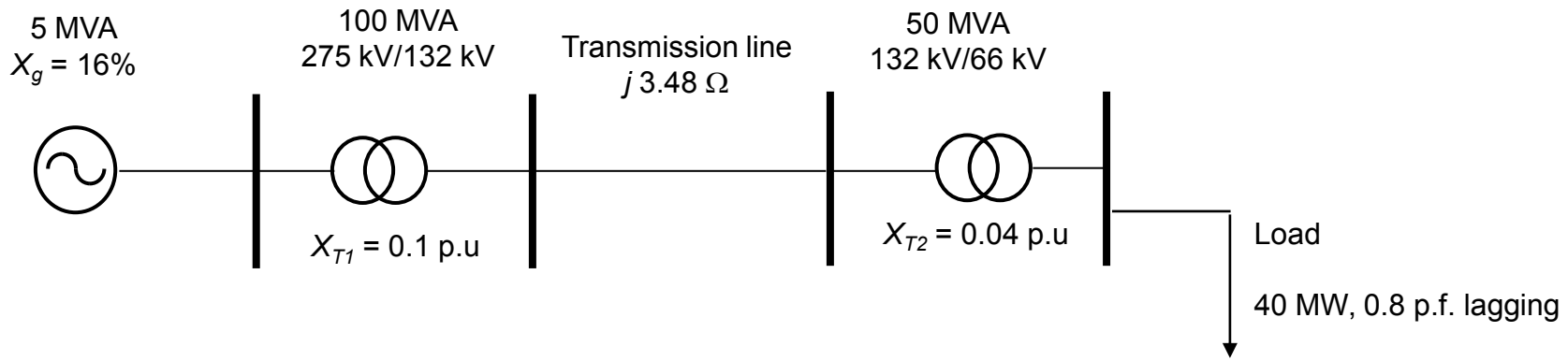
Lecture 3

Example 1

Determine the per-unit values of the following single-line diagram and draw the impedance diagram.



Solution:

Chosen base: Always choose the largest rating, therefore S_{base} = 100 MVA, V = 66 kV, 132 kV and 275 kV

Per-unit calculations:

Generator G1:

$$Z_{NEW}(pu) = Z_{OLD} \times \frac{\left[kV_{base\ OLD}\right]^2}{\left[kV_{base\ NEW}\right]^2} \times \frac{MVA_{base\ NEW}}{MVA_{base\ OLD}}$$

$$X_g(pu) = 0.16 \times \frac{100}{50} = 0.32 \quad \text{p.u.}$$

Transformer T1:

$$X_{T1}(pu) = 0.1 \quad \text{p.u.}$$

Transmission line TL:

$$Z_{base} = \frac{[kV_{base}]^2}{MVA_{base}} \qquad Z_{pu} = \frac{Z_{actual}}{Z_{base}}$$

$$X_{TL}(pu) = \frac{3.4 \times 100}{132^2} = 0.0195 \quad \text{p.u.}$$

Inductive load:

$$Z_{actual} = \frac{66 \times 10^3 / \sqrt{3}}{40 \times 10^6 / \sqrt{3} \times 66 \times 10^3 \times 0.8} = 87.12 \angle 36.87^o \quad \Omega$$

$$Z_L(pu) = \frac{87.12 \angle 36.87^o \times 100}{66^2} = 2 \angle 36.87^o \ or \ (1.6 + j1.2) \quad \text{p.u.}$$

Transformer T2:

$$X_{T2}(pu) = 0.04 \times \frac{100}{50} = 0.08 \quad \text{p.u.}$$

Now, we have all the impedance values in per-unit with a common base and we can now combine all the impedances and determine the overall impedance.