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

ECX3210 – Electro -Techniques

Final Examination 2012/2013 **Closed Book Test**

Date: 28th July 2013 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) Two identical point charges, fixed in place, attract each other with an electrostatic force of 0.1N when their separation is 50 cm. The charges are then connected by a thin conducting wire. When the wire is removed, the charges repel each other with an electrostatic force of 0.036 N. Find the initial values of the charges.

c) A non-conducting solid sphere of radius a, with uniform volume charge density is concentric with a conducting shell of inner radius b = 2a and outer radius c = 2.5a, 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 $0 < r < 3a$.

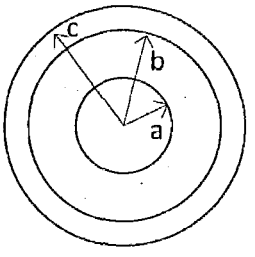

Figure Q1

2.

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

b) Describe the magnetisation and demagnetisation process with the help of a Hysteresis loop. How does this characteristic decide the suitability of materials as a core for electro magnets? Explain.

c) A concentrated coil of 500 turns is of 10 cm diameter. A 10 A current flows through it. Determine the magnetic field caused by this coil (i) at the centre of the coil; (ii) at a point on the axis 8 cm from the centre.

3.

a) State the basic characteristic of a Capacitor.

b) A parallel plate capacitor with a capacitance of 1 μF is known to have Mylar ($\varepsilon_r = 2.5$) filling the space between its plates. This capacitor is connected to an ideal dc source of 10 V. Calculate:

i) The charge accumulated

ii) Energy stored

Now the distance between the plates is doubled (d' = 2d) without changing any other characteristics of the capacitor, while still connected to the source. Calculate:

iii) New Voltage between the plates

iv) New charge accumulated

v) New energy stored.

Finally, the capacitor is disconnected from the source, and thereafter the plates brought back to the original separation (d" = d). Now calculate:

vi) New Voltage between the plates

vii) New charge accumulated

viii) New energy stored.

4.

a) Describe the condition that determines a Series, and a Parallel connection in circuit respectively.

b) When connected to an ideal dc power source in parallel, two resistors R_A and R_B dissipate five times the power compared to their series combination. Find the possible values for R_B, when R_A is known to be 100 Ω.

c) In the circuit of Fig Q4 R1 = 2 kΩ, R2 = 4 kΩ, R3 = 6 kΩ, and I3 = 6 mA. The potential difference between points A and B is found to be 78 V. A 'Box' containing circuit element(s) is also in the circuit.

i) Is the 'Box' absorbing from or providing energy to the circuit? Explain.

ii) How much is the above rate?

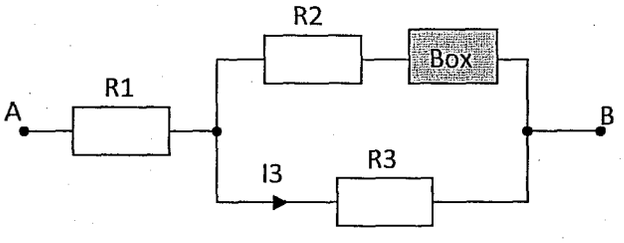

Figure Q4

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

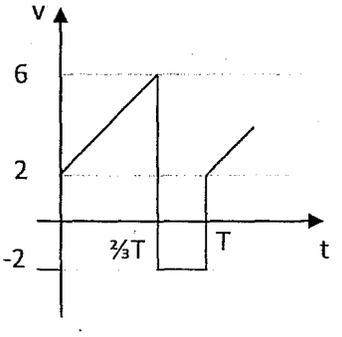

Figure Q5b

c) For the circuit in Fig Q5c, it was measured that |R1| = 300 Ω, |R2| = 500 Ω, |XC1| = 400 Ω, |XC2| = 300 Ω, and |XL| = 300 Ω. Taking the Current through R1 as the base reference draw a suitable phasor diagram for this circuit to scale, showing all relevant currents and voltages, including V_{AB}.

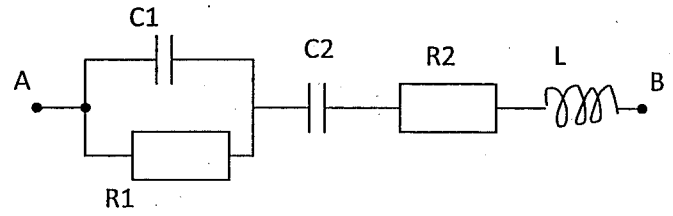

Figure Q5c

6.

a) State the characteristic of a circuit at resonance.

b) For the circuit in fig Q6, e is known to be of simple sinusoidal wave form. Derive a formula in terms of R, 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 R = 300 Ω, L = 100 mH, and C = 1 μF respectively.

d) Given e = 34 sin ωt V, calculate the respective currents through the Capacitor and the Inductor at resonance.

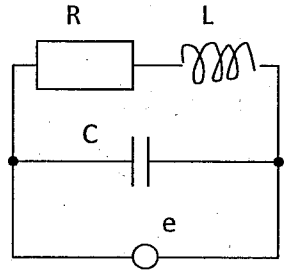

Figure Q6

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 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 500 mA;

ii) a range of 0 – 10 V

Indicate the suitable circuit for each task, including calculations.

8.

a) Describe briefly the behaviour of a semiconductor diode, based on the characteristic curve.

b) Describe the functioning of

i) the Clipper circuit and

ii) the Clamper circuit

including the circuits and output waveforms.

c) Describe 3 special diodes, specifying their special characteristics and behaviour. Also include relevant circuits where appropriate.