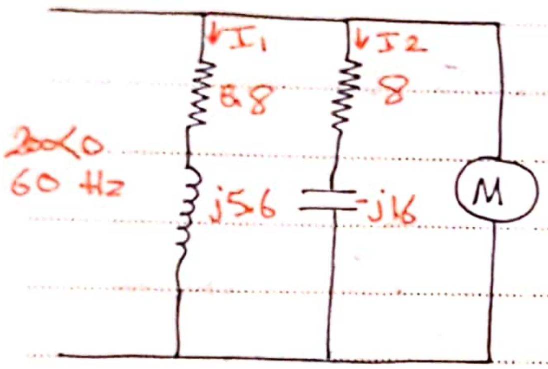
3 - 3 - 2019

Example (Quiz) :-



$S_3 = 5$ kVA at 0.8 pf lag

1) $S_1 = \dfrac{|V|^2}{Z_1^*} = \dfrac{|200|^2}{0.8 - j5.6} = 1000 + j7000$ (W, var)

$S_2 = \dfrac{(200)^2}{8 + j0.16} = 1000 - j2000$ (W, var)

$S_3 = 5000 \angle 36.87 = 4000 + j2000$

$\therefore S_{Total} = S_1 + S_2 + S_3$

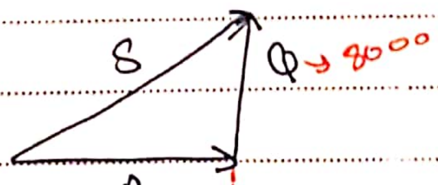
$= 6 + j8 = 10 \angle 53.13$

2) $S = V \cdot I^* \rightarrow I = \dfrac{S^*}{V^*} = \dfrac{1000 \angle -53.3}{200 \angle 0} = 50 \angle -53.13$ A

lag −

lead +

3)



→ Q نضع C عشان يعوض الـ

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$\therefore Z_c = \frac{|U|^2}{S_c^*} = \frac{200^2}{j8000} = -j5\ \Omega$

$\therefore C = \frac{1}{2\pi \cdot 60.5} = \frac{10^6}{2\pi \cdot 60.5} = 530.5\ \mu F$

* * *

chapter 2 : قوانين مهمة

* average = real = active power $\rightarrow P = |U||I|\cos\theta$

* apperant power = $|U||I| \rightarrow$ voltamper (VA)

* reactive power = $Q = |U||I|\sin\theta \rightarrow$ VAR

* Complex power = $S = UI^* = P + jQ$

$S = \frac{|U|^2}{Z^*}$

* $Z = \frac{|U|^2}{S^*}$

* $C = \frac{10^6}{2\pi(f) X_c} \rightarrow X_c = \frac{|U|^2}{S_c^*}$

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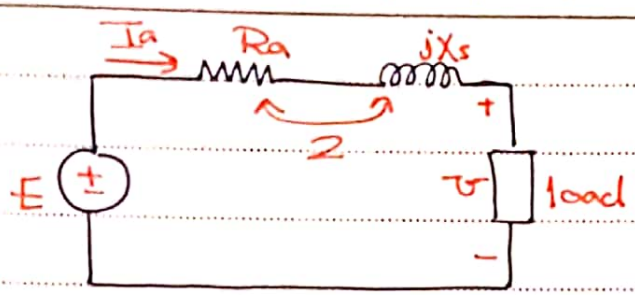
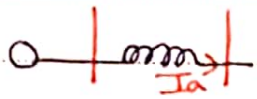


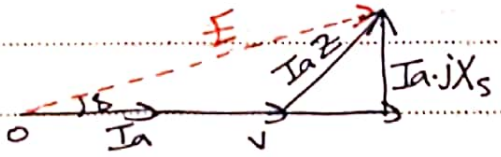
$\rightarrow \bar{E} = V_{load} + (I_a . Z_s)$.

$\begin{cases} E \angle \delta \\ V \angle 0 \\ Z_s \angle \theta \end{cases}$

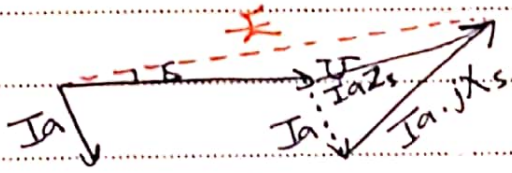


* $E = 4.44 * k_w * f . N\phi$
* $f = \frac{P}{2} . \frac{n}{60} = \frac{Pn}{120}$.
* $V = E - I_a . Z$.
* $S_{3\phi} = 3 V I_a^*$.

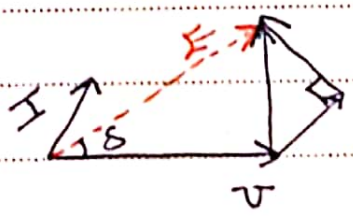
1) pf = 1 :-



2) pf lag :-



3) pf leacl :-



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* Voltage regulation :-   * الافضل تكون قيمة قليلة

$$VR = \frac{V_{no.L} - V_{rated}}{V_{rated}}$$

$$S_{3\phi} = 3 V \, I_a^*$$

$$I_a = \frac{E\angle\delta - V\angle 0}{Z\angle\gamma}$$

$$S_{3\phi} = \frac{3|E||V|}{|Z_s|} \angle\gamma-\delta - \frac{3|V|^2}{|Z_s|} \angle\gamma$$

$$\therefore P_{3\phi} = \frac{3|E||V|}{|Z_s|} \cos\angle\gamma-\delta - \frac{3|V|^2}{|Z_s|} \angle\gamma$$

$$\therefore Q_{3\phi} = \frac{3|E||V|}{|Z_s|} \sin\angle(\gamma-\delta) - \frac{3|V|^2}{|Z_s|} \sin\angle 90$$

$$\therefore P_{max\,3\phi} = \frac{3|E||V|}{X_s} \sin\angle 90$$

$$\therefore P_{3\phi\,max} = \frac{3|E||V|}{X_s}$$

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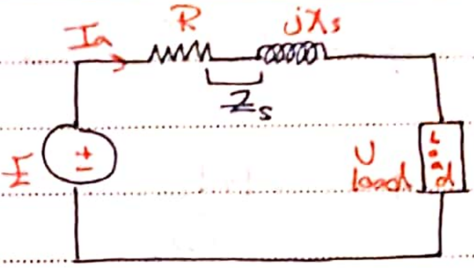
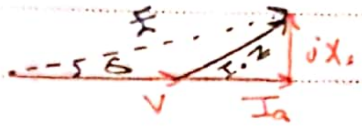
Ex:(3.1) :-

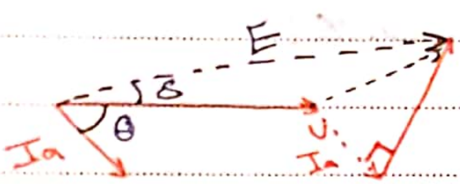
$E = I_a (R_a + jX_s) + V_{load}$.

$E = I_a Z_s + V_{load}$.

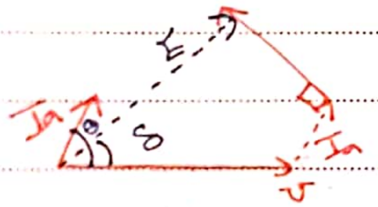




→ pf = 1



→ pf = lag.



→ pf = lead

Note :- θ الزاوية بين I , U اما δ الزاوية بين U , E

* at no load ⇒ I_a = zero , $E = V$.

$E \angle \delta$

$V \angle 0$

$Z \angle \gamma$

* اذا ما حدد في السؤال ال phase
يشتغل على line

Solution :-

$S_{3\phi} = 3 \cdot V I_a^*$

$|E| \angle \delta = |V| \angle 0 + I_a |Z_s| \angle \gamma$.

$\therefore I_a = \dfrac{|E| \angle \delta - |V| \angle 0}{|Z_s| \angle \gamma}$

$\therefore S_{3\phi} = 3V I_a^*$ → عوض قيمة I_a

$$S_{3\phi} = \frac{3|E||V| \angle \gamma - \delta}{|Z_s|} - \frac{3|V|^2}{|Z_s|} \angle \gamma$$

$$\therefore P_{3\phi} = \frac{3|E||V| \cos \angle \gamma - \delta}{Z_s} - \frac{3|V|^2}{|Z_s|} \cos \gamma \rightarrow \text{let } \gamma = 90^\circ$$

active

$$\therefore Q_{3\phi} = \frac{3|E||V| \sin \angle 90 - \delta}{Z_s} - \frac{3|V|^2}{|Z_s|} \sin 90$$

$$\therefore \text{active power} = \frac{3|E||V|}{|Z_s|} \sin \delta$$

$$\therefore P_{max\,3\phi} = \frac{3|E||V|}{Z_s} \cdot 1$$

$\sin \delta$ → $\delta = 90^\circ$ تعتبر max في حالة

* * *

ملاحظة : اذا ما قال بالسؤال V phase نعتبر الجهد (V line) ونحول الى V phase عن طريق القسمة على $\sqrt{3}$

Ex (3.1) :

pf = 0.8 lag → $\cos^{-1}(pf) = 36.87^\circ$ → lag ∴ $\angle -36.87$

$\therefore 50 \angle 36.87 = 40 + j30$

$$I_a = \frac{S^*}{3V^*} = \frac{(50 \angle 36.87)(10^6)}{3(17.32 * 10^3 \angle 0)} = 962.25 \angle -36.87 \text{ A}$$

(17.32: V phase)

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$$E = V + I_a \cdot jX_s$$

$$= 17.32\angle 0 + (9625\angle -36.87 * j9) = 28.558\angle 17.1 \text{ kV}$$

2) $P_{3\phi} = \frac{3|E||V|}{|X_s|} \sin\delta$

$$25 \text{ MW} = \frac{3|E||V|}{|X_s|} \sin\delta$$

$$\therefore \delta = \sin^{-1}\left(\frac{9.25}{3 * 23.56 * 17.32}\right) = 10.591^\circ$$

$$I_a = \frac{E\angle\delta - V\angle 0}{jX_s} = \frac{23.558\angle 10.591 - 17.32\angle 0}{j9}$$

$$= 807.48\angle -53.4$$

Problem (3.2)