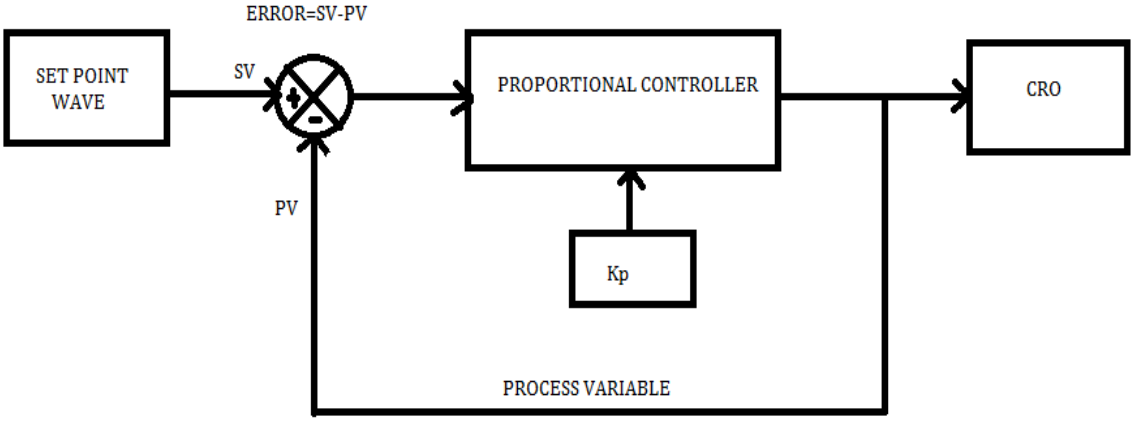
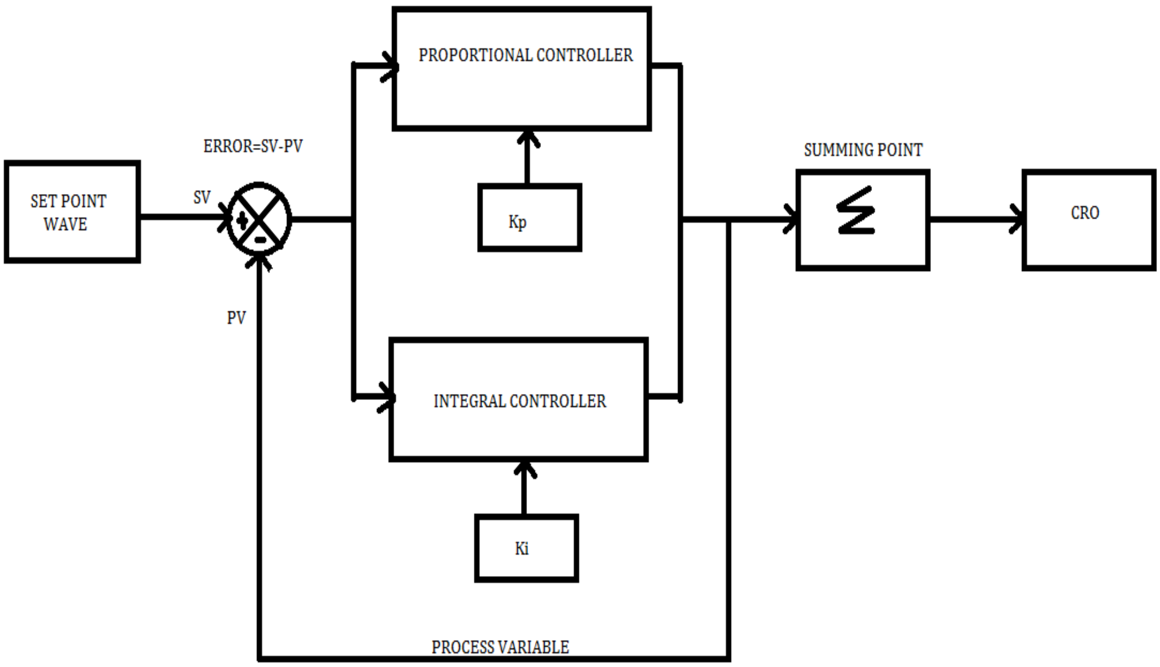
CONTROL SYSTEMS

PROPORTIONAL CONTROLLER:



PROPORTIONAL- INTEGRAL CONTROLLER:



Exp. No. : 1
Date :

P, PI, PID CONTROLLERS

AIM:

To study controller response of P, PI & PID

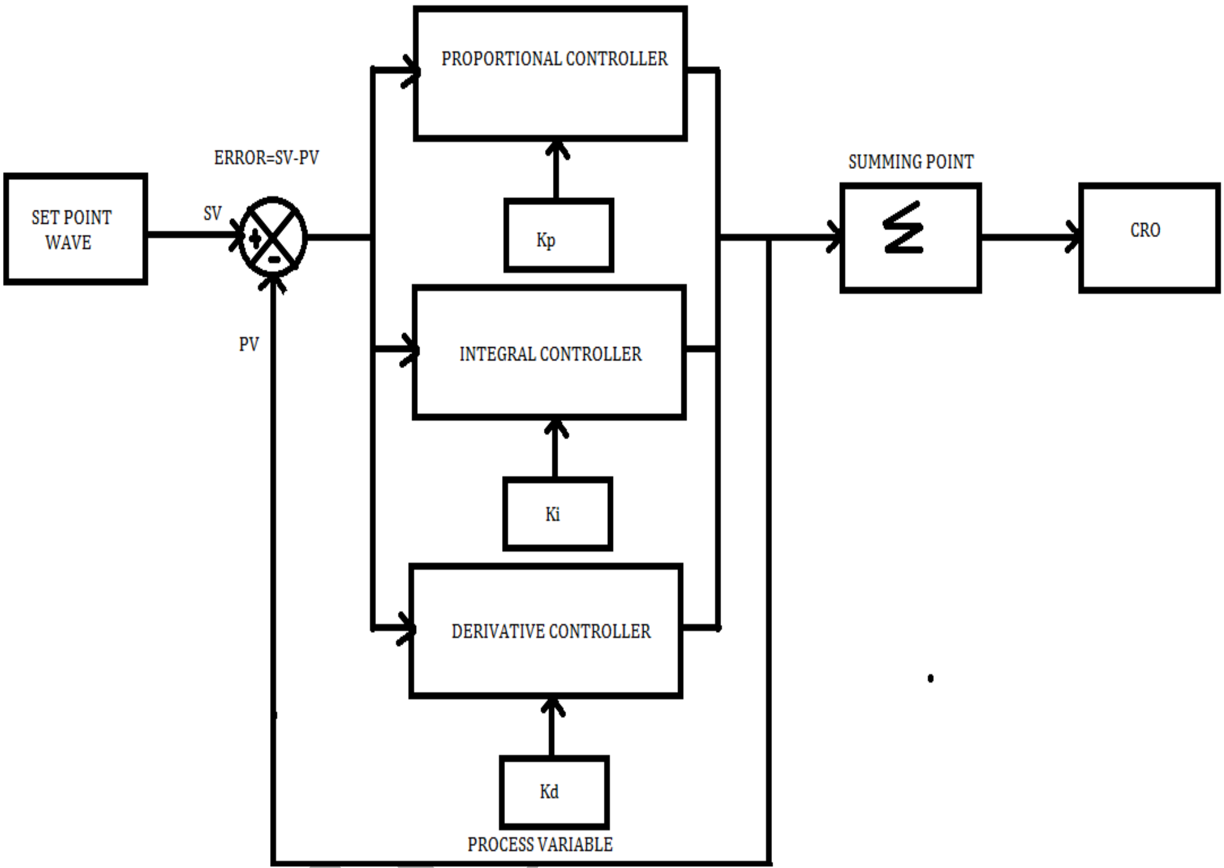
APPARATUS REQUIRED:

1. PID Kit
2. CRO
3. Patch Chords

THEORY:

Controllers are designed to eliminate the need for continuous operator attention. With a proportional controller offset (deviation from set point) is present. Increasing the controller gain will make the loop go unstable. With integral action, the controller output is proportional to the amount of time the error is present. Integral action eliminates offset. Integral action gives the controller a large gain at low frequencies that results in eliminating offset and "beating down" load disturbances. Derivative action can compensate for a changing measurement. Thus, derivative takes action to inhibit more rapid changes of the measurement than proportional action. When a load or set point change occurs, the derivative action causes the controller gain to move the "wrong" way when the measurement gets near the set point.

PROPORTIONAL – INTEGRAL- DERIVATIVE CONTROLLER:



PROCEDURE:

PROPORTIONAL CONTROLLER:

1. Connections for Proportional controller are as shown in figure.

2. Ground PV and inputs of summing block which are not in use.

3. Set +0.5V at test point+10V set point output.

4. Apply set point to proportional input.

5. Check the output of proportional block with digital volt meter given on board.

6. Vary slowly the Kp value, observe the change in the output, and find out the proportional band that is PB = 100/Kp.

7. In the same manner, we can check by applying square and triangular wave and compare the output .

PROPORTIONAL – INTEGRAL CONTROLLER:

1. Connections for Proportional + Integrator (PI) controller are as shown in the figure .

2. Ground PV and inputs of summing block which are not in use.

3. Apply square wave to the set point (SP).

4. Check the output of summer block ∑ of summing block on CRO

5. Vary slowly the KP & KI value and observe the changes in the output.

6. In the same manner, we can check by applying tri angular wave.

PROPORTIONAL – INTEGRAL- DERIVATIVE CONTROLLER:

1. Connections for Proportional + Integrator + Derivative (PID) controller are as shown in the figure

2. Ground PV and inputs of summing block which are not in use.

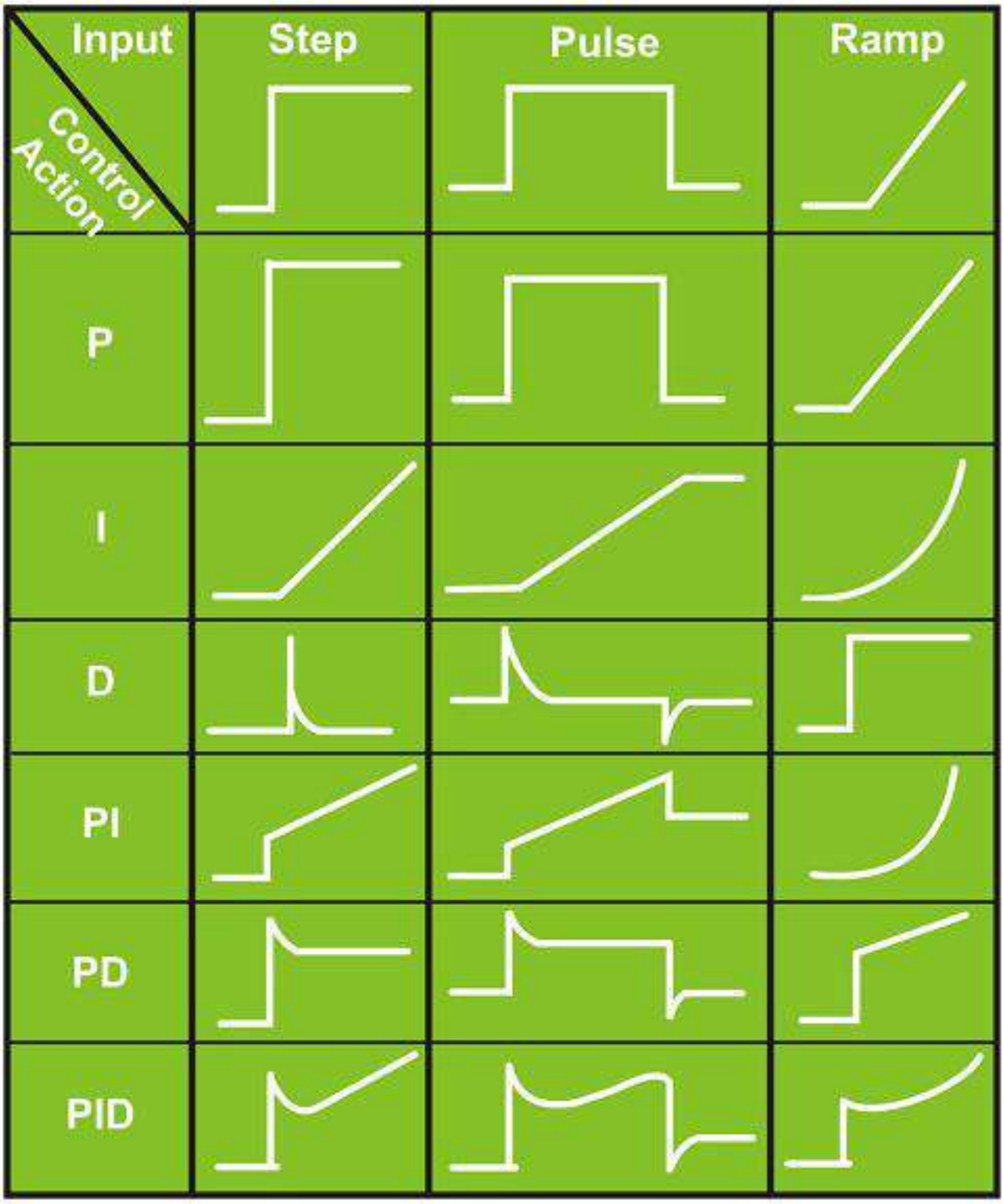
3. Apply square wave to the set point (SP).

4. Check the output of summer block ∑ of summing block on CRO

5. Vary slowly the KP, KI & Kd value and observe the changes in the output.

6. In the same manner, we can check by applying triangular wave.

TABLE:



Controller Responses to Different Excitations

RESULT:

Exp. No. : 2
Date :

STABILITY ANALYSIS

AIM:

To analyse the stability of linear system using bode plot, root locus & nyquist plot.

APPARATUS REQUIRED:

A PC with MATLAB tools.

PROGRAM:

(i) Root Locus:

```
Num=[          ];
Den=[           ];
Sys=tf(num,den);
Rlocus=(sys)
Zeta=6.5;
Omega=0.8;
sgrid=(zeta,omega)
[K,poles]=rlocfin(sys)
```

(ii) Blode Plot:

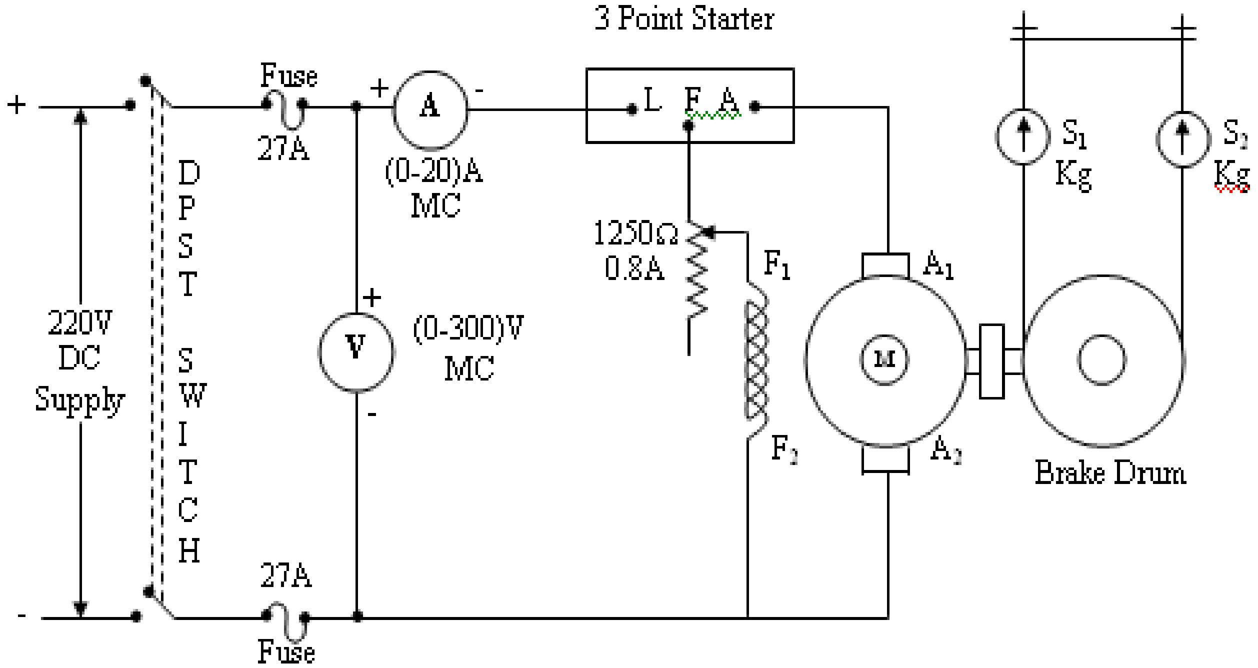
```
Num=[          ];
Den=[           ];
Sys=tf(num,den);
w=logspace(-2,4,100);
bode(sys,w)
[gm,pm,wpc,wgc]=margin(sys)
Gmdb=20*log10(gm)
```

(iii) Nyquist Plot:

```
Num=[          ];
Den=[           ];
Sys=tf(num,den);
Nyquist(sys)
[gm,pm,wpc,wgc]=margin(sys)
```

RESULT:

CIRCUIT DIAGRAM:



FUSE RATING:

125% of rated current

$$\frac{125 \times 21}{100} = 26.25A$$

NAME PLATE DETAILS:

Rated Voltage : 220V
Rated Current : 21A
Rated Power : 3.5KW
Rated Speed : 1500 RPM

Exp. No. : 3 (a)
Date :

MODELLING OF SYSTEMS- DC MOTOR

AIM:

To determine the transfer function of DC motor using

i) Load test
ii) Speed control by armature method

APPARATUS REQUIRED:

S.NO	NAME OF THE APPARATUS	RANGE	QUANTITY
1	DC Shunt Motor	-	1
2	Ammeter	(0-20)A	1
3	Voltmeter	(0-300)V	1
4	Field Rheostat	1250Ω/0.8A	1
5	Armature Rheostat	100Ω/1.8 A	1
6	Connecting Wires	-	As required

FORMULA:

Transfer Function of DC Motor = $\frac{K_t/RaB}{S(1+S\tau a)(1+S\tau m)+\frac{KaKt}{RaB}}$

Where , $K_t = \frac{\Delta T}{\Delta Ia}$

$K_b = \frac{\Delta Eb}{\Delta \omega}$

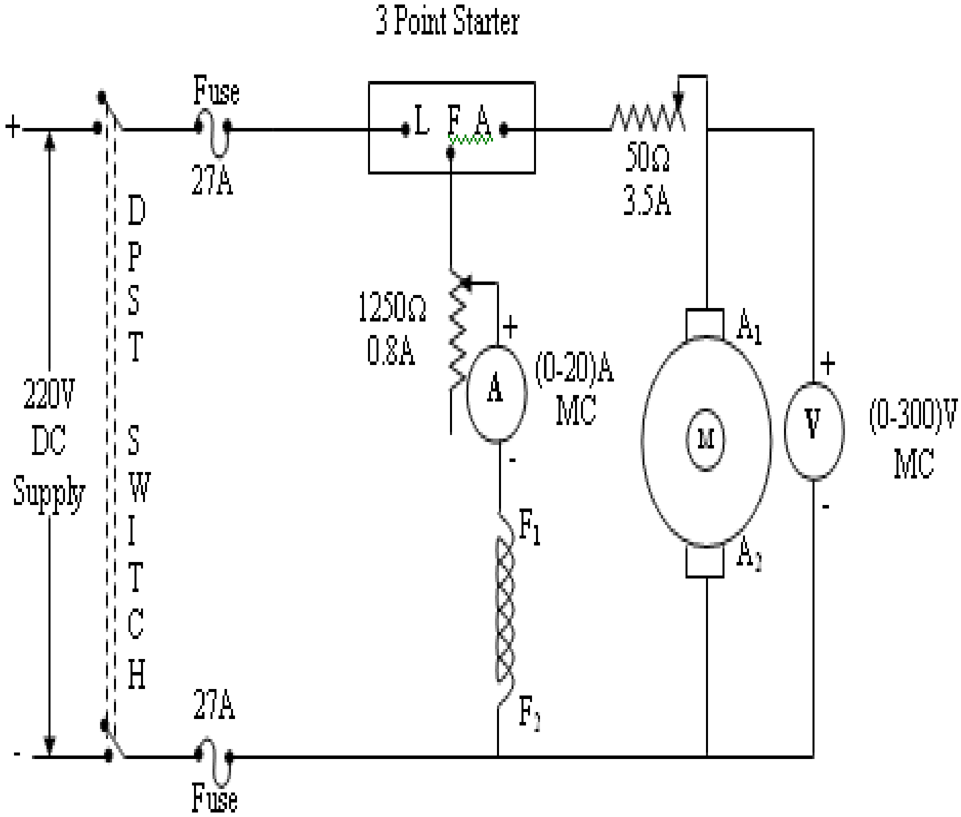
Torque ,T =$(S_1 \sim S_2)$*R*9.81 Nm

Back Emf , $E_b = V - I_aR_a$

THEORY:

A motor is a device which converts an electrical energy into mechanical energy. The principle of operation of DC motor 'Whenever a current carrying conductor is placed in a magnetic field, it experiences a force tending to move it'. The magnitude of the force experienced by the conductor ,F=BIl. The direction of motion is given by Fleming's left hand rule. The classification of DC motor is based on the connections of field winding in relation to the armature

CIRCUIT DIAGRAM:



FUSE RATING:

125% of rated current

$$\frac{125 \times 21}{100} = 26.25A$$

NAME PLATE DETAILS:

Rated Voltage	:	220V
Rated Current	:	21A
Rated Power	:	3.5KW
Rated Speed	:	1500 RPM

PROCEDURE:

i) Load test:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, and minimum field rheostat position, DPST switch is closed and starter resistance is gradually removed.
3. The motor is brought to its rated speed by adjusting the field rheostat.
4. Ammeter, Voltmeter readings, speed and spring balance readings are noted under no load condition.
5. The load is then added to the motor gradually and for each load, voltmeter, ammeter, spring balance readings and speed of the motor are noted.
6. The motor is then brought to no load condition and field rheostat to minimum position, then DPST switch is opened.

ii) Speed Control by armature method:

1. Connections are made as per the circuit diagram.
2. After checking the maximum position of armature rheostat and minimum position of field rheostat, DPST switch is closed
3. Field current is fixed to various values and for each fixed value, by varying the armature rheostat, speed is noted for various voltages across the armature.

TABULATION:

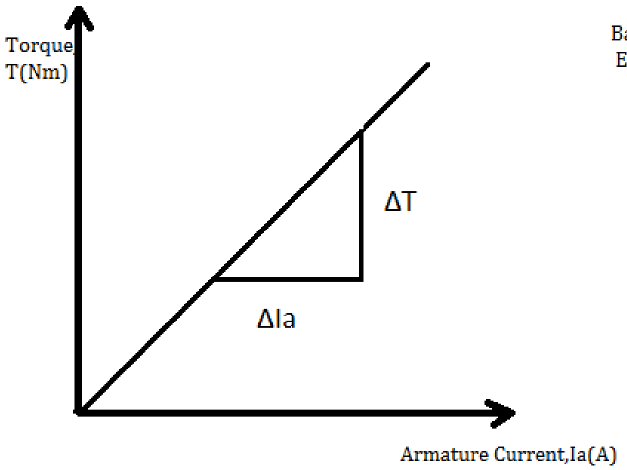
i) Load test:

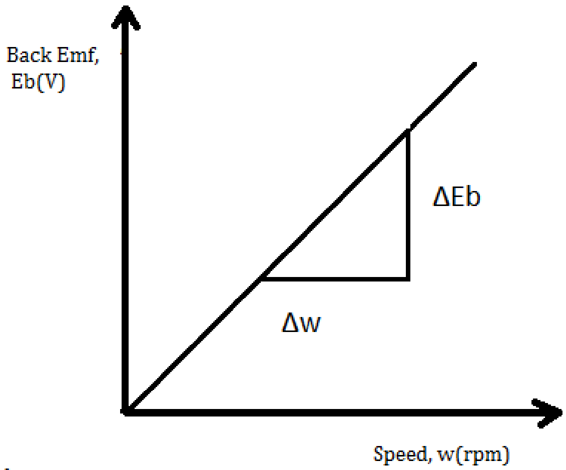
S.NO	I_a(A)	S_1	S_2	T (Nm)	N(rpm)

ii) Speed Control by armature method:

S.NO	I_a(A)	V_a(V)	N(rpm)	E_b	W

MODEL GRAPH:

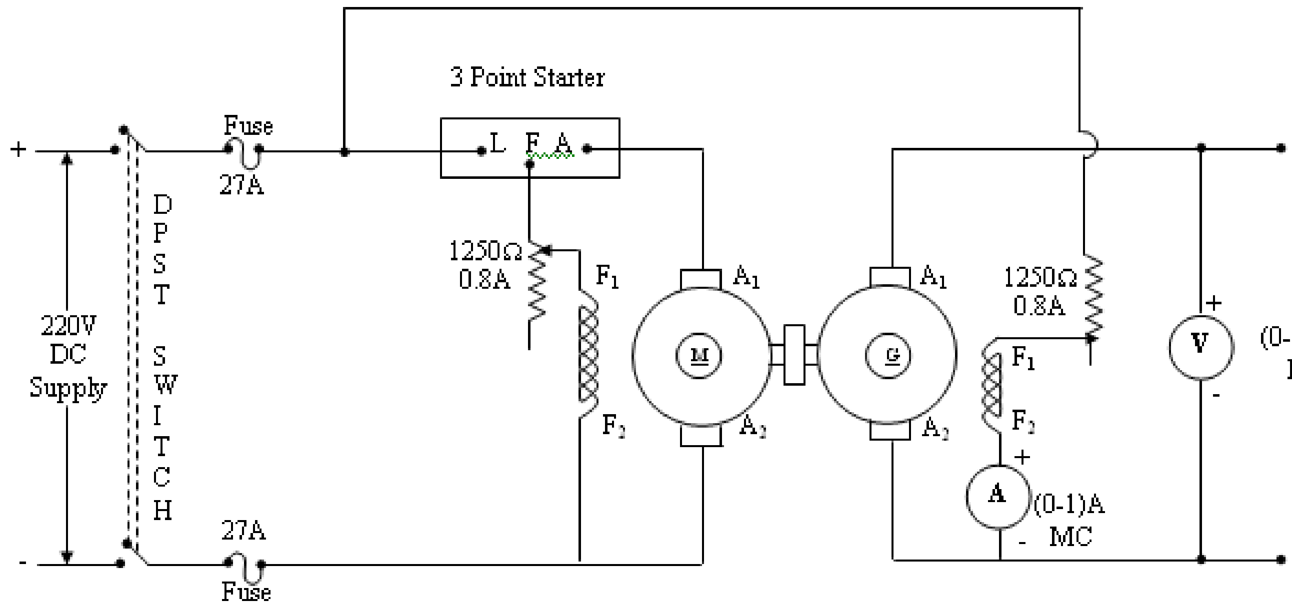




MODEL CALCULATION:

RESULT:

CIRCUIT DIAGRAM:



FUSE RATING:

125% of rated current

$$\frac{125 \times 21}{100} = 26.25A$$

NAME PLATE DETAILS:

	Motor	Generator
Rated Voltage :	220V	220V
Rated Current :	21A	21A
Rated Power :	3.5KW	7.5KW
Rated Speed :	1500 RPM	1500 RPM

Exp. No. : 3 (b)	
Date :	

MODELLING OF SYSTEMS- DC GENERATOR

AIM:

To determine the transfer function of Separately excited DC generator.

APPARATUS REQUIRED:

S.NO	NAME OF THE APPARATUS	RANGE	QUANTITY
1	DC Shunt Generator	-	1
2	Ammeter	(0-20)A	1
3	Voltmeter	(0-300)V	1
4	Rheostat	1250Ω/0.8A	1
5	Connecting Wires	-	As required

FORMULA:

Transfer Function of DC Generator = $\frac{K_g/L_g}{S+R_g/L_g}$

Where , $K_g = \frac{\Delta E_g}{\Delta I_f}$

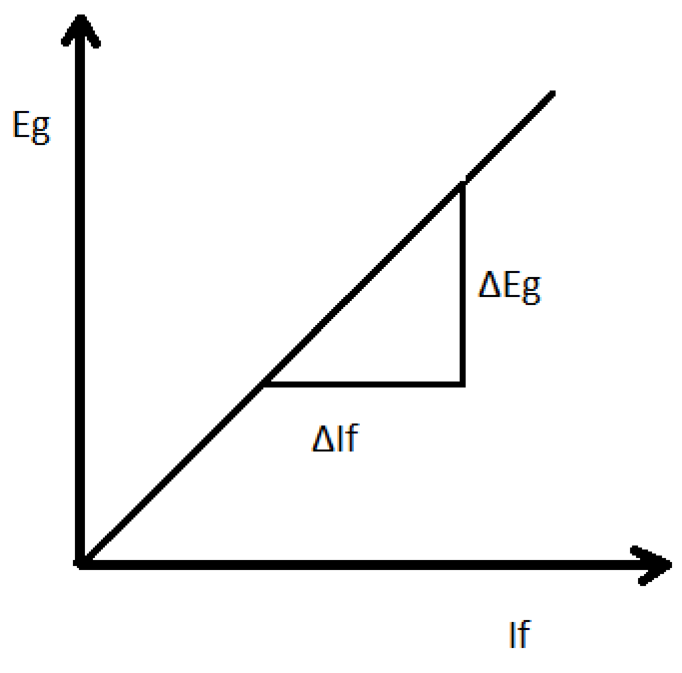
THEORY:

Generator is a machine which converts mechanical energy into electrical energy. The energy conversion is based on the principle of the production of dynamically induced emf. Whenever a conductor cuts magnetic flux, dynamically induced emf produced in it according to Faraday's Law of electromagnetic induction. The emf causes a current to flow if the conductor circuit is closed. Two basic essential parts of an generator are magnetic field & conductor.

TABULATION:

S.NO	I_f(A)	V(V)	$E_g=V+I_fR_a$

MODEL GRAPH:

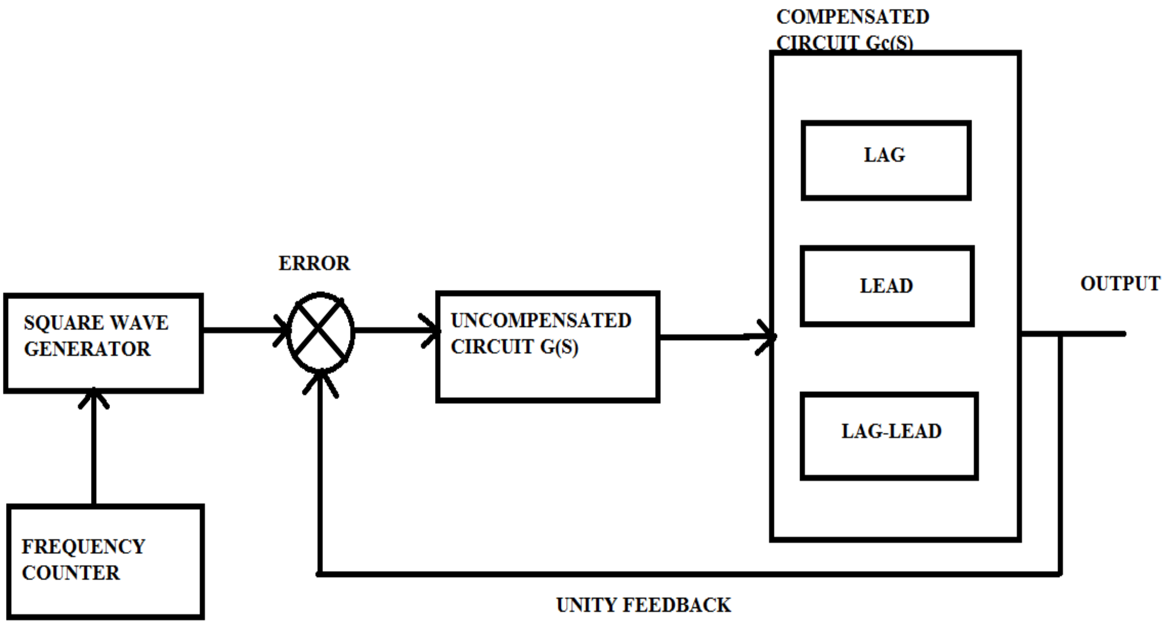


PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking minimum position of motor field rheostat, maximum position of generator field rheostat, DPST switch is closed and starting resistance is gradually removed.
3. By adjusting the field rheostat, the motor is brought to rated speed.
4. By varying the generator field rheostat, voltmeter and ammeter readings are taken.
5. After bringing the generator rheostat to maximum position, field rheostat of motor to minimum position, DPST switch is opened.

RESULT:

BLOCK DIAGRAM:



TABULATION:

S.NO	NETWORK	UNCOMPENSATION	COMPENSATION

Exp. No. : 4
Date :

DESIGN OF LAG,LEAD AND LAG-LEAD COMPENSATORS

AIM:

To study the Operation of lag,lead & lag-lead compensators

APPARATUS REQUIRED:

1. Lag-lead compensator Module.
2. CRO
3. Patch Chords.

THEORY:

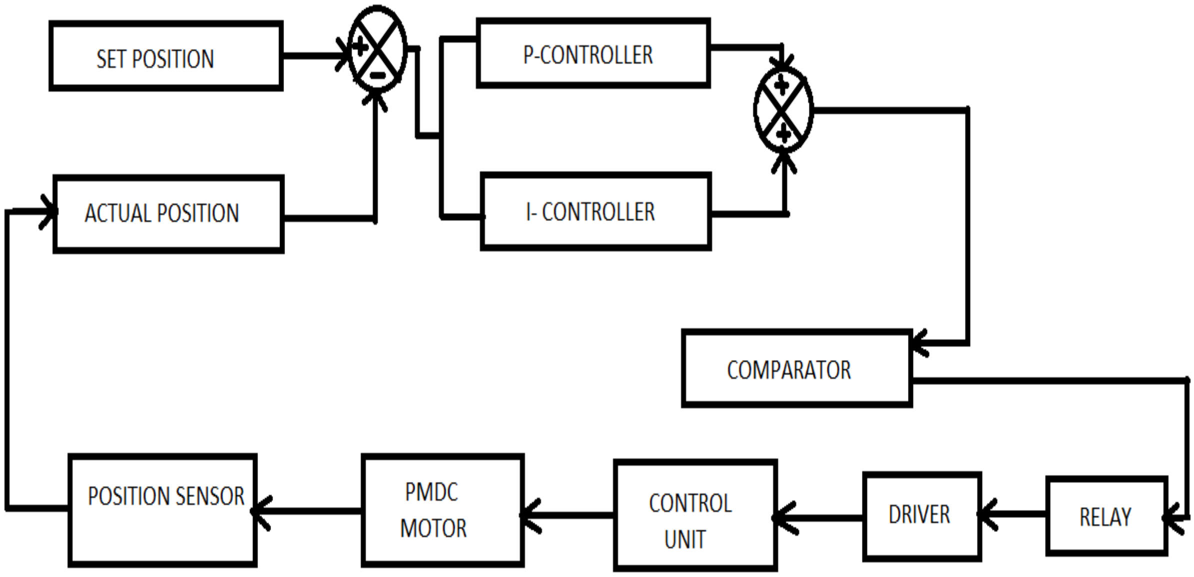
Compensation is the modifications of the system dynamics to satisfy the given specification. series compensation and feedback compensation depends on the nature of the signals in the system, the power levels at various points. To avoid power dissipation, the series compensator is inserted at the lowest energy point in the feed forward path. If a sinusoidal input ei is applied to the input of the network and steady state output eo which is also sinusoidal has a phase lead then the network is called lead network. If the steady-state output eo has a phase lag, then the network is called as a lag network. In a lag-lead network both phase lag and phase lead occur in the output but in different frequency regions. A compensator having a characteristic of a lead network, lag network and lag-lead network is called a lead compensator, lag compensator and lag-lead compensator.

PROCEDURE:

1. Connect the Square Wave Generator to the upper point of LCD provided and connect lower point of LCD to ground.
2. Now switch ON the Techbook.
3. Set the frequency of input Square Wave through knob provided in the square wave generator block to 1KHz.
4. Switch OFF the techbook. Make the circuit through patch chords.
5. Connect Square Wave Generator (1) to uncompensated circuit (2). Uncompensated circuit (4) to Compensated circuit (7).
6. Select the toggle switch to down position. Connect Compensated network (8) to gain
7. Feed the output of gain (12) to CRO through a crocodile to BNC cable..
8. Switch ON the techbook. Now observe the waveform on CRO.

RESULT:

BLOCK DIAGRAM:



TABULATION:

S.NO	SET POSITION	CURRENT POSITION	ERROR

Exp. No. : 5
Date :

POSITION CONTROL SYSTEMS

AIM:

To study the Operation of AC servomotor position control using PLT-CS01A Module.

APPARATUS REQUIRED:

1. PLT-01A Module.
2. AC Servo Motor Set up.
3. Patch Chords.

THEORY:

The AC servomotor is basically a two phase induction motor with some special design features. The stator consists of two pole-pairs(A-B and C-D) mounted on the inner periphery of the stator, Such that their axes are at an angle of 90° in space. The exciting current in the winding should have a phase displacement of 90°. The rotor construction is usually squirrel cage or drag-cup type. The stator winding are excited by voltages of equal rms magnitude and 90°phasedifference. This results in exciting currents i displayed by 90°and have equal rms values. These current give rise to a rotating magnetic field of constant magnitude. The direction of rotation depends on the phase relationship of the two currents(or voltages). The exciting current produces a clockwise rotating magnetic field The rotating magnetic field sweeps over the rotor conductors. The rotor conductors experience a change in flux and so voltages are induced in rotor conductors .This voltages circulates currents in the short circuited rotor conductors and the currents create rotor flux. Due to the interaction of stator and rotor flux, a mechanical force (or torque) is developed on the rotor and so the rotor starts moving in the same direction as that of rotating magnetic field.

FORMULA:

ERROR = Set position – Current position

PROCEDURE:

1.Switch ON the trainer using power ON/OFF switch.

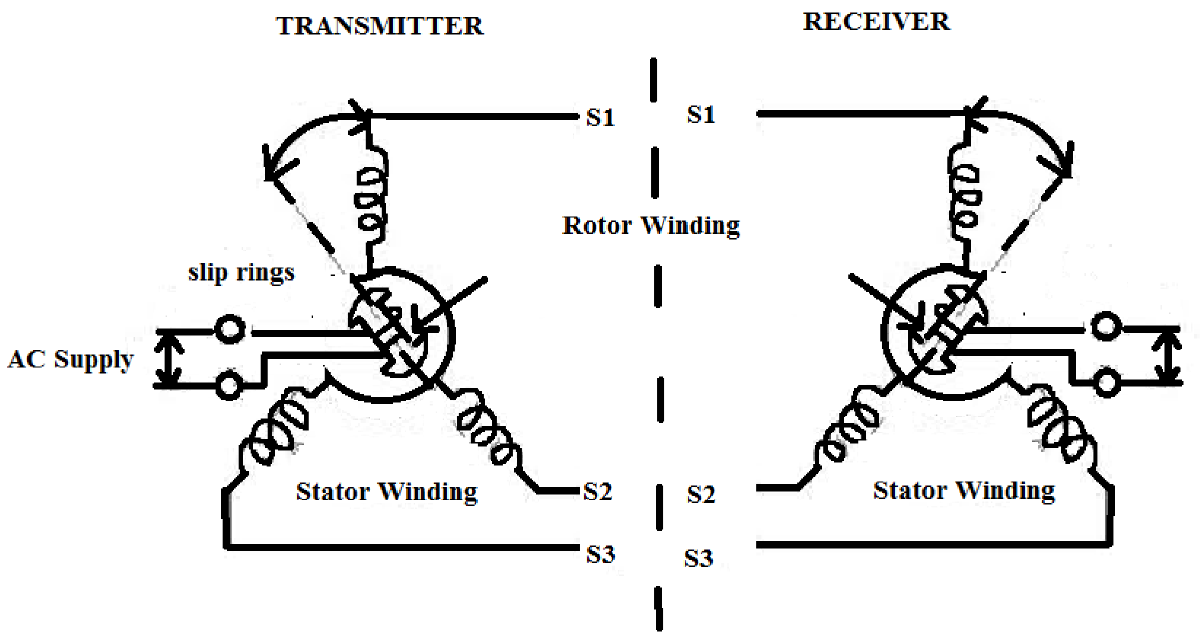
2. Switch ON the 24VAC supply using S1switch in front panel.

3. By adjusting the potentiometer in front panel Set the motor position (set position) 10-340 degree

4. Note down the Set position and Actual position reading in LCD display and tabulate it

RESULT:

AC SYNCHRO SYSTEM:



TABULATION:

Measure the stator output voltage with respect to motor position

Synchro Transmitter Rotor position Vs Stator Voltage for 3 phases				
S.N	Position in degree	Stator Voltage in RMS (VS3-S1)	Stator Voltage in RMS (VS1-S2)	Stator Voltage in RMS (VS2-S3)
01	0			
02	30			
03	60			
04	90			
05	120			
06	150			
07	180			
08	210			
09	240			
10	270			
11	300			
12	330			

Exp. No. : 6
Date :

SYNCHRO-TRANSMITTER & RECEIVER CHARACTERISTICS

AIM:

To Measure the stator output voltage with respect to motor position.

APPARATUS REQUIRED:

1. AC Synchros System
2. Patch Chords

THEORY:

A synchro is an electromagnetic transducer commonly used to convert an angular position of a shaft into an electric signal. The basic synchro is usually called a synchro transmitter. Its construction is similar to that of a three phase alternator. The stator (stationary member) is of laminated silicon steel and is slotted to accommodate a balanced three phase winding which is usually of concentric coil type (Three identical coils are placed n the stator with their axis 120 degree apart) and is Y connected. The rotor is a dumb bell construction and wound with a concentric coil. An AC voltage is applied to the rotor winding through slip rings.

PROCEDURE:

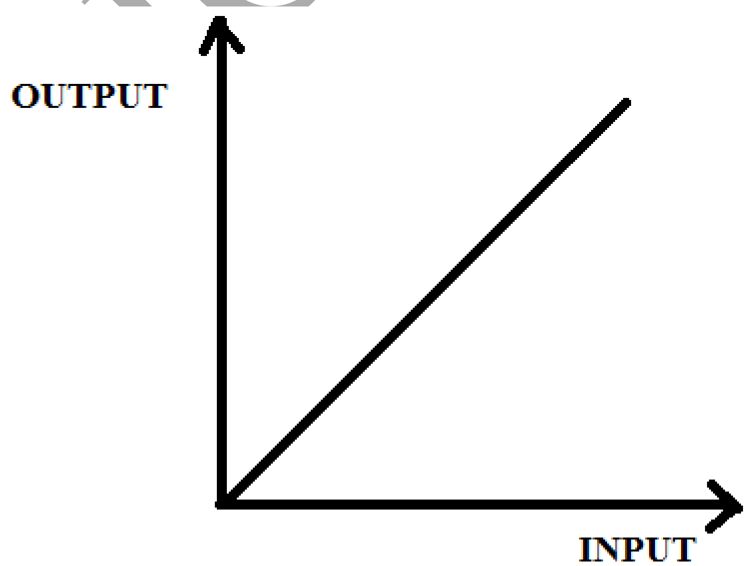
Measure the stator output voltage with respect to motor position

- Connect the mains supply to the system with the help of cable provided. Do not connected any patch cords to terminals marked “S1, S2 and S3”
- Connect 110V AC Source output to Synchro transmitter- Rotor (R1&R2)
- Switch on mains supply for the unit.
- Starting from zero position, note down the voltage between stator winding terminals i.e Vs1s2, Vs2s3 and Vs3s1 in a sequential manner. Enter readings in a tabular form and plot a graph of angular position of rotor voltages for all three phases.
- Note that zero position of the stator rotor coinsides with Vs2s1 voltage equal to zero voltage. Do not disturb this condition.

Measure the transmitter position & receiver position

S.No	Angular Position in degree (Transmitter input)	Angular Position in degree (Reciever output)
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		

MODEL GRAPH:



Measure the transmitter position & receiver position

- Connect mains supply cable.
- Connect S1, S2 and S3 terminals of transmitter to S1, S2 and S3 of synchro receiver by patch cords provided respectively.
- Connect 110V AC Source output to Synchro transmitter- Rotor (R1&R2) & Receiver Rotor (R1&R2) – terminal [110VAC Source applied to both rotors]
- Switch on the mains supply
- Move the pointer i.e rotor position of synchrono transmitter Tx in steps of 30 degrees and observe the new rotor position. Observe that whenever Tx rotor is rotated, the Tr rotor follows it for both the directions of rotations and their positions are in good agreement.
- Enter the input angular position and output angular position in the tabular form and plot a graph.

RESULT:

Exp. No. : 7
Date :

SIMULATION OF CONTROL SYSTEMS BY MATHEMATICAL DEVELOPMENT TOOLS

AIM:

To find the magnitude & phase plot of first order & Second order system.

APPARATUS REQUIRED:

A PC with MATLAB tools.

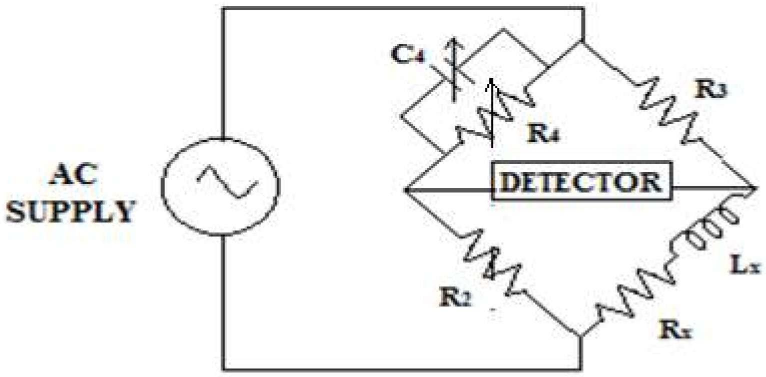
PROGRAM:

```
Num=[          ];
Den=[           ];
Sys=tf(num,den);
step(sys)
impulse(sys)
```


RESULT:

INSTRUMENTATION

CIRCUIT DIAGRAM:



TABULATION:

R_4*10Ω	**R_4*100Ω**	**R_4*1000Ω**
C_4*0.001µF	**C_4*0.01µF**	**C_4*0.1µF**

Exp. No. :8 a	
Date :	

AC BRIDGES – MAXWELL'S INDUCTANCE CAPACITANCE BRIDGE

AIM:

To determine the value of unknown inductance using Maxwell's inductance capacitance bridge.

APPARATUS REQUIRED:

1.Capacitance Bridge.

4. Mulitmeter.
5. Oscilloscope.
6. Unknown Inductance.
7. Set of patching chords.

THEORY:

Maxwell's inductance capacitance bridge is used for measurement of inductance in terms of standard variable capacitance.

L1 – Unknown Inductance

R1 – Effective resistance of Inductance

R2, R3, R4 – Known Resistance

C4 – Standard capacitor and

For the bridge to be balanced

$$(R_1 + j\omega L1)\left(\frac{R_4}{1 + j\omega C_4 R_4}\right) = R_2 R_3$$

Separating Real and Imaginary terms,

We have $R_1 = R_2 R_3/R_4$ and $L_1 = R_2 R_3 C_4$

Thus we have two variables R4 and C4 which appear in one of the two balance equations and hence the two equations are independent.

The expression for Q factor,

$Q = \omega L_1/R_1 = \omega C_4 R_4$

In this bridge, two balance equations are independent if we choose R_4 and C_4 as variable elements and the frequency does not appear in any of the two equations.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Switch ON the trainer and check the power supply to be 15V and observe the output line of CRO.
3. Connect the unknown inductance Lx at the bridge.
4. Connect the CRO terminal to output of the detector.
5. Adjust the null balance to get a minimum sound in a loudspeaker.
6. For faster balance vary R1 which will be compensated by the formula

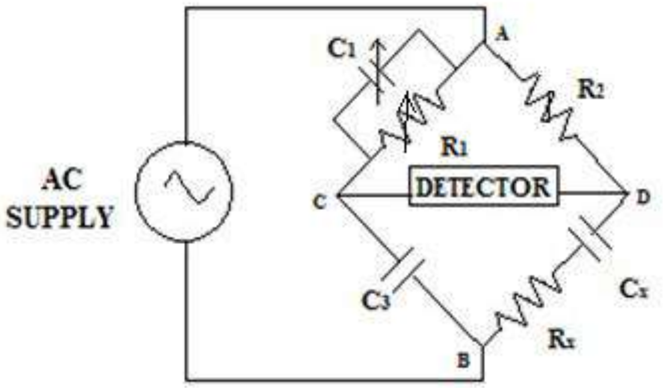
$$L_1 = R_2 \times R_3 \times C_4 \text{ in Henry}$$

$$R_1 = \frac{R_2 R_3}{R_4}$$

MODEL CALCULATION:

RESULT:

CIRCUIT DIAGRAM:



TABULATION:

R_1 (Ω)	R_2 (Ω)	C_3 (μF)	C_x(F)		% error
			Practical value	Theoretical value	

MODEL CALCULATION:

Exp. No. : 8 b
Date :

AC BRIDGES – SCHERING BRIDGE

AIM:

To determine the value of unknown capacitance using Schering's bridge.

APPARATUS REQUIRED:

1. Schering's Bridge trainer.
2. Multimeter.
3. Oscilloscope.
4. Unknown capacitance.
5. Set of patching chords.

THEORY:

Schering's Bridge is an important ac bridge used for the measurement of capacitance. It is particularly used for measuring insulating properties. From the figure for the bridge to be balanced,

$$\left(R_x + \frac{1}{j\omega C_x}\right)\left(\frac{R_1}{1 + j\omega C_1 R_1}\right) = R_2 \frac{1}{j\omega C_3}$$

$$\frac{1 + j\omega R_x C_x}{j\omega C_x} \frac{R_1}{1 + j\omega C_1 R_1} = \frac{R_2}{j\omega C_3}$$

$$R_x - \frac{j}{\omega C_x} = \frac{R_2\, C_1}{C_3} - \frac{j\, R_2}{\omega C_3 R_1}$$

Equating the real and imaginary parts,

$$R_x = \frac{R_2\, C_1}{C_3} \; and \; C_x = \frac{R_1 C_3}{R_2}$$

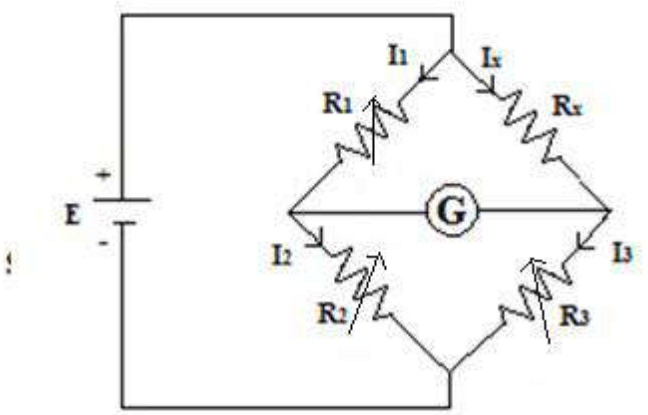
PROCEDURE:

1. Switch ON the trainer and connect the unknown capacitance in the arm marked C_x.
2. Observe sine wave at the output of 1KHz oscillator and patch the circuit using the wiring diagram. Connect the oscilloscope between ground and output point.
3. Select some value of R_2. Vary $R_1$from the minimum position in clockwise direction.
4. If the selection of R_3 is correct, the balance point (DC line) can be observed on the oscilloscope. If not the case select another value of R_2.
5. For further fine balance vary R_2.

6. The balance of the bridge can be observed using loudspeaker. Connect the output of the bridge to the input of the detector.
7. Connect the loudspeaker to the output of the detector. Alternately adjust R_1 and proper selection of R_2 for a minimum sound in loudspeaker.
8. Calculate C_x using the formula $C_x = C_3R_1/R_2$.

RESULT:

CIRCUIT DIAGRAM:



TABULATION:

R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	R_x		Multimeter Value of R_x	% error
			Practical value	Theoretical value		

MODEL CALCULATION:

Exp. No. : 8 c
Date :

DC BRIDGES – WHEATSTONES BRIDGE

AIM:

To measure the unknown value of resistance using Wheatstone bridge.

APPARATUS REQUIRED:

1. Wheatstone bridge trainer.
2. Multimeter.
3. Oscilloscope.
4. Set of patching chords.
5. Resistors of different values (R_x)

THEORY:

Wheatstone bridge is an accurate and reliable device for the measurement of medium resistances. Wheatstone bridge makes comparison measurements and operates upon a null indication principle. The bridge has four resistive arms as shown in figure (a). For the bridge to be balanced the current through the galvanometer should be zero. Hencce the bridge is balanced when $I_1 R_1 = I_x R_x$

$$I_1 = I_2 = \frac{E}{R_1 + R_2} \quad \& \quad I_3 = I_x = \frac{E}{R_3 + R_x}$$

$$\frac{E}{R_1 + R_2} \times R_1 = \frac{E}{R_3 + R_x} \times R_x$$

$$R_x = \frac{R_1 R_3}{R_2}$$

FORMULA:

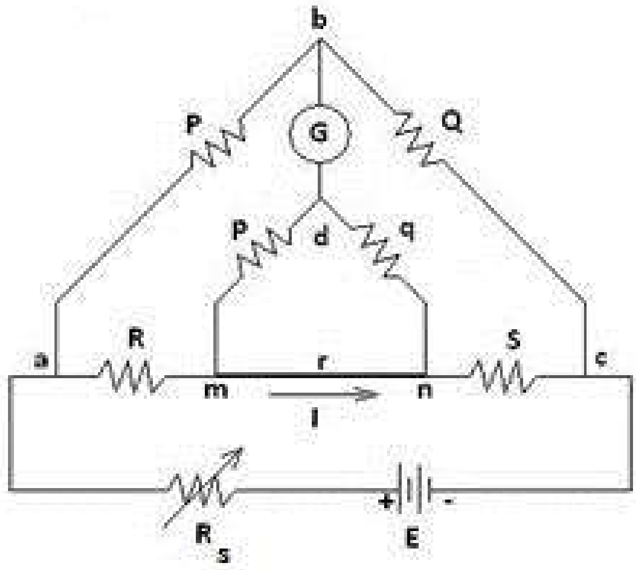
$$\text{Error} = \frac{(\text{Actual value} - \text{Indicated value})}{\text{Actual value}}$$

PROCEDURE:

1. Switch on the trainer and check the power supply to be +15V
2. Patch the circuit as shown in wiring diagram.
3. Connect the unknown resistor in the arm marked $R_x$and select some values of R_2 and R_3
4. Vary R_1 from the minimum position in the clockwise direction. If the selection of R_2 and $R_3$are correct the balance or null point can be observed in the oscilloscope connected between the ground and the output point i.e the amplitude of the output waveform comes to a minimum for a particular value of R_1in the same clockwise direction. If not the case select another value of R_2 and R_3.
5. The null condition can also be observed by using loudspeaker. Connect the output of the bridge to the input of the detector. The loudspeaker is connected at the output of the detector. Adjust R_1, R_2 and R_3 for a minimum sound in the loudspeaker.
6. At balance disconnect the wires and measure the resistance using multimeter.
7. Calculate the unknown resistance using formula $R_x = R_1R_3/R_2$.

RESULT:

CIRCUIT DIAGRAM:



TABULATION:

S	P	Q	p	q	R_x		% error
					Practical value	Theoretical value	

MODEL CALCULATION:

Exp. No. : 8 d
Date :

DC BRIDGES – KELVIN'S DOUBLE BRIDGE

AIM:

To measure the unknown value of resistance using Wheatstone bridge.

APPARATUS REQUIRED:

1. Kelvin's double bridge trainer.
2. Multimeter.
3. Oscilloscope.
4. Set of patching chords.
5. Resistors of different values (R_x)

THEORY:

Kelvin's double bridge provides increased accuracy in the measurement of low resistances. It has two sets of ratio arms. The first set of ratio arms are P and Q. The second set of ratio arms are p and q is used to connect the galvanometer to the point C at the appropriate potential m and n to eliminate the effect of connecting lead of resistance r between the known resistance R and the standard resistance S. The ratio p/q is made equal to P/Q. Under balanced condition no current should flows through the galvanometer which means that the voltage drop between a and d is equal to the voltage drop between a and c.

$$E_{ad} = \frac{p}{P+Q} E_{ab}$$

$$E_{ab} = I\left[R + S + \frac{(p+q)\,r}{p+q+r}\right]$$

$$E_{amc} = I\left[R + \frac{p}{p+q}\left[\frac{(p+q)\,r}{p+q+r}\right]\right]$$

for zero galvanometer deflection $E_{ad} = E_{amc}$

$$R = \frac{P}{Q} S + \frac{q\,r}{p+q+r}\left[\frac{P}{Q} - \frac{p}{q}\right]$$

$$\text{If } \frac{P}{Q} = \frac{p}{q}, \quad R = \frac{P}{Q} S$$

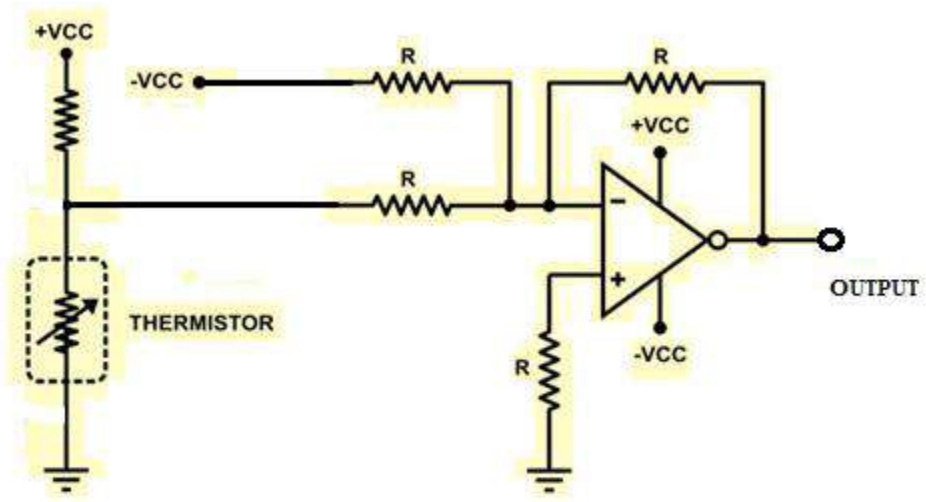
PROCEDURE:

1. Switch on the trainer and check the power supply to be +15V.
2. Connect externally a galvanometer as indicated on the trainer.
3. Connect the unknown resistor in the arm marked R_x. Select the values of P/Q = p/q = 0.01.
4. Adjust S for proper balance and at balance measure the value of S.
5. Calculate the value of the unknown resistance using the formula,

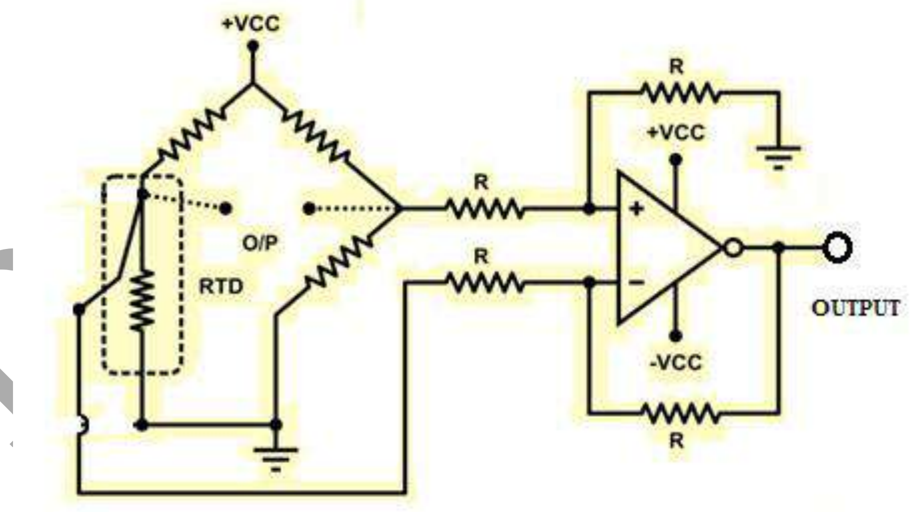
$$R = \frac{P}{Q} S + \frac{q\,r}{p+q+r}\left[\frac{P}{Q} - \frac{p}{q}\right]$$

RESULT:

TEMPERATURE MEASUREMENT USING THERMISTOR:



TEMPERATURE MEASUREMENT USING RTD:



Exp. No. : 9 a
Date :

TEMPERATURE TRANSDUCER

AIM:

To measure temperature using RTD & Thermistor

APPARATUS REQUIRED:

1. Trainer kit
2. Thermistor
3. RTD
4. Electric Kettle
5. Thermometer
6. Patch cords

THEORY:

Temperature Sensors measure the amount of heat energy or even coldness that is generated by an object or system, allowing us to "sense" or detect any physical change to that temperature producing either an analogue or digital output.

The **Thermistor** is another type of temperature sensor, whose name is a combination of the wordsTHERM-ally sensitive res-ISTOR. A thermistor is a special type of resistor which changes its physical resistance when exposed to changes in temperature. Thermistors are generally made from ceramic materials such as oxides of nickel, manganese or cobalt coated in glass which makes them easily damaged. Their main advantage over snap-action types is their speed of response to any changes in temperature, accuracy and repeatability.

Another type of electrical resistance temperature sensor is the **Resistance Temperature Detector**or **RTD**. RTD's are precision temperature sensors made from high-purity conducting metals such as platinum, copper or nickel wound into a coil and whose electrical resistance changes as a function of temperature, similar to that of the thermistor.

TABULATION:

TEMPERATURE MEASUREMENT USING THERMISTOR:

S.N	Temperature in degree (Measured by THERMOMETER)	Temperature in degree (Measured by THERMISTOR)	Error
01	Room temperature ( )		
02			
03			
04			
05			

TEMPERATURE MEASUREMENT USING RTD:

S.N	Temperature in degree (Measured by THERMOMETER)	Temperature in degree (Measured by RTD)	Error
01	Room temperature ( )		
02			
03			
04			
05			

PROCEDURE:

TEMPERATURE MEASUREMENT USING THERMISTOR

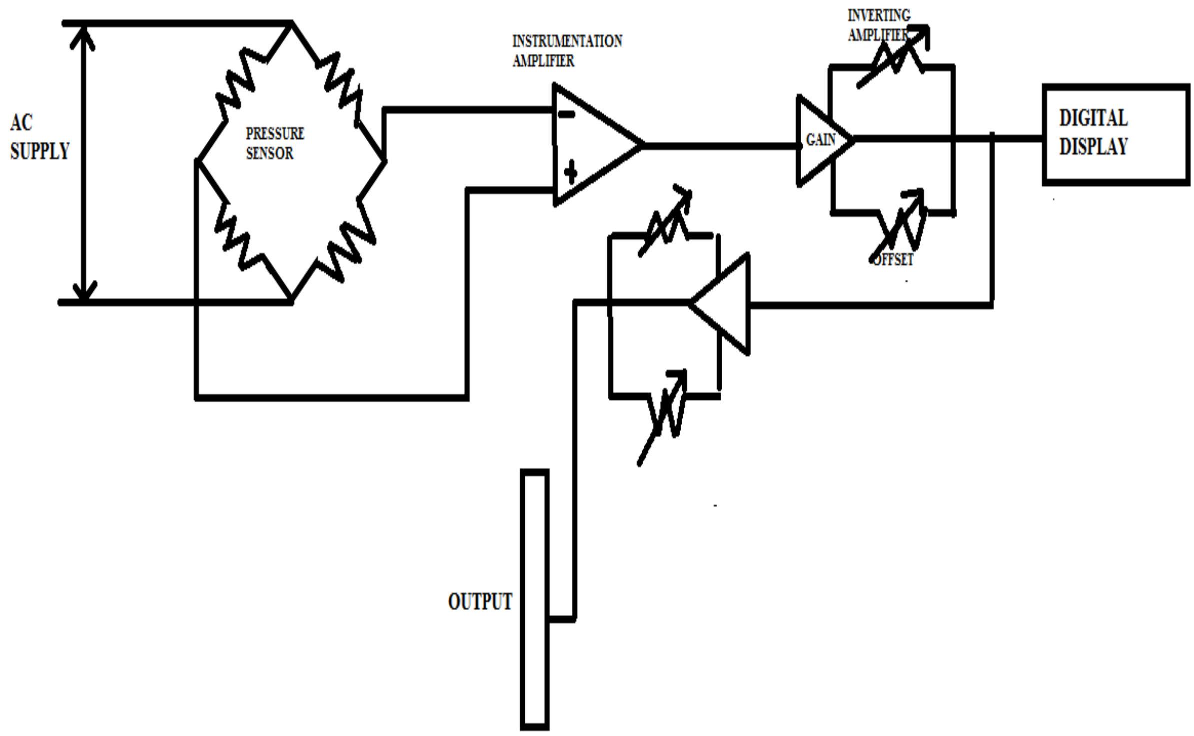
- Connect thermistor probe one end to P1 terminal of trainer
- Connect thermistor probe other end to P2 terminal of trainer
- Connect thermistor P4 terminal to P5 terminal in trainer
- Connect thermistor P6 terminal to P7 terminal (Display input) in trainer
- Insert THERMISTOR probe in water kettle & ensure thermistor probe fully immersed in water
- Insert GLASS Thermo meter probe in water kettle & ensure probe fully immersed in water
- Note down initial (ROOM) temperature value in display ,now switch ON water heater kettle
- Note down & tabulate the Trainer display reading & Thermometer reading
- Switch OFF the trainer .

TEMPERATURE MEASUREMENT USING RTD

- Connect RTD Probe –WHITE-1 color wire to P 09 terminal of trainer
- Connect RTD Probe –WHITE-2 color wire to P10 terminal of trainer
- Connect RTD Probe –Red color wire to P11 terminal of trainer
- Connect thermistor P12 terminal to P13 terminal (Display input) in trainer
- Insert RTD probe in water kettle & ensure RTD probe fully immersed in water
- Insert GLASS Thermo meter probe in water kettle & ensure probe fully immersed in water
- Note down initial (ROOM) temperature value in display ,now switch ON water heater kettle
- Note down & tabulate the Trainer display reading & Thermometer reading
- Switch OFF the trainer

RESULT:

PRESSURE TRANSDUCER



TABULATION:

S.NO	ACTUAL PRESSURE	INDICATED PRESSURE	% ERROR

Exp. No. : 9 b
Date :

PRESSURE TRANSDUCER

AIM:

To measure pressure using Bourdon Tube.

APPARATUS REQUIRED:

1. Bourdon Pressure transducer kit
2. Foot Pump

THEORY:

Pressure cells are divisors that convert pressure into electrical signal through a measurement of either displacement strain or piezoelectric response. The pressure cell is connected to the tank whose pressure is to be measured. An instrumentation system is used to measure the output signal produced by a transducer and often to control the physical signal producing it. The pressure tank is mounted on the base plate. The control valve and the inlet valve are provided in it. One Bourdon Gauge is mounted on the top of the tank to measure inlet pressure.

FORMULA:

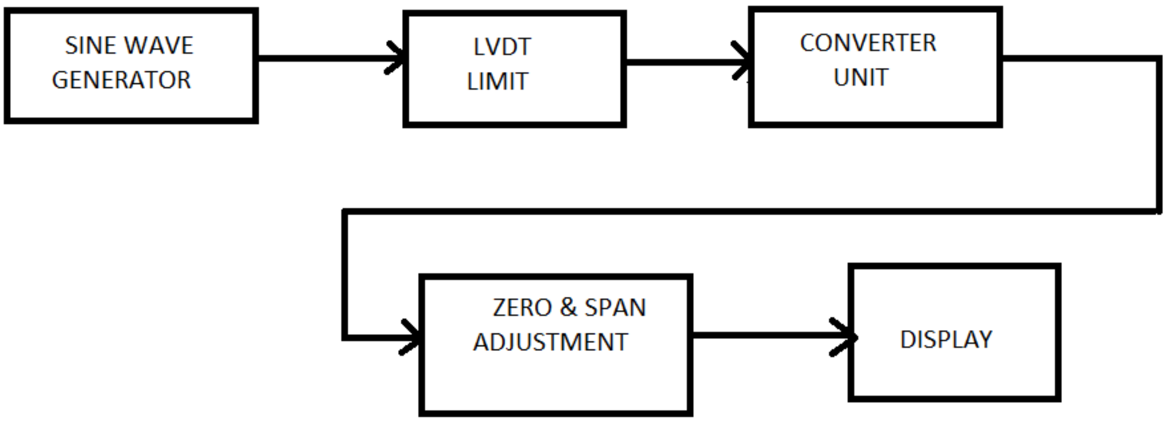
$$\text{Error} = \frac{(\text{Actual value} - \text{Indicated value})}{\text{Actual value}}$$

PROCEDURE:

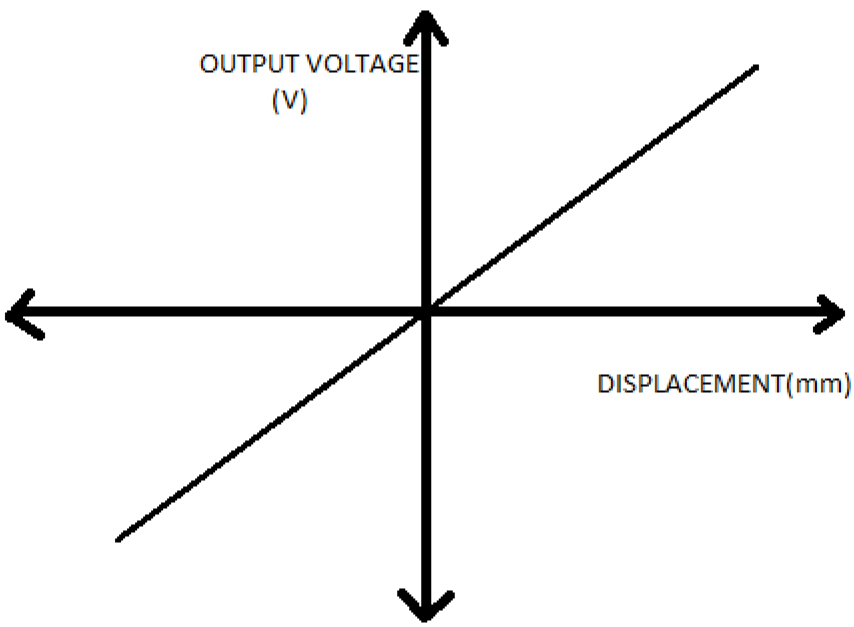
1. Release the air in the pressure tank using release valve till the pressure guage indicates zero & close the valve
2. Switch on the trainer
3. Now built the pressure by pedelinging the foot pump
4. Pedel the pump till pressure to loops
5. Tabulate the reading.

RESULT:

BLOCK DIAGRAM:



MODEL GRAPH:



Exp. No. : 9 c
Date :

DISPLACEMENT TRANSDUCER

AIM:

To measure displacement using LVDT and to find percentage error.

APPARATUS REQUIRED:

1. LVDT trainer kit
2. LVDT Sensor with screw gauge set

THEORY:

LVDT is the most widely used inductive transducer in the measurement of displacement. LVDT is a differential transformer consisting of one primary winding and two identical secondary windings connected in series opposition. A soft iron core attached to the sensing element of which the displacement is to be measured slides freely in the hollow portion. The output of LVDT is a linear function of core displacement within a limited range of motion. The output voltage at the null position should be equal to zero. But practically there exists a small voltage called residual voltage due to stray magnetic fields and temperature effects.

FORMULA:

$$\text{Error} = \frac{(\text{Actual value} - \text{Indicated value})}{\text{Actual value}}$$

PROCEDURE:

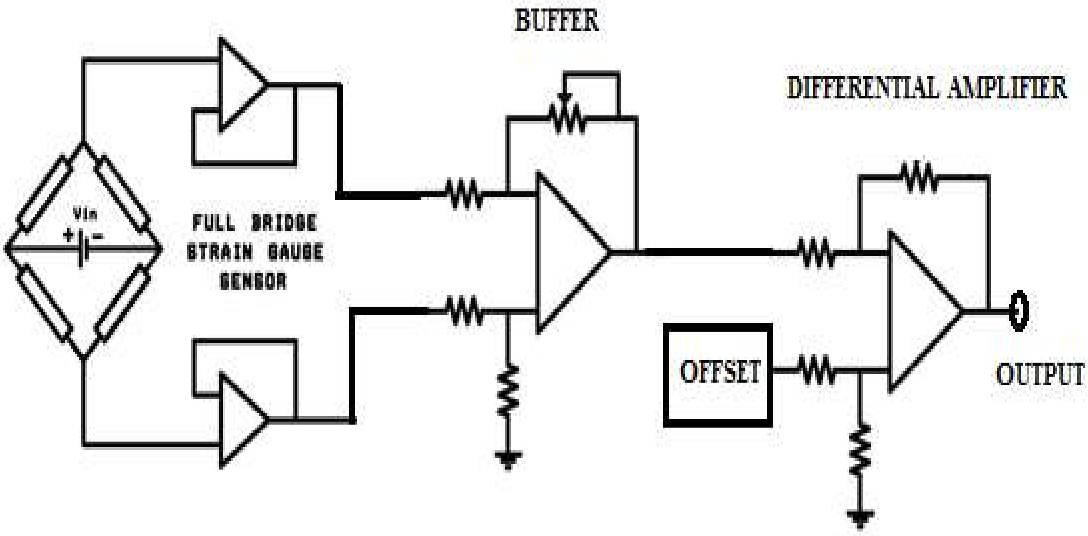
1. Switch on the LVDT trainer.
2. Adjust the screw guage at 10mm which corresponds to null position of LVDT. The display should read 0 volts.
3. Adjust the screw guage to 12mm and record the corresponding reading displayed.
4. Repeat the above in steps of 2mm till the screw guage reading is 20mm.
5. Repeat step 2 of above procedure.
6. Adjust the screw guage to 8mm and record the corresponding reading displayed.
7. Repeat the above in steps of -2mm till the screw guage reading is 0mm.
8. Record the readings in a tabular column and plot the graph displacement vs voltage.

TABULATION:

Displacement (mm)	Output Voltage (V)

RESULT:

STRAIN TRANSDUCER



TABULATION:

S.N	Applied Weight in Gram	LCD DISPLAY			Strain (Theortical)	Error
		Weight in Gram	ME	Voltage		
01	100 gram					
02	200 gram					
03	300 gram					
04	400 gram					
05	500 gram					
06	600 gram					
07	700 gram					
08	800 gram					
09	900 gram					
10	1000 gram					

Exp. No. : 9 d
Date :

STRAIN TRANSDUCER

AIM:

To measure the strain in the beam using Strain Gauge Trainer Kit.

APPARATUS REQUIRED:

1. Stain Gauge Trainer Kit (PLT CS07SG)
2. Load (100gm X 10 Numbers)
3. Cantilever Beam set

THEORY:

The strain gauge is an example of a passive transducer that uses the variation in electrical resistance in wires to sense the strain produced by a force on the wires. It is well known that stress (force/unit area) and strain (elongation or compression/unit length) in a member or portion of any object under pressure is directly related to the modulus of elasticity. Since strain can be measured more easily by using variable resistance transducers, it is a common practice to measure strain instead of stress, to serve as an index of pressure. Such transducers are popularly known as strain gauges. If a metal conductor is stretched or compressed, its resistance changes on account of the fact that both the length and diameter of the conductor changes. Also, there is a change in the value of the Resistivity of the conductor when subjected to strain, a property called the Piezo –resistive gauges. When a gauge is subjected to a positive stress, its length increases while its area of cross – section decreases. Since the resistance of a conductor is directly proportional to its length and inversely proportional to its area of cross – section, the resistance of the gauge increases with positive strain. The change in resistance value of a conductor under strain is more than for an increase in resistance due to its Dimensional changes. This property is called the Piezo resistive effect.

PROCEDURE:

1. Switch ON the Stain Gauge tutor.

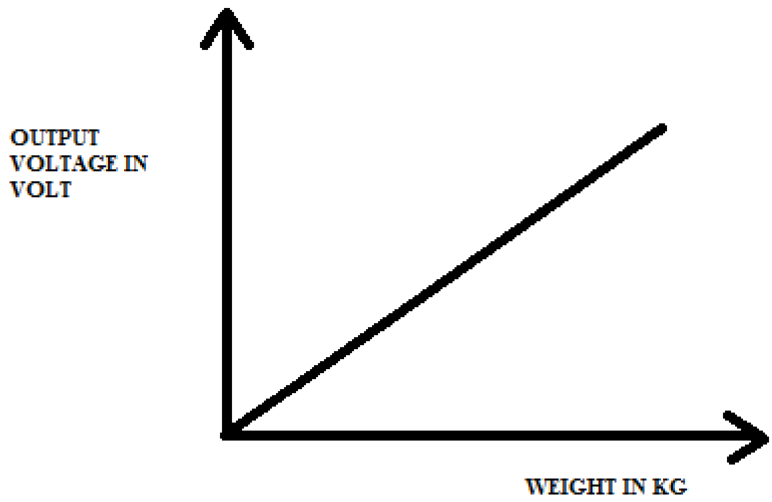
2. The bridge output voltage (across P5 & P9 Connector) and LCD Display readings are noted without applying any load in the set up.

3. Apply the load (100g) note down the corresponding readings.

4. Then the load is increased in 100gm up to 1000 kg for each step and readings are tabulated.

5. Switch OFF the supply.

MODEL GRAPH:



FORMULA:

Strain = 6WD / M X T^2 --- (1)

Where:

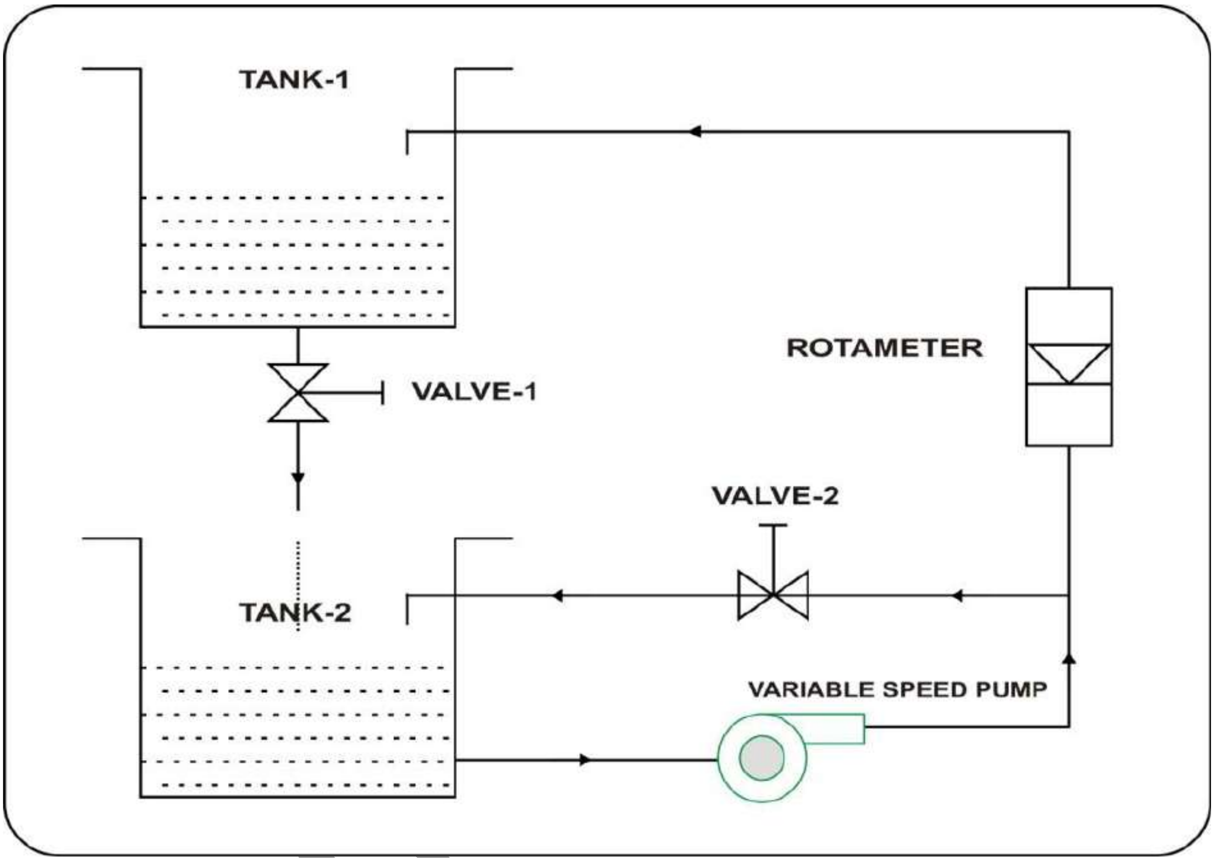
W	→	Weight in Lb / N	=	**Applied load in set up**	
D	→	Beam Length in mm	=	220mm	[Constant]
X	→	Beam Width in mm	=	28mm	[Constant]
T	→	Beam Thickness in mm	=	2.5mm	[Constant]
M	→	Modulas of elasticity (stainless steel)	=	28 x 10^6	[Constant]

Weight in **Grams** to **Lb / N** Conversion :

(Grams) x (9.80665002864) = **Lb / N** **------------------------ (2)**

RESULT:

FLOW DIAGRAM



Exp. No. : 9 e
Date :

FLOW MEASUREMENT

AIM:

To measure the Water Flow Rate in LPM by using Rota meter

APPARATUS REQUIRED:

1. Flow measurement trainer
2. Scale
3. Stop Clock

THEORY:

The rotameter's operation is based on the variable area principle: fluid flow raises a float in a tapered tube, increasing the area for passage of the fluid. The greater the flow, the higher the float is raised. The height of the float is directly proportional to the flowrate. With liquids, the float is raised by a combination of the buoyancy of the liquid and the velocity head of the fluid. With gases, buoyancy is negligible, and the float responds to the velocity head alone. The float moves up or down in the tube in proportion to the fluid flowrate and the annular area between the float and the tube wall. The float reaches a stable position in the tube when the upward force exerted by the flowing fluid equals the downward gravitational force exerted by the weight of the float. A change in flowrate upsets this balance of forces. The float then moves up or down, changing the annular area until it again reaches a position where the forces are in equilibrium. To satisfy the force equation, the rotameter float assumes a distinct position for every constant flowrate. However, it is important to note that because the float position is gravity dependent, rotameters must be vertically oriented and mounted.

TABULATION:

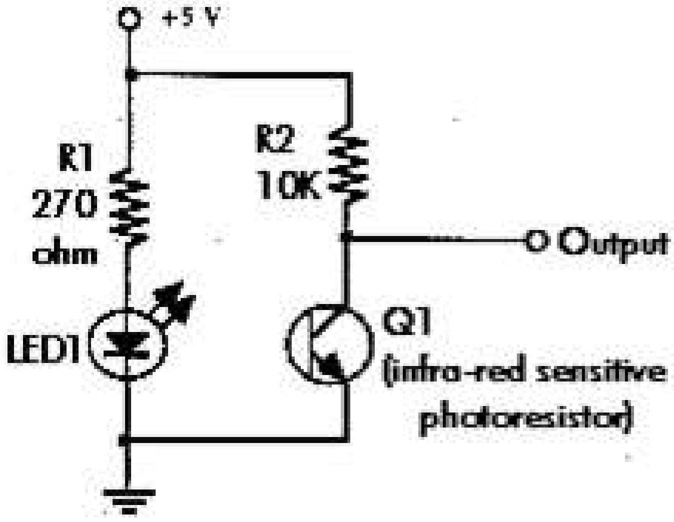
Rotameter Error Constant = 0.3333 (CONSTANT VALUE)

Level of Water in litre	Time taken to fill	Rotameter Reading	Actual Reading of Rotameter = (Rotameter Reading x error constant)	Calculated LPM = T /60

PROCEDURE:

1. Drain all the water in Tank -1 using S1 switch
2. Fill the water in Tank -2
3. Switch ON Power ON/OFF Switch (S1)
4. Switch ON Pump speed adjustment regulator & Adjust slowly
5. Now the water is flow from Tank-2 to Tank-1 through Rota meter
6. Rota meter indicate the Flow rate in LPM
7. To Vary the Flow Rate adjust any one of the Below
    1. Rotameter Knob\
    2. S2-Valve
    3. Pump speed adjustment regulator
8. By adjusting any one of the above ,the Flow Rate of water will be varied & corresponding Rotameter Reading in LPM (Litre per Minutes) will vary. Observe the reading.

RESULT:


+5 V
R1
270
ohm
R2
10K
Output
LED1
Q1
(infra-red sensitive
photoresistor)

Exp. No. : 9 f
Date :

OPTICAL TRANSDUCER

AIM:

To study the behavior/properties/functions of LDR (Photo resistor) & Photo diode

APPARATUS REQUIRED:

1. Optical sensor/ transducer trainer kits
2. Small Light (Torch light)
3. Patch chords

THEORY:

A photoresistor or light-dependent resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits.

Photoelectric sensing requires an emitter (to generate light) and a receiver (which "sees" the light from the emitter).Most photoelectric sensors use LEDs (Light Emitting Diodes) as a light source - a solid-state semiconductor, similar electrically to a diode, except that it emits a small amount of light when current flows through it in the forward direction. LEDs can be built to emit green, blue, blue-green, yellow, red, or infrared light.

PROCEDURE:

➢ **TO STUDY THE APPLICATION OF PHOTO DIODE**

- Connect P3 terminal to P4 terminal of trainer using patch chords
- P5 is ground & internally connected
- Connect P8 terminal to P10 terminal of trainer using patch chords
- Now the display indicate ‘0’ otherwise press Reset switch (S2) in trainer
- Now apply single Pulse by applying One pressing in S1 switch, now display will indicate ‘1’
- Press S1 switch slowly with equal time delay , now the display indicate up to ‘9’

TABULATION:

- **TO STUDY THE APPLICATION OF PHOTO DIODE**

S.N	S1 INPUT	Display
01	1	1
02	11	2
03	111	3
04	1111	4
05	11111	5
06	111111	6
07	1111111	7
08	11111111	8
09	111111111	9
10	1111111111	0

- **TO STUDY THE BEHAVIOUR OF PHOTO DIODE**

S.N	Sensor input frequency (Across P4&P5 Terminal)	Sensor output frequency (Across P8&P9 Terminal)
01		
02		
03		
04		

- **TO STUDY THE BEHAVIOUR OF PHOTO DIODE**

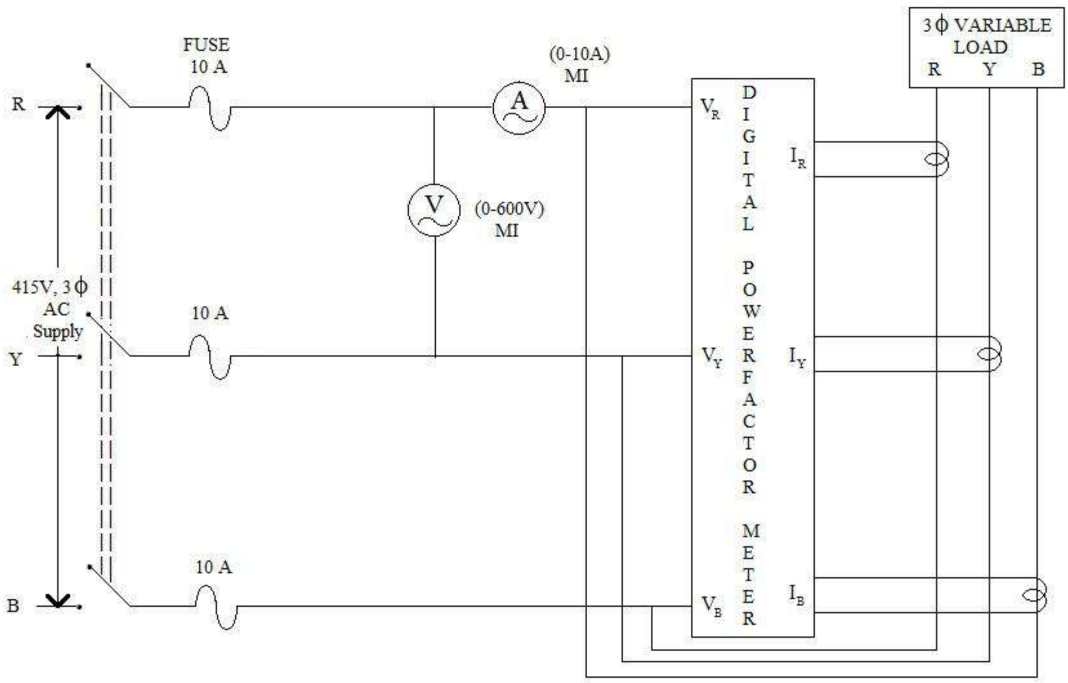
- Connect P1 terminal to P2 terminal of trainer using patch chords
- Connect P2 terminal to P4 terminal of trainer using patch chords
- P5 is ground & internally connected
- switch ON the Power in trainer
- Set the signal frequency @ __ Hz by using Pot -2
- Now measure the frequency across terminal P4 & P5, tabulate
- Now measure the frequency across terminal P8 & P9, tabulate
- Repeat the above with different SET FREQUENCY and observe across P8 & P9 & Tabulate

- **TO STUDY THE BEHAVIOUR OF LDR**

- Connect P11 terminal to P12 terminal of trainer using patch chords
- Connect P13 terminal to P14 terminal of trainer using patch chords
- Connect P15 terminal to P16 terminal of trainer using patch chords
- Connect P19 terminal to P18 terminal of trainer using patch chords
- Set __ Vdc by using Pot -1
- Now the comparator output is high & Relay is ON & Lamp is glown
- Apply light to LDR
- Note down the changes in
    - Comparator output
    - Relay status
    - Lamp status
- Repeat the above with different set voltage

RESULT:

CIRCUIT DIAGRAM:



TABULATION:

LOAD	VOLTAGE VL (V)	CURRENT IL (A)	POWER FACTOR COS ϕ	POWER (W)

MODEL CALCULATION:

Exp. No. : 10 a
Date :

MEASUREMENT OF 3 PHASE POWER & POWER FACTOR

AIM:

To conduct a suitable experiment on a 3-phase load connected in star or delta to measure the 3-phase power and power factor using 2 wattmeter method.

APPARATUS REQUIRED:

1. Wattmeter rated 10A, 600V UPF – 2 nos.
2. Voltmeter rated 600V of type MI – 1 no.
3. Ammeter rated 10A of type MI – 1 no.
4. Three phase resistive load
5. Three phase inductive load
6. Three phase capacitive load
7. Connecting wires.

THEORY:

Power in a three phase circuit can be measured using two wattmeters. The current coil of wattmeter 1 is connected in R phase. The voltage coil of wattmeter is connected between R-phase and Y-phase. The current coil of wattmeter 2 is connected between B and Y-phase. The current coil of wattmeter 2 is connected in B phase. The sum of two wattmeter readings indicates the total power in the circuit.

FORMULA:

$Vph = V_L/\sqrt{3}$

$I_L = Iph$

Power = 3* Vph* Iph Cosϕ

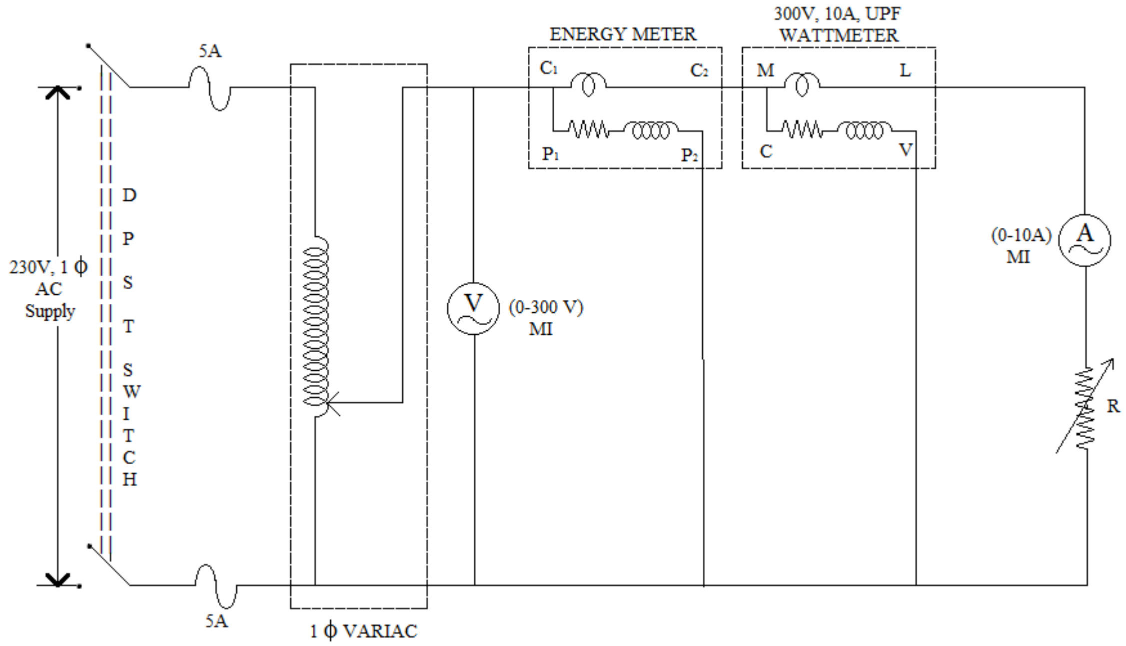
PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The three phase AC supply is switched ON for setting the rated voltage in the voltmeter.
3. At no load condition all the meter readings are noted down.
4. The resistive load is increased in steps and the meter readings are noted down.
5. Repeat the same procedure for inductive and capacitive loads.

MODEL CALCULATION:

RESULT:

CIRCUIT DIAGRAM:



TABULATION:

TIME FOR 5 REVOLUTIONS OF ENERGYMETER (S)	WATTMETER (W)	ENERGY RECORDED	ACTUAL ENERGY	ERROR

MODEL CALCULATION:

Exp. No. : 10 b
Date :

CALIBRATION OF 1ϕ ENERGY METER

AIM:

To calibrate the given single phase energy metre and to find the percentage error.

APPARATUS REQUIRED:

1. Single phase RSS meter.
2. Single phase Energy meter.
3. Single phase lamp load.
4. Ammeter ranged 10A of type MI – 1 no.
5. Voltmeter ranged 300V of type MI – 1 no.
6. Connecting wires.

THEORY:

Electrical energy is measured by means of energy meter. The energy meter is an integrated type instrument that takes into account both the quantities of power and time which product gives the Energy. An energy meter keeps the record of total energy consumed during a particular period. The ratings associated with an energy meter are voltage rating, current rating, frequency rating and meter constant.The driving system of energy meter has two electromagnets. The coil is excited by load current for one magnet and connected across the supply for other. There exist two fluxes and hence eddy currents. The driving torque is produced by the interaction of the two eddy current fluxes. At steady speed the driving torque is equal to braking torque and the energy consumed is equal to number of revolutions per Kwhr.

FORMULA:

$$\text{Actual Energy} = \frac{\text{Power} * \text{Time}}{1000*3600}$$

$$\% \text{ Error} = \frac{(\text{Energy Recorded} - \text{Actual Energy})*100}{\text{Actual Energy}}$$

$$\text{Energy Recorded} = \frac{\text{No.of Revolutions}}{600}$$

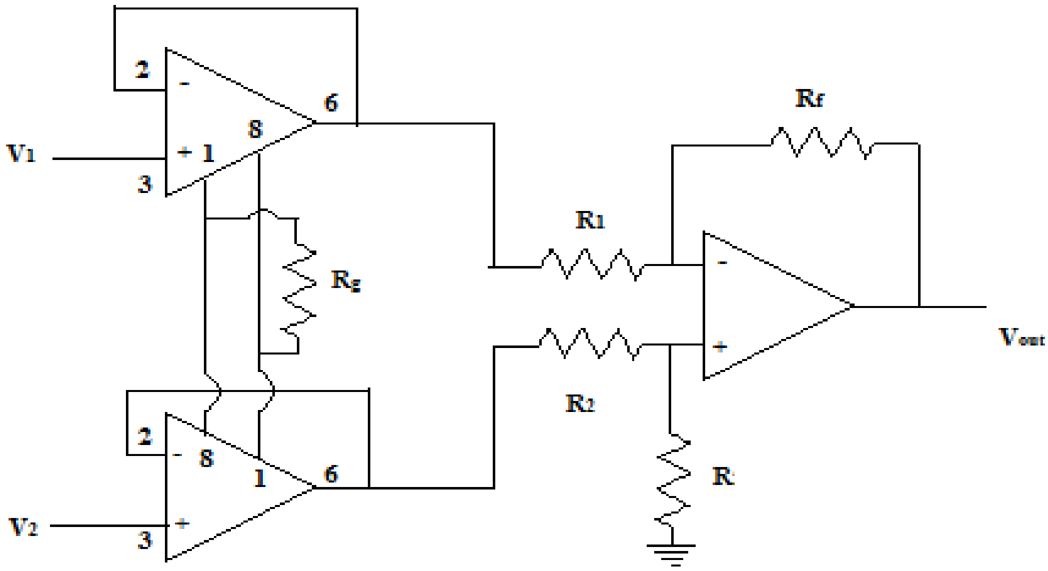
MODEL CALCULATION:

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Switch ON the RSS meter.
3. Set the time period at the RSS meter to count the disc revolution on both meters (RSS & Test meter).
4. Next reset the button on the RSS meter.
5. Apply the load and note down the corresponding readings.
6. Again reset the button on RSS meter and repeat the same procedure for various loads.
7. A graph is plotted between current and %error.

RESULT:

CIRCUIT DIAGRAM:



TABULATION:

V_1	V_2	V_o At R_F=100K R=10K	V_o R_F=47K R=1K

Exp. No. : 11 a
Date :

INSTRUMENTATION AMPLIFIER – Using VARIABLE VOLTAGE

AIM:

To study the instrumentation amplifier operation by using variable voltage as a input to the amplifier.

APPARATUS REQUIRED:

1. Instrumentation amplifier trainer kit
2. Thermocouple
3. Digital multimetre.

THEORY:

Instrumentation Amplifier amplifies the difference between two ground referenced input signals. In many industrial and commercial applications, the measurement and control of physical condition are very important. Generally a transducer is used at the measuring site.

The input stage consists of a pre-amplifier and some sort of transducer dependent on the physical quantity to be measured. An instrumentation system is used to measure the output signal produced by a transducer and often to control the physical signal producing it. The output stage my use devices such as meters, oscilloscopes, charts or magnetic recorders.

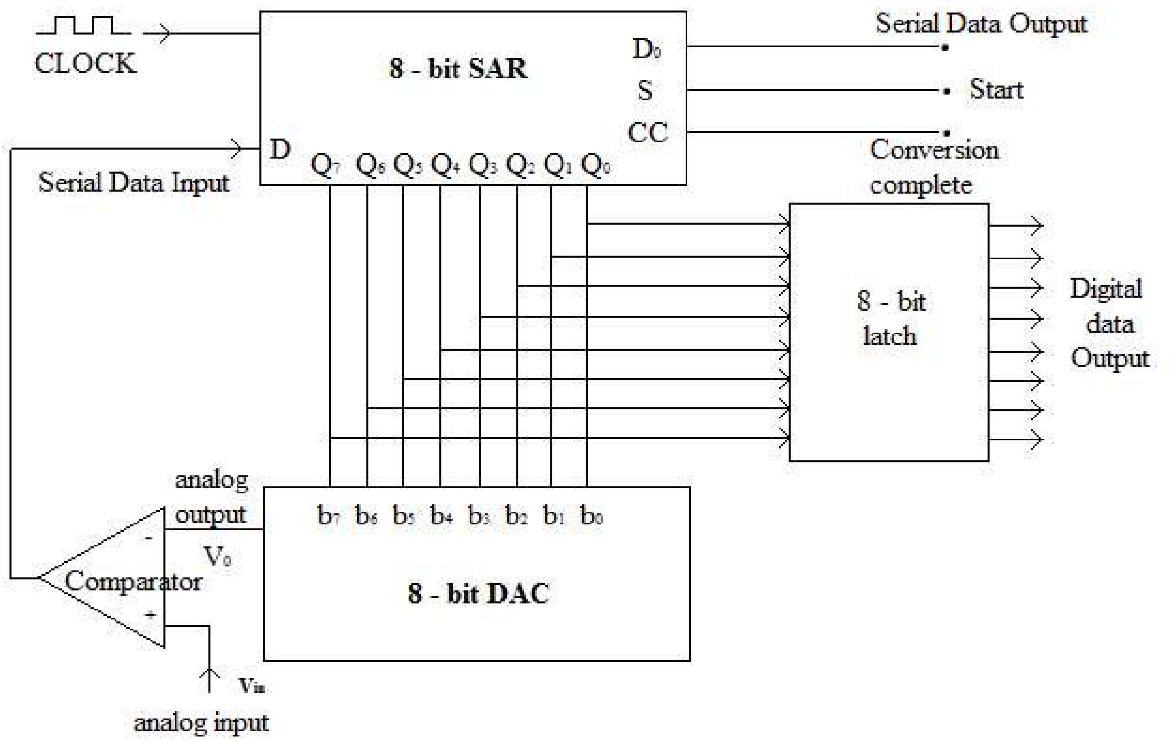
PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Set the V_1 input votage using (0-1V) variable POT provided.
3. Connect the V_2 input to GND.
4. Connect the R_F and R values at 100K and 10K.
5. Verify the output voltage using the formula $V0 = (V_1 – V_2)R_F/R_{in.}$
6. Repeat the above with another set of R_F and R values (i.e) 47K and 1K also do with different input voltage.

RESULT:

CIRCUIT DIAGRAM:

SUCCESSIVE APPROXIMATION TYPE:



TABULATION:

Input Analog Voltage	Digital outputs

Exp. No. : 11 b
Date :

A/D CONVERTER

AIM:

To study the Analog to Digital converter operation through Successive Approximation converter in i) Single mode operation and ii) Continuous mode operation.

APPARATUS REQUIRED:

1. ADC Trainer kit.
2. Digital multimetre.

THEORY:

With the development of microprocessor data processing has become an integeral part of various systems. Data processing involves transfer of data to and from the microcomputer via input/output devices. Since the digital systems such as microcomputer uses a binary system of ones and zeros, the data to be put into the microcomputer has to be converted from analog form to digital form. The circuit that performs the conversion is called Analog to Digital (A/D) converter. An ADC consists of a comparator, a number of registers, control logic and a DAC. ADC usually starts conversion after the receipt of a start signal and stop at the end of conversion signal.

The Successive Approximation type ADC uses DAC as a feedback element. A ring counter provides timing waveform to control the operation of the converter. The ring counter sets the MSB of the DAC to 1 and others to 0. The basic operating principle of successive approximation converter is that the voltage output of DAC corresponding to MSB is compared by the comparator with the input voltage and if the voltage is less, the bit 1is retained. If the voltage is more, it is reset to 0 and counter moves to next position. Similar decisions are made at each bit position until the nearest value is reached.

PROCEDURE:

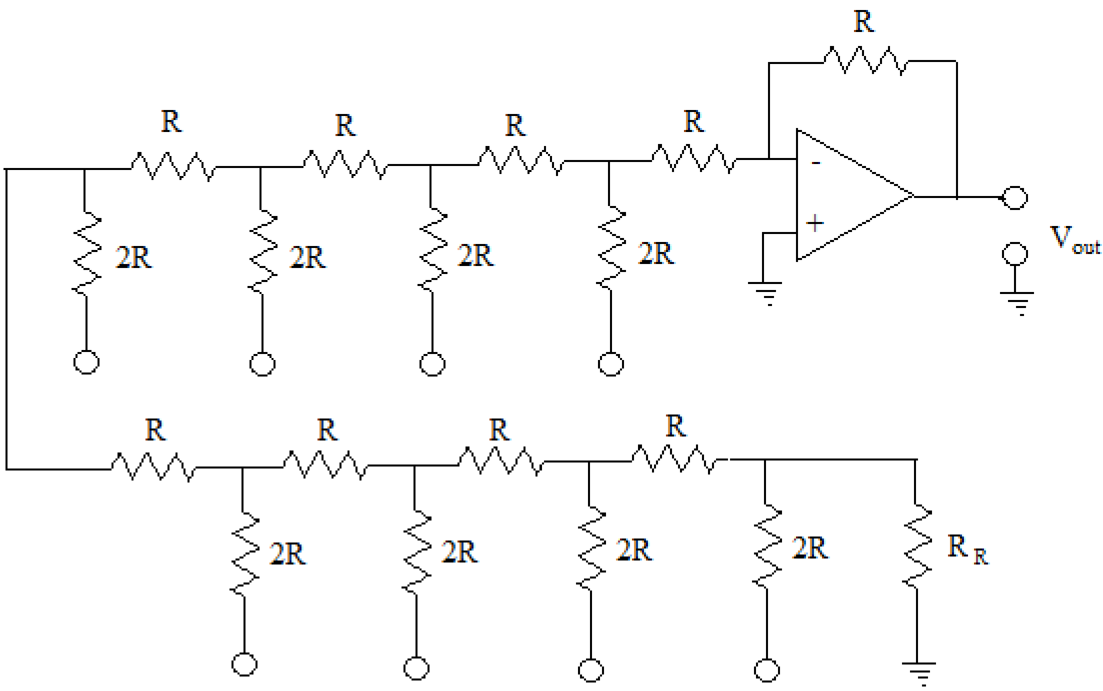
1. Interconnect the circuit as per circuit diagram.
2. Interconnect the ADC trainer and power supply circuit through the 4-pin RMC connector.
3. Switch ON the supply and adjust the input to the ADC is 1V through the POT meter.
4. Put the chip select (CS) switch in the low position and give the start of conversion (WR-) signal High to low and high (Normally WR is in high position).

5. After the conversion completion action the digital output of the ADC corresponding to the input is displayed in the LED's and terminated in the D0 to D7 test terminals.
6. Change the input to the ADC as 2V through the POT meter. Also give the chip select (CS-) and start of conversion signal to the ADC, corresponding Digital output is indicated in the output LED's.
7. Repeat the experiment at the different Analog input and tabulate it.
8. Plot the graph between Analog input voltage VS Digital output.

RESULT:

CIRCUIT DIAGRAM:

R-2R LADDER:



TABULATION:

Digital data using input switches								Observed Analog value in volts	Calculated Analog value in volts V_0
D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0		

Exp. No. : 11 c
Date :

D/A CONVERTER

AIM:

To study the Digital to Analog operation using i) Binary weighted resistor technique and ii) R-2R Ladder resistor technique.

APPARATUS REQUIRED:

1. DAC Trainer kit.
2. Digital multimetre.

THEORY:

A digital to analog converter is used when a binary output from a digital system must be converted to some equivalent analog voltage or current. A D/A converter in its simplest form uses an op-amp and resistors. There are two resistive techniques such as Binary weighted resistor technique and R-2R ladder resistor technique. A binary weighted resistance DAC has a weighted resistor network R to 2^{n-1}R, n switches one for each bit applied to input, a reference voltage and a summing element which sums up the currents flowing in the resistors to give an output proportional to input. When the switch is connected to the supply the bit a_i=1 and when grounded a_i=0. Maximum output current will flow when all the switches are connected to the supply. The chief detect of weighted binary D/A converter is that the resistor values increase in multiples of 2. This can be avoided in R-2R ladder resistor technique where there are only two values of resistors.

PROCEDURE:

1. Inter connect the R-2R ladder circuit as per the circuit diagram.
2. Keep the digital data switches in zero position.
3. Connect the DAC output to Digital multimeter.
4. Switch ON the trainer and give the digital input to the DAC through logic switches.
5. Verify the corresponding Analog output voltages which are displayed in the digital panel metre and tabulate it.
6. Also verify the DAC output through the thevenin's theoretical formula

$$V_0 = -R_F\left[\frac{V_{D7}}{2R}+\frac{V_{D6}}{4R}+\frac{V_{D5}}{8R}+\frac{V_{D4}}{16R}+\frac{V_{D3}}{32R}+\frac{V_{D2}}{64R}+\frac{V_{D1}}{128R}+\frac{V_{D0}}{256R}\right]$$

7. Draw the graph between Digital input versus Analog output

RESULT: