

Analysis of electrical power and energy systems

Practical session 4

12 October 2020

1 Transformers in power systems¹

1. Assume the transformer in Figure 1 to be ideal. Winding 1 is applied a sinusoidal voltage in steady-state with $\bar{V}_1 = 120 \text{ V} \angle 0^\circ$ at a frequency $f = 60 \text{ Hz}$. $N_1/N_2 = 3$. The load on winding 2 is a series combination of R and L with $Z_L = (5 + j3) \Omega$. Calculate the current drawn from the voltage source.

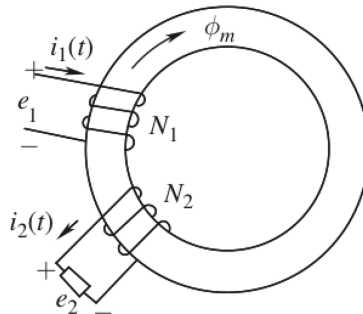


Figure 1: Transformer with load connected to the secondary winding.

2. A 2400/240-V, 60-Hz transformer has the following parameters in the equivalent circuit of Figure 2: the high-side leakage impedance is $(1.2 + j2.0) \Omega$ and the low-side leakage impedance is $(0.012 + j0.02) \Omega$. Neglect R_{he} . Calculate the input voltage if the output voltage is 240 V (rms), supplying a load of 1.5Ω at a power factor of 0.9 (lagging)
 - (a) if X_m at the high side is 1800Ω ;
 - (b) if X_m at the high side is neglected.

Use the per-unit formalism, considering the (2400 V, 38400 VA) base on the primary side.

2 Solutions

1. $\bar{I}_1 = 20.58 \text{ A} \angle 149.04^\circ$
2.
 - (a) $\bar{V}_1 = 2465.48 \text{ V} \angle 0.91^\circ$
 - (b) $\bar{V}_1 = 2462.80 \text{ V} \angle 0.95^\circ$

¹Exercises 6.2, 6.4 of Ned Mohan's book "Electric power systems, a first course"

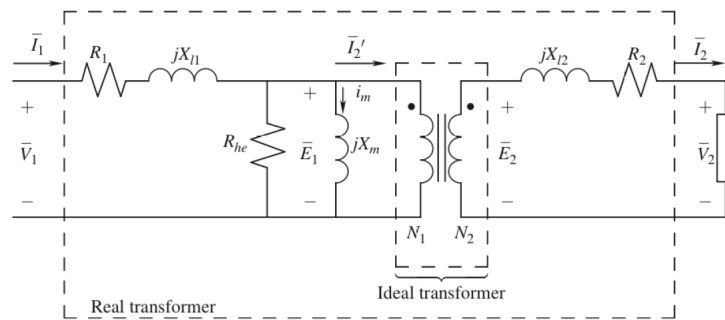


Figure 2: Transformer equivalent circuit.