SIR ARTHUR LEWIS COMMUNITY COLLEGE

FACULTY OF ENGINEERING

ACADEMIC YEAR (2024/2025) – SEMESTER TWO

END OF SEMESTER EXAMINATION

LECTURER(S)	**:**	**Mr Kwame Frederick**
PROGRAMME TITLE	**:**	**Mechanical Engineering**
COURSE TITLE	**:**	**Applied Electricity**
COURSE CODE	**:**	**ELT213**
LEVEL	**:**	**Associate degree**
PAPER	**:**	**Alternate**
DATE	**:**	**Monday, 26th May 2025**
COMMENCEMENT TIME	**:**	**9:00a.m.**
DURATION	**:**	**Two (2) Hours**
INVIGILATOR(S)	**:**	**-**
ROOM(S)	**:**	**VAR-02-02**
STUDENT ID	**:**	

GENERAL INFORMATION AND INSTRUCTIONS

- This paper contains **One (1)** Section with **five (5) questions**. You are required to answer **Three (3)** Questions. You must attempt **Question 4 and Question 5** (both are compulsory), and **one (1) question from Questions 1 to 3**.
- All questions must be attempted **on this question paper in the spaces provided**.
- Students must sign **IN** and **OUT** on the examination class list.
- Students must **not** write their names on their answer sheets, only their ID number.
- Students are reminded to read **all** questions and instructions in each section very carefully.
- Please number your responses accordingly.
- Where you are required to draw to scale FREE HAND SKETCHES will not be accepted.
- **Formula sheet can be found on the last page.**
- **Calculators are needed.**

DO NOT TURN THIS COVER SHEET UNTIL
YOU ARE TOLD TO DO SO!!!

Student ID#_____

SECTION A: Long Answer Questions

Answer Three (3) questions

(Questions 4 and 5 are compulsory) and **one (1) question from Questions 1 to 3**

Question 1

Two alternating currents flowing through parallel branches are given by:

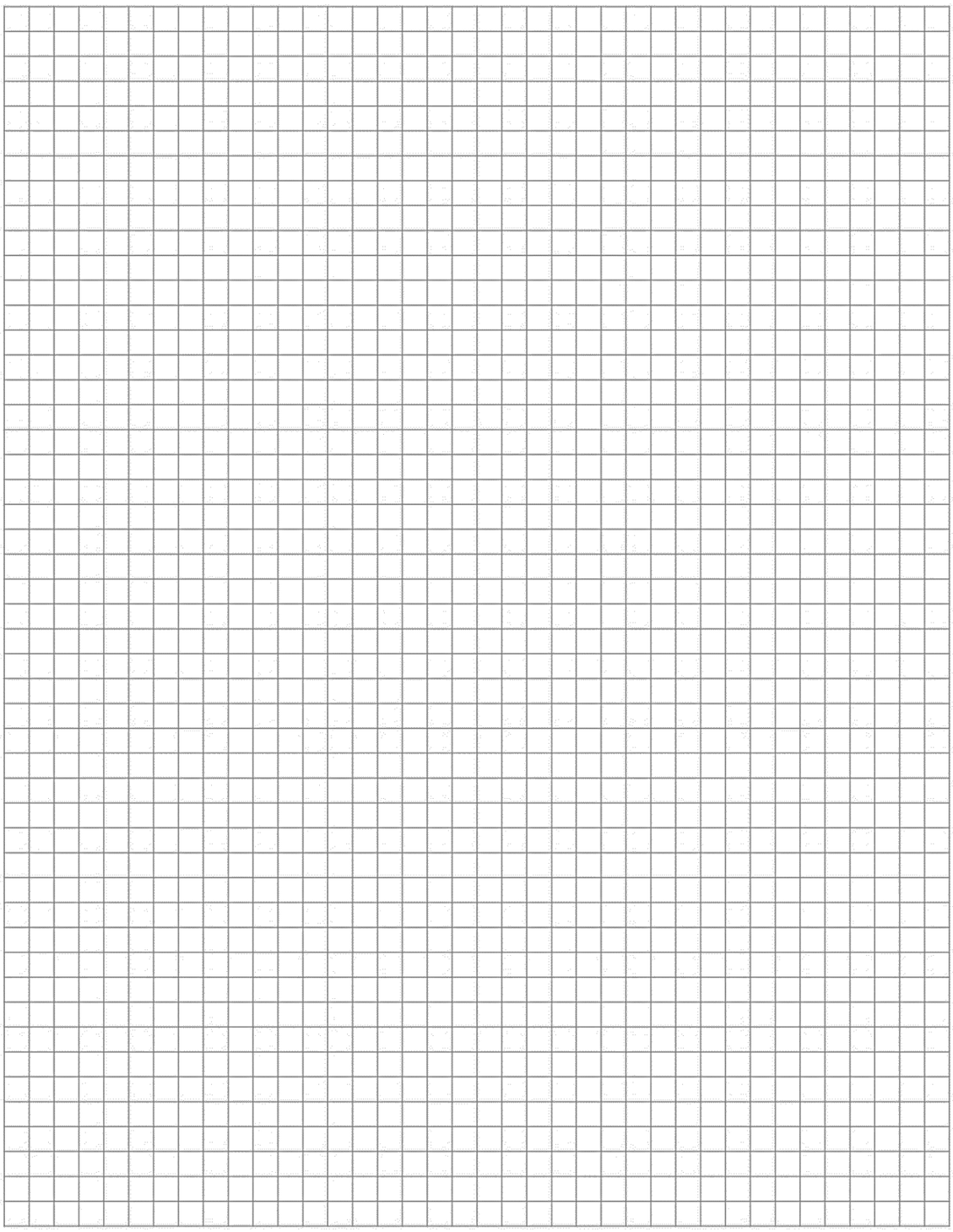
$$i_1 = 15\sin(\omega t)\ A$$
$$i_2 = 10\sin\left(\omega t + \frac{\pi}{6}\right) A$$

a) Sketch the waveforms of both currents over one cycle, showing maximum values and phase shift.

b) Construct a phasor diagram to scale (1 cm = 5 A) and determine the resultant current.

c) Express the resultant current in trigonometric form and calculate its r.m.s. value and frequency (assume 50 Hz supply).

[25 Marks]



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Show working below

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Question 2

Four e.m.f.s are induced in series-connected coils as follows:

$$\boldsymbol{E_1 = 12\angle 0°\, V, E_2 = 9\angle 90°\, V, E_3 = 7\angle 180°\, V, E_4 = 10\angle 270°V}$$

a) Draw a scaled phasor diagram (1 cm = 3 V) showing all e.m.f.s.
b) Calculate the total resultant e.m.f.
c) Find the phase difference between the resultant and (i) $\boldsymbol{E_2}$, (ii) $\boldsymbol{E_3}$.

[25 Marks]

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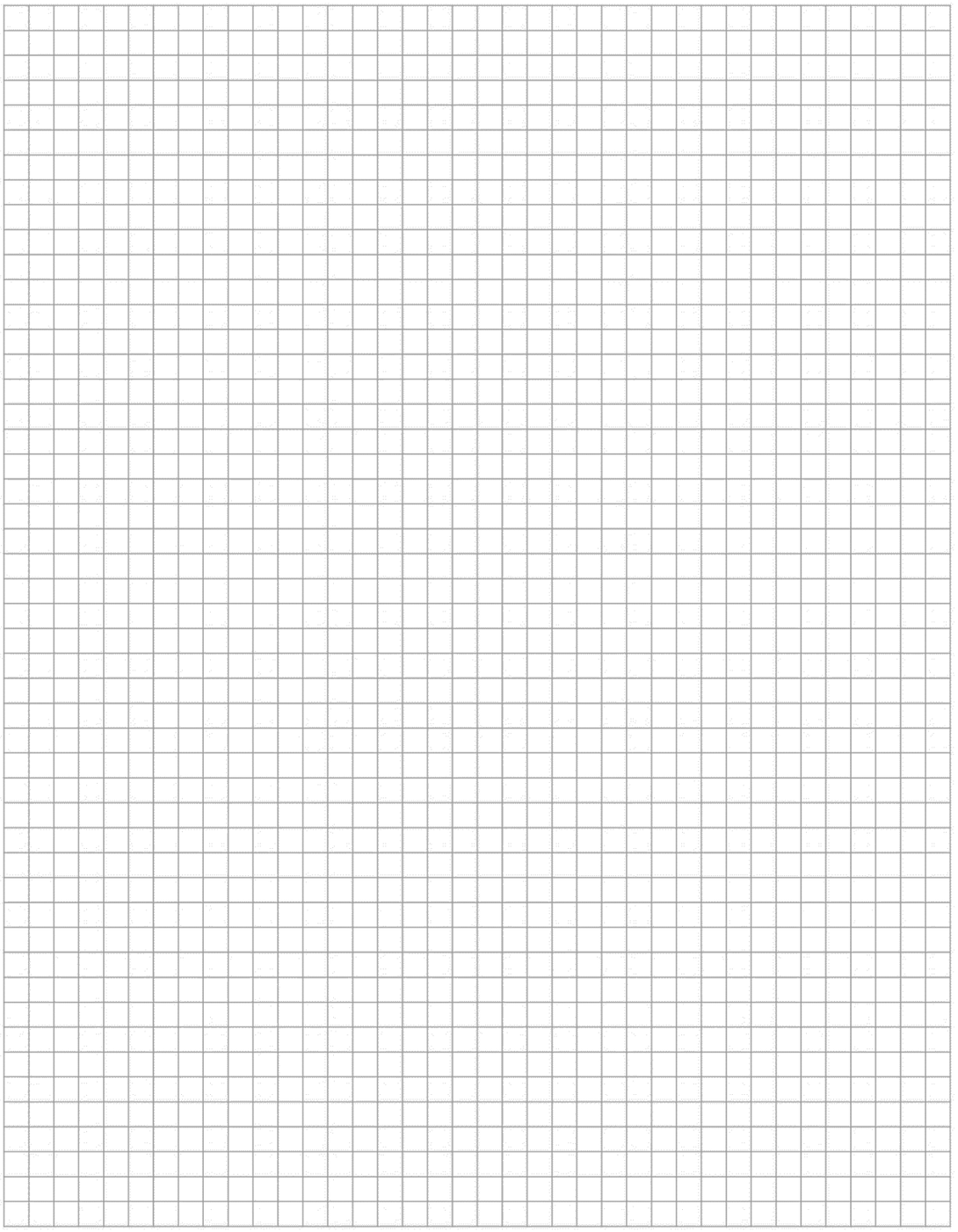
Question 3

A single-phase circuit consists of three parallel branches with the following current contributions:?

$$\boldsymbol{Branch\ A}: \mathbf{12\angle 0^\circ}\ \boldsymbol{A}$$
$$\boldsymbol{Branch\ B}: \mathbf{6\angle -60^\circ}\ \boldsymbol{A}$$
$$\boldsymbol{Branch\ C}: \mathbf{5\angle +90^\circ}\ \boldsymbol{A}$$

a) Draw a phasor diagram (1 cm = 2 A) showing all branch currents.
b) Calculate the total current taken from the supply and its phase angle.
c) Express the total current in polar and rectangular forms.
d) If the supply voltage is V=220V, calculate the total impedance, resistance, and reactance.

[25 marks]



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Question 4

A 240 V single-phase supply feeds the following:

1. A water heater drawing 10 A at unity power factor.
2. An air conditioner drawing 6 A at 0.85 lagging power factor.
3. A solar inverter feeding back 4 A at 0.95 leading power factor.

a) Construct a phasor diagram showing all current components.
b) Determine the total supply current, active power, reactive power, and overall power factor.

[25 Marks]

Student ID#_____

Question 5

Calculate the following:

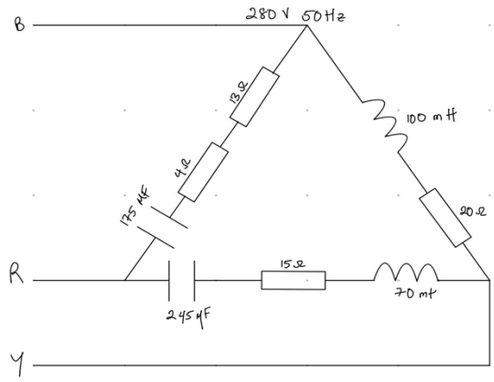
a) The impedance in each phase (8 marks)

b) The current and power factor in each phase (10 marks)

c) The apparent power, reactive power and active power in each phase (9 marks)

d) Draw a sketch of the phasor diagram showing the currents and phase voltage (7 marks)

e) Calculate the line current in each line (6 marks)



[40 Marks]

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Show working below

Total [90 Marks]

END OF EXAMINATION!!!

Student ID#_____

FORMULA SHEET

General AC Theory

Trigonometric current/voltage form: $i(t) = I_m sin(\omega t + \phi)$

RMS value: $I_{rms} = \frac{I_{max}}{\sqrt{2}}$

Frequency and angular frequency: $\omega = 2\pi f$

Phasor Addition & Resultant

Phasor representation: $I = I\angle\theta$

Resultant current (phasor sum): $I_{res} = \sqrt{(I_x)^2 + \left(I_y\right)^2}$

Phase angle of resultant: $\theta = \tan^{-1}\left(\frac{I_y}{I_x}\right)$

Power in AC Circuits

Active Power (Real Power): $P = VIcos\phi$

Reactive Power: $Q = VIsin\,\phi$

Apparent Power: $S = VI\ or\ S = \sqrt{P^2 + Q^2}$

Power Factor: $pf = cos\,\phi = \frac{P}{S}$

Impedance and Power Factor (Single-phase)

Impedance: $Z = \frac{V}{I}$

Impedance components: $Z = R + jX\ where\ |\ Z\ | = \sqrt{R^2 + X^2}$

Power factor from impedance: $cos\,\phi = \frac{R}{|Z|}$

Three-Phase System

Line and phase voltage (Delta or Star connection):

Delta: $V_L = V_\phi,\ I_L = \sqrt{3}I_\phi$

Star: $V_L = \sqrt{3}V_\phi,\ I_L = I_\phi$

Power per phase: $P = V_\phi I_\phi \cos\phi\ ,\ \ Q = V_\phi I_\phi \sin\phi,\ \ S = V_\phi I_\phi$

Vector Calculations

Rectangular to polar conversion: $r = \sqrt{x^2 + y^2},\ \theta = \tan^{-1}\left(\frac{y}{x}\right)$

Polar to rectangular conversion: $x = rcos\,\theta, y = rsin\,\theta$