ELEMENTS OF POWER SYSTEM

Experiment 2

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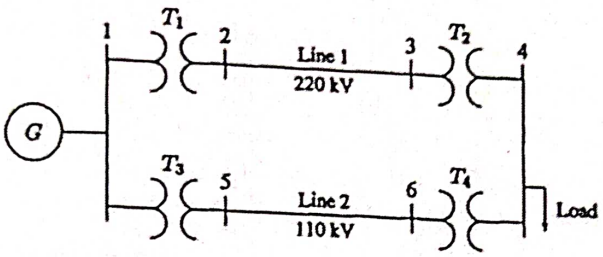
Aim: To develop and study Simulink model of the power system networks for the given one- line diagram. **Circuit Diagram:**



The reactance data of the elements are given below

Generator No. 1	90 MVA	22 kV	
Transformer T1	50 MVA	(3 phase) 22/220 kV	X=0.1 p.u.
Transformer T2	40 MVA	(3 phase) 220/11 kV	X = 0.06 p.u.
Transformer T3	40 MVA	(3 phase) 22/110 kV	X = 0.064 p.u.
Transformer T4	40 MVA	(3 phase) 110/11 kV	X = 0.08 p.u.

The three-phase load at bus 4 absorbs 57 MVA, 0.6 power factor lagging at 10.45 kV. Line 1 and line 2 have impedances of 48.4 and 65.43 Ω, respectively

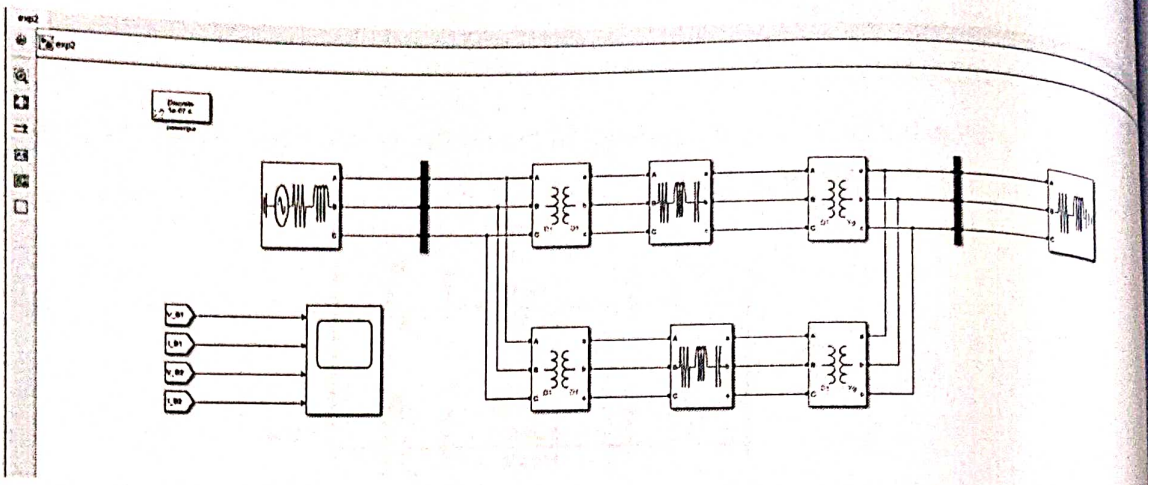
Theory:

A one-line diagram of a power system shows the main connections and arrangements of components. Any particular component may or may not be shown depending on the information required in a system. A simplified diagram of an electric system is called a single-line or one-line diagram in which per phase equivalent of the three phase lines is shown omitting the neutral.

Procedure:

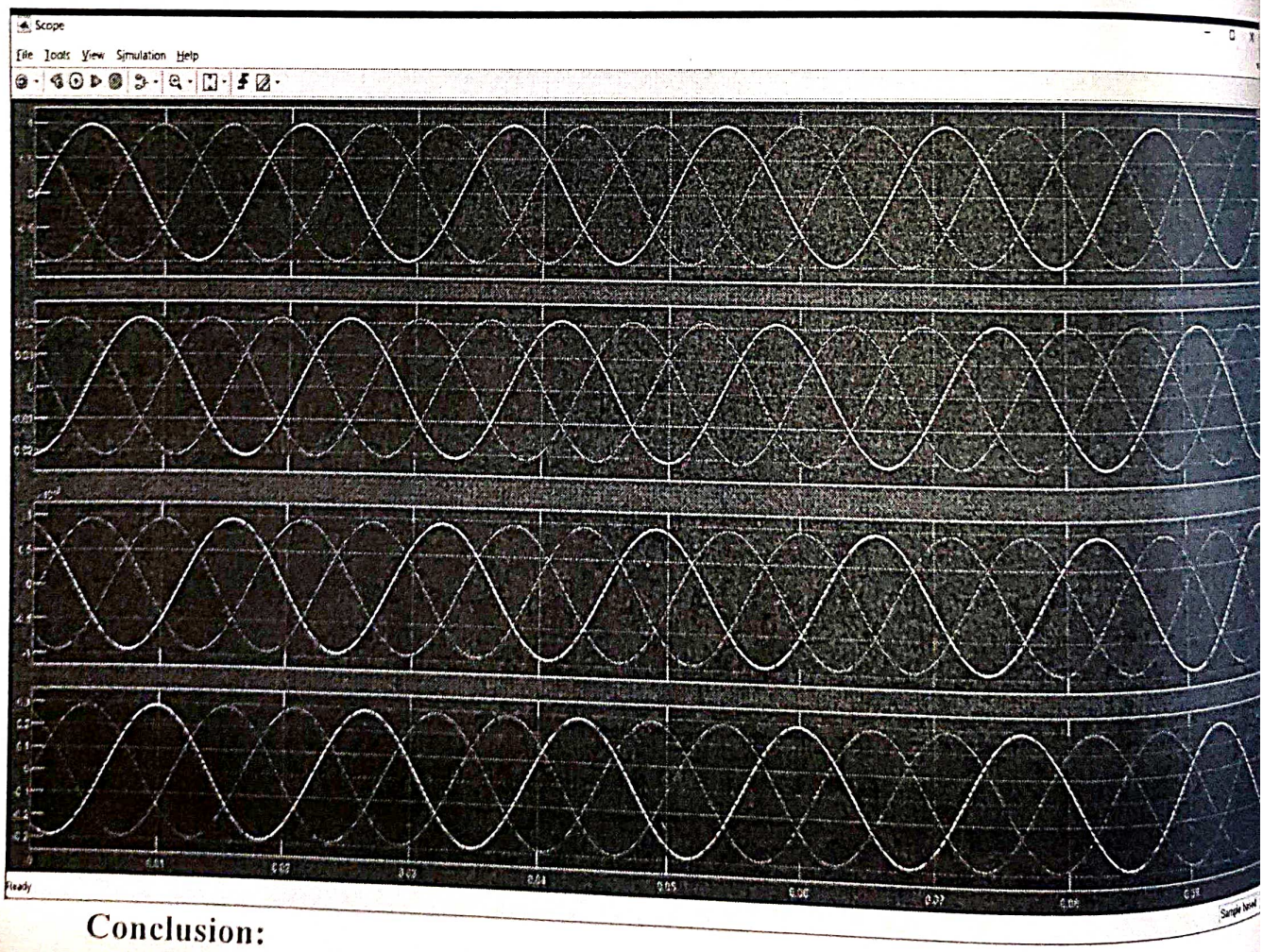
Develop a Simulink model of the given one-line diagram of the power network.

Simulink Model:



Observation:

Output waveform of the Simulink model



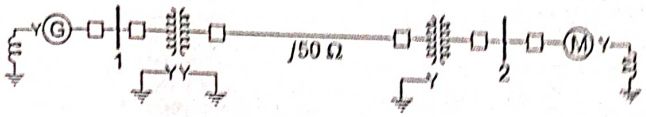
Conclusion:

In this experiment we successfully developed the Simulink model and got the graph.

Question:

Q1. Draw the pu impedance diagram for the power system shown in Fig.. Neglect resistance, and use a base of 100 MVA, 220 kV in 50 W line. The ratings of the generator, motor and transformers are

Generator	40 MVA,	25 kV,	$X'' = 20\%$
Motor	50 MVA,	11 kV,	$X'' = 30\%$
Y–Y transformer,	40 MVA,	33 Y–220 Y kV,	$X = 15\%$
Y–Δ transformer,	30 MVA,	11 Δ–220 Y kV,	$X = 15\%$



Q2. Define infinite bus in the power system.

Q3. What is the purpose of VI measurement block in Simulink?

Ans (1) Base $MVA_{b\,new} = 100\ MVA$, Base $kV_{b\,new} = 220\ kV$

Transmission Line $j50\ \Omega$

$$Z_{pu} = \frac{Z_{actual}}{Z_{base}} = \frac{Z_{actual}}{kV_{b\,new}^2} \times MVA_{b\,new}$$

$$Z_{pu} = \frac{j50}{(220)^2} \times 100 = j\,0.1033\ pu$$

Transformer T_1 :→

$$kV_{b(new)} = \frac{kV_{b(old)} \times \text{LT side voltage rating } T_1}{\text{HV side voltage rating } T_2}$$

$$kV_{b(new)} = 220\left(\frac{33}{220}\right) = 33\,kV$$

$$Z_{pu(new)} = Z_{pu(old)}\left(\frac{kV_{b(old)}}{kV_{b(new)}}\right)^2 \times \left(\frac{MVA_{b(new)}}{MVA_{b\,old}}\right)$$

$$= j(0.15)\left(\frac{33}{33}\right)^2 \times \left(\frac{100}{40}\right) = j\,0.375\ pu$$

Generator G_2 :-

$$Z_{pu(new)} = Z_{pu(old)} \times \left(\frac{kV_{b(old)}}{kV_{b(new)}}\right)^2 \times \left(\frac{MVA_{b(new)}}{MVA_{b(old)}}\right)$$

$$j(0.2) \times \left(\frac{25}{33}\right)^2 \times \left(\frac{100}{70}\right) = j(0.287)\ pu$$

Transformer T_2 :-

$KV_b(old) = 220kV$ (HT side voltage)

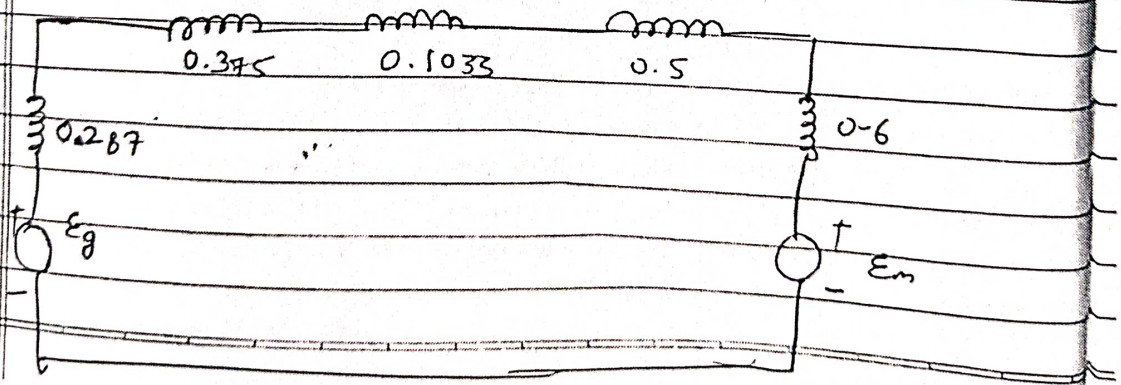
$$KV_{b(new)} = KV_b(old) \times \frac{\text{LT side voltage of } T_2}{\text{HT side voltage of } T_2}$$

$$(KV_b)_{new} = 220 \times \frac{15}{220} = 11\ kV$$

$$Z_{pu(new)} = j(0.5) \times \left(\frac{11}{11}\right)^2 \times \frac{100}{30} = j(0.5)\ pu$$

synch. motor :-

$$Z_{pu(new)} = (j0.15) \times \left(\frac{15}{11}\right)^2 \times \frac{100}{50} = j(0.6)\ pu$$



Ans (2) The bus whose voltage & frequency remain constant even after the variation in the load is known as the infinite bus. The alternators operating in parallel in a power system are the example of the infinite bus.

Ans (3) The three-ϕ VI measurement block is used to measure instanious three phase voltage and current in a circuit. When it is connected in series with 3-ϕ elements, it returns the three phase to ground or phase to phase to phase peak voltage and current. The block output the voltages and currents in per unit (pu) or in volts & ampers.