



Complete, fold and seal
(see note 2 below)

SURNAME: Costello - Downs

FORENAME(S): Iwan

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.**

List the numbers of the questions you have attempted	Office Use
Q3	7
Q5	7
~~Q4~~	
Total	14

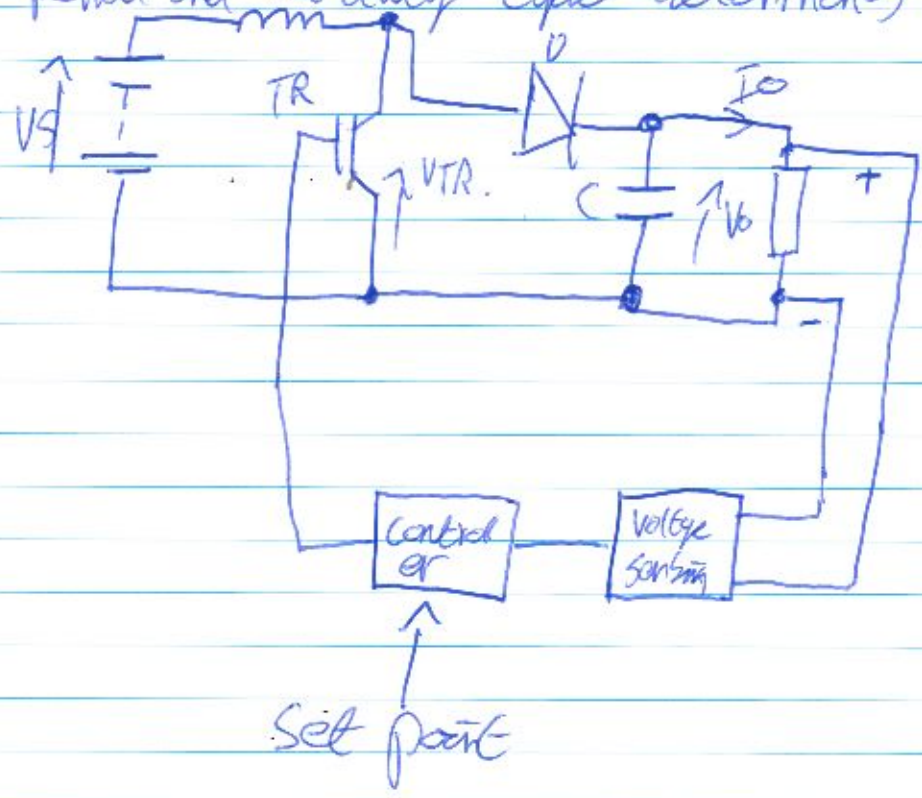
Mark confirmed as 14

(Q3) a) The circuit is a DC to DC Boost converter. that outputs DC Voltage. in which $V_o > V_s$. It achieves this by switching the transistor TR. on and off. and when the transistor is on voltage passes through the inductor and charges it. when the transistor closes it passes through the diode D and charges the capacitor C. This is done for a certain transient period and the duty cycle determines the output Voltage.

Current

opens

2



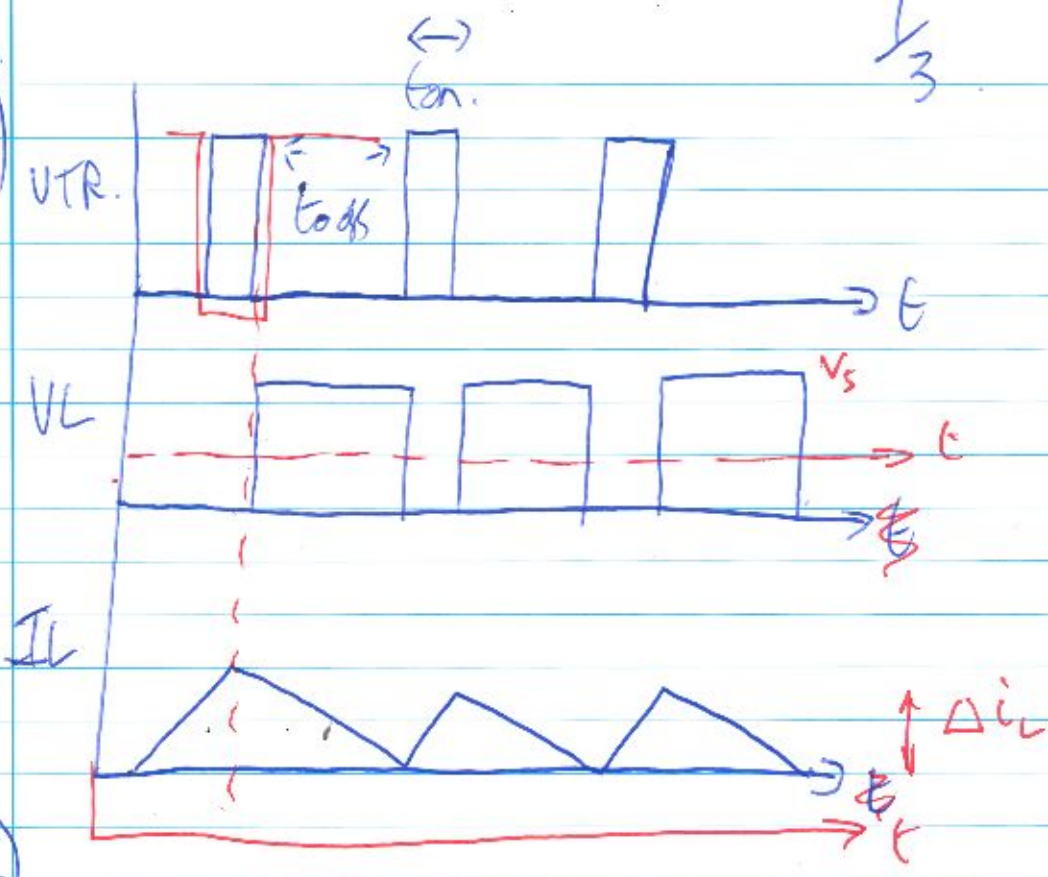
To achieve Voltage control a Voltage Sensing device can be placed on the load. that feeds back into a controller with a determined set point. This allows the transistor to maintain a desired duty cycle keeping the output Voltage constant.

3

pto

1/3

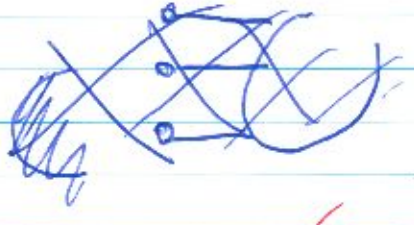
6)



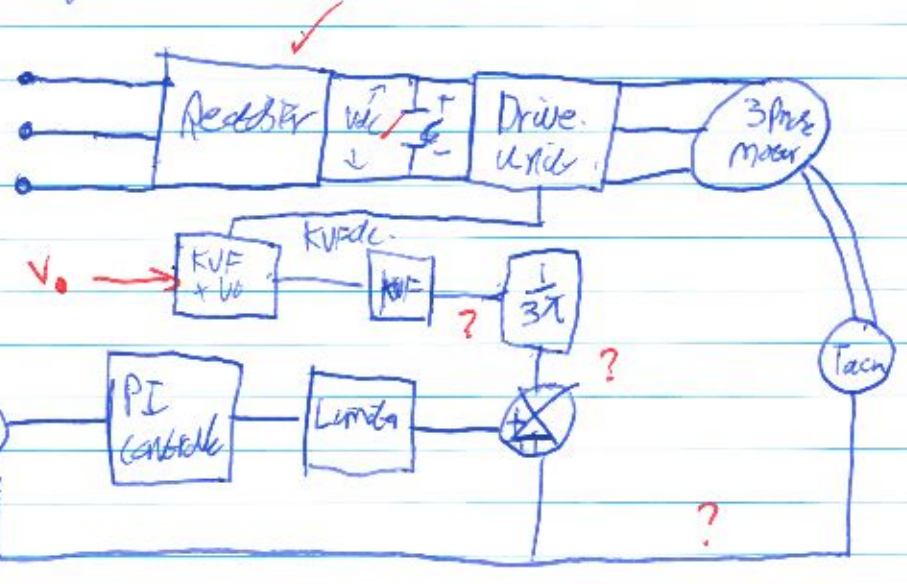
(2)

Q5)

a)



3 Phase AC Supply



(2)

The motor maintains a speed/frequency control. Using a tachogenerator to record speed and offset it into a PI controller. Allowing the drive to run at a set V_o or output speed. V_o needs to be offset to maintain steady speed & this is fed into the controller to offset it.

(1)

Q $H_p = 6 \therefore$

$V_{\text{line}} = 220V \therefore V_{\text{ph}} = 127.017V$

$f = 50 \text{ Hz}$

$P = 4 \therefore P_m = 4 \times 74.5 = 298W$

$\phi = 0.87 \therefore P_e = \frac{2980}{0.87} = 3425.287$

$\text{Eff} = 0.83$

$P_e = 3425.287$

5385.5422

$R_s = 0.281 \Omega$

$R_r = 0.185 \Omega$

$X_m = 21.1 \Omega$

$X_{Ls} = 0.56 \Omega$

$X_r = 0.853 \Omega$

$W_{sc} = \frac{R_s}{2 \times X_{Ls} F} + \frac{R_s}{2 \times X_r F}$

$\frac{0.281}{2 \times 0.56 \times 50} + \frac{0.281}{2 \times 0.853 \times 50}$

(3)

$0.001597 + 0.0010485$
 $W_{sc} = 0.002645594$

correct method
wrong value of R_r

$$I_{s1} = \frac{hp \times 745.6}{3 V_{ph} \times p.f. \times \text{eff}}$$

$$I_s = 3 \times V_{ph} \times \cos \phi \quad \times$$

$$I_s = 3 \times 127.017 \times 0.87$$

$$I_s = 331.47 \text{ A.}$$

$$V_o = I_s \times R_r \quad \checkmark$$

$$V_o = 331.47 \times 0.185$$

$$V_o = 61.32195 \text{ V.}$$

$$K_{VF} = V_o \times I_s \quad ? \times \quad V_{rf} = \frac{V_{ph} - V_o}{f_s}$$

$$K_{VF} = 61 \times 331.47$$

$$K_{VF} = 20219.67$$

$$V_{dc} = (V_o + (K_{VF} \times F)) \quad \text{2.22}$$

$$V_{dc} = 61.322 - (20219 \times 50)$$

$$61.322 - 1010950.$$

$$V_{dc} = \frac{-1010888.678}{-2244172.855} \text{ V}$$

- c) A PWM inverter drive allows for a fast response in relation to other speed control methods, the such as chopper drives. It is more responsive and can be used in servo applications.

$V_s = 12 \text{ V}$
 $V_o = 20 \text{ V}$
 $I_o = 1.5 \text{ A}$
 $150 \mu\text{H}$
 $270 \mu\text{H}$
 20 kHz

Don't forget!



i) $\text{Duty cycle} = \frac{20}{1.5} = 13.33\%$

ii) $\text{Pr} \propto \text{Pr} \text{ \& tms inductor} = 1.5 \times 150 \mu$

$$\frac{225 \text{ V}}{20 \times 10^3} = 0.01125$$

iii) $150 + 270 = 420 \mu$

$$\frac{420}{1.5} = 280 \text{ V}$$

$$280 \times 20 \times 10^3 = 5600,000 \text{ A}$$

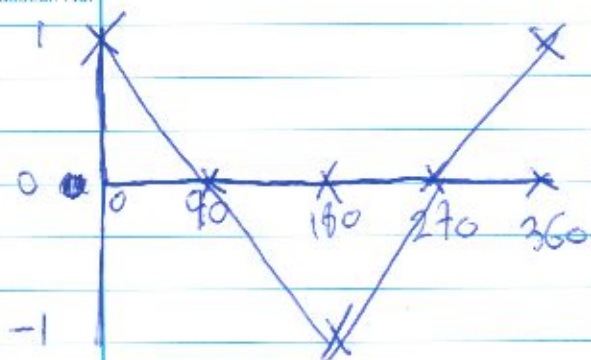
$$V_o / V_s = 1.6 \text{ Duty cycle: } 1.6 \times 13.33\% = 21.33\%$$

$$V_o \times I_s = 20 \times 1.5 = 30$$

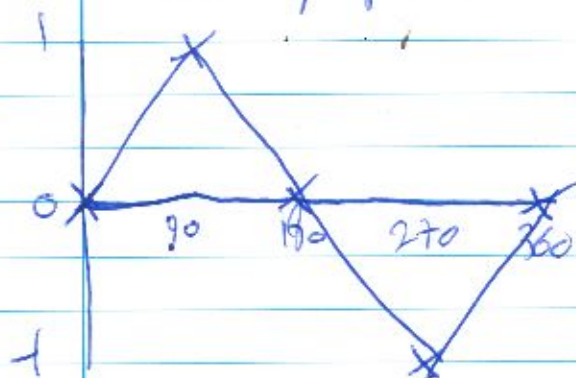
Cosine graph

Question No.

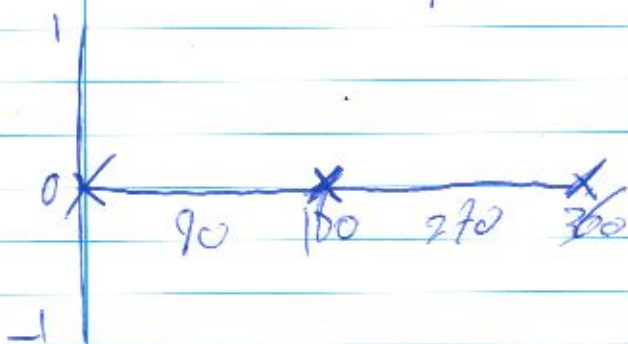
Examiner Only



Sine graph



Tangent graph



$$69! = 171122452 \times 10^{90}$$