UNIVERSITY OF JOHANNESBURG

PROGRAM	**:**	BACHELOR OF ENGINEERING TECHNOLOGY: *ELECTRICAL/MECHANICAL/INDUSTRIAL* ENGINEERING
MODULE	:	**ELECTROTECHNOLOGY 1A**
MODULE CODE	:	**ELTELA1**
DATE	:	MAIN EXAMINATION 2019 11 JUNE 2019
DURATION	:	(3 HOURS) 12:30 – 15:30
WEIGHT	:	40: 60
TOTAL MARKS	:	100

ASSESSOR	:	DR W. DOORSAMY, MS L. MUREMI
MODERATOR	:	DR P. BOKORO
NUMBER OF PAGES	:	5 PAGES (INCLUDING THIS PAGE)

INSTRUCTIONS TO STUDENTS

WORK IN PENCIL WILL NOT BE MARKED.
ALL WORK WITH THE EXCEPTION OF DIAGRAMS MUST BE IN BLUE OR BLACK INK.
ONE MARK EQUALS ONE PERCENT.
NO UNITS NO MARKS.
QUESTIONS MAY BE ANSWERED IN ANY ORDER.
ANSWER ALL QUESTIONS.
USE UP TO FIVE DECIMAL PLACES.
ONLY ONE POCKET CALCULATOR PER STUDENT MAY BE USED.

<u>QUESTION 1</u> (25 MARKS)

1.1 A 0.5 nF capacitor is constructed by two parallel metal plates each 300 cm^2 in area separated by a dielectric slab of 3.5 mm thick. Calculate the following when a potential difference of 12 kV is applied:

1.1.1 Total charge on the plates (2)

1.1.2 Potential gradient (2)

1.1.3 Relative permittivity of the dielectric. (3)

Given: $\boldsymbol{\varepsilon_o} = 8.854 \times 10^{-12}$

1.2 A coil of copper wire has a resistance of 10 Ω at 20°C. If the temperature coefficient of resistance of copper at 20°C is 0.004 /°C, determine the resistance of the coil when the temperature rises to 100°C (4)

1.3 A 4 m length of wire has a cross-sectional area of 4 cm^2 and resistance of 0.8 Ω. This length of wire is extruded to a new length of 11 m and cross-sectional area of 3.5 mm^2. What will be the new resistance of the wire? (4)

1.3 A mild steel ring has a cross-sectional area of 300 mm^2 and a mean diameter of 40 cm. The ring is wound with coil of 600 turns and the value of relative permeability of the ring is 380. A current of 0.5 A is applied to the coil. Calculate the

1.3.1 Magnetic field strength H, and (5)

1.3.2 Magnetic flux ϕ. (5)

Given: $\boldsymbol{\mu_o} = 4\pi\times10^{-7}$

<u>QUESTION 2</u> (15 MARKS)

2.1 The following two sinusoidal signals are given:

$$V_1 = 100\sin(20t + 35°)\,V$$

$$V_2 = 4\sin(20t + 45°)\,V$$

2.1.1 What is the frequency of the voltage V_1? (2)

2.1.2 If V_1 is added to V_2, determine the <u>polar form</u> expression of the result ($V_t = V_1 + V_2$). The answer should be in the form: $V_t = X\angle\theta\ \ V$ (3)

2.2 In the circuit given in figure 1 below, after some time the switch moves to the position as indicated at time $t = 0$. Given that $R = 5k\Omega, C = 3\ \mu F$, answer the following:

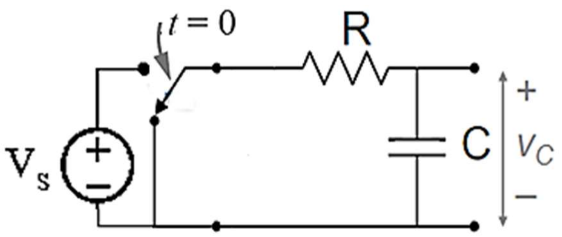

FIGURE 1

2.2.1 Write an expression for $V_C(t)$, given that the initial voltage is 2.5 V (4)

2.2.2 What is the final voltage of across capacitor – i.e. $V_C(t = \infty)$ (2)

2.2.3 Calculate the voltage at the time constant – i.e. $V_C(t = \tau)$ (4)

<u>QUESTION 3</u> (33 MARKS)

3.1 For the network given in **FIGURE 2**, apply the mesh analysis method and answer the following questions.

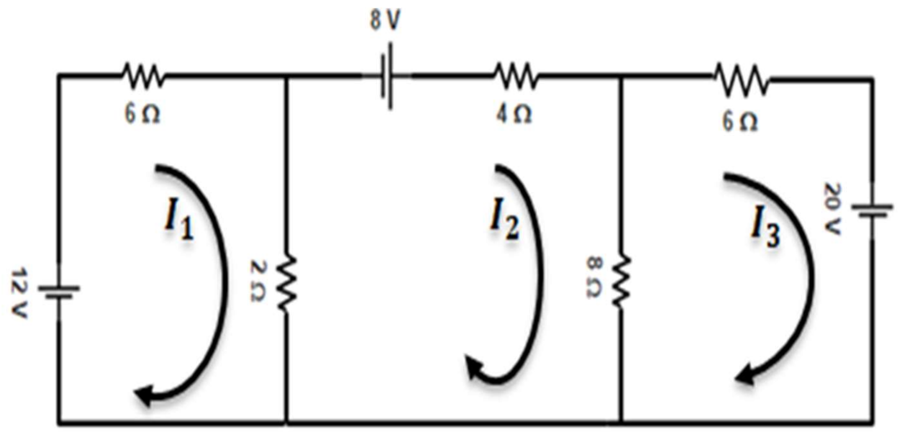

FIGURE 2

3.1.1 Write Kirchhoff's voltage law and resulting mesh equations in the circuit. (6)

3.1.2 Use Cramer's rule to compute mesh currents I1, I2 and I3. (10)

3.1.3 Determine the voltage across 2 Ω and 4 Ω resistors in the circuit. (6)

3.2 For network given in **FIGURE 3**, apply Nodal analysis and answer the following questions.

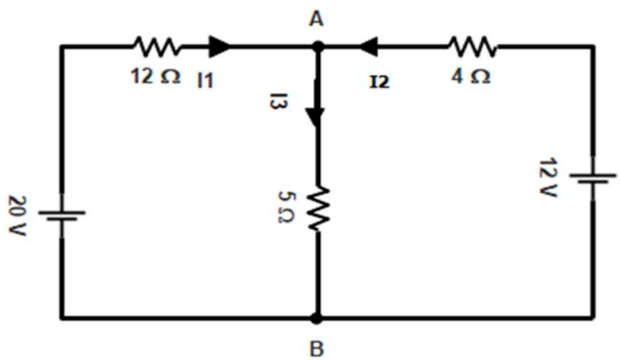

FIGURE 3

3.2.1 Determine the voltage across terminals **A** and **B**. (5)

3.2.2 Determine the values of currents I_1, I_2 and I_3 (6)

<u>QUESTION 4</u> (17 MARKS)

4.1 The current in an a.c. circuit at any time t seconds is given by:

$$I\ (t) = 300 \sin (250\pi t+0.26) \text{ amperes}$$

Determine:

4.1.1 The peak-peak current. (1)

4.1.2 The periodic time and frequency. (2)

4.1.3 The phase shift in degrees. (2)

4.2 Suppose an AC generator with $V(t) = 180\ sin\omega t$ at a frequency of 50 Hz is connected to a series RLC circuit with R=35 Ω, L= 50 mH and C= 60 µF. Sketch a neat diagram representing this network, and calculate:

4.2.1 The inductive reactance, capacitive reactance and Identify if the circuit is highly inductive or capacitive. (6)

4.2.2 The impedance of the circuit. (2)

4.2.3 The frequency at resonance. (2)

4.2.4 The Q factor of the circuit at resonance. (2)

<u>QUESTION 5</u> (10 MARKS)

5.1 A circuit has an impedance $Z = (4+ 6j)\ \Omega$ and a source p.d. of $80\angle 30^\circ$V at a frequency of 50 Hz. Determine

5.1.1 The supply current. (3)

5.1.2 The active, apparent and reactive power. (4)

5.1.3 The rating of a capacitor (in var) to be connected in parallel with impedance Z to improve the power factor of the circuit to 0.92 lagging. (3)

END