MACHAKOS UNIVERSITY

University Examinations 2019/2020Academic year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE APPLIED PHYSICS AND TECHNOLOGY

SPH 208: ELECTRICAL CIRCUITS

DATE: 6/12/2019 **TIME: 2.00-4.00 PM**

INSTRUCTIONS TO CANDIDATES

1. Answer question No 1 and any other two questions.
2. Question No 1 carries 30 marks while the other two carry 20 marks each.
3. Read the instructions on the booklet keenly and adhere to them.

QUESTION ONE (30 MARKS)

a) Give the polar form of a voltage which is expressed in rectangular form as $V = (5 + j12)$ volts (2 marks)

b) Determine the charge that enters an element by time t when $i = 8t^2 - 4t$, $t \geq 0$. Assume q(t) =0 for $t < 0$ (2 marks)

c) Give two differences between series and parallel reactance in RLC circuits (2 marks)

d) When a voltage of $12e^{-8t}$ V was connected across the element in Figure 1 a current of $5e^{-8t}$A flowed for $t \geq 0$. Both V(t) and i(t) are zero at $t < 0$. Find the energy supplied by the element over the first 100 ms. (3 marks)

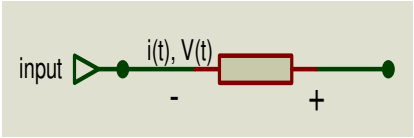


Fig 1

e) Distinguish between independent and dependent sources (2 marks)

f) A voltage source $V(t) = 10\cos t$ V is connected across a resistor of 10Ω. Find the power delivered to the resistor (2 marks)

g) Show that the voltage V_n across the n[th] resistor in a series of resistors connected in series to a voltage source V_s is given by $V_n = \frac{R_n}{R_1 + R_2 \ldots\ldots R_n} V_s$ (3 marks)

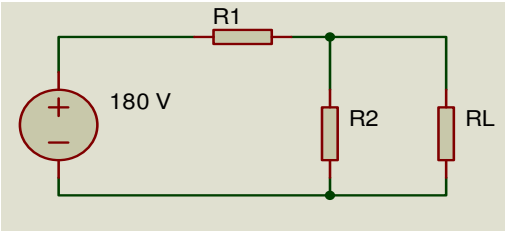
h) i) State the Ampere's circuital law (1 mark)

ii) Compute the magnetic field of a long straight wire that has a circular loop with a radius of 0.05m carrying a current of 2A.($\mu_o = 4\pi \times 10^{-7}\ H/m$) (3 marks)

i) i) State the maximum power transfer theorem in electrical networks (1 mark)

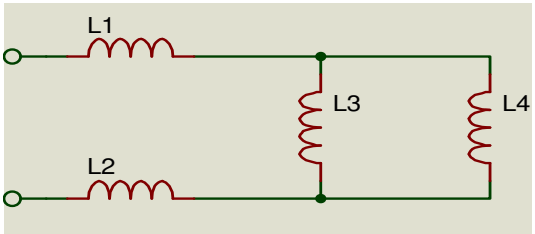
ii) Given that R1 = 150 Ω and R2 = 30 Ω, find the load resistor R_L that will result into maximum power delivery to the load for the circuit in Figure 2. Hence determine the maximum power (4 marks)

Fig 2



j) The circuit in figure 3 has inductors L1 = 2mH, L2= 3mH, L3= 5mH, and L4= 20 mH. Determine the equivalent inductance in the circuit (2 marks)

Fig 3



k) i) Sketch the magnetization curve of a magnetic material (1 mark)

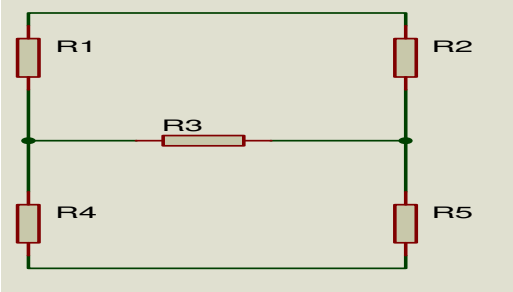
ii) A loop having a cross sectional area of 500 mm^2, circumference of 400 mm and $\emptyset = 800\ \mu Wb$ has a coil of 200 turns wound around it. Relative permeability of the ring μ_r is 380. Calculate the magnetic current ($\mu_o = 4\pi \times 10^{-7}\ H/m$) (3 marks)

QUESTION TWO (20 MARKS)

a) Give circuit descriptions of the wye - delta network transformations and write the equations that relate the two (4 marks)

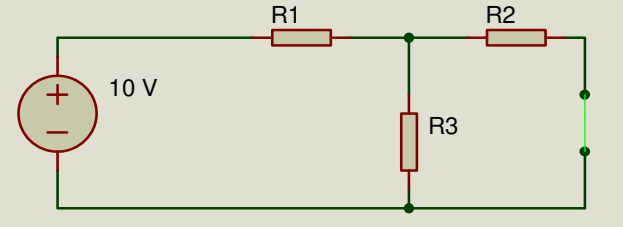
b) Using the delta to wye network conversion, find the equivalent resistance in Figure 4 given that R1 = 6Ω, R2 = 10Ω, R3= 4Ω, R4=4Ω, R5=6Ω (5 marks)

Fig 4



c) State and prove the reciprocity theorem using the circuit in Figure 5 .R1 = 5Ω, R2 = 7Ω and R3 = 6Ω (5 marks)

Fig 5



d) An AC series circuit consists of a resistor with resistance of 90Ω, a coil with inductance of 1.3 H and a capacitor with capacitance of 10 μF. The circuit is connected to an AC voltage source with amplitude of 100 V and frequency of 50 Hz. Write the equations for instantaneous values of voltage and current in the circuit if the initial phase of the current is zero (6 marks)

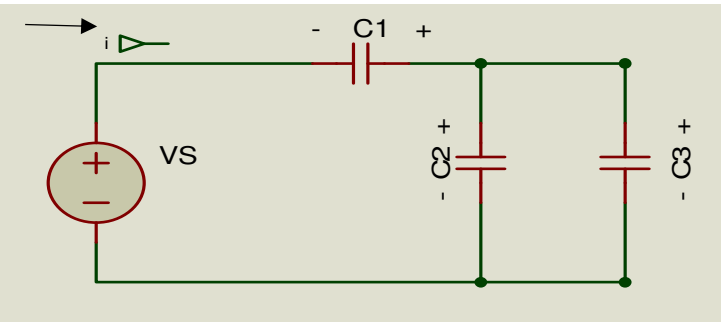
QUESTION THREE (20 MARKS)

a) Describe the four types of dependent sources showing how the gain and the voltage or current through an element can be determined (6 marks)

b) i) What is a capacitor (1 mark)

ii) Using figure 6 find the equivalent capacitance and voltage Vs when C1= C2=C3 = 2mF, $V_1(0) = 10$ V, $V_2(0) = V_3(0) = 20$ V. (4 marks)

Fig 6



c) i) Define the term transient response (1 mark)

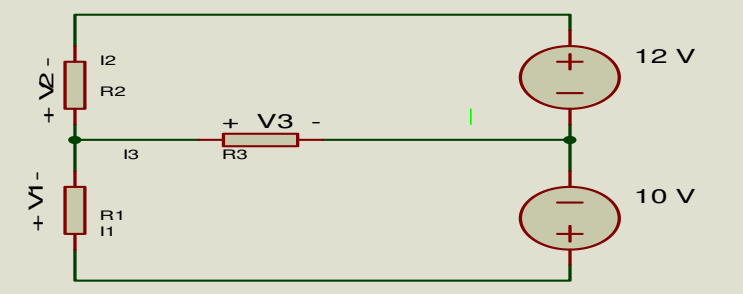
ii) Derive expressions to show the transient behavior of a RC and RL circuits then show how the time constant (τ) can be determined in each (8 marks)

QUESTION FOUR (20 MARKS)

a) State the Kirchhoff's current law in electrical circuits (1 mark)

b) Consider the circuit in Figure 7

Fig 7

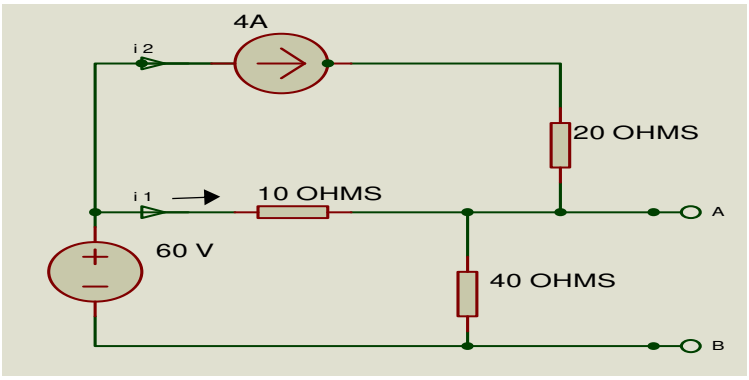


Find each current and each voltage through the elements hence determine resistance R_2. Currents and voltages through resistors R_1, R_2 and R_3 are I_1, I_2, I_3 and V_1, V_2, V_3 respectively. R_1= 8Ω, V_2 = -10V, I_3 = 2A and R_3 = 1Ω. (5 marks)

c) i) State the Thevenin's and Norton's network theorems (2 marks)

ii) Considering the circuit in Figure 8

Fig 8



Find the Thevenin's and Nortion's voltage across AB hence sketch the Thevenin's and Nortion's equivalent circuits (7 marks)

d) i) Give one difference between an inductor and a capacitor (1 mark)

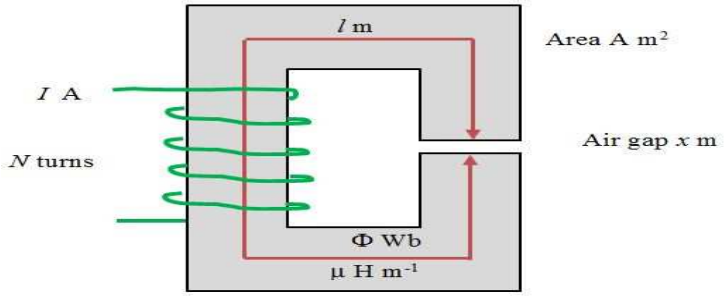
ii) Find the voltage across an inductor L= 0.1H for $t > 0$ and $t = 0$ when the current in the inductor is $i(t) = 20te^{-2t}\ A.\ i(0) = 0$ (4 marks)

QUESTION FIVE (20 MARKS)

a) State the ohms law of magnetic circuits (1 mark)

b) The magnetic circuit in figure 9 has a magnetic material of relative permeability of 1.75. It has a cross section of 2.5 cm by 2.5 cm and an average length of 25 cm. The air gap cut into it which is 1mm in length.

Fig 9



Calculate

i. Reluctance of the material (3 marks)

ii. Reluctance of the air gap (2 marks)

iii. Total reluctance (1 mark)

c) The magnetic circuit in Figure 9 consists of 300 turns that carry a current of 0.75 A.

Calculate

i. Magnetic motive force (2 marks)

ii. Magnetic flux (2 marks)

d) A series RLC circuit containing a resistance of 12 Ω, an inductance of 0.15 H and a capacitor of 100μF are connected in series across a 100 V, 50 Hz supply. Required

i. Total impedance, (4 marks)

ii. The total current, (1 mark)

iii. The power factor (2 marks)

iv. Voltage phasor diagram (2 marks)