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(see note 2 below)

SURNAME:

Dedoncker

FORENAME(S): _____

Scott

12 Pages

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1	Student Number	1203234/2.
2	Title of Examination Paper	Paper and routines
3	Module Code	PSDE 5027
4	Date and Time of Examination	17/5/18 9:30am
5	Examination Venue	Coley s.r. Gar Group
6	Seat Number	45
7	Number of Answer Books handed in	1

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

③ $\frac{1}{2}$



$$R_1'' = 1 + \left(\frac{N_2}{N_1}\right)^2$$

$$X_2 F = X_1 + X_2$$

$I_1 =$ primary current

$I_L = \text{Secondary Current}$

$R_c = \text{core current loss}$

$$X_m = \text{Core impedance}$$

①

6. ϕ_2 lagging P.f. Phasor diagram -



C. Percentage regulation is the varying performance percentage of a system from power factor 1, being +% for lagging and -% for leading.

$$\% \text{ regulation} = \frac{I_2}{V_2} \left(R_2 E \times \cos \phi_2 + X_2 E \times \sin \phi_2 \right) \times 100$$

Arbeitsjahr 2011

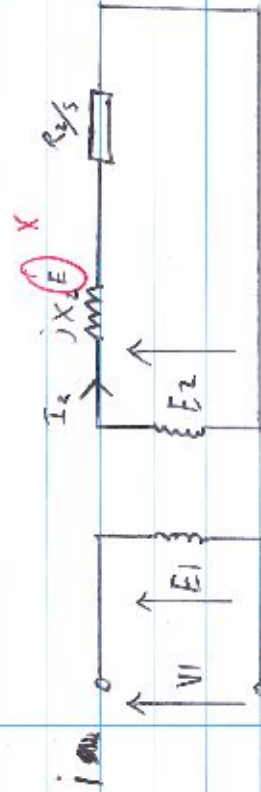
ENT & ORBITAL

Q.2.

6. Two pole Delta Three phase

440V 50 Hz 2875 rpm Rotor $Z = 0.5 + j1.34$

Stator turns = 1.6



$$\text{Rotor impedance } (Z) = \sqrt{\left(\frac{R_2}{s}\right)^2 + X_2^2}$$

$$\text{Rotor Current } |I_2| = \frac{|E_2|}{|Z_2|} = \frac{|E_2|}{\sqrt{\frac{R_2^2}{s^2} + X_2^2}}$$

$$|I_2| = \frac{|E_2|}{\frac{1}{s} \sqrt{R_2^2 + X_2^2}} = \frac{s |E_2|}{\sqrt{R_2^2 + X_2^2}}$$

$$\text{Rotor current resistance} = |I_2|^2 R_2$$

$$\text{Rotor current resistance} = \frac{s^2 |E_2|^2 R_2}{R_2^2 + X_2^2}$$

$$\text{Rotor losses} = 2 \pi n T \text{ (watts)}$$

$$\text{Stator field losses} = 2 \pi n s T \text{ (watts)}$$

$$\text{Considering copper losses} = 2 \pi s n T$$

$$\text{Torque} = 2 \pi s n s T = \frac{s^2 |E_2|^2 R_2}{R_2^2 + X_2^2}$$

$$\text{Per phase Torque } (T) = \frac{1}{2 \pi n s} \times \frac{s |E_2|^2 R_2}{R_2^2 + X_2^2}$$

Full load Torque

1 pole pair
2875 Rpm

$$T = \frac{1}{2 \pi n s} \times \frac{s |E_2|^2 R_2}{R_2^2 + X_2^2}$$

$$R_2 E = 0.5 \Omega \quad \text{Stator turns} = 1.6 \quad V = 440V$$

$$X_2 E = j1.34 \Omega \quad \text{Rotor turns} = 1 \quad F = 50 \text{ Hz}$$

$$E_1 = V / \text{Stator turns} = 440V / 1.6 = 275$$

$$E_2 = E_1 \times \text{Rotor turns} = 275 \times 1 = 275$$

$$n s = F / \text{Pole Pairs} = 50 \text{ Hz} / 1 (\text{pole pair}) = 50$$

$$n r = \text{Rpm} / 60 \text{ seconds} = 2875 / 60 = 47.916$$

$$s = \frac{n s - n r}{n s} = \frac{50 - 47.916}{50} = 0.042$$

$$\therefore \text{Single phase } T = \frac{1}{2 \pi n \times 50} \times \frac{0.042 \times 275^2 \times 0.5}{(0.5^2 + 0.042^2 \times 1.34^2)}$$

$$\text{Single phase } T = 20.031 \text{ Nm/s}$$

$$3 \text{ phase Torque} = 3T = 3 \times 20.031 = 60.094 \text{ Nm/s}$$

$$\text{Full load 3 phase Torque} = 60.094 \text{ Nm/s}$$

$$T_{OM} = 14 \frac{1}{2}$$

Q 3

C.

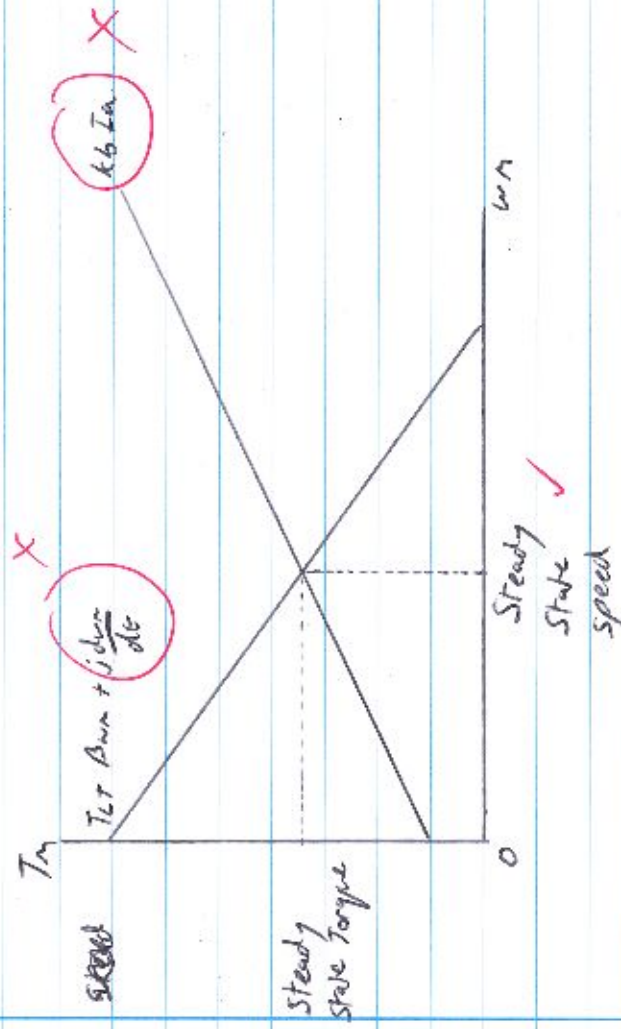
$$i. \quad V_A = E_A + I_A R_A + L_A \frac{dI_A}{dt} \quad \textcircled{1}$$

$$T_m = T_L + B_m + j \frac{d\omega_m}{dt} \quad \textcircled{2}$$

$$E_A = k_b \omega_m \quad \textcircled{3}$$

$$\omega_m = k_b I_A \quad \textcircled{4}$$

$$I_A = \frac{T_m}{k_b}$$



$$ii. \quad \text{If } \frac{dI_A}{dt} = 0 \quad \text{and} \quad \frac{d\omega_m}{dt} = 0 \quad \checkmark$$

$$V_A = E_A + I_A R_A + L_A \frac{dI_A}{dt}$$

$$I_A = \frac{120}{0.75} = 160 \quad \omega_m = 0.75 \times 160 = 120$$

$$E_A = 0.75 \times 120 = 90$$

$$\therefore V_A = E_A + I_A R_A + L_A \frac{dI_A}{dt}$$

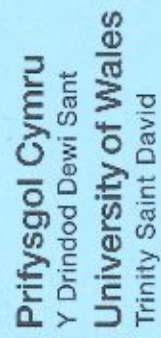
$$230 = 0.75 \times 160 + 160 \times 0.45 \quad (L_A \text{ is ignored}) \quad \times$$

$$T_m = T_L + B_m \quad \checkmark$$

$$T_L = T_m - B_m \quad \checkmark$$

$$T_L = 120 - 120 = 0 \quad ?$$

$$T_{\text{arm}} = 10$$



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12 Pages

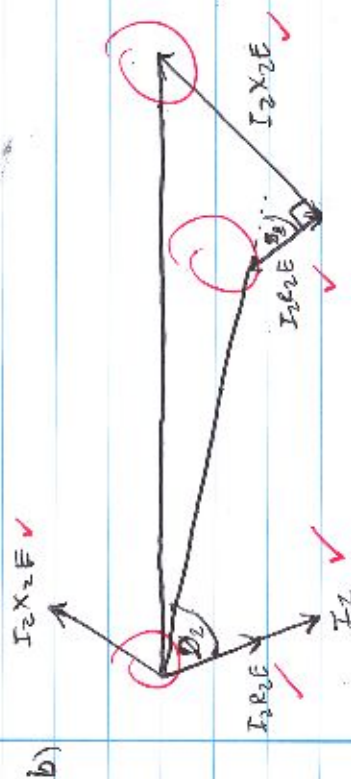
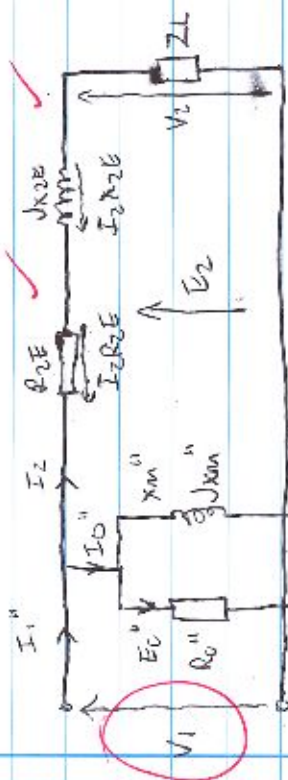
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1	Student Number	20326212
2	Title of Examination Paper	Power & Machines
3	Module Code	PSME 5027
4	Date and Time of Examination	17/5/18 9:30 - 11:30
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

- 1a)
- R_1 = primary winding resistance
 - X_1 = primary winding leakage reactance
 - R_2 = secondary winding resistance
 - X_2 = secondary winding leakage reactance
 - R_C = core losses, core resistance
 - I_C = core losses, primary current flow
 - I_M = magnetising current
 - X_m = core reactance
 - I_0 = open circuit current
 - I_2 = secondary current
 - I_2'' = rotor primary balancing current



phasor diagram with terminal voltage reference and lagging p.f. ϕ_2

$$c) \quad \% \text{ reg} = \frac{I_2 (R_2 \cos \phi + X_2 \sin \phi) \times 100}{V_2} \quad \text{for lagging}$$

$$\% \text{ reg} = \frac{I_2 (R_2 \cos \phi + X_2 \sin \phi) \times 100}{V_2} \quad \text{for leading}$$

Percentage regulation of a transformer is where the amount of energy being stored up/down or passed through the transformer.

Question No.	Examiner Only	Question No.	Examiner Only
d) $I_2 (V_2) = \frac{VA_{output}}{V_2} = \frac{2.9 \times 10^3}{110} = 26.36 A$	(2)	d) $I_2 (V_2) = \frac{VA_{output}}{V_2} = \frac{2.9 \times 10^3}{110} = 26.36 A$	(2)
e) $\cos \theta = 0.88$ leading $\therefore \cos^{-1} \theta = 28.36^\circ$, $\sin \theta = 0.47$	(3)	e) $\cos \theta = 0.88$ leading $\therefore \cos^{-1} \theta = 28.36^\circ$, $\sin \theta = 0.47$	(3)
$\therefore \text{reg} = \frac{25.45 (0.08 \times 0.88 - 0.47 \times 0.47)}{110} \times 100 = -2.94 \%$	(2.5)	$\therefore \text{reg} = \frac{25.45 (0.08 \times 0.88 - 0.47 \times 0.47)}{110} \times 100 = -2.94 \%$	(2.5)
Copper losses $= I_2^2 R_2 = 25.45^2 \times 0.08 = 51.82 W$	(1)	Copper losses $= I_2^2 R_2 = 25.45^2 \times 0.08 = 51.82 W$	(1)
$\therefore \text{eff} = \frac{\text{output power} \times 100}{\text{output power} + \text{iron losses} + \text{copper losses}} = \frac{VA_{output} \times P.F. \times 100}{VA_{output} \times P.F. + \text{iron loss} + \text{copper loss}} = 96.48 \%$	(1)	$\therefore \text{eff} = \frac{\text{output power} \times 100}{\text{output power} + \text{iron losses} + \text{copper losses}} = \frac{VA_{output} \times P.F. \times 100}{VA_{output} \times P.F. + \text{iron loss} + \text{copper loss}} = 96.48 \%$	(1)

$$2\pi s n s T = \frac{s^2 |E_2|^2 R_2}{(R_2^2 + s^2 X_2^2)}$$

$$T = \frac{1}{2\pi n s} \times \frac{s |E_2|^2 R_2}{(R_2^2 + s^2 X_2^2)}$$

$$E_2 = \frac{440}{1.6} = 275 \text{ V}$$

$$E_2 = 1 \times 275 = 275 \text{ V}$$

$$n s = \frac{f}{\text{no. pole pairs}} = \frac{50}{1} = 50 \text{ rps}$$

$$\frac{n s}{n c} = \frac{2875}{60} = 47.92 \text{ rps}$$

$$s = \frac{n s - n c}{n s} = \frac{50 - 47.92}{50} = 0.042$$

$$T = \frac{1}{2\pi 50} \times \frac{(0.042 \times 275^2 \times 0.5)}{(0.5^2 + 0.042^2 \times 1.34^2)}$$

$$= 19.97 \text{ Nm}$$

$$\text{Under phase} = 19.97 \times 3 = 59.9 \text{ Nm}$$

$$\text{Total} = 16 \frac{1}{2}$$

3b)

$$V_a = E_a + I_a R_a + L_a \frac{dI_a}{dt}$$

$$T_m = T_L + b \omega_m + J \frac{d\omega_m}{dt}$$

$$E_a = K_b \omega_m$$

$$T_m = I_a K_b$$

$$I_a = \frac{T_m}{K_b}$$

Step
c) steady state

$$\frac{dI_a}{dt} = 0, \quad \frac{d\omega_m}{dt} = 0$$

$$\text{Therefore } \textcircled{1} = V_a = E_a + I_a R_a$$

$$= V_a = K_b \omega_m + \frac{T_m}{K_b} \times R_a$$

$$\textcircled{2} = T_m = T_L + b \omega_m$$

$$\textcircled{5} = \overset{250}{K_b} \omega_m = 0.75 \omega_m + \frac{T_m}{0.15} \times 0.45$$

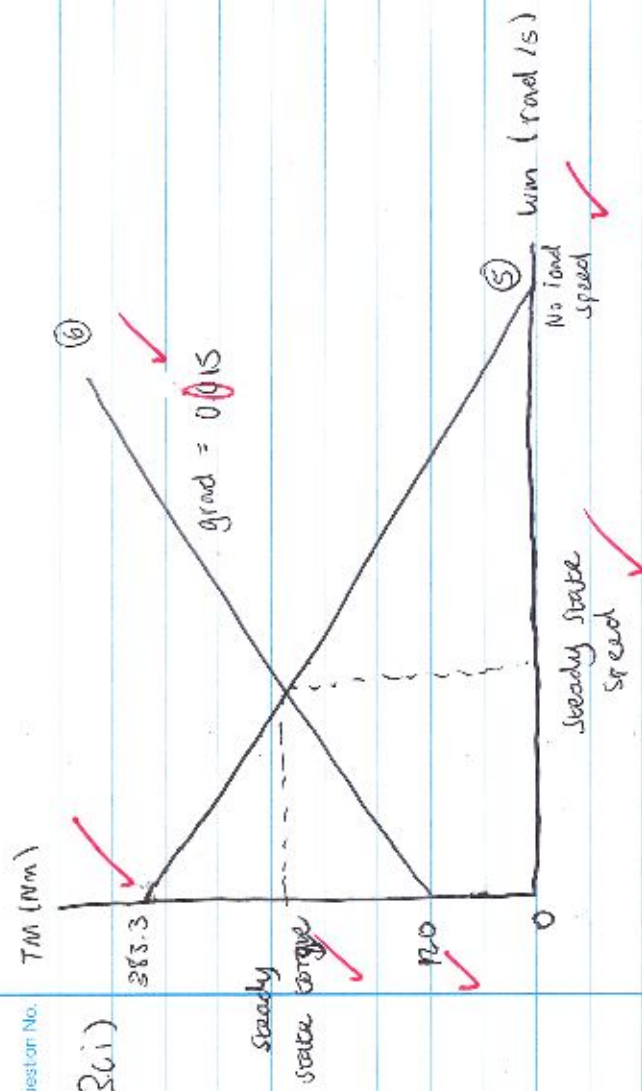
$$= 250 = 0.75 \omega_m + 0.6 T_m \quad \div \text{ by } 0.6$$

$$= 383.3 = 1.25 \omega_m + T_m$$

$$T_m = 383.3 - 1.25 \omega_m$$

$$\textcircled{6} \quad T_m = 120 + 0.615 \omega_m$$

26(i)



(5)

ii) equate (5) and (6)

$$383.3 - 1.25 \omega_m = 120 + 0.015 \omega_m$$

$$383.3 - 120 = 0.015 \omega_m + 1.25 \omega_m$$

$$= 263.3 = 1.265 \omega_m$$

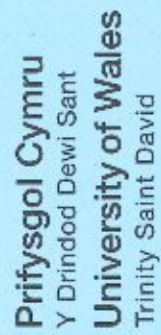
$$\omega_m = \frac{263.3}{1.265} = 208.14 \text{ rad/s}$$

$$T_m = 383.3 - 1.25 \times 208.14 = 123.13 \text{ Nm}$$

$$\text{No load speed} = 0 = \frac{383.3}{1.25} = 306.64 \text{ rad/s}$$

$$EMF = 0.75 \times 208.14 = 156.11 \text{ V}$$

$$I_a = \frac{T_m}{K_b} = \frac{123.13}{0.75} = 164.17 \text{ A}$$



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SURNAME: Dyer

12 Pages

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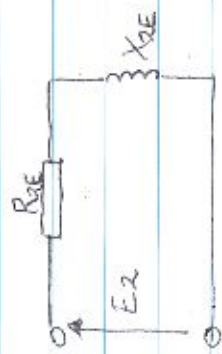
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2	Title of Examination Paper	POWER AND MACHINES
3	Module Code	PSDE5027
4	Date and Time of Examination	17.05.2018 09:30
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	1

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

Q1. (a)



①

(c)

$$\% \text{ reg} = \frac{I_2 (R_{0E} \cos \phi) \pm (X_{0E} \sin \phi)}{V_2} \times 100$$

The equation above shows percentage regulation for the secondary of a transformer in terms of an equivalent circuit. The '+' is used depending on the power factor, which is '+' when lagging and '-' when leading.

1½

(bii) (a)

$$\% \text{ reg} = \frac{I_2 R_{0E} \cos \phi}{V_2} = \frac{2800}{110} = 25.46\% \quad \checkmark$$

2

(ii)

$$\% \text{ reg} = \frac{I_2 R_{0E} \cos \phi \pm I_2 X_{0E} \sin \phi}{V_2} = \frac{25.46 (0.08 \times 1 + 0.42 \times 0)}{110} = 1.85\% \quad \checkmark$$

1

2

$$\% \text{ reg} = \frac{I_2 R_{0E} \cos \phi \pm I_2 X_{0E} \sin \phi}{V_2} = \frac{25.46 (0.08 \times 0.75 + 0.42 \times 0.66)}{110} = 7.81\% \quad \checkmark$$

3

Leading $\cos \phi = 0.88$, $\phi = 28.36^\circ$, $\sin \phi = 0.48$
 $\% \text{ Reg.} = \frac{25.46 \times 0.88 - 0.42 \times 0.48}{110} \times 100 = -3.04\%$ approx

(e) Iron Loss (F_e) = 35 W

Copper Loss (C_u) = $11.1^2 R = 25.46^2 \times 0.08 = 51.86 \text{ W}$ ✓

efficiency $\% \eta = \frac{2800 \times 0.85 \times 100}{2800 \times 0.85 + 35 + 51.86} = 96.48\%$ ✓

$T_{\text{om}} = 19$

(b)

$P = 1$
 $V_a = 440 \text{ V}$

$f = 50 \text{ Hz}$

$\frac{1}{2}$ Full Load Speed = 2875 rpm

$|E_1| = 440 \text{ V}$ $|E_2| = \frac{440}{1.6} = 275 \text{ V}$ ✓

$N_s = \frac{50}{1} = 50 \text{ rps}$

$N_r = \frac{2875}{60} = 47.92 \text{ rps}$ ✓

$s = 0.04$ ✓

$T_{\text{ind}} = \frac{3 P}{2\pi N_s} \frac{s |E_2|^2 R}{s |X|^2} = \frac{3 \times 0.04 \times 275^2 \times 0.5}{2 \times \pi \times 50 \times (0.04 \times 1.3^2)} = 201.09 \text{ Nm}$ X

$T_{\text{om}} = 3 \frac{1}{2}$

(c) $T_L = 120 \text{ Nm}$ $B = 0.015 \text{ Nm/rad/s}$ 230 V DC supply $R_a = 0.45 \Omega$ $K_b = 0.75 \text{ V/rad/s}$

$$T_m = E + I_a R_a$$

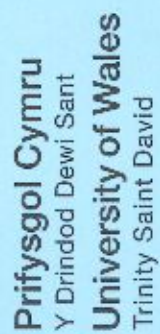
$$T_m = 230 + I_a R_a$$

$$0.75$$

$$230 =$$

$$I_a = \frac{\omega_m}{K_b}$$

 $\times$



Complete, fold and seal
(see note 2 below)

SURNAME: Jones

FORENAME(S): Joseff Owen

12 Pages

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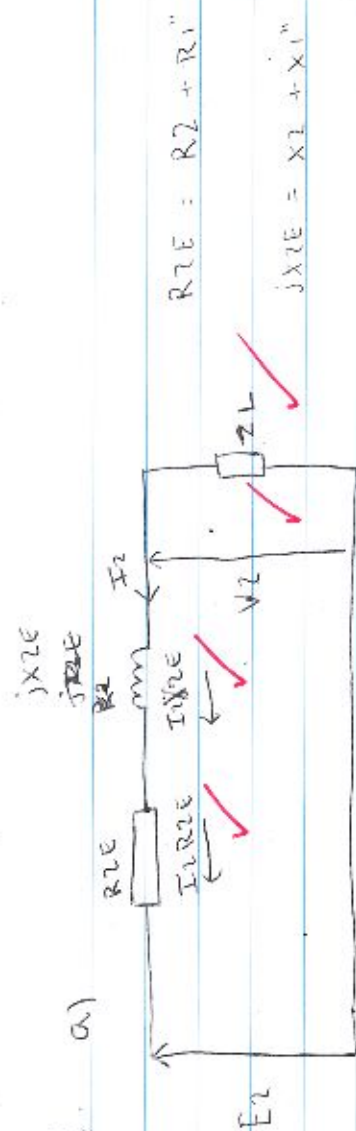
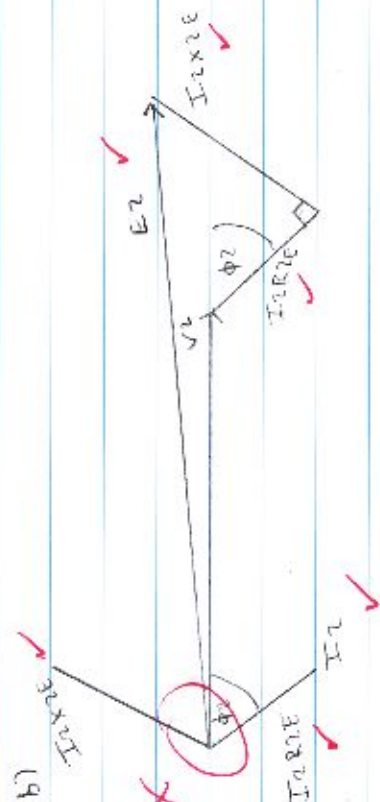
1	Student Number	1502999/1
2	Title of Examination Paper	Power + machines
3	Module Code	PSDE 5028
4	Date and Time of Examination	17.5.18 9:30am
5	Examination Venue	Sports began Hall
6	Seat Number	N/A
7	Number of Answer Books handed in	1

[illegible]

37%

(Gweler yr ochr arall am y fersiwn Cymraeg)

7. a)


 $Z_L = \text{load impedance}$

 $\text{c) } \text{total voltage} \times \text{power factor} \times 100$

$$\frac{I_2 (\cos \phi_2 R_{TE} + \sin \phi_2 X_{TE})}{V_2} \times 100$$

Percentage regulation is the ~~accuracy~~ ^{accuracy} percent of the transformer. If the p.f. is leading a "-" symbol is used, otherwise a "+" symbol is used.

d) 380 : 110V (50Hz)

per-phase resistance + reactance = 0.08 ohm and 0.42 ohm
2.8 KVA

i) Full-load secondary current

$$\frac{\text{kVA}}{V_2} = \frac{2800}{110} = 25.45 \text{ A}$$

$$\text{ii) } \cos \phi_2 = 1 \quad \phi_2 = 0$$

$$\sin \phi_2 = 0$$

$$\% \text{ reg} = \frac{I_2 (\cos \phi_2 R_{TE} + \sin \phi_2 X_{TE})}{V_2} \times 100$$

$$= \frac{25.45 (1 \times 0.08 + 0)}{110} \times 100 = 1.81\%$$

(i) b) 0.75 lagging

$$\cos \phi_2 = 0.75 \therefore \phi_2 = \cos^{-1}(0.75) = 0.723$$

$$\sin \phi_1 = 0.66$$

$$\% \text{ reg} = \frac{25.45 (0.75 \times 0.08 + 0.66 \times 0.42)}{110} \times 100$$

$$= 7.8\%$$

(ii) c) 0.98 leading

$$\cos \phi_2 = 0.98 \therefore \phi_2 = \cos^{-1} 0.98 = 0.1495$$

$$\sin \phi_2 = 0.1475$$

$$\% \text{ reg} = \frac{25.45 (0.88 \times 0.08 - 0.1475 \times 0.42)}{110} \times 100$$

$$= -2.98\%$$

d) Iron losses = 35W

$$\text{Copper losses} = I^2 R_{2e} = 25.45^2 \times 0.08 = 51.81 \text{ W}$$

$$\% \text{ efficiency} = \frac{\text{Total power} \times \text{Power factor}}{\text{Total power} \times \text{power factor} + \text{iron losses} + \text{copper losses}} \times 100$$

$$= \frac{2800 \times 0.85 \times 100}{2800 \times 0.85 + 35 + 51.81}$$

$$= 96.48\%$$

Question 2

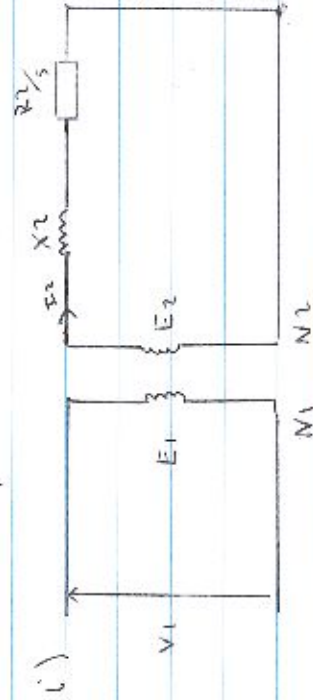
b) $P = 1$

440V, 50Hz

2875 RPM

rotor impedance = $0.5 + j1.34 \Omega$

turns ratio = 1.6:1



$$T = \frac{1}{2\pi s} \times \frac{s E_2^2 R_2}{R_2^2 + s^2 X_2^2}$$

$$s = \frac{f_s}{P} = \frac{50}{1} = 50$$

$$R_r = \frac{\text{Full-load speed}}{60} = \frac{2875}{60} = 47.916$$

$$s = \frac{ns - nr}{ns} = \frac{50 - 47.916}{50} = 0.04168$$

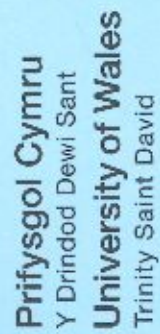
$$E_2 = \left(\frac{N_1}{N_2}\right) E_1 = \frac{1}{1.6} \times 440 = 275 \text{ V}$$

$$T = \frac{1}{2\pi s} \times \frac{0.04168 \times 275^2 \times 0.5}{0.5^2 + 0.04168^2 \times 1.34^2} = 19.82 \text{ Nm}$$

$$\text{Total full-load torque} = \text{per-phase full-load torque} \times 3$$

$$= 19.82 \times 3$$

$$= 59.46 \text{ Nm}$$



Complete, fold and seal
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SURNAME: Smith

FORENAME(S): Nathan John

12 Pages

Instructions to Candidates

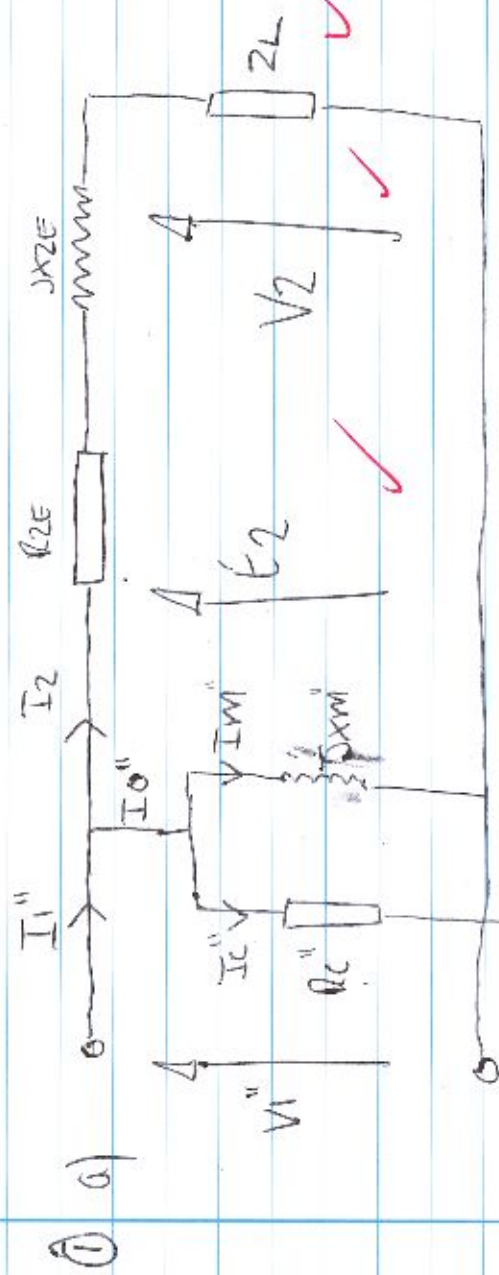
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2	Title of Examination Paper	Power and machines
3	Module Code	PSPE 5027
4	Date and Time of Examination	17/5/19 9:30
5	Examination Venue	
6	Seat Number	53
7	Number of Answer Books handed in	1

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

41%

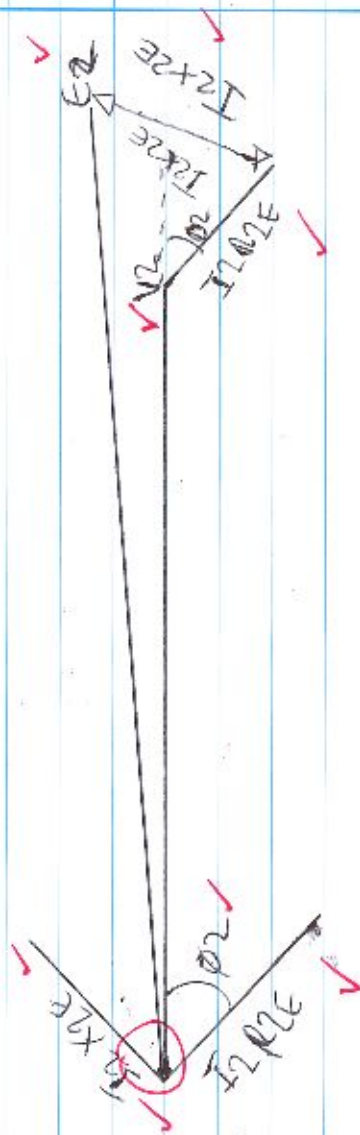


$$R_1 = R_1' + R_2$$

$$X_1 = X_1' + X_2$$

- R_1 = Primary Resistance
 R_2 = Secondary Resistance
 X_1 = Primary Reactance (Leakage Reactance)
 X_2 = Secondary Reactance (Leakage Reactance)
 I_0 = Open Circuit Supply Current
 I_1 = Primary Current
 I_2 = Secondary Current
 I_C = Current Supplying Core Losses
 R_C = Resistance of core losses open circuit.
 I_M = Magnetizing Current
 X_M = Reactance of the core

b)



E_2 is the phasor sum of $V_2 = (I_2 R_2 + I_2 X_2)$

1 c) Percentage regulation = $\frac{I_2 (R_{2E} \cos \phi + X_{2E} \sin \phi) \times 100}{V_2}$

b) $\cos \phi = 0.75$, $\phi = 41.41$, $\sin 41.41 = 0.661$
 $\% \eta = \frac{I_2 (R_{2E} \cos \phi + X_{2E} \sin \phi) \times 100}{110}$
 $= \frac{25.45 (0.08 \times 0.75 + 0.42 \times 0.661) \times 100}{110}$
 $= \frac{25.45 (0.06 + 0.278) \times 100}{110}$

$= 7.82$ ✓

c) $\cos \phi = 0.88$, $\phi = 28.36$, $\sin \phi = 0.473$
 $= \frac{25.45 (0.08 \times 0.88 + 0.42 \times 0.473) \times 100}{110}$
 $= \frac{25.45 (0.070 + 0.1995) \times 100}{110}$
 $= 6.235$ ✗

1 d) i) $I_2 = \frac{KVA}{V_2} = \frac{2800}{110} = 25.45$ ✓

ii) a) $\% \eta = \cos \phi = 1$, $\phi = 0$, $\sin \phi = 0$ ✓

$= \frac{I_2 (R_{2E} \cos \phi + X_{2E} \sin \phi) \times 100}{V_2}$

$= \frac{25.45 (0.08 \times 1 + 0.42 \times 0) \times 100}{110}$

$= \frac{25.45 (0.08 \times 1) \times 100}{110}$

$= 1.85\%$ ✓

1 c)

$$\text{Hence Copper losses} = 2800 \times 0.85 = 2380 \text{ W}$$

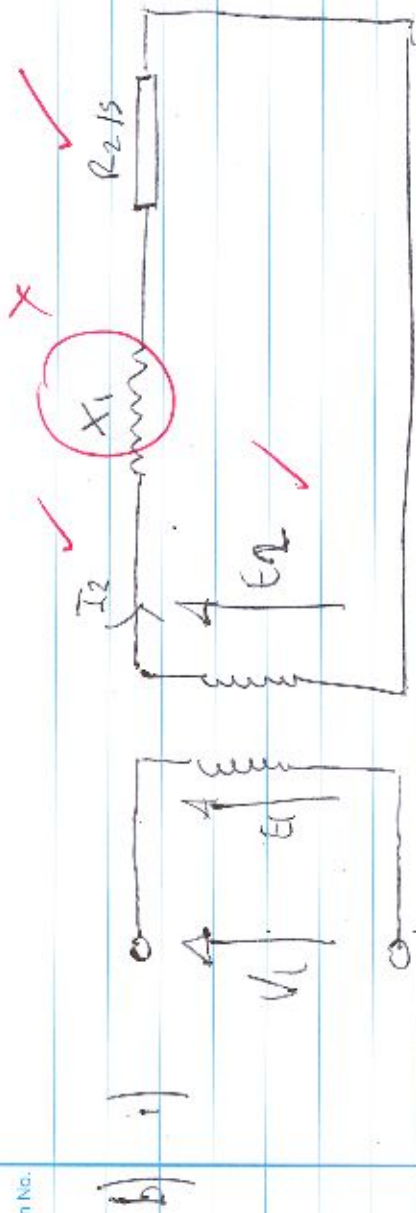
$$I_2^2 R_{2E} = 25.45^2 \times 0.08 = 51.8 \text{ W}$$

$$\% \text{ effice} = \frac{\text{Output } V_{2E} \times \text{PF} \times 100}{\text{Output } V_{2E} \times \text{PF} + \text{Iron losses} + \text{Copper losses}}$$

$$\% = \frac{2800 \times 0.85 \times 100}{2400 \times 0.85 + 35 + 51.8} = 96.48 \text{ rad/s}$$

$$I_{0MA} = 25$$

2 a)



$$Z_2 = \sqrt{R_2^2 + X_2^2}$$

$$I_2 X_2 = \frac{E_2}{Z_2} = \frac{S^2 |E_2|^2 R_2}{\sqrt{R_2^2 + S^2 X_2^2}}$$

$$= \frac{S^2 |E_2|^2 R_2}{R_2^2 + S^2 X_2^2}$$

$$? \text{ } n_r = 2\pi nRT$$

$$? \text{ } n_s = 2\pi nST$$

$$n_r = 2\pi nST - 2\pi nST$$

$$n_r = n_s - SPS$$

$$n_r = 2\pi nST$$

$$SPS = 0$$

$$? = 2\pi nST \times \frac{S^2 |E_2|^2 R_2}{R_2^2 + S^2 X_2^2}$$

$$= \frac{1}{2\pi nS} \times \frac{S^2 |E_2|^2 R_2}{R_2^2 + S^2 X_2^2}$$

ii)

$$T_{max} = \frac{1}{2\pi n_s} \times \frac{S^2 |E_2|^2 R_2}{R_2^2 + S^2 X_2^2} \times 3$$

$$n_s = \frac{f}{\text{Pole pairs}} = \frac{50}{1} = 50 \checkmark$$

$$nR = \frac{RPM}{60} = \frac{2475}{60} = 47.92 \checkmark$$

$$X_2 = 1.34 \text{ (Impedance)}$$

$$S = \frac{n_s - nR}{n_s} = \frac{50 - 47.92}{50} = 0.042 \checkmark$$

$$E_1 = 440$$

$$E_2 = \frac{440}{1.6} = 275 \checkmark$$

$$I = \frac{1}{2\pi 50} \times \frac{0.042 \times 275^2 \times 0.5}{0.5^2 + 0.042^2 \times 1.34^2} \checkmark$$

$$\therefore 0.834 \times 3 = 2.516 \text{ am}$$

$$I_{\text{arm}} = 8.2 \checkmark$$

(3) a)

$$V_a = E_a + I_a R_a \times$$

$$T_m = T_L + K_{\omega m} \times$$

$$E = K_{\omega m} \checkmark$$

$$T_m = K_b I_a \checkmark$$

$$I_a = \frac{T_m}{K_b}$$

$$c) i) V_a = E_a + I_a R_a \checkmark$$

$$V_a = K_{\omega m} + \frac{T_m}{K_b} \times R_a \checkmark$$

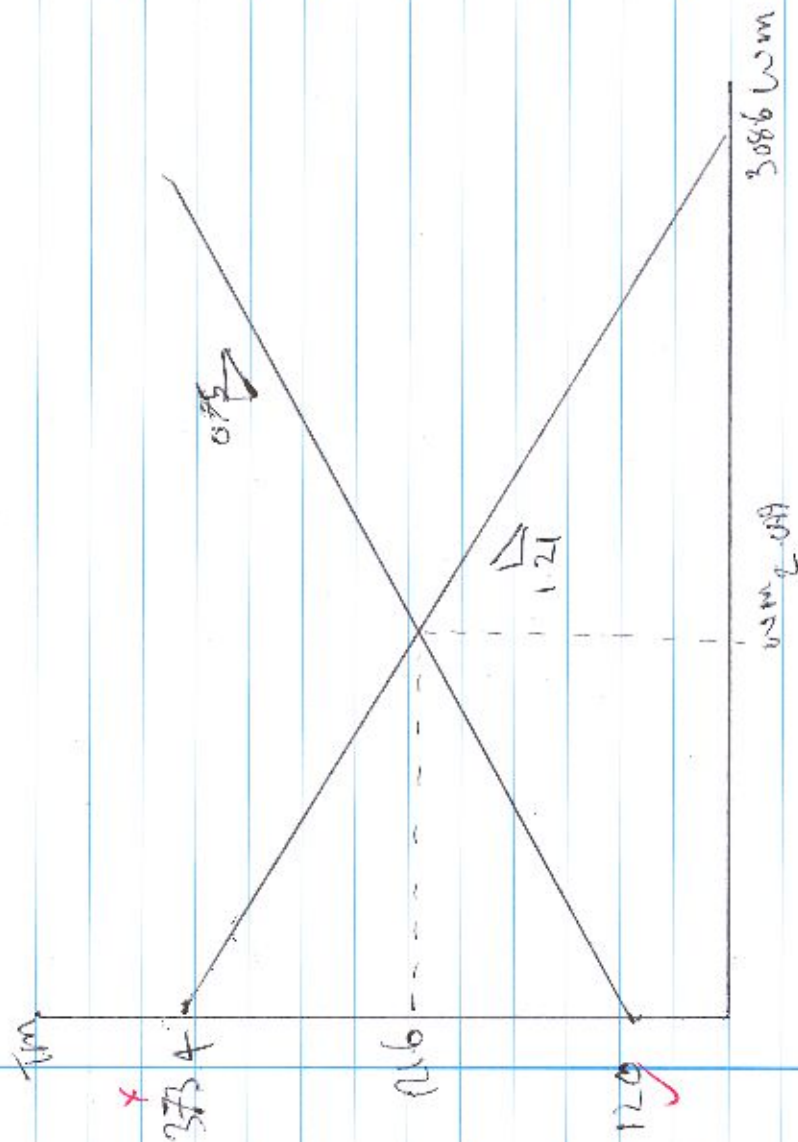
$$230 = 0.75 \omega_m + \frac{T_m}{0.75} \times 0.45 \checkmark$$

$$230 = 0.75 \omega_m + \frac{0.45}{0.75}$$

$$230 = 0.75 \omega_m + 0.6 \div \text{by } 0.6 \checkmark$$

$$T_m = 373.4 \checkmark 1.21$$

$$T_m = T_L + V_{sw} = 120 + 0.75 \omega_m$$



3

$$\omega_m = 8 \frac{1}{2}$$

at no load speed

$$= \frac{373.4}{1.21} = 308.6$$

1/2

Equate the $T_m =$

$$\begin{aligned} 373.4 + 1.21 \omega_m &= 120 + 0.75 \omega_m \\ 373.4 - 120 &= 0.75 \omega_m + 120 \omega_m \quad \times \\ &= 253.4 = 120.75 \omega_m \end{aligned}$$

1/2

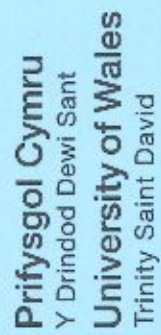
$$\omega_m = \frac{253.4}{120.75} = 2.099$$

$$T_m = 120 + 0.75 \times 2.099 = 121.6$$

$$E = 0.75 \times 2.099 = 1.57$$

$$I_a = \frac{121.6}{0.75} = 162.13$$

$$V_{ss} = 373.4$$



**Complete, fold and seal
(see note 2 below)**

SURNAME: HARRIES

FORENAME(S): DAVID SAMUEL

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	15024471
2	Title of Examination Paper	POWER AND MACHINES
3	Module Code	
4	Date and Time of Examination	17/5/18 9:30 am
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

4a) ~~A short transmission line can consider voltage drop negligible in calculations however for medium length transmission lines the resistance of the cable is larger due to its length and must therefore be taken into consideration. This introduces voltage drop-~~

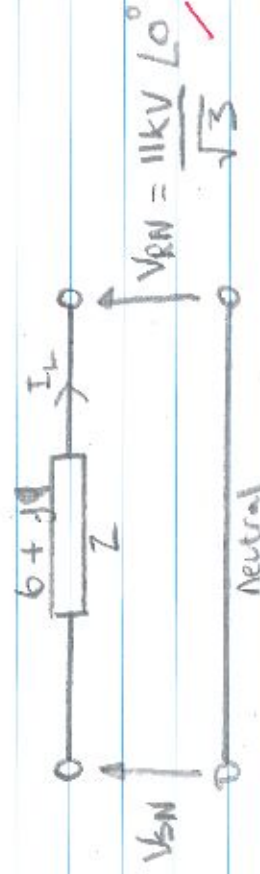


short length

2

Medium length transmission lines have capacitance and inductance.

b) i)



2

$$I_L = \frac{P}{\sqrt{3} V_{LN} \times \text{p.f.}} = \frac{2.5 \times 10^6}{\sqrt{3} \times 11 \text{ kV} \times 0.85} = 154.37 \text{ A} \quad \text{@ } 0.85 \text{ lagging power factor}$$

2

2

2

$$\begin{aligned} V_{LN} &= V_{SN} + I_L Z \\ &= 6350 + 154.37 \angle -31.79^\circ \times 10.82 \angle 56.51^\circ \\ &= 6350 + 1670.28 \angle 24.52^\circ \\ &= 6350 + 1514.65 + j 693.18 \\ &= 7869.65 + j 693.18 \\ &= 7900.12 \angle 5^\circ \text{ V} \end{aligned}$$

13683.41 V line to line

2

2

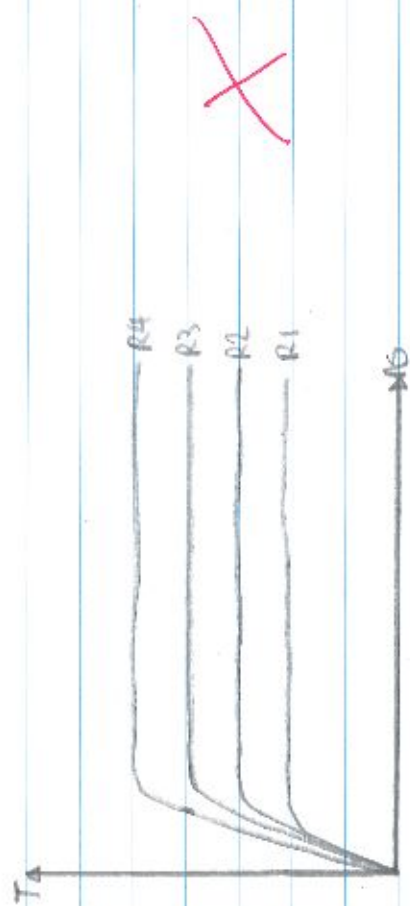
ii)

$$\begin{aligned} a_c &= 154.37 \sin(31.79^\circ) = 81.32 \text{ A} \\ a_d &= 154.37 \cos(31.79^\circ) = 131.21 \text{ A} \\ a_b &= 131.21 \tan(18.19^\circ) = 43.11 \text{ A} \\ \therefore b_c &= |I_L| = a_c - a_b = 38.21 \text{ A} \\ C &= \frac{I_L}{2\pi f V_{LN}} = \frac{38.21}{2\pi \times 50 \times 6350} = 19.15 \mu\text{F} \end{aligned}$$

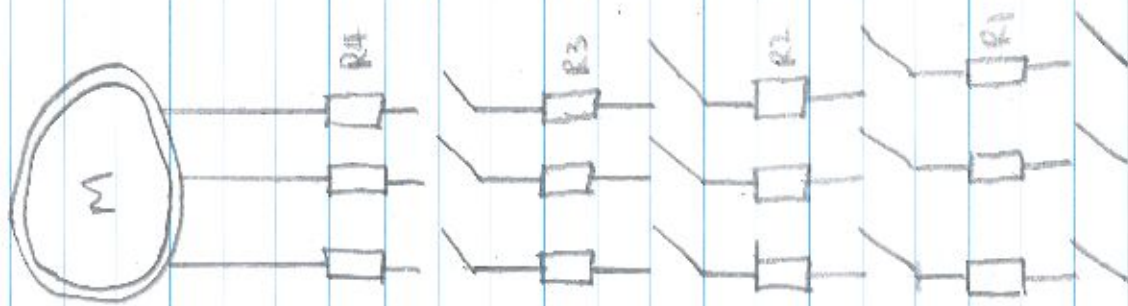
2

2

2



As the resistors get shorted out by the switches, the resistance decreases allowing more current to the motor. The Torque and speed increase as shown in the graph.



$$T_{0M} = 910.$$