

$$P_{\text{core}} = \frac{V_p'^2}{R_c} = \frac{283^2}{50} = 1602 \text{ W}$$

iv What is the transformer's efficiency under the conditions of part (iii)?

$$P_{\text{OUT}} = S \cos \theta = (100 \text{ kVA})(0.85) = 85 \text{ kW}$$

$$\eta = \frac{P_{\text{OUT}}}{P_{\text{OUT}} + P_{\text{CU}} + P_{\text{core}}} \times 100\% = \frac{85,000}{85,000 + 1430 + 1602} \times 100\% = 96.6\%$$

7. A single-phase transformer has 600 primary turns and 100 secondary turns. The primary and secondary resistances are  $0.1\Omega$  and  $0.01\Omega$  respectively and the corresponding leakage reactance are  $0.6\Omega$  and  $0.025\Omega$  respectively. Determine;
- Equivalent resistance
  - Equivalent reactance
  - Equivalent impedance
  - Phase angle of the impedance
- (6 marks)

**Solution**

i Equivalent resistance

$$R_e = R_1 + R_2 \left(\frac{N_1}{N_2}\right)^2 = R_1 + R_2 \left(\frac{N_1}{N_2}\right)^2 = R_1 + R_2(a)^2 = 0.1 + 0.01 \left(\frac{600}{100}\right)^2 = 0.46 \Omega .$$

ii Equivalent reactance

$$X_e = X_1 + X_2 \left(\frac{N_1}{N_2}\right)^2 = X_e = X_1 + X_2 \left(\frac{N_1}{N_2}\right)^2 = X_e = X_1 + X_2(a)^2 = 0.6 + 0.025 \left(\frac{600}{100}\right)^2 = 1.5\Omega$$

iii Equivalent impedance

$$Z_e = \sqrt{R_e^2 + X_e^2} = \sqrt{0.46^2 + 1.5^2} = 1.568948 \Omega \text{ or } 1.569 \Omega$$

i Phase angle of the impedance

$$\cos \varphi_e = \frac{R_e}{Z_e} = \frac{0.46}{1.569}$$

$$\text{and phase angle of impedance, } \varphi_e = \cos^{-1} \left( \frac{0.46}{1.569} \right) = 72.95^\circ$$