

task_d9io924n0e3du21g_with_calculation

Student Group

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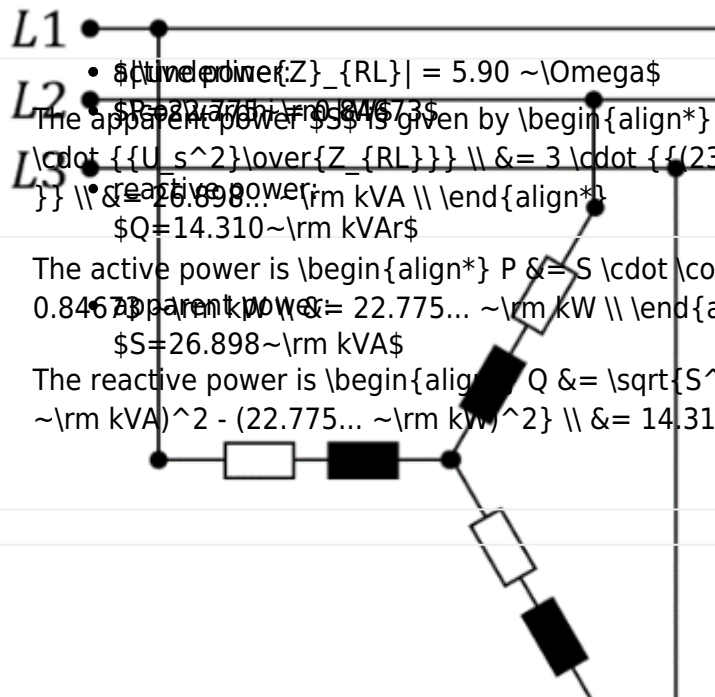
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resonance, impedance, resonant circuit, exam ee2 SS2024

Exercise E1 Magnetic Circuit**(written test, approx. 10 % of a 120-minute written test, SS2024)**

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



$|Z_{RL}| = 5.90 \text{ } \Omega$
 $R=5 \text{ } \Omega$
 $L=10 \text{ mH}$
 $f=50 \text{ Hz}$
 $U_s=230 \text{ V}$
 $I_s=38.46 \text{ A}$
 $\cos \varphi = 0.84673$
 $\varphi = 32^\circ$
 $P=26.898 \text{ kW}$
 $Q=14.310 \text{ kVar}$
 $S=22.775 \text{ kVA}$

The apparent power S is given by
$$S = 3 \cdot U_s \cdot I_s = 3 \cdot \frac{U_s^2}{|Z_{RL}|} = 3 \cdot \frac{(230 \text{ V})^2}{5.90 \text{ } \Omega} = 22.775 \text{ kVA}$$

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

The reactive power is
$$Q = \sqrt{S^2 - P^2} = 14.310 \text{ kVar}$$

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

Path

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

With this, the $\cos \varphi$ becomes
$$\cos \varphi = \cos(0.5609 \text{ rad}) = 0.84673$$

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

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

