00740

The Open University of Sri Lanka
Department of Electrical and Computer Engineering

ECX3210 – Electro-Techniques

Final Examination 2016/2017 **Closed Book Test**

Date: 14th November 2017 Time: 13.30-16.30

Answer any 5 out of 8 questions provided. All questions carry equal marks. Show all relevant steps of calculation. State clearly the laws/equation/formulae you use.

1) a. What is the resistance range of a resistor displaying colour bands Blue, Grey, Red, Silver?

b. Two light bulbs have resistances of 400 Ω, and 800 Ω. If the two bulbs are connected in series across a 220 V outlet, find

i. the current through each bulb
ii. the power dissipated in each bulb
iii. the total power dissipated in both bulbs

The two light bulbs are now connected in parallel to the 220 V outlet.

iv. Find the current through each bulb
v. the power dissipated in each bulb
vi. the total power dissipated in both bulbs

vii. In which situation is there the greater total light output from both bulbs combined?

c.

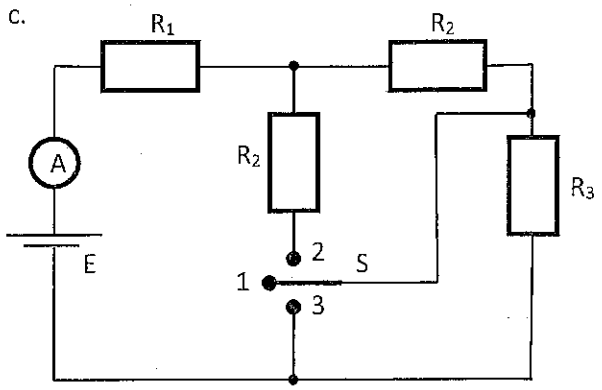


Figure Q1

In the circuit in Figure Q1 when the switch S moves between positions 1, 2 and 3, the reading of the ideal ammeter **A** changes from 1 mA, 1.2 mA, to 2 mA respectively. If the emf of the source **E** is 6 V, find the resistances $\mathbf{R_1}$, $\mathbf{R_2}$ and $\mathbf{R_3}$.

2) a. Describe briefly the two Kirchhoff's Laws of electric circuits, indicating the underlying conservation laws.

b. In the circuit of fig. Q2 find the magnitude and direction of the current flowing in wire between points **b** and **c**.

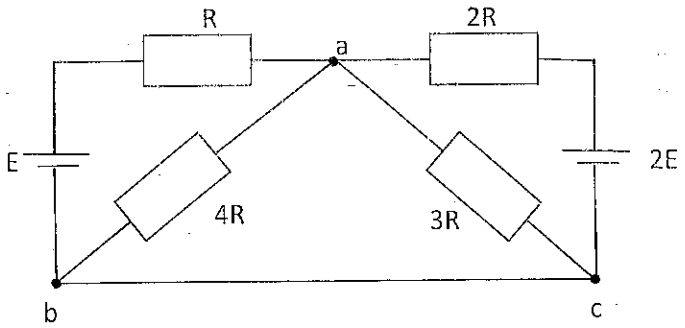


Figure Q2

E = 200 V R = 1 kΩ

3) a. Describe and compare briefly soft and hard magnetic material.

b. A vehicle has a vertical radio antenna 1.2 m long. It travels at 65 km/h on a horizontal road where the Earth's magnetic field is 50 μT directed toward the north and downward at an angle of 65° below the horizontal.

i. Specify the horizontal direction that the vehicle should move in order to generate the maximum motional emf in the antenna, with the top of the antenna positive relative to the bottom.

ii. Calculate the magnitude of this induced emf.

c. Three identical point charges q are placed at each of three corners of a square of side length **a**. State, in terms of **q** and **a**, magnitude and direction of the net force on a point charge -3q placed

iii. at the centre of the square and

iv. at the vacant corner of the square.

v. Calculate above values when **a** = 5 cm, and **q** = 2 μC. $[1/(4\pi\varepsilon) = 9\times10^9\ Nm^2/C^2]$

4) a. A capacitor has vacuum in the space between the conductors. If you double the amount of charge on each conductor, what happens to the capacitance?

b. A capacitor of unknown capacitance has been charged to a potential difference of 90 V. When the charged capacitor is then connected in parallel to an uncharged 10 μF capacitor, the potential difference across the combination is 30 V.

I. Calculate the unknown capacitance.

II. Calculate the change of energy in this capacitor.

c. A parallel plate capacitor is found to have a capacitance of 10 μF when the space between its plates is empty. Calculate its capacitance when this space is half-filled with a material having a relative permittivity of $\varepsilon_r = 2$, as shown in Figure Q4. Calculate the new capacitance of the capacitor.

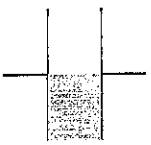


Figure Q4

5) a. A student using an ammeter comments that two AC branch currents, of 3 A and 5 A respectively, combine together at a point to give a total current of 6.6 A. She states that this is a violation of Kirchhoff's current law. What is your opinion? Explain.

b. A simple circuit is created with only three single components L = 250 mH, C = 1 μF, and R = 250 Ω, and a single source providing a symmetrical sinusoidal emf. It was found that the common voltage across the capacitor C and the resistor R, v_{RC} is 3.4 sin ωt V.
The Figure Q5 shows a part of the phasor diagram of the circuit, where I_L is the current through the inductor.
Measured values for resistor current I_R and capacitor current I_C readings are found to be I_R = 48 mA and I_C = 24 mA respectively.

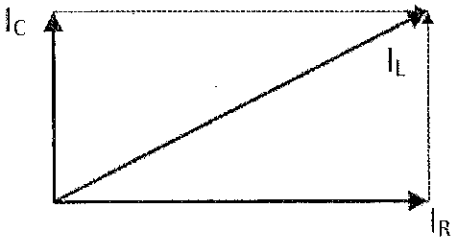
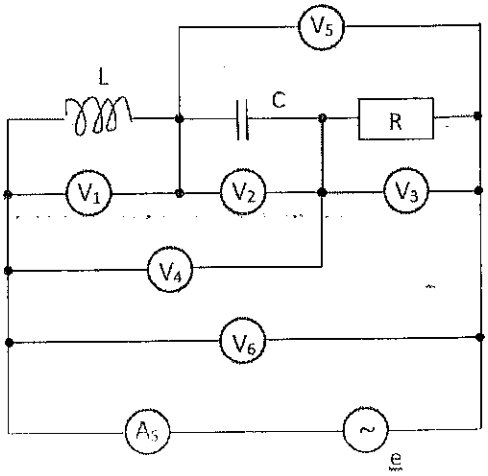


Figure Q5

i. Sketch an appropriate circuit matching the partial phasor diagram.
ii. Calculate the value of ω.
iii. Calculate the voltage across the inductor, taking the voltage across the resistor as reference.
iv. State the source emf **e(t)** in *E sin (ωt+ϕ)* form.
v. Sketch the complete phasor diagram for the circuit to scale based on your calculations.
vi. What is the power factor of the circuit?

6) a. What is the characteristic of a (portion of a) circuit at resonance? Give the primary characteristic only. – *Incorrect answers may be awarded negative marks.*

Figure Q6



b. For the circuit in figure Q6, it is found that for a particular frequency, the resistance is 300 Ω and both reactances have the magnitude of 600 Ω each. The ammeter and voltmeters can be considered ideal.

The source supplies an input voltage of e = 17 sin ωt V.

i. Calculate /deduce the values shown by voltmeters V1 ... V6 and the ammeter A_S
ii. Draw to scale the phasor diagram for the circuit.

Show your calculations. In deductions state your justifications clearly.

7) a. Describe briefly main precautions to take to get accurate readings safely when measuring DC voltages and DC currents using a digital multimeter.

b. A certain multi-range meter uses a 50 μA, 2 kΩ meter. Determine the connections and the values of the necessary resistances for measurement of

i. voltages in the range 0 - 10 V and

ii. currents in the range 0 - 3 mA

8) a. Sketch and describe behaviour of diode in a circuit using the I-V curve.

b. The source in the circuit of Figure Q8 provides an input e = 8 sin 300t V, and the source E provides 4 V. Sketch, relative to the input the graphs of voltages V_R and V_D. The diode D may be considered as ideal.

c. Describe briefly zenner and light emitting diodes, including their practical applications and relevant circuits.

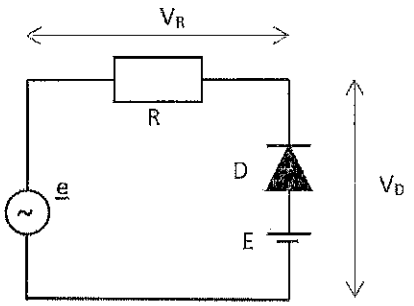


Figure Q8