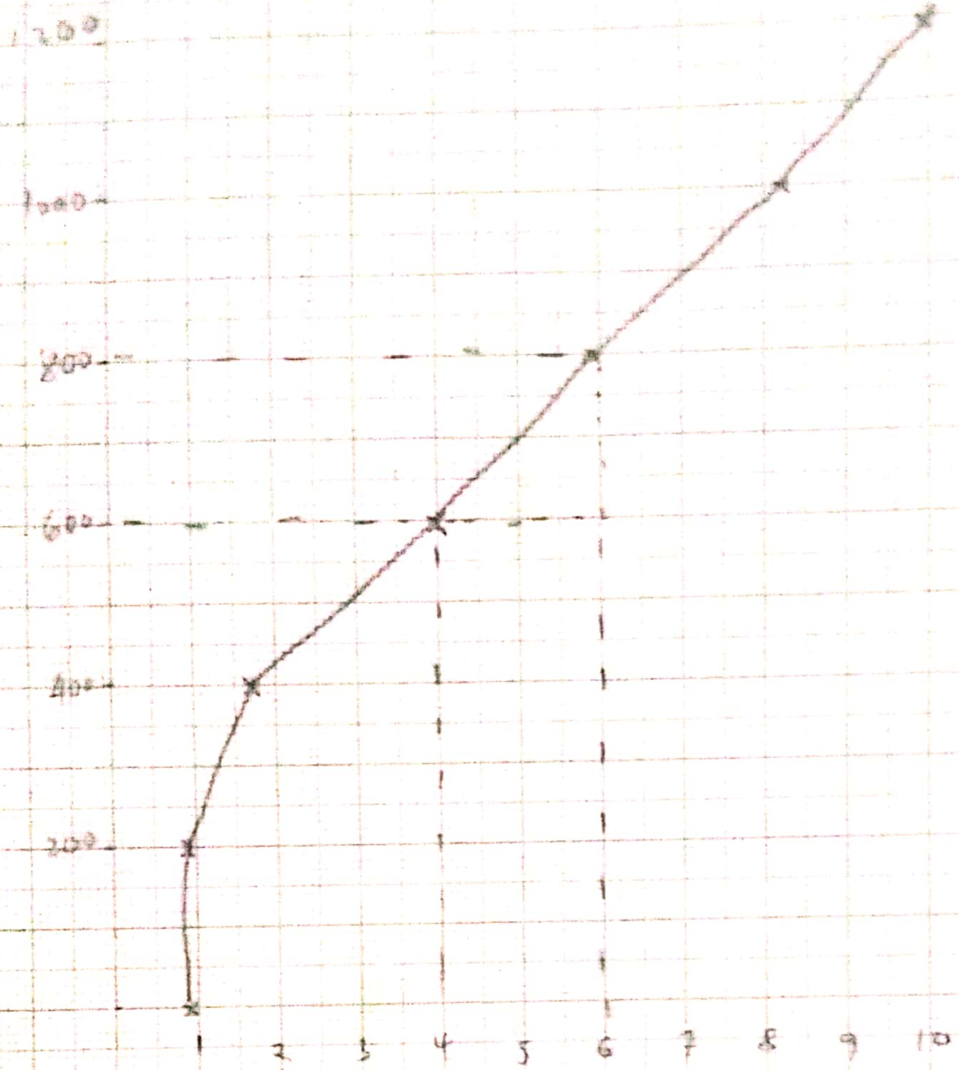


$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{800-600}{6-4} = 100$$

C

$L = 14m$ $EI = 20MNm^2$

$F = 15kN$

1) Max deflection

$= \cancel{(15kN \times 7)}$

$= \cancel{105kNm}$

$= \cancel{\frac{105 \times 10^3}{20 \times 10^6}} =$

$$= \frac{WL^3}{3EI} = \frac{15 \times 10^3 \times 14^3}{3 \times 20 \times 10^6}$$

$= 0.686m.$

11) Slope of the beam.

$W = mg$

$$\frac{1}{R} = \frac{M}{EI} = \frac{d^2y}{dx^2}$$

$$m = \frac{15000}{9.81}$$

$= 1529.051$

$$= \frac{1529.051}{20 \times 10^6}$$

$= 3.058102$

$\frac{1}{R}$

Radius of curvature.

$R = 3.27 \times 10^{-11}$

600	0.0077.
800	0.00592.
1000	0.0082
1200	0.01

From graph.

ii) $K = \sqrt{\dfrac{\text{slope} \times g r_1^2}{2m}}$

$m = D/V$

slope = 100.

$V = A h$

$= \pi r^2$

$= \cancel{\pi \times (1.5)^2 \times 1 \times 2}$

$= \cancel{9.81\,cm^3}$

$V = \pi \times 0.125^2 \times 1 \times 0.02$

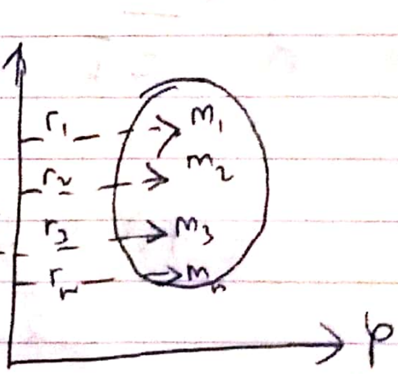
$= 9.8174 \times 10^{-4}$

$K = \sqrt{\dfrac{100 \times 9.81 \times 1^2}{9.8174 \times 10^{-4}}}$

$= \underline{9.99}$

Theoretical, $K = \dfrac{R}{\sqrt{2}} = \dfrac{12.5}{\sqrt{2}} = \underline{8.83}$

$K = \sqrt{\dfrac{\text{slope} \times g r_1^2}{2m}}$



$K = \sqrt{I/M}$ - I - moment of inert

m = mass

Moment of inertia acting under gravity $I = g r^2$. from graph, slope is the proportionality

Q4

415V, 50Hz 6pole 3phase Induction motor
Slip of 4%

Wattmeter method < 65KW / 50KW

$slip = \frac{N_s - N}{N_s}$

Delta ⇒ 0.5 Ω.

stator loss 1.5KW
Mechanical loss = 2KW

i) Synchronous speed

$$N_s = \frac{F \times 60}{\text{number of poles}} = \frac{50 \times 120}{6} =$$

$$= 1000 \text{ rev/min}$$

ii) Rotor speed

$$n = n_s \times (1 - s)$$

$$= 1000 \times (1 - 0.04)$$

$$= 960 \text{ rev/min}$$

iii) Total Input power

$$W = V \times A \qquad = 415 \times$$

$$=$$

From ohms law $V = IR$.

$$I = V/R = \frac{415}{0.5} = 830A$$

$$= 415 \times 830 = 344.450KW$$

iv) line current from supply.

$$I_p = \frac{I_L}{\sqrt{3}} \qquad I_L = \sqrt{3} I_p$$

$$= 830\sqrt{3} = 1437.60A$$

vi. Stator copper loss

$$P = 3I^2R = 3 \times (14376)^2 \times 0.5$$
$$= 3100.4 kW$$

vii. Air gap power

$$P_{gap} = \frac{P}{s} = \frac{344.45}{0.04}$$
$$= 8611.2 W$$

viii) Rotor copper loss

$$s = \frac{\text{Rotor Copper loss}}{\text{Rotor Input}} = \text{Slip} \times \text{Air gap}$$

$$\text{Rotor Copper loss} = 0.04 \times 8611.2$$
$$= 344.48 W.$$

ix Useful power output

$$T = \frac{P}{\omega_n}$$

$$\omega_n = \frac{2\pi N}{60} = \frac{2 \times \pi \times 1000}{60} = 104.72 rad/s.$$

$$T = \frac{344.450}{104.72} = 32131 \times 10^3 Nm.$$

$$= 115000 \times 32131$$

$$= 3695.125 kW$$

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x) Useful output torque.

$$T = \frac{3695.125}{104.72} = 35.530 \times 10^{3}\ Nm.$$

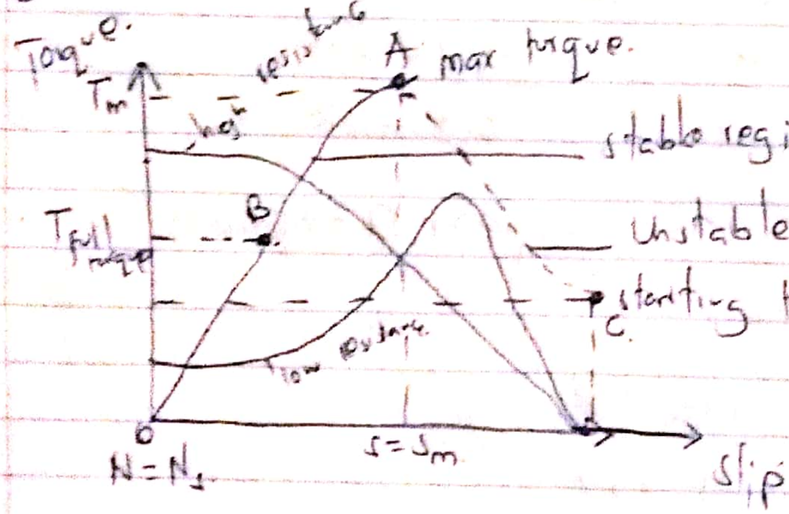
xi) Machine efficiency

$$E = \frac{P_{in}}{P_{out}} \times 100$$

$$= \frac{115}{3695.12} \times 100$$

$$= 3.1\%$$

b



i) adjusting rotor resistance will cause a faster full torque. Point B
ii) Reducing supply voltage. raise the starting torque at point C

Benefits
i) Allow control of the speed or motor and torque
ii) Increase torque of ~~mach~~ motor.

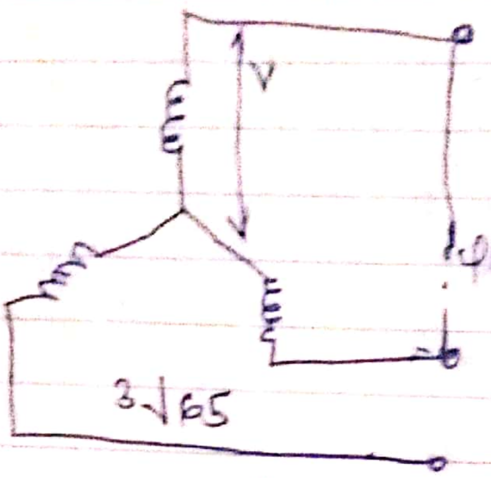
45V 50Hz 8pole star 3phase

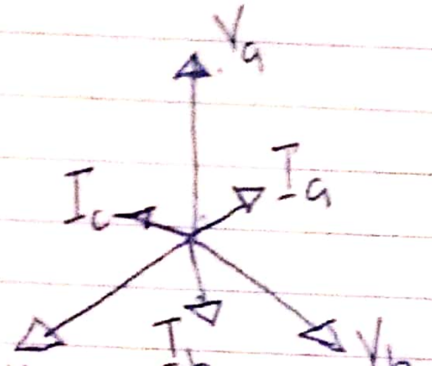
$I_L = 65$

$P_f = 0.8$

Synchrono R 0.75Ω

i)





(ii) Required induced e.m.f.

$$E = V - I_a(r_s + r_a)$$

$$E = \frac{P\phi N}{60} \times \frac{Z}{A}$$

$$E = 415 - 200(0.75)$$
$$= 265V$$

5

415 V, 50 Hz, 8 pole star con

iii) Mechanical load angle

δ = is the angle btw supply voltage and back emf

$V = 415\,V$

$E_b = 265\,V$

$\Rightarrow 2\sin^{-1}\left(\frac{265}{415}\right)$

$= 39.68^{\circ}$

b

$P = 1.75\,MVA$

$P_f = 0.6$

$V = 11\,kV$

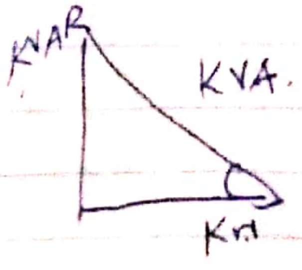
i)

$$kW = \frac{V \times I \times P_f \times 1.732}{1000}$$

$$= \frac{11\times10^3 \times 1.75\times10^6 \times 1.732 \times 0.6}{1000}$$

$= \underline{20004.6\,kW}$

KVAR $\Rightarrow Q = X \cdot I^2$



$\varphi = \sin\theta = \frac{KVA}{KW}$

$\sin\theta =$

$= (20004.6 \times 0.6)$

$= \underline{\underline{12002.76}}$

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line Current $= \frac{VA}{V} = \frac{1.75 \times 10^6}{11 \times 10^3}$

$= 159.09A$

iii) VAR

$P = 500kW$

Effic $= 80\%$

$P.f = 0.9$ lag

$P = V \times A \times Pf.$

apparent power $\frac{\text{real Power}}{\text{apparent}} = Pf.$

~~Apparent power $= \frac{500kW}{0.9} = 555.5kW$~~

load power factor, $\cos\theta = 0.9$

$= 25.84^\circ$

motor power $= 500kW$

Overall power factor $= \cos\alpha = 0.9$ lag

Apparent power $= \frac{500}{0.9} = 555.5kW$

Motor $P.F = \frac{555.5}{} \frac{415}{555.5} = 0.75$

Q.

i) $I = 125\,A$ $\quad R = .25\,\Omega$

850 rpm

$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 850}{60}$

$= 89.018\ rad/s$

~~Power output~~

$VI_a = E_bI_a + I_a^2R_a$

Input power $= I \times V$

$= 125 \times 250$

$= 31.250\,kW$

$P_{out} = T\omega$ $\quad$ shaft torque

$T = \frac{P}{\omega} = \frac{31.250 \times 10^3}{89.018} = 351.047\,N_m$

$P_{out} = E_bI_a - I^2R_a$

$E_b = V - I_a(R)$

$= 250 - 125(0.25)$

$= 218.75\,kW$ $\cancel{+8000}$

$= 218.75 \times 89.018$

$= 19469.14\,kW$

efficiency $= \frac{P_{out}}{P_{in}} = \frac{19489.14}{31250}$

$= 62.3\%$

b. $I_a = 200A$

$E_b = V - I_a(R)$

$= 250 - 200(0.25)$

$= 200V$

$E = \frac{P\phi N}{60} \times \frac{Z}{A}$

$\phi = \frac{200}{250} = 53$ $P =$

$P = 1500W$

$200 = \frac{\cancel{1500}^{3125} \times 53 \times N}{60}$