

task_d9io924n0e3du21g_with_calculation

Student Group

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resonance, impedance, resonant circuit, exam ee2 SS2024

Exercise E21 Magnetic Circuit
(written test, approx. 10 % of a 120-minute written test, SS2024)

2. Calculate the real power, the apparent power, and the reactive power of the 400 V / 50 Hz three-phase power net. Each single string has a resistor $R=5 \text{ } \Omega$ and an inductance of $L=10 \text{ mH}$.

Path

$|Z_{RL}| = 5.90 \text{ } \Omega$
 $S = 21.477 \text{ kVA}$
 $P = 26.898 \text{ kW}$
 $Q = 14.310 \text{ kVAr}$

The apparent power S is given by $S = 3 \cdot U_s \cdot I_s = 3 \cdot \frac{U_s^2}{|Z_{RL}|} = 3 \cdot \frac{(230 \text{ V})^2}{5.90 \text{ } \Omega} = 26.898 \text{ kVA}$

The active power is $P = S \cdot \cos \varphi = 26.898 \text{ kVA} \cdot 0.84673 = 22.775 \text{ kW}$

The reactive power is $Q = \sqrt{S^2 - P^2} = \sqrt{(26.898 \text{ kVA})^2 - (22.775 \text{ kW})^2} = 14.310 \text{ kVAr}$

1. Calculate the $\cos \varphi$, and the magnitude of the impedance $|Z|$ for a single string.

Path

The phase φ is given by: $\varphi = \arctan \left(\frac{X_L}{R} \right) = \arctan \left(\frac{2\pi \cdot f \cdot L}{R} \right) = \arctan \left(\frac{2\pi \cdot 50 \text{ Hz} \cdot 10 \cdot 10^{-3} \text{ H}}{5 \text{ } \Omega} \right) = 0.5609 \dots \hat{=} +32^\circ$

With this, the $\cos \varphi$ becomes $\cos \varphi = \cos(0.5609 \dots) = 0.84673 \dots$

The impedance is given by: $|Z_{RL}| = \sqrt{X_L^2 + R^2} = \sqrt{(2\pi \cdot f \cdot L)^2 + R^2} = \sqrt{(2\pi \cdot 50 \text{ Hz} \cdot 10 \cdot 10^{-3} \text{ H})^2 + (5 \text{ } \Omega)^2} = 5.905 \dots \text{ } \Omega$

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Last update: **2024/07/16 00:17**

