

# Analysis of electrical power and energy systems

## Practical session 4

13 October 2022

### 1 Transformers in power systems<sup>1</sup>

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.

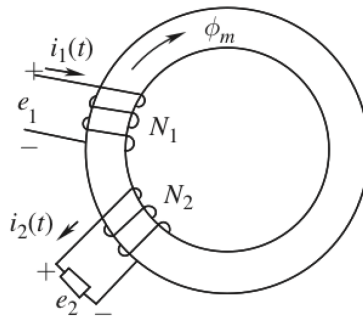


Figure 1: Transformer with load connected to the secondary winding.

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  $1.5 \Omega$  at a power factor of 0.9 (lagging)
  - (a) if  $X_m$  at the high side is  $1800 \Omega$ ;
  - (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.  $\bar{I}_1 = 2.29 \text{ A} \angle -30.94^\circ$
2.
  - (a)  $\bar{V}_1 = 2465.48 \text{ V} \angle 0.91^\circ$
  - (b)  $\bar{V}_1 = 2462.80 \text{ V} \angle 0.95^\circ$

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

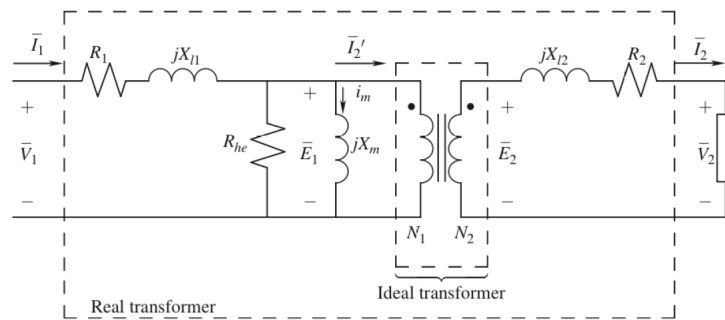


Figure 2: Transformer equivalent circuit.