



Complete, fold and seal
(see note 2 below)

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Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

1	Student Number	WIL18847411
2	Title of Examination Paper	ELECTRICAL POWER
3	Module Code	GOEE5000
4	Date and Time of Examination	17/05/22 PM
5	Examination Venue	W2
6	Seat Number	6
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1	18
Q2	22
Q3	18
Q4	18
Total	75/100

Q1 a) $I_{an} = \frac{V}{Z} = \frac{220 \angle 0^\circ}{2 + 20 - j10\Omega} = \frac{220 \angle 0^\circ}{22 - j10} = \frac{220 \angle 0^\circ}{24.17 \angle -24.4^\circ}$

$= \frac{220 \angle 0^\circ}{24.17 \angle -24.4^\circ} = 9.1 \angle 24.4^\circ A$ or $8.3 + j3.6 A$

Q1
= a
11/15

$I_{bn} = \frac{V}{Z} = \frac{220 \angle -120^\circ}{2 + 30\Omega} = \frac{220 \angle -120^\circ}{32} = \frac{220 \angle -120^\circ}{32 \angle 0^\circ}$

$= \frac{220 \angle -120^\circ}{32 \angle 0^\circ} = 6.9 \angle -120^\circ A$ or $-3.45 - j5.6 A$

$I_{cn} = \frac{V}{Z} = \frac{220 \angle +120^\circ}{2 + 15 + j5} = \frac{220 \angle +120^\circ}{17 + j5} = \frac{220 \angle +120^\circ}{17.7 \angle 16.4^\circ}$

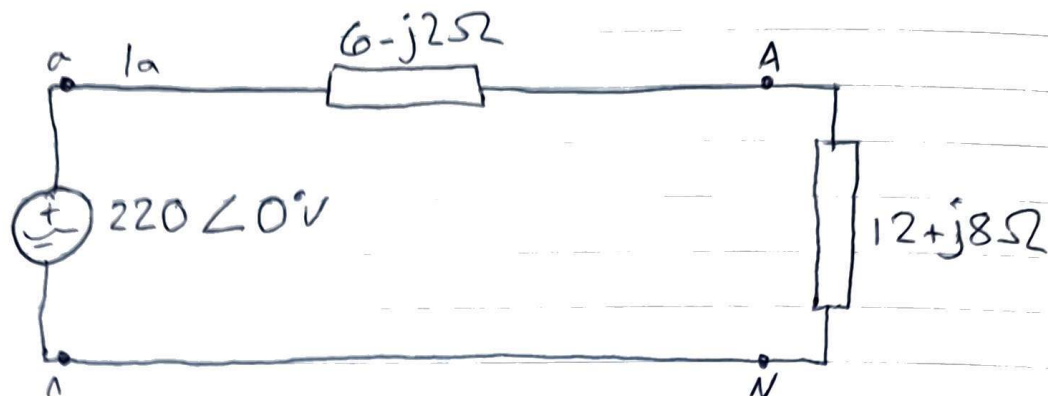
$= \frac{220 \angle +120^\circ}{17.7 \angle 16.4^\circ} = 12.4 \angle 103.6^\circ$ or $-2.9 + j5.6 A$

$I_n = I_{an} + I_{bn} + I_{cn}$

$= I_{an} + I_{bn} + I_{cn} = (8.3 + j3.6) + (-3.45 - j5.6) + (-2.9 + j5.6)$

$I_n = \frac{2.4 + j3.6}{\text{or } 4.3 \angle 56.3^\circ A}$

Q1 b)



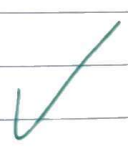
$$I_a = \frac{V_{an}}{Z_{an}} \Rightarrow \frac{220 \angle 0^\circ}{(6-j2) + (12+j8)} = \frac{220 \angle 0^\circ}{18+j8} \Rightarrow \frac{220 \angle 0^\circ}{19.7 \angle 24^\circ}$$

$$\therefore \frac{220 \angle 0^\circ}{19.7 \angle 24^\circ} = \underline{\underline{11 \angle -24^\circ \text{ A} \text{ or } 10 - j4.47 \text{ A}}}$$

$$I_b = \frac{V_{bn}}{Z_{bn}} = \frac{220 \angle -120^\circ}{19.7 \angle 24^\circ} = \underline{\underline{11 \angle 144^\circ \text{ A} \text{ or } -8 + j6.5 \text{ A}}}$$

Correct method, error carried forward

$$I_c = \frac{V_{cn}}{Z_{cn}} = \frac{220 \angle +120^\circ}{19.7 \angle 24^\circ} = \underline{\underline{11 \angle 96^\circ \text{ A} \text{ or } -1.1 + j11 \text{ A}}}$$

Correct method,
error carried forward

Q2

22/25

Q2 i) $Z_R = 20 + j0$
 $Z_L = 60 + j30$
 $Z_C = 0 - j10$

$$Z_{TOTAL} = Z_R + \frac{Z_C \cdot Z_L}{Z_C + Z_L} = 20 + \frac{(-j10) \cdot (60 + j30)}{(-j10) + (60 + j30)}$$

$$\therefore \frac{-j600 - 300}{60 + j20} = \frac{-300 - j600}{60 + j20}$$

$$\text{or } \frac{670.8 \angle -116.6^\circ}{63.25 \angle 18.43^\circ} \Rightarrow 10.6 \angle -135.03^\circ$$

$$\therefore \frac{Z_C \cdot Z_L}{Z_C + Z_L} = 10.6 \angle -135.03^\circ \text{ or } -7.5 - j7.5$$

$$\therefore Z_R + \frac{Z_C \cdot Z_L}{Z_C + Z_L} = 20 + -7.5 - j7.5$$

$$= 12.5 - j7.5 \Omega$$

Correct method
error carried forward

$$\text{or } 14.6 \angle -31^\circ$$

$$\text{ii) } I_T = \frac{V_T}{Z_T} = \frac{230 \angle 0^\circ \text{ V}}{14.6 \angle -31^\circ} = 15.6 \angle 31^\circ \text{ A}$$

or $13.4 + j8 \text{ A}$

$$\text{iii) } S = V \cdot I^* \quad I^* = 15.6 \angle -31^\circ \text{ A} \quad \text{Correct method}$$

$$\therefore (230 \angle 0^\circ) \cdot (15.6 \angle -31^\circ) = 3588 \angle -31^\circ$$

$$S = 3075.5 - j1848 \text{ VA}$$

$$\text{iv) } P = 3075.5 \text{ W}$$

$$\text{v) } Q = 1848 \text{ VAR}$$

error carried forward



Q3a)

$$i) V_{ab} = \underline{330 \angle 0^\circ V} \quad \checkmark$$

$$V_{bc} = V_{ab} \angle -120^\circ \therefore V_{bc} = \underline{330 \angle -120^\circ V} \quad \checkmark$$

$$V_{ca} = V_{ab} \angle +120^\circ \therefore V_{ca} = \underline{330 \angle 120^\circ V} \quad \checkmark$$

$$ii) I_{AB} = \frac{V_{ab}}{Z_{AB}} = \frac{330 \angle 0^\circ V}{20 - j15 \Omega} = \frac{330 \angle 0^\circ V}{25 \angle -37^\circ} \quad \checkmark$$

$$\therefore \frac{330 \angle 0^\circ V}{25 \angle -37^\circ} = \underline{13.2 \angle 37^\circ A} \text{ or } \underline{10.5 + j8 A} \quad \checkmark$$

$$I_{BC} = \frac{V_{bc}}{Z_{BC}} = \frac{330 \angle -120^\circ V}{25 \angle -37^\circ} = \underline{13.2 \angle -83^\circ A} \quad \checkmark$$

or $\underline{1.6 - j13.1 A}$

$$I_{CA} = \frac{V_{ca}}{Z_{CA}} = \frac{330 \angle 120^\circ V}{25 \angle -37^\circ} = \underline{13.2 \angle 157^\circ A} \quad \checkmark$$

or $\underline{-12 + j5}$

$$iii) I_a = \sqrt{3} \cdot I_\phi \angle -30^\circ \therefore \sqrt{3} (13.2) \angle \cancel{330} 37^\circ - 30^\circ$$

$$I_a = \underline{22.86 \angle 7^\circ A} \quad \checkmark$$

$$I_b = \sqrt{3} (13.2) \angle -83^\circ - 30^\circ$$

$$I_b = \underline{22.86 \angle -113^\circ A} \quad \checkmark$$

$$I_c = \sqrt{3} (13.2) \angle 157^\circ - 30^\circ$$

$$I_c = \underline{22.86 \angle 127^\circ A} \quad \checkmark$$

Q3a

15/15

$$b) Z_T = (4 + j3) + (4 + j3) + (4 + j3) = 12 + j9$$

$$Z_T = 15 \angle 36.9^\circ$$

$$pf = \cos \phi$$

$$\therefore \cos \phi = pf$$

$$\cos(36.9) = 0.8 \text{ power factor.}$$

$$I_T = \frac{V}{Z_T} = \frac{208 \angle 0^\circ}{15 \angle 36.9^\circ} = 13.9 \angle -36.9^\circ$$

$$S = V \cdot I^*$$

$$I^* = 13.9 \angle 36.9^\circ$$

$$S = (208 \angle 0^\circ) \times (13.9 \angle 36.9^\circ) = 2891.2 \angle 36.9^\circ \text{ VA}$$

$$S = \underline{\underline{2312 + j1736 \text{ VA}}}$$

$$P = \underline{\underline{2312 \text{ W}}}$$

$$Q = \underline{\underline{1736 \text{ VAR}}}$$

Q3b

2/10

Q4

100 kVA

0.6 pf lagging $\rightarrow 0.85$

220V

50 Hz

$$pf_1 = 0.6 \checkmark$$

$$\phi_1 = \cos^{-1}(0.6) = 53.13^\circ \checkmark$$

$$P(\text{Real Power}) = S \cos \phi$$

$$\therefore P = 100 \cos(53.13^\circ) = 60 \text{ kW} \checkmark \checkmark$$

$$Q_1 (\text{Reactive Power}) = S \sin \phi$$

$$\therefore Q_1 = 100 \sin(53.13^\circ) = 80 \text{ kVAR} \checkmark \checkmark$$

$$pf_2 = 0.85 \checkmark$$

$$\phi_2 = \cos^{-1}(0.85) = 31.8^\circ \checkmark$$

$P = \text{Real Power}$ does not change $\therefore P = 60 \text{ kW} \checkmark$

$$Q_2 = S_2 \sin \phi_2$$

$$\therefore Q_2 = 100 \sin(31.8^\circ) = 52.7 \text{ kVAR}$$

$$Q_c = Q_1 - Q_2 \checkmark$$

$$Q_c = 80 \text{ kVAR} - 52.7 \text{ kVAR} \checkmark \checkmark$$

$$Q_c = 27.3 \text{ kVAR} \checkmark$$

Q4

18/25

$$Q_c = \frac{V^2}{X_c} \quad \therefore X_c = \frac{V^2}{Q_c}$$

$$X_c = \frac{220^2}{27.3 \times 10^3} = 1.77 \text{ k}\Omega \quad \text{correct method}$$

$$X_c = \frac{1}{2 \pi f C} \quad \therefore C = \frac{1}{2 \pi f X_c}$$

$$C = \frac{1}{(2)(\pi)(50)(1.77 \times 10^3)} = 1.796 \times 10^{-6}$$

$$\text{Capacitor Value} = \underline{\underline{C = 1.8 \mu\text{F}}}$$

