

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	:	One
DATE	:	Tuesday, 6th May 2025
COMMENCEMENT TIME	:	1:00 p.m.
DURATION	:	2 hours
INVIGILATOR(S)	:	N. Fevrier (Chief), S. Joseph, H. Malcolm & J. Vité
ROOM(S)	:	UWI-0R-01
STUDENT ID	:	<input type="text"/>

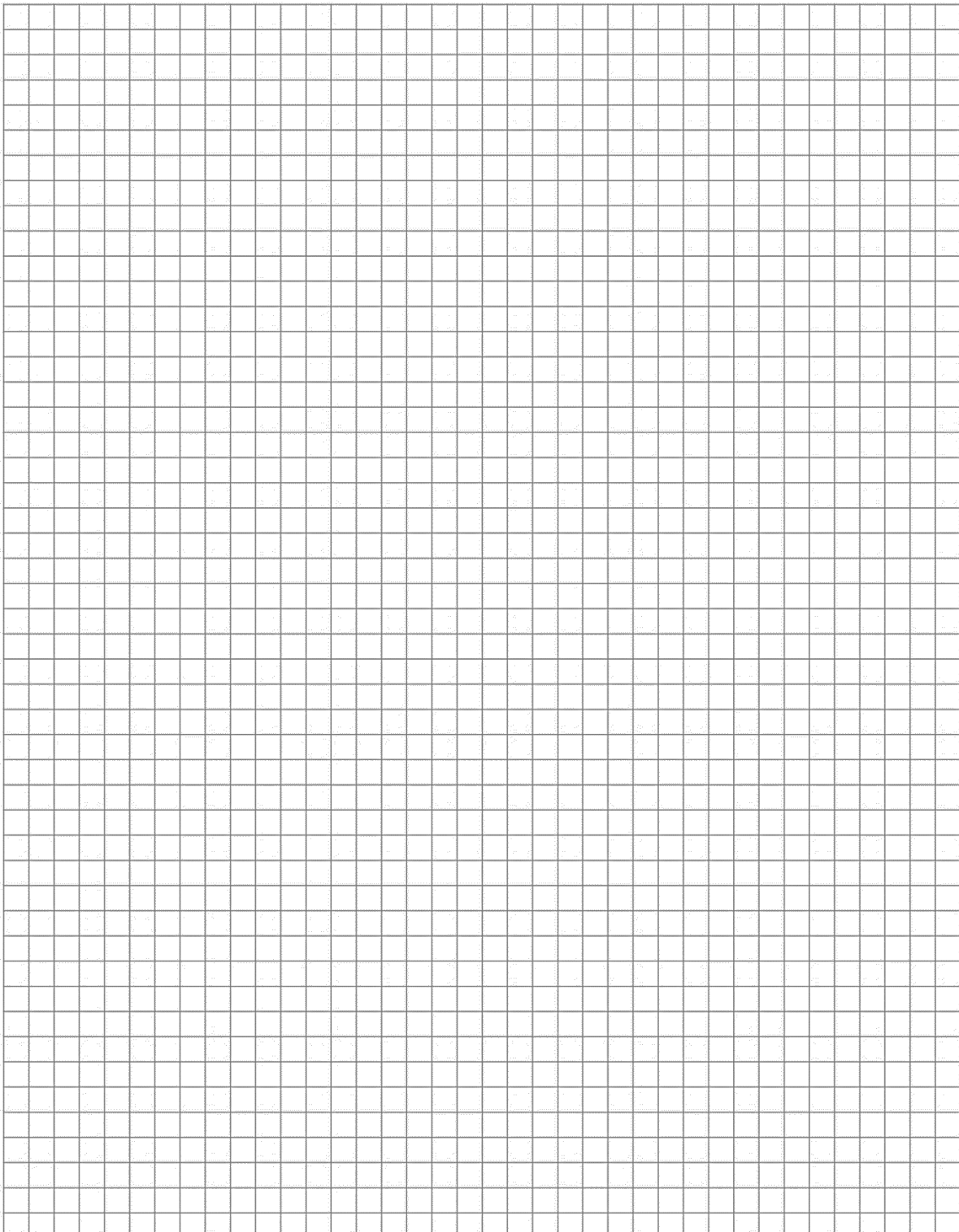
GENERAL INFORMATION AND INSTRUCTIONS

- 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!!!**

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 circuits connected in parallel take alternating currents which can be expressed trigonometrically as $i_1 = 12 \sin 225t$ amperes and $i_2 = 18 \sin(225t + \frac{\pi}{3})$ amperes. Sketch the waveforms of these currents to illustrate maximum values and phase relationships. By means of a phasor diagram drawn to scale, determine the resultant of these currents, and express it in trigonometric form. Give also the r.m.s. value and the frequency of the resultant current.

[25 Marks]

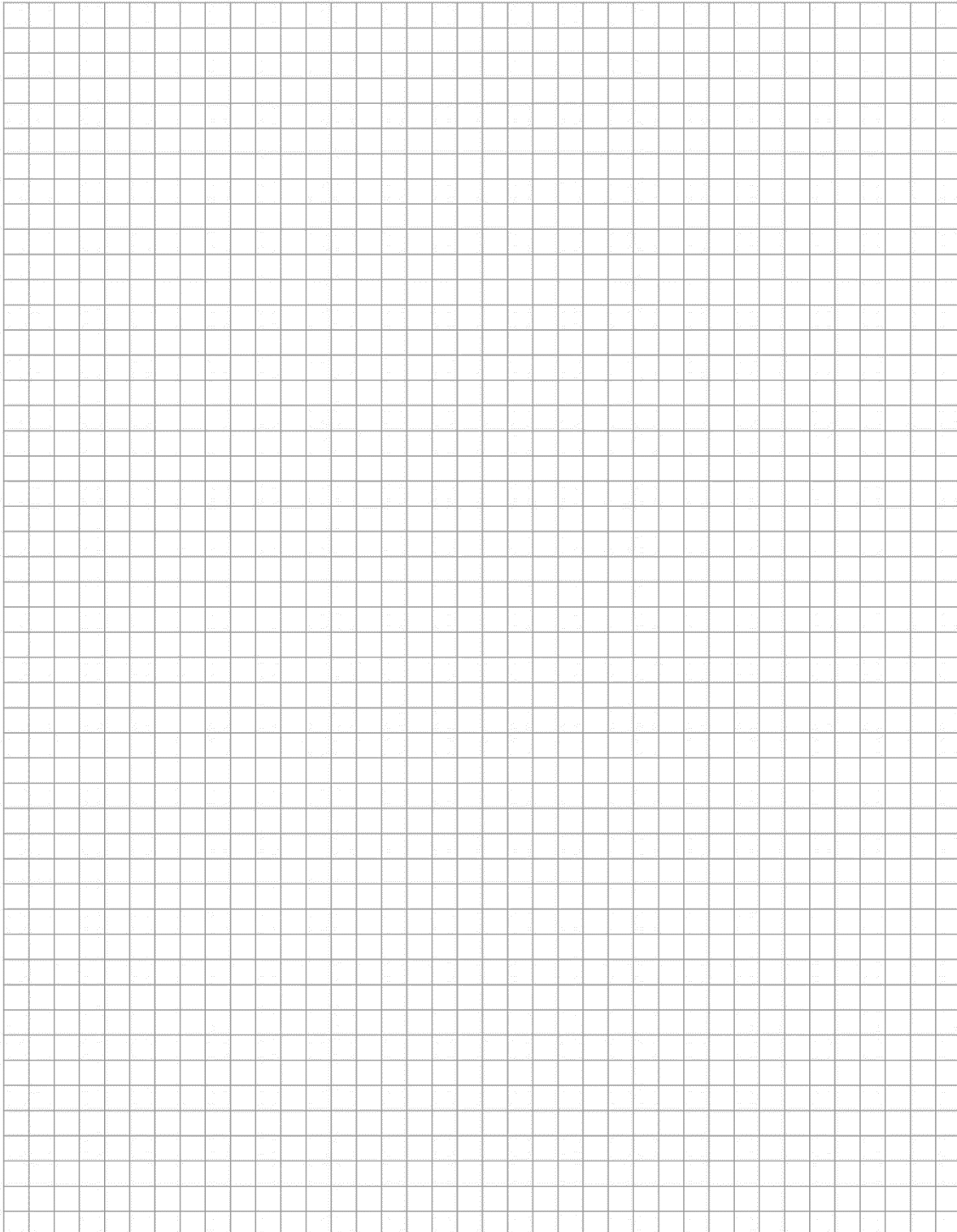
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Question 2

Four e.m.f.s, $e_1 = 100 \sin \omega t$, $e_2 = 80 \sin(\omega t - \frac{\pi}{6})$, $e_3 = 120 \sin(\omega t + \frac{\pi}{4})$ and $e_4 = 100 \sin(\omega t - \frac{2\pi}{3})$, are induced in four coils connected in series so that the sum of the four e.m.f.s is obtained. To scale draw a phasor diagram illustrating these four e.m.f.s. By calculation the resultant e.m.f. and its phase difference with (a) e_3 and (b) e_4 .

[25 Marks]



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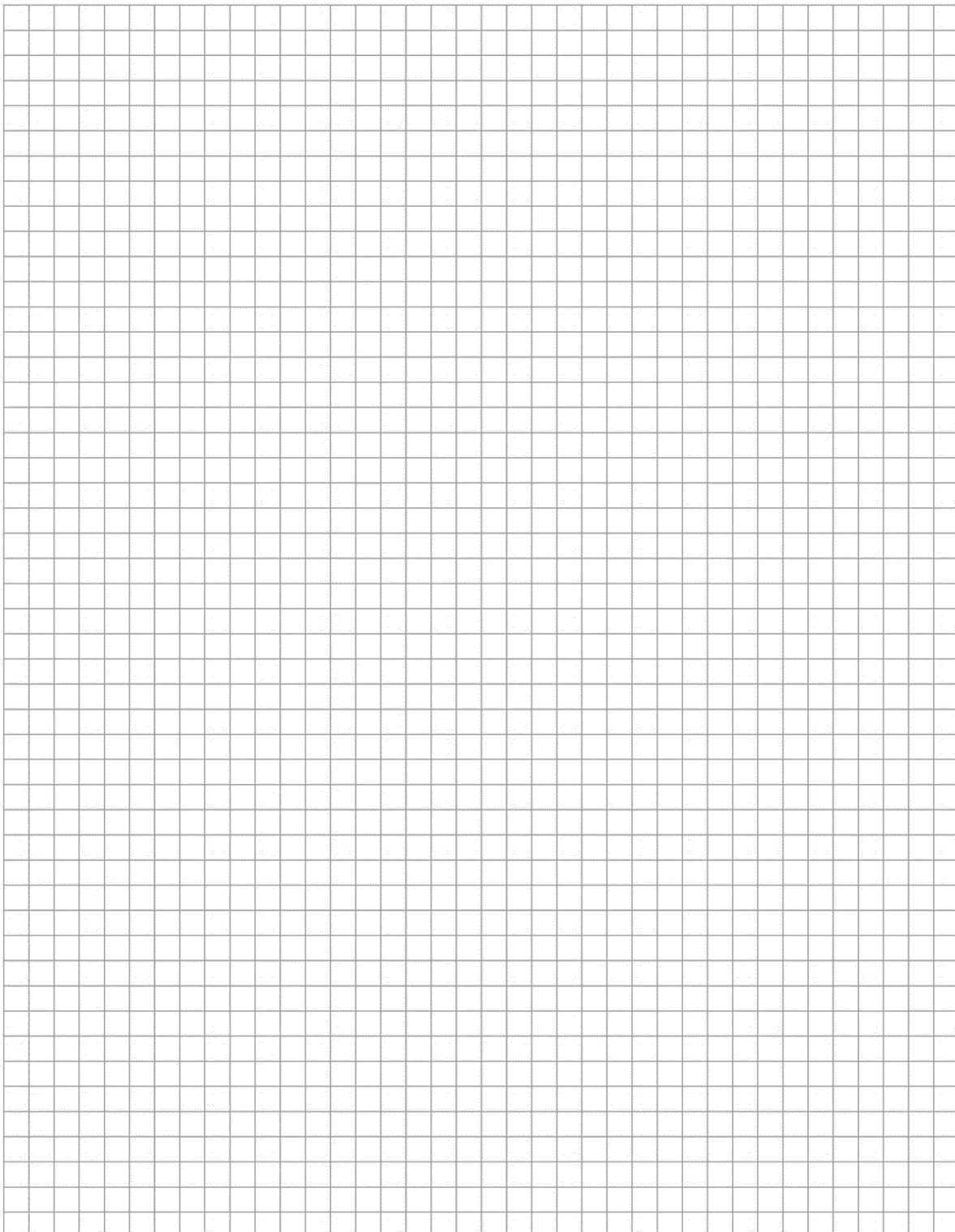
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Question 3

A single-phase network consists of three parallel branches, the currents in the respective branches being represented by: $i_1 = 35 \sin 420t$ A; $i_2 = 35 \sin \left(420t - \frac{\pi}{3}\right)$ A; and $i_3 = 20 \sin \left(314t + \frac{\pi}{4}\right)$ A.

- a) Using a scale of 1 cm = 5 A, draw a phasor diagram and find the total maximum value of current taken from the supply and the overall phase angle.
- b) Express the total current in a form similar to that of the branch currents.
- c) If the supply voltage is represented by $200 \sin 420t$ volts, find the impedance, resistance and reactance of the network.

[25 marks]



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Question 4

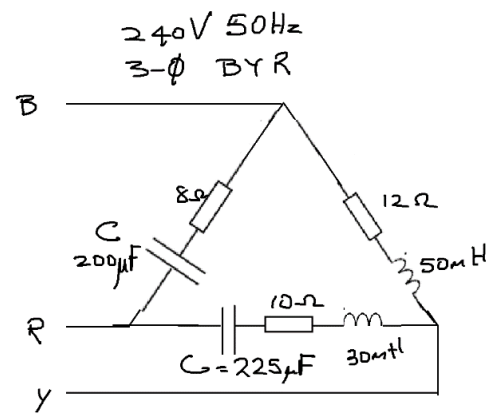
A 230 V, single-phase supply feeds the following loads: (a) incandescent lamps taking a current of 8 A at unity power factor; (b) fluorescent lamps taking a current of 5 A at 0.8 leading power factor; (c) a motor taking a current of 7 A at 0.75 lagging power factor. Sketch the phasor diagram and determine the total current, active power and reactive power taken from the supply and the overall power factor.

[25 Marks]

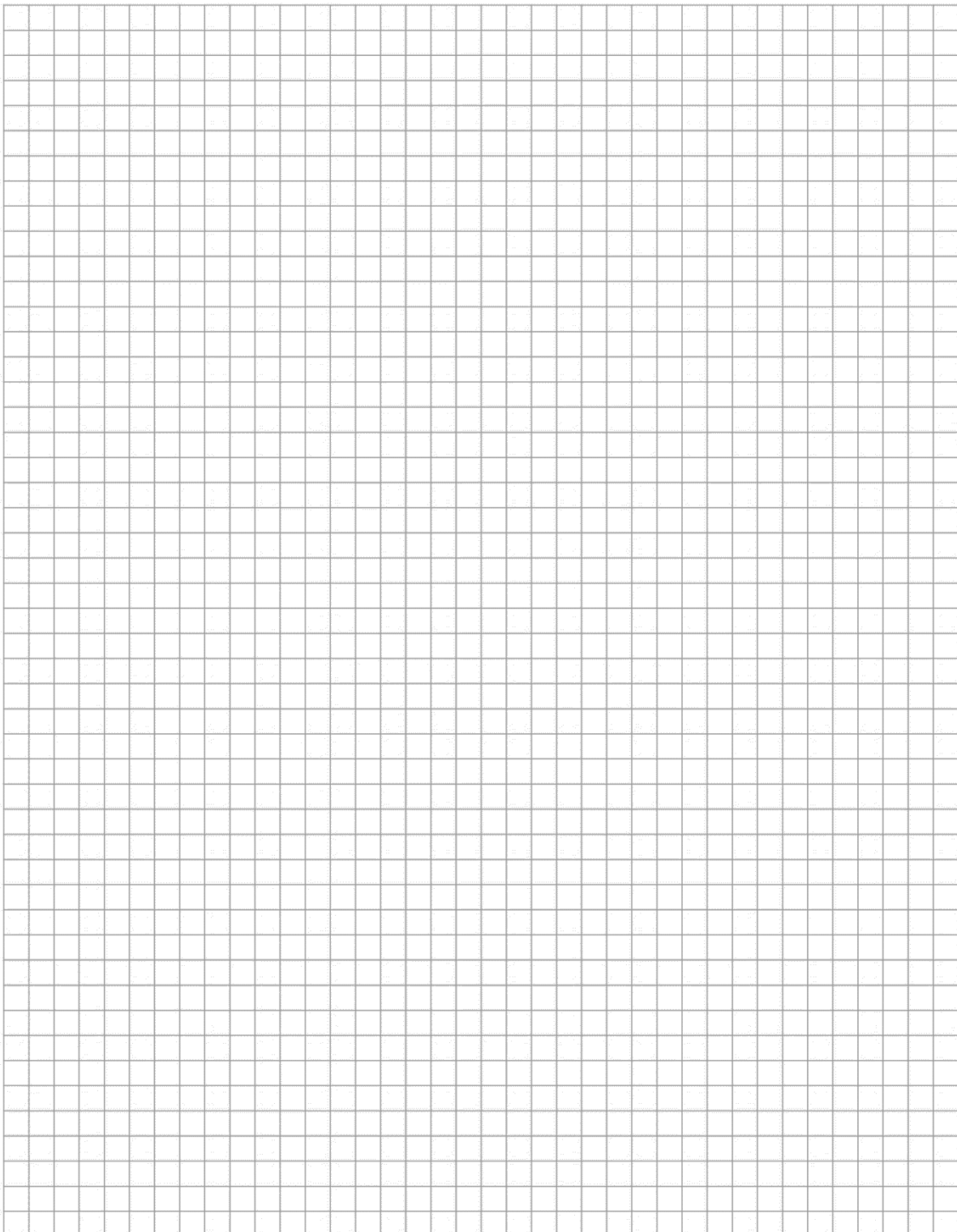
Question 5

Calculate the following:

- The impedance in each phase (8 marks)
- The current and power factor in each phase (10 marks)
- The apparent power, reactive power and active power in each phase (9 marks)
- Draw a sketch of the phasor diagram showing the currents and phase voltage (7 marks)
- Calculate the line current in each line (6 marks)



[40 Marks]



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[Total 90 Marks]

END OF EXAMINATION!!!

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): $I_{res} = \sqrt{(I_x)^2 + (I_y)^2}$

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

Power in AC Circuits

Active Power (Real Power): $P = VI \cos \phi$

Reactive Power: $Q = VI \sin \phi$

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: $x = r \cos \theta$, $y = r \sin \theta$