

Complete, fold and seal
(see note 2 below)

SURNAME: Rogers

FORENAME(S): Jack Nathan

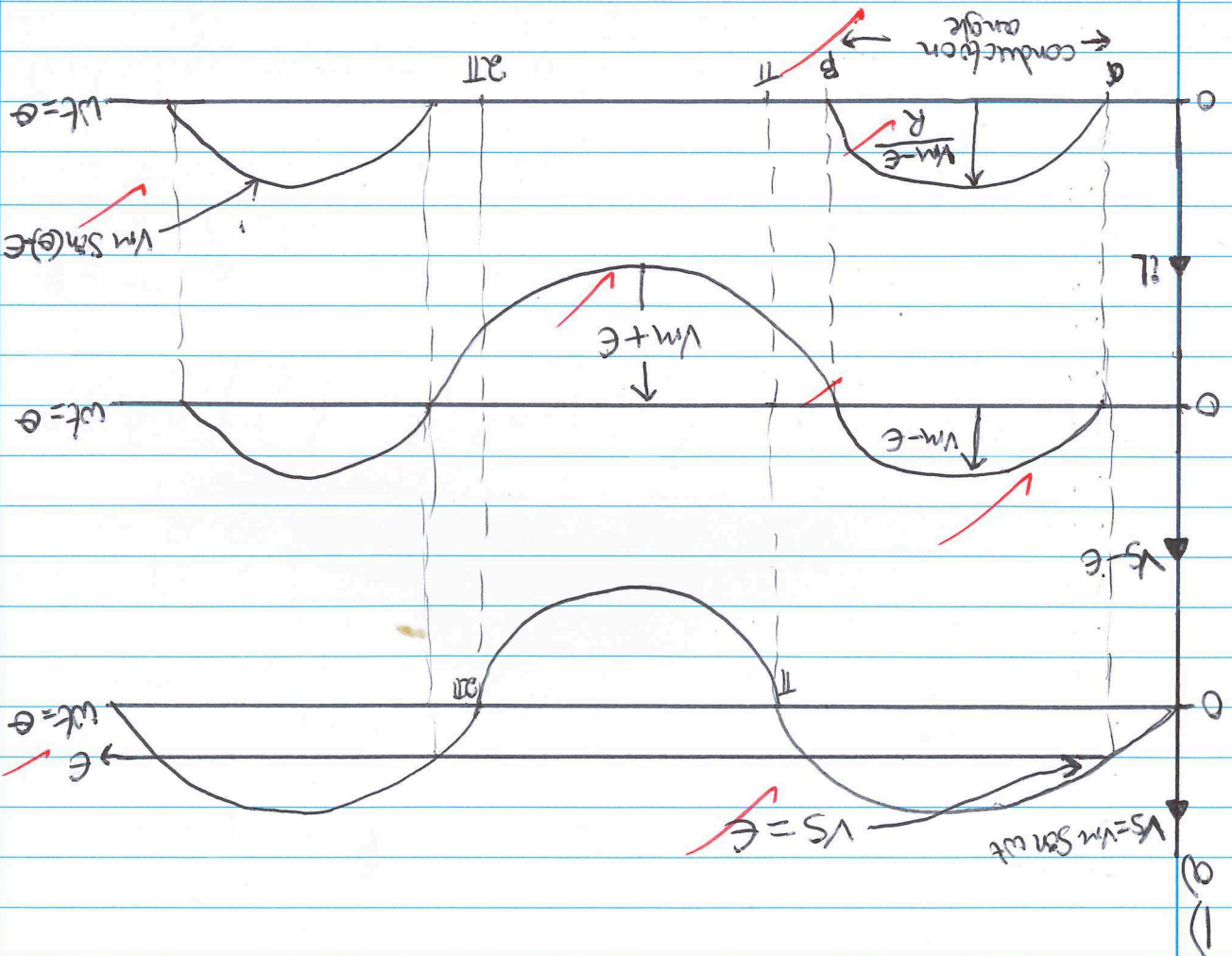
1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense 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	2017196
2	Title of Examination Paper	Power Electronics + Drives
3	Module Code	SGEE 6001
4	Date and Time of Examination	Start 9:30 Finish 12:00
5	Examination Venue	G 43
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	21 1/2
4	21 1/2
Total	439

(Gweler yr ochr arall am y fersiwn Cymraeg)

- Diode D_1 conducts when $V_s \geq E$ at which point α as indicated on diagram
- α (alpha) can be shown $V_m \sin(\alpha) = E \therefore \alpha = \sin^{-1}(\frac{E}{V_m})$ where $\beta = \pi - \alpha$ shown on diagram
- D_1 blocks out at $V_s < E$ until $\pi > \alpha$ and starts back at $2\pi + \alpha$
- The charging current can be shown in volt drop across R .
- $V_s - E = i_l R \therefore i_l = \frac{V_s - E}{R} = \frac{V_m \sin(\theta) - E}{R}$ where condition $\alpha < \theta < \beta$ where $\omega t = \theta$



a)
b)

(Conduction angle of diode:

$$V_s = \frac{120}{2} = 60V$$

$$V_m = 60 \times \sqrt{2} = 84.85V$$

$$\alpha = \sin^{-1}\left(\frac{E}{V_m}\right) = \sin^{-1}\left(\frac{24}{84.85}\right) = 0.287 \text{ rad/s or } 16^\circ$$

$$\beta = \pi - \alpha$$

$$= \pi - 0.287$$

$$= 2.855 \text{ rad/s or } 164^\circ$$

$$\text{Conduction angle} = \beta + \alpha$$

$$= 2.855 + 0.287$$

$$= 3.142 \text{ rad/s or } 180^\circ$$

$$(\text{ii}) \quad I_L = \frac{1}{\pi} \int_{\beta}^{\alpha} \left[\frac{V_m \sin(\theta) - E}{R} \right] d\theta$$

$$= \frac{1}{\pi} [V_m \cos(\theta) - E\theta]_{\beta}^{\alpha}$$

$$= \frac{1}{\pi} [V_m \cos(\beta) - E\beta - (-V_m \cos(\alpha) + E\alpha)]$$

$$= \frac{1}{\pi} [84.85 \cos(0.855) - 24 \times 2.855 + 84.85 \cos(0.287) + 24 \times 0.287]$$

$$= \frac{1}{\pi} [107.96] \quad \therefore \frac{2\pi \times R}{96.796} = 5 \quad \therefore R = 107.96 \times \frac{2\pi \times 5}{2\pi \times 5} = 3.44 \Omega$$

$$R = 3.44 \Omega$$

b) (i)

$$V_m = 120 \times \sqrt{2} = 170 \text{ V}$$

$$\alpha = 60^\circ \text{ or } 1.047 \text{ rad/s}$$

$$= \frac{\pi}{V_m} [\cos \alpha - \cos \beta]$$

$$= \frac{\pi}{V_m} [\cos \beta - (-\cos \alpha)]$$

$$V_{avg} = \frac{1}{\pi} \int_{\beta}^{\alpha} V_m \sin \omega t \cdot d\omega t = \frac{\pi}{V_m} [\cos \theta - \cos \theta']$$

$$\beta = \pi + \theta$$

$$W_L = 2\pi f L = 2\pi \times 60 \times 60 \times 10^{-3} = 2.512$$

$$\text{Forcing angle } \theta = \tan^{-1} \left(\frac{R}{\omega L} \right)$$

$$\theta = \tan^{-1} \left(\frac{7.54}{10} \right)$$

$$\theta = 0.646 \text{ rad/s or } 37^\circ$$

$$\beta = \pi - 0.646 = 2.474 \text{ rad/s or } 143^\circ$$

$$V_{avg} = \frac{\pi}{V_m} [\cos(\theta) - \cos(\beta)]$$

$$= \frac{\pi}{170} [1.301]$$

$$V_{avg} = 70 \text{ V}$$

$$I_{avg} = \frac{V_m}{\pi R} [\cos \alpha - \cos \beta]$$

↓ does not affect final answer.

$$\cos(3.214) = -0.05$$

$$\cos(2.5) = 0.69$$

6/2

$$I_{avg} = 7 \text{ A}$$

$$= \frac{\pi \times 10}{170}$$

$$[1.301]$$

10/10



$$V_{rms} = \frac{1}{T} \int_0^T [v_m \sin \omega t]^2 dt \quad \checkmark$$

$$= \sqrt{\frac{V_m^2}{T} \left[R - \alpha - \frac{1}{2} \sin 2\beta + \frac{1}{2} \sin 2\alpha \right]} \quad \checkmark$$

$$= \sqrt{\frac{170^2}{\pi} \left[2.5 - 1.047 - \frac{1}{2} \sin(2 \times 2.5) + \frac{1}{2} \sin(2 \times 1.047) \right]}$$

→ 2.5° turned over from B

$$= \sqrt{\frac{170^2}{\pi} [2.366]}$$

$$= 147.53 \text{ V}$$

$$I_{rms} = \frac{V_{rms}}{Z} \quad Z = \sqrt{R^2 + (W)^2}$$

$$Z = \sqrt{10^2 + 7.54^2} \quad \checkmark$$

$$Z = 12.52 \quad \checkmark$$

$$I_{rms} = \frac{\sqrt{\frac{170^2}{\pi} \left[R - \alpha - \frac{1}{2} \sin 2\beta + \frac{1}{2} \sin 2\alpha \right]}}{12.52}$$

$$I_{rms} = \frac{147.53}{12.52}$$

$$I_{rms} = 11.8 \text{ A} \quad \checkmark \quad \text{Correct for the value calculated}$$

$$P = I_{rms}^2 \times R \quad \text{Correct formula.}$$

$$= 11.8^2 \times 10 \quad \times \quad \text{Correct for formula.}$$

$$P = 1392.2 \text{ W} \quad \times \quad \text{Correct for formula}$$