EEN-304: Electrical Energy Systems **TUTORIAL-III**

(Transformer)

Q1. A single-phase 60-Hz transformer has a nameplate voltage rating of 7.97 kV:266 V, which is based on its winding turns ratio. The manufacturer calculates that the primary (7.97-kV) leakage inductance is 165 mH and the primary magnetizing inductance is 135 H. For an applied primary voltage of 7970 V at 60 Hz, calculate the resultant open-circuit secondary voltage.

[Ans: 266 V]

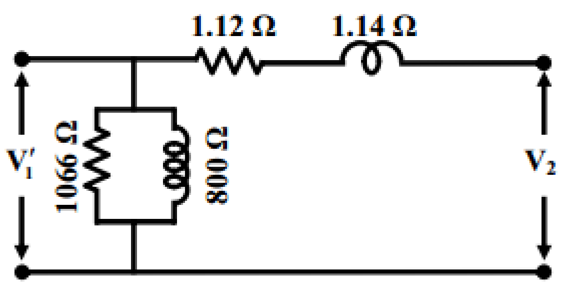
Q2. A 460-V: 2400-V transformer has a series leakage reactance of 37.2 ohm as referred to the high-voltage side. A load connected to the low-voltage side is observed to be absorbing 25 kW, unity power factor, and the voltage is measured to be 450 V. Calculate the corresponding voltage and power factor as measured at the high-voltage terminals.

[Ans: $2381\angle 9.6^{\circ}$ **0.986(lagging)]**

Q3. A single phase load is supplied through a 34.5 KV feeder and a 34.5/2.4 KV transformer. The feeder has an impedance of 50+j80 ohms and the transformer has an equivalent impedance of 20+j120 ohms referred to its high voltage side. The load takes 260 KW at 2.3 KV and 0.866 lagging pf.

i. Find voltage at the primary side of the transformer.
ii. Determine voltage at the sending end of the feeder
iii. Calculate real and reactive power inputs at the sending end of the feeder.

Q4. The equivalent circuit of a transformer (single phase, 5 kVA, 200V/400V, 50 Hz), is shown below,



Calculate the following:

i) The efficiency of the transformer at 75% loading with load power factor = 0.7

ii) At what load or kVA the transformer is to be operated for maximum efficiency? Also calculate the value of maximum efficiency.

iii) The regulation of the transformer at full load 0.8 power factor lag.

iv) What should be the applied voltage to the LV side when the transformer delivers rated current at 0.7 power factor lagging, at a terminal voltage of 400 V?

[Ans: i) 91.35 %, ii) 4.15 KVA, iii) 4.9 %, iv) 210 V]

Q5. The nameplate on a 50-MVA, 60-Hz single-phase transformer indicates that it has a voltage rating of 8.0-kV:78-kV. An open-circuit test is conducted from the low-voltage side, and the corresponding instrument readings are 8.0 kV, 62.1 A, and 206 kW. Similarly, a short-circuit test from the low-voltage side gives readings of 674 V, 6.25 kA, and 187 kW.

a. Calculate the equivalent series impedance, resistance, and reactance of the transformer as referred to the low-voltage terminals.

b. Calculate the equivalent series impedance of the transformer as referred to the high-voltage terminals.

c. Determine the efficiency, if the transformer is operating at the rated voltage and load (unity power factor).

d. Repeat part (c), assuming the load to be at 0.9 power factor leading.

[Ans.: 107.8 mΩ, 4.78 mΩ, 107.7 mΩ, (b) 10.3 + j 0.46 mΩ, (c)99.2 %, (d)99.2 %, -3.02 %]

Q6. A balanced delta connected resistive load of 8000 kW is connected to the low-voltage, delta-connected side of star-delta transformer rated 10,000 kVA, 138/13.8 kV. Find the load resistance in ohms in each phase as measured from line to neutral on the high-voltage side of the transformer. Neglect transformer impedance and assume rated voltage is applied to the transformer primary.
[2380Ω]

Q7. A transformer rated 200 MVA, 345Y/20.5Δ kV connects a balanced load rated 180 MVA, 22.5 kV, 0.8 power-factor lag to a transmission line. Determine

(a) The rating of each of three single-phase transformers which when properly connected will be equivalent to the above three-phase transformer.
(b) The complex impedance of the load in per unit in the impedance diagram if the base in the transmission line is 100 MVA, 345 kV.

[Ans.: (a) 66.67MVA; (345/√3)/20.5 kV, (b) 2.81 Ω $\angle 36.87^0$]