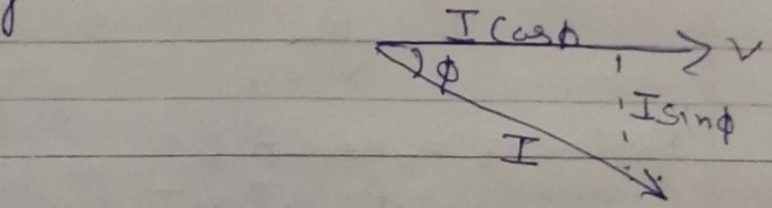
Power Factor

The Cosine of angle between Voltage and Current in A.C System is called power factor.

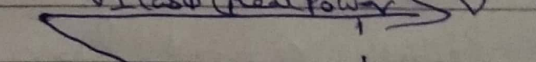
For Inductive Circuit Current lags the Voltage by angle ϕ then power factor is known as lagging Power factor

In Capacitive Circuit Current leads the Voltage then power factor is known as leading power factor



phasor diagram of Inductive Circuit

V is taken as refrence vector. and I lags V by by angle ϕ in case of Inductive Cir.. the horizontal component of current is known as I Cosϕ (known as Active Component of Current) which is in phase with Voltage whereas Vertical Component of Current I Sinϕ is known as Reactive Component of Current If all the three sides are multiplied by Voltage V power triangle is obtained



VI Cosϕ real power in KW
VI Sinϕ Reactive power in KVAR
VI Apparent power in KVA

power factor = Real Power / Apparent power = VI Cosϕ / VI = Cosϕ

Disadvantage of Low power factor

power Consumed in Single phase A.C Circuit $P = VI\cos\phi$

$$I = \frac{P}{V\cos\phi}$$

In Case of 3 phase A.C

$$P = \sqrt{3}\, V_L I_L \cos\phi$$

$$I_L = \frac{P}{\sqrt{3}\, V_L \cos\phi}$$

Here load current are inversely proportional to power factor, for fixed power & Voltage
Lower power factor, higher the current & vice versa

(1) Greater Conductor Size :- To transmit fix amount of power at fixed Voltage at lower power factor. The Conductor will have to large amount of Current which required large Conductor size

2 large Copper losses - Due to more Current carried by Conductor I^2R losses will increase which result to poor efficiency in transmission

3 Poor Voltage Regulation - Due to low P.F and increased Current the voltage in transformer alternator & transmission line.

4 large KVA rating of equipment

Output power of Alternator & transformer are rated in Apparent power KVA

$$KVA = \frac{kW}{\cos\phi}$$

Rating is inversely proportional to Power factor. At lower power fact KVA will increase. At low P.F equipment of high KVA is required which is large in size & costly.

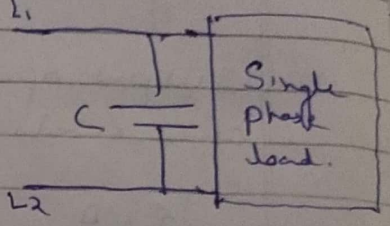
CAUSES OF low P.F

(1) Transformer are inductive devices which causes Current to lags behind Voltage. At normal load, magnetizing Current does not effect too much but at low load magnetizing Current effect too much & lower P.F

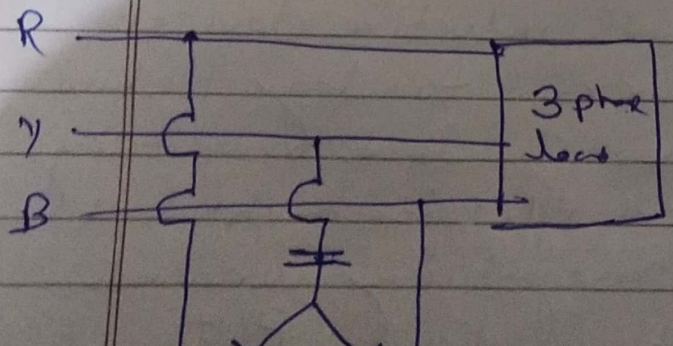
2 In Industry having Induction motor run on inductive load which have low P.F:- Normally P.F 0.8 to 0.85 when operating at full load & 0.3 to 0.5 when running at light load.

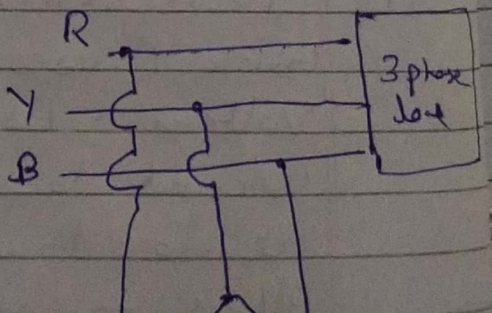
Power factor Improvement using Static Capacitor.

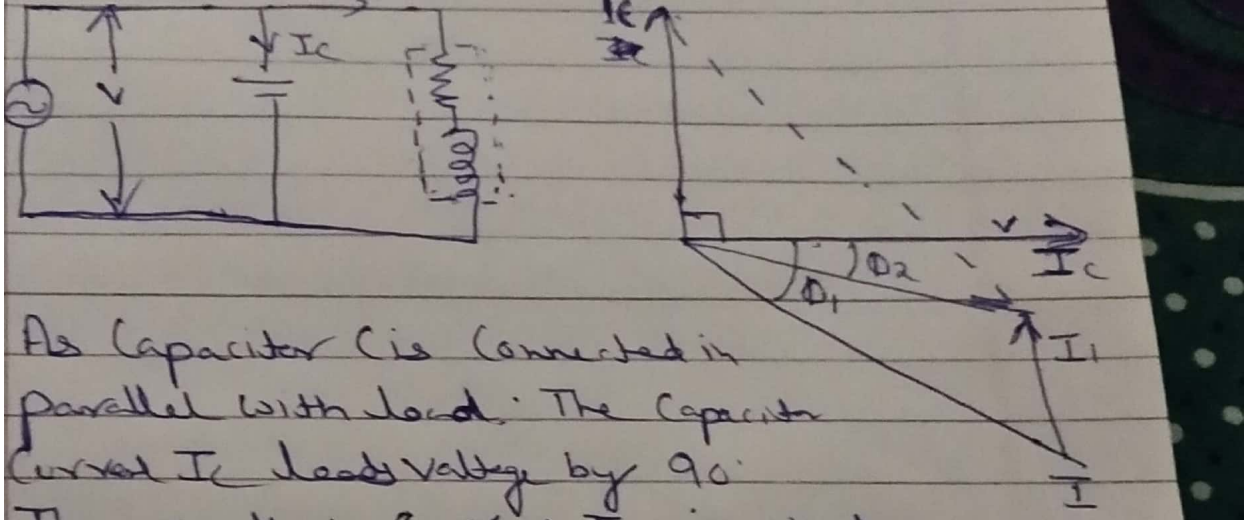
(1) The P.F is low generally due to Inductive load. and take current at lagging P.F. In order to raise Improve P.F Static Capacitor is Connected in parallel with load. The static Capacitor draws a Current which leads Voltage & neutralises the lagging Component.



For 3 phase load. Capacitor are Connected in Star or delta







As Capacitor C is connected in parallel with load. The Capacitor current Ic leads voltage by 90°
The resultant current I_1 is vector sum of I & Ic and its angle of lag is now Φ_2 which is less than Φ_1
The value of $\cos\Phi_2$ is more than $\cos\Phi_1$
Hence P.F of load is improved from $\cos\Phi_1$ to $\cos\Phi_2$.