ELEMENTS OF ELECTRICAL ENGINEERING
Course Code : UE25EE141A/B

PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING

Numerical Examples on Two Wattmeter Method

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Numerical Example 1

Question:

Three coils each having a resistance of 20Ω and a reactance of 15Ω are connected in star across a three phase 400V, 50Hz supply. Calculate the readings of the two wattmeters connected to measure the power input.

If the coils are now connected in delta across the same supply, calculate the new wattmeter readings.

Solution:

Case 1: Balanced Star connected Load

Given Data:

Line voltage, V_L = 400V, f = 50Hz

Resistance per phase, R = 20Ω

Reactance per phase, X_L = 15Ω

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Numerical Example 1

Phase current, $I_{ph} = \frac{V_{ph}}{|Z|} = 9.24A = I_L$ (since star system)

Calculations:

Impedance per phase, Z = (20+j15)Ω

Therefore, |Z| = 25Ω & Phase Angle, ϕ = 36.87°

Phase voltage, $V_{ph} = \frac{V_L}{\sqrt{3}} = 230.94V$

Phase current, $I_{ph} = \frac{V_{ph}}{|Z|} = 9.24A = I_L$ (since star system)

Therefore, $W_1 = V_L I_L \cos(30+\phi) = 1.451KW$

Similarly, $W_2 = V_L I_L \cos(30-\phi) = 3.67KW$

Numerical Example 1

Case 2: Same Load reconnected as Delta Load

Since same supply, V_L remains same and since same load, Z remains same

Phase voltage, $V_{ph} = V_L = 400V$

Phase current, $I_{ph} = \frac{V_{ph}}{|Z|} = 16A$

Line current, $I_L = \sqrt{3} * I_{ph} = 27.71A$

Therefore, $W_1 = V_L I_L \cos(30+\phi) = 4.354KW$

Similarly, $W_2 = V_L I_L \cos(30-\phi) = 11KW$

Numerical Example 2

Question:

Two wattmeters are connected to measure power in a three phase circuit. The reading of one of the wattmeters is 5KW when the load power factor is unity. If the power factor of the load is changed to 0.707 lag without changing the total input power, calculate the new readings of the wattmeters.

Solution:

Case 1: Load Power factor is unity

Given Data:

W_1 = 5KW

Numerical Example 2

Calculations:

Since, power factor is unity, $W_1 = W_2$

Therefore, $P_{3\text{-phase}} = W_1 + W_2 = 10KW$

Case 2: Load Power factor is changed to 0.707 Lag with total input power unchanged.

Since total input power is same, $P_{3\text{-phase}} = W_1 + W_2 = 10KW$ ---- (1)

Power factor = $\cos\left(Tan^{-1}\left(\sqrt{3}*\frac{(W_2 - W_1)}{(W_1 + W_2)}\right)\right) = 0.707$ ---- (2)

Solving (1) & (2), $W_1 = 2.12KW$; $W_2 = 7.88KW$

Text Book & References

Text Book:

1. "Basic Electrical Engineering" S.K Bhattacharya, 1st Edition Pearson India Education Services Pvt. Ltd., 2017
2. "Basic Electrical Engineering", D. C. Kulshreshta, 2nd Edition, McGraw-Hill. 2019
3. "Special Electrical Machines" E G Janardanan, PHI Learning Pvt. Ltd., 2014

Reference Books:

1. "Engineering Circuit Analysis" William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023

2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.

THANK YOU

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