ENG13

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG(HONS) ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER 1 EXAM 2024/25

INTRODUCTORY ELECTRICAL PRINCIPLES

MODULE NO: EEE4012

Date: Monday 13th January 2025 **Time: 2:00pm – 4:00pm**

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.

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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

[9 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 V_{AG} and V_{BG} in the circuit given in Figure Q1c below. **[8 marks]**

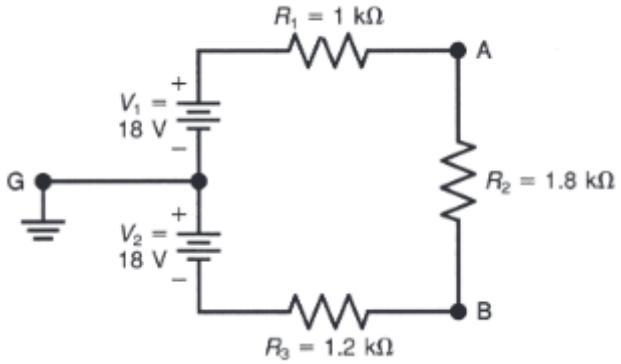

Fig.Q1c

Total Marks: 25

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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.

[10 marks]

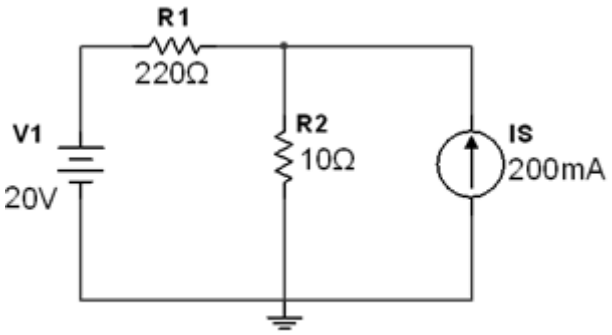

Figure Q2b

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]**

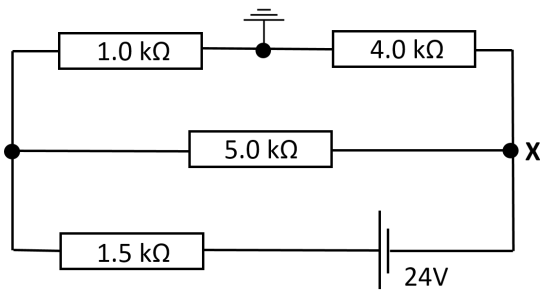

Fig.Q2c

Total Marks: 25

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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 current supplied by V_T. **[15 marks]**

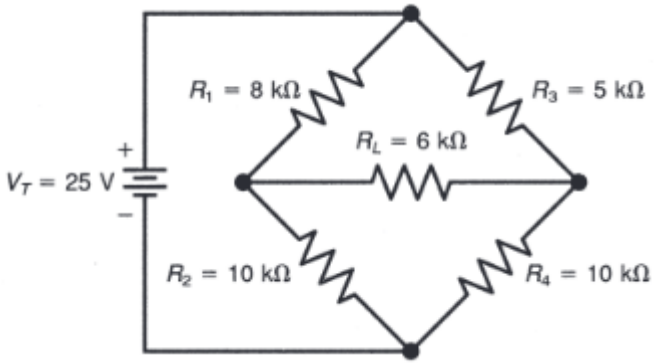

Fig.Q3a

b) Use Thevenins Theorem to calculate the voltage and current through the resistor R_L **[10 marks]**

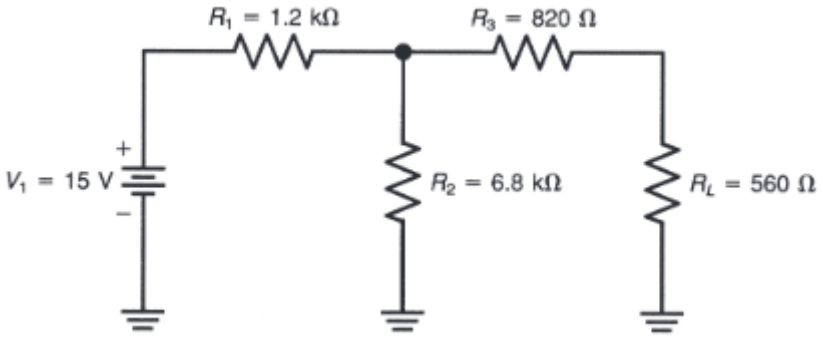

Fig.Q3b

Total Marks: 25

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Question 4

a) For the circuit shown in Fig. Q4, R=30Ω, L=150mH and C=100uF calculate:

i. The inductive reactance and the capacitive reactance; **[2 marks]**

ii. The current through each branch, I_R, I_L and I_C; **[3 marks]**

iii. The total current I_T; **[3 marks]**

iv. The phase angle between the voltage and the total current θ; **[3 marks]**

v. The total impedance Z; **[3 marks]**

vi. Is the circuit inductive or capacitive and why? **[3 marks]**

vii. The resonance frequency. **[3 marks]**

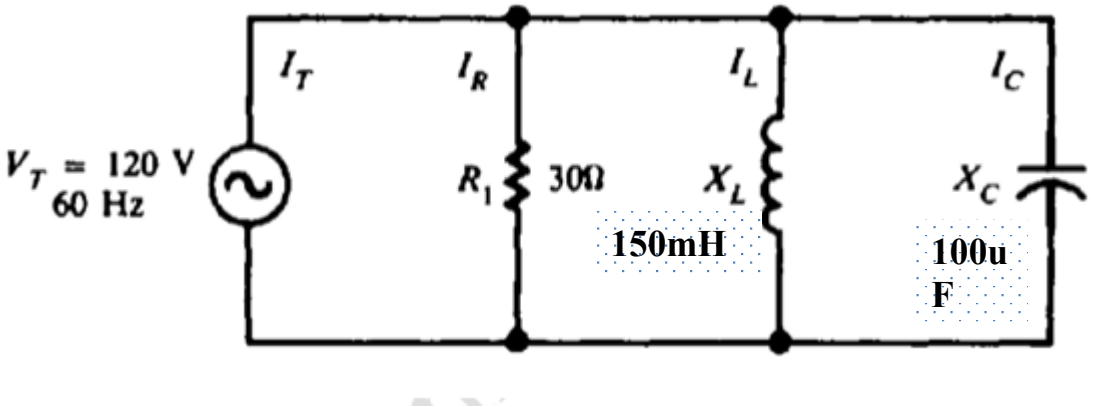

Figure Q4

b) For a single-phase transformer of rated power of 250 V.A, what would be its secondary voltage and current if it has turns ratio ($N1/N2$) of 10:1(step down) when it is connected to a supply mains of 250 V, 50 Hz. **[5 marks]**

Total Marks: 25

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Question 5

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

b) In a resistance-capacitor circuit shown in Figure Q5.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]**

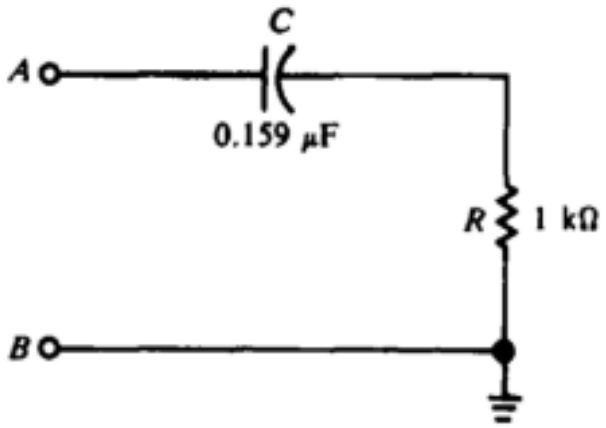

Figure Q5b

c) An 8-pole AC motor is running at a synchronous speed of 750 revolution per minute, what would be supply frequency? **[2 marks]**

d) A stepper motor has an angular resolution of 9 degrees per step. Find out the motor speed in rpm if the frequency is 50 Hz. **[10 marks]**

Total Marks: 25

END OF QUESTIONS

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APPENDIX: Formula Sheet

The following symbols in the formulae have their standard meaning:

$R\theta = R0(1 + \alpha \cdot \theta)$

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

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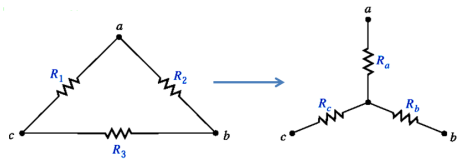
Summary Table for Series and Parallel *RC* Circuits

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:

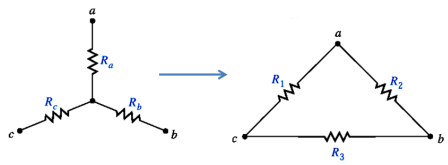


Delta to Star conversion:

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

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

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



Star to Delta conversion:

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

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

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

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