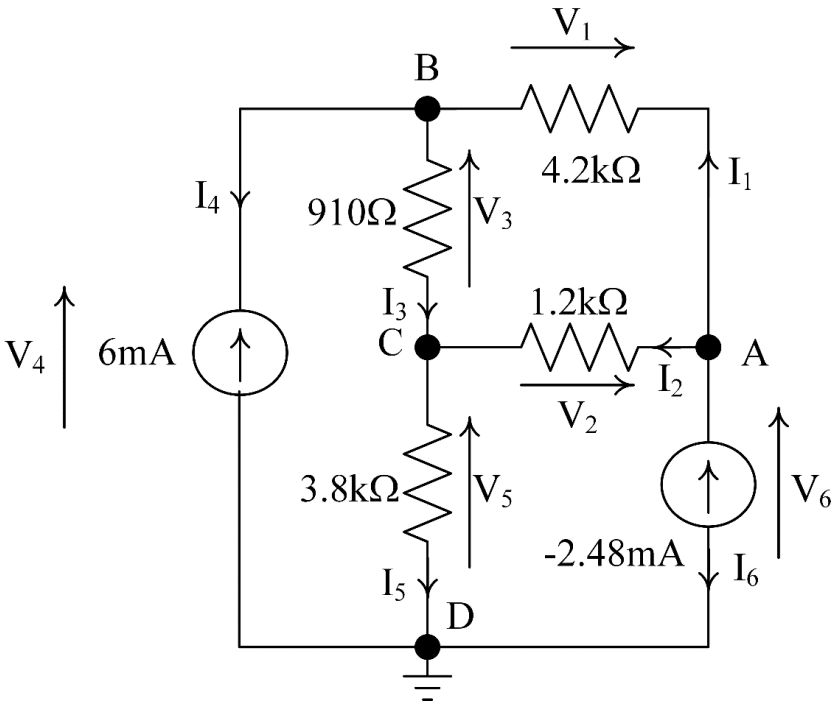


Figure 1: Circuit Schematic for Question (6)-(17)

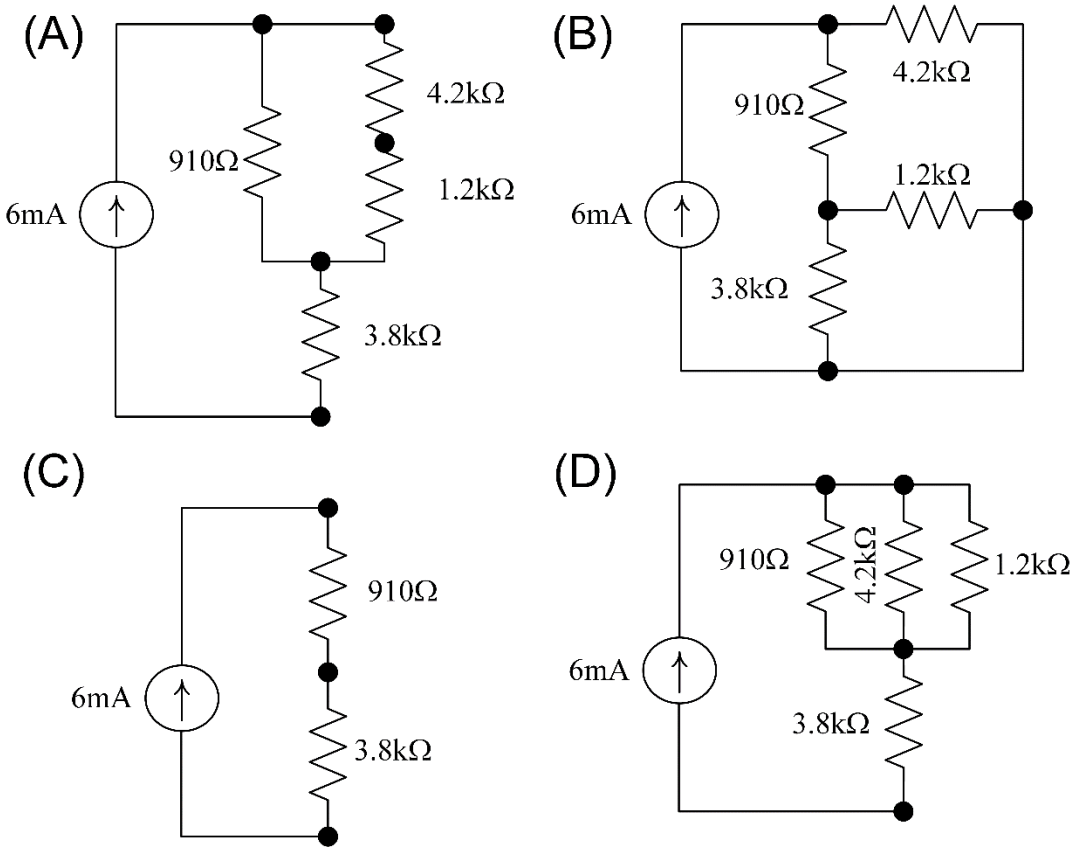
Space for working

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 2.49mA current 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. $V_1 + V_2 + V_3 = 0$
B. $V_1 = V_2 + V_3$
C. $V_3 = V_1 + V_2$
D. $V_2 = V_1 + V_3$
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. $\frac{V_B - V_C}{910} + \frac{V_C - V_D}{3800} + \frac{V_C - V_A}{1200} = 0$

B. $\frac{V_B - V_A}{4200} + \frac{V_B - V_C}{910} = 0.006$

C. $\frac{V_A - V_B}{4200} + \frac{V_C - V_B}{910} = 0.006$

D. $\frac{V_B - V_C}{910} + \frac{V_D - V_C}{3800} + \frac{V_C - V_A}{1200} = 0$

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. $I_4 = I_5 + I_6$

B. $I_5 = I_4 + I_6$

C. $I_6 = I_4 + I_5$

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 10

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

A. 0.600 A
B. -0.600 A
C. 6 mA
D. -6 mA
E. None of the above.

Question 11

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

A. 4.66 mA
B. -6.00 mA
C. 3.52 mA
D. -3.52 mA
E. None of the above.

Question 12

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

A. 17.63 V
B. 12.0 V
C. 24.0 V
D. -13.42 V
E. None of the above

Question 13

In the circuit shown in Figure 1, what is the value of branch voltage V_6?

A. -12 V
B. 12 V
C. -14.67 V
D. 14.67 V
E. None of the above.

Question 14

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

A. 12.0 V
B. 1.381 V
C. 13.381 V
D. 16.95 V
E. None of the above.

Question 15

In the circuit shown in Figure 1, what is the value of the power **consumed** by the 6mA current source?

A. 105.7 mW
B. –105.7 mW
C. 0 W
D. -72 mW
E. None of the above

Question 16

In the circuit shown in Figure 1, what is the value of the power **consumed** by the 910Ω resistor?

A. 19.8 mW
B. -19.8mW
C. 0 W
D. 22 mW
E. None of the above

Question 17

In the circuit shown in Figure 1, what is the value of the power **consumed** by all the components in the circuit in total (i.e. including the 4200Ω, 1200Ω, 910Ω and 3800Ω resistors; the 2.49mA current source; and the 6mA current source)?

A. 0 W
B. 135.6mW
C. 152.1 mW
D. 76.04 mW
E. None of the above.

Questions (18)−(21) 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.

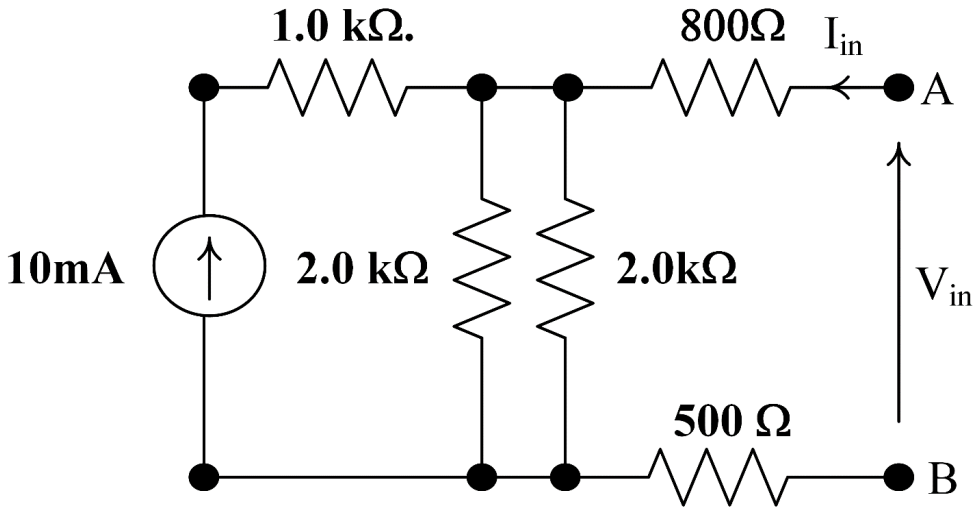


Figure 2: Circuit Schematic for Question 18-21

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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. 5 V
B. 6.67 V
C. 10 V
D. 20 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. 800 Ω
B. 1300 Ω
C. 1800 Ω
D. 2300 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. 4.35 mA
B. -4.35 mA
C. 10 mA
D. -10 mA
E. None of the above.

Question 21

Which of the following equations correctly relates the variables V_{in} and I_{in} as observed at the terminal of the one-port network in Figure 2? Note, R_T refers to the Thevenin resistance, and I_N refers to the Norton equivalent current source.

A. $I_{in} = -(R_T V_{in} + I_N)$
B. $I_{in} = R_T V_{in} - I_N$
C. $I_{in} = \frac{1}{R_T} V_{in} - I_N$
D. It is not possible to derive a general equation which relates these two variables, because the relationship between V_{in} and I_{in} is dependent on the circuit that is connected to the terminal.
E. It is possible to derive a general equation which relates these two variables, but none of answers (A), (B) or (C) are correct.

For Questions (22)-(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.

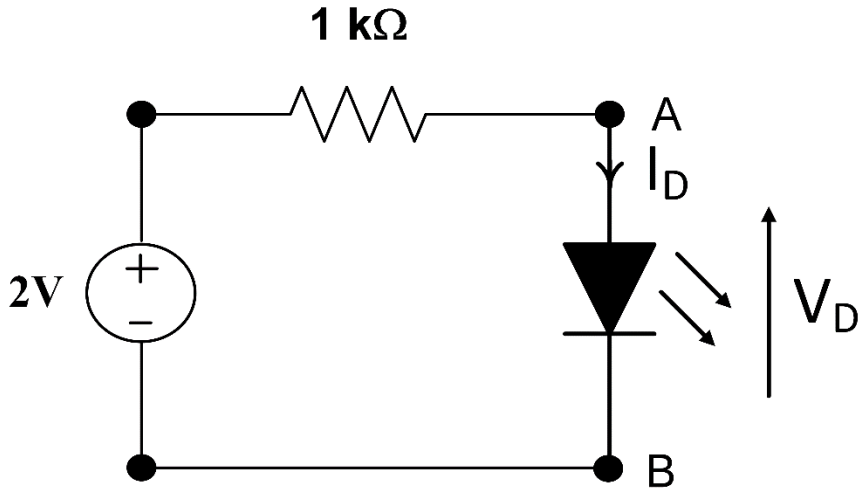


Figure 3: Circuit Schematic for Question (22)-(23)

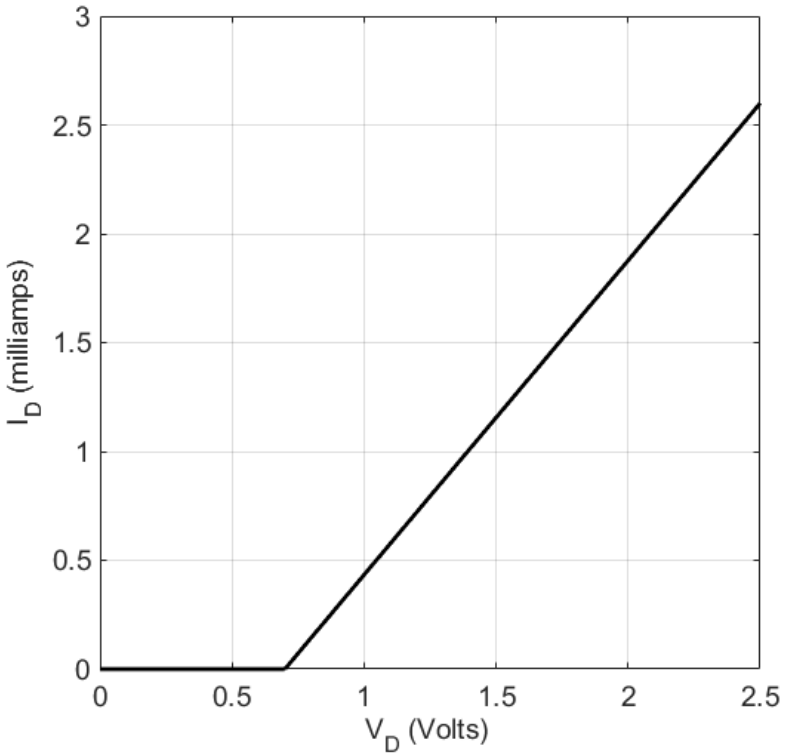


Figure 4: Circuit Schematic for Question (22)-(23)

Space for working

Question 22.

Given the circuit in 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. 1.25 V
C. 1.75 V
D. 2.25 V
E. V_D is less than or equal to 0.25 V or greater than or equal to 2.5 V.

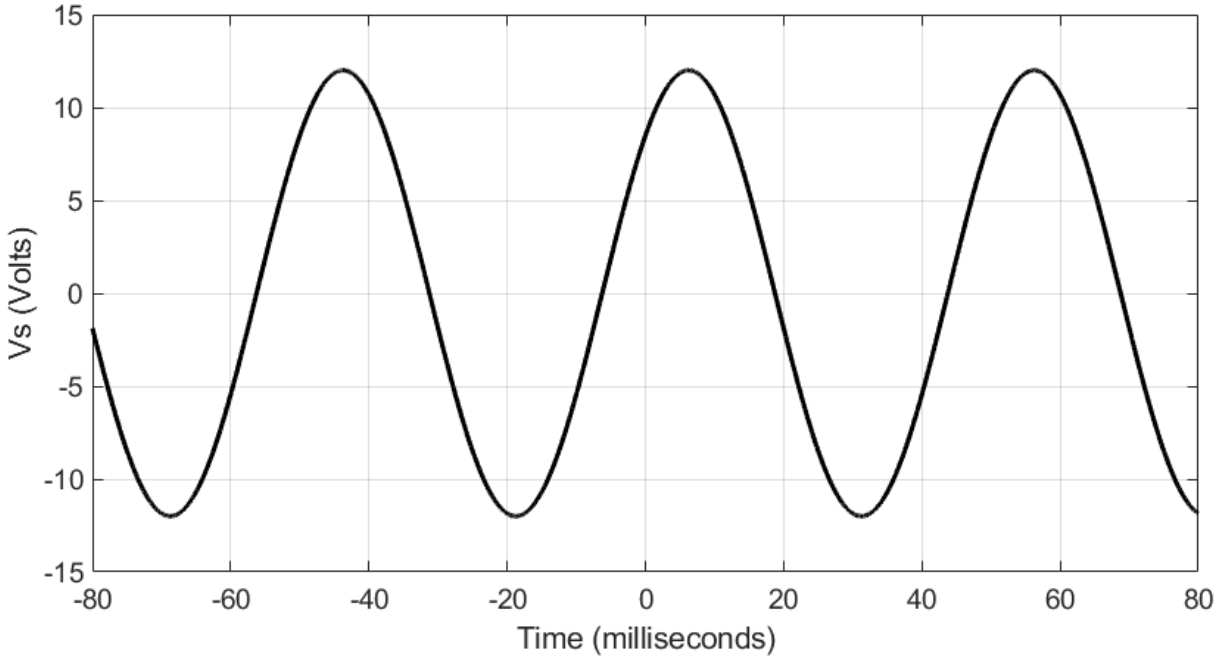
Question 23.

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

A. 0.25 mA
B. 0.75 mA
C. 1.25 mA
D. 1.75 mA
E. I_D is less than or equal to 0 mA or greater than or equal to 2.25 mA.

Question 24

A sinusoidal voltage is displayed in the figure below.



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

A. $Vs(t) = 12Cos(125t - 0.007)$
B. $Vs(t) = 12Cos(20t + 0.79)$
C. $Vs(t) = 12Cos(20t - 0.79)$
D. $Vs(t) = 24Cos(125t + 0.79)$
E. $Vs(t) = 12Cos(125t - 0.79)$

Questions (25) and (26) refer to the schematic in Figure 5.

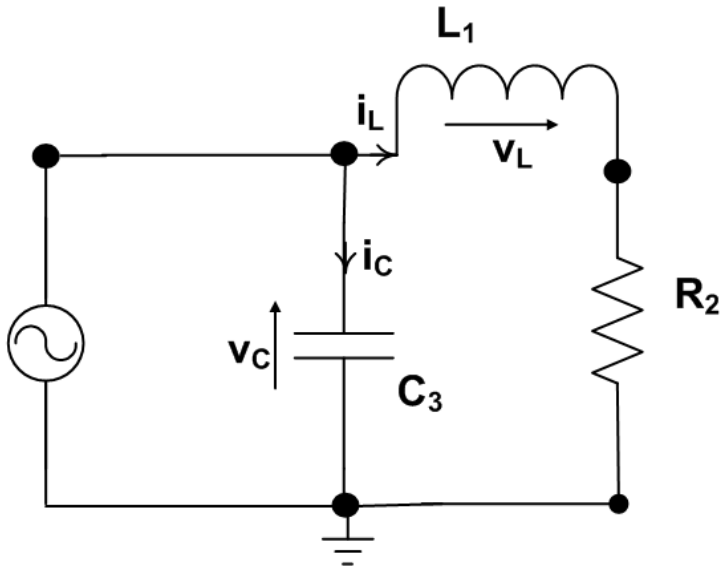


Figure 5: Circuit Schematic for Questions (25)-(26)

Space for working

Question 25.

In the circuit shown in Figure 5, $L_1 = 8$ H, $R_2 = 200\ \Omega$, $C_3 = 12\ \mu$F.
At a particular instant of time, $v_C = -10$V, $i_C = -8$ A, $v_L = 20$V, $i_L = 5$A.
At that instant of time, how much energy is stored in the capacitor?

A. 0.6 mJ
B. −0.6mJ
C. 0.38 mJ
D. −0.38 mJ
E. None of the above.

Question 26.

In the circuit shown in Figure 5, $L_1 = 8$ H, $R_2 = 200\ \Omega$, $C_3 = 12\ \mu$F.
At a particular instant of time, $v_C = -10$V, $i_C = -8$ A, $v_L = 20$V, $i_L = 5$A.
At that instant of time, how much energy is stored in the inductor?

A. -1600 J
B. 1600 J
C. -100 J
D. 100 J
E. None of the above.

Question 27.

Which of the following expressions correctly models the voltage *v(t)* across a capacitor (with capacitance C) to the current *i(t)* through the capacitor?

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

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

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

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

E. None of the above.

Question 28.

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

A. Voltage
B. Stored Energy
C. Electric Field
D. Current
E. (A), (B) and (C)

Question 29.

A sinusoidal voltage with a frequency of 50Hz has the following phasor representation in the complex exponential format:

$\underline{V_s} = 340e^{-j\pi/3}$ Volts

Which of the following is a correct representation of this time-varying voltage:

A. $Vs(t) = 340Cos(314t - \pi/3)$ Volts

B. $Vs(t) = 340Cos(50t + \pi/3)$ Volts

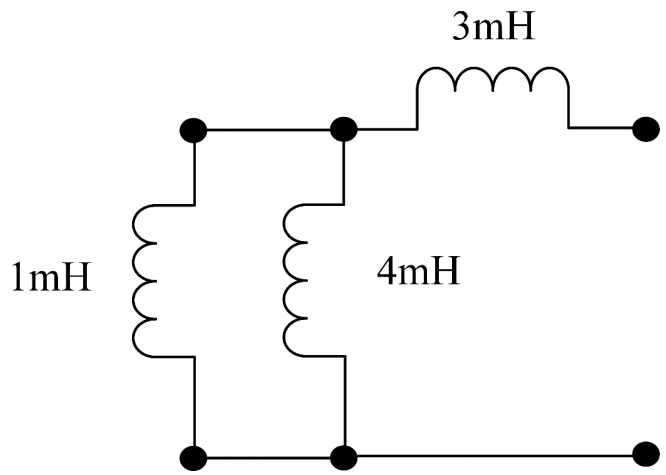
C. $Vs(t) = 50Cos(340t)$ Volts

D. $Vs(t) = 50Cos(\pi/3\, t + 314)$ Volts

E. None of the above.

Question 30.

Consider the one-port network shown below:



What is the equivalent inductance of this network?

A. 8 mH
B. 5.22 mH
C. 3.80 mH
D. 0.632 mH
E. None of the above.

Space for working