[ESS27]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG (HONS) ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER ONE EXAMINATION 2019/2020

INTRODUCTORY ELECTRICAL PRINCIPLES

MODULE NO: EEE4012

Date: Monday 13th January 2020 Time: 14:00 – 16:00

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions.

Answer ANY FOUR questions.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

Formulae sheet is attached at the end of the paper.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester One Examination 2019/2020
Introductory Electrical Principles
Module No. EEE4012

Question 1

a) A coil of copper wire has a resistance of 150 Ω, when its temperature is 0 °C. Determine its resistance at 50°C if the temperature coefficient of resistance (TCR) of copper at 0 °C is 0.0043/ °C.

[3 marks]

b) In For the following circuit (Figure Q1b), using superposition theorem or otherwise, find out the current flowing through the 20Ω resistor.

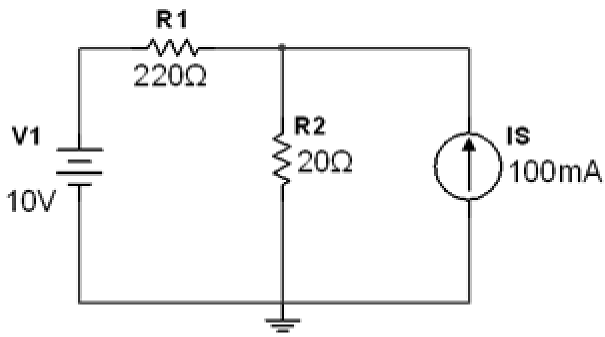

Figure Q1b

[10 marks]

c) For the circuit shown in Figure Q1c below, calculate:

(i) the voltage drop across the 4 kΩ resistor **[3 marks]**

(ii) the current through the 5 kΩ resistor **[3 marks]**

(iii) the power developed in the 1.5 kΩ resistor **[3 marks]**

(iv) the voltage at point X w.r.t. earth **[3 marks]**

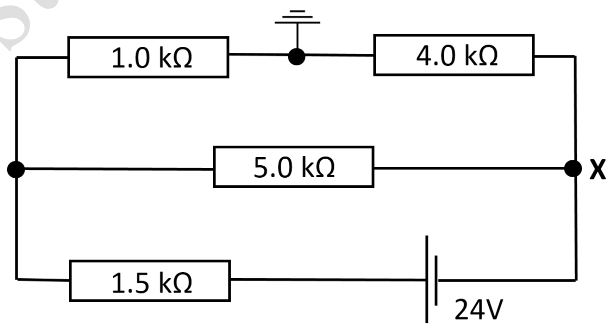

Figure Q1c

Total 25 marks

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Question 2

a) In a Wheatstone bridge ABCD, a galvanometer is connected between B & D, and a battery of 10V emf and 2Ω internal resistance is connected between A & C. A resistor of unknown voltage is connected between A & B. When the bridge is balanced, the resistance between B&C is 100Ω, between C&D is 10Ω and between D&A is 500Ω. Calculate:

(i) the value of unknown resistance between point A & B and **[5 marks]**

(ii) the total current supplied by the battery. **[5 marks]**

b) Use network conversion to find the

i) current flowing through the 6 ohm resistance in Figure Q2b.
ii) potential difference across the 6 ohm resistance in Figure Q2b.

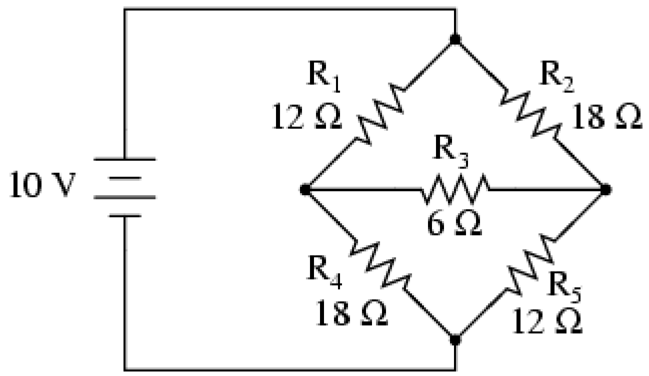

Figure Q2b

[15 marks]

Total 25 marks

Question 3

a) Define the following terms (1 mark for each definition):

i) Frequency
ii) Period
iii) Phase angle
iv) Peak voltage
v) Peak to peak value
vi) Average value
vii) RMS value
viii) Internal resistance
ix) Inductance
x) Capacitance

[10 marks]

b) A magnetic flux of 300μWb passing through a coil of 1000 turns is reversed in 0.2s. Calculate the value of emf induced in the coil. **[5 marks]**

c) An AC ammeter reads 22 A rms current through a combination of two resistive loads, and a voltmeter reads 385 V rms drop across the load. The current through the first resistor is 8 A rms and the current through the second resistor 14 A rms. What type of load connection is this?**[2 marks]** Are they connected in series or parallel and why?**[2 marks].** What are the peak values and the average values of the alternating current and voltage**? [4marks]** , and then calculate the load resistances**[2 marks].**

[10 marks]

Total 25 marks

Question 4

a) A 30-Ω resistor, an inductor, and a capacitor are connected in parallel across a 120-V 60-Hz AC line as shown in figure Q4 below. The circuit main current is $4.123\angle -14.03^{o}$ A. and the inductor current is 1.5 times the capacitor current. Find

i) The current in each branch; **[5 marks]**

ii) The inductive ,capacitive reactances, and the circuit impedance **[5 marks]**

iii) The resonance frequency of the circuit. **[4 marks]**

iv) Is the circuit inductive or capacitive? Draw the current-phasor diagram **[5 marks]**

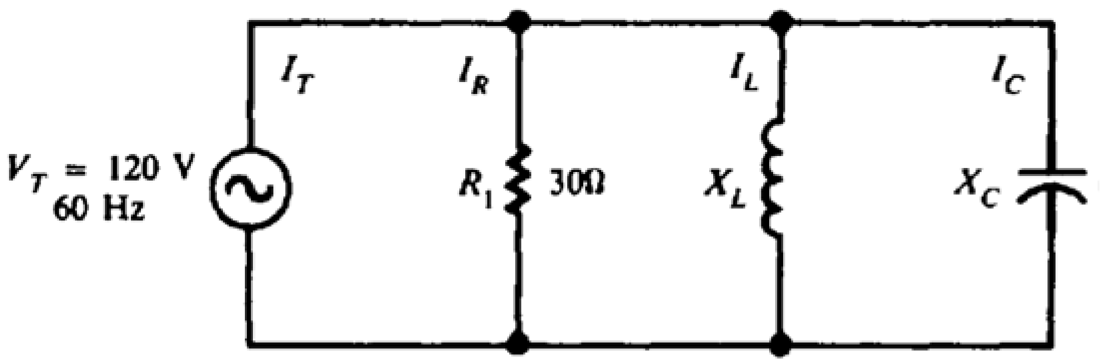

Figure Q4

b) Find the indicated values for an RC series circuit using the table below. **[6 marks]**

V_T (V)	R (Ω)	X_C (Ω)	V_R (V)	I (A)	Z (Ω)	θ (°)	P (W)
240	60	100					

Total 25 marks

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Question 5

a) Enumerate the losses of a direct-current (DC) machine **[5 marks]**

b) Draw the output (load) voltage waveform (across brushes 1 and 2) of the single-loop DC generator shown in figure Q5b below. What is the value of the maximum current flowing in the external resistor (Load) if the flux cutting the wire loop has a rate of 3.5 Web/sec and the resistor is 2.5 Ohms? **[5 marks]**

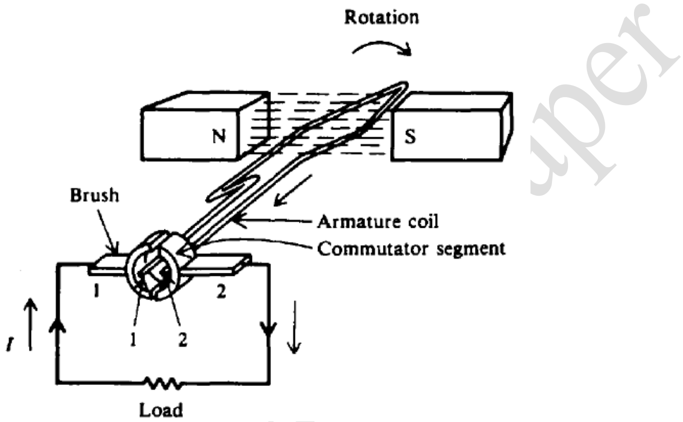

Figure Q5b

c) If we want the AC generator shown in figure Q5c to generate a direct-current (DC) voltage, what alteration is required to perform this function? draw this arrangement. **[3 marks]**

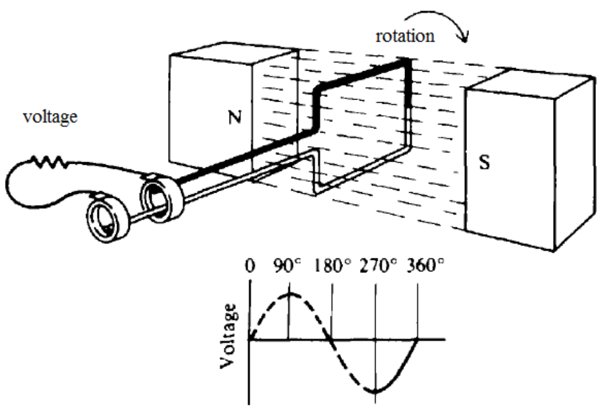

Figure Q5c

Question 5 continues over the page….

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Question 5 continued….

d) A 8-pole AC motor is running at 750 revolution per minute, what would be supply frequency? **[2 marks]**

e) A 166.67 RPM stepper motor has an angular resolution of 5 degrees per step. What would be the clock frequency supplying this motor? **[10 marks]**

Total 25 marks

END OF QUESTIONS

Formula sheets over the page….

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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

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

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

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

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

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

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

Formula sheets continue over the page….

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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