



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	
2	Title of Examination Paper	POWER ELECS & DEVICES
3	Module Code	SGEE6001
4	Date and Time of Examination	20/05/22 09:30
5	Examination Venue	Sports hall
6	Seat Number	8
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1 (6/6)	16
(1/1)	
(2/2)	
(3/3)	
Q3 (6/6)	1 1/2
Q5 (6/6)	12 1/2
(4/4)	
(5/5)	
(6/6)	
(7/7)	
(8/8)	
(9/9)	
(10/10)	
(11/11)	
(12/12)	
(13/13)	
(14/14)	
(15/15)	
Total	30

Mark confirmed as 30

Question 1
(a)

Question 1

(b)(i) (b)(i) TURN-ON



$$i = \frac{I}{T} t$$

$$v = -\frac{V}{T} t + V$$

$$= V \left(1 - \frac{t}{T} \right)$$

$$\left(\begin{array}{l} \text{Instantaneous values} \\ = v i \end{array} \right)$$

Instantaneous values

$$= V \left(1 - \frac{t}{T} \right) \frac{I}{T} t$$

$$vi = VI \left(\frac{t}{T} - \frac{t^2}{T^2} \right)$$

Energy lost

$$\int_0^T vi \, dt = VI \int_0^T \left(\frac{t}{T} - \frac{t^2}{T^2} \right) dt$$

$$= VI \left[\frac{t}{T} - \frac{t^2}{T^2} \right]_0^T dt$$

$$= VI \left[\frac{t^2}{2T} - \frac{t^3}{3T^2} \right]_0^T dt$$

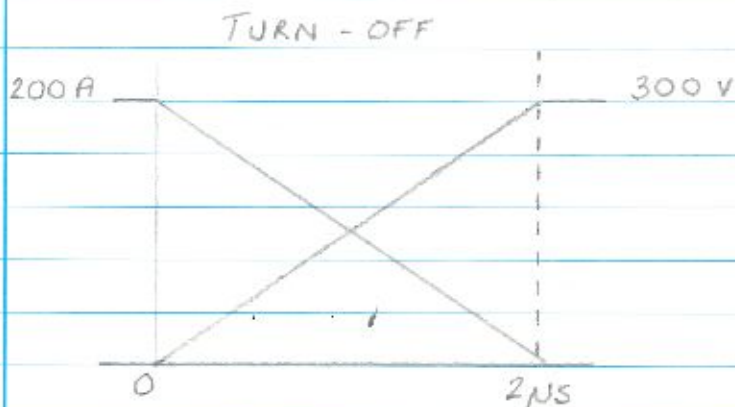
$t \neq T$
until you put the
limits in

* TURN OVER *

$$= VI \left[\frac{T}{2} - \frac{T}{3} \right]$$

$$= VI \left[\frac{T}{6} \right] = \frac{VIT}{6} \text{ Joules}$$

(2)



$$v = \frac{V}{T} t$$

$$i = -\frac{I}{T} t + I$$

$$= I \left(1 - \frac{t}{T} \right)$$

$$= I \left(1 - \frac{t}{T} \right) \frac{V}{T} t$$

$$= VI \left(1 - \frac{t}{T} \right) \frac{t}{T}$$

$$= VI \left(\frac{t}{T} - \frac{t^2}{T^2} \right)$$

* Exactly the same as Turn-on value, meaning answer will equal : $\frac{VIT}{6}$ Joules

(3)

(ii) (ii) Mean power loss due to switching at a freq. of 10 kHz

$$\text{TURN-ON} : \frac{300 \times 200 \times 1 \times 10^{-6}}{6} \\ = 0.01 \text{ J}$$

①

$$\text{TURN-OFF} : \frac{200 \times 300 \times 2 \times 10^{-6}}{6} \\ = 0.02 \text{ J}$$

①

Average switching power losses :

$$(0.01 + 0.02) \times 10 \times 10^3 \\ = 300 \text{ W}$$



②

(iii) (iii) Conduction losses

If the transistor is running at half of the time:

$$V_{CE} \times I_A \times 0.5 \\ = 2.1 \times 200 \times 0.5 \\ = 210 \text{ W}$$

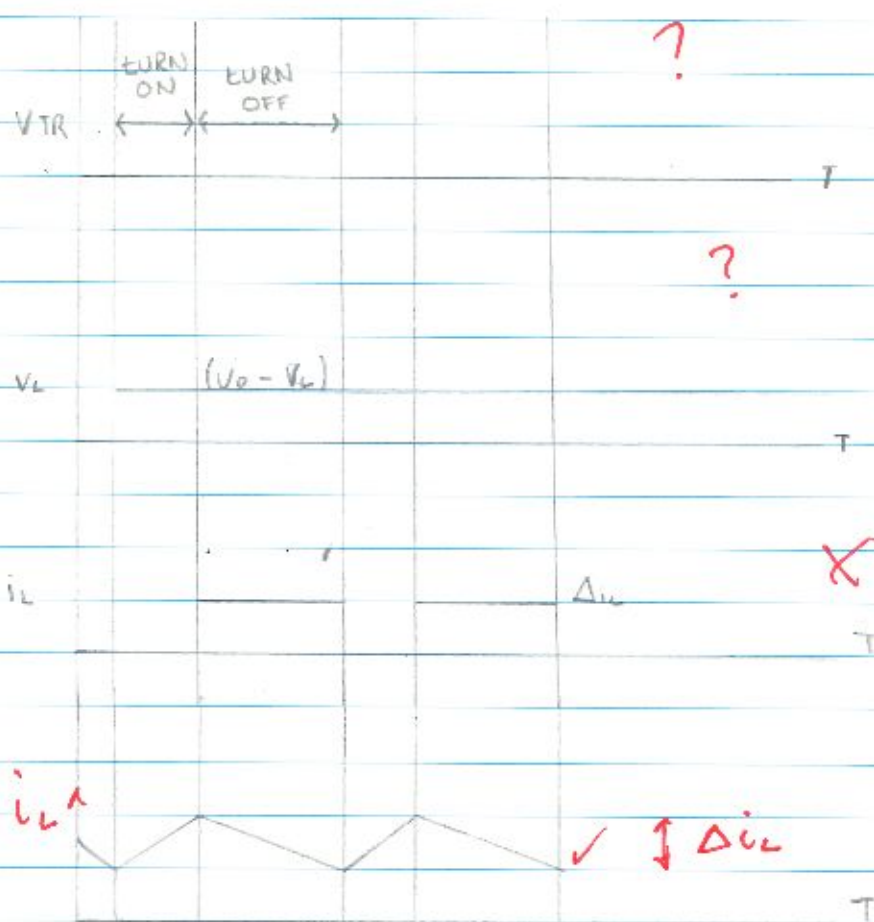
②

(iv) (iv) Total Losses

$$\text{Conduction Losses} + \text{Average switching power losses} \\ = 210 + 300 = 510 \text{ W}$$

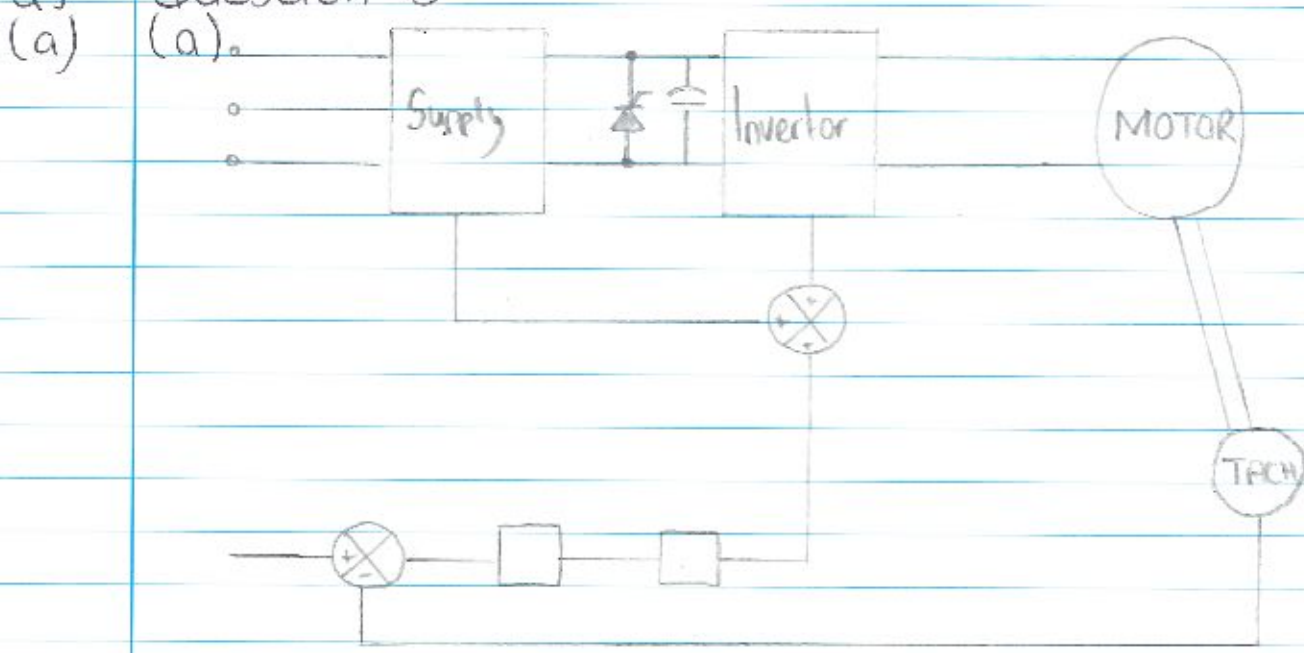
①

(b) Question 3



(1 1/2)

Q5 Question 5



(2)

Question 5

(b)(i) (b)(i) Maximum slip speed in rad/s

$$W_{SL} = \frac{R_R}{L_S + L_R}$$

$$L_S = \frac{X_S}{2\pi f_L} = \frac{0.56}{2\pi \times 50} = \frac{0.00149 \text{ H}}{0.00178 \text{ H}} \quad \checkmark$$

$$L_R = \frac{X_R}{2\pi f_L} = \frac{0.853}{2\pi \times 50} = 0.00272 \text{ H} \quad \checkmark$$

$$W_{SL} = \frac{0.185}{(0.00178 + 0.00272)}$$

$$= 41.1 \text{ rad/s} \quad \checkmark$$

(4)

(ii) (ii) Rated stator phase current (I_s)

$$P_e = 3 V_{PH} I_s \cos \phi$$

$$I_s = \frac{P_e}{3 V_{PH} \cos \phi}$$

$$V_{PH} = \frac{V_{LINE}}{\sqrt{3}} = \frac{220}{\sqrt{3}} = 127.02 \text{ V}$$

$$P_e = \frac{P_{mech}}{\eta} = \frac{HP \times 745.6}{0.83} = \frac{6 \times 745.6}{0.83}$$

$$= 5389.88 \text{ W}$$

$$I_s = \frac{5389.88}{3 \times 127.02 \times 0.87}$$

$$= 16.25 \text{ A} \quad \checkmark$$

(2)

(iii) (iii) Offset phase voltage

$$V_o = R_s \times I_s$$

$$= 0.281 \times 16.25$$

$$= 4.566 \text{ V}$$

①

(iv) (iv) Voltage - frequency constant

$$K_{VF} = \frac{V_{PH} - V_o}{F_L}$$

$$= \frac{127.02 - 4.566}{50}$$

$$= 2.449 \text{ V/Hz}$$

①

(v) (v) DC link voltage V_{dc}
 $2.22 (V_o + K_{VF} F_L)$

$$= 2.22 (4.566 + 2.449 F_L)$$

$$= 10.137 + 5.437 F_L$$

②

$$O_r = 5.437 F_L + 10.137$$

@ 50 Hz

$$= 5.437 \times 50 + 10.137$$

$$= 281.987 \text{ Hz V}$$

(c) (c) A PWM inverter drive allows you to regulate the amount of voltage you need.

②