ELEMENTS OF ELECTRICAL ENGINEERING
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PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING

Balanced Delta Connected Three Phase System – Numerical Examples

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Numerical Example 1

Question :

1. A balanced delta connected load consumes 2 KW of power whenconnected to a three phase, 400 V, 50Hz supply. The same load when connected to a three phase 230V , 50 Hz supply, draws a current of 2 A at lagging power factor. Determine the load power factor and resistance and inductance per phase.

Solution :

Case1: Delta connected Load

Given Data:

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

Three phase Active Power, $P_{3\text{-phase}}$ = 2KW

Numerical Example 1 (contd..)

Therefore, $3*V_{ph}*I_{ph}*\cos\phi = 2000W$

i.e., $3* V_{ph}*\frac{V_{ph}}{Z} * \frac{R}{Z} = 2000W$

Since, delta connected system, $V_{ph} = V_L = 400V$

Therefore, $3* 400^2 *\frac{R}{Z^2} = 2000W$; Hence, $\frac{R}{Z^2} = 0.004167$ ------ (1)

Case2: Same Delta connected Load

Given Data:

Line voltage, $V_L = 230V$; f = 50Hz

Line current, $I_L = 2A$

Since same load, Z is same in both the cases.

Numerical Example 1 (contd..)

Since, delta connected system, $V_{ph} = V_L = 230V$

And, $I_{ph} = \frac{I_L}{\sqrt{3}} = 1.155A$

Therefore, $Z = \frac{V_{ph}}{I_{ph}} = 199.13\Omega$

Substituting 'Z' value in equation (1) above,

Resistance per phase, $R = 165.24\Omega$

Inductive reactance per phase, $X_L = \sqrt{Z^2 - R^2} = 111.12\Omega$

Inductance per phase, $L = \frac{X_L}{\omega} = 0.354H$

Power factor of the Load, $\cos\phi = \frac{R}{Z} = 0.83$ Lag

Numerical Example 2

Question:

2.The load connected to a three phase supply comprises three similar coils connected in star. The line current is 25 A, the real and apparent powers are 11KW, 20 KVA. Find the line voltage, resistance and reactance of each coil. If the coils are connected in delta, find the line current and power taken.

Solution :

Case1: Balanced Star connected Load

Given Data:

Line current, I_L = 25A

Three phase Active Power, $P_{3\text{-phase}}$ = 11KW

Three phase Apparent Power, $S_{3\text{-phase}}$ = 20KVA

Numerical Example 2 (contd..)

Calculations:

$S_{3\text{-phase}} = \sqrt{3} * V_L * I_L = 20KVA$
Hence, $V_L = 461.88V$

Since balanced star connected load,

$I_{ph} = I_L = 25A$; $V_{ph} = \frac{V_L}{\sqrt{3}} = 266.66V$

Impedance per phase, $Z = \frac{V_{ph}}{I_{ph}} = 10.66\Omega$

$P_{3\text{-phase}} = 11KW = 3 * I_{ph}^2 * R$; Hence, $R = 5.86\Omega$

Inductive reactance per phase, $X_L = \sqrt{(Z^2 - R^2)} = 8.905\Omega$

umerical Example 2 (contd..)

Case2: Same Load reconnected as Delta Load across same supply

Since same supply, V_L remains same and since same load, Z, R & L in each phase remain same.

Since balanced delta connected load, $V_{ph} = V_L = 461.88V$

Phase current, $I_{ph} = \frac{V_{ph}}{Z} = 43.33A$

Line current, $I_L = \sqrt{3} * I_{ph} = 75.04A$

Power drawn, $P_{3\text{-phase}} = 3 * I_{ph}^{2} * R = 33KW$

Apparent Power, $S_{3\text{-phase}} = \sqrt{3} * V_L * I_L = 60KVA$

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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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