Maulana Azad National Institute Of Technology, Bhopal

Assignment - 3

Roll No........................Scholar No........................

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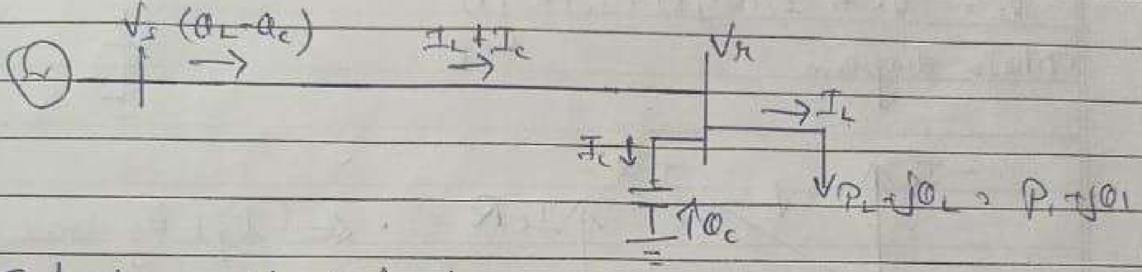
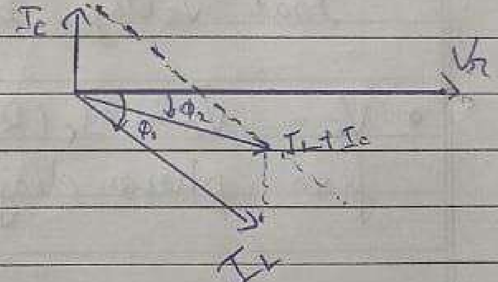
Branch : Electrical

Section : I



Initially, without shunt capacitor
current draw I_L lags V_r
after shunt capacitor,
capacitor takes leading current I_c



Initial pf angle ϕ_1
after shunt capacitor
pf angle $= \phi_2$
$\phi_1 > \phi_2$
$\cos\phi_1 < \cos\phi_2$
$pf_1 < pf_2$
hence power factor improved

Voltage drop $= |V_s| - |V_r|$
$= IR\cos\phi + IX\sin\phi$
if R neglected as compare to X
$IR\cos\phi \approx 0$
than voltage drop $= IX\sin\phi$
after shunt capacitance $\phi\downarrow \Rightarrow \sin\phi\downarrow$
hence voltage drop $|V_s| - |V_r|$ reduces
and voltage regulation improved

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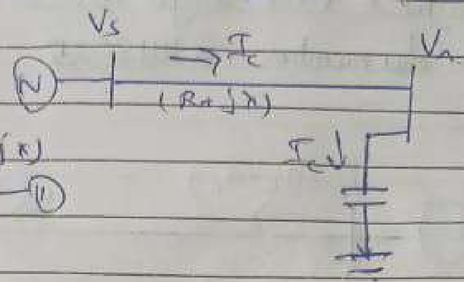
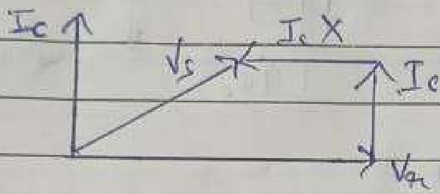
2) Under lightly load condition $I_L = 0$ (load current only I_c is drawn

under normal condition

$V_s = \bar{V}_r + \bar{I}_c(R+jX) + \bar{I}_L(R+jX)$ — (1)



Phasor diagram



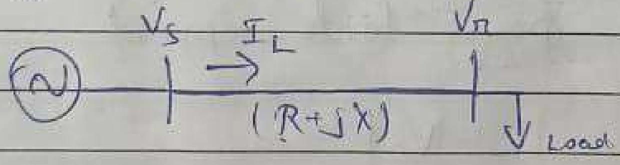
⇐ (lightly loaded)

Under lightly loaded condition load voltage is increased load voltage becomes more than source voltage

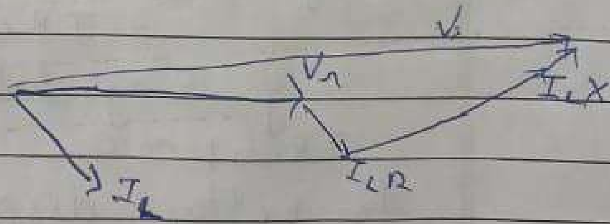
- $\bar{V}_s = \bar{V}_r + \bar{I}_c(R+jX)$ — (2)

from phasor diagram we can see $V_r > V_s$

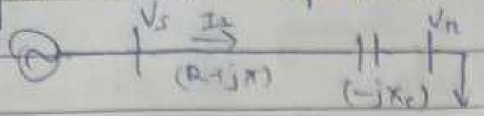
3) Before Series capacitance



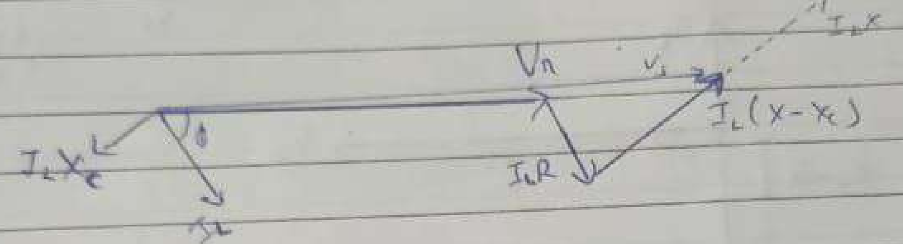
$V_S = \bar{V}_r + I_L(R+jX)$



After series capacitor added



$V_s = V_r + I_L(R + jX - jX_c)$



→ Hence line reactance is reduced

Voltage drop before series compensation

$|V_s| - |V_r| = IR\cos\phi + IX\sin\phi$

neglecting R as very small in line $(R \ll X)$

$|V_s| - |V_r| = IX\sin\phi$ — (1)

Voltage drop after series compensation (capacitor)

$|V_s| - |V_r| = I(X - X_c)\sin\phi$ — (2)

from (1) and (2) we can say voltage drop reduces after adding series ~~compens~~ capacitor and hence voltage regulation is improved

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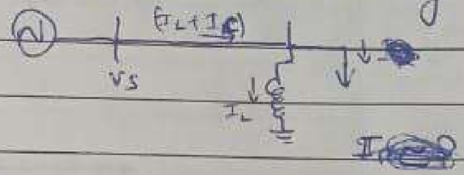
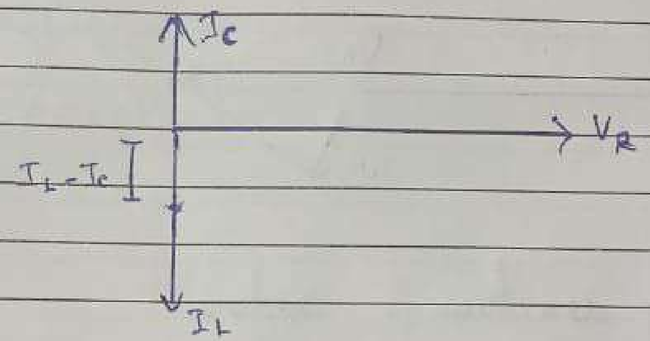
4) In lightly loading condition only line charging current (I_c) flows ($I_L \approx 0$), so a leading power factor is there. After adding shunt inductance, the inductor draws lagging ~~cure~~ current thus controlling power factor





Adding shunt inductor draws a lagging current reducing phase angle b/w V and net current I. ~~hil~~ This helps in improving power factor and reduce reactive power demand.

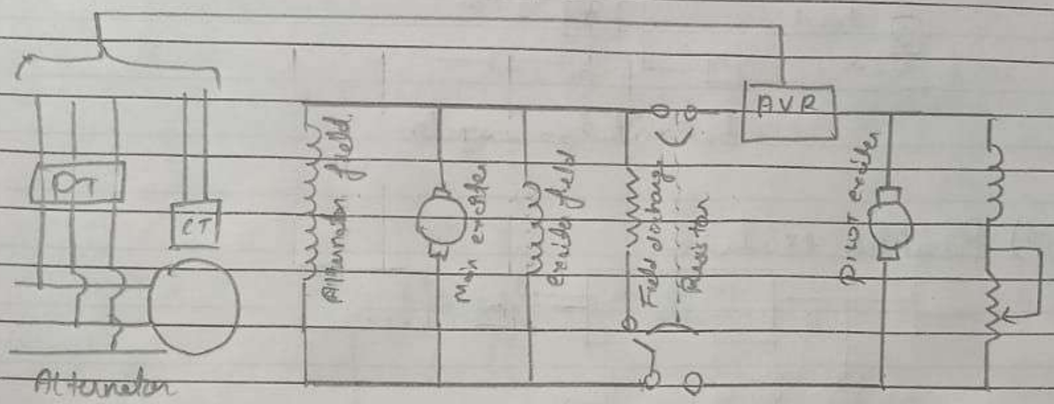
5) Use of Series inductor compensation system in power system

→ Series inductor can be used to compensate for excessive line capacitance especially in long transmission line

→ Series inductor introduces a voltage drop VT that partially cancels the voltage drop across the line capacitance.

→ This reduces the overall voltage drop across the line improving voltage regulation

6) (i) DC excitation system



-> The DC excitation system includes two exciters, the main exciter and pilot exciter

-> Exciter drive: Both exciters can be driven by the main shaft or by a separate motor
Shaft driven exciters are preferred as they maintain cnt system operation and less affected by external disturbances

-> Automatic voltage Regulator:- Adjust exciter o/p to control alternator terminal voltage

-> field discharge Resistor:- engages when field breaker is open to dissipate energy stored in inductive field winding

(ii) Static excitation system:-
In this method the excitation power for main alternator field is drawn from o/p terminal of main 3ϕ alternator. This 3ϕ voltage is fed to 3ϕ full converter bridge using thyristor. The firing angle of thyristor controlled by means of regulator which picks up signal from alternator terminals through PT. The controlled power o/p from thyristor and delivered to field wdg of main alternator through brushes and slip rings.

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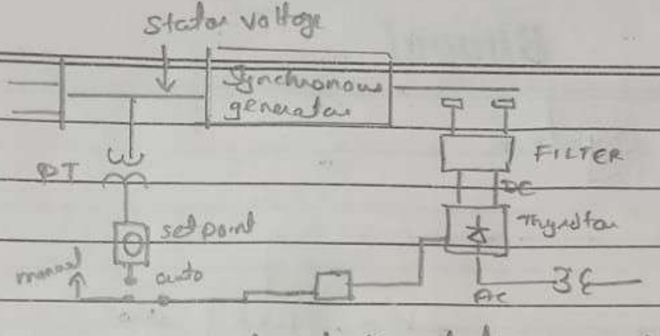
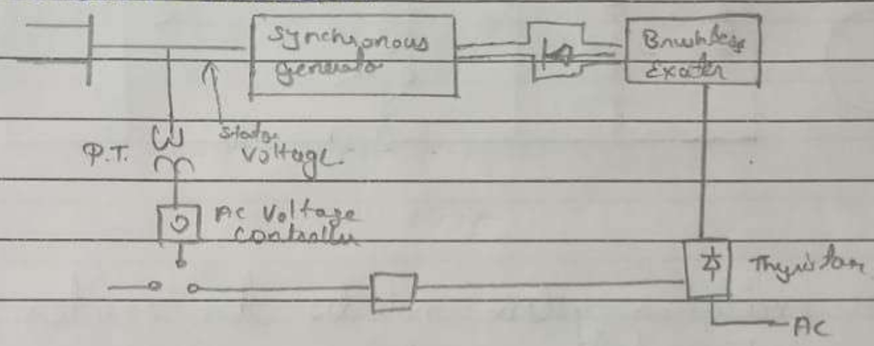


(Static Excitation system)

(iii) Brushless excitation



In this the exciter is actually small ac generator built on end of gen. shaft instead of rings, in this exciter a stationary mag. field is provided from DC winding which is wound on stator. The rotor winding produces ac voltage and this is fed directly into diode type rectifier which are built into the ~~shaft~~ shaft so we have in effect a rotating rectifier. The DC o/p from rectifier is connected directly to main rotor ~~wdg~~ winding through leads which pass inside shaft. There is no need for collector rings or brushes. The thyristor DC o/p is controlled by controlling the firing angle which is governed by field voltage regulator