



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	2024421
2	Title of Examination Paper	Power Electronics and Drives.
3	Module Code	5GET6001
4	Date and Time of Examination	03-05-2024. 09:30 12:00
5	Examination Venue	G43.
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	4
	2
	16
	5
Office Use	23
	23
Total	662

6620

Complete, fold and seal
(see note 2 below)

SURNAME:

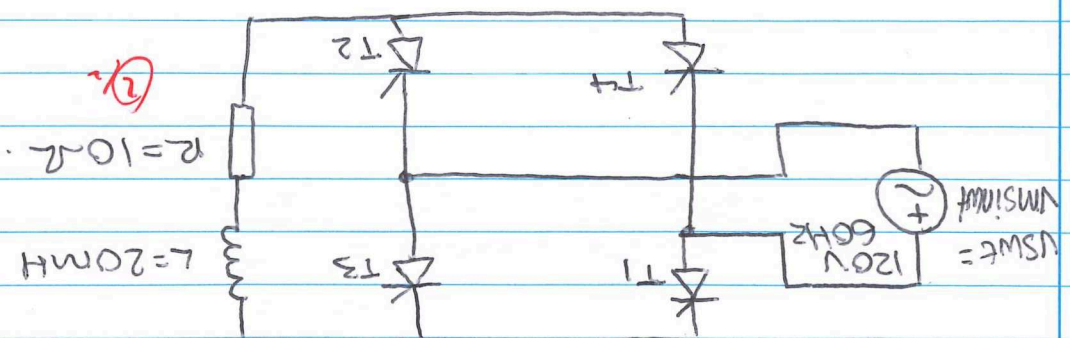
PERRY

FORENAME(S):

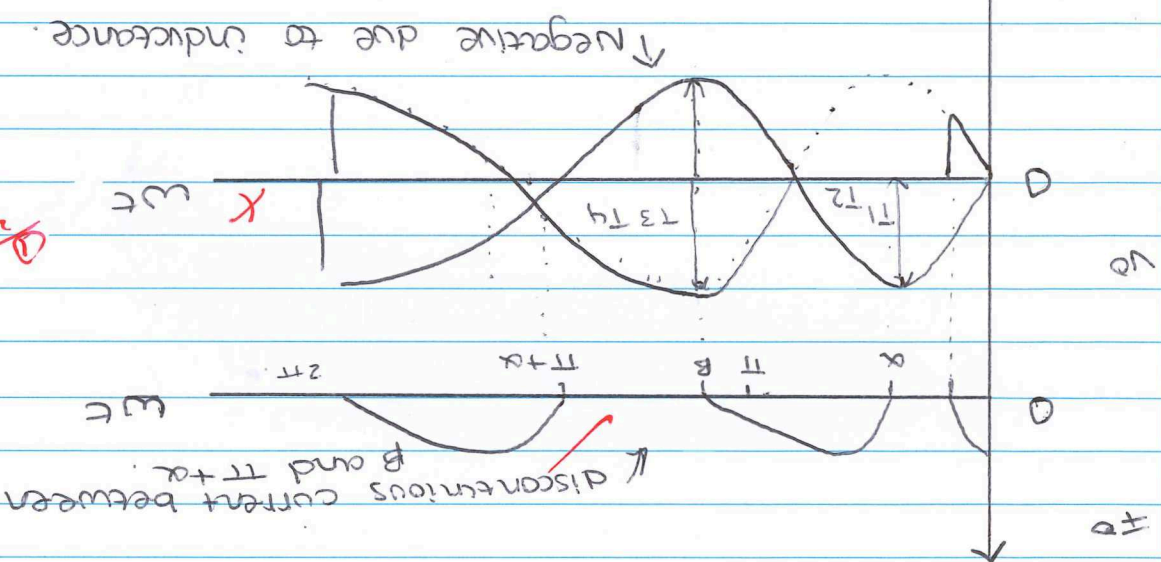
MATTHEW

120V 60Hz R=10 L=20mH $\alpha=60^\circ$

(1)



$$v_{swt} = V_m \sin \omega t$$



discontinuous current between π and $\pi + \alpha$.

↓ Negative due to inductance.

Discontinuous current = $\pi < \pi + \alpha$.

continuous = larger inductance

: smaller firing angle α .

$$V_{avg} = \frac{1}{\pi} \int_{\alpha}^{\pi} v_m \sin \omega t \, d\omega t$$

$$= \frac{V_m}{\pi} [-\cos \omega t]_{\alpha}^{\pi}$$

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

!!!

b.i)

$$V_{avg} = \frac{\pi}{2} V_m [\cos(\alpha) - \cos(\beta)]$$

$$V_m = V_s \times \sqrt{2}$$

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

$$\alpha = 60^\circ \times \frac{\pi}{180} = 1.047 \text{ rad/s}$$

$$\omega t = 2\pi f t = 2\pi \times 60 \times (20 \times 10^{-3}) = 7.532$$

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

$$= \pi + 0.643$$

$$= 3.785$$

$$V_{avg} = \frac{\pi}{2} V_m [\cos(1.047) - \cos(3.785)]$$

$$= 70.3V$$

$$I_{avg} = I_{dc} = \frac{P}{R}$$

$$V_m [\cos(\alpha) - \cos(\beta)]$$

$$= \frac{\pi \times 10}{2} [\cos(1.047) - \cos(3.785)]$$

$$= 7.03A$$



$$P = I^2_{RMS} \times R$$

$$V_{RMS} = \sqrt{\frac{1}{T} \int_0^T v_{ms}^2 dt}$$

$$= \sqrt{v_{m2}^2 (B - \alpha - \frac{1}{2} \sin(2 \times B) + \frac{1}{2} \sin(2 \times \alpha))}$$

$$= \sqrt{130^2 (3.785 - 1.047 - \frac{1}{2} \sin(2 \times 3.785) + \frac{1}{2} \sin(2 \times 1.047))}$$

$$= 111.25 \text{ V}_{RMS}$$

I_{RMS}

$$Z = \sqrt{R^2 + \omega L^2}$$

$$= \sqrt{10^2 + 7.5^2} = 12.5 \Omega$$

$$\frac{1}{Z} \sqrt{v_{m2}^2 (B - \alpha - \frac{1}{2} \sin(2 \times B) + \frac{1}{2} \sin(2 \times \alpha))}$$

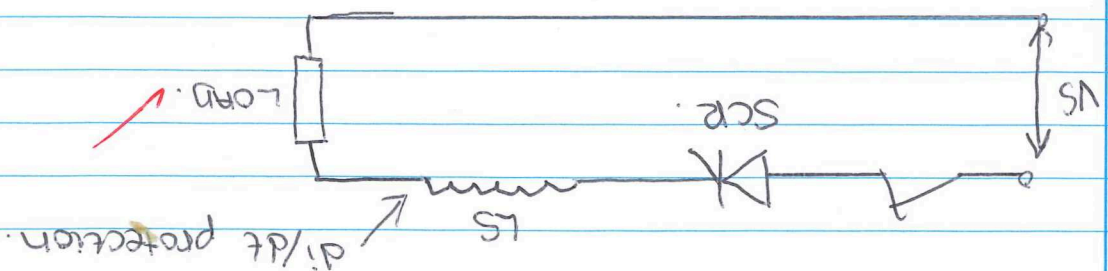
$$\frac{1}{12.5} \sqrt{130^2 (3.785 - 1.047 - \frac{1}{2} \sin(2 \times 3.785) + \frac{1}{2} \sin(2 \times 1.047))}$$

$$= 8.9 \text{ I}_{RMS}$$

$$P = I^2_{RMS} \times R$$

$$= 9.836^2 \times 10$$

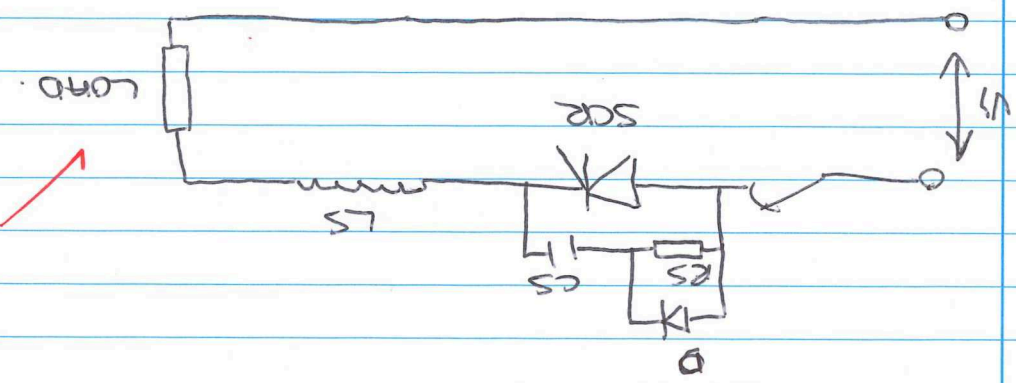
$$= 972 \text{ watts}$$



Series inductor limits high values of $\frac{di}{dt}$ which can occur at initial turn on. High values of $\frac{di}{dt}$ can cause uneven distribution of current and can cause 'hotspotting' on junctions.

$$V_s = L_s \frac{di}{dt} \quad L = \frac{V}{\frac{di}{dt}}$$

For protection $L > \frac{V}{\frac{di}{dt}}$



High values of $\frac{dv}{dt}$ can cause false turn ons. This is combated by a snubber circuit which is made up of:

- D to prevent losses and to bypass R_s to charge C_s .
- R_s to absorb discharge current from C_s .
- C_s bypass capacitor.

C_s is to bypass high values of $\frac{dv}{dt}$ through SCR

6 1/2

6 1/2

$$R = \frac{L}{A} \times \frac{dV}{dI}$$

$$\frac{dV}{dI} = \frac{L}{A} \times R$$

$$\frac{dV}{dI} = \frac{dI}{dI} \times R$$

$$V = I \times R$$

$$L = \frac{V}{dI/dI}$$

$$\frac{dI}{dI} = \frac{L}{V} \times 1$$

$$e^{-0} = 1$$

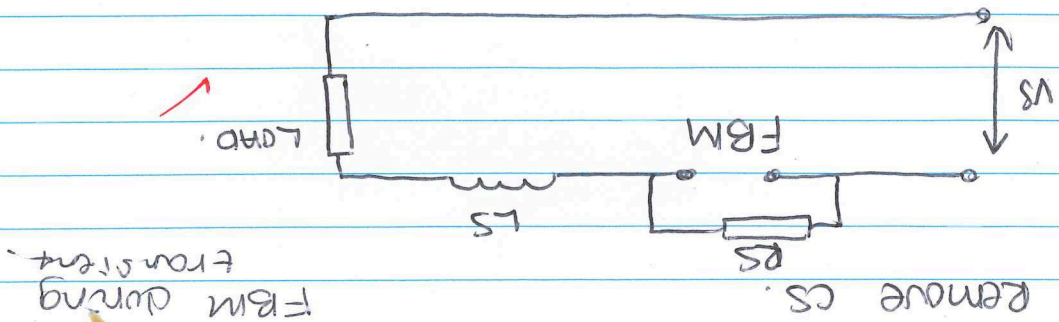
$$\frac{dI}{dI} = \frac{V}{L} [0 - e^{-\frac{t}{L/R}}] \times 0$$

As this should be zero!

when $t=0$

$$\frac{dI}{dI} = \frac{V}{L} [0 - e^{-\frac{t}{L/R}}]$$

$$I = \frac{V}{L} [1 - e^{-\frac{t}{L/R}}]$$



ii.]

$$4s^2 = \frac{L}{RS} = CS$$

$$4s^2 \frac{1}{LCS} = RS^2 \frac{1}{LS^2}$$

$$4s^2 \omega^2 = RS^2 \frac{1}{LS^2}$$

$$2s\omega = RS \frac{1}{LS}$$

$$\omega^2 = \frac{1}{LCS}$$

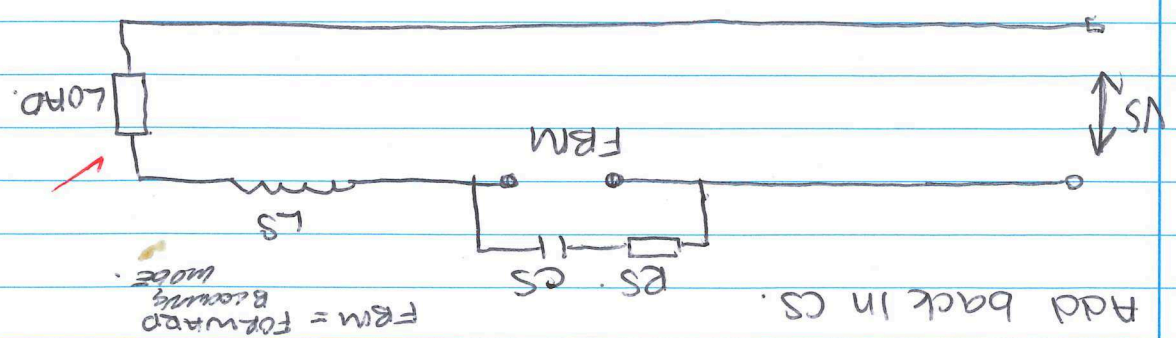
$$s^2 + 2s\omega + \omega^2 = 0 \text{ compared to}$$

$$s^2 + RS \frac{1}{LCS} + \frac{1}{LCS} = 0$$

$$LS^2 + sRS + \frac{1}{CS} = 0$$

$$L \frac{d^2 I}{dt^2} + R \frac{dI}{dt} + \frac{1}{CS} = 0$$

$$VS = IRS + L \frac{dI}{dt} + \frac{1}{CS} I$$





$$432 \text{ } \overline{RS} = CS.$$

$$432 \times L = CS.$$

$$\begin{bmatrix} 23 \\ RS \end{bmatrix}^2 \times L = CS.$$

$$CS = \begin{bmatrix} 23 \\ RS \end{bmatrix}^2 \times L.$$

b.)

$$L = \frac{V}{\frac{dV}{dt}} = \frac{400}{\frac{20}{10^{-6}}} = 20 \times 10^{-6}.$$

$$= 20 \mu H.$$

$$R = \frac{V}{I} \times \frac{dI}{dV} = \frac{400}{20 \times 10^{-4}} \times \frac{10^{-6}}{500} = 4 \times 10^{-6}.$$

$$= 25 \mu H.$$

$$CS = \begin{bmatrix} 23 \\ RS \end{bmatrix}^2 \times L$$

$$= \begin{bmatrix} 2 \times 0.5 \\ 25 \end{bmatrix}^2 \times (20 \times 10^{-6}).$$

$$= 32 \times 10^{-9} = 32 nF.$$

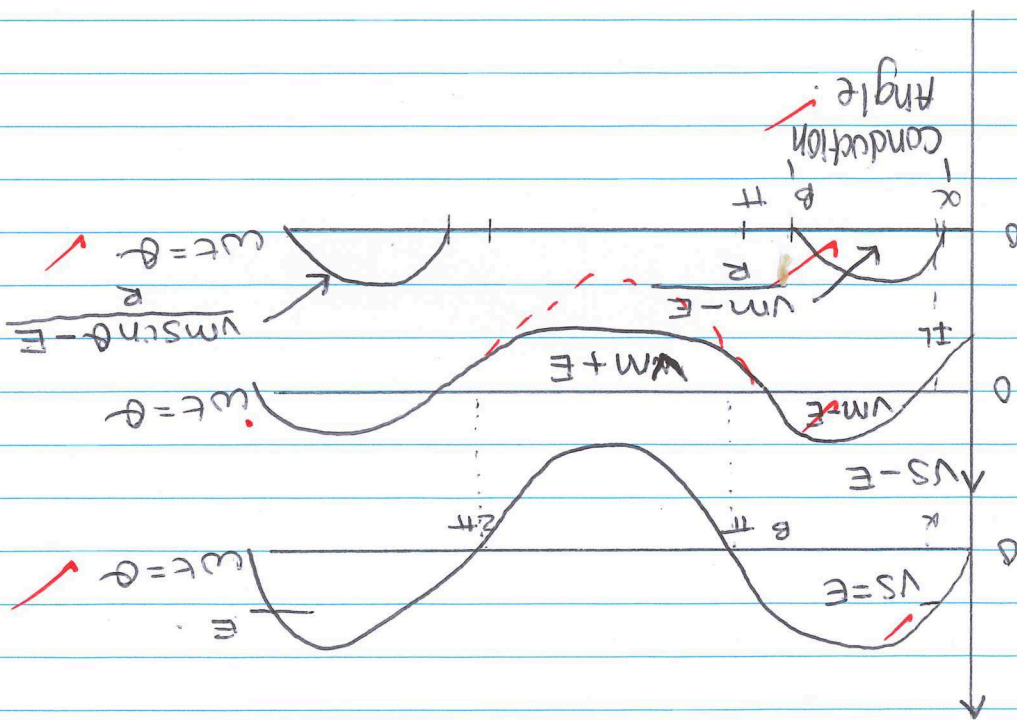
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10%

16/11/21

11)

$$V_s = V_m \sin \theta$$



Conduction angle = $\beta - \alpha$.

$$V_s = V_p / 2$$

$$= 120 / 2$$

$$= 60$$

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

$$\alpha = \sin^{-1} \left(\frac{V_p}{V_m} \right)$$

$$= \sin^{-1} \left(\frac{24}{84.85} \right) = 0.2867$$

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

$$= \pi - 0.2867$$

$$= 2.8548$$

$$C_A = \beta - \alpha$$

$$= 2.85 - 0.2867$$

$$= 2.568$$

b(i)

6

6

12

Current limiting resistance

$$I_L = \frac{1}{2\pi} \int_0^{2\pi} [v_m \sin \theta - E] e$$

$$I_L = \frac{1}{2\pi} \int_0^{2\pi} [-v_m \sin \theta - E] e$$

$$I_L = \frac{1}{2\pi} \int_0^{2\pi} [-v_m \sin \theta - E] e$$

$$\frac{1}{2\pi} \int_0^{2\pi} [-v_m \sin \theta - E] e$$

$$\frac{1}{2\pi} \int_0^{2\pi} [-v_m \sin \theta - E] e$$

$$[0.2867] + E(0.2867)$$

$$E = 24$$

$$S = \frac{84.85}{2\pi} [-61.64]$$

$$R = \frac{61.64}{2\pi \times 5} = 1.9$$

Rhif y Cwestiwn Examiner Only	Arholwr yn unig $\begin{aligned} PIV &= VM + F \\ &= 84.85 + 24 \\ &= 108.84 \end{aligned}$	Question No. !!!
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- R_1 and jX_1 is stator resistance and leakage reactance.
- R_2 and jX_2 is rotor resistance and leakage reactance.
- R_c and jX_m represent core/laminations.
- I_0 is no load current in core.
- V_1 is stator phase voltage

