NOTES Class-47

Variation in Wattmeter readings with power factor of the load

Variation in wattmeter readings – Inductive load

For inductive loads, $W_1 = V_L*I_L*\cos(30+\phi)$ & $W_2 = V_L*I_L*\cos(30-\phi)$

As phase angle ϕ increases, load power factor decreases.

With an increase in the phase angle ϕ, $W_1 = V_L*I_L*\cos(30+\phi)$ decreases &

$W_2 = V_L*I_L*\cos(30-\phi)$ increases.

Phase Angle, ϕ	**Load Power factor, $\cos\phi$**	**$W_1 = V_L I_L \cos(30+\phi)$**	**$W_2 = V_L I_L \cos(30-\phi)$**	**Comments**
0°	1	$\frac{\sqrt{3}V_L I_L}{2}$	$\frac{\sqrt{3}V_L I_L}{2}$	$W_1 = W_2$
30°	0.866 Lag	$\frac{V_L I_L}{2}$	$V_L I_L$	$W_1 = \frac{W_2}{2}$
60°	0.5 Lag	0	$\frac{\sqrt{3}V_L I_L}{2}$	$W_1 = 0$; $W_2 = P_{3-\text{phase}}$
>60°	< 0.5 Lag	Negative	Positive	W_1 = -ve; W_2 = +ve

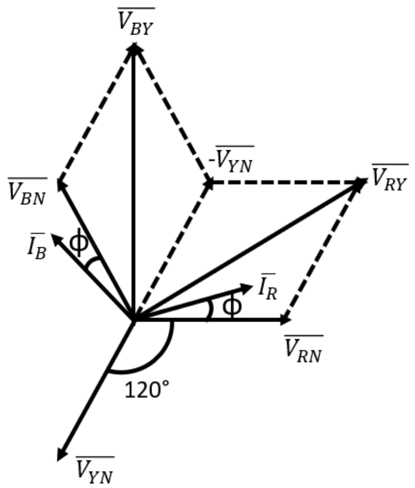
Important observations:

- When phase angle is <60° (or) power factor of the load is > 0.5 Lag, both the wattmeters read positive readings.
- When phase angle = 60° (or) power factor of the load is = 0.5 Lag, one of the wattmeters reads zero and the other reads the total three phase active power.

- When phase angle is >60° (or) power factor of the load is < 0.5 Lag, one of the wattmeters reads negative i.e., its pointer moves behind zero. To record its reading, either reverse its CC connections or PC connections (not both) & record this value with a negative sign.

Variation in wattmeter readings – Capacitive load

Now, consider capacitive Loads



For this case, $W_1 = V_{RY}*I_R*\cos(30-\phi)$ & $W_2 = V_{BY}*I_B*\cos(30+\phi)$

Phase Angle, ϕ	**Load Power factor, cosϕ**	**$W_1 = V_LI_L\cos(30-\phi)$**	**$W_2 = V_LI_L\cos(30+\phi)$**	**Comments**
0°	1	$\frac{\sqrt{3}V_LI_L}{2}$	$\frac{\sqrt{3}V_LI_L}{2}$	$W_1 = W_2$
30°	0.866 Lead	V_LI_L	$\frac{V_LI_L}{2}$	$W_2 = \frac{W1}{2}$
60°	0.5 Lead	$\frac{\sqrt{3}V_LI_L}{2}$	0	$W_1 = P_{3-phase}$; $W_2 = 0$
>60°	< 0.5 Lead	Positive	Negative	W_1 = +ve; W_2 = -ve

Thus, the readings become just the opposite to that of inductive load case.

Numerical Example 1

Question:

In a two wattmeter method of measuring three phase power, it is observed that the wattmeter readings are in the ratio of 3:1. Determine the power factor of the Load.

Solution:

Given Data:

$W_1 : W_2 = 3:1$

Power factor = cosϕ = $\cos(Tan^{-1}(\sqrt{3}*\frac{(W_1 - W_2)}{(W_1 + W_2)}))$

Therefore, Power factor = 0.756

Numerical Example 2

Question:

Two wattmeters are connected to measure input to a balanced three phase circuit indicate 2000W and 500W respectively. Find the power factor when

i) **Both readings are positive**

ii) **Latter reading is obtained after reversing its CC**

Solution:

Case 1: $W_1 = 2000W$; $W_2 = 500W$

Power factor = $\cos(Tan^{-1}(\sqrt{3}*\frac{(W_1 - W_2)}{(W_1 + W_2)}))$ = 0.693

Case 2: $W_1 = 2000W$; $W_2 = -500W$

Power factor = $\cos(Tan^{-1}(\sqrt{3}*\frac{(W_1 - W_2)}{(W_1 + W_2)}))$ = 0.327