



Examination Answer Books

12 Pages

Complete, fold and seal
(see note 2 below)

SURNAME: Byrne

FORENAME(S): Ethan Lyndon John

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	BYR19852790
2	Title of Examination Paper	Electrical Power
3	Module Code	GOEE5000
4	Date and Time of Examination	15/5/24 10:00 am - 12:00pm
5	Examination Venue	GOS Tysach Main Hall
6	Seat Number	E2
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	
2	
3	
4	
Q1	24 ✓
Q2	18 ✓
Q3	20 ✓
Q4	2 ✓
Total	64/100 ✓

64%

Question One

a.

$$Z_T = 6 + j3 + 20 + j15$$

$$= 26 + j18 \Omega$$

$$= 31.62 \angle 34.7^\circ \Omega$$

error carried forward

$$P = I \times V$$

$$I = \frac{V}{Z_T} = \frac{240 \angle 0^\circ}{31.62 \angle 34.7^\circ} = 7.59 \angle -34.7^\circ \text{ A}$$

$$P = I \times V = 7.59 \times 240 = 1821.6 \text{ W} = 1.82 \text{ kW}$$

correct method
error carried forward

$$P = S \cos \phi = 1821.6 \times \cos(34.7) = 1037 \text{ W} = 1.04 \text{ kW}$$

$$pf = \frac{P}{S} = \frac{1.04}{1.82} = 0.57$$

error carried forward

b.

$$Z_C = 0 - j15 \Omega, \quad Z_R = 25 + j0 \Omega, \quad Z_L = 65 + j35 \Omega$$

$$Z_T = Z_R + Z_C + Z_L = 25 + (0 - j15) + (65 + j35) = 25 + 65 - j975 + j525$$

$$= 90 - j450 = 450 \angle -78.7^\circ \Omega$$

$$= 4.38 - j16.01 + 25 = 29.38 - j16.01 \Omega$$

$$I_T = \frac{V}{Z_T} = \frac{220 \angle 0^\circ}{29.38 - j16.01} = 6.58 \angle 28.59^\circ \text{ A}$$

$$S = V \times (I)^* = (220 \angle 0^\circ) \times (6.58 \angle -28.59^\circ) = 1447.6 \angle -28.59^\circ$$

$$S = P + jQ$$

$$P = 1271.09 \text{ W}$$

$$Q = -j692.73 \text{ VAR}$$

correct method
error carried forward

Q1

24/30

Q1a

3/5

Q1b

21/25

Question Two

a.

$$pf_1 = 0.65$$

$$pf_1 = \cos \theta_1$$

$$\theta_1 = \cos^{-1}(0.65) = 49.46^\circ$$

$$S_1 = 120 \text{ kVA}$$

$$Q_1 = S_1 \times \sin \theta_1 = 120 \times \sin(49.46) = 91.19 \text{ kVAR}$$

$$P = S_1 \cos \theta_1 = 120 \times \cos(49.46) = P = S_1 \cos \theta_1 = 120 \times \cos(49.46) = 78 \text{ kW}$$

$$pf_2 = 0.9$$

$$\theta_2 = \cos^{-1}(0.9) = 25.84^\circ$$

$$P = S_2 \cos \theta_2 \rightarrow S_2 = \frac{P}{\cos \theta_2} = \frac{78}{0.9} = 86.67 \text{ kVA}$$

$$S_2 = \frac{P}{\cos \theta_2} = \frac{78}{0.9} = 86.67 \text{ kVA}$$

$$Q_2 = S_2 \times \sin \theta_2 = 86.67 \times \sin(25.84) = 37.78 \text{ kVAR}$$

$$Q = Q_1 - Q_2 = 91.19 - 37.78 = 53.41 \text{ kVAR}$$

$$Q = \frac{(V)^2}{X_c}$$

$$X_c = \frac{(V)^2}{Q} = \frac{(220)^2}{53.41 \times 10^3} = 906.2 \Omega$$

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

$$C = \frac{1}{2\pi f X_c} = \frac{1}{2\pi \times 50 \times 906.2} = 3.51 \times 10^{-6} \text{ F} = 3.51 \mu\text{F}$$

error carried forward

b.

$$Z_L = 50 + j40 \Omega$$

$$Z_R = 10 + j0 \Omega$$

$$Z_C = ? \Omega$$

$$Z_T = 10 + 50 + j40 = 60 + j40$$

Q2

18/25

Q2a

18/20

Q2b

10

Question ~~One~~ Three

a.

phase voltages :

$$V_{ab} = 220 \angle 0^\circ \text{ V}$$

$$V_{bc} = V_{ab} \angle -120^\circ = 220 \angle -120^\circ \text{ V}$$

$$V_{ac} = V_{ab} \angle +120^\circ = 220 \angle 120^\circ \text{ V}$$

$$Z_A = 10 - j5 \Omega = 11.18 \angle -26.57^\circ \Omega$$

phase currents :

$$I_{AB} = \frac{V_{ab}}{Z_A} = \frac{220 \angle 0^\circ}{11.18 \angle -26.57^\circ} = 19.68 \angle 26.57^\circ \text{ A}$$

$$I_{BC} = \frac{V_{bc}}{Z_A} = \frac{220 \angle -120^\circ}{11.18 \angle -26.57^\circ} = 19.68 \angle -93.43^\circ \text{ A}$$

$$I_{AC} = \frac{V_{ac}}{Z_A} = \frac{220 \angle 120^\circ}{11.18 \angle -26.57^\circ} = 19.68 \angle 146.57^\circ \text{ A}$$

line currents :

$$I_a = I_{AB} \sqrt{3} \angle -30^\circ = 19.68 \times \sqrt{3} \angle 26.57^\circ - 30^\circ = 34.09 \angle -3.43^\circ \text{ A}$$

$$I_b = I_a \angle -120^\circ = 34.09 \angle -3.43^\circ - 120^\circ = 34.09 \angle -123.43^\circ \text{ A}$$

$$I_c = I_a \angle +120^\circ = 34.09 \angle -3.43^\circ + 120^\circ = 34.09 \angle 116.57^\circ \text{ A}$$

b.

phase voltages :

$$V_{ab} = 400 \angle 0^\circ \text{ V}$$

$$V_{bc} = 400 \angle -120^\circ \text{ V}$$

$$V_{ac} = 400 \angle 120^\circ \text{ V}$$

Q3
20/30Q3a
15/15Q3b
5/15

phase currents:

$$I_{ab} = V_{ab} \quad I_a = V_{an}$$

$$V_{an} = \frac{V_{ab}}{\sqrt{3} \angle 30^\circ} = \frac{400 \angle 0^\circ}{\sqrt{3} \angle 30^\circ} = 230.94 \angle -30^\circ \text{ V}$$

$$I_a = \frac{V_{an}}{Z_Y} = \frac{230.94 \angle -30^\circ}{6 + j6} = \frac{230.94 \angle -30^\circ}{8.49 \angle 45^\circ} = 27.2 \angle 15^\circ \text{ A}$$

$$I_b = I_a \angle -120^\circ = 27.2 \angle -105^\circ \text{ A}$$

$$I_c = I_a \angle +120^\circ = 27.2 \angle 135^\circ \text{ A} \quad \text{error carried forward}$$

power factor:

$$\text{pf} = \cos \phi = \cos (15^\circ) = 0.97$$

power consumed per phase:

Question Four

a.

no-load $I = 3A$, no-load speed = 1500 rev/min, armature $R_a = 0.2\Omega$,
 full load $I = 30A$, $V = 240V$

Q42/15

?

Q4a0

b.

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}, \quad pf = 0.9$$

$$\frac{V_1}{V_2} = \frac{4}{1} = \frac{440}{110} = \frac{20}{I_1}$$

$$I_1 = 20 \times \left(\frac{110}{440} \right) = 5A$$

$$P = ??$$

Q4b2/15