Analysis of electrical power and energy systems

Practical session 4

14 October 2021

1 Transformers in power systems[1]

1. Assume the transformer in Figure 1 to be ideal. Winding 1 is applied a sinusoidal voltage in steady-state with $\overline{V}_1 = 120$ V$\angle 0°$ at a frequency $f = 60$ 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.

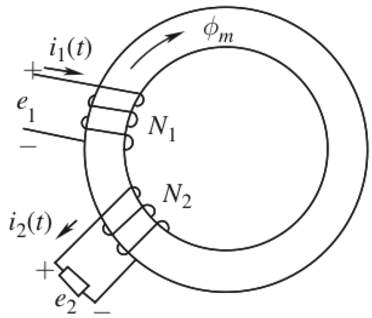

Figure 1: Transformer with load connected to the secondary winding.

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 1.5 Ω at a power factor of 0.9 (lagging)

   (a) if X_m at the high side is 1800 Ω;

   (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 and the (240 V, 38400 VA) base on the secondary one.

2 Solutions

Link to the python notebook shown during the session: Python Notebook TP4

1. $\overline{I}_1 = 2.29$ A$\angle - 30.94°$

2. (a) $\overline{V}_1 = 2465.48$V$\angle 0.91°$

   (b) $\overline{V}_1 = 2462.80$V$\angle 0.95°$

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

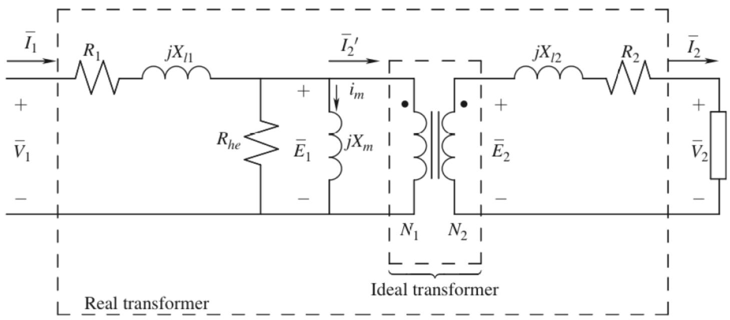

Figure 2: Transformer equivalent circuit.