



Prifysgol Cymru  
Y Drindod Dewi Sant  
University of Wales  
Trinity Saint David

## 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.

Complete, fold and seal  
(see note 2 below)

SURNAME: Armin

FORENAME(S): Bailey

|   |                              |                         |
|---|------------------------------|-------------------------|
| 1 | Student Number               | ARM22874486             |
| 2 | Title of Examination Paper   | Electrical power        |
| 3 | Module Code                  | GOEE5000                |
| 4 | Date and Time of Examination | 14/05/26                |
| 5 | Examination Venue            | Tychoch Floor D Room 24 |
| 6 | Seat Number                  |                         |

|   |                                  |   |
|---|----------------------------------|---|
| 7 | Number of Answer Books handed in | 1 |
|---|----------------------------------|---|

| List the numbers of the questions you have attempted | Office Use |
|------------------------------------------------------|------------|
|                                                      |            |
| Q1                                                   | 25 ✓       |
| Q2                                                   | 25 ✓       |
| Q3                                                   | 21 ✓       |
| Q4                                                   | 13 ✓       |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
| Total                                                | 84/100 ✓   |

84%

(Gweler yr ochr arall am y fersiwn Cymraeg)

$$a) Z_T = j1.3 + 5 + j0.7 + 2 + j0.8 \, (\Omega)$$

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

$$p.f = \cos \phi = \cos(21.8^\circ)$$

$$p.f = 0.93 \text{ Lagging} \quad \underline{\underline{5/5}}$$

Q125/25

$$b) V_S = 230 \angle 0^\circ \text{ V}$$

$$R_1 = 20 \, \Omega$$

$$X_C = -j10 \, \Omega$$

$$X_L = j30 \, \Omega$$

$$R_2 = 60 \, \Omega$$

$$Z_1 = \frac{-j10(j30 + 60) \, \Omega}{-j10 + j30 + 60 \, \Omega} = \frac{300 - j600 \, \Omega}{60 + j20 \, \Omega}$$

$$\text{polar} \rightarrow \frac{670.82 \angle -63.43^\circ \, \Omega}{63.25 \angle 18.43^\circ \, \Omega}$$

$$\downarrow$$

$$10.61 \angle -81.86^\circ \, \Omega \quad \underline{\underline{10/10}}$$

$$\downarrow$$

conversion

$$1.5 - j10.5 \, \Omega$$

$$Z_T = Z_1 + R_1 = 1.5 - j10.5 \, \Omega + 20 \, \Omega = 21.5 - j10.5 \, \Omega$$

$$\text{or}$$

$$23.93 \angle -26^\circ \, \Omega$$

$$I = \frac{V_S}{Z} = \frac{230 \angle 0^\circ \text{ V}}{23.93 \angle -26^\circ \, \Omega} = 9.61 \angle 26^\circ \text{ A}$$

$$\text{or}$$

$$8.64 + j4.21 \text{ A}$$

2/2Q1a5/5Q1b20/20

$$S = VI^* = 230(8.64 - j4.21) = 1987.2 - j968.3 \text{ VA}$$

$$P = 1987.2 \text{ W}$$

$$Q = -968.3 \text{ VAR}$$

Question 2

$$\left. \begin{aligned} \text{a) i) } V_{AB} &= 330 \angle 0^\circ \text{ V} \\ &\text{out of phase by } \pm 120^\circ \\ V_{BC} &= 330 \angle -120^\circ \text{ V} \\ V_{AC} &= 330 \angle 120^\circ \text{ V} \end{aligned} \right\} V_L = V_p$$

Q2

25/25

Q2a

13/13

$$\text{ii) } Z_\Delta = 20 - j15 \Omega = \rho \angle \theta \Rightarrow 25 \angle -36.87^\circ \Omega$$

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

$$\text{out of phase by } \pm 120^\circ$$

$$I_{BC} = 13.2 \angle -83.13^\circ \text{ A}$$

$$I_{AC} = 13.2 \angle 156.87^\circ \text{ A}$$

$$\text{iii) } I_a = I_{AB} \sqrt{3} \angle -30^\circ = 13.2 \sqrt{3} \angle 36.87^\circ \angle -30^\circ \text{ A}$$

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

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

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

$$iv) P = V_p I_p \cos \phi$$

$$\phi = -36.87^\circ$$

$$V_p = 330 \text{ V}$$

$$I_p = 13.2 \text{ A}$$

$$= 330 \times 13.2 \times \cos(-36.87^\circ)$$

$$P_p = 3484.79 \text{ W}$$

3/3

b)

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

out of phase by  $\pm 120^\circ$

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

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

Q2b

12/12

$$ii) V_{ab} = \sqrt{3} V_{an} \angle 30^\circ = 220\sqrt{3} \angle 0^\circ / 30^\circ$$

$$= 381.1 \angle 30^\circ \text{ V}$$

out of phase by  $\pm 120^\circ$

$$V_{bc} = 381.1 \angle -90^\circ \text{ V}$$

$$V_{ac} = 381.1 \angle 150^\circ \text{ V}$$

2/2

$$\text{iii) } I_p = I_L$$

$$Z_Y = 6 - j2 + 12 + j8 \Omega$$

IV)

$$I_a = \frac{V_{cn}}{Z_Y}$$

$$Z_Y = 18 + j6 \Omega \text{ or } 18.97 \angle 18.43^\circ \Omega$$

$$I_a = \frac{220 \angle 0^\circ \text{ V}}{18.97 \angle 18.43^\circ \Omega} = 11.6 \angle -18.43^\circ \text{ A}$$

out of phase by  $\pm 120^\circ$

$$I_b = 11.6 \angle -138.43^\circ \text{ A} \quad \underline{\underline{313}}$$

$$I_c = 11.6 \angle 101.57^\circ \text{ A}$$

$$I_a = I_{AN} = 11.6 \angle -18.43^\circ \text{ A} \Rightarrow \text{cart} \Rightarrow 11 - j3.67 \text{ A}$$

$$I_b = I_{BN} = 11.6 \angle -138.43^\circ \text{ A} \quad |I_a| = \sqrt{11^2 + 3.67^2} = 11.6 \text{ A}$$

$$I_c = I_{CN} = 11.6 \angle 101.57^\circ \text{ A} \quad \underline{\underline{212}}$$

$$\text{v) } S_p = P_p + jQ_p = V_p I_p^* = \cancel{220 \angle 18.43^\circ}$$

$$P_p = V_p I_p \cos \alpha = 220 \times 11.6 \times \cos(18.43^\circ) = \cancel{220 \times 11.6 \times \cos(18.43^\circ)}$$

$$P_p = \underline{\underline{2421.11 \text{ W}}} \quad \checkmark$$

$$Q_p = V_p I_p \sin \alpha = 220 \times 11.6 \times \sin(18.43^\circ)$$

$$Q_p = \underline{\underline{806.8 \text{ VAR}}} \quad \checkmark$$

$$S_p = P_p + jQ_p = \underline{\underline{2421.11 + j806.8 \text{ VA}}} \quad \underline{\underline{313}}$$

$$S_{p_{\text{total}}} = 3(2421.11 + j806.8) = \underline{\underline{7263.33 + j2420.4 \text{ VA}}} \quad \checkmark$$

## Question 3

$$a) S_1 = 120 \text{ kVA} \checkmark$$

$$p.f_1 = 0.65 \checkmark$$

$$\theta_1 = \cos^{-1}(p.f) \checkmark$$

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

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

$$P = S \cos \theta = 120 \times 0.65 = 78 \text{ kW} \checkmark$$

$$p.f_2 = 0.9 \checkmark$$

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

$$P = S \cos \theta \Rightarrow S_2 = \frac{P}{\cos \theta} = \frac{78}{0.9} = 86.67 \text{ kVA} \checkmark$$

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

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

$$\text{or} \\ 53410 \text{ VAR} \checkmark$$

$$X_c = \frac{V^2}{Q_c} = \frac{240^2}{53410} = 1.08 \Omega \checkmark$$

$$C = \frac{1}{2\pi f X_c} = \frac{1}{2\pi(50)(1.08)} = 0.0029 \text{ F or } 2900 \mu\text{F} \checkmark$$

$$* V = 240 \text{ V} \quad * f = 50 \text{ Hz} \checkmark$$

Q321/25Q3a20/20

6) High power factor means a higher ratio of real power to reactive power, and the greater the ratio, the higher the power factor (efficiency) of the system, which improves the lifespan of the system & provides cheaper bills due to lower loss of power.

Q3b1/51/5

Zone 1

$$a) \frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2}$$

$$\frac{V_2}{400} = \frac{5}{1} = \frac{I_1}{I_2}$$

$$V_2 = 400 \times 5 = 2000V$$

$$S_b = 20 \text{ kVA}$$

$$S = VI$$

$$V_b = 400V$$

$$I_b = \frac{S_b}{V_b} = \frac{20000}{400} = 50A$$

~~Zone 1:~~

$$Z_b = j0 \Omega$$

1/2Zone 2:

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2}$$

$$\frac{V_2}{400V} = \frac{5}{1} = \frac{50}{I_2}$$

$$V_2 = 400 \times 5 = 2000V \quad V_b = 2000V$$

$$I_2 = \frac{50}{5} = 10A \quad I_b = 10A$$

2/3

$$S = IV = 10(2000) = 20000VA \text{ or } 20 \text{ kVA}$$

$$Z = 18 + j36$$

Q413/25Q4a5/15

zone 3:

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} \quad \frac{V_2}{2000} = \frac{10}{10} = \frac{10}{I_2}$$

$$V_2 = \frac{2000}{10} = 200V \quad V_b = 200V$$

$$I_2 = 10 \times 10 = 100A \quad I_b = 100A$$

$$S = IV = 100 \times 200 = 20000VA \text{ or } 20kVA$$

$$Z_b = ??$$

?

$$b) V_s = 78V \quad \checkmark$$

$$R_a = 0.12\Omega \quad \checkmark$$

$$R_f = 0.05\Omega \quad \checkmark$$

$$I_a = 30A \quad \checkmark$$

$$N = 1200 \text{ rpm} \quad \checkmark$$

$$\omega =$$

$$E_a = V_s - (R_a + R_f) I_a = 74.4V \quad \times \quad 0.12$$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi(1200)}{60} = 125.67 \text{ r/s} \quad \underline{\underline{2/2}}$$

$$P_m = T_d \omega \quad \checkmark \quad T_d = k\phi I_a \quad \checkmark \quad k\phi = \frac{E_a}{\omega} \quad \checkmark$$

$$k\phi = \frac{74.4}{125.67} = 0.59 \quad \text{E.C.F.} \quad \text{Correct method} \quad \text{E.C.F.}$$

$$T_d = 0.59(30) = 17.7 \text{ Nm} \quad \text{E.C.F.} \quad \underline{\underline{4/4}}$$

$$P_m = 17.7 \times 125.67 = 2224.36W \quad \underline{\underline{2/2}} \quad \text{Correct method}$$

Q4b

8110