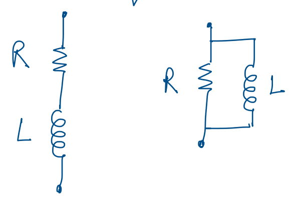
Lecture 4

Tuesday, 16 January 2024 3:32 PM

When we have only R type of load then

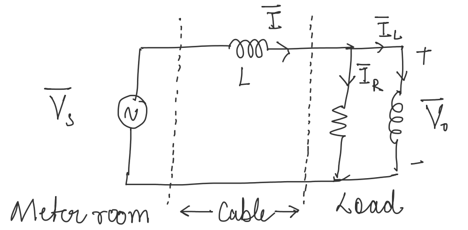
Power factor = 1 → UPF
unity power factor

Typically loads are of R+L type

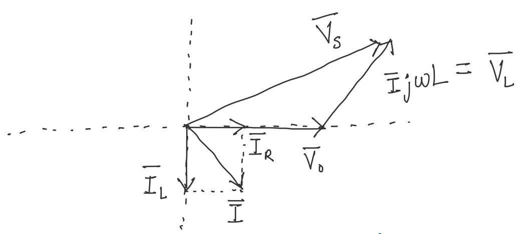


We don't want inductive type of load. This leads to higher RMS current leading to higher losses in transmission cable. If there was no inductive element we could have drawn the same real power with lesser value of RMS current. Therefore it leads to poor utilization of common resource.

Another reason to not want L.



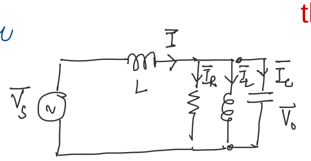
Drawing phasor diagram :-

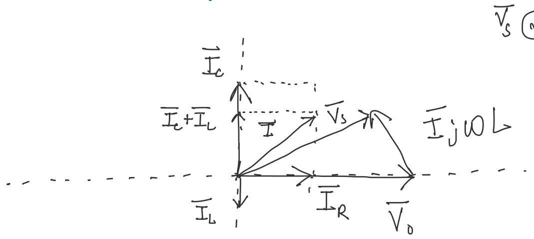


From the phasor diagram it can be seen that $|\bar{V}_s| > |\bar{V}_L|$
Therefore the magnitude of voltage recieved by load is less than the supply voltage at source. As the cable length increase, the voltage magnitude

Take the most common thing as the base of the phaser diagram.

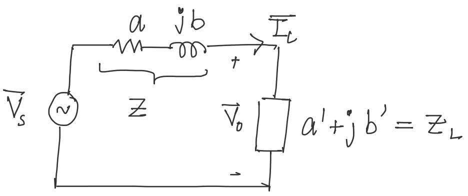
If we have a large enough capacitor





We observe that load voltage magnitude is more than the voltage magnitude at source. Therefor a capacitor bank can be used to mitigate for voltage magnitude drop at the load end. Too much capacitor is also not good as it increases $|\bar{I}|$.

* Maximum power transfer theorem :-



What is the value of load impedance to maximize the real power drawn by load Z_L.

$$\bar{V}_o = \frac{\bar{V}_s \cdot (a'+jb')}{(a+a')+j(b+b')}$$

$$\bar{I}_L = \frac{\bar{V}_s}{(a+a')+j(b+b')}$$

Real power drawn by load Z_L, P

$$= Re\left\{ \bar{V}_o \bar{I}_L^* \right\}$$

$$= Re\left\{ \frac{\bar{V}_s (a'+jb')}{(a+a')+j(b+b')} \cdot \frac{\bar{V}_s^*}{(a+a')-j(b+b')} \right\}$$

$$= Re\left\{ \frac{|\bar{V}_s|^2 (a'+jb')}{(a+a')^2+(b+b')^2} \right\}$$

$$P = \frac{|\bar{V}_s|^2 a'}{(a+a')^2+(b+b')^2}$$

To maximize P, we put $b' = -b$ (to minimize denominator)

$$P = \frac{|V_s|^2 a'}{(a+a')^2}$$

$$\frac{dP}{da'} = 0$$

$$(a+a')^2 |V_s|^2 - 2|V_s|^2 a' (a+a') = 0$$

$$(a+a')\left[a+a'-2a'\right] = 0$$

$$(a+a')(a-a') = 0$$

$$\boxed{a = a'}$$ a' can't be negative

$Z_L = a - jb = Z^*$

To maximize real power drawn by the load, the impedance should be

$$\boxed{Z_L = Z^*}$$

We don't use this theorem to maximize power drawn by the equipments because the voltage at the load will be reduced to half.