00221

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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX3410 Introduction to Electrical Engineering**
Academic Year	: 2020/21
Date	: 22/02/2022
Time	: 0930 – 1230 hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only, including **all** from Part A and **Two (2)** from Part B.
4. Answer for each question should commence from a new page.
5. Relevant charts / codes / values are provided.
6. This is a Closed Book Examination.
7. Answers should be in clear handwriting.
8. Clearly indicate all formula and calculations for full marks.
9. Do not use red colour pen.

PART A - Answer all questions

Q1 **[20 marks]**

Two long parallel conductors, X and Y, having distance **d** between them are inclined at the angle δ to the horizontal. The conductors are connected by a conducting wire W at the top. This whole setup is inside a vertically upward magnetic field. Flux density of the field is **B** (Figure 1). An iron rod (Z) with resistance **R** and mass **m** is initially held on the parallel conductors at the top. When the rod is just released it starts to move downward with an acceleration and after a while it continues to move with a constant velocity **u**. The resistance of the conductors X, Y and wire W are negligible.

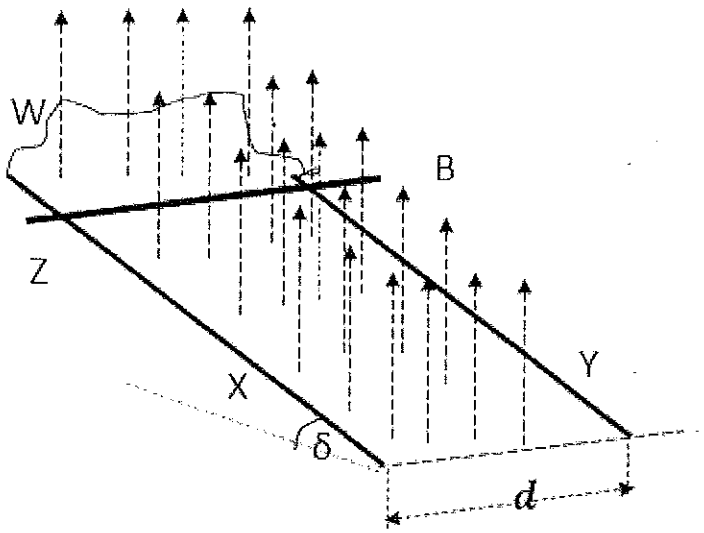

Figure 1

a) What is the force influencing to move the rod with acceleration just after its release? [2]

b) Briefly explain why the rod attains a constant speed. [4]

c) Derive expression and determine the direction of

   i. induced emf in the rod [3]

   ii. current through the rod [2]

   iii. magnetic force acting on the rod [3]

d) If $\delta = 10°$; **m** = 50 g; **d** = 25 cm; **R** = 5 Ω, calculate the required magnetic flux density **B** to move the rod at the constant speed **u** of 10 m/s. [*consider g = 9.8 m/s²*] [4]

e) Now (with the rod moving at the constant velocity **u**), what would be the impact to the velocity, if

   i. magnetic flux density is doubled [1]

   ii. direction of the magnetic field is reversed [1]

Q2 **[40 marks]**

a)

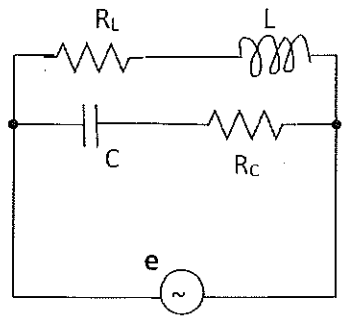

Figure 2a

In the Circuit of Figure 2a, it is given that L = 150 mH, C = 2.5 μF, R_L = 400 Ω, and R_C = 200 Ω. The source delivers a sinusoidal output.

The current and voltage of the Capacitor, as measured with an ideal multimeter at AC setting, read 60 mA and 12 V respectively.

i. Calculate the frequency, and currents and voltages of the other 3 passive components. *Consider the current through the Capacitor as reference.* [12]

ii. Calculate the supply voltage, and express it in the time domain (in the form $e(t) = E_m \sin(\omega t \pm \phi)$). [2]

iii. Calculate the power dissipated from the circuit, and its power factor. [4]

iv. Draw a phasor diagram for the circuit, using the above values, taking the current through the Capacitor as reference. [12]

Draw the phasor diagram (approximately) to scale on a sperate page. They should match the values from i. Draw the reference horizontal to right.

b)

i. Describe the main characteristic of a circuit at resonance. [3]

You are provided an inductor L = 100 mH, a capacitor C = 10 μF, a resistor R = 200 Ω, a source providing frequency $e(t) = 34 \sin(\omega t)$ V, and a set of ideal AC ammeters (A_1 .. A_5) connected as shown in Figure 2b.

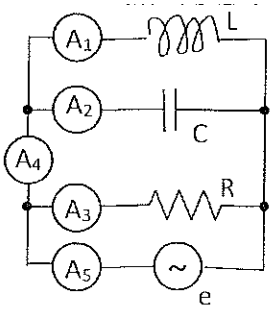

Figure 2b

When the reading of ammeter A_1 is 240 mA, find

ii. ω iii. A_2 reading iv. A_3 reading v. A_4 reading vi. A_5 reading

vii. Draw to scale the phasor diagram for the circuit, using the source voltage as reference. [7]

Q3 **[10 marks]**

A transistor amplifier circuit is shown in Figure 3a. The output characteristics of the transistor and the DC load line for the amplifier are shown in Figure 3b.

Q is the operating point (biasing point of the amplifier).

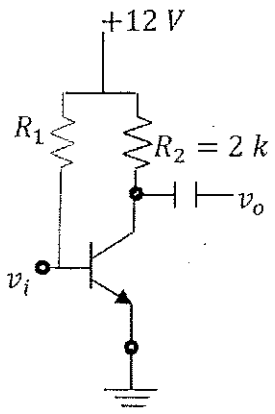

Figure 3a

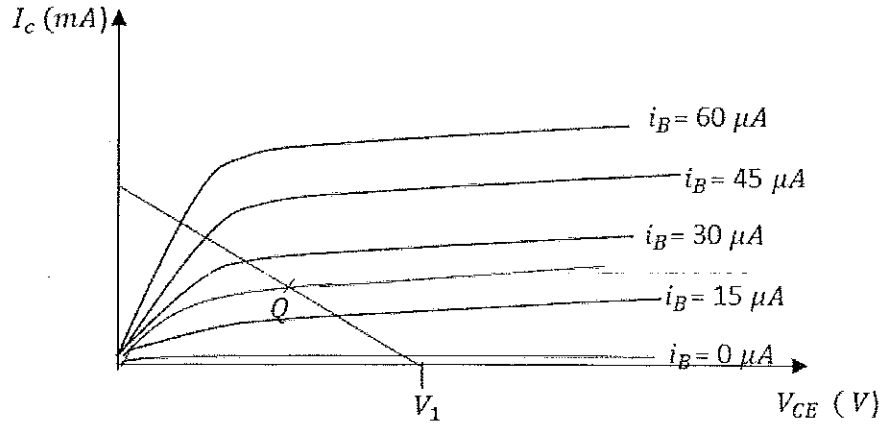

Figure 3b

i. Find the value of V_1. [3]

ii. When $v_i = 0$, find

a. the base current [2]

b. the collector- emitter voltage [2]

c. the collector current [3]

Part B – Answer any two Questions

Q4 **[15 marks]**

a) The earth has a net electric charge that causes a field at points near its surface of about 150 N/C and directed in toward the centre of the earth.

i. What magnitude and sign of charge would a 60 kg human have to acquire to overcome his or her weight by the force exerted (generated) by the earth's electric field? [3]

ii. What would be the force of repulsion between two people each with the charge calculated in part i. and separated by a distance of 100 m? [3]

Consider $g = 9.8\ m/s^2$; $k = 9\times10^9\ Nm^2/C^2$

b) The capacitors in Fig. 4 are initially uncharged and are connected, as in the diagram, with switch S open. The capacitors are of values $C_1 = 3\ \mu F$ and $C_2 = 6\ \mu F$. A potential difference of $V_{ab} = 210$ V is applied between a and b.

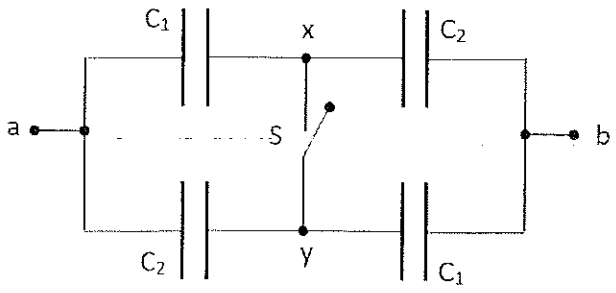

Figure 4

i. What is the potential difference V_{xy}? [3]

ii. What is the potential difference across each capacitor after switch S is closed? [3]

iii. How much charge flowed through the switch when it was closed? [3]

Q5 **[15 marks]**

A moving coil type indicating instrument requires 100 μA DC current for the full-scale deflection. The resistance of the instrument is 1000 Ω.

i. If the instrument is required to be used as an ammeter in the following measuring ranges, calculate the shunt resistances you need for each case.

   a. 1 mA DC full scale deviation [3]

   b. 50 mA DC full scale deviation [3]

ii. If the instrument is required to be used as a voltmeter of 50 V DC (full scale) range, calculate the series resistance you need to connect. [3]

iii. If the voltmeter prepared in 'ii' is used to measure the voltage between the points A and B in the circuit shown in Figure 5, calculate the voltage reading. Assume that the voltage source is ideal. [5]

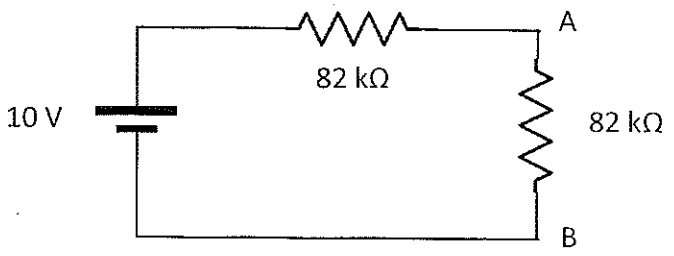

Figure 5

iv. Calculate the percentage error of the meter reading you have calculated in 'iii'. [1]

Q6 **[15 marks]**

a) While giving **three reasons** briefly explain why the electrical energy is superior to all other forms of energy. [3]

b) What are the differences between conventional and non-conventional energy sources? Briefly explain **two types** of conventional energy sources which are more usable in the electrical power industry including their energy conversion process. [4]

c) Is it convenient to increase the transmission voltage as high as possible? Justify your answer. [2]

d) A 2-wire DC distributor cable AB is 2 km long and supplies loads of 100 A, 150 A, 200 A and 50 A situated 500 m, 1000 m, 1600 m and 2000 m from the feeding point A as in Figure 6. Each conductor has a resistance of 0.01 Ω per 1000 m. Calculate the power distribution at each load point (B, C, D, E) if a voltage of 300 V is maintained at point A. [6]

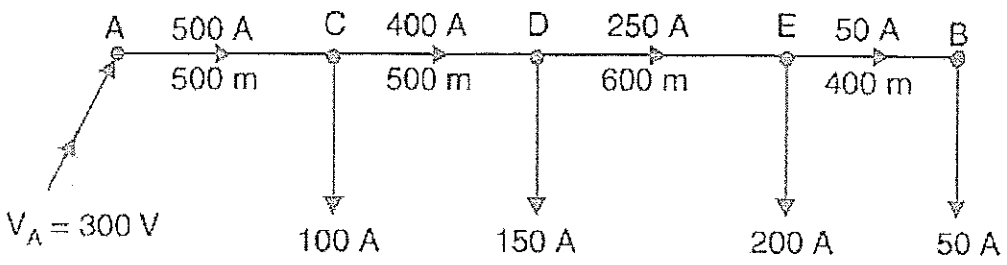

Figure 6