[ENG16]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG(HONS) ELECTRICAL AND ELECTRONIC ENGINEERING

SEMESTER ONE EXAMINATION 2018/2019

INTRODUCTORY ELECTRICAL PRINCIPLES

MODULE NO: EEE4012

Date: Monday 14th January 2019 **Time: 14:00 – 16:00**

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions.

Answer ANY FOUR questions.

All questions carry equal marks.

Individual marks are shown within the question.

A formula sheet is given at the end of the paper.

Question 1

a) For the circuit shown in Fig. Q1.a, using node analysis technique or otherwise, find out the value of the current flowing through the 6 kΩ resistor.

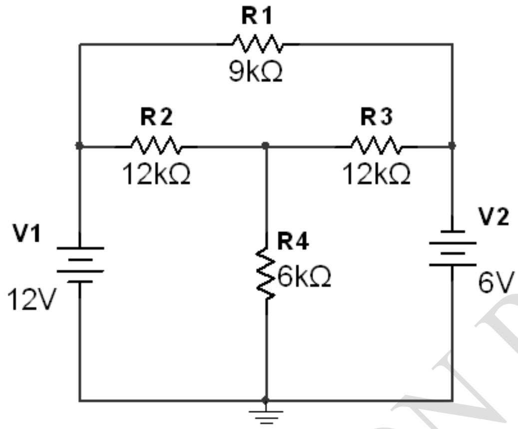

Fig. Q1.a

[10 marks]

b) A straight wire carries a current of 0.75 A. What is the magnetic field strength *H* at a distance of 100 mm from the wire?

[5 marks]

c) A coil of copper wire has a resistance of 100 Ω when its temperature is 20 ^{o}C. Determine its resistance at 100 ^{o}C if the temperature coefficient of resistance (TCR) of copper at 20 ^{o}C is 0.0039/ ^{o}C.

[5 marks]

d) A rectangular coil measuring 200 mm x 100 mm is mounted in such a manner that it can be rotated around the midpoint of the 100 mm side. The axis of rotation is at right angle to a magnetic field of uniform flux density 0.1 T. Calculate the flux in the coil for the following conditions:

(i) Maximum flux through the coil and the position at which it will occur

[2.5 marks]

(ii) Flux through the coil when 100 mm side is inclined at 45^{o} to direction of the flux.

[2.5 marks]

Total 25 marks

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Question 2

a) For the following circuit (Fig Q2.a), using superposition theorem or otherwise, find out the current flowing through the 100 Ω resistor.

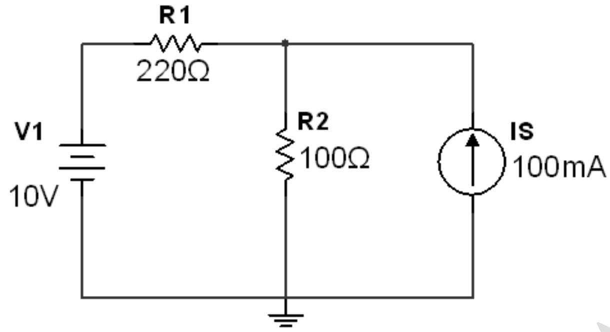

Fig. Q2.a

[10 marks]

b)

For the circuit shown below (Fig. Q2.b), considering the RLoad as the load resistance

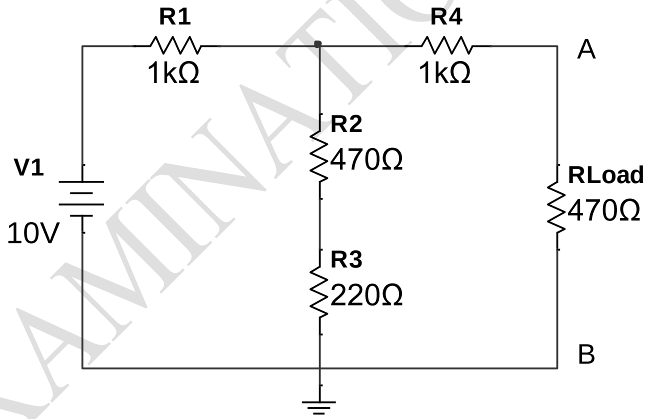

Fig. Q2.b

(i) Derive the equivalent Thevenin circuit between points "A" and "B" **[10 marks]**

(ii) Derive the equivalent Norton circuit between points "A" and "B" **[5 marks]**

Total 25 marks

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Question 3

a) For the circuit shown in Fig. Q3.a, calculate:

1. The total impedance Z; **[5 marks]**
2. The phase angle between the voltage and the total current θ; **[3 marks]**
3. The total current I_T; **[3 marks]**
4. Draw the currents and voltage phasor diagram; **[3 marks]**
5. Is the circuit inductive or capacitive and why?; and **[3 marks]**
6. The resonance frequency. **[3 marks]**

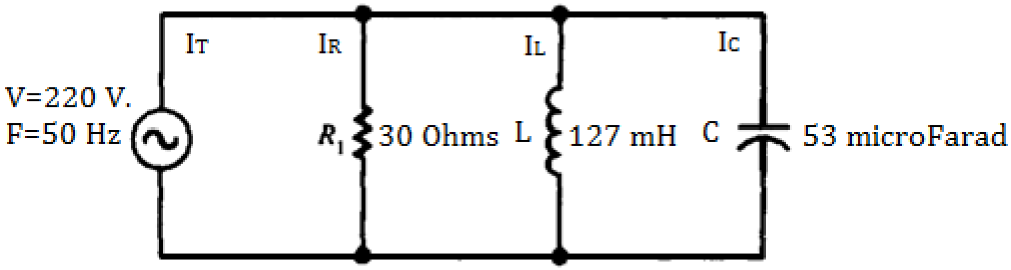

Fig. Q3.a a parallel RLC circuit

b) In a resistance-capacitor circuit shown in Fig. Q3.b, the voltage drop across points A and B is 28.28 V. If the frequency of the current is 1 kHz,

(i) Find the voltage across the resistor. **[6 marks]**
(ii) Draw the phasor diagram. **[4 marks]**

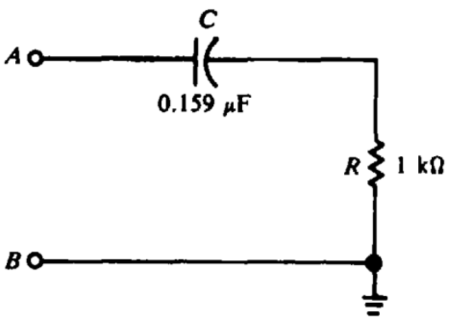

Fig. Q3.b an RC series circuit

Total 25 marks

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Question 4

a) A 800 VA single-phase transformer delivers 10 Amperes current to a resistive load. If the supply current at the primary is 2 Amperes . Calculate:

i. The transformer voltage ratio **[2 marks]**

ii. The transformer primary voltage **[2 marks]**

b) What is the inductance of an inductor if number of turns are 100 turns, relative permeability of 1000, and coil area to coil length ratio is 3 ? **[3 marks]**

c) A stepper motor has an angular resolution of 5 degrees per step. If the clock input producing the stepper motor drive sequence is 100 Hz, what will be the rotational speed of the stepper motor in revolutions per minute? **[8 marks]**

d) Derive the generated EMF equation of a single-loop wire rotating at constant angular velocity within a magnetic field whose magnetic flux density is constant. **[3 marks]**

e) Calculate the current and power delivered to a 0.1 ohms load resistor connected across the terminals of the wire loop of branch c if the magnetic flux density is 0.5 T, the angular velocity is 314.2 rad/sec, radius of the loop is 10 cm and the side length of the loop is 8 cm. **[7 marks]**

Total 25 marks

Question 5

a) Define the following terms (**2 marks for each definition**):

i. Frequency
ii. Period
iii. Phase angle
iv. Peak to peak value
v. Capacitance
vi. Inductance

[10 marks]

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Q5 continued

b) X, Y and Z are three sine AC voltage waveforms of the same frequency. Sinewave X leads sinewave Y by a phase angle of 60° and lags sinewave Z by 70°.

(i) What is the phase angle between wave Y and wave Z? **[3 marks]**

(ii) Which wave is leading? **[2 marks]**

c) A 240-V AC voltage is applied across two resistors connected in series, namely a 20-Ω, and a 60- Ω. Find the value of **(2.5 marks for each branch)**:

i. The source rms and peak current
ii. Vmax and Vav
iii. The rms V_{R1} and V_{R2}
iv. Power dissipated in each resistor.

[10 marks]

Total 25 marks

END OF QUESTIONS

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School of Engineering
BEng (Hons) Electrical and Electronic Engineering
Semester One Examination 2018/2019
Introductory Electrical Principles
Module No. EEE4012

APPENDIX: Formula Sheet

The following symbols in the formulae have their standard meaning:

Ohm's law: $V = IR$

Power: $P = IV$

Magnetic flux: $\Phi = BA$

Induced voltage: $V = \Delta\Phi/\Delta t$

Force experienced by charged particle = $qvBsin\theta$

Motional emf: $E = Blv$

$$f = \frac{pn}{120}$$

Magnitude of the Reactance of Inductor L: $X_L = 2\pi fL$

Magnitude of the Reactance of Capacitor C: $X_C = \frac{1}{2\pi fC}$

Pythagorean theorem: $c^2 = a^2 + b^2$

Tangent function: tanA=opposite/adjacent

$\mu_o = 4\pi X10^{-7} H/m$, $\epsilon_o = 8.85X10^{-12} F/m$

$H = \frac{N.I}{l}$

MMF=N.I

$L = \frac{\mu_o \mu_r A N^2}{l}$, $E = \frac{1}{2} LI^2$

C=Q/V , $C = \frac{\epsilon A}{d}$, $E = \frac{1}{2} CV^2$

$v_L = L.\frac{di_L}{dt}$

$i_C = C\frac{dv_C}{dt}$

$f = \frac{pn}{120}$

Transformer voltage ratio: $\frac{V_1}{V_2} = \frac{N_1}{N_2}$, $P = V_1.I_1 = V_2.I_2$

Multiply the Value	By	To Get the Value
Peak	2	Peak-to-peak
Peak-to-peak	0.5	Peak
Peak	0.637	Average
Average	1.570	Peak
Peak	0.707	RMS (effective)
RMS (effective)	1.414	Peak
Average	1.110	RMS (effective)
RMS (effective)	0.901	Average

Summary Table for Series and Parallel *RL* Circuits

X_L and R in Series	X_L and R in Parallel
I the same in X_L and R $V_T = \sqrt{V_R^2 + V_L^2}$ $Z = \sqrt{R^2 + X_L^2} = \frac{V_T}{I}$ V_R lags V_L by 90° $\theta = \arctan \frac{X_L}{R}$	V_T the same across X_L and R $I_T = \sqrt{I_R^2 + I_L^2}$ $Z_T = \frac{V_T}{I_T}$ I_L lags I_R by 90° $\theta = \arctan\left(-\frac{I_L}{I_R}\right)$

Summary Table for Series and Parallel *RC* Circuits

X_C and R in Series	X_C and R in Parallel
I the same in X_C and R $V_T = \sqrt{V_R^2 + V_C^2}$ $Z = \sqrt{R^2 + X_C^2} = \frac{V_T}{I}$ V_C lags V_R by 90° $\theta = \arctan\left(-\frac{X_C}{R}\right)$	V_T the same across X_C and R $I_T = \sqrt{I_R^2 + I_C^2}$ $Z_T = \frac{V_T}{I_T}$ I_C leads I_R by 90° $\theta = \arctan \frac{I_C}{I_R}$

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