



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	W0024874535
2	Title of Examination Paper	ELECTRICAL POWER
3	Module Code	GDEE5000
4	Date and Time of Examination	15/05/2024 10:00
5	Examination Venue	MAIN HALL TY LUCH
6	Seat Number	I4
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	
2	
3	
4	
Q1	26 ✓
Q2	18 ✓
Q3	30 ✓
Q4	2 ✓
Total	76/100

L2

76%

1

a) $V = 240 \angle 0^\circ \text{ V}$ $Z = (6 + j3) + (20 - j15) = 26 - j12$
 $\rightarrow 28.64 \angle -24.78^\circ \Omega$

$S = VI$ $I = \frac{V}{Z} = \frac{240 \angle 0^\circ \text{ V}}{28.64 \angle -24.78^\circ \Omega}$

$I = 8.38 \angle 24.78^\circ \text{ A} \rightarrow 7.61 + j3.51$

$S = 240 \angle 0^\circ \text{ V} \times 8.38 \angle 24.78^\circ \text{ A}$

$S = 2011.2 \angle 24.78^\circ \text{ kVA}$

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

$\text{pf} = \cos(24.78^\circ) = 0.91$

Q1
26/30

Q1a
5/5

b) $V = 220 \angle 0^\circ \text{ V}$ $Z_T = Z_R + \frac{Z_L Z_C}{Z_L + Z_C}$

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

$Z_T = 25 + \frac{(65 + j35)(-j15)}{(65 + j35) + (-j15)}$

$Z_T = 25 + \frac{-975j - j^2 525}{65 + j20}$

$j^2 = -1$
 $\therefore j^2 525 = (-1)(525) = -525$

$Z_T = 25 + \frac{525 - j975}{65 + j20}$

$\therefore -975j - j^2 525 = 525 - j975$

$Z_T = 25 + 3.16 - j15.97$ $525 - j975 = 1107.36 \angle -61.7^\circ$ $65 + j20 = 68 \angle 17.1^\circ$

$Z_T = 28.16 - j15.97$

$\frac{1107.36 \angle -61.7^\circ}{68 \angle 17.1^\circ} = 16.28 \angle -78.8^\circ$

$16.28 \angle -78.8^\circ \rightarrow 3.16 - j15.97$

Q1b
21/25

$$Z_T = 28.16 - j15.97 \, \Omega \text{ or } 16.28 \angle -78.8^\circ \, \Omega$$

$$S = VI^*$$

~~$$S = 220 \angle 0^\circ \, V \times 16.78$$~~

$$I = \frac{V}{Z_T} = \frac{220 \angle 0^\circ \, V}{16.28 \angle -78.8^\circ \, \Omega} = 13.51 \angle 78.8^\circ \, A$$

error carried forward

$$S = 220 \angle 0^\circ \, V \times 13.51 \angle 78.8^\circ \, A = 2972.2 \angle 78.8^\circ \, VA$$

I^*

$$\rightarrow 577.3 + j2915.59 \, VA = S$$

correct method
error carried forward

$$S = P + jQ$$

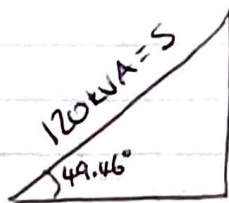
$$\therefore P = 577.3 \, W$$

$$\therefore Q = 2915.59 \, VAR$$

correct method
error carried forward

2

a) $S = 120 \text{ kVA}$ $\text{pf} = 0.65 = \cos \theta$ ✓
 $\therefore \theta = \cos^{-1}(0.65) = 49.46^\circ$ ✓✓



$V = 220 \text{ V}$ $f = 50 \text{ Hz}$

$Q_1 = S \sin \theta = 120000 \times \sin(49.46^\circ) = 91194.29 \text{ VAR}$ ✓
 $= 91.19 \text{ kVAR}$ ✓✓ 5

$P_1 = S \cos \theta = 120000 \times \cos(49.46^\circ) = 77997.45 \text{ W}$ ✓
 $= 78 \text{ kW}$ ✓✓ 3

$\text{pf}_2 = 0.9 = \cos \theta_2$ ✓
 $\therefore \theta_2 = \cos^{-1}(0.9) = 25.84^\circ$ ✓

$0.9 = \frac{P}{S}$ ✓

$\tan \theta = \frac{Q_2}{P}$ ✓✓ 4

$0.9 = \frac{78}{S}$ ✓

$\tan(25.84^\circ) = \frac{Q_2}{78}$ ✓

$S = \frac{78}{0.9} = 86.6 \text{ kVA}$ ✓

$78 \times \tan(25.84^\circ) = Q_2 = 37.77 \text{ kVAR}$ ✓✓ 2

$Q_c = Q_1 - Q_2 = 91.19 - 37.77 \text{ kVAR} = 53.42 \text{ kVAR}$ ✓

$Q_c = 53.42 \times 10^3 \text{ VAR}$ ✓✓ 2

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

$Q = CV$ ✓

$C = \frac{Q}{V} = \frac{53.42 \times 10^3}{220} = 242.81 \text{ F}$ ✓

$C = \frac{1}{2 \times 50 \times 242.81} = 1.31 \times 10^{-5}$

$= 13.1 \times 10^{-6} \text{ F}$

$X_c = 131 \times 10^{-5} \Omega$ ✓

$C = 13.1 \mu\text{F}$

Q218/25Q2a16/20

2 b) i)

?

Q2b215

2b ii)

$$X_c = \frac{1}{2\pi f C} \quad \therefore C = \frac{1}{2\pi \times f \times X_c} \quad f = 1.5 \text{ kHz} \checkmark$$

$$X_c = 114 \, \Omega \checkmark$$

$$\therefore C = \frac{1}{2\pi \times 1500 \times 114} = 9.31 \times 10^{-7} \text{ F}$$

$$= 931 \times 10^{-9} \text{ F} \checkmark$$

$$C = 931 \text{ nF} \checkmark$$

3

a)

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

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

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

$$ii) I_{AB} = \frac{V_{ab}}{Z_{\Delta}} = \frac{220 \angle 0^\circ \text{ V}}{11.18 \angle -26.57^\circ \Omega} \quad Z_{\Delta} = 10 - j5 \Omega \rightarrow 11.18 \angle -26.57^\circ \Omega$$

$$I_{AB} = 19.68 \angle 26.57^\circ \text{ A} \quad \text{or}$$

$$I_{BC} = \frac{V_{bc}}{Z_{\Delta}} = \frac{220 \angle -120^\circ \text{ V}}{11.18 \angle -26.57^\circ \Omega}$$

$$~~I_{BC} = 19.68 \angle -146.57^\circ \text{ A}~~ \quad I_{BC} = 19.68 \angle -93.43^\circ \text{ A}$$

$$I_{CA} = \frac{V_{ca}}{Z_{\Delta}} = \frac{220 \angle 120^\circ \text{ V}}{11.18 \angle -26.57^\circ \Omega}$$

$$I_{CA} = 19.68 \angle 146.57^\circ \text{ A} \quad \text{or}$$

$$iii) I_a = I_{AB} \sqrt{3} \angle -30^\circ = 19.68 \times \sqrt{3} \angle 26.57 - 30^\circ$$

$$I_a = 34.09 \angle -3.43^\circ \text{ A} \quad \text{or} \quad 34.03 - j2.04 \text{ A}$$

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

$$= 34.09 \angle -123.43^\circ \text{ A}$$

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

$$= 34.09 \angle 116.57^\circ \text{ A}$$

Q330/30Q3a15/15

3)

b) $V_{NB} = 400 \angle 0^\circ \text{ V}$

$$Z_Y = 6 + j6 \Omega$$
$$\rightarrow 8.49 \angle 45^\circ \Omega$$

$$V_{AB} = \sqrt{3} V_{an} \angle 30^\circ \text{ V}$$

$$\frac{V_{AB}}{\sqrt{3}} \angle -30^\circ = V_{an}$$

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

$$V_{bn} = V_{an} \angle -120^\circ \text{ V} = 230.94 \angle -30 - 120 = 230.94 \angle -150^\circ \text{ V}$$

$$V_{cn} = V_{an} \angle 120^\circ \text{ V} = 230.94 \angle -30 + 120 = 230.94 \angle 90^\circ \text{ V}$$

$$V_p = 230.94 \text{ V}$$

ii) $I_{an} = I_a = \frac{V_{an}}{Z_Y}$

$$Z_Y = 8.49 \angle 45^\circ \Omega$$

$$I_{an} = \frac{230.94 \angle -30^\circ \text{ V}}{8.49 \angle 45^\circ \Omega} = 27.2 \angle -75^\circ \text{ A}$$

$$I_{bn} = I_b = I_a \angle -120^\circ = 27.2 \angle -75 - 120 = 27.2 \angle -195^\circ \text{ A}$$

$$I_{cn} = I_c = I_a \angle 120^\circ = 27.2 \angle -75 + 120 = 27.2 \angle 45^\circ \text{ A}$$

$$I_p = 27.2 \text{ A}$$

$$\text{iii) } S_p = V_p \times I_p = 230.94 \times 27.2 = S_p = 6281.578 \text{ VA}$$
$$= 6.3 \text{ kVA}$$

$$P = \frac{V^2}{R}$$

$$P = \frac{230.94^2}{6} = 8885.8 \text{ W} = 8.9 \text{ kW}$$
$$pf = \frac{P}{S} = \frac{8.9}{6.3} = 1.41$$

Q3b

15/15

3b)

iii) $P = I^2 R$ $I = 27.2 A$ $R = 6 \Omega$

$P = 4670.46 W$

$S_p = V_p I_p$ $V = 230.94 V$ $I_p = 27.2$

$S_p = 6281.57 VA$

$pf = \frac{P}{S} = \frac{4670.46}{6281.57} = 0.74 = \cos \theta$

$\therefore \theta = \cos^{-1}(0.74) = 42.27$

iv) $P_p = V_p I_p \cos \theta$

$P_p = 230.94 \times 27.2 \times \cos(42.27) = 4648.26 W$
 $= 4.6 kW$

v) $p(t) = P_p \times 3 = 4.6 kW \times 3 = 13.8 kW$

~~$P_p \cos \theta \times 3 =$~~

4
a)

?

Q42/15Q4a0Q4b2/15

4b) $N_1 = 4$ $N_2 = 1$ $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$ ✓
 $V_1 = 440V$ $V_2 = 110V$ ✓
 $I_1 = 5A$ $I_2 = 20A$ ✓

i) $P = IV = 110 \times 20 = 2200 \text{ W} = 2.2 \text{ kW}$

ii) $I_1 = 5A$ $I_1 = \frac{I_2 \times V_2}{V_1} = \frac{20 \times 110}{440} = 5A$