



Complete, fold and seal
(see note 2 below)

SURNAME: Daniel

FORENAME(S): Connor

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	DANI9848477
2	Title of Examination Paper	Electrical Power
3	Module Code	GOEES000
4	Date and Time of Examination	17/5/2022 2:00PM
5	Examination Venue	W2
6	Seat Number	4
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1	25
Q2	25
Q3	18
Q4	23
Total	91/100

910/0
Ka7

Q1

$$a) \quad Z_{AB} = 2 + 20 - j10$$

$$Z_{An} = 22 - j10$$

Q1a

15/15

$$I_a = \frac{V_{an}}{Z_{an}} = \frac{220 \angle 0^\circ}{22 - j10} = \frac{220 \angle 0^\circ}{24.17 \angle -24.4^\circ} = 9.1 \angle 24.4^\circ \text{ A}$$

$$I_a = 8.29 + j3.8 \text{ A}$$

$$I_b = \frac{V_{bn}}{Z_{bn}} = \frac{220 \angle -120^\circ}{32} = 6.875 \angle -120^\circ$$

$$I_b = -3.44 - j5.95 \text{ A}$$

$$I_c = \frac{V_{cn}}{Z_{cn}} = \frac{220 \angle 120^\circ}{17 + j5} = \frac{220 \angle 120^\circ}{17.7 \angle 16.4^\circ} = 12.43 \angle 103.6^\circ$$

$$I_c = -2.92 + j12.1 \text{ A}$$

$$-I_n = (I_a + I_b + I_c)$$

$$-I_n = (8.29 + j3.8) + (-3.44 - j5.95) + (-2.92 + j12.1)$$

$$\cancel{I_n = 1.93 + j10.3 \text{ A}} \quad -I_n = 1.93 + j9.95 \text{ A}$$

$$\cancel{I_n = 1.93 - j10.3 \text{ A}} \quad I_n = -1.93 - j9.95 \text{ A}$$

b) $Z_{AN} = 6 - j2 + 12 + j8$
 $Z_{AN} = 18 + j6$

Q1b

10/10

$$I_{AN} = \frac{V_{AN}}{Z_{AN}} = \frac{220 \angle 0^\circ}{18 + j6} = \frac{220 \angle 0^\circ}{18.97 \angle 18.4^\circ} = 11.6 \angle -18.4^\circ$$

$$I_{AN} = 11.6 \angle -18.4^\circ \text{ A} \quad \checkmark$$

$$I_{BN} = 11.6 \angle (-18.4 - 120)^\circ = ~~11.6~~ 11.6 \angle -138.4^\circ \text{ A}$$

$$I_{CN} = 11.6 \angle (-18.4 + 120)^\circ = 11.6 \angle 101.6^\circ \text{ A} \quad \checkmark$$

Line currents same as phase currents.

$$I_{AN} = I_a$$

$$I_a = 11.6 \angle -18.4^\circ \text{ A} \quad \checkmark$$

$$I_{BN} = I_b$$

$$I_b = 11.6 \angle -138.4^\circ \text{ A} \quad \checkmark$$

$$I_{CN} = I_c$$

$$I_c = 11.6 \angle 101.6^\circ \text{ A} \quad \checkmark$$



Q2 $Z_R = 20\Omega$ $Z_C = -j10$ $Z_L = 60 + j30$

i) $Z_T = Z_R + \frac{Z_C Z_L}{Z_C + Z_L}$

$$Z_{CL} = \frac{-j10(60 + j30)}{-j10 + (60 + j30)} = \frac{-j600 + 300}{60 + j20}$$

$$Z_{CL} = \frac{300 - j600}{60 + j20} = \frac{670.8 \angle -63.4^\circ}{63.2 \angle 18.4^\circ} = 10.61 \angle -81.8^\circ$$

$$Z_{CL} = 10.61 \angle -81.8^\circ = 1.51 - j10.5$$

$$Z_T = Z_R + Z_{CL} = 20 + 1.51 - j10.5$$

$$Z_T = 21.51 - j10.5\Omega$$

ii) $I_T = \frac{V_T}{Z_T} = \frac{230 \angle 0^\circ}{21.51 - j10.5} = \frac{230 \angle 0^\circ}{23.9 \angle -26^\circ} = 9.62 \angle 26^\circ$

$$I_T = 9.62 \angle 26^\circ \text{ A}$$

iii) $S = V \times I^*$ $I^* = 9.62 \angle -26^\circ \text{ A}$

$$S = 230 \angle 0^\circ \times 9.62 \angle -26^\circ = 2212.6 \angle -26^\circ \text{ VA}$$

$$S = 1988.67 - j969.9 \text{ VA}$$

iv) $S = P + jQ \therefore P = 1988.67 \text{ W}$

v) $S = P + jQ \therefore Q = -969.9 \text{ VAR}$

Q2

25/25

Q3

a)

i) $V_{ab} = 330 \angle 0^\circ$ ✓

$V_{bc} = 330 \angle (0 - 120)^\circ = 330 \angle -120^\circ$ ✓

$V_{ca} = 330 \angle (0 + 120)^\circ = 330 \angle 120^\circ$ ✓

ii) $I_{AB} = \frac{V_{AB}}{Z_{AB}} = \frac{330 \angle 0^\circ}{20 - j15} = \frac{330 \angle 0^\circ}{25 \angle -36.87^\circ}$

$I_{AB} = 13.2 \angle 36.87^\circ \text{ A}$ ✓

$I_{BC} = 13.2 \angle (36.87 - 120)^\circ = 13.2 \angle -83.13^\circ \text{ A}$ ✓

$I_{CA} = 13.2 \angle (36.87 + 120)^\circ = 13.2 \angle 156.87^\circ \text{ A}$ ✓

iii) line currents lags phase currents by 30°

$I_L = \sqrt{3} \times I_\phi \angle -30^\circ$ ✓

$I_a = \sqrt{3} \times 13.2 \angle (36.87 - 30)^\circ = 22.86 \angle 6.87^\circ$ ✓

$I_a = 22.86 \angle 6.87^\circ \text{ A}$ ✓

$I_b = 22.86 \angle (6.87 - 120)^\circ = 22.86 \angle -113.13^\circ \text{ A}$

$I_b = 22.86 \angle -113.13^\circ \text{ A}$ ✓

 ~~I_c~~

$I_c = 22.86 \angle (6.87 + 120)^\circ = 22.86 \angle 126.87^\circ \text{ A}$

$I_c = 22.86 \angle 126.87^\circ \text{ A}$ ✓

b) $Z = 4 + j3$ $V_L = 208\text{V}$ ✓

Q3b

$$I_L = \frac{V_L}{Z_L} = \frac{208}{4 + j3} = \frac{208}{5 \angle 36.87^\circ} = 41.6 \angle -36.87^\circ \text{ A}$$

ϕ $\angle$ 2ϕ $\angle$ ϕ

3/10

$$S = V \times I = 208 \times 41.6 \angle -36.87^\circ$$

$$S = 8652.8 \angle -36.87^\circ \text{ VA} \quad S_T = ?$$

$$S = 6922.23 - j5191.7 \text{ VA}$$

$$S = V \times I^* = 208 \times 41.6 \angle 36.87^\circ = 8652.8 \angle 36.87^\circ$$

$$S = P + jQ = 6922.23 + j5191.7 \text{ VA}$$

$$P = 6922.23 \text{ W} \quad \checkmark \quad P_\phi \quad \approx P_T = ?$$

$$Q = 5191.7 \text{ VAR} \quad \checkmark \quad Q_\phi \quad Q_T = ?$$

$$\text{Power Factor} = \frac{P}{S} = \frac{6922.23}{8652.8} = 0.79999$$

$$\text{Power Factor} = 0.8$$



Q4

$$S_1 = 100 \text{ kVA} \quad \text{PF}_1 = 0.6 \quad V = 220 \text{ V} \quad f = 50 \text{ Hz}$$

$$\text{PF} = \cos \theta$$

$$\theta = \cos^{-1}(0.6) = 53.1^\circ \quad \checkmark$$

$$Q_1 = S_1 \sin \theta = 100 \text{ kVA} \sin(53.1^\circ) = 79.97 \text{ kVAR} \quad \checkmark$$

$$Q_1 = 79.97 \text{ kVAR} \quad \checkmark \quad \text{u//}$$

$$P_1 = S_1 \cos \theta = 100 \cos(53.1^\circ) = 60 \text{ W} \quad \checkmark$$

$$P_1 = 60 \text{ W} \quad \checkmark \quad \text{u//}$$

$$\text{New power factor} = 0.85 \quad \therefore \theta = \cos^{-1}(0.85) = 31.79^\circ$$

$$\text{Power factor} = \frac{P}{S} \quad \therefore S_2 = \frac{P}{\text{PF}} \quad \checkmark$$

$$S_2 = \frac{60}{0.85} = 70.6 \text{ kVA} \quad \checkmark$$

$$S_2 = 70.6 \text{ kVA} \quad \checkmark \quad \text{u//}$$

$$Q_2 = S_2 \sin \theta = 70.6 \sin(31.79^\circ) = 37.2 \text{ kVAR} \quad \checkmark$$

$$Q_2 = 37.2 \text{ kVAR} \quad \checkmark \quad \text{u//}$$

$$Q_{\text{cap}} = Q_1 - Q_2 = 79.97 - 37.2 = 42.77 \text{ kVAR} \quad \checkmark$$

$$Q_{\text{cap}} = 42.77 \text{ kVAR} \quad \checkmark \quad \text{u//}$$

$$Q_{\text{cap}} = \frac{V^2}{X_c} \quad \therefore X_c = \frac{V^2}{Q_{\text{cap}}} \quad \checkmark$$

$$X_c = \frac{(220)^2}{42.77 \times 10^3} = 1.13 \text{ unit?} \quad \checkmark$$

$$X_c = 1.13 \text{ units} \quad \checkmark \quad \text{u//}$$



Q4

23/25

$$X_C = \frac{1}{2\pi fC} \quad \therefore C = \frac{1}{2\pi fX_C}$$

$$C = \frac{1}{2\pi \times 50 \times 1.13} = 2.82 \times 10^{-3} \text{ F}$$

$$C = 2.82 \times 10^{-3} \text{ F}$$

$$C = 2.82 \text{ mF}$$