Tutorial Sheet – No 6

(Transformers 2)

1 A transformer has a primary to secondary turns ratio of 1:20 and operates from a $250V_{rms}$ supply. The transformer has negligible resistance and leakage reactance but draws a primary magnetising current of $30A_{rms}$, which can be considered as a purely reactive current. If the load consists of a resistance of 400Ω in series with an inductive reactance of 300Ω calculate the amplitude and phase of the output voltage and current, the output power and the total input current.

($5\angle 0°kV_{rms}$; $10\angle -36.9°A_{rms}$; 40kW; $219.3\angle -43.2°A_{rms}$)

2 A ground heating cable of resistance 0.1Ω is connected to the secondary of a transformer of 50:1 primary to secondary turns ratio whose primary is connected to a $250V_{rms}$ supply. The transformer primary and secondary have winding resistances of 3.0Ω and 0.005Ω and leakage reactances of 10Ω and 0.02Ω respectively. What power will be dissipated in the ground by the cable and what is the efficiency of the transformer if its core losses are 5 Watts?

(210.7W; 92%)

3 A transformer has a primary to secondary turns ratio of *n:1*, an infinite magnetising impedance and a total effective winding resistance R_e and leakage reactance X_e, both referred to the primary. Show that the magnitude of the secondary voltage V_2 across a load of resistance R, in terms of the primary input voltage V_1 is:

$$V_2 = \frac{nV_1R}{\sqrt{\left(R_e + n^2R\right)^2 + X_e^{\,2}}}$$

The transformer above is connected to a low voltage bulb which appears as a resistance of 1.0Ω at it's operating temperature. The transformer has the following parameters:

n = 20; V_1 = $250V_{rms}$; R_e = 0Ω; X_e = 117Ω

Calculate the voltage across the bulb, the power supplied to the bulb and the necessary current rating of the supply cable to the transformer primary.

($12V_{rms}$; 144W; $0.6A_{rms}$)

4 A 12kVA, 400:$230V_{rms}$, 50Hz, single-phase transformer gave the following test results:

On no load: V_1 = $400V_{rms}$, I_1 = $1.15A_{rms}$, input power, W_{oc} = 120W

On short circuit: V_1 = $25V_{rms}$, I_1 = $25A_{rms}$, input power, W_{sc} = 80W

(a) Find the total transformer resistance and leakage reactance referred to the primary, the no-load input current and its power factor.

(0.128Ω; 0.99Ω; $1.15A_{rms}$ at 0.26 pf lagging)

(b) If the transformer delivers full load at unity power-factor calculate its losses and efficiency.
(Note: assume the transformer VA rating applies to its output capability).

(235W; 98.1%)

(c) If the transformer is connected to a load of (4+j1)Ω, calculate the amplitude and phase of the load voltage and the transformer regulation for this load condition.

($222.9\angle -4.14°\ V_{rms}$; 3.1%)