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00618

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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX3510/ECX3210 Electro-techniques**
Academic Year	: 2017/18
Date	: 23rd January 2019
Time	: 1330 - 1630 hrs
Duration	**: 3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear hand writing.
7. Do not use Red colour.

Q1

a. What is the resistance range of a resistor displaying colour bands Green, Violet, Red, Silver?

(3 marks)

b.

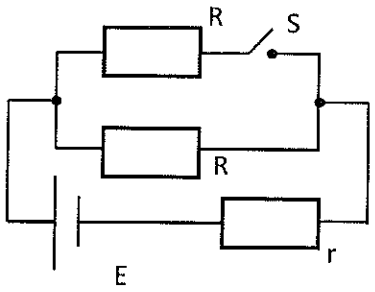


Figure 1A

A simple device consists of two resistors of value R, one of which can be switched on or off. When connected to a source with resistance r, as in Figure 1A, it is found that the power delivered to the device does not depend on whether the switch S is opened or closed.

Derive an expression for R in terms of r.

(8 marks)

c.

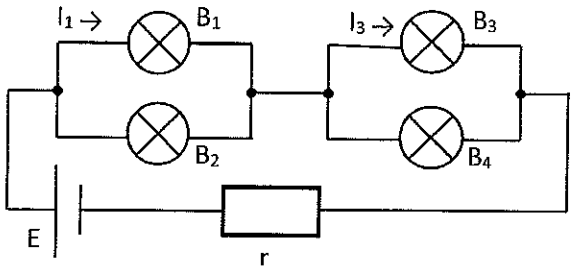


Figure 1B

Four bulbs B1 ... B4 are connected to a cell with internal resistance r as shown in figure 1B.

i) When bulb ratings are given as B_1 is 4V/4W, B_2 is 4V/8W, B_3 is 4V/2W, with r = 0.5 Ω, I_1 = 360 mA, and I_3 = 540 mA, calculate the values of B_4, and cell emf E. [B_4 is also rated relative to 4 V]

ii) What is the total power dissipated by the circuit?

(9 marks)

Q2

a.

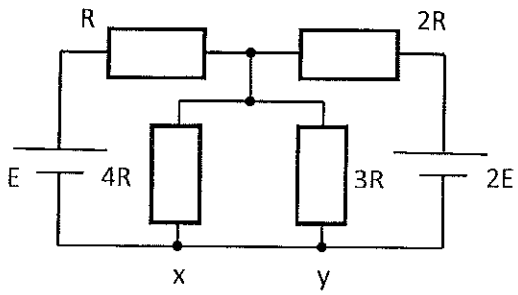


Figure 2

If R = 1 kΩ and E = 25 V in figure 2, determine, **using Kirchhoff's laws** the currents through the resistors

(13 marks)

b. State the superposition principle. (3 marks)

c. Sketch the sub-circuits that can be used to analyse the circuit in figure 2 with superposition principle. (4 marks)

Q3

a. State Gauss's Law. (2 marks)

b. A small conducting sphere of radius a is concentric with a larger insulating spherical shell with inner radius b and outer radius c as in figure 3. The inner sphere has total charge +2q, and the outer shell has total charge -4q. Assume uniform charge distribution in insulating material.

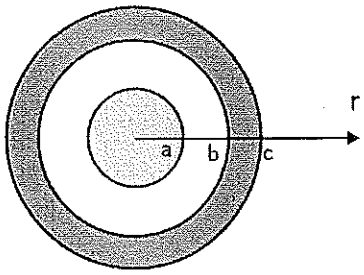


Figure 3

State the electric field (magnitude and direction) in terms of q and the distance r from the common centre for

i) $r < a$; ii) $a < r < b$; iii) $b < r < c$; iv) $r > c$

v) Show your results in a graph of the radial component of E as a function of r. (12 marks)

c. Consider the situations when, for the same total charges,

vi) both sphere and shell are filled with conducting material

vii) both sphere and shell are filled with insulating material

Sketch a new graph each for the above scenarios. (6 marks)

Q4

a. A charged particle q enters a uniform magnetic field **B,** directed into the page, and follows the circular path shown in figure 4A.

i) Is the particle positively or negatively charged? Explain.

ii) The speed of the particle is 140 m/s, the magnitude of the magnetic field is 0.48 T, and the radius of the path is 960 m. If magnitude of q = 8.2×10^{-4} C, calculate the mass of the particle.

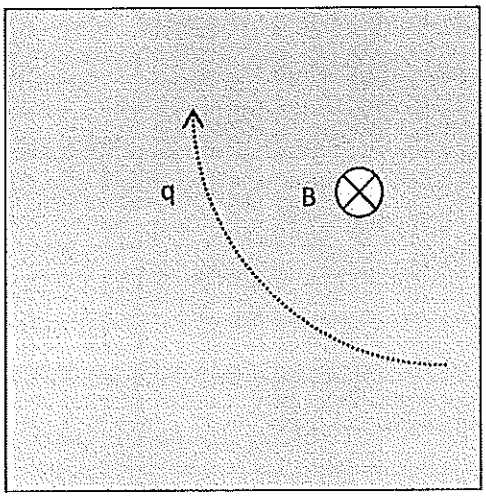


Figure 4A

You may neglect any other effects on the charge

(10 marks)

b. The triangular loop of wire shown in figure 4B carries a current I = 5 A in the direction shown. The loop is in a uniform magnetic field that has magnitude B = 3 T and the same direction as the current in the side PQ of the loop. PQ = 0.6 m, PR = 0. 8 m

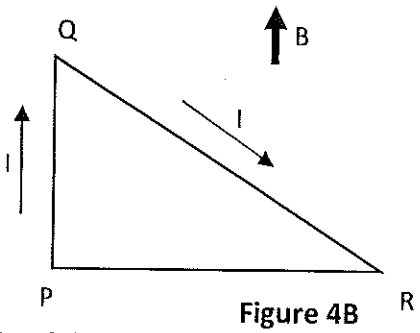


Figure 4B

iii) Find the force exerted by the magnetic field on each side of the triangle.
iv) What is the net force on the loop?

(10 marks)

Q5

a. The current in an ac power line changes direction 100 times per second, and its average value is zero. Explain how it is possible for energy to be transmitted in such a system. (2 marks)

b. In the circuit of figure 5, it is given that L = 250 mH, C = 2 μF, and R = 250 Ω. The voltage across the inductor is found to be $v_L = 34 \sin 2000t$ V.

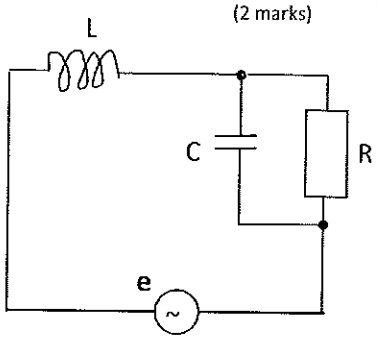


Figure 5

i) Calculate the currents through the L, R and C in time domain (in the form $i = I_m \sin(\omega t \pm \phi)$), taking V_L as reference.

ii) Calculate the supply voltage, and express it in the time domain (in the form $e = V_m \sin(\omega t \pm \phi)$).

Calculate iii) power dissipated from the circuit and
iv) its power factor.

v) Sketch the phasor diagram for the circuit taking V_L as reference. [Draw V_L in positive-x (left-to-right) direction] (18 marks)

Q6

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.* (3 marks)

b. The circuit in figure 5 is brought to resonance with components remaining unchanged. The amplitude of the input voltage remains fixed at 34 V. Calculate currents through all the components in this situation. Show all intermediate calculations to gain the marks. (12 marks)

c. Sketch the corresponding phasor diagram for part b. (5 marks)

Q7

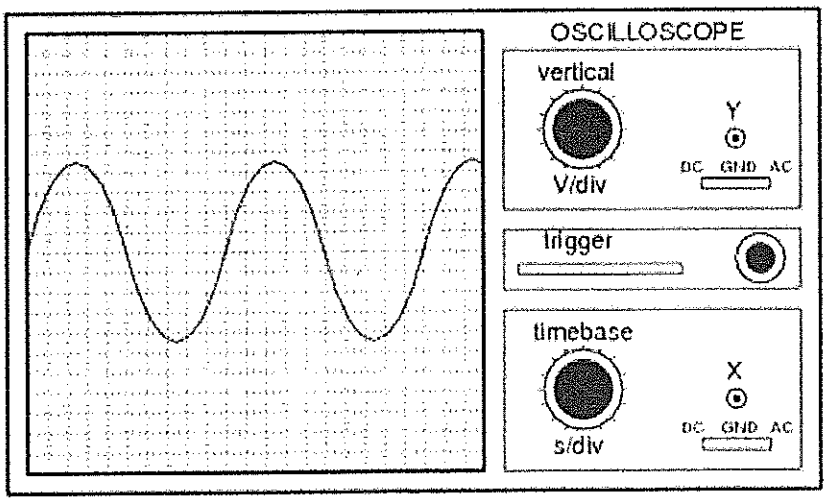


Figure 7A

a. i) State 3 steps to follow to get a stable image on the oscilloscope screen.

ii) Assuming the vertical sensitivity control is set to 0.5 volts per division, and the timebase control is set to 2.5 ms per division, calculate the amplitude of the sine wave of figure 7A (in volts peak, volts peak-to-peak, and volts RMS) as well as its frequency.

(8 marks)

b.

Figure 7B

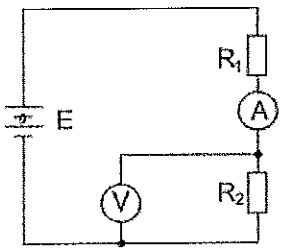
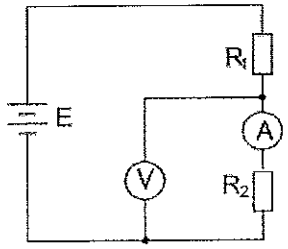


Figure 7C



The adjoining circuit is set up to measure the current and voltage of R_2 using voltmeter V and ammeter A, either short shunt or long shunt, as shown in figures 7B and 7C respectively. The ammeter displays the current flowing through it, and the voltmeter shows the potential difference between its terminals.

For E = 7 V, R_1 = 1 kΩ, and R_2 = 400 Ω, calculate the readings of V and A when

i) V, A ideal – short shunt
ii) V, A ideal – long shunt
iii) V, A real – short shunt
iv) V, A real – long shunt

The real voltmeter V with an internal resistance r_V of 500 kΩ and the real ammeter A with an internal resistance r_A of 50 Ω respectively. The source can be considered ideal.

v) Based on above results, which configuration would you recommend for use for the measurements with real meters when measuring R_2?

(12 marks)

Q8

a. Sketch and describe behaviour of diode in a circuit using I-V curve. (5 marks)

b. Sketch the design for a diode-clipper circuit that clips the input sinusoidal 12 V maximum at 8V in the positive half and 6V in the negative half. Assume use of ideal diodes. Show all relevant calculated values on the sketch. (9 marks)

c. You are given 3 common LEDs of Red, Green and Blue colours. Devise a simple circuit to light up all 3 diodes when they are connected in series. The voltages needed to light up the LEDs are given as 1.8 V, 2.1 V and 3.3 V respectively. Recommended maximum current rating for the diodes is 30 mA.
Draw the circuit and calculate a suitable resistor to construct a circuit to light up these LEDs simultaneously using a 10 V ideal DC source. (6 marks)