ELECTRICAL MACHINES LAB NOTES

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Electrical Machines Lab Notes, First Edition

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Expt 1 : No load Test on single ϕ transformer

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

(a) Find equivalent circuit Parameters

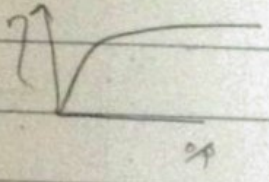
load values

(b) (η) vs load at 0.8 pf

→ O/P

K (1 KVA) (pf) / O/P + losses → $P_{core} + P_{iron}$ (P_i)

$K^2 P_c \rightarrow I_{rated}^2 R_{eq}$

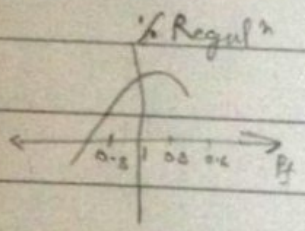


(c) $\eta_{max} = \frac{x \cdot pf}{(x) pf + 2P_i}$

$x = \sqrt{\frac{P_i}{P_c}} \times$ Rated KVA

(d) Regul^n vs pf

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

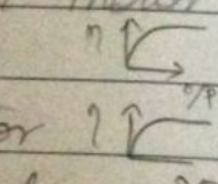


Expt 2 : No load test on DC Shunt motor

Find R_{eq}

(a) Find η vs O/P → Gen

→ Motor



(b) Field control & Arm. control

(a)

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

$P_L = P_K + P_V \rightarrow I_a^2 R_a$

$\sqrt{I_L^2 - I_{ao}^2 R_a}$ → 6.8 A

$I_L = I_{ao} + I_f$

S1 : Vary Ra ext to bring to 220 V

S2 : Vary FR to bring to 1500 rpm.

I_{ao}, I_f ✓

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

VI_L

(b) Field control

V = 220 (Keep const^{n})

Vary FR → n —

I_f —

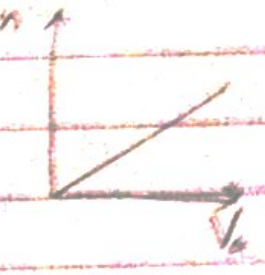
Arm. control.

I_f = const^{n} (any value)

Vary $R_{a\,ext}$

n —

V_a —



Expt. 3 : No load test on synchronous machine

Find R_{eq}

(a) Plot V_{OCL} vs I_f

OC Test:

S1) Vary FR to bring n_s = 1500 rpm

S2) ↑ I_f & note V

Vary $R_{a\,ext}$

I_f —

V_{OCL} — ($V_{PH} = V_{OCL}/\sqrt{3}$)

(b) Plot I_{sc} vs I_f

S1) Switch off armature ($R_{a\,ext}$) excit^{n}

S2) Put S as on

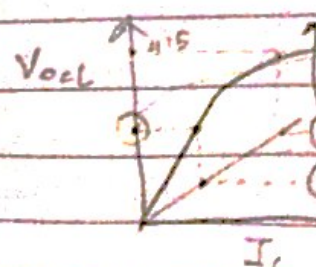
S3) Switch on $R_{a\,ext}$ excit^{n}

S4) Vary $R_{a\,ext}$ to ↑ I_f & note I_{SCL}

I_f —

I_{SCL} — → Any dt. on linear line

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



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

(e) Z_s vs I_f graph → using Part (a) Table

4-2 (rated for 5A)

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

415 (Rated for 5A)

R_{eq} → $\sqrt{Z^2_{(adj)} - R^2_{eq}}$

Expt 4: No load test on DC Shunt Generator

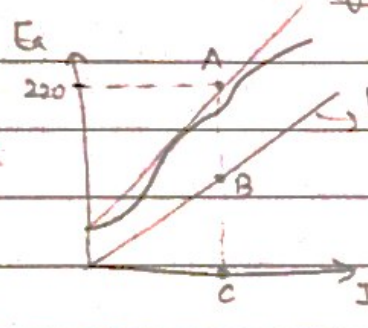
Find R_{eq}

(a) Plot E_a vs I_f

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

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

S3) Plot graph



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

R_{avg}

(b) Plot E_a vs n

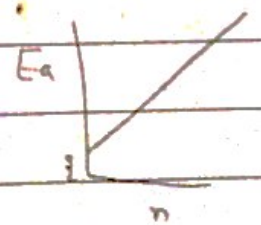
S1) Vary FR to set to 1500 rpm

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

S3) Vary $R_{a_{ext}}$ → n —

E_a —

$R = \frac{E_a}{I_f}$ —



see 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}, $W(=P_{OT})$ ($V_L = 415$)

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 3ϕ Induction Motor

S1) Vary variac to bring $V_m = 415$ V.

S2) Vary $(FR)_g$ & set $V_g = 220$ V.

S3) Take reading at No load.

S4) Switch on load & take readings of $I_{(L)_{Load}}$, $W(=P_{in})$, n

Block rotor

S1) Bring variac to zero.

S2) Block rotor.

S3) Again set it s.t $V_m = 415$ V. & Vary $(FR)_g$ to $V_g = 220$ V

S4) Note value of P_{BR} (from wattmeter)

(a) $\eta = \frac{P_o}{P_{in}}$ → $P_{in} - P_L$ → 0.995

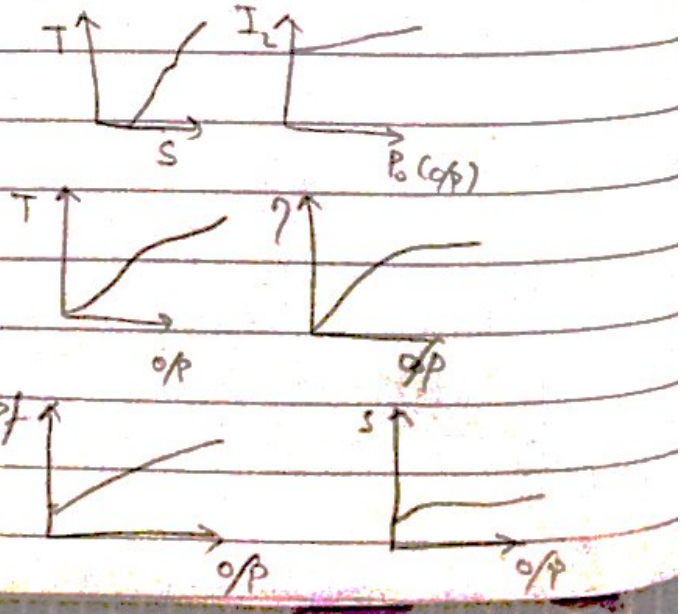
$P_{BR} + P_{core\,fl}$

$P_{in} - P_{BR}$

(b) $pf = \frac{P_{in}}{\sqrt{3} V_L I_2}$ (3 ϕ's)

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

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



Initially, $(FR)_m$: min

$(FR)_g$: max

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Expt 5

Load Test on DC Shunt Generator

Find R_{eq}

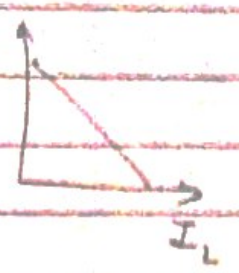
(a) V_L vs I_L

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 limit

Expt 6(i)

Sumpner's Test

(a) Find Parameters of equivalent circuit of transformer (Single ϕ)

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

S2) Check $V_3 (= 0)$ → else reverse HV_1 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

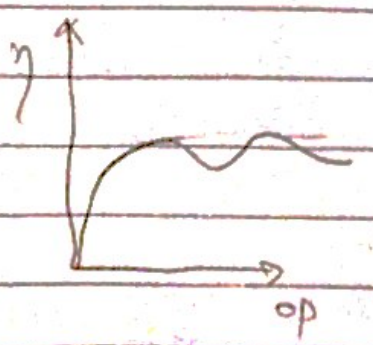
(a) Find η on diff^t loads

S1) Vary Variac to set Secondary voltage to 115 V

So, Primary is automatically set to 230 V

S2) Apply diff^t loads & find $\eta = \frac{o/p}{i/p} = \frac{V_A I_a + V_b I_b}{W_1 + W_2}$

Graph η vs o/p.



Expt 7: Hopkinson's Test

S1) Adjust $(FR)_m$ to bring to rated speed (1500 rpm)

Find R_{eq} S2) Adjust $(FR)_g$ to make $V_2 = 0$

$R_{eq} = R_{am} = R_{ag}$

S3) Close switch

S4) Keep changing $(FR)_m$ & $(FR)_g$ 4-5 times to keep n const (1500). Note values of $I_{am}, I_{fm}, I_{ag}, I_{fg}$

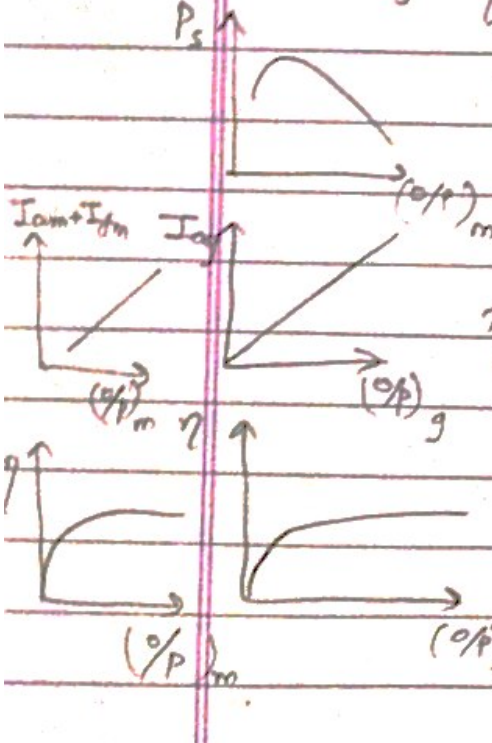
Finding η_m & η_g

Armature + field + Stray

$I_{am}^2 R_{am} + VI_{fm} + P_s$ → $\frac{1}{2}(P_{in(arm)} - P_a)$

$V(I_{am} - I_{ag})$

$I_{am}^2 R_{am} + I_{ag}^2 R_{ag}$



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

$$\eta_g = \frac{o/p}{o/p + (Loss)} \rightarrow VI_{ag}$$

Arm + field + Stray

$I_{ag}^2 R_{ag} + VI_{fg} + (P_s)$

$\frac{1}{2}(P_{in(arm)} - P_a)$

$V(I_{am} - I_{ag})$ $\quad I_{am}^2 R_{am} + I_{ag}^2 R_{ag}$

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

Part ①

S1) Turn on DC

S2) Vary FR to set to $n_{rated} = 1500$ rpm

S3) Vary $R_{a\,ext}$ to set to 400 V (see box)

S4) Red button Turn on
- beside machine
- ~~beside box~~

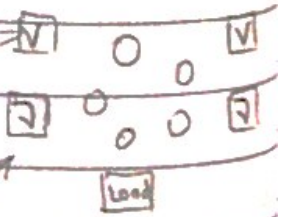
S5) Turn on AC

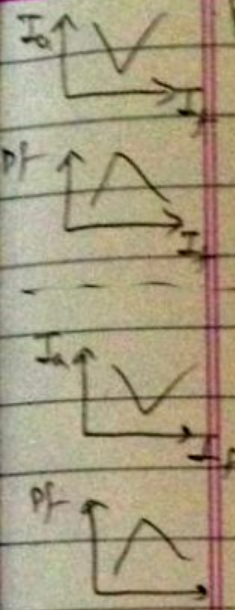
S6) Note phase (connect to RYB & see ↻ or ↺ dir^n)

S7) Vary $R_{a\,ext}$ to bring $f = 50$ Hz

S8) Vary FR to make bulb off

S9) Switch on (Load)





Part ② Add load from leading unit & vary $R_{a_{ext}}$ 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 ① Block rotor ; Sync. motor :

S1) Switch off DC supply

S2) Vary $R_{a_{ext}}$ & note Readings of P_{in}, I_a for +ve & -ve values of I_f

$$pf = \frac{P_{in}}{\sqrt{3}\,V_L I_L}$$

V_L → V

I_L → $I_a - I_f$: Gen, $I_a + I_f$: Motor