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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                   | ANT26892015             |
| 2 | Title of Examination Paper       | ELECTRICAL POWER        |
| 3 | Module Code                      | GOEE5000                |
| 4 | Date and Time of Examination     | 14/05/2026<br>13:32     |
| 5 | Examination Venue                | GOWER COLLEGE<br>TYLOCH |
| 6 | Seat Number                      |                         |
| 7 | Number of Answer Books handed in | 1                       |

Complete, fold and seal  
(see note 2 below)

SURNAME: ANTUNOVIC

FORENAME(S): SULANA

| List the numbers of the questions you have attempted | Office Use |
|------------------------------------------------------|------------|
|                                                      |            |
|                                                      |            |
| Q1                                                   | 22 ✓       |
|                                                      |            |
| Q2                                                   | 21 ✓       |
|                                                      |            |
| Q3                                                   | 18 ✓       |
|                                                      |            |
| Q4                                                   | 20 ✓       |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
| Total                                                | 81/100 ✓   |

81%

81%

(Gweler yr ochr arall am y fersiwn Cymraeg)

①  
a)

$$V = 240V, 50Hz$$

$$Z = j1.3 + 5 + j0.7 + 2 + j0.8$$

$$Z = 7 + j2.8 \Omega \Rightarrow \text{in polar} = 7.54 \angle 21.8^\circ \Omega$$

$$\text{p.f.} = \cos \phi$$

show workings.

$$\cos \phi = 0.93$$

$$\text{p.f.} = 0.93 \text{ lagging}$$

b)

$$Z_s = 60 + j30$$

$$Z_p = \frac{(0 - j10) \times (60 + j30)}{(0 - j10) + (60 + j30)}$$

$$Z_p = \frac{-j600 + 300}{60 + j20} = \frac{300 - j600}{60 + j20} = \frac{670.8 \angle -63.4^\circ}{63.2 \angle 18.43^\circ}$$

$$Z_p = 10.61 \angle -81.83^\circ = 1.51 - j10.5 \Omega$$

$$Z_T = Z_s + Z_p$$

$$Z_T = 20 + 1.51 - j10.5$$

$$Z_T = 21.51 - j10.5 \Omega = \text{in polar} \Rightarrow 23.94 \angle -26^\circ \Omega$$

$$I = \frac{V}{Z} = \frac{230 \angle 0^\circ}{23.94 \angle -26^\circ}$$

$$I = 9.61 \angle 26^\circ A$$

$$I^* = 9.61 \angle -26^\circ A$$

$$p.f. = \cos \phi = 0.89$$

$$P = VI^* \cos \phi = 1967.17 \text{ W}$$

$$S = VI^* = 230 \angle 0^\circ \times 9.61 \angle -26^\circ \quad \underline{2/4}$$

$$S = 2210.3 \text{ VA} \quad \text{show working}$$

$$P = 1986.6 \text{ W} \quad \underline{2/2}$$

$$Q = -968.9 \text{ VAR} \quad \underline{2/2}$$

Question 2

a)

$$Z_{\Delta} = 20 - j15 \Omega \Rightarrow \text{in polar} = 25 \angle -36.87^\circ \Omega$$

Q22/25

$$1) V_{ab} = 330 \angle 0^\circ \text{ V} \quad \underline{2/2}$$

$$V_{bc} = 330 \angle -120^\circ \text{ V}$$

$$V_{ca} = 330 \angle +120^\circ \text{ V}$$

Q2a13/13

$$2) I_{AB} = \frac{V_{ab}}{Z_{\Delta}} = \frac{330 \angle 0^\circ}{25 \angle -36.87^\circ} = 13.2 \angle 36.87^\circ \text{ A}$$

$$I_{BC} = \frac{V_{bc}}{Z_{\Delta}} = \frac{330 \angle -120^\circ}{25 \angle -36.87^\circ} = 13.2 \angle -83.13^\circ \text{ A}$$

$$I_{CA} = \frac{V_{ca}}{Z_{\Delta}} = \frac{330 \angle +120^\circ}{25 \angle -36.87^\circ} = 13.2 \angle 156.87^\circ \text{ A}$$

6/6

3)

$$I_a = I_{AB} \sqrt{3} \angle -30^\circ = \sqrt{3} \times 13.2 (\angle 36.87^\circ) (\angle -30^\circ)$$

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

$$I_b = I_a \angle -120^\circ = 22.86 (\angle 6.87^\circ) (\angle -120^\circ)$$

$$I_b = 22.86 \angle -113.13^\circ \text{ A} \quad \underline{\underline{2/2}}$$

$$I_c = I_a \angle +120^\circ = 22.86 (\angle 6.87^\circ) (\angle +120^\circ)$$

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

4) Real power per phase:

$$P_p = V_p I_p \cos \phi \quad \cos \phi = \cos (-36.87^\circ)$$

$$\cos \phi = 0.8 \text{ leading}$$

$$P_p = V_{ab} I_{AB} \cos \phi$$

$$P_p = 330 \times 13.2 \times 0.8$$

$$P_p = 3484.8 \text{ W} \quad \underline{\underline{3/3}}$$

② b)

①  $V_{an} = 220 \angle 0^\circ \text{ V}$  ✓

$V_{bn} = 220 \angle -120^\circ \text{ V}$  ✓ 2/2

$V_{cn} = 220 \angle +120^\circ \text{ V}$  ✓

Q2b8/12

②

$V_{ab} = \frac{220 \angle 0^\circ}{\sqrt{3} \angle 30^\circ} = 127 \angle -30^\circ \text{ V}$  ✗

$V_{bc} = \frac{220 \angle -120^\circ}{\sqrt{3} \angle 30^\circ} = 127 \angle -150^\circ \text{ V}$  ✗ 0/2

$V_{bc} = 127 \angle -150^\circ \text{ V}$  ✗

$V_{ca} = V_{ab} \angle +120^\circ = 127 \angle 90^\circ \text{ V}$  ✗

③

$I_{AN} = I_a$  ✓

$I_b = I_{bN}$  ✓

$I_c = I_{cN}$  ✓

$\cos \phi = 0.95$  ✓ 2/2

④  $I_a = \frac{V_{an}}{Z_y} = \frac{220 \angle 0^\circ}{18 + j6} = \frac{220 \angle 0^\circ}{18.97 \angle 18.43^\circ} = 11.6 \angle -18.43^\circ \text{ A}$  ✓

$I_b = I_a \angle -120^\circ = 11.6 \angle -138.43^\circ \text{ A}$  ✓

$I_b = 11.6 \angle -138.43^\circ \text{ A}$  ✓ 3/3

$I_c = I_a \angle +120^\circ = 11.6 \angle 101.57^\circ \text{ A}$  ✓

⑤  $P_p = V_p I_p \cos \phi = 2424.4 \text{ W}$  ✓

$S_p = V_p I_p^* = 2252 \angle 18.43^\circ \text{ VA}$  ✓ (x3)

Total power = 7273.2 W 1/3

a)

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

$$\text{p.f. 1} = 0.65 \text{ lagging}$$

$$\phi_1 = \cos^{-1} 0.65 = 49.46^\circ$$

$$V = 240 \text{ V}, 50 \text{ Hz}$$

$$\text{p.f. 2} = 0.9 \text{ lagging}$$

$$\phi_2 = \cos^{-1} 0.9 = 25.84^\circ$$

$$P = S \cos \phi = 120 \times 10^3 \times 0.65$$

$$P = 78 \text{ kW}$$

$$Q_1 = S \sin \phi = 120 \times 10^3 \times \sin(49.46)$$

$$Q_1 = 91.44 \text{ kVAR}$$

$$S_2 = \frac{P}{\text{p.f. 2}} = \frac{78000}{0.9}$$

$$S_2 = 86.67 \text{ kVA}$$

$$Q_2 = S_2 \sin \phi_2 = 86.67 \times \sin(25.84)$$

$$Q_2 = 78003 \text{ VAR} \text{ cal. error}$$

$$Q_c = Q_1 - Q_2 = 91.44 \times 10^3 - 78003 =$$

$$Q_c = 13437 \text{ VAR}$$

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

$$C = \frac{1}{2\pi f X_c} = 743.71 \times 10^{-6}$$

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

$$X_c = \frac{240^2}{13437} = 4.28 \Omega$$

Q3

18/25

Q3a

18/20

3 a)

The value of the capacitor is  $743.71 \mu F$ .

b)

Maintaining a high power factor in industrial electrical installations is important because

the higher the power factor, the lower the apparent power. This consequently enables the real power to be used by machines.

Reducing the apparent power, there would be less power losses in the system as the real power would be used.

The ~~reason~~ reason a power factor could be high is if the electrical system is not equipped with a power factor correction ~~device~~ component (either capacitor or inductor).

The apparent power is just an appearance, so it can appear that the load can draw this power, which in reality is not there.

This increases operating costs.

Q3b0/50/5

(4)

a)

Zone 1

$$V_t = 400V \quad \checkmark$$

$$S_B = 20 \text{ kVA} \quad \checkmark$$

$$Z_{b1} = \frac{V_t^2}{S_B} = \frac{400^2}{20 \times 10^3} = 8 \Omega \quad \checkmark$$

$$I_{b1} = \frac{V_{b1}}{Z_{b1}} = \frac{400}{8} = 50A \quad \checkmark \quad \underline{\underline{2/2}}$$

$$Z_{\text{load-pu}} = \frac{Z}{Z_{b1}} = \frac{j0}{8} = 0 \Omega \quad \checkmark$$

Zone 2

$$S_B = 20 \text{ kVA} \quad \checkmark$$

$$V_{b2} = 2000V \quad \checkmark$$

$$Z_{b2} = \frac{V_{b2}^2}{S_B} = \frac{2000^2}{20 \times 10^3} = 200 \Omega \quad \checkmark \quad \underline{\underline{3/3}}$$

$$I_{b2} = \frac{V_{b2}}{Z_{b2}} = 10A \quad \checkmark$$

$$Z_{\text{load-pu}} = \frac{Z}{Z_{b2}} = \frac{18 + j36}{200} = 0.09 + j0.18 \quad \checkmark$$

Q420/25Q4a10/15

Zone 3

$$S_{B3} = 20 \text{ kVA} \quad \checkmark$$

$$V_{B3} = 200 \text{ V} \quad \checkmark$$

$$Z_{B3} = \frac{V_{B3}^2}{S_{B3}} = \frac{200^2}{20 \times 10^3} = 2 \, \Omega \quad \checkmark \checkmark \checkmark$$

$$I_{B3} = \frac{V_{B3}}{Z_{B3}} = \frac{200}{2} = 100 \text{ A} \quad \checkmark \quad \underline{\underline{3/3}}$$

$$Z_{\text{load-pu}} = \frac{Z}{Z_{B3}} = \frac{j0}{2} = 0 \, \Omega$$

$$Z_{\text{load}} = \frac{10 \angle 30^\circ}{2} = \frac{10 \angle 30^\circ}{2} = 5 \angle 30^\circ \quad \checkmark \checkmark \checkmark$$

$$\text{or } 4.33 + j2.5 \quad \checkmark \checkmark \quad \underline{\underline{1}}$$

(4)

b)

$$V_s = 72 \text{ V DC}$$

$$R_a = 0.12 \Omega$$

$$R_f = 0.05 \Omega$$

$$I_a = 30 \text{ A}$$

$$N = 1200 \text{ rev/min}$$

Q4b

10/10

(1)

$$E = V_s - (I_a (R_a + R_f))$$

$$E = 72 - (30 \times 0.17)$$

$$E = 66.9 \text{ V} \quad \underline{\underline{2/2}}$$

(2)

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 1200}{60}$$

$$\omega = 125.66 \text{ rad/sec} \quad \underline{\underline{2/2}}$$

(3)

$$E = k\phi\omega$$

$$k\phi = \frac{E}{\omega} = \frac{66.9}{125.66} = 0.53$$

$$T_d = k\phi I_a = 0.53 \times 30 \quad \underline{\underline{4/4}}$$

$$T_d = 15.9 \text{ Nm}$$

4) Mechanical power

$$P_m = Td \omega = 15.9 \times 125.66$$

$$P_m = 1998 \text{ W}$$

2/2