The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Foundation in Technology

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ECX2330 – Principles of Electricity
Final Examination 2008/2009 **Closed book exam**

Date: 01st April 2009 Time: 13.30-16.30

This paper contains eight questions. Answer any five questions. All questions carry equal marks. Marks will not be given unless your calculations are clearly shown. Be sure to use proper units and significant figures.

Gravitational acceleration	$g = 9.81\ ms^{-2}$
Electric space constant	$\varepsilon_o = 8.85\times10^{-12}\ Fm^{-1}$
Magnetic space constant	$\mu_o = 4\pi\times10^{-7}\ Hm^{-1}$

1. The concepts of electric potential, current, impedance and energy are the fundamental concept we use in circuit analysis.
   a)Describe briefly the terms (i) electric potential; (ii) electric current; and (iii) electric impedance

   b) A 20 W bulb designed to operate with a 12 V potential difference across its terminals is connected to a 12 V battery having an internal resistance of 0.6 Ω.
   (i) Determine the potential difference across the bulb
   (ii) Determine the power dissipated from the bulb.
   (iii) Now a second identical 20W is connected across the battery. Determine the change in potential difference, and the change in power converted by the first bulb.

   c)

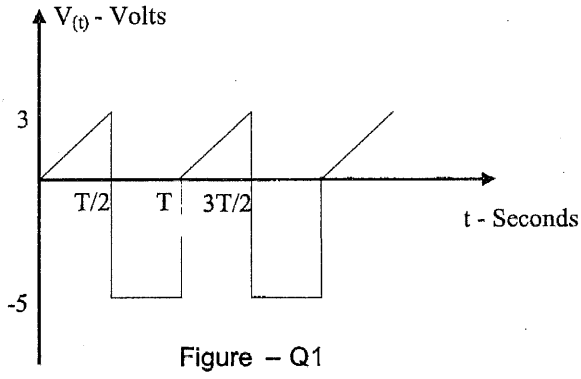


Figure – Q1

Calculate the average and rms values of the voltage waveform in Fig – Q1.

2. Different methods are used in analysing electrical circuits.

   a)Describe the two Kirchoff's laws.
   b)Calculate the magnitude of the EMF of source E_2 in Fig. – Q2.

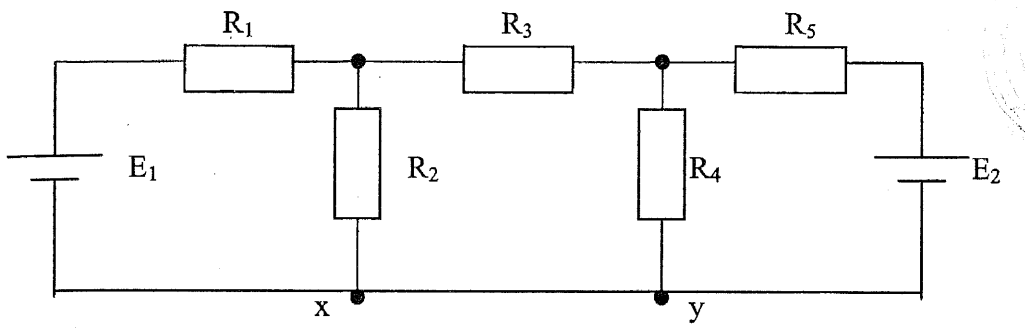


Figure - Q2

$R_1 = 12\ k\Omega$ $R_2 = 6\ k\Omega$ $R_3 = 2\ k\Omega$ $R_4 = R_5 = 10\ k\Omega$ $E_1 = 12\ V$.
It is found that no current flows between points x and y.

3. Capacitors were used in circuits to store charges.

a) Describe the behaviour of capacitors connected in series and parallel.

b) The capacitors in Fig. Q3 are initially uncharged, and are connected as shown, with switches S_1 and S_2 open. S_1 is then closed.

(i) What is the potential difference V_{ab}?

Now switch S_2 is also closed.
(ii) What is the potential at point b?
(iii) How much charge flows through the switch S_2 after it closes?

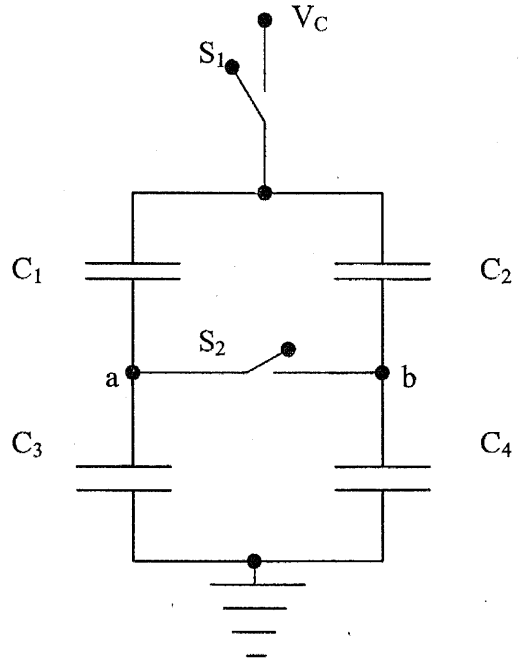


Figure - Q3

$C_1 = C_4 = 6\ \mu F$; $C_2 = C_3 = 3\ \mu F$; $V_C = 36\ V$

4. Magnetic fields affect moving charges.

a) Derive an expression for the force between two current carrying parallel wires of very long length.

b) Two long parallel wires are hung by cords of 4 cm length from a common axis, as shown in Fig. - Q4 The wires have a mass per unit length of 50 g/m, and carry the same current in opposite directions. What is the magnitude of current, if the cords hang at a steady angle of 6° with the vertical?

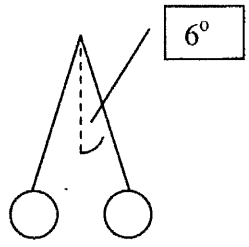


Figure - Q4

5. AC is the preferred method of power transmission.

a) Explain briefly the need for complex numbers / phasors, when calculating values of AC circuits.

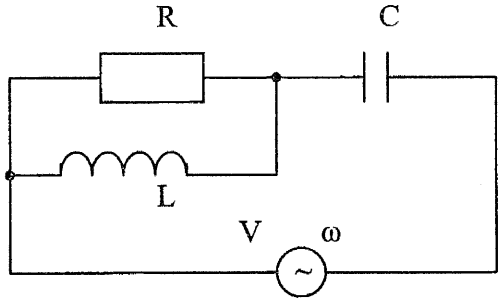


Figure – Q5

$R = 300\ \Omega$
$C = 2.5\ \mu F$
$L = 400\ mH$
$V_{eff} = 10V$
$\omega = 1000\ rad/s$

b) A RLC circuit is given in Fig - Q5.

(i) Calculate currents through all the components.
(ii) Draw the Phasor diagram describing this circuit.

6. Resonance circuits are commonly used in electric filters and radios.

a) Describe the defining characteristic of a circuit at resonance.
b) The circuit in Fig. - Q6 is tuned to resonance, and five AC voltmeters V_A - V_E are connected to it as shown in Fig - Q6. Give the reading of each voltmeter, if $e = 12\ V \sin \omega_o t$, where ω_o is the angular velocity at the resonance.

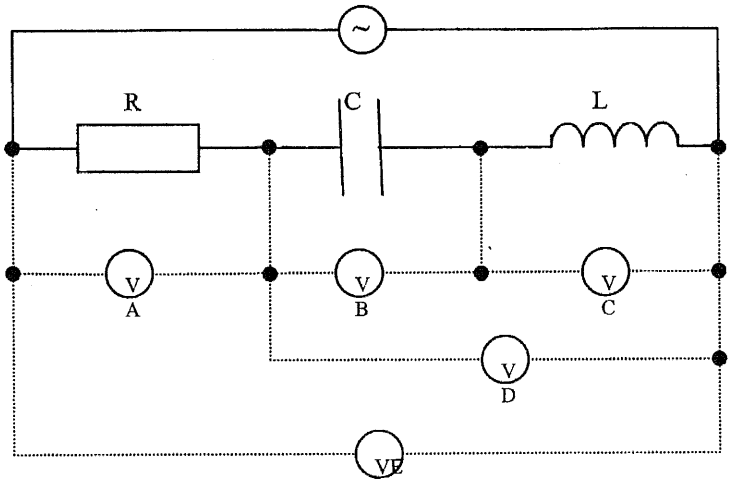


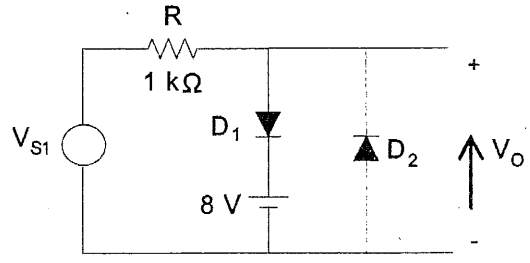
Figure – Q6

$R = 300\ \Omega$
$C = 3\ \mu F$
$L = 400\ mH$
$V_{eff} = 24\ V$

7. Rectifier circuits are responsible for providing a DC output from an AC input.

a) Sketch a full-wave rectifier, and describe how it functions. Differentiate between an ideal full-wave rectifier and a real one.

b)



$V_{S1} = 12\ V \sin \omega_o t$

Figure – Q7

Sketch the wave forms Vo and, the V_R, which is the voltage across R. The forward-bias voltages across the diodes are 0.7 V each, and the reverse-bias resistance is 10 GΩ.

8. The Zener diode provides a method to create a low-cost stabiliser.

(a) Describe briefly the difference between the zener-breakdown and the avalanche-breakdown of a semiconductor junction.
(b) Draw and describe how the simple zener stabiliser circuit works.
(c) What are its limiting factors?

(d) A 5.0 V stabilised power supply is required from a 12 V dc input source. The maximum power rating of the relevant Zener diode used is 2 W. Using the circuit above calculate:
  (i) The maximum current flowing in the Zener Diode.
  (ii) The value of the series resistor, R_S.
  (iii) The load current I_L if a load resistor of 1 kΩ is connected across the Zener diode.
  (iv) The total supply current I_S, for this circuit.