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he Open University of Sri Lanka
epartment of Electrical and Computer Engineering
oundation in Technology

CX3210 Electro-Techniques
inal Examination 2009/2010

Closed book exam

Date: 06th March 2010 Time: 1330-1630 hrs.

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

Gravitational acceleration	$g = 9.81\ \mathrm{ms^{-2}}$
Electric space constant	$\varepsilon_0 = 8.85\times10^{-12}\ \mathrm{Fm^{-1}}$
Magnetic space constant	$\mu_0 = 4\pi\times10^{-7}\ \mathrm{Hm^{-1}}$
Charge of an electron	$e = -1.60\times10^{-19}\ \mathrm{C}$
Rest mass of an electron	$m_e = 9.11\times10^{-31}\ \mathrm{kg}$
Rest mass of a proton	$m_p = 1.67\times10^{-27}\ \mathrm{kg}$

State Coulomb's law.

Two identical spheres are each attached to silk threads of length l = 0.500 m and hung from a common point. Each sphere has mass m = 8.00 g. The radius of each sphere is very small compared to the distance between the spheres, so they may be treated as point charges. One sphere is given positive charge q_1, and the other a different positive charge q_2. This causes the spheres to separate so that when the spheres are in equilibrium, each thread makes an angle $\theta = 20.0°$ with the vertical.

(a) Determine the magnitude of the electrostatic force that acts on each sphere, and determine the tension in each thread.

(b) Based on the information you have been given, what can you say about the magnitudes of q_1 and q_2? Explain your answers.

(c) A small wire is now connected between the spheres, allowing charge to be transferred from one sphere to the other until the two spheres have equal charges; the wire is then removed. Each thread now makes an angle of 30.0° with the vertical. Determine the original charges. *(Hint: The total charge on the pair of spheres is conserved)*

Describe how the physical dimensions influence the capacitance of a parallel plate capacitor.

An air capacitor is made by using two flat plates, each with area **A**, separated by a distance **d**. Then a metal slab having thickness a (less than **d**) and the same shape and size as the plates is inserted between them, parallel to the plates and not touching either plate.

(a) What is the capacitance of this arrangement?

(b) Express the capacitance as a multiple of the capacitance C_0 when the metal slab is not present.

In a computer keyboard, each key holds a small metal plate that serves as one plate of a parallel-plate, air-filled capacitor. When the key is depressed, the capacitance increases. Electronic circuitry detects the change in capacitance and thus detects that the key has been pressed. In one keyboard, the area of each metal plate is 42.0 mm², and the separation between the plates is 0.700 mm before the key is depressed.

(c) Calculate the capacitance before the key is depressed.

(d) If the circuitry can detect a change in capacitance of 0.250 pF, how far must the key be depressed before the circuitry detects its depression?

3. Describe possible reasons for internal resistance of an electric cell.

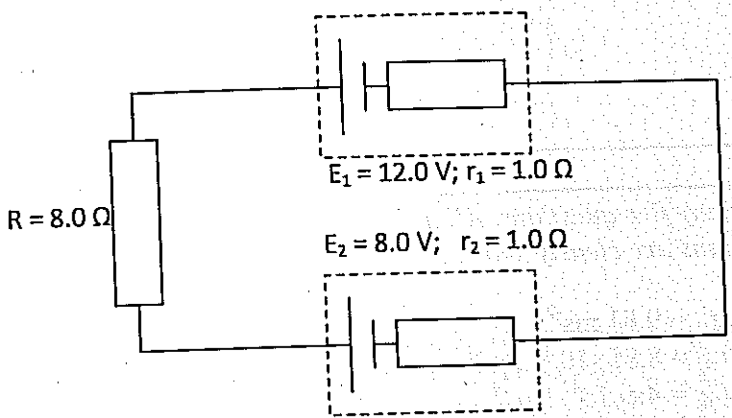

Figure Q3

The Fig. Q3 shows two rechargeable batteries E_1 and E_2 connected to the resistor **R**. Find

(a) the current through the 8.0 Ω resistor and

(b) the total rate of dissipation of electrical energy in the 8.0 Ω resistor and in the internal resistance of the batteries.

(c) In one of the batteries, chemical energy is being converted into electrical energy. In which one is this happening, and at what rate?

(d) In one of the batteries, electrical energy is being converted into chemical energy. In which one is this happening, and at what rate?

(e) Show that the overall rate of production of electrical energy equals the overall rate of consumption of electrical energy in the circuit.

4. How do you convert a simple galvanometer into a multi-range voltmeter?

A galvanometer having a resistance of 25.0 Ω has a 1.00 Ω shunt resistance installed to convert it to an ammeter. It is then used to measure the current in a circuit consisting of a 15.0 Ω resistor connected across the terminals of a 25.0 V battery having no appreciable internal resistance.

(a) What current does the ammeter measure?
(Consider the ammeter capable of correctly measuring the current flowing through it.)

(b) What should be the true current in the circuit (that is, the current without the ammeter present)?

(c) By what percentage is the ammeter reading in error from the true current?

5. Describe the factors affecting a moving charge in a magnetic field.

A beam of protons travelling at 1.20 km/s enters a uniform magnetic field, travelling perpendicular to the field. The beam exits the magnetic field, leaving the field in a direction perpendicular to its original direction. The beam travels a distance of 1.18 cm while in the field. What is the magnitude of the magnetic field? (You may ignore gravitational effects)

What is the characteristic of a circuit at resonance?

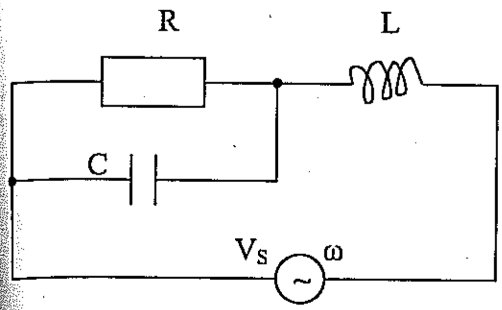

Figure Q6

R = 300 Ω
C = 1.25 μF

L = 250 mH

(a) Calculate currents through all elements of the circuit in Fig. Q6 when source voltage is given as V_s = 34 sin 2000t V.

(b) Draw the phasor diagram for the circuit at this input.

(c) Calculate the resonance frequency of the circuit.

(d) Calculate the currents through all elements when the circuit is at resonance, if the amplitude of the input voltage is unchanged.

escribe the effect of a magnetic field on a conductor moving within it.

rectangle measuring 30.0 cm by 40.0 cm is located inside a region of a uniform magnetic field of 1.25 T, ith the field perpendicular to the plane of the coil. The coil is pulled out at a steady rate of 2.00 cm/s ravelling perpendicular to the field lines. The region of the field ends abruptly. Describe the emf induced this coil when it is

) all inside the field;
) partly inside the field;
) all outside the field.

tify your answers.

aw the output of the circuit for a pure sinusoidal input for each circuit below. Draw both input and put waveforms on the same graph. Mark all axis-values clearly. You may assume that each diode you as ideal.

Describe how the positive-biased clamper circuit functions as a DC level shifter.

Describe how a clipper circuit functions.