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

ECX3210 – Electro-Technique

Final Examination 2015/2016 **Closed Book Test**

Date: 22nd November 2016 Time: 13.30-16.30

Answer any 5 out of 8 questions provided. All questions carry equal marks. Show all relevant steps of calculation.

1) a. What is the resistance range of a resistor displaying colour bands Violet, Green, Black, Gold?

b. The potential difference across the terminals of a battery is 8.4 V when there is a current of 1.5 A in the battery from the negative to the positive terminal. When the current is 3.5 A in the reverse direction, the potential difference becomes 9.4 V.

i. What is the internal resistance of the battery?
ii. What is the emf of the battery?

c. An electric teakettle has a multi-position switch and two heating coils. When only coil 1 is switched on, the well-insulated kettle brings a full pot of water to a boil in 1 minute. When only coil 2 is switched on, it requires 2 minutes to boil the same amount of water. Find the time interval required to boil the same amount of water if both coils are switched on

iii. in a parallel connection and
iv. in a series connection.

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**.

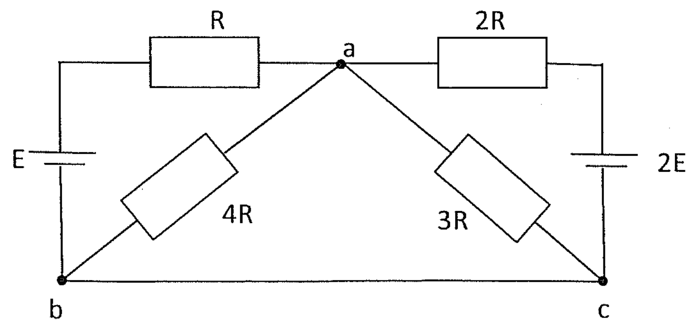

Figure Q2

E = 250 V R = 1 kΩ

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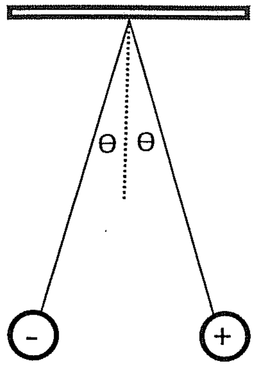
3) a. Describe Lenz's Law of induction.



b. Two small spheres, each of mass 2 g, are suspended by light strings 10 cm in length and a uniform electric field is applied as shown in Fig Q3. The spheres have charges equal to -5×10^{-8} C and $+5\times10^{-8}$ C. Determine the magnitude and direction of the electric field that enables the spheres to be in equilibrium at an angle of $\theta = 10^{\circ}$ to the vertical. **Figure Q3**

c. A proton moving in a circular path perpendicular to a constant magnetic field takes 1 ns to complete one revolution. Determine the magnitude of the magnetic field. Neglect any gravitational effects. [$m_p = 1.67\times10^{-27}$ kg, $+p = 1.6\times10^{-19}$ C]

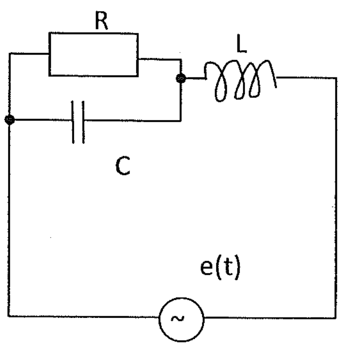
4) a. A capacitor has vacuum in the space between the conductors. If you double the amount of charge on each conductor, what happens to the capacitance?

b. An isolated capacitor of unknown capacitance has been charged to a potential difference of 100 V. When the charged capacitor is then connected in parallel to an uncharged 10 μF capacitor, the voltage across the combination is 30 V. Calculate the unknown capacitance.

c. Two capacitors of 9 μF and 4 μF are connected in series with each other and with a DC source of 26 V. Then the charged capacitors are disconnected from the source and from each other, and then reconnected to each other with plates of **opposite** sign together. By how much does the energy of the system change?

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. For circuit in fig Q5, with L = 100 mH, C = 2.5 μF, and R = 200 Ω, it was found that the admittances of capacitor C and the inductor L have the same magnitude at the angular frequency ω_C provided by the sinusoidal source e(t). The current I_{rms} through the resistor was measured as 12 mA. **Figure Q5**



i. Calculate the value of ω_C.
ii. Calculate the currents through the other components, taking the current through the resistor as reference.
iii. State **e(t)** in $E \sin(\omega t+\phi)$ form.
iv. Sketch the phasor diagram for the circuit to scale based on your calculations.
v. 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.

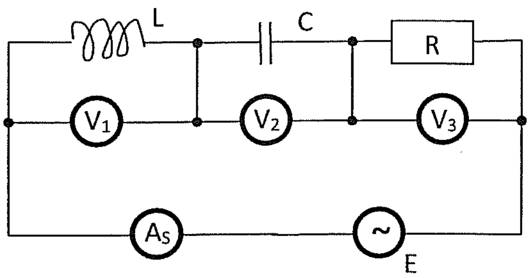
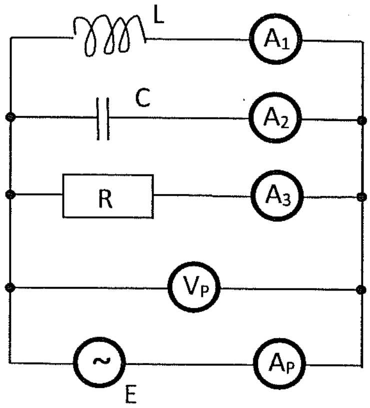


Figure Q6-i

Figure Q6-ii



b. To investigate series and parallel resonance, you are provided an inductor L = 100 mH, a capacitor C = 10 μF, a resistor R = 200 Ω, a source of variable frequency E = 17 sin (ωt), and a selection of ideal AC ammeters (A), and voltmeters (V).

First you investigate series resonance by setting-up the circuit in fig Q6-i, and tune the source E to the series resonance angular frequency ω_{SO}. Based on your knowledge of resonance calculate /deduce the following values:

i. ω_{SO} ii. V_1 reading iii. V_2 reading iv. V_3 reading v. A_S reading

vi. Draw to scale the phasor diagram for the circuit.

Now you investigate parallel resonance by setting-up the circuit in fig Q6-ii, and tune the source E to the parallel resonance angular frequency ω_{PO}. Based on your knowledge of resonance calculate /deduce the following values:

vii. ω_{PO} viii. A_1 reading ix. A_2 reading x. A_3 reading xi. A_P reading xii. V_P reading

xiii. Draw to scale the phasor diagram for the circuit.

Show your calculations. In deductions state your justifications clearly.

7) a. Sketch and explain the principles of operation of a simple AC generator (dynamo).

b. How can you transform this (without the help of electronic components/circuits) to a DC generator? Explain.

c. What is a simple method of increasing the smoothness of the generated DC output? Describe.

d. Go back to simple AC generator. What is the output of a simple half-wave rectifier when it is connected across the output terminals of the simple AC generator?

e. Describe the functioning of the bridge rectifier, and compare this to the half-wave rectifier.

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

b. Sketch the design for a diode-clipper circuit that clips the input sinusoidal 12 V maximum at 8V at the positive half. Assume use of ideal diodes.

c. Describe 3 types of common diodes.