**MGM's**
**Jawaharlal Nehru Engineering College, Aurangabad**

# Laboratory Manual

## Power System Lab-I

**For**
**M.Tech (EPS) Students**

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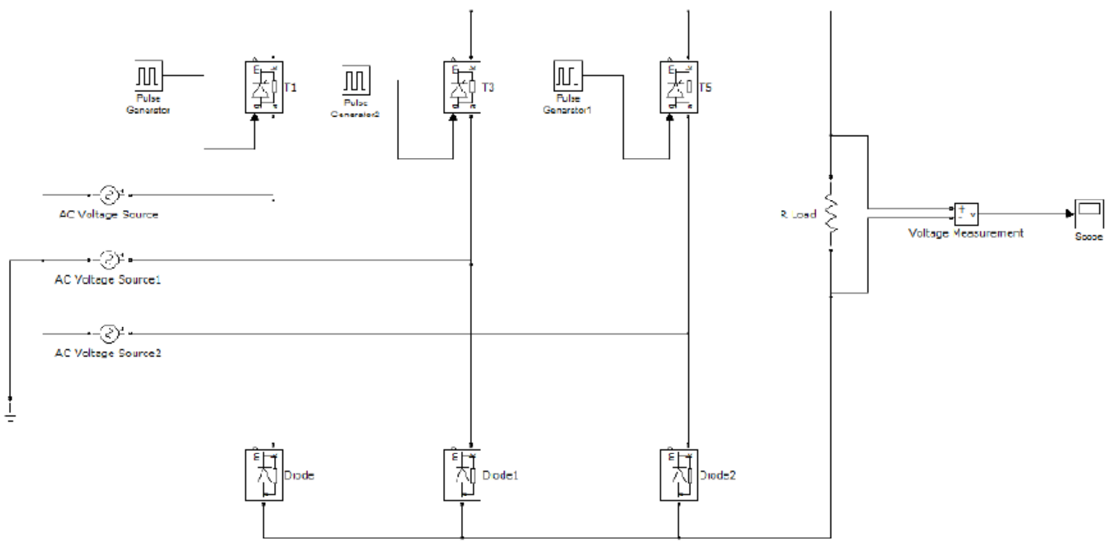
**Exercise No.: 01**

**AIM: Simulation of Three-Phase Thyristor Controlled Converter.**

**Simulation Circuit Diagram:**




**Outputs:**

1. Observe the waveforms for output signals.
2. Note the remarks on observed signals.

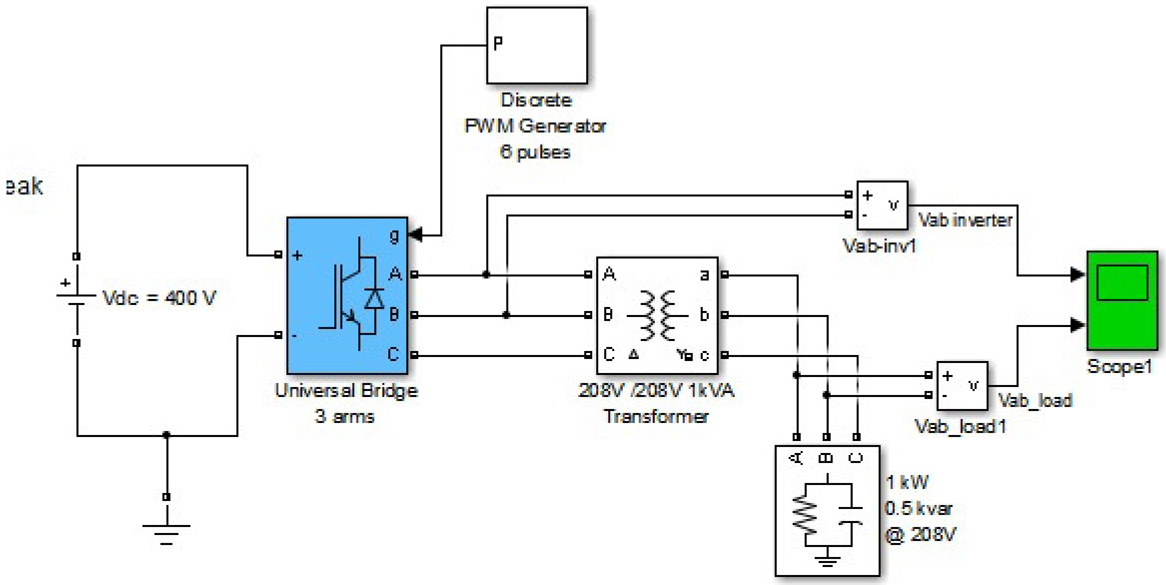
**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.

**Exercise No.:02**

**AIM: Simulation of Three-Phase Two-Level PWM Converters.**

**Simulation Circuit Diagram:**




**Outputs:**

1. Observe the waveforms for output signals.
2. Note the remarks on observed signals.

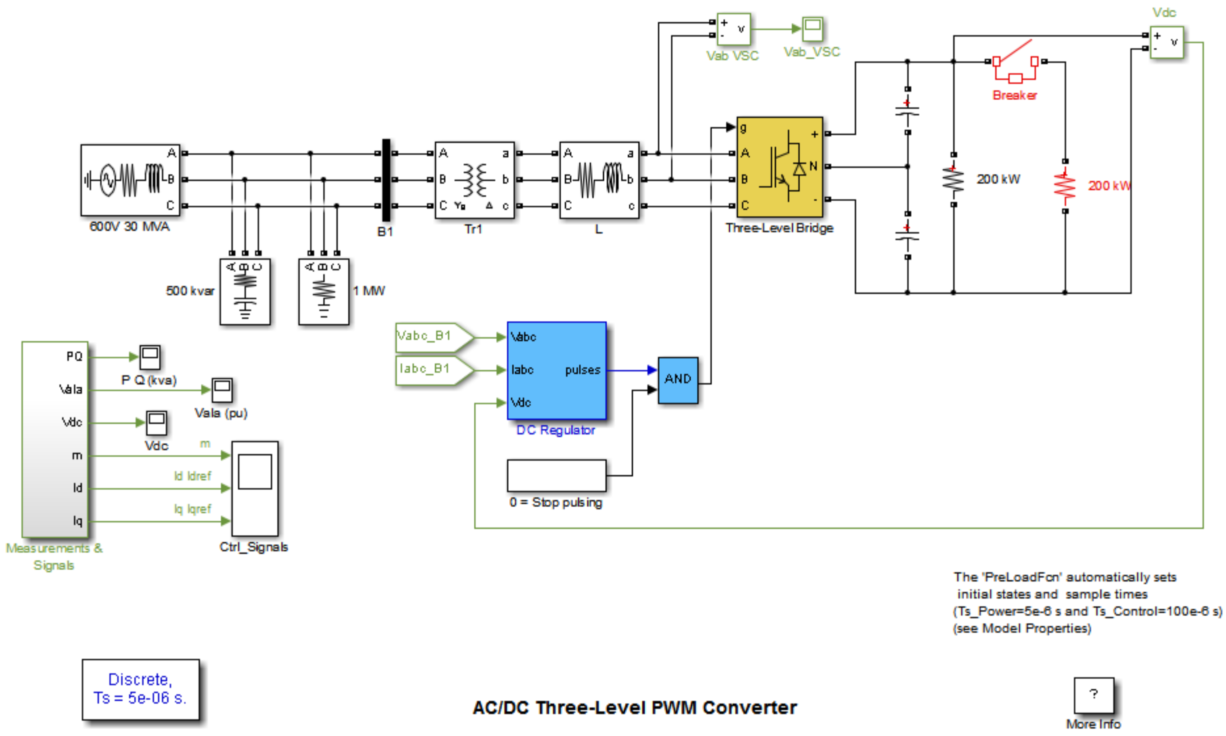
**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.

## Exercise No.: 03

## Aim: Simulation of AC/DC Three Level PWM Converters.

## Simulation Circuit Diagram:




## Outputs:

1. Observe the waveforms for output signals.
2. Note the remarks on observed signals.

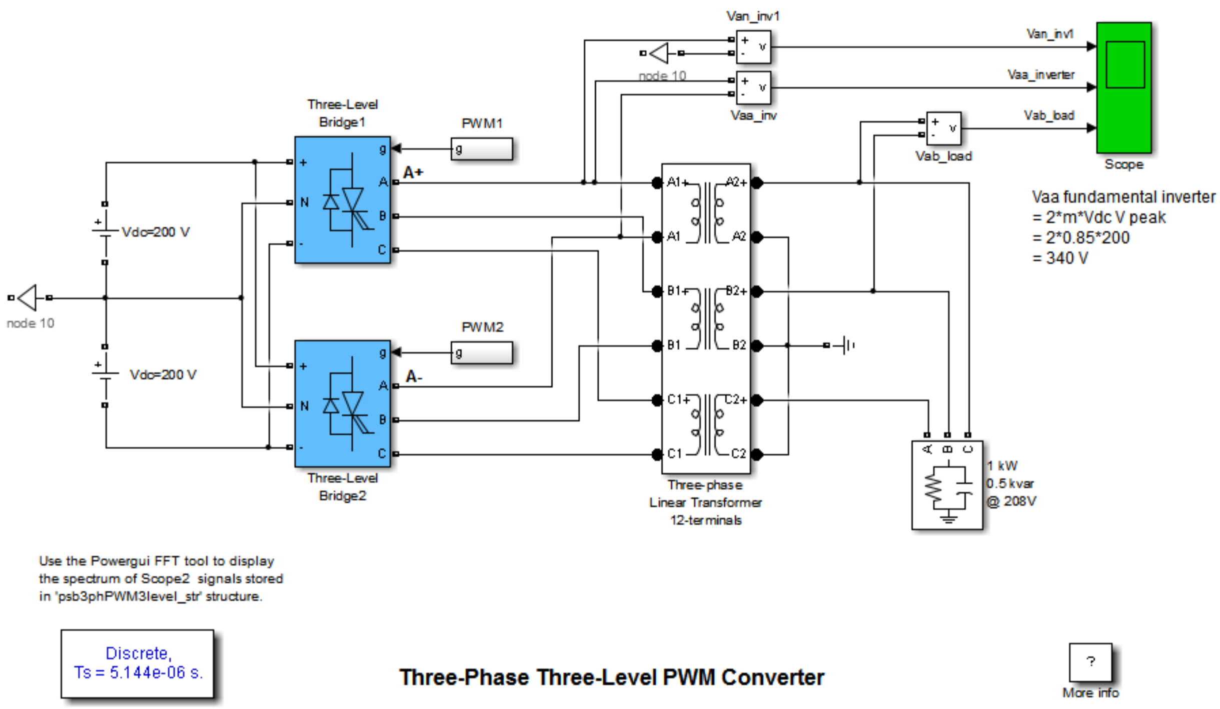
## Concluding Remarks:

Write brief concluding remarks on the circuit studied and observed waveforms.

**Exercise No: 04**

**AIM: Simulation of Three-Phase Three Level PWM Converters.**

**Simulation Circuit Diagram:**




**Outputs:**

1. Observe the waveforms for output signals.
2. Note the remarks on observed signals.

**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.

**Exercise No: 05**

**AIM: To determine sinusoidal voltages and currents**

**Theory :** The RMS Voltage of an AC Waveform The RMS value is the square root of the mean (average) value of the squared function of the instantaneous values. The symbols used for defining an RMS value are VRMS or I RMS. The term RMS, refers to time-varying sinusoidal voltages, currents or complex waveforms were the magnitude of the waveform changes over time and is not used in DC circuit analysis or calculations were the magnitude is always constant. When used to compare the equivalent RMS voltage value of an alternating sinusoidal waveform that supplies the same electrical power to a given load as an equivalent DC circuit, the RMS value is called the “effective value” and is presented as: Veffor Ieff. In other words, the effective value is an equivalent DC value which tells you how many volts or amps of DC that a time-varying sinusoidal waveform is equal to in terms of its ability to produce the same power. For example, the domestic mains supply in the United Kingdom is 240Vac. This value is assumed to indicate an effective value of “240 Volts RMS”. This means then that the sinusoidal RMS voltage from the wall sockets of a UK home is capable of producing the same average positive power as 240 volts of steady DC voltage as shown below.

**Simulation Circuit Diagram:**

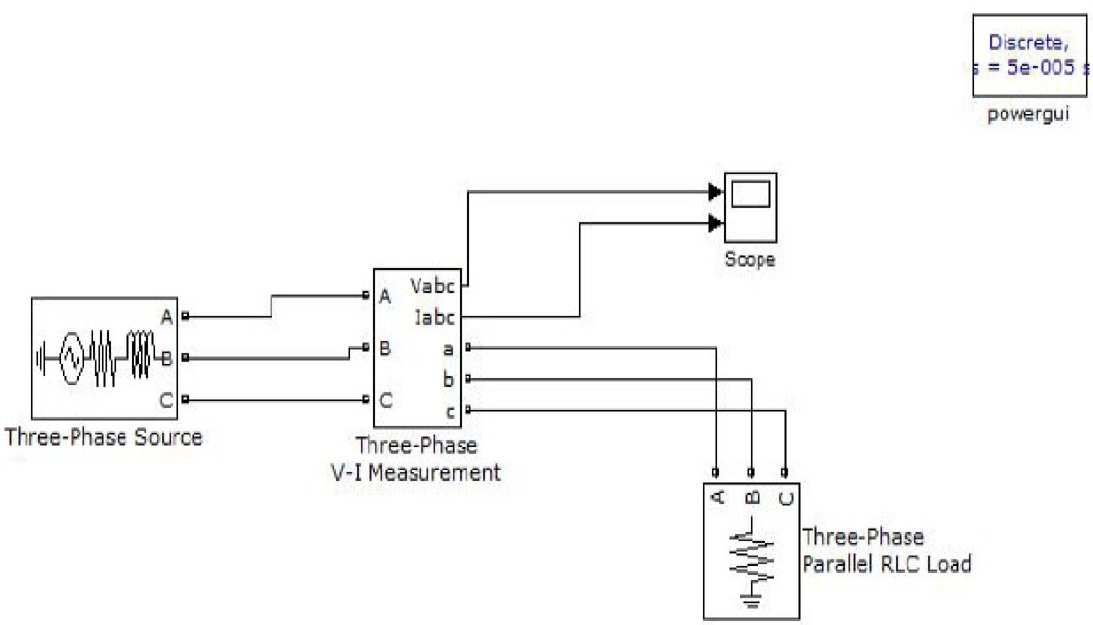
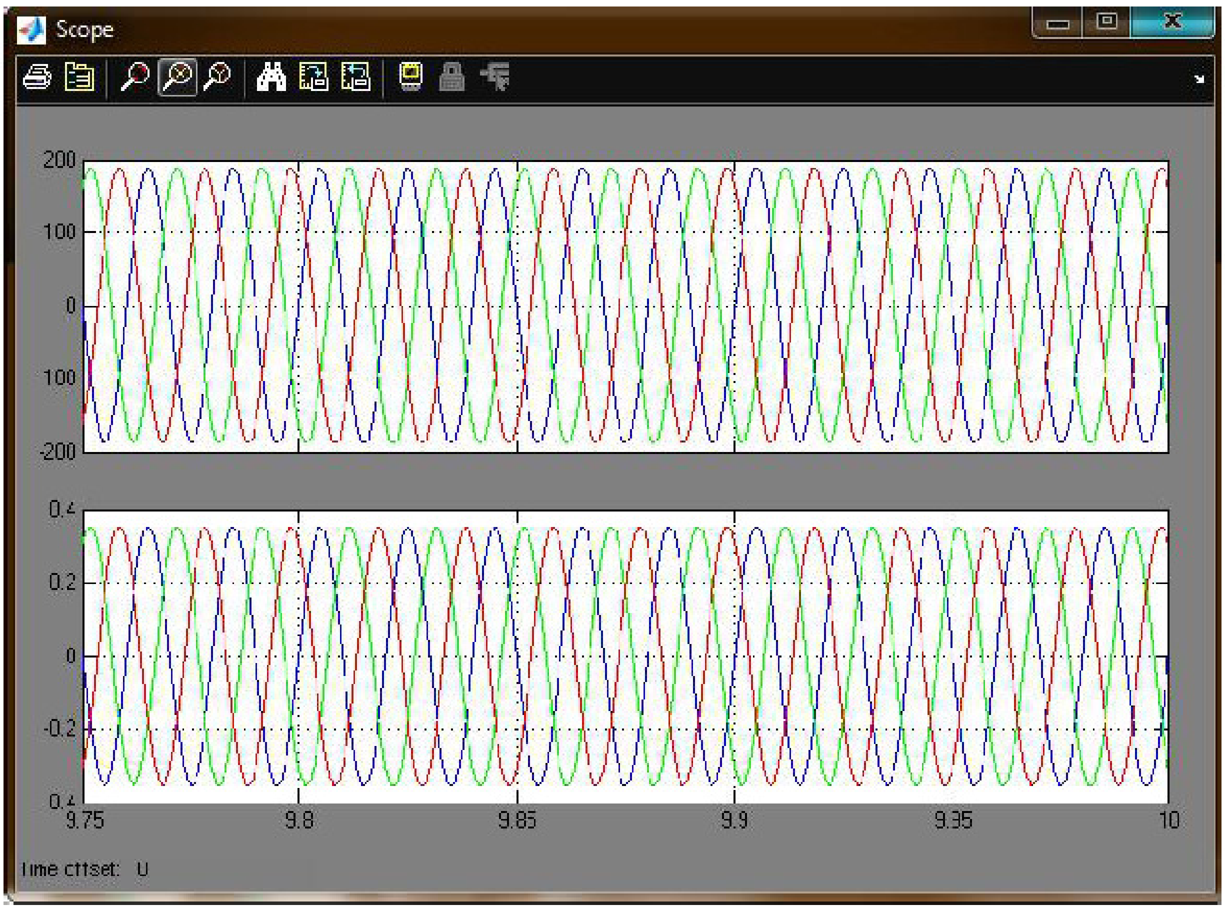



**Fig: Simulink model for voltage and current measurement**

**Procedure:**
1. Open Matlab-->Simulink--> File ---> New---> Model
**2.** Open Simulink Library and browse the components
**3.** Connect the components as per circuit diagram
**4.** Set the desired voltage and required frequency
**5.** Simulate the circuit using MATLAB
**6.** Plot the waveforms.

**Graph:**




**Calculations:**

**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.

**Exercise No: 06**

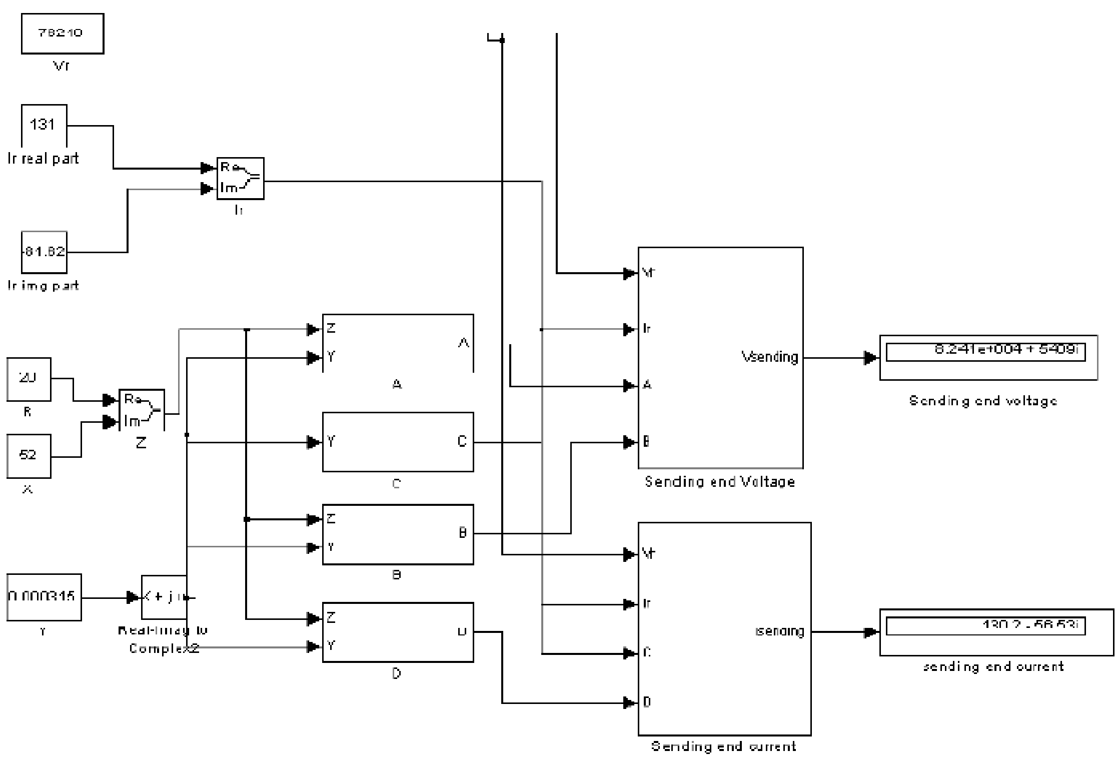
**AIM:** To simulate models of different power system components such as Transmission lines..

**THEORY:**
1. What is modeling of power systems components?
2. How this modeling helps to understand the nature of that particular power system component?
3. What is the relation of output and input of that device and how that results can be compared to the output of Model developed in MATLAB?

**PROCEDURE:**
1) Make a new model file in MATLAB.
2) Use Sim Power System Toolbox and Mathematical Operations Toolbox for inserting the models of different mathematical operations such as add, subtract, limiters etc. and different electrical displays such as scope and Displays .
3) Insert the blocks from respective toolboxes into new model by dragging it and connect that blocks.
4) Give proper input to the model and check the output at the output port/display/scope.
5) Calculate & plot the graphs. Output Vs speed, Output Vs Efficiency, Output Vs motor current.
Output Vs slip, output Vs P.F.

**Simulation Circuit Diagram:**

Example: Mathematical model development of transmission line



**Observations: Observe the readings of input quantities and output quantities.**

**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.

**Exercise No: 07**

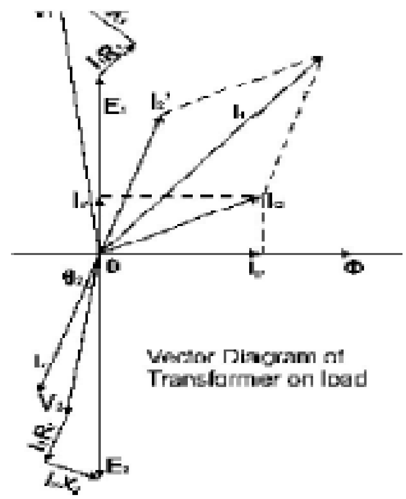
**AIM:** To determine the parameters of equivalent circuit of transformer from OC SC test data

**Theory : Equivalent Circuit of Transformer**
Equivalent impedance of transformer is essential to be calculated because the electrical power transformer is an electrical power system equipment for estimating different parameters of electrical power system which may be required to calculate total internal impedance of an electrical power transformer, viewing from primary side or secondary side as per requirement. This calculation requires equivalent circuit of transformer referred to primary **or** equivalent circuit of transformer referred to secondary sides respectively.

**Equivalent Circuit of Transformer Referred to Primary**

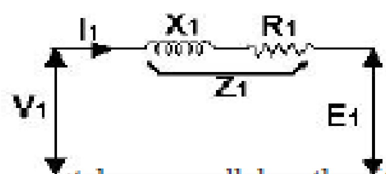
Let us consider the transformation ratio be,

$$K = \frac{N_1}{N_2} = \frac{E_1}{E_1}$$




In the figure right, the applied voltage to the primary is $V_1$ and voltage across the primary winding is $E_1$. Total electric current supplied to primary is $I_1$. So the voltage $V_1$ applied to the primary is partly dropped by $I_1Z_1$ or $I_1R_1 + jI_1X_1$ before it appears across primary winding. The voltage appeared across winding is countered by primary induced emf $E_1$. So voltage equation of this portion of the transformer can be written as,

$$V_1 - (I_1R_1 + jI_1X_1) = E_1$$

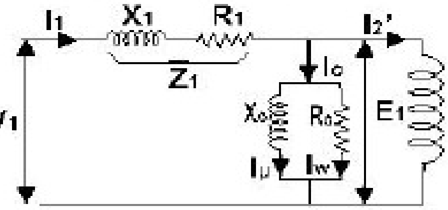


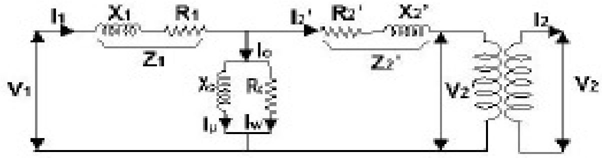

From the vector diagram above, it is found that the total primary current $I_1$ has two components, one is no - load component $I_0$ and the other is load component $I_2'$. As this primary current has two components or branches, so there must be a parallel path with primary winding of transformer. This parallel path of electric current is known as excitation branch of equivalent circuit of transformer. The resistive and reactive branches of the excitation circuit can be represented as

$$R_0 = \frac{E_1}{I_w} \quad and \quad X_0 = \frac{E_1}{I_\mu}$$

The load component $I_2'$ flows through the primary winding of transformer and induced voltage across the winding is $E_1$ as shown in the figure right. This induced voltage $E_1$ transforms to secondary and it is $E_2$ and load component of primary current $I_2'$ is transformed to secondary as secondary current $I_2$. Current of secondary is $I_2$. So the voltage $E_2$ across secondary winding is partly dropped by $I_2Z_2$ or $I_2R_2 + j.I_2X_2$ before it appears across load. The load voltage is $V_2$.

Equivalent Circuit of Primary Side of Transformer




Equivalent Circuit of Transformer referred to Primary

Now if we see the voltage drop in secondary from primary side, then it would be 'K' times greater and would be written as $K.Z_2.I_2$.
Again $I_2'.N_1 = I_2.N_2$

$$\Rightarrow I_2 = I_2'\frac{N_1}{N_2}$$
$$\Rightarrow I_2 = KI_2'$$

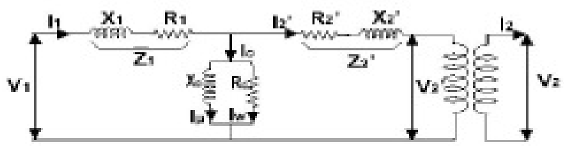
Therefore,

$$KZ_2I_2 = KZ_2KI_2' = K^2Z_2I_2'$$

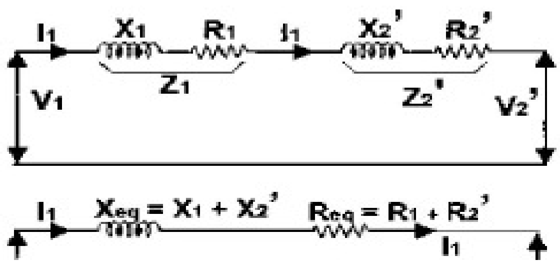
From above equation, secondary impedance of transformer referred to primary is,

$$Z_2' = K^2Z_2$$

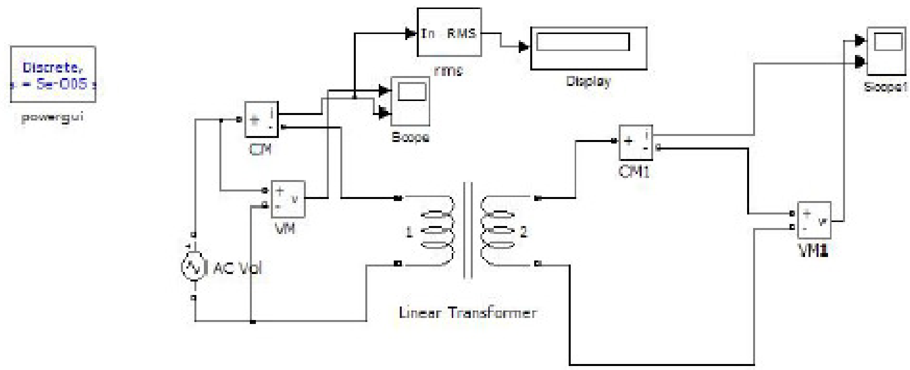
*Hence,* $R_2' = K^2R_2$ *and*
So, the complete equivalent circuit of transformer referred to primary is shown in the figure below,




Equivalent Circuit of Transformer referred to Primary



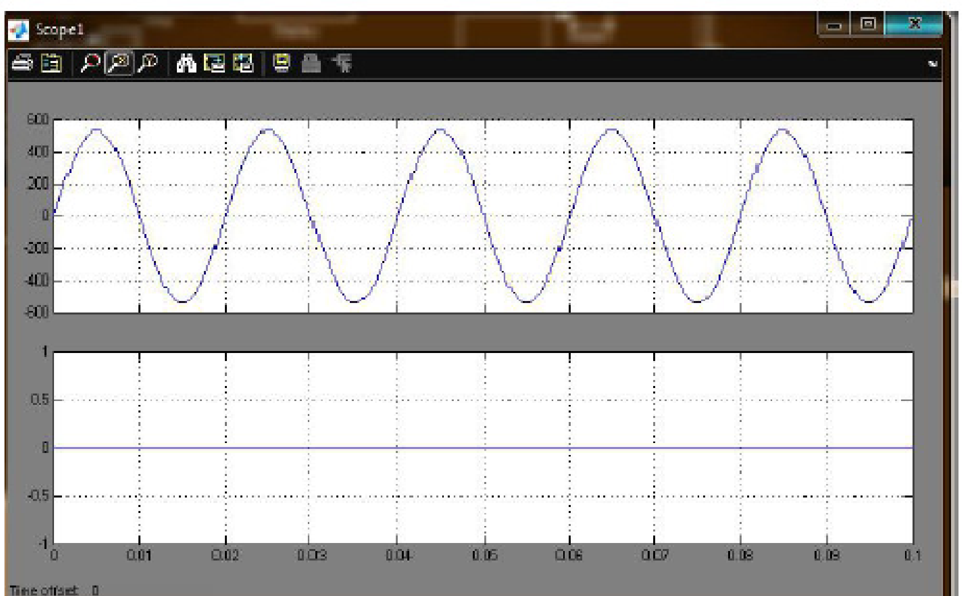
**Circuit Diagram:**




**Procedure:**

1. Open Matlab-->Simulink--> File ---> New---> Model
2. Open Simulink Library and browse the components
3. Connect the components as per circuit diagram
4. Set the desired voltage and current
5. Simulate the circuit using MATLAB
6. Plot the waveforms

**Graph:**




**Result:**

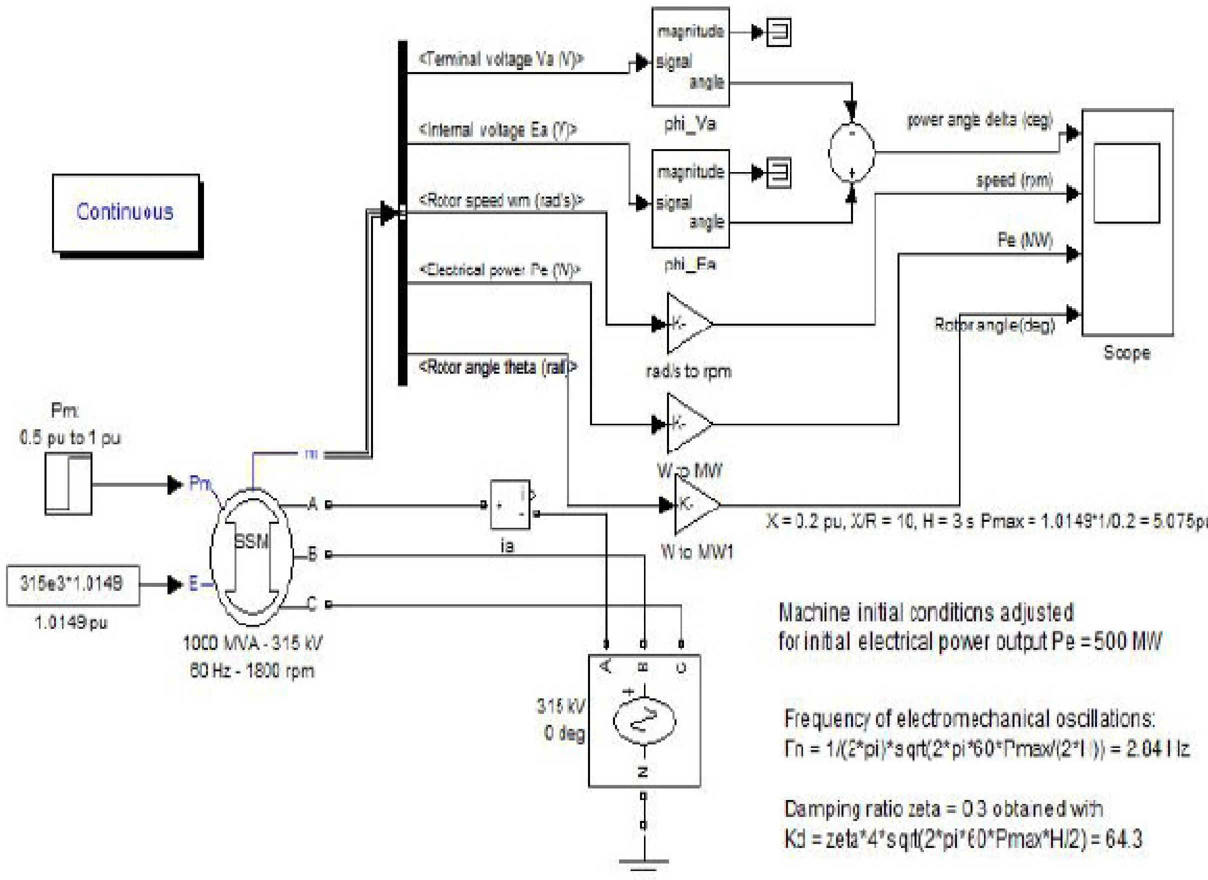
**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.

**Exercise No: 08**

**AIM:** To obtain step response of rotor angle and generator frequency of a synchronous machine

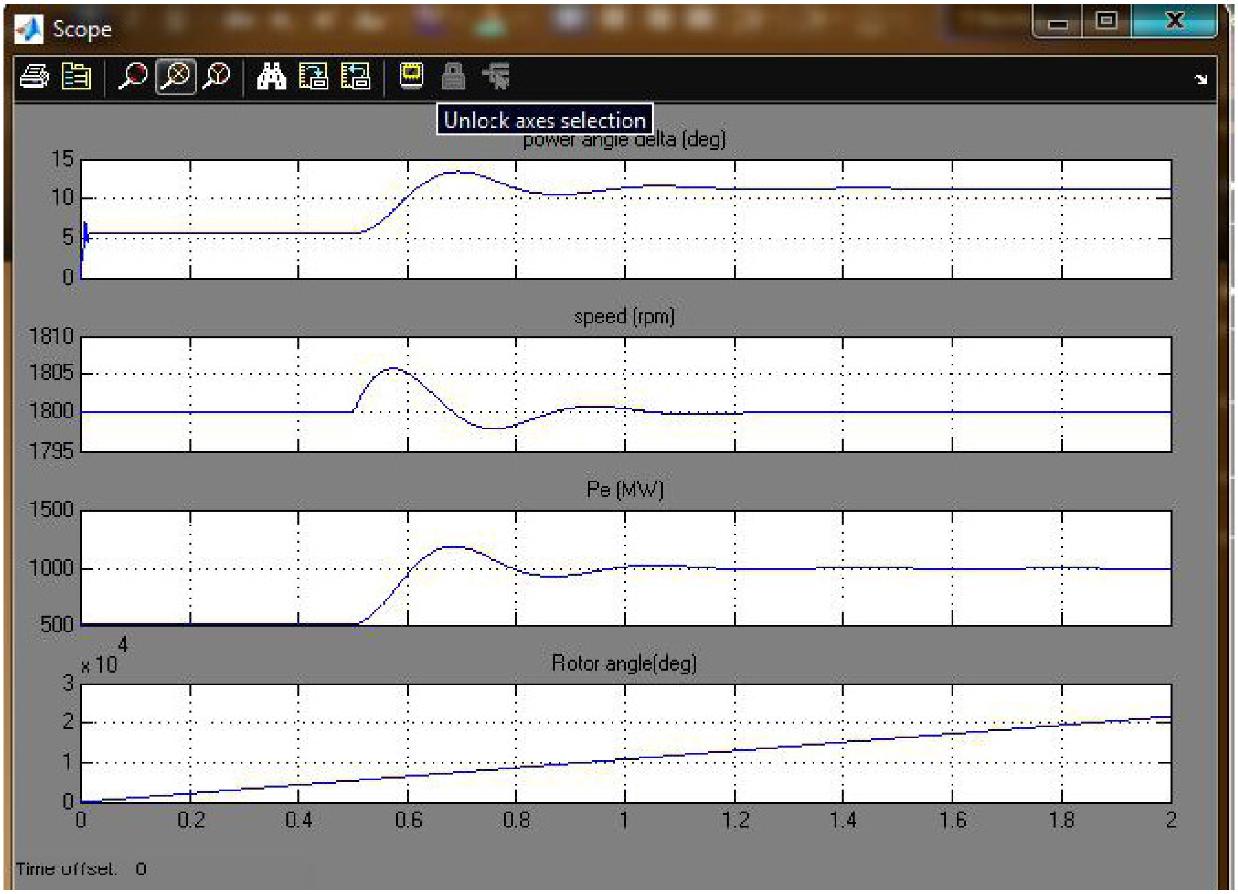
**Simulation Circuit Diagram:**




**Procedure:**

1. Open File ---> New---> Model
2. Open Simulink Library and browse the components
3. Connect the components as per circuit diagram
4. Set the desired voltage and required frequency
5. Simulate the circuit using MATLAB
6. Plot the waveforms

**Graph:**




**Concluding Remarks:**

Write brief concluding remarks on the circuit studied and observed waveforms.