Course No: EEE 270

Course Title: Electrical Drives and Instrumentation Sessional

Experiment No: 02

Name of the Experiment: TWO WATTMETER METHOD OF MEASURING POWER IN A BALANCED THREE PHASE WYE CONNECTED R-L LOAD.

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Objective:

The objective of this experiment is to know the way we can use two wattmeters method to calculate the total power of a balanced three phase wye (Y) connected R-L load. We also compared the theoretical values with the practical ones and the values we got from "Two Wattmeters Method".

Equipments:

1. One AC voltmeter
2. Two wattmeters
3. Three Lampboards
4. Three SPST and one DPST switches
5. Two ammeters

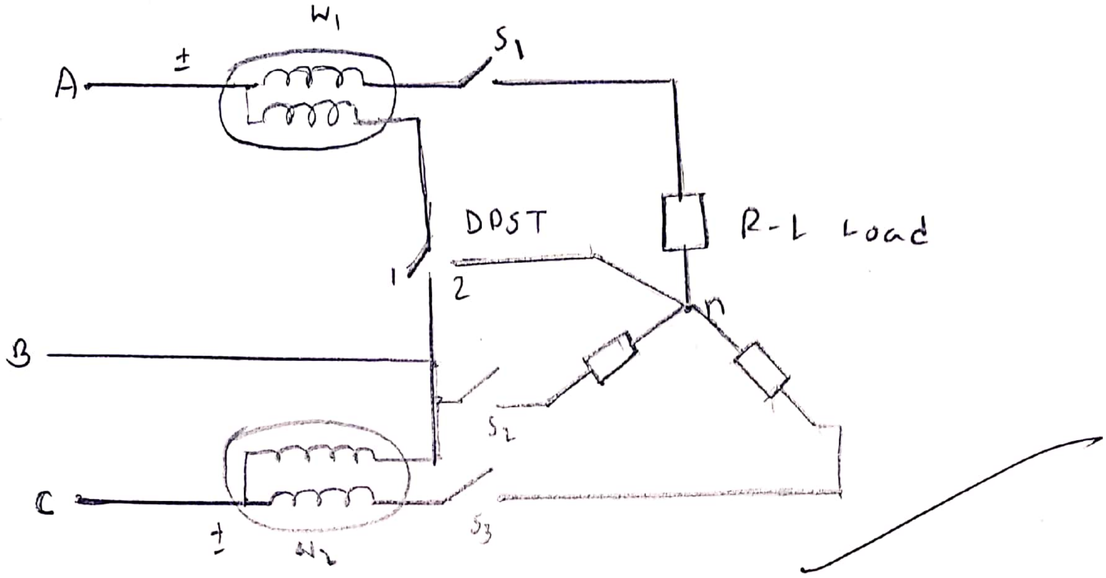


Fig. Circuit connections

Data Collection

Number of Lamps	$W_T = W_1 + W_2$ (watts)	W_P (watts)	$W_T = 3 W_P$ (watts)	V_P (volts)	I_P (amps)	$PF = \frac{W}{3 V_P I_P}$
1	80	24	72	133.8	0.3	0.67
2	140	50	150	134.4	0.5	0.7
3	220	80	240	135	0.7	0.78

Reports:

1. Show that three times per phase power W_P is equal to the sum of the readings of two wattmeter for each set of data.

Ans. Since the three-phase system we are using here consists of a balanced Wye connected load, if we multiply power per phase by three, we'll be getting the total power consumed by the three phase wye-connected loads. Also using two wattmeters method, the sum of readings from the two wattmeters is equal to the total power consumed by the wye connected loads.

We connected 1st wattmeter W_1 between A and B, 2nd wattmeter W_2 between B and C.

so the power reading from W_1,

$$P_1 = V_{AB} I_A \cos(\theta + 30^\circ)$$

from W_2,

$$P_2 = V_{CB} I_C \cos(\theta - 30^\circ)$$

for balanced loads, $V_{AB} = V_{CB} = V_L$

and $I_A = I_C = I_L$

$$\therefore P = P_1 + P_2 = V_L I_L \cos(\theta + 30^\circ) + V_L I_L \cos(\theta - 30^\circ)$$

$$= V_L I_L \times 2 \cos\theta \times \cos 30^\circ$$

$$= \sqrt{3} V_L I_L \cos\theta = \text{total real power}$$

$\therefore$ ~~...~~ P is the total real power delivered to the load which is three times the power consumed by each load in Wye connection.

It is also clear from our Data table. for 1 lamp $W_p = 24$

so $3W_p = 72W$ which is close to $W_T = 80W$

for 2 lamps, $W_p = 50W$, $3W_p = 150W$

which is close to $W_T = 140W$

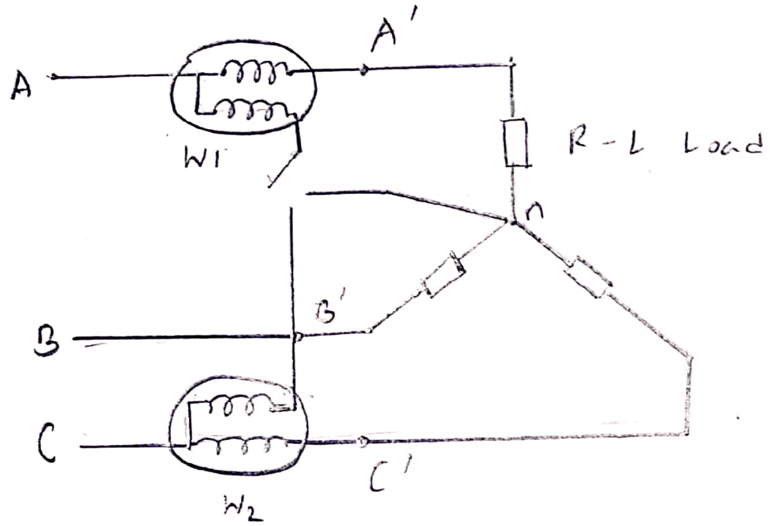
for 3 lamps, $W_p = 80W$, $3W_p = 240W$

which is close to $W_T = 220W$.

So three times per phase power is equal to the sum of the readings of two wattmeters for each set of data.

2. Draw a phasor diagram showing the vectors that determine W_1 and W_2.

Ans. The circuit that we formed is



Wattmeter W_1 measures line voltage V_{AB} and line/phase current $I_{AA'}$. Wattmeter W_2 measures line voltage V_{CB} and Line/phase current $I_{CC'}$.

Here,

$$V_{AB} = V_{AN} + V_{NB} = V_{AN} + (-V_{BN}), \quad I_{AA'} = I_{AN}$$

$$V_{CB} = V_{CN} + V_{NB} = V_{CN} + (-V_{CN}), \quad I_{CC'} = I_{CN}$$

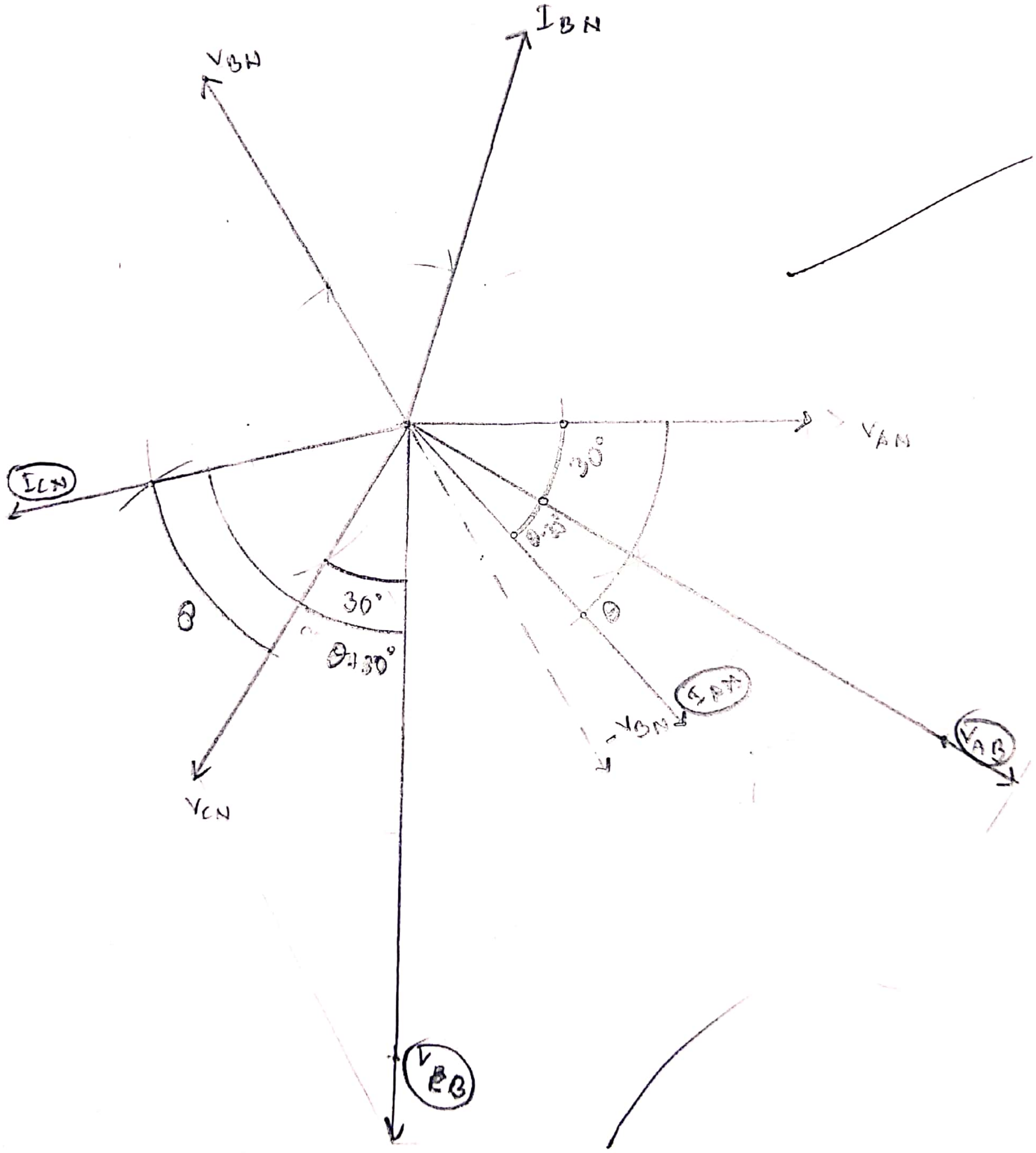


Fig. Phasor diagram showing vectors that determine W1 and W2 (the circled ones)

Discussion:

It was expected that the theoretical and practical values would be exactly same and also the power measured in two processes would also be same. However, these did not happen.

1. The $W_T = W_1 + W_2$ and $3W_p$ values were not exactly equal. There were some distance between these values. It is because the wires we used were not purely conductive and so in different ~~con~~ processes of measurement of power (two wattmeter's process and phase power) different values of internal resistance of the wires were included. So, W_T was not quite accurate with $3W_p$.

2. When we were measuring powers of a single phase, we saw that the powers consumed by different phases

appeared to be different. This confirms that the wye connection was not perfectly balanced and this can be another reason behind our not getting the accurate values as expected

3. The power factors obtained in different numbers of bulbs were different. It was expected that the power factors would be above 0.9, but we got them in the range 0.7-0.8 which are quite different. This indicates that there were some errors in connecting the circuit elements properly or not using the correctly rated ammeter. Moreover, ammeters with errors may result in wrong current output readings and thus result in a wrong power factor value.

Although there were some errors, we can consider our result to be close enough and reliable.