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

ECX3210 – Electro -Techniques

Final Examination 2013/2014 **Closed Book Test**

Date: 11th August 2014 Time: 13.30-16.30

Answer any 5 questions. All questions carry equal marks. Show all relevant steps of the calculations.

1.

a) Describe Gauss's Theorem.

b) Three point charges A, B and C, are fixed in place, so that B and C are together at point **P**, and A is placed at the point **O** that is 50 cm from B and C. A feels a repulsive force of 2 N due to B and C. Then charge C is moved to the point **Q**, 50 cm from A that is directly opposite to P. (**PQ** = 100 cm). Now A feels a total electrostatic force of 4 N towards **Q**, due to B and C. Find the **ratio of charge** in B and C.

c) A conducting solid sphere of radius **a** is concentric with a non-conducting shell with uniform volume charge density, of inner radius **b** = 2**a** and outer radius **c** = 2.5**a**, as shown in Fig Q1. If the total charge of the inner sphere is q and the total charge of the outer shell is –Q (with $|Q| > |q|$) sketch the variation of the magnitude of the Electric field in the Radial direction, starting from the centre of the sphere for range $0 < \mathbf{r} < 3\mathbf{a}$.

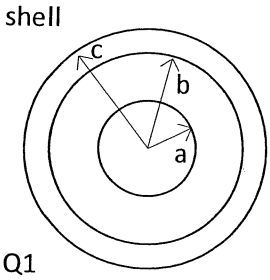

Figure Q1

2.

a) Describe the classification of different materials according to their permeability and dipole orientation. State one example each for each type above.

b) From among above material(s) which would you recommend to be used to construct

i) Permanent magnets ii) Electromagnet cores, giving justification for each.

c) A closely wound solenoid of 1000 turns has an axial length of 50 cm and a radius of 2 cm. When a current of 1.5 A flows in the solenoid, determine the magnetic field

iii) at the centre of the solenoid and iv) on the axis at one end of the solenoid.

3.

a) State the basic characteristic of a capacitor.

b) Three capacitors having capacitances of 8.4, 8.4, and 4.2 μF are connected in series across a 36 V potential difference.

i) What is the charge on the 4.2 μF capacitor?

ii) What is the total energy stored in all three capacitors?

The capacitors are disconnected from the potential difference without allowing them to discharge. They are then reconnected in parallel with each other, with the positively charged plates connected together.

iii) What is the voltage across each capacitor in the parallel combination?

iv) What is the total energy now stored in the capacitors?

c) A parallel-plate capacitor with only air between the plates is charged by connecting it to a battery. The capacitor is then disconnected from the battery, without any of the charge leaving the plates. A voltmeter reads 45 V when placed across the capacitor. When a dielectric is inserted between the plates, completely filling the space, the voltmeter reads 11.5 V.

v) What is the dielectric constant of this material?

vi) What will the voltmeter read if the dielectric is now pulled partially out so it fills only one-third of the space between the plates?

4.

a) The 4 bands on a Carbon Resistor carry the colours Blue, Grey, Red and Gold respectively. Calculate the expected range in which the resistance of the resistor may lie.

b)

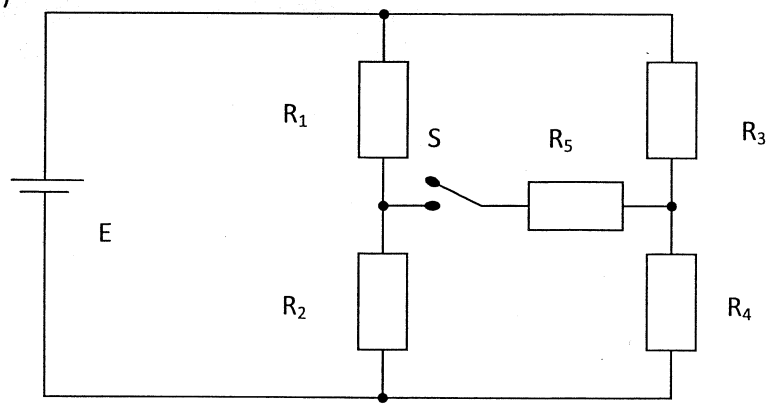

Figure Q4

The values of components of circuit in Figure Q4 are E = 12 V, R_1 = 4 kΩ, R_2 = 2 kΩ, R_3 = 4 kΩ, R_4 = 8 kΩ, and R_5 = 6 kΩ.

The switch **S** is initially open.

i) Calculate the current through the source E.

ii) What is the potential difference across the switch S?

Now the switch **S** is closed.

iii) Calculate the power dissipated by the resistor R_5.

iv) Calculate the new current through the source E.

5.

a) Describe different types of power that you encounter in an ac circuit. What is the relationship between these types? Explain. What is the significance of the power factor?

b) Calculate the following for the periodic wave shown in Fig Q5b

i) Mean value

ii) Rectified average

iii) RMS value

iv) Form factor

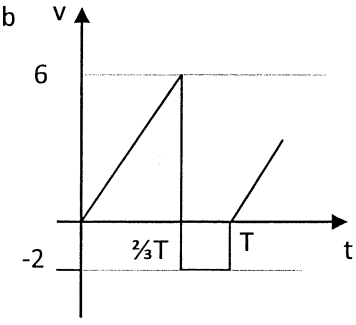

Figure Q5b

c)

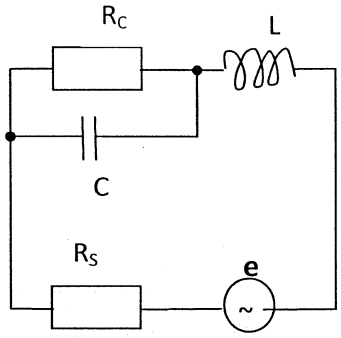

Figure Q5c

In the Circuit of Figure 5c, it is given that L = 200 mH, C = 1μF, R_C = 500 Ω and R_S = 400 Ω.

The current and voltage of the capacitor, as measured with a multimeter at AC setting, read 8 mA and 4 V respectively. Calculate the currents through R_C, R_S and L.

d) Draw the pahsor diagram describing the circuit in 5c), taking the voltage across the capacitor as referance.

6.

a) State the characteristic of a circuit at resonance.

b) For the circuit in fig Q5c, e is known to be of simple sinusoidal waveform. Derive a formula in terms of **R_C**, **R_S**, **L** and **C** to calculate the resonance frequency f_o for this circuit.

c) Calculate the value of the resonance frequency when the values of the components are as given in 5c).

d) Assuming the maximum voltage of e is 34 V, calculate the respective currents through the capacitor and the inductor at resonance.

7.

a) Explain the dot notation representation of coupled inductors.

b) Describe, with the help of a simple sketch, the operating principles of a simple ac motor. Compare this with a dc motor.

c) A 50 μA meter movement, with an internal resistance of 2 kΩ, is to be used to construct a multi-range meter to measure

i) a range of 1000 mA;

ii) a range of 0 – 10 V

Indicate the suitable circuit for each task, including calculations.

8.

a) Describe briefly the main ways in which injury may occur when working with electricity.

b) Describe actions to be taken in such accidents.

c) Name four main types of fire extinguishers. Which of these are suitable to extinguish fires caused by electrical circuits? Explain.

d) List five safety precautions to be taken to avoid electrical accidents / minimise damage.