[ENG26]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING, SPORTS AND SCIENCES

BENG (HONS) ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER 1 EXAMINATION 2021/2022

INTRODUCTORY ELECTRICAL PRINCIPLES

MODULE NO: EEE4012

Date: Monday 10th January 2022 **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.

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
Introductory Electrical Principles
Module No. EEE4012

Question 1

a) Define the following terms (**1.5 marks for each definition**):

i. Frequency
ii. Period
iii. Phase angle
iv. Peak to peak value
v. RMS value
vi. Internal resistance
vii. Current
viii. Resistance

[12 marks]

b) An AC ammeter reads 11A rms current through a resistive load, and a voltmeter reads 360V rms drop across the load.

(i) What are the peak values and the average values of the alternating current and voltage**?** **[6 marks]**

(ii) Calculate the load resistance. **[2 marks]**

c) Find the Thevenin equivalent of the circuit given in Figure Q1c below. **[5 marks]**

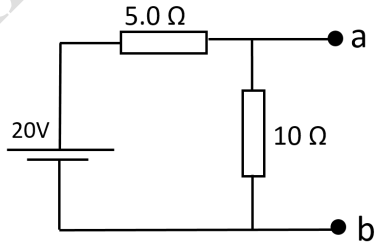


Fig.Q1c

Total Marks: 25

PLEASE TURN THE PAGE….

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
Introductory Electrical Principles
Module No. EEE4012

Question 2

a) A coil of aluminium wire has a resistance of 50 Ω, when its temperature is 0 °C. Determine its resistance at 100 °C if the temperature coefficient of resistance (TCR) of aluminium at 0 °C is 0.0038/ °C.

[3 marks]

b) For the following circuit (Figure Q2b), using superposition theorem or otherwise, find out the current flowing through the 10 Ω resistor.

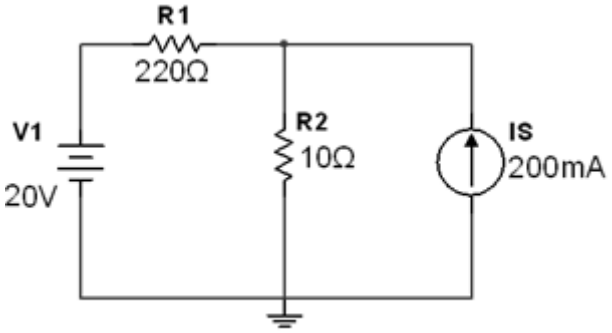


Figure Q2b

[10 marks]

c) For the circuit shown in figure Q2c 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]**

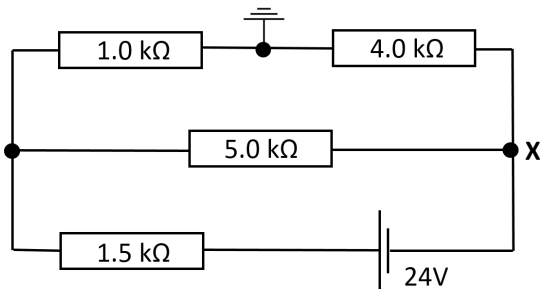


Fig.Q2c

Total Marks: 25

PLEASE TURN THE PAGE….

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
Introductory Electrical Principles
Module No. EEE4012

Question 3

a) In the circuit given in figure Q3a below, use appropriate network conversion (Δ to Y/Y to Δ) to find the total resistance between points "a" and "b".

[10 marks]

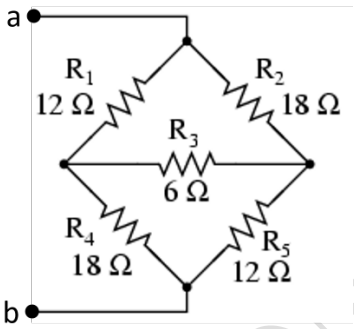


Fig.Q3a

b) For the network shown in figure Q3b below, calculate the potential difference existing between points "N" and "M" i.e. V_{NM}.

[15 marks]

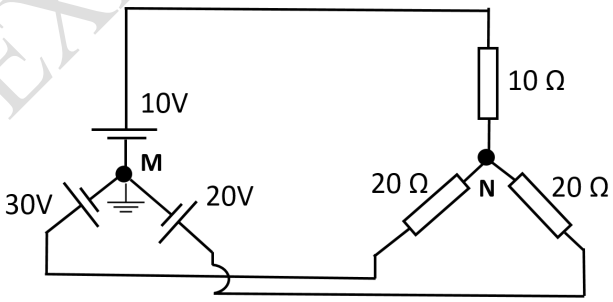


Fig.Q3b

Total Marks: 25

PLEASE TURN THE PAGE….

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
Introductory Electrical Principles
Module No. EEE4012

Question 4

An AC source of voltage 750cos(5000t+30°) is applied to a series RLC circuit as shown in Figure Q4 below.

a) Calculate the total impedance of the circuit Z. **[5 marks]**

b) Calculate the current and phase angle between the voltage and current. **[8 marks]**

c) Calculate the resonance frequency **[5 marks]**

d) Is the circuit inductive or capacitive? **[3 marks]**

e) Draw the phasor diagram **[4 marks]**

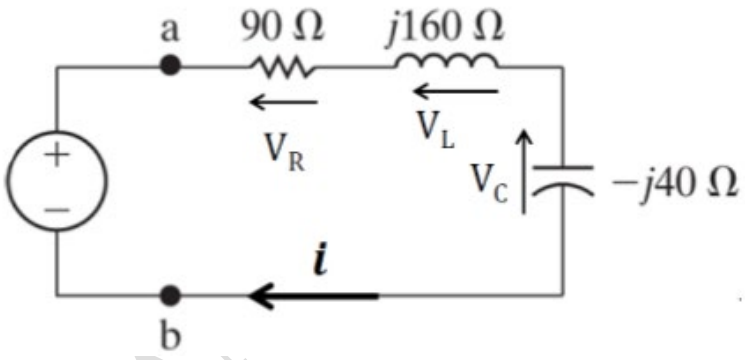


Figure Q4

Total Marks: 25

PLEASE TURN THE PAGE….

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
Introductory Electrical Principles
Module No. EEE4012

Question 5

a) Explain why AC current through an inductor lags AC voltage across the inductor by 90 degrees, give the physical and mathematical interpretation for this phase difference.

[6 marks]

b) For a single-phase transformer of rated power of 100 V.A what would be its secondary voltage and current if it has turns ratio ($\frac{N_1}{N_2}$) of 5:1(step down) when it is connected to a supply mains of 100 V, 50 Hz. **[5 marks]**

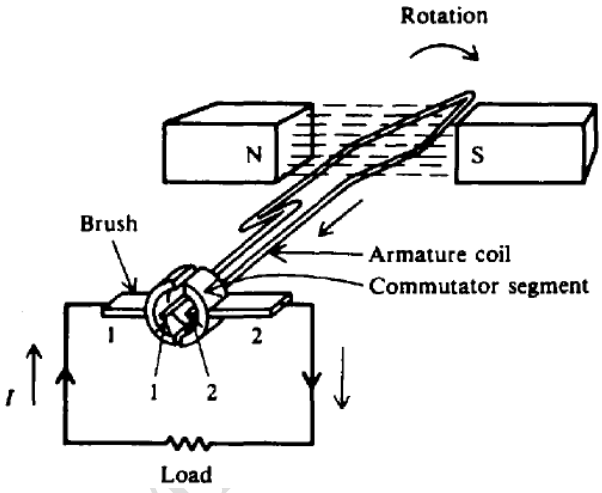


Fig.Q5c

c) If the DC generator shown above in Fig.Q5c generates 6 volts (peak value) across the brushes, what would be the rms current that flows in the 2- Ω load?

[3 marks]

d) An AC motor is running at 750 revolutions per minute when supplied from a 50 Hz supply mains, what would be its number of magnetic poles? **[4 marks]**

e) Design the clock signal frequency of a steps motor to rotate at 300 rpm +/- 10 rpm. Given that the stepper motor has the accuracy of 2.5 degree per step. **[7 marks]**

Total Marks: 25

END OF QUESTIONS

Formula sheets over the page….
PLEASE TURN THE PAGE….

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
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: $V = \Delta\Phi/\Delta t$

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

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

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

School of Engineering
BEng (Hons) Electrical and Electronics Engineering
Semester 1 Examination 2021/22
Introductory Electrical Principles
Module No. EEE4012

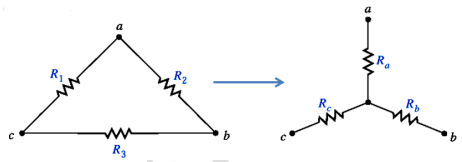
Summary Table for Series and Parallel *RC* Circuits

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

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

Three-phase systems:

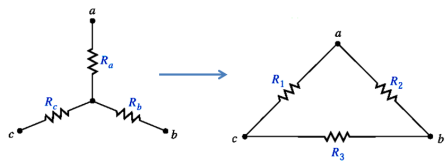


Delta to Star conversion:

$$R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

$$R_b = \frac{R_2 R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_3 R_1}{R_1 + R_2 + R_3}$$



Star to Delta conversion:

$$R_1 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_b}$$

$$R_2 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_c}$$

$$R_3 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_a}$$

END OF PAPER