

# ELECTRICAL MACHINES LAB NOTES

AKSHANSH CHAUDHARY

## Electrical Machines Lab Notes, First Edition

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Presented by: Akshansh Chaudhary  
Graduate of BITS Pilani, Dubai Campus  
Batch of 2011

Course content by: Dr. R. Gomathi Bhavani  
Then Faculty, BITS Pilani, Dubai Campus

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Expt 1 : No load Test on single  $\phi$  transformer

- ✓ OC test :- Circuit diagram :- OC HV side
- SC Test :- " " :- SC LV side
- ✓ OC Test :- Set rated voltage using variac  $\rightarrow$  115 V
- ✓ SC Test - Set rated current " "  $\rightarrow$  4.34 A (1000VA / 230V)

(a) Find equivalent circuit Parameters

(b)  $\eta$  vs load. at 0.8 pf

load values  $\rightarrow$  (K) (1KVA) (0.8)  $\rightarrow$  O/P + losses  $\rightarrow$   $P_{core} + P_{iron}$

$\eta = \frac{O/P}{O/P + losses}$

$\eta_{max} = \frac{x \cdot pf}{(2)pf + 2P_i}$

$\rightarrow \sqrt{\frac{P_i}{P_e}} \times \text{Rated kVA}$

(d) Regul<sup>n</sup> vs pf

$\frac{I_{rated} (R_{cos\theta} \pm X \sin\theta)}{V}$

Expt 2 : No load test on DC Shunt motor

- Find Reg
- (a) Find  $\eta$  vs o/p  $\rightarrow$  Gen  $\eta$   $\rightarrow$  Motor  $\eta$
- (b) Field control & Arm. control

(a)

$\eta = \frac{O/P}{O/P + loss}$

$\eta_m = \frac{i/p - loss}{i/p}$

$I_L = I_{a0} + I_f$

$P_L = P_K + P_V \rightarrow I_{a0}^2 R_a$

$\sqrt{I_L^2 - I_{a0}^2} R_a$  16.8A

S1: Vary  $R_a$  ext to bring to 220V

S2: Vary FR to bring to 1500 rpm.

$I_{a0}, I_f \checkmark$



(b) Field control

$V = 220$  (Keep const)

Vary FR  $\rightarrow$   $n$  —  
 $I_f$  —

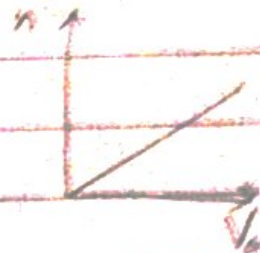


Arm. control.

$I_f = \text{const}$  (any value)

Vary  $R_{a \text{ ext}}$

$n$  —  
 $V_a$  —



Find Reg

Expt. 3 : No load test on synchronous machine

(a) Plot  $V_{ocL}$  vs  $I_f$

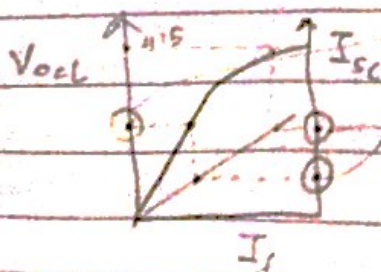
- DC Test {
- S1) Vary FR to bring  $n_c = 1500 \text{ rpm}$
  - S2)  $\uparrow I_f$  & note  $V$
  - S3) Vary  $R_{a \text{ ext}}$   $I_f$  —  
 $V_{ocL}$  —
- ( $V_{ph} = V_{ocL}/\sqrt{3}$ )

(b) Plot  $I_{sc}$  vs  $I_f$

- S1) Switch off armature ( $R_{a \text{ ext}}$ ) excit<sup>n</sup>
- S2) Put S as on
- S3) Switch on  $R_{a \text{ ext}}$  excit<sup>n</sup>
- S4) Vary  $R_{a \text{ ext}}$  to  $\uparrow I_f$  & note  $I_{sc}$

$I_f$  —  
 $I_{sc}$  —  $\rightarrow$  Any pt. on linear line

(c)  $Z_s$  (unsaturated) =  $\frac{V_{ocL}/\sqrt{3}}{I_{sc}}$



(d)  $Z_s$  (adj) =  $\frac{415/\sqrt{3}}{I_{sc}}$

(e)  $Z_s$  vs  $I_f$  graph using Part (c) table



4.2 (rated for SG)

(f) % regul<sup>n</sup> :-  $\frac{I}{V} ((R \cos \theta \pm X \sin \theta))$

$\downarrow$   
 415 (Rated for SG)

$R_{eq} \rightarrow \sqrt{Z_{adj}^2 - R_{eq}^2}$

## Expt 4: No load test on DC Shunt Generator

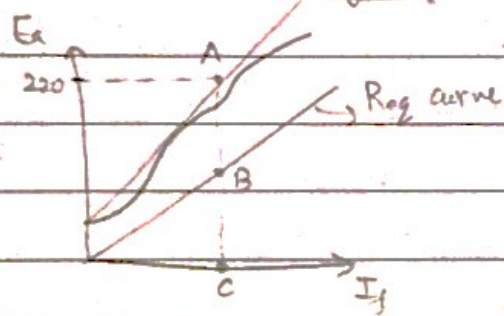
Find Reg

(a) Plot  $E_a$  vs  $I_f$

S1) Vary FR to set to rated speed (1500 rpm)

S2) Vary  $R_{ext}$  to get values of  $E_a$  &  $I_f$

S3) Plot graph



$\checkmark \frac{BC}{AC} = \frac{n_c}{n_{rated}} \quad ? \quad (\text{from graph})$

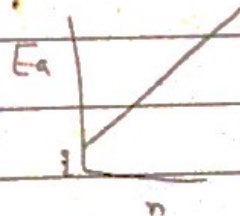
$\checkmark R_{avg} \checkmark$

(b) Plot  $E_a$  vs  $n$

S1) Vary FR to set to 1500 rpm

S2) Note value of  $I_f \rightarrow \frac{220}{I_f} \rightarrow R_c$

S3) Vary  $R_{ext} \rightarrow n -$   
 $E_a -$



$R = \frac{E_a}{I_f}$

Lee matching  
 $n$  corresponding  
 to that is  $n_c$



Expt 10:- No load test on Induction Motor

Find Req

- s1) Set 415 V using variac
- s2) Note:-  $I_{OL}$ ,  $W(=P_o)$  ( $V_L = 415$ )

Block rotor test.

- s1) Block rotor
- s2) Set Variac s.t  $I_{BRL} (= I_{OL}) = 4.8 A$

Note:-  $V_{BRL}$ ,  $W(=P_{BRT})$

Expt 9:- Load test on 3 $\phi$  Induction Motor

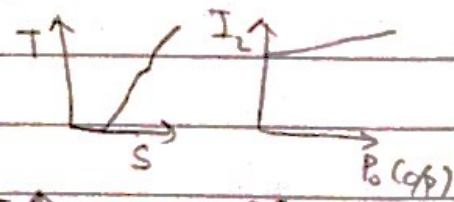
- s1) Vary variac to bring  $V_m = 415 V$
- s2) Vary (FR)<sub>g</sub> & set  $V_g = 220 V$
- s3) Take reading at No load.
- s4) Switch on load & take readings of  $I_2$ ,  $W(=P_{in})$ ,  $\eta$

Block rotor

- s1) Bring variac to zero
- s2) Block rotor
- s3) Again set it s.t  $V_m = 415 V$  & Vary (FR)<sub>g</sub> to  $V_g = 220 V$
- s4) Note value of  $P_{BR}$  (from wattmeter)

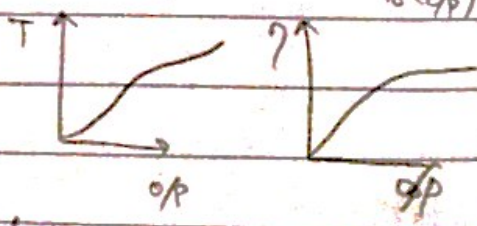
(a)  $\eta = \frac{P_o}{P_{in}} \rightarrow P_{in} - P_{BR} = 0.995$

$\downarrow$   
 $P_{BR} + P_{constr}$   
 $\downarrow$   
 $P_{in} - P_{BR}$

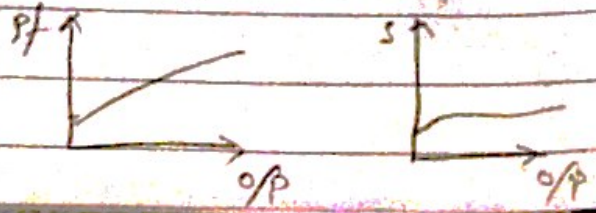


(b)  $ipf = \frac{P_{in}}{\sqrt{3} V_L I_2}$

$\downarrow$   
 $sin \phi$



(c)  $T = \frac{P_o}{2\pi n/60}$



(d)  $slip = \frac{n_s - n}{n_s} \rightarrow 1500$



Initially,  $(FR)_m = \text{min}$

$(FR)_g = \text{max}$

Expt 5

## Load Test on DC Shunt Generator

Find Reg

(a)  $V_L$  vs  $I_L$

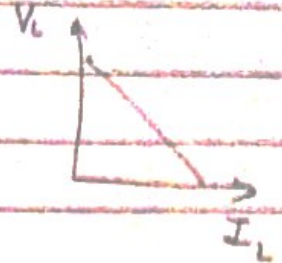
S1)  $(FR)_m$  set to 1500 rpm

S2)  $(FR)_g$  set to  $V_{rated} = 220$  V

S3) connect load & ↑ step by step

Note -  $V_L$  &  $I_L$  in each case

larger one  
near loading  
unit



Expt 6(i)

## Sumpner's Test

(a) Find Parameters of equivalent circuit of transformer (single  $\phi$ )

S1) Variac 1 → Set to  $V_{rated} = 115$  V

S2) Check  $V_3 (= 0)$  → else reverse HV<sub>1</sub> terminals

S3) Close switch. Vary Variac 2 → Rated current (4.34 A)

(LV)  $V_1, I_1 (= 2I_0), W_1 (= 2P_i)$

(HV)  $V_2 (= V_{sc}), I_2 (= I_{sc}), W_2 (= 2P_{sc})$

$$a = 2 (230/115)$$

Expt 6(ii)

## Scott Connection

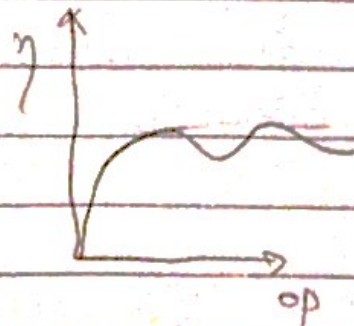
(a) Find  $\eta$  on diff<sup>t</sup> loads

S1) Vary Variac to set Secondary voltage to 115 V

So, Primary is automatically set to 230 V

S2) Apply diff<sup>t</sup> loads & find  $\eta = \frac{\text{o/p}}{\text{i/p}} = \frac{V_A I_A + V_B I_B}{W_1 + W_2}$

Graph  $\eta$  vs o/p.





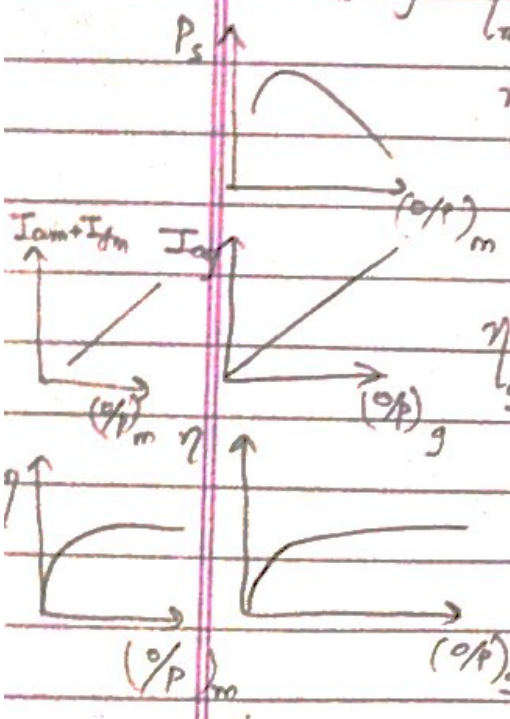
## Expt 7: Hopkinson's Test

Find Req  
Req = P<sub>arm</sub>  
= P<sub>ag</sub>

- S1) Adjust (FR)<sub>m</sub> to bring to rated speed (1500 rpm)
- S2) Adjust (FR)<sub>g</sub> to make V<sub>2</sub> = 0
- S3) Close switch
- S4) Keep changing (FR)<sub>m</sub> & (FR)<sub>g</sub> 4-5 times to keep η const (1500). Note values of I<sub>am</sub>, I<sub>fm</sub>, I<sub>ag</sub>, I<sub>fg</sub>

Finding η<sub>m</sub> & η<sub>g</sub>

Armature + field + Stray  
I<sub>am</sub><sup>2</sup> R<sub>am</sub> + V I<sub>fm</sub> + P<sub>s</sub> → 1/2 (P<sub>in(arm)</sub>)



$$\eta_m = \frac{\text{o/p} - \text{loss}}{\text{i/p}} = \frac{V(I_{fm} + I_{am}) - \text{Loss}}{V(I_{fm} + I_{am})}$$

$$\eta_g = \frac{\text{o/p}}{\text{o/p} + \text{Loss}} = \frac{V I_{ag}}{V I_{ag} + \text{Loss}}$$

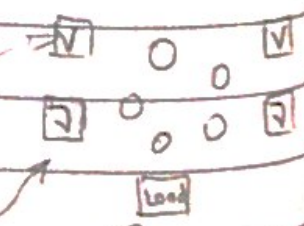
Arm + field + Stray  
I<sub>ag</sub><sup>2</sup> R<sub>ag</sub> + V I<sub>fg</sub> + P<sub>g</sub>

$$\frac{1}{2} (P_{in(arm)} - P_a) = \frac{V(I_{am} - I_{ag})}{I_{am}^2 R_{am} + I_{ag}^2 R_{ag}}$$

## Expt 8: Load Test on Sync Machine (Motor)

Part ①

- S1) Turn on DC
- S2) Vary FR to set to η<sub>rated</sub> = 1500 rpm
- S3) Vary P<sub>out</sub> to set to 400 W (see bar)
- S4) Red button Turn on  
beside machine  
beside bus
- S5) Turn on AC
- S6) Note phase (conned to RYB & see 5 or 2 dir<sup>n</sup>)
- S7) Vary P<sub>out</sub> to bring f = 50 Hz
- S8) Vary FR to make bulb off
- S9) Switch on Load



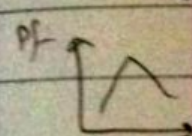
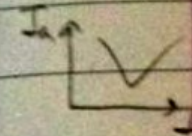
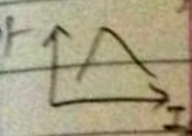
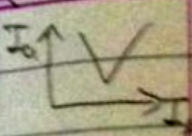


Part ②) Add load from loading unit & vary  $R_{ext}$  for +ve & -ve values of  $I_f$

- ✓  $P_{in}$  (wattmeter)
  - ✓  $I_a$
- } Bring it back to lower value of  $I_f$  before Part ③

Part ③) Block rotor: Sync. motor:

- s1) Switch off DC supply
- s2) Vary  $R_{ext}$  & note Readings of  $P_{in}$ ,  $I_a$  for +ve & -ve values of  $I_f$



$$P_f = \frac{P_{in}}{\sqrt{3} V_L I_L} \rightarrow \begin{matrix} I_a - I_f : \text{Gen} \\ I_a + I_f : \text{Motor} \end{matrix}$$