MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 209: ELECTRICAL ENGINEERING 1

DATE: 16/8/2021 **TIME: 2:00 – 4:00 PM**

INSTRUCTIONS

(i) There are **Five** questions.
(ii) Question No.1 is **Compulsory** and carries **30 Marks.**
(iii) Select any **other Two** questions, each of which carries 20 Marks.
(iv) Define all symbols used .
(v) Marks will be awarded for procedure, methodologies used and not necessarily on the final answer.

(a) (i) Show that for an inductance L, the energy stored (W_L) is:-

$$W_L = \tfrac{1}{2}Li^2 = \tfrac{1}{2}\frac{\Psi^2}{L}$$ (5 marks)

(ii) Consider Fig Q1. Determine the voltage across the 25kΩ resistor at $t = 0$, which is just after the switch S is closed. (5 marks)

(b) (i) What do you understand by the term *"Time Constant"* of an electrical circuit? (3 marks)

(ii) Sketch the transient current and voltage response curves of an R-C circuit when excited by a d.c. step voltage of E volts. (4 marks)

(iii) Demonstrate thorough understanding of the term *"Power Triangle"*. (3 marks)

(c) (i) Sketch how the impedance of a resistor, inductor and capacitor varies with frequency. (6 marks)

(ii) Using Kirchhoff's Laws, find the current through resistor R_3 in Fig. Q1c. (4 marks)

QUESTION TWO (20 MARKS)

(a) Using Loop Analysis, solve for the currents in *Network* at Fig. Q2. (10 marks)

(b) Using relevant 3∅ diagrams for a balanced star and delta load, indicate as appropriate: -

i Line and phase voltage. (5 marks)

ii Line and phase current. (5 marks)

QUESTION THREE (20 MARKS)

(a) With the aid of a phasor diagram, show that for both star and delta connected balanced loads, the total active power is given by $\sqrt{3}viCos\emptyset$ where $v\ and\ i$ are line values of voltage and current respectively and ∅ is the angle between phase values of current and voltage. (10 marks)

(b) In Fig.Q3, the switch is opened at $t = 0$ having been closed long enough for the circuit to attain a steady state.

(i) Find *v(t)* for $t > 0$. (8 marks)

(ii) Sketch the resultant curve of *v(t).* (2 marks)

QUESTION FOUR (20 MARKS)

(a) (i) Using the definition of average power as $P_{av} = \int_0^T v(t)i(t)dt$, obtain the expression for the power flowing in a circuit in which $i(t) = I_m Sin\ \omega t$ and $v(t) = V_m Sin(\omega t - \varphi)$. (5 marks)

(ii) Explain the meaning of the results obtained in (i). (5 marks)

(b) (i) Show that in a 3∅ power supply system, $V_L = \sqrt{3}V_{ph}$, where V_L is the line voltage and V_{ph} is the phase voltage. (7 marks)

(ii) Using schematic diagrams, explain the difference between the line and phase voltages. (3 marks)

QUESTION FIVE (20 MARKS)

(a) Explain what reluctance of magnetic circuit is. (5 marks)

(b) A magnetic circuit comprises of two parts in series, each of uniform cross-sectional area (csa) as follows: -

1) A length of *90mm* and a csa *60mm*^{2}
2) A length of *50mm* and csa *80mm*^{2}
3) An air gap of length *0.4 mm* and csa *140mm*^{2}

A coil of *3000 turns* is wound in part (1) and the flux density in the air gap is *0.45T*.

Assuming that all flux passes through the given circuit, determine the current in the coil required to produce such a flux density. Take $\mu_0 = 4\pi \times 10^{-7}$ *H/m* and $\mu_r = 1200$.

(15 marks)

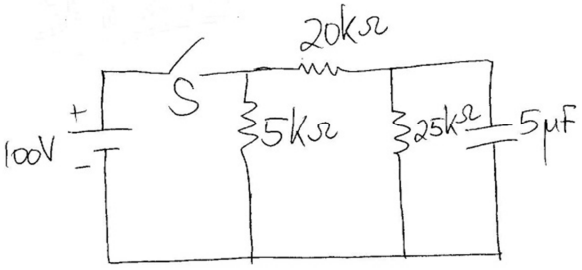

fig Q1

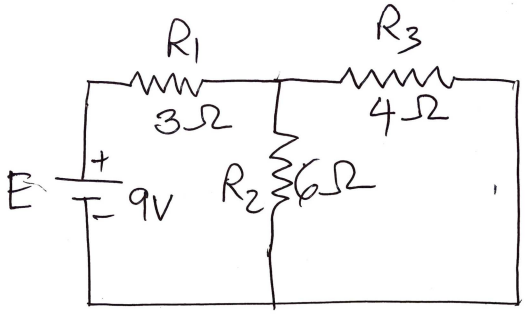

fig Q1c

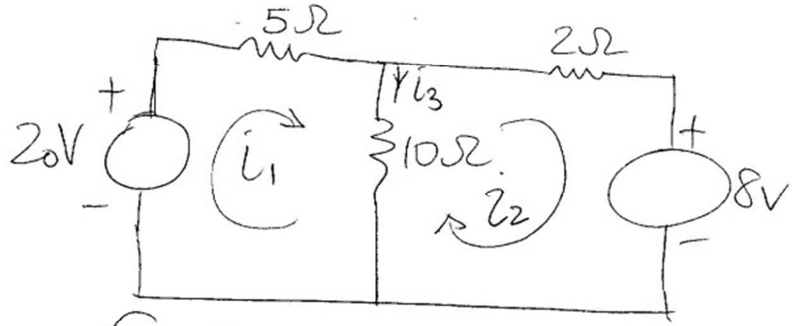

fig Q2

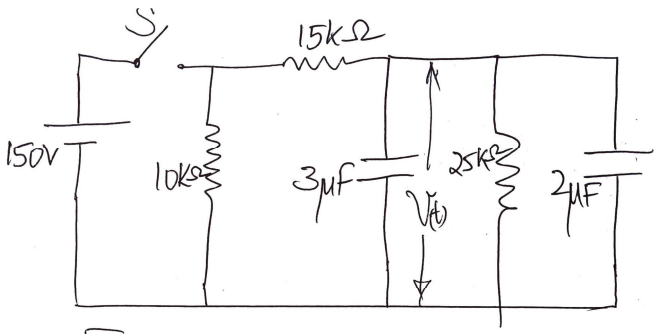

Fig Q3