

COMPUTER ADDED ELECTRIC
MACHINES
DESIGN
LAB MANUAL
(EE-326)
VI SEMESTER
ELECTRICAL ENGINEERING



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EXPERIMENT NO. - 1

AIM: - Introduction to MATLAB Software

Introduction:

MATLAB is a high-performance language for technical computing. It integrates Computation, visualization, and programming in an easy-to-use environment where Problems and solutions are expressed in familiar mathematical notation.

Typical uses include:

- Math and computation
- Algorithm development
- Modelling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In University environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis. MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow learning and applying specialized technology.

Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve

Particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others the MATLAB system consists of five four parts:

MATLAB Language:

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

MATLAB Working Environment:

This is the set of tools and facilities that you work with as the MATLAB user or programmer. It includes facilities for managing the variables in your workspace and importing and exporting data. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications.

Handle Graphics:

This is the MATLAB graphics system. It includes high-level commands for two Dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete Graphical User Interfaces on your MATLAB applications.

MATLAB Mathematical Function Library:

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transformers.

SIMULINK:

SIMULINK is an extension of the MATLAB program. To get it, you will need to run MATLAB. From the directory in which you intend to work SIMULINK files, enter the Matlab to start the program. SIMULINK provides several types of output devices in the sinks library blocks for you to monitor variables. The scope provided has a single input which will accept multiplexed signals.

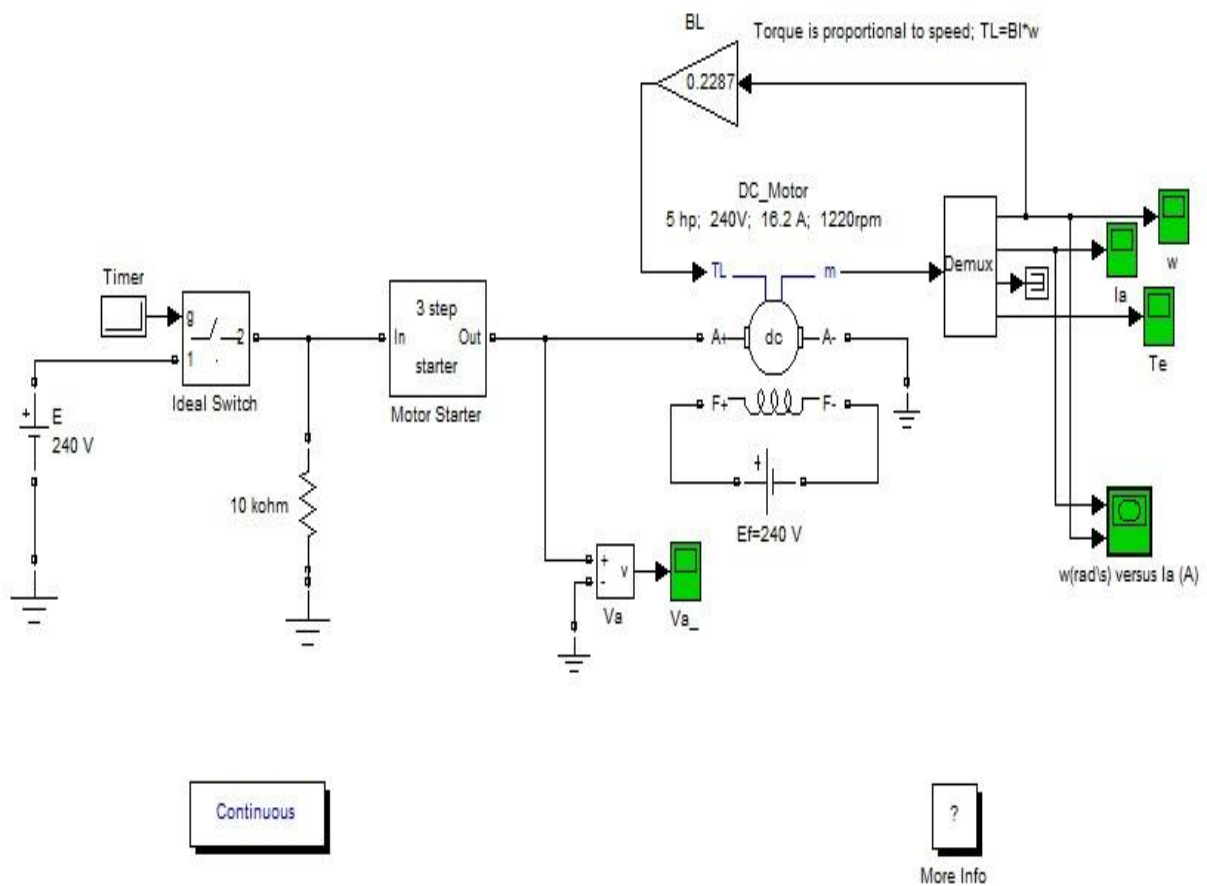
EXPERIMENT NO. -2

AIM: - Design of D.C Machine by using Matlab

Requirements:-

1. Computer
2. Matlab software.

Circuit Diagram:-



Theory:

Build Electromechanical energy conversion in magnetic type mechanical occurs in the magnetic field type Machines occurs in the space where the machine concentrates the energy of a magnetic field knowing the field, we can estimate voltages, currents, mechanical torques, and other quantities of interest under the steady state and transient condition.

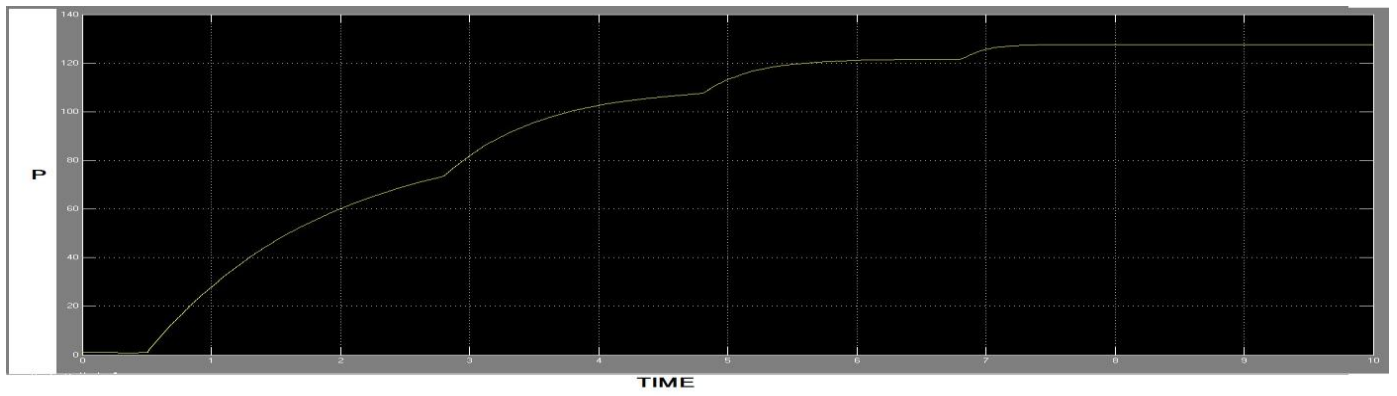
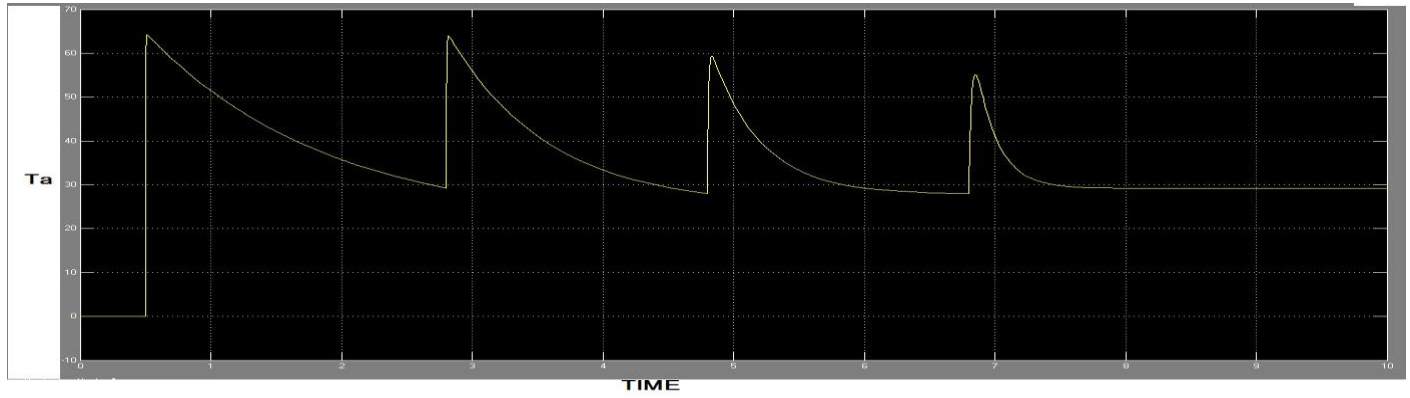
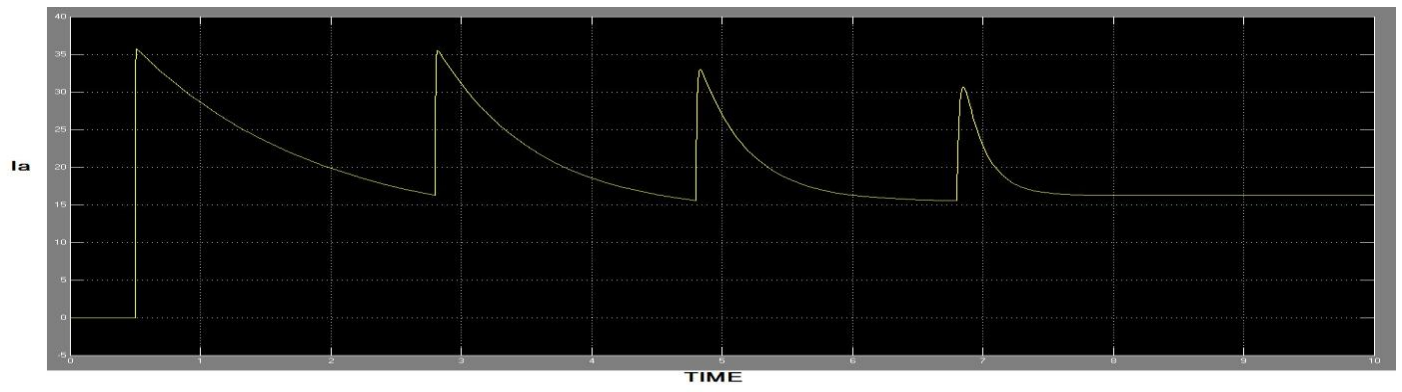
Powering an electric motor with a battery isn't easy. The battery's direct current is fine for electromagnets, but because there's nothing that naturally changes with time, the poles of the electromagnets stay the same forever. Since a motor needs magnetic poles that change periodically, something must reverse the current flow through the electromagnets at the proper moments. In most DC electric motors, the rotor is an electromagnet that turns within a shell of stationary permanent magnets. To make the electromagnet stronger, the rotor's coil contains an iron core that's magnetized when current flows through the coil. The rotor will spin as long as this current reverses each time its magnetic poles reach the opposite poles of the stationary magnets.

The most common way to produce these reversals is with a commutator. In its simplest form, a commutator has two curved plates that are fixed to the rotor and connected to opposite ends of the wire coil. Electric current flows into the rotor through a conducting brush that touches one of these plates and leaves the rotor through a second brush that touches the other plate. As the rotor turns, each brush makes contact first with one plate and then with the other. Each time the rotor turns half of a turn, the plates the two brushes touch are interchanged and with this swapping of connections comes a reversal in the direction of current flow around the coil. The DC motor spins forever.

Procedure:

- Build the Simulink block by using Matlab library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:



EXPERIMENT NO. -3

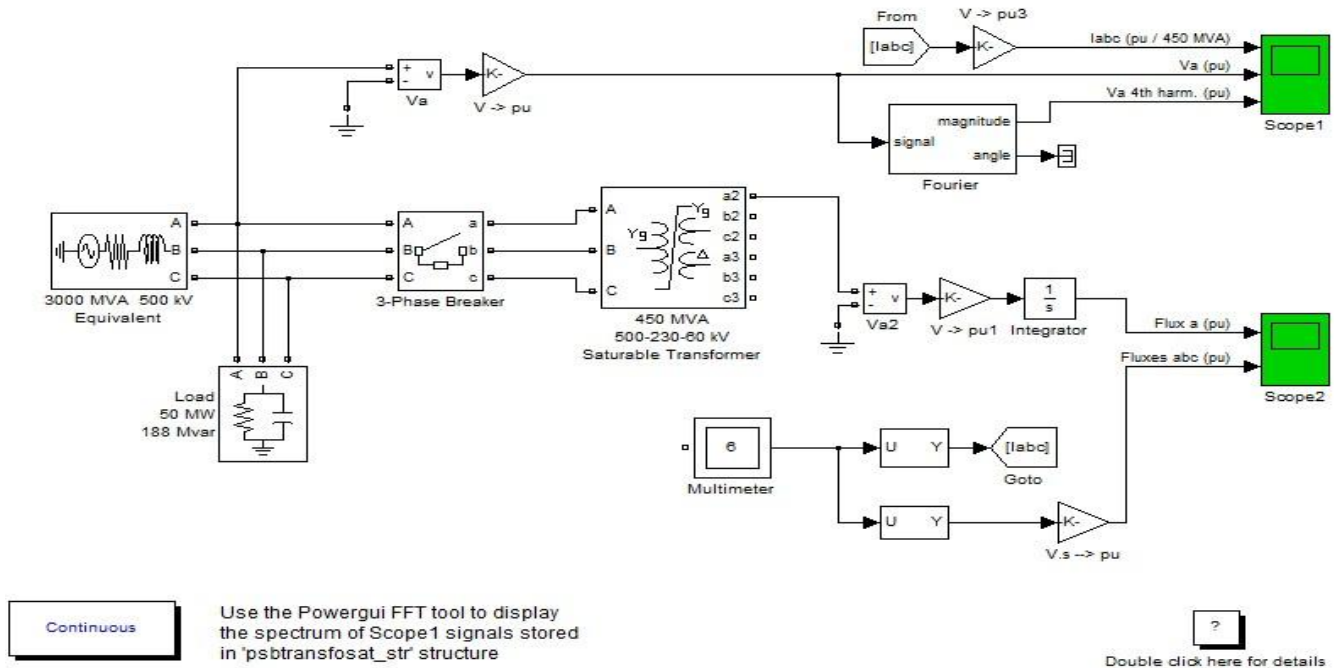
AIM: - Design of 3- ϕ Transformer by Using Matlab

Requirements:-

1. Computer
2. Matlab software.

Theory:

Transformers are devices that transfer energy from one circuit to another by means of a common magnetic field. In all cases except auto transformers, there is no direct electrical connection from one circuit to the other. When an alternating current flows in a conductor, a magnetic field exists around the conductor, If another conductor is placed in the field created by the first conductor such that the flux



Lines link the second conductor, then a voltage is induced into these conductor. The use of a magnetic field from one coil to induce a voltage into a second coil is the principle on which transformer theory and application is based.

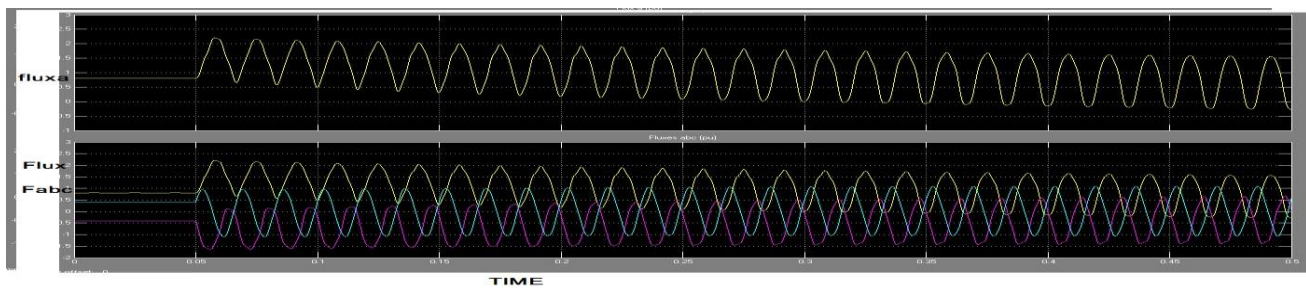
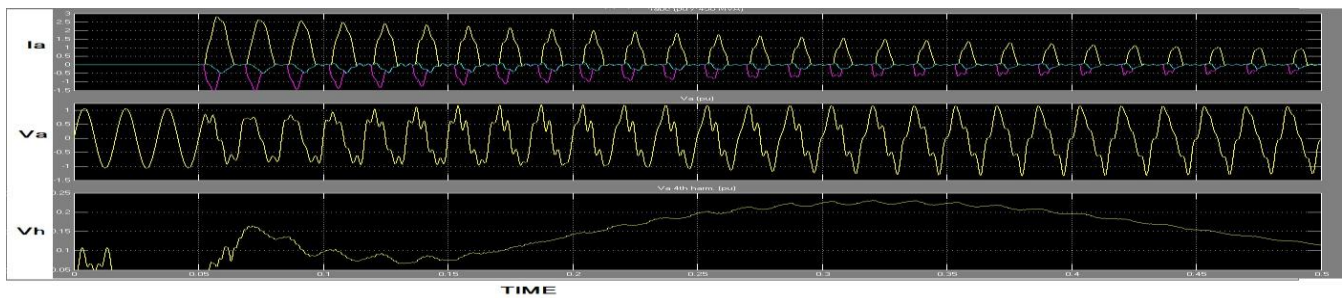
When voltage is applied to the exciting or primary winding of the transformer, a magnetizing current flows in the primary winding. This current produces the flux in the core. The flow of flux in magnetic circuits is analogous to the flow of current in electrical circuits. When flux flows in the steel core, losses occur in the steel. There are two components of this loss, which are termed “eddy” and “hysteresis” losses. An explanation of these losses would require a full chapter. For the purpose of this text, it can be stated that the hysteresis loss is caused by the cyclic reversal of flux in the magnetic circuit and can be reduced by metallurgical control of the steel. Eddy loss is caused by eddy currents circulating within the steel induced by the flow of magnetic flux normal to the width of the core, and it can be controlled by reducing the thickness of the steel lamination or by applying a thin insulating coating.

Procedure:

- Build the Simulink block by using Matlab library.
- Give the connection as per circuit diagram.

- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms

Result:



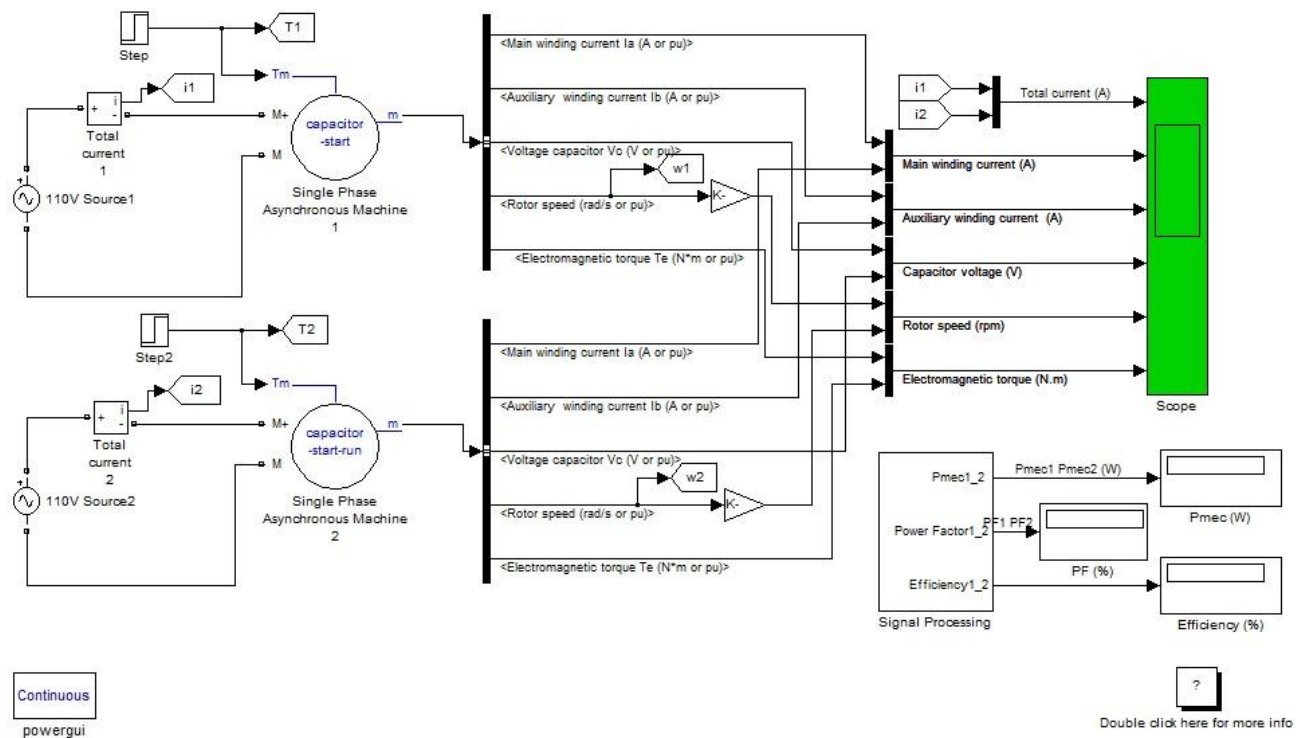
EXPERIMENT NO. - 4

AIM: -Design of 1- ϕ Induction Motor by Using Matlab

Requirements:-

1. Computer
2. Matlab software.

Simulink Diagram:



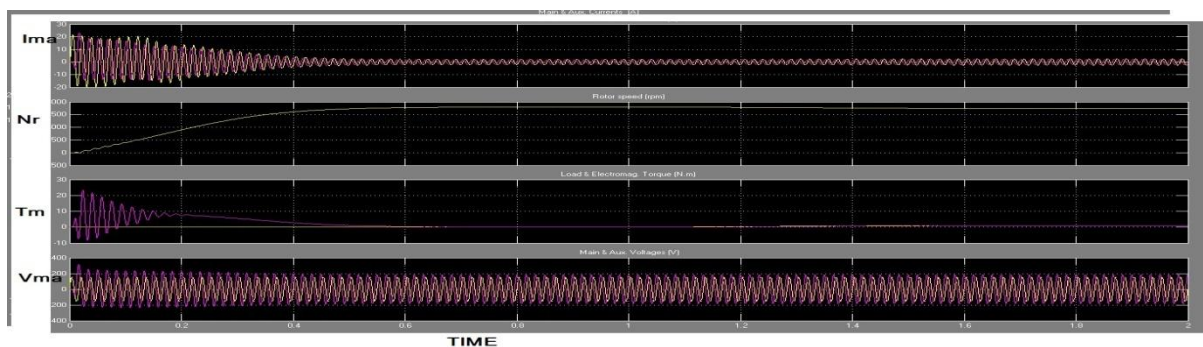
Theory:-

The principle of operation of the induction machine is based on the generation of a rotating magnetic field. Motors that use induction to create magnetism in their rotors are called induction motors. Induction motors are probably the most common type of AC motor, appearing in everything from household fans to industrial pumps to cable-lift elevators. They provide lots of torque, start easily, and are inexpensive. An induction motor works by moving a magnetic field around the rotor. The stationary shell surrounding the rotor contains a sophisticated electromagnet called a stator. While the stator doesn't move, the field it produces does. Through a clever use of various electromagnetic devices, the stator is able to create magnetic poles that move in a circle and travel around and around the rotor. In the stator's North Pole travels counter clockwise around the rotor. Since the pole's motion is based on current reversals of the AC power line, the North Pole usually travels once around the rotor for every full cycle of the current. A south pole also circles the rotor on the opposite side. These moving magnetic poles pull the rotor along with them. They induce magnetic poles in the rotor and the rotor experiences magnetic torques. The rotor begins to spin, rotating faster and faster until it's turning almost as rapidly as the moving magnetic poles of the stator.

Procedure:-

- Build the Simulink block by using Matlab library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:-



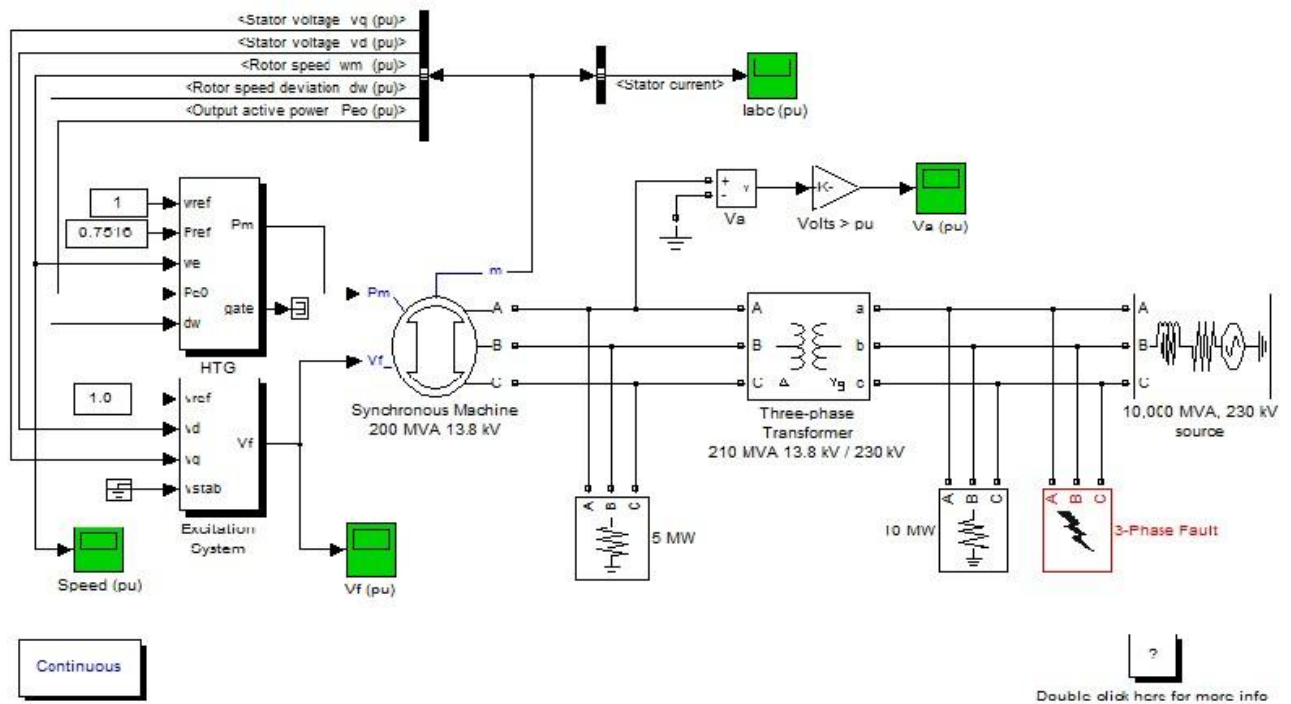
EXPERIMENT NO. - 5

AIM: - Design of Synchronous Machine by Using Matlab

Requirements:-

1. Computer
2. Matlab software.

Simulink Diagram:-



Theory:-

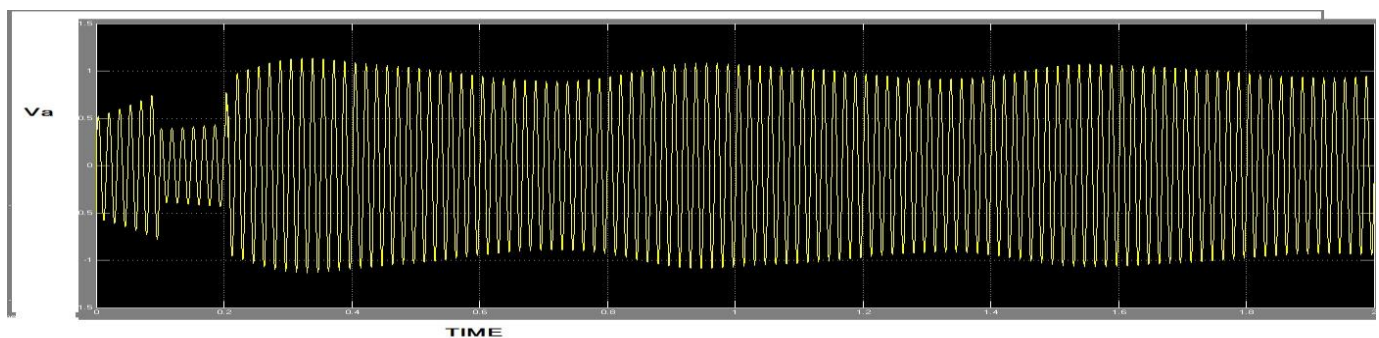
This motor is essentially identical to the generator from the previous section because generators and motors are closely related. A generator uses work to produce electric energy while a motor uses electric energy to produce work. The rotor in is a permanent magnet that spins between two stationary electromagnets. Because the electromagnets are powered by alternating current, their poles reverse with every current reversal. The rotor spins as its north pole is pulled first toward the upper electromagnet and then toward the lower electromagnet. Each time the rotor's north pole is about to reach the south pole of a stationary electromagnet, the current reverses and that south pole becomes a north pole. The rotor turns endlessly, completing one turn for each cycle of the AC current. Because its rotation is perfectly synchronized with the current reversals, this motor is called a synchronous AC electric motor. Synchronous AC motors advance the hands in some electric clocks. These motors follow the cycles of the power line exactly and thus keep excellent time. However, synchronous motors are hard to start because their rotors must be spinning rapidly before they can follow the reversals of the electromagnets. Because they must be brought up to speed by other motor techniques, synchronous AC motors are only used when a steady rotational speed is essential. However, synchronous motors illustrate an important point about motors and generators: they're essentially the same devices. If you connect a synchronous

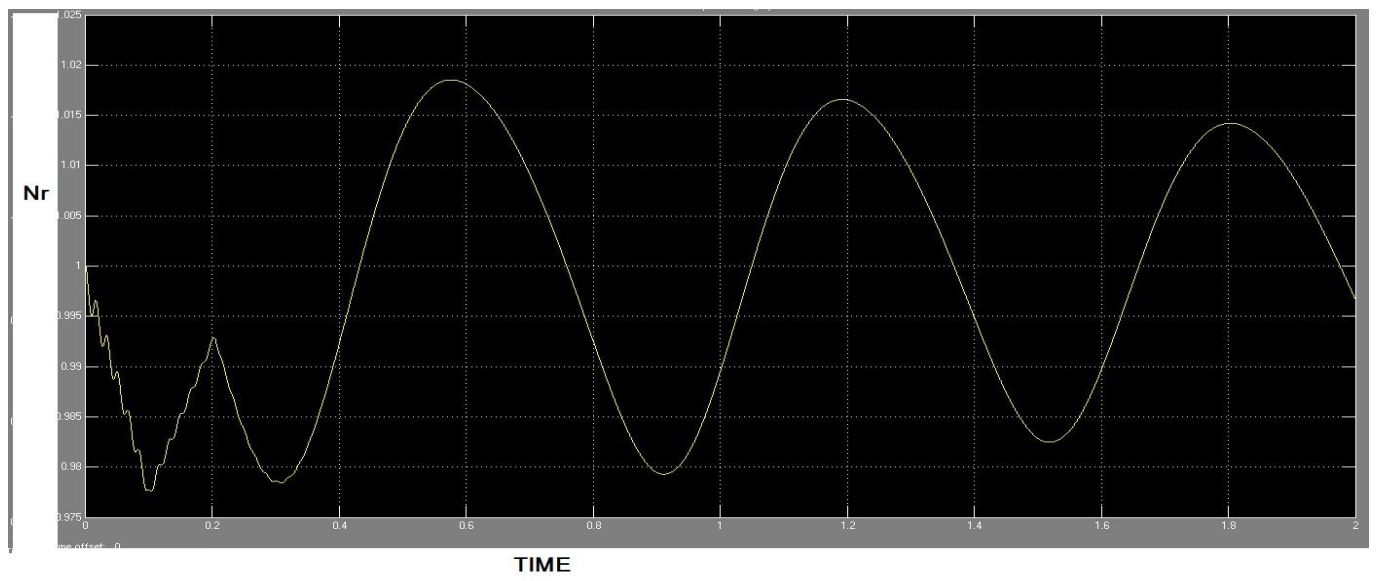
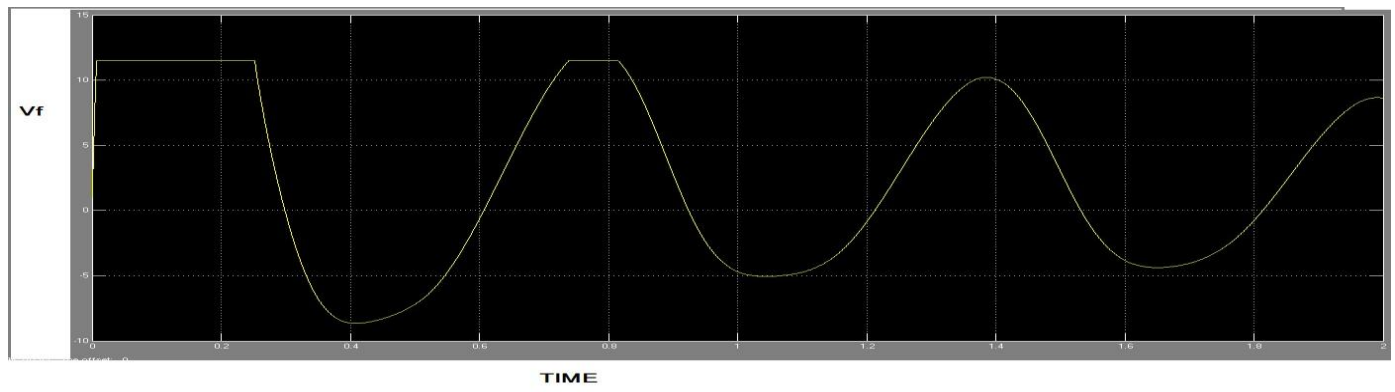
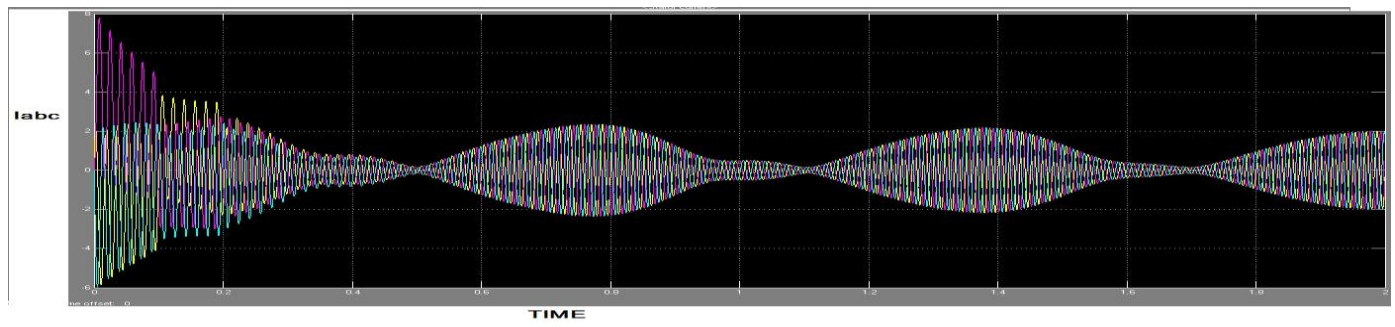
AC motor to the power line and let it turn, it will draw energy out of the electric circuit and provide work. But if you connect that same motor to a light bulb and turn its rotor by hand, it will generate electricity and light the bulb.

Procedure:-

- Build the Simulink block by using matlab library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:-





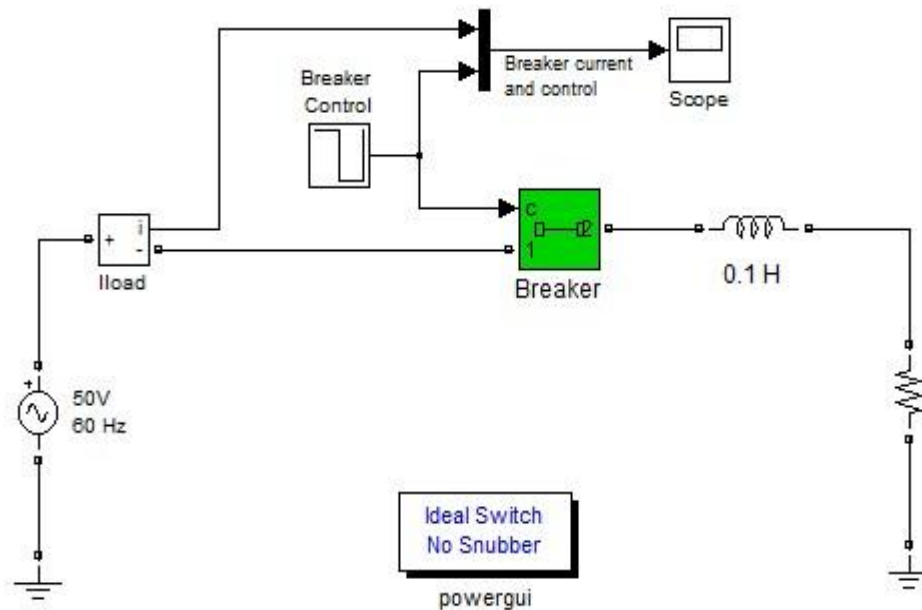
EXPERIMENT NO. - 6

AIM: - Design of Circuit Breaker Operation By using Matlab

Requirements:-

1. Computer
2. Matlab software.

Simulink Diagram:-



Theory:

Excessive current is referred to as overcurrent. An overcurrent may result from an overload, short circuit, or ground fault. Some circuit breakers provide only short circuit protection, but most circuit breakers provide protection against short circuits and overloads, and some circuit breakers provide protection against all three types of overcurrent.

An over load occurs when too many devices are operated on a single circuit or when electrical equipment is made to work beyond its rated capabilities. When an overload occurs, damage to connected equipment or the conductors that supply that equipment can occur unless the circuit is shut down by an overcurrent protection device. Slight overloads can be allowed to continue for a short time, but as the current magnitude increases, the circuit breaker must open faster.

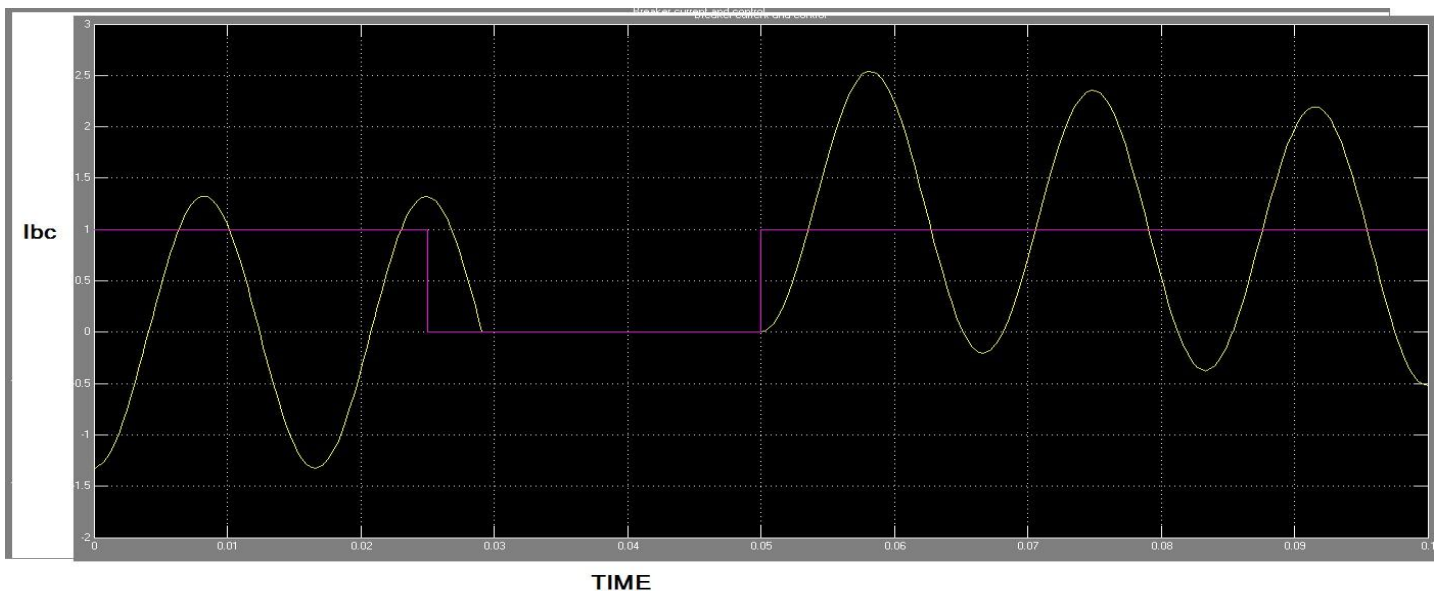
A short circuit is a low resistance path for current created when bare conductors touch. When a short circuit occurs with voltage applied, the decrease in resistance results in a

short circuit current that can be thousands of times higher than normal operating current. The heat generated by this current will cause extensive damage to connected equipment and conductors unless current is interrupted immediately.

Procedure:

- Build the Simulink block by using matlab library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:



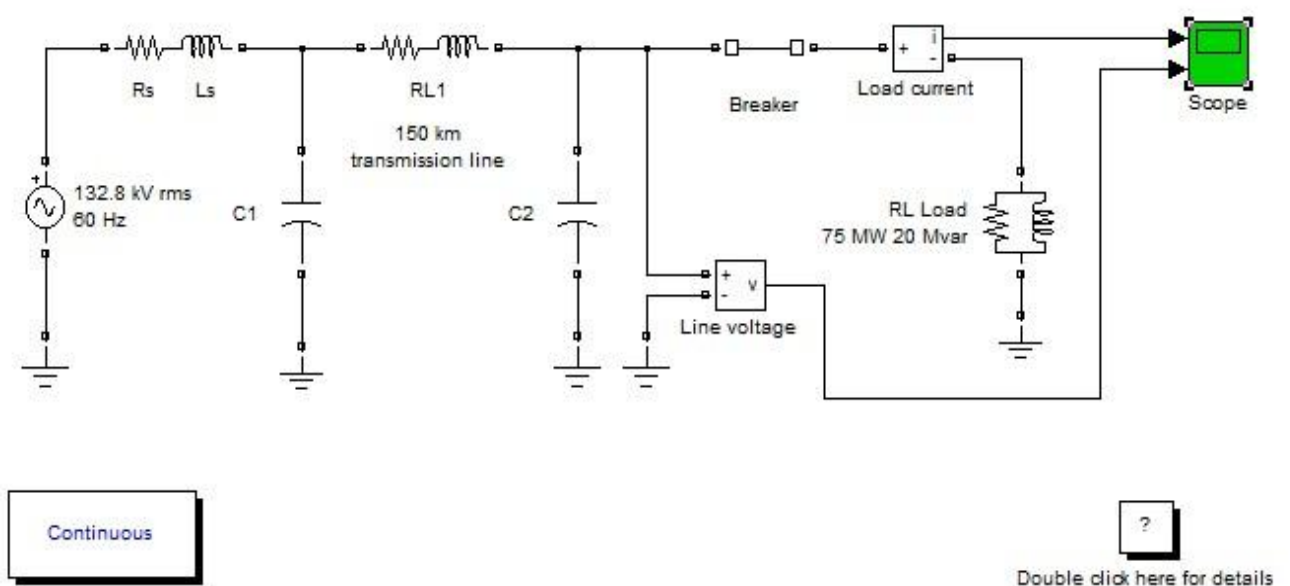
EXPERIMENT NO. - 7

AIM: - Testing of Different Types of Relays using Matlab

Requirements:-

1. Computer
2. Matlab software.

Circuit diagram:



Theory:

The function of a relay is to detect abnormal conditions in the system and to initiate through appropriate circuit breakers the disconnection of faulty circuits so that interference with the general supply is minimized. Relays are of many types. Some depend on the operation of an armature by some form of electromagnet. A very large number of relays operate on the induction principle. When a relay operates it closes contacts in the trip circuit which is normally connected across 110 V D.C. supply from a battery.

The passage of current in the coil of the trip circuit actuates the plunger, which causes operation of the circuit breaker, disconnecting the faulty system. In the laboratory, a 3-phase contactor simulates the operation of the circuit breaker. The closure of the relay contacts short-circuits the 'no-volt' coil of the contactor, which, in turn, disconnects the faulty system.

The protective relaying which responds to a rise in current flowing through the protected element over a pre-determined value is called 'overcurrent protection' and the relays used for this purpose are known as overcurrent relays. Earth fault protection can be provided with normal overcurrent relays, if the minimum earth fault current is sufficient in magnitude. The design of a comprehensive protection scheme in a power system requires the detailed study of time-current characteristics of the various relays used in the scheme. Thus it is necessary to obtain the time current characteristics of these relays.

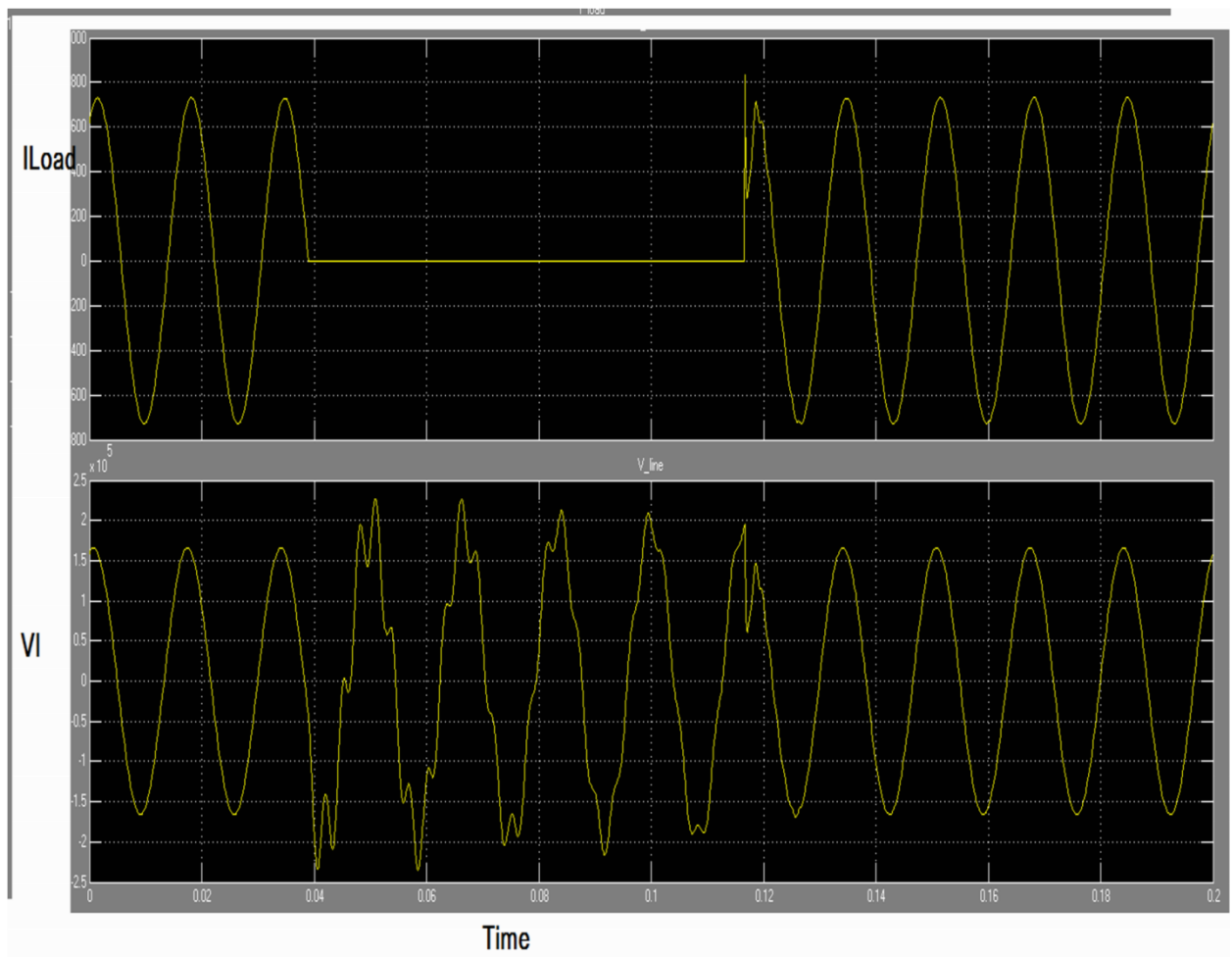
The overcurrent relay works on the induction principle. The moving system consists of an aluminum disc fixed on a vertical shaft and rotating on two jeweled bearings between the poles of an electromagnet and a damping magnet. The winding of the electromagnet is provided with seven taps (generally 0, which are brought on the front panel, and the required tap is selected by a push-in -type plug. The pick-up current setting can thus be varied by the use of such plug multiplier setting. The pick-up current values of earth fault relays are normally quite low. The operating time of all overcurrent relays tends to become asymptotic to a definite minimum value with increase in the value of current. This is an inherent property of the electromagnetic relays due to saturation of the magnetic circuit. By varying the point of saturation, different characteristics can be obtained and these are

1. Definite time
2. Inverse Definite Minimum Time (IDMT)
3. Very Inverse
4. Extremely Inverse

Procedure:

- Build the Simulink block by using MATLAB library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:-



EXPERIMENT NO. - 8

AIM: - Study of Protective Equipment & Layout of 220/11KV Substation

Requirements:

1. Computer
2. Matlab software.

Circuit diagram:

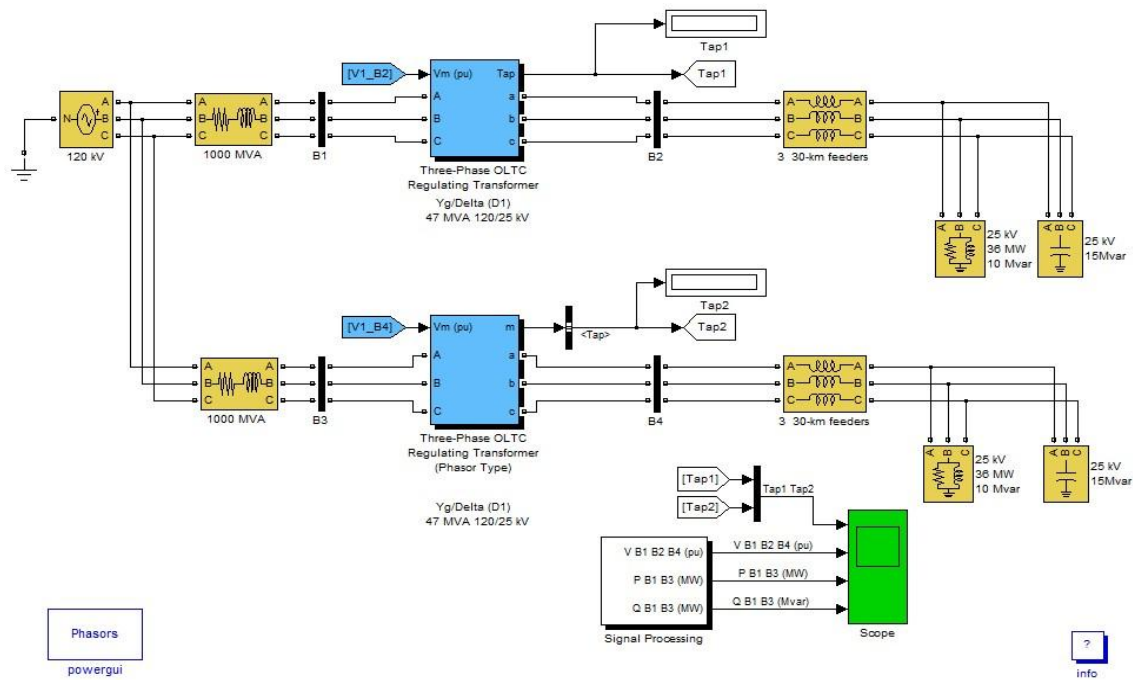
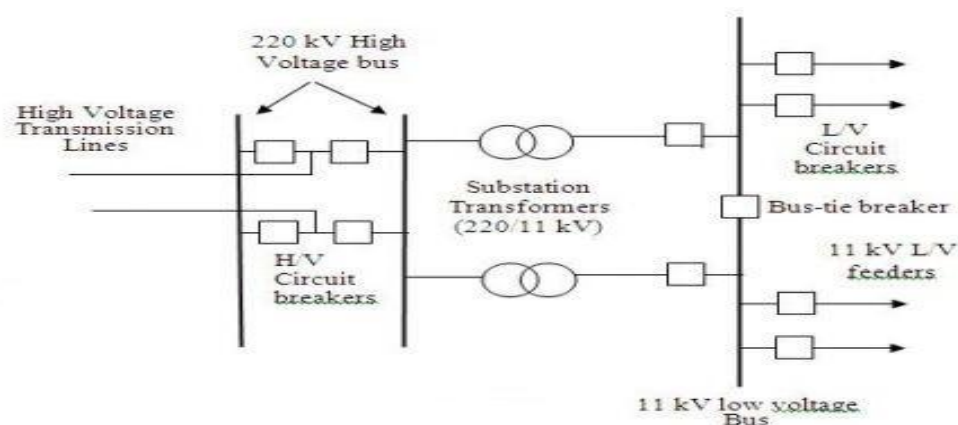


Fig: 1

Single Line Diagram:-



Theory:

Now days the electrical power demand is increasing very rapidly. For fulfilling these huge power demands the modern time requires creation of bigger and bigger power generating stations. These power generating stations may be hydro – electric, thermal or atomic. Depending upon the availability of resources these stations are constructed in different places. These places may not be nearer to load centers where the actual consumption of power takes place. So it is necessary to transmit these huge power blocks from generating station to their load centers. Long and high voltage transmission networks are needed for this purpose. Power is generated comparatively in low voltage level. It is economical to transmit power at high voltage level. Distribution of electric power is done at lower voltage levels as specified by consumers. For maintaining these voltage levels and for providing greater stability a number of transformation and switching stations have to be created in between generating station and consumer ends. These transformation and switching stations are generally known as electrical substations. Depending upon the purposes, the substations may be classified as-

Step Up Substation

Step up substations are associated with generating stations. Generation of power is limited to low voltage levels due to limitations of the rotating alternators. These generating voltages must be stepped up for economical transmission of power over long distance. So there must be a step up substation associated with generating station.

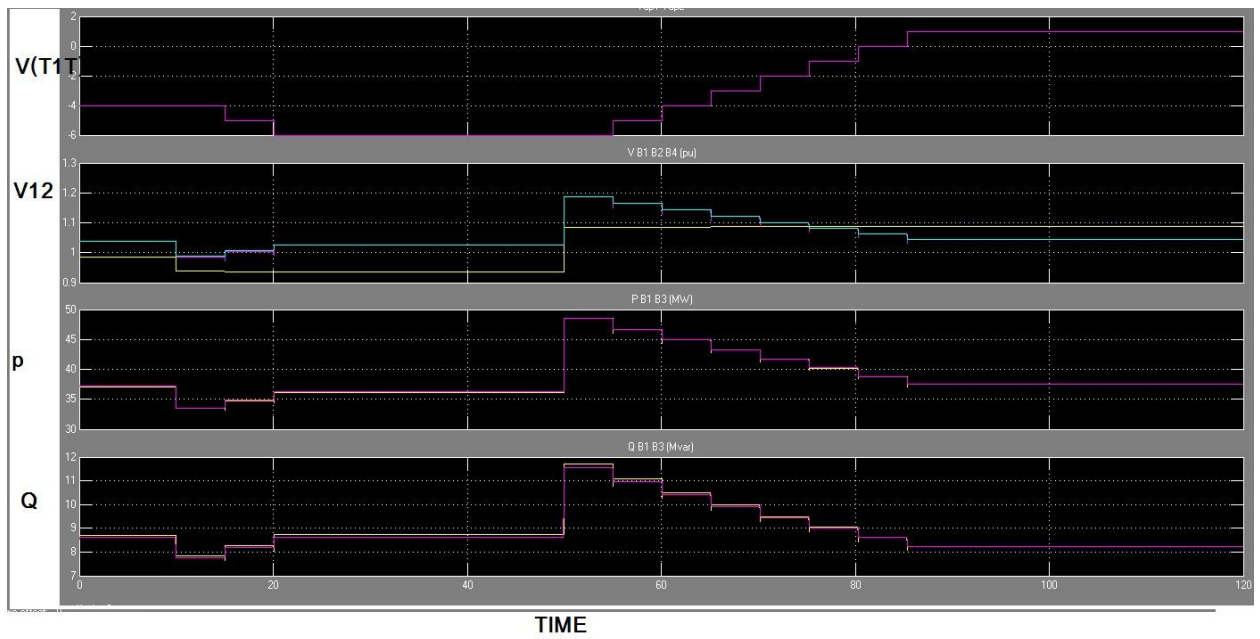
Step Down Substation

The stepped up voltages must be stepped down at load centers, to different voltage levels for different purposes. Depending upon these purposes the step down substations are further categorized in different sub categories.

Procedure:

- Build the Simulink block by using MATLAB library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:



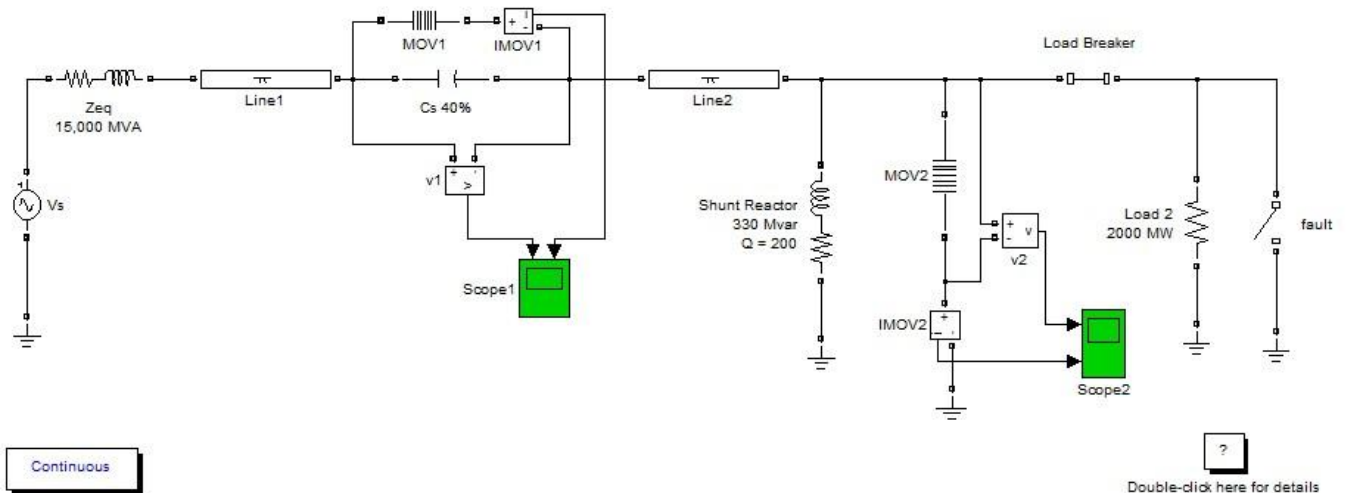
EXPERIMENT NO. - 9

AIM:- Design of Surge Arresters in Transmission System by Using Matlab

Requirements:

1. Computer
2. Matlab software.

Circuit diagram:



Theory:

An overhead earth wire provides considerable protection against direct strikes. They also reduce induced over voltages. However, they do not provide protection against surges that may still reach the terminal equipment. Such protection may either be done by diverting the major part of the energy of the surge to earth (surge diverters), or by modifying the waveform to make it less harmful (surge modifiers). The insertion of a short length of cable between an overhead line and a terminal equipment is the commonest form of surge modifier. Surge diverters (or lightning arrestors) generally consist of one or more spark gaps in series, together with one or more non-linear resistors in series. Silicon Carbide (SiC) was the material most often used in these nonlinear resistor surge diverters. However, Zinc Oxide

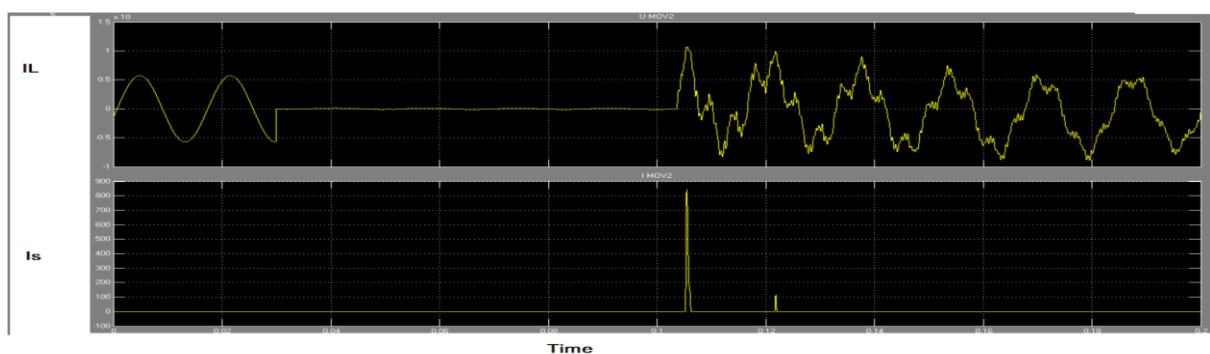
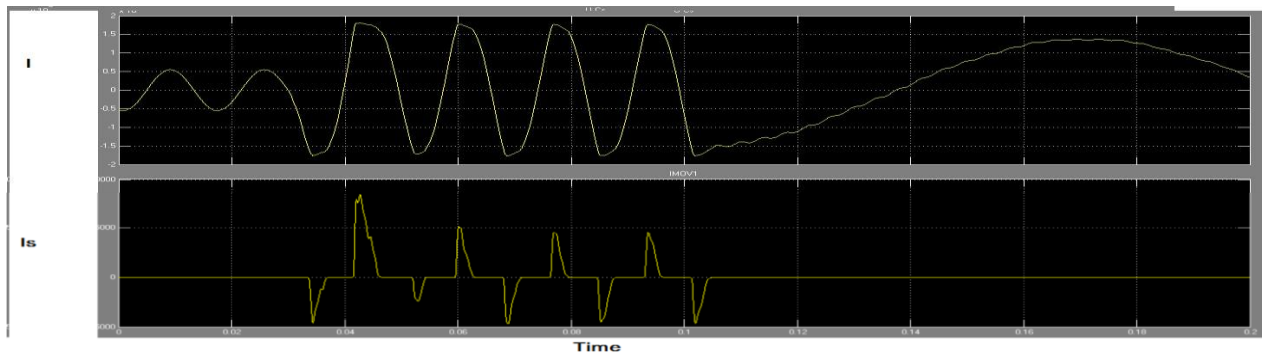
(ZnO) is being used in most modern day surge diverters on account of its superior volt-ampere characteristic. In fact the ZnO arrester is often used gapless, as its normal follow current is negligibly small.

An ideal lightning arrester should: (i) conduct electric current at a certain voltage above the rated voltage; (ii) hold the voltage with little change for the duration of overvoltage; and (iii) substantially cease conduction at very nearly the same voltage at which conduction started.

Procedure:

- Build the Simulink block by using MATLAB library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:



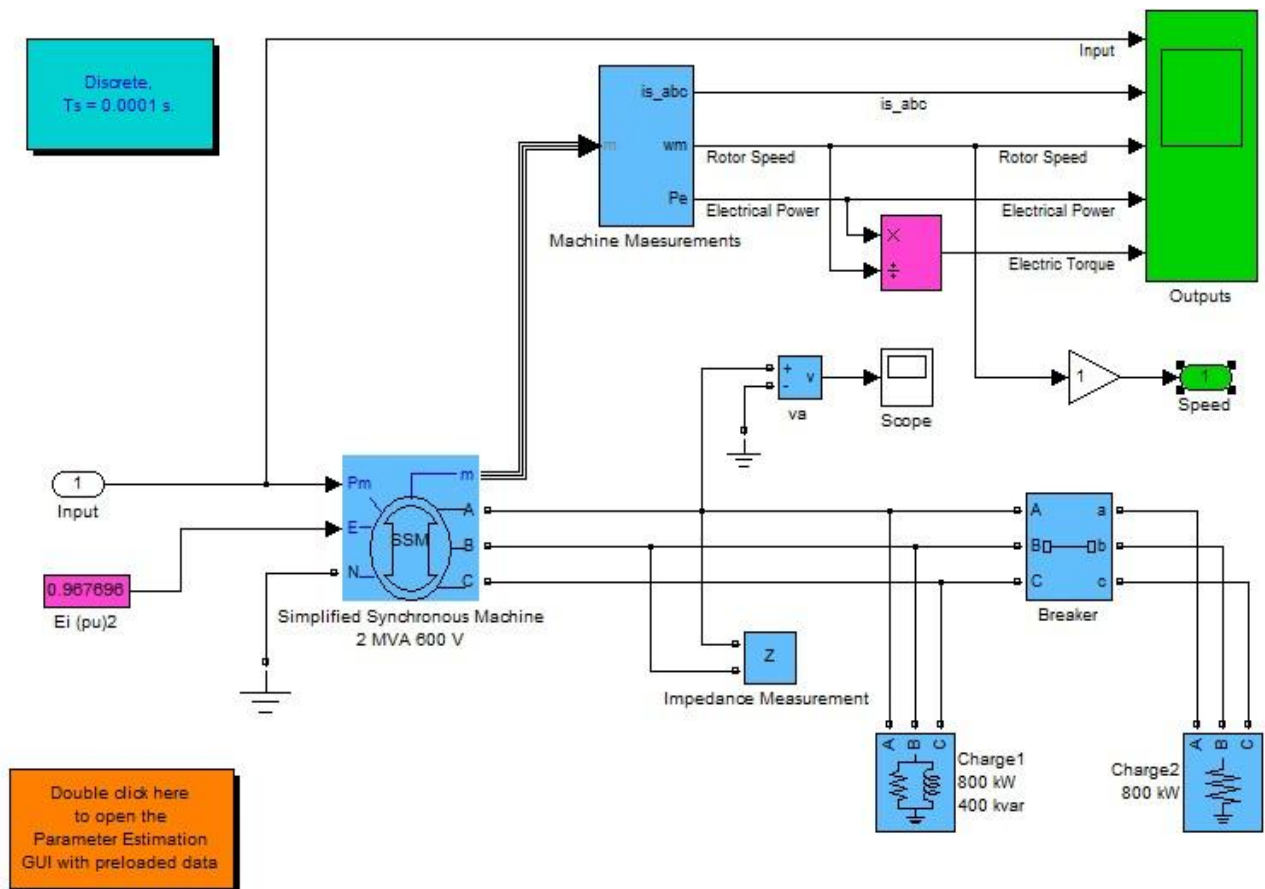
EXPERIMENT NO. - 10

AIM: - Design and Parameter Estimation of Alternator by Using Matlab

Requirements:

1. Computer
2. Matlab software.

Circuit diagram:



Theory:

Regardless of size, all electrical generators, whether dc or ac, depend upon the principle of magnetic induction. An emf is induced in a coil as a result of (1) a coil cutting through a magnetic field, or (2) a magnetic field cutting through a coil. As long as there is relative motion between a conductor and a magnetic field, a voltage will be induced in the conductor. That part of a generator that produces the magnetic field is called the field. That part in which the voltage is induced is called the armature. For relative motion to take place

between the conductor and the magnetic field, all generators must have two mechanical parts — a rotor and a stator. The rotor is the part that rotates; the stator is the part that remains stationary. In a dc generator, the armature is always the rotor. In alternators, the armature may be either the rotor or stator.

The rotating-armature alternator is similar in construction to the dc generator in that the armature rotates in a stationary magnetic field. In the dc generator, the emf generated in the armature windings is converted from ac to dc by means of the commutator. In the alternator, the generated ac is brought to the load unchanged by means of slip rings. The rotating armature is found only in alternators of low power rating and generally is not used to supply electric power in large quantities.

Procedure:

- Build the Simulink block by using MATLAB library.
- Give the connection as per circuit diagram.
- Run the program.
- Observe the wave form for different input values.
- Note down the values and wave forms.

Results:

