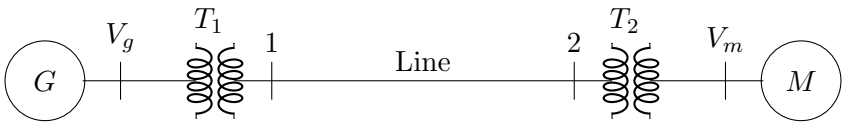
Problem Set - 2
Performance of Transmission Lines and Per unit Calculation

1. A short 3-phase transmission line has a series line impedance per phase of $(0.5 + \jmath 0.7)\ \Omega$. The line delivers a load of 50 MW at 33 kV and 0.7 pf lagging. Determine the regulation of the line. If the same load is delivered at 0.7 pf leading, determine the regulation of the line.**(Ans: 5.58 % , -0.83 %)**

2. A 230 kV, three-phase transmission line has a per phase series impedance of $z = 0.05 + \jmath 0.45\ \Omega$ per km and a per phase shunt admittance of $y = \jmath 3.4 \times 10^{-6}\ \mho$ per km. The line is 80 km long. Using the nominal-π model, find the sending end voltage and current, voltage regulation, the sending end power and the transmission efficiency when the line delivers 200 MVA, 0.8 pf lagging at 220 kV. **(Ans:242.67 kV, 502.38$\angle -$ 33.69°,10.47 %, 163.18 MW, 134.02 MVAr, 98.052 %)**

3. A 3-phase 50 Hz transmission line has resistance, inductance, and capacitance per phase of 10 Ω, 0.1 H and 0.9 μF respectively and delivers a load of 35 MW at 132 kV and 0.8 pf lagging. Determine the efficiency and regulation of the line using nominal -T method. **(Ans: 97.15 %, 6.83 %)**

4. The three phase power and line-line ratings of the electric power system shown here are •

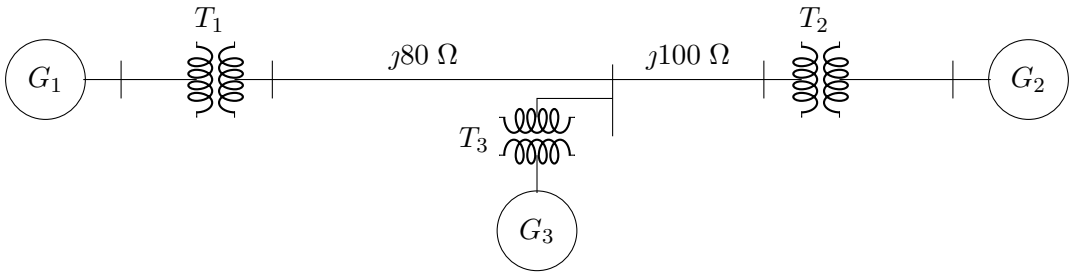


G :	60 MVA	20 kV	X = 9 %
T_1 :	50 MVA	20/200 kV	X = 10 %
T_2 :	50 MVA	200/20 kV	X = 10 %
M :	43.2 MVA	18 kV	X = 8 %
Line:		200 kV	$Z = 120 + \jmath 200\ \Omega$

   (a) Draw an impedacne diagram showing all impedances in per unit on a 100 MVA base. Choose 20 kV as the voltage base for generator.

   (b) The motor is drawing 45 MVA, 0.8 pf lagging at 18 kV. Determine the terminal voltage of the generator in kV. **(Ans: 26.359 kV)**

5. Draw the reactance diagram with all reactances marked in per unit.



G_1 :	20 MVA	13.8 kV	X = 20 %
G_2 :	30 MVA	18 kV	X = 20 %
G_3 :	30 MVA	20 kV	X = 20 %
T_1 :	25 MVA	220 Y /13.8 Δ kV	X = 10 %
T_2 :	(Y / Δ) Single phase units each rated 10 MVA, 127/18 kV, X =10 %		
T_3 :	35 MVA	220 Y /22 Y kV	X = 10 %

Choose a base of 50 MVA, 13.8 kV in the circuit of Generator 1.