MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 209: ELECTRICAL ENGINEERING 1

DATE: 29/8/2022 **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.

1. (a) (i) Show that the energy stored in a capacitor C is $^1/_2\ Cv^2$. (4 marks)

(ii) Fig Q1 (a) depicts a coil on a toroid iron core. Sketch the equivalent magnetic circuit and give the mean magnetic path length. (6 marks)

(b) (i) Using relevant diagrams and examples, distinguish between mutual-inductance and self-inductance (5 marks)

(iii) Demonstrate thorough understanding of the term *"Reactive Power"*. (5 marks)

(c) (i) Use Mesh-Current analysis techniques to solve for the current in each element of the circuit shown in Fig. Q 1(c). (7 marks)

(ii) State Ampere's Law and write its formula. (3 marks)

2. (a) The *Network* in Fig. Q2. Has the switch closed at time $t = 0$. After the steady state is reached with the switch closed the switch is opened. Obtain: -

(i) An expression for the current in the circuit when the switch is closed. (4 marks)

(ii) An expression for the current after the swich is opened. (4 marks)

(iii) For both cases in (i) and (ii) above sketch the current waveforms. (2 marks)

(b) For the circuit shown in Fig. Q2(b) determine: -

i Apparent power . (3 marks)

ii Average power. (3 marks)

iii Power factor. (4 marks)

3. (a) For the network in Fig. Q3 (a) assume that R, L, C have magnitudes all equal to unity. If $V_R(t)$ has the wave form shown in Fig. Q3 (b) obtain the wave form for: -

(i) $i(t)$ (2 marks)

(ii) $v_L(t)$ (4 marks)

(iii) $v_C(t)$ (4 marks)

(b) (i) Demonstrate thorough understanding of what hysteresis is. (5 marks)

(ii) Find the unknown impedance Z_1 in Fig. Q3 (c). (5 marks)

4. Consider the circuit shown in Fig. Q4. The switch is opened at time $t = 0$ after the circuit has reached in steady state.

(a) Derive the expressions for the current $i(t)$ and the voltage $v(t)$. (4 marks)

(b) Give the time constant for the circuit after the switch opens. (4 marks)

(c) Determine the maximum magnitude of $v(t)$. (4 marks)

(d) Find the time at which $v(t)$ is one-half of its value immediately after the switch opens. (4 marks)

(e) Sketch the wave forms for $i(t)$ and $v(t)$. (4 marks)

5. (a) Consider the magnetic core with an air gap depicted in Fig. Q5. The core material has $\mu_r = 7000$. Taking $\mu_0 = 4\pi \times 10^{-7}$,

(i) Sketch the magnetic circuit. (3 marks)

(ii) Determine the current required to establish a magnetic flux density of $B_{gap} = 0.25T$ in the air gap. (7 marks)

(b) A balanced positive-sequence wye-connected 60-Hz 3∅ supply source has line-to-line voltages of $1{,}000\ V$. This source is in turn connected to a balanced wye-connected load. Each phase of the load consists of a $0.2\ H$ inductance in series with a $100\ \Omega$ resistance. Assuming that V_R is zero, find: -

(i) Line-to-neutral voltages. (3 marks)

(ii) Line currents. (3 marks)

(iv) The power delivered to the load. (4 marks)

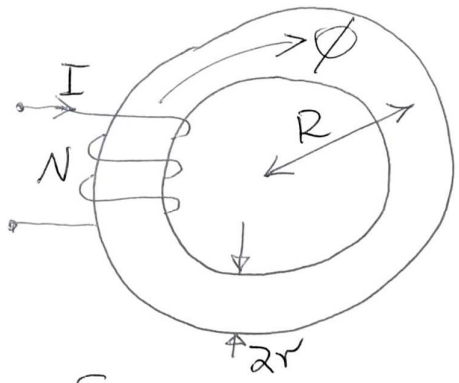

Fig Q1(a)

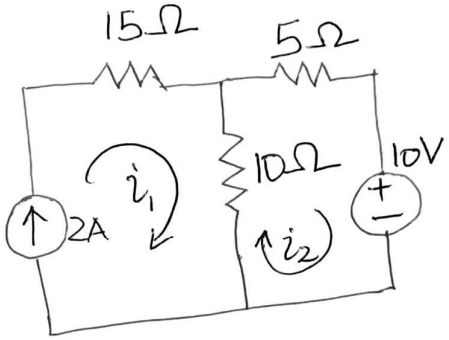

Fig Q1(c)

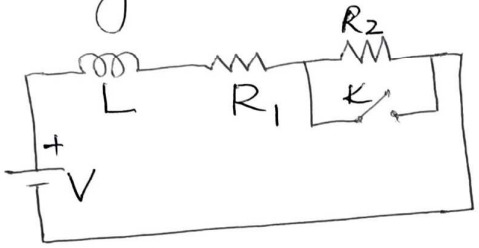

Fig Q2(a)

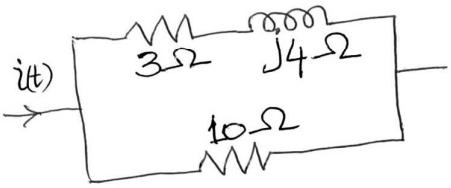

Fig Q2(b)

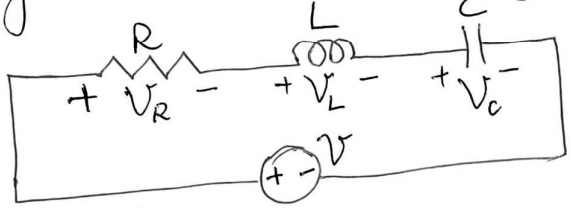

Fig Q3(a)

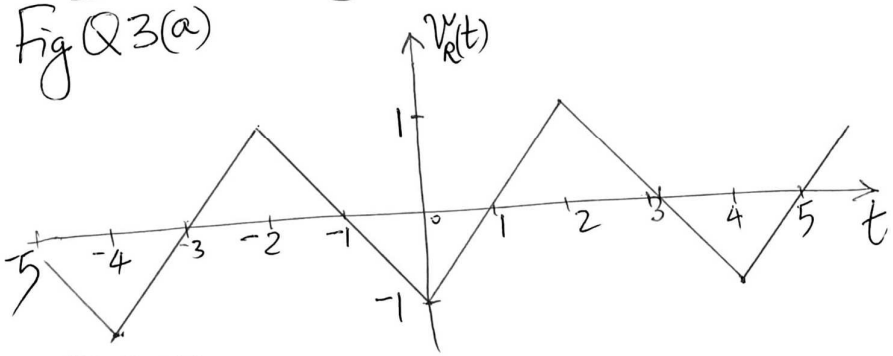

Fig Q3(b)

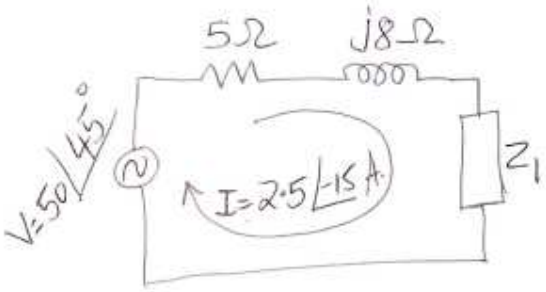

fig Q3c.

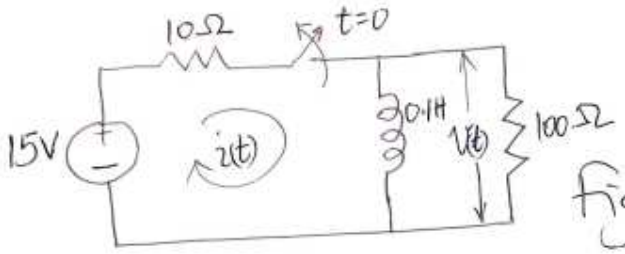

fig Q.4

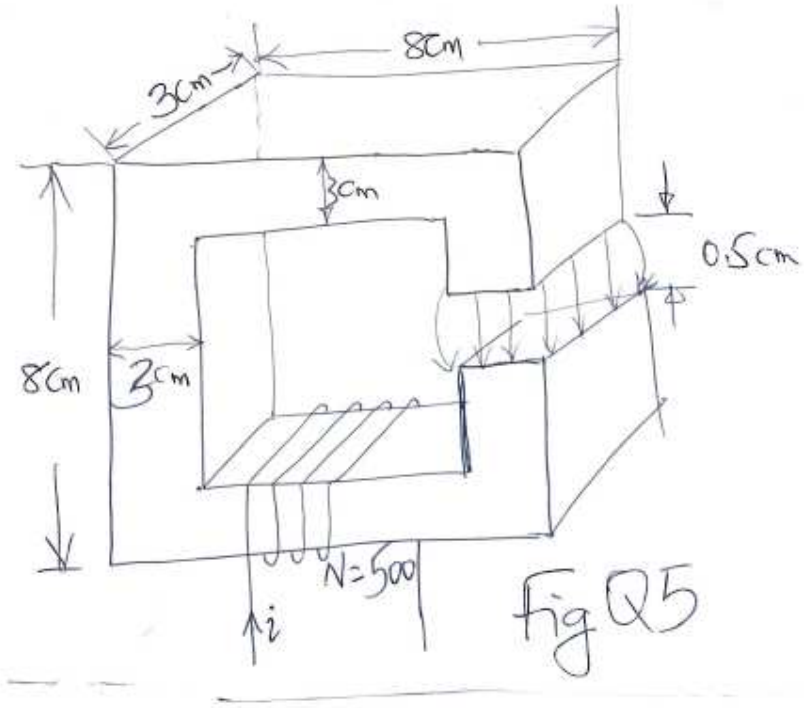

fig Q5