SAFETY RULES

1. SAFETY is of paramount importance in the Electrical Engineering Laboratories.
2. Electricity NEVER EXECUSES careless persons. So, exercise enough care and attention in handling electrical equipment and follow safety practices in the laboratory. (Electricity is a good servant but a bad master).
3. Avoid direct contact with any voltage source and power line voltages. (Otherwise, any such contact may subject you to electrical shock)
4. Wear rubber-soled shoes. (To insulate you from earth so that even if you accidentally contact a live point, current will not flow through your body to earth and hence you will be protected from electrical shock)
5. Wear laboratory-coat and avoid loose clothing. (Loose clothing may get caught on an equipment/instrument and this may lead to an accident particularly if the equipment happens to be a rotating machine)
6. Girl students should have their hair tucked under their coat or have it in a knot.
7. Do not wear any metallic rings, bangles, bracelets, wristwatches and neck chains. (When you move your hand/body, such conducting items may create a short circuit or may touch a live point and thereby subject you to electrical shock)
8. Be certain that your hands are dry and that you are not standing on wet floor. (Wet parts of the body reduce the contact resistance thereby increasing the severity of the shock)
9. Ensure that the power is OFF before you start connecting up the circuit.(Otherwise you will be touching the live parts in the circuit)
10. Get your circuit diagram approved by the staff member and connect up the circuit strictly as per the approved circuit diagram.
11. Check power chords for any sign of damage and be certain that the chords use safety plugs and do not defeat the safety feature of these plugs by using ungrounded plugs.
12. When using connection leads, check for any insulation damage in the leads and avoid such defective leads.
13. Do not defeat any safety devices such as fuse or circuit breaker by shorting across it. Safety devices protect YOU and your equipment.
14. Switch on the power to your circuit and equipment only after getting them checked up and approved by the staff member.

15. Take the measurement with one hand in your pocket. (To avoid shock in case you accidentally touch two points at different potentials with your two hands)

16. Do not make any change in the connection without the approval of the staff member.

17. In case you notice any abnormal condition in your circuit (like insulation heating up, resistor heating up etc), switch off the power to your circuit immediately and inform the staff member.

18. Keep hot soldering iron in the holder when not in use.

19. After completing the experiment show your readings to the staff member and switch off the power to your circuit after getting approval from the staff member.

20. Some students have been found to damage meters by mishandling in the following ways:

i. Keeping unnecessary material like books, lab records, unused meters etc. causing meters to fall down the table.

ii. Putting pressure on the meter (specially glass) while making connections or while talking or listening somebody.

Students are strictly warned that full cost of the meter will be recovered from the individual who has damaged it in such a manner.

Copy these rules in your Lab Record. Observe these yourself and help your friends to observe.

I have read and understand these rules and procedures. I agree to abide by these rules and procedures at all times while using these facilities. I understand that failure to follow these rules and procedures will result in my immediate dismissal from the laboratory and additional disciplinary action may be taken.

GUIDELINES FOR LABORATORY NOTEBOOK

The laboratory notebook is a record of all work pertaining to the experiment. This record should be sufficiently complete so that you or anyone else of similar technical background can duplicate the experiment and data by simply following your laboratory notebook. Record everything directly into the notebook during the experiment. Do not use scratch paper for recording data. Do not trust your memory to fill in the details at a later time.

Organization in your notebook is important. Descriptive headings should be used to separate and identify the various parts of the experiment. Record data in chronological order. A neat, organized and complete record of an experiment is just as important as the experimental work.

1. HEADING:

The experiment identification (number) should be at the top of each page. Your name and date should be at the top of the first page of each day's experimental work. **2.Object:**

A brief but complete statement of what you intend to find out or verify in the experiment should be at the beginning of each experiment

3. DIAGRAM:

A circuit diagram should be drawn and labeled so that the actual experiment circuitry could be easily duplicated at any time in the future. Be especially careful to record all circuit changes made during the experiment.

4. EQUIPMENT LIST:

List those items of equipment which have a direct effect on the accuracy of the data. It may be necessary later to locate specific items of equipment for rechecks if discrepancies develop in the results.

5. PROCEDURE:

In general, lengthy explanations of procedures are unnecessary. Be brief. Short commentaries along side the corresponding data may be used. Keep in mind the fact that the experiment must be reproducible from the information given in your notebook.

6. DATA:

Think carefully about what data is required and prepare suitable data tables. Record instrument readings directly. Do not use calculated results in place of direct data; however, calculated results may be recorded in the same table with the direct data. Data tables should be clearly identified and each data column labeled and headed by the proper units of measure.

7. CALCULATIONS:

Not always necessary but equations and sample calculations are often given to illustrate the treatment of the experimental data in obtaining the results.

8. GRAPHS:

Graphs are used to present large amounts of data in a concise visual form. Data to be presented in graphical form should be plotted in the laboratory so that any questionable data points can be checked while the experiment is still set up. The grid lines in the notebook can be used for most graphs. If special graph paper is required, affix the graph permanently into the notebook. Give all graphs a short descriptive title. Label and scale the axes. Use units of measure. Label each curve if more than one on a graph.

9. RESULTS:

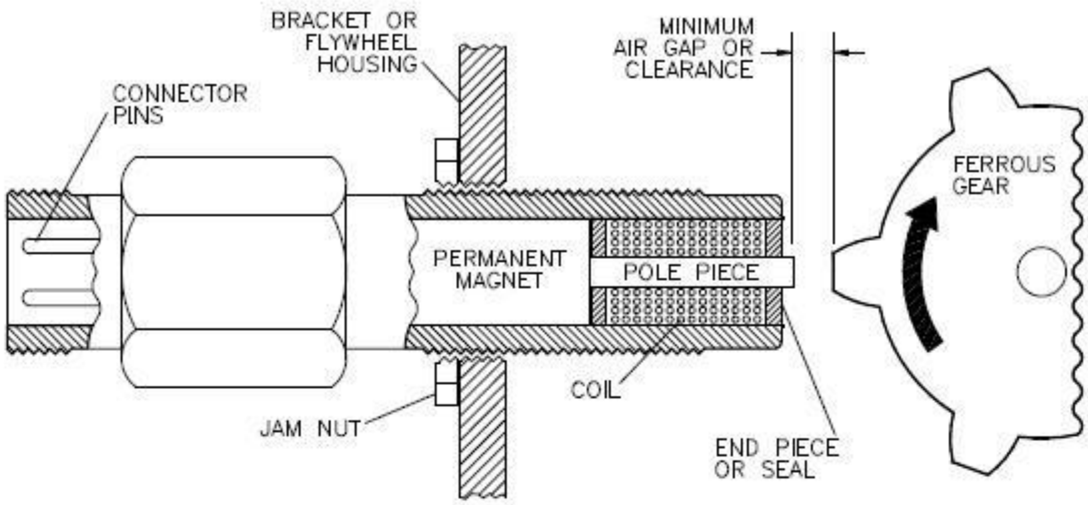
The results should be presented in a form which makes the interpretation easy. Large amounts of numerical results are generally presented in graphical form. Tables are generally used for small amounts of results. Theoretical and experimental results should be on the same graph or arrange in the same table in a way for easy correlation of these results.

10. CONCLUSION:

This is your interpretation of the results of the experiment as an engineer. Be brief and specific. Give reasons for important discrepancies.

EXP: 1

SPEED MEASUREMENT USING PHOTOELECTRIC TACHOMETER



OUTPUT FREQUENCY OF MAGNETIC PICKUP IN HERTZ

$$Hz = \frac{\text{NO. OF GEAR TEETH X GEAR RPM}}{60}$$

EN–0122
97–04–23

Magnetic Pickup

EXP N0: 1 SPEED MEASUREMENT USING PHOTOELECTRIC TACHOMETER

AIM: -

To measure the speed of a motor shaft with the help of non-contact type pick-ups (magnetic or photoelectric).

APPARATUS: -

DC Motor, photoelectric pick up kit, CRO connecting.

THEORY: -

There are electric tachometer consists of a transducer which converts rotational speed into an electrical signal coupled to an indicator. The transducer produces an electrical signal in proportion to speed. The signal may be in the analog form or in the form of pulses. Tachometer or pickups of this type produce pulses form a rotating shaft without being mechanically connected to it. As the energy produced by these devices is not sufficient to actual an indicator directly, amplifiers of sufficient sensitivity are employed. The various types of non-contact pick-ups are optical pick ups or photoelectric or photoconductive cell.

- Electromagnetic pick up
- Capacitive pick up

Here we will measure the speed by optical pick up. As they don't have moving parts so speed up to 3 million rpm. These are available in a variety of designs using the principle of shaft rotation to interrupt a beam of light falling on a photoelectric or photo conductive cell. The pulse thus obtained are first amplified & then either fed to an electric counter, or shaped to an along signal and connected to the indicator. A bright white spot is made on the rotating shaft. A beam of light originating from the tachometer case hits the white spot & the reflected light falls on photoconductive cell inside the case, producing pulse in transes torised amplifier, which is turn, causes the indicator to deflect which is measure of speed of the shaft.

FORMULA USED: -

Speed (rpm) = Frequency x Diameter of Disk / No. of segments.

TABULATION:

Sl.No	RPM	Display Reading

Calculations: -

RPM = (frequency) x diameter of disc/No. of teeth of segments

N = PM = f x d / T Where f = 1/t

Where t = time period of one cycle of out put wave & f = 1.8 x 2ms = 3.6 x 10-3 s [on CRO] and d = 56.5mm.

Therefore, R.P.M = 2.79 x 102 x 56.5/ 60 = 262 rpm

Procedure : -

1. Connect the CKT & CRO with the required apparatus & switch on the supply.

2. Adjust the speed of the motor by the knob and wait for some time till the motor attains the maximum speed at corresponding knob position.

3. Measure the frequency from out put wave on CRO.

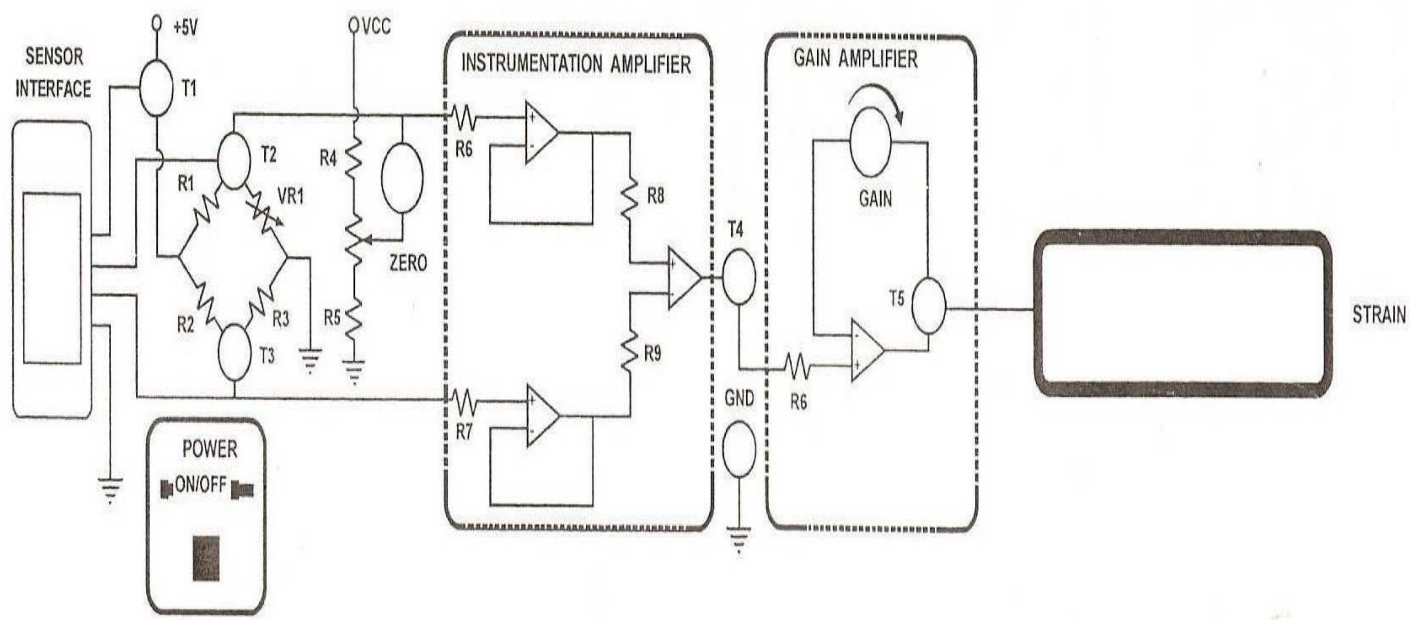
4. Find the speed of the motor.

Result: - Speed of position ‘A’ = _________ rpm

EXP: 2

STRAIN GAUGE CHARACTERISTICS

STRAIN MEASUREMENT MODULE (ITB-17 CE)



EX.NO: 2 STRAIN GAUGE CHARACTERISTICS

AIM:

To study the characteristics between strain applied to the cantilever beam strain sensor and the bridge voltage.

APPARATUS REQUIERD:

1. ITB – 17 – CE trainer kit
2. multimeter (in V)
3. cantilever beam strain sensor setup
4. weight (100g * 10 no's)
5. power chord

FORMULA USED:

Theoretical strain

$$= \frac{6PL}{Bt^2Y} = \frac{6 * 1 * 21.58}{2.8 * 0.25^2 * 2 * 10^6} = 370\mu\, strain$$

Where,

Applied load to the beam (p) = 1 Kg

Thickness of the beam (t) = 0.25 cm

Breath of the beam (B) = 2.8 cm

Length of the beam (L) = 21.58 cm

Young's modulus (Y) of the beam = 2*10^6 Kg /cm²

$$\%\boldsymbol{error} = \frac{\boldsymbol{actual\ strain - theoritical\ strain}}{\boldsymbol{theoritical\ strain}} * \mathbf{100}$$

TABULATION:

Applied strain versus bridge voltage:

APPLIED LOAD(GRAM)	THEORETICALSTRAIN (μs)	BRIDGE VOLYAGE(mV)

<u>Applied strain versus the Signal conditioned sensor output voltage</u>

Theoretical strain(μs)	Signal conditioned sensor output voltage(V)	Actual strain (μs)	%error

THEORY:

The change in the value of resistance by resistance by straining the guage may be partly explained by the normal dimensional behavior of elastic material.if a strip of elastic material is subjected to tension or in other words positively strained, its longitudinal dimension will increase while there will be a reduction in the lateral dimension. So when a guage is subjected to a positive strain, its length increases while its area of cross-section decreases.

Since the resistance of a conductor is 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 the value resistance due to dimensional changes.the extra change in the value of resistance is attributed to a change in the value of resistivity of a conductor when strained. This property is known as piezo-resistive effect.

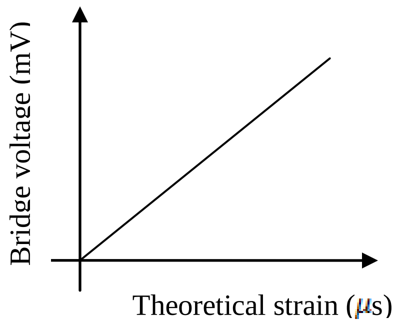
Let us consider a strain gauge made of circular wire as shown fig1. The wire has the dimensions L=length, A=area,D=diameter before being strained.the material of the wire has a resistivity ρ.

Let a tensile stresss s be applied to the wire. This produces a positive strain causing the length to increase and area to decrease as shown.thus when the wire is strained there are changes in its dimensions. Let ΔL=change in length, ΔA=change in area, ΔD=change in diameter and ΔR=change in resistance.

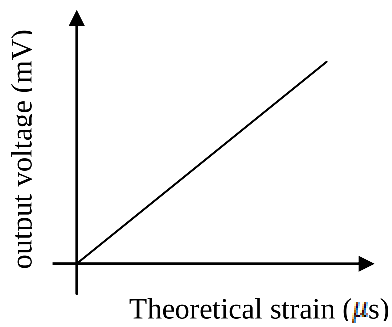
PROCEDURE:

1. Install the cantilever strain sensor setup and interface the 9 pin D connector with ITB- 17 – CE kit.
2. Connect the multimeter in millivolts mode across T2 and T3 for bridge voltmeter measurement.
3. Switch ON the module.
4. Initially, unload the beam and nullify the bridge voltage by using zero adjustment POT.
5. Now apply the load to the beam, strain will develop applied on the beam and measure the bridge voltage (mV) across T2 and T3.
6. Gradually increase the load on the beam and note down applied load and the bridge voltage (mV).

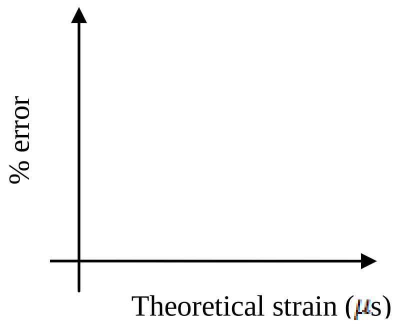
MODEL GRAPH:



Theoretical strain versus bridge voltage



Theoretical strain versus signal conditioned sensor output voltage



Theoretical strain versus % error

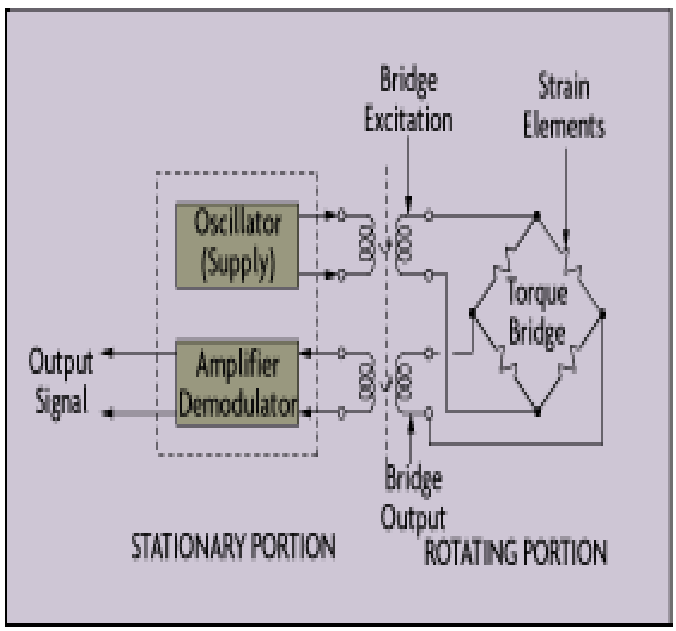
7. Tabulate the values of applied load, theoretical strain and the bridge voltage (mV).
8. Plot a graph between theoretical strain versus bridge voltmeter (mV).
9. Install the cantilever strain sensor setup and interface the 9 pin D connector with ITB- 17 – CE kit.
10. Connect the multimeter in millivolts mode across T2 and T3 for bridge voltmeter measurement.
11. Switch ON the module.
12. Initially, unload the beam and nullify the bridge voltage by using zero adjustment POT.
13. Now apply the load to the beam, strain will develop applied on the beam and measure the bridge voltage (mV) across T2 and T3.
14. Gradually increase the load on the beam and note down applied load and the bridge voltage (mV).
15. Tabulate the values of applied load, theoretical strain and the bridge voltage (mV).
16. Plot a graph between theoretical strain versus bridge voltmeter (mV).

RESULT:

Thus the characteristics between strain applied to the cantilever strain sensor and the bridge voltage was studied and graph was plotted.

EXP:3

TORQUE MEASUREMENT


Bridge
Excitation
Strain
Elements
Oscillator
(Supply)
Torque
Bridge
Output
Signal
Amplifier
Demodulator
Bridge
Output
STATIONARY PORTION
ROTATING PORTION

EX.NO: 3 TORQUE MEASUREMENT

Aim:

To measure torque of a rotating shaft using strain gauge torque transducer.

Apparatus used:

Strain gauge torque transducer.

Theory:

Torque is the tendency of a force to rotate an object about an axis, fulcrum, or pivot. (or) Torque is defined as a force around a given point, applied at a radius from that point.

An engine produces power by providing a rotating shaft which can exert a given amount of torque on a load at a given rpm. The amount of torque the engine can exert usually varies with rpm.

Facts about calculations:

1. Power (the rate of doing work) is dependent on **torque** and rpm.
2. **Torque** and rpm are the measured quantities of engine output.
3. Power is calculated from **torque** and rpm, by the following equation: P =**Torque** x RPM

The power transmitted can be calculated from the torque, using the equation

$$P = \omega T$$

Where,

P is the power (in watts),

T is torque (N m)

ω is angular speed (rad / s).

Strain gauge torque transducer

The strain monitoring system is called torque meter (or) strain gauge torque transducer A Torque sensor is a transducer that converts a torsional mechanical input into an electrical output signal. Torque Sensor, are also commonly known as a Torque Transducer.

TABULATION:

Sl.No	Mass(gms)	Torque Generated (Nm)	V		
			Vi	Vf	V=Vi-Vf

Torque is measured by either sensing the actual shaft deflection caused by a twisting force, or by detecting the effects of this deflection. The surface of a shaft under torque will experience compression and tension.

To measure torque, strain gage elements usually are mounted in pairs on the shaft, one gauge measuring the increase in length (in the direction in which the surface is under tension), the other measuring the decrease in length in the other direction. A strain gage can be installed directly on a shaft. Because the shaft is rotating, the torque sensor can be connected to its power source and signal conditioning electronics via a slip ring. The strain gage also can be connected via a transformer, eliminating the need for high maintenance slip rings. The excitation voltage for the strain gage is inductively coupled, and the strain gage output is converted to a modulated pulse frequency as shown in figure. Maximum speed of such an arrangement is 15,000 rpm.

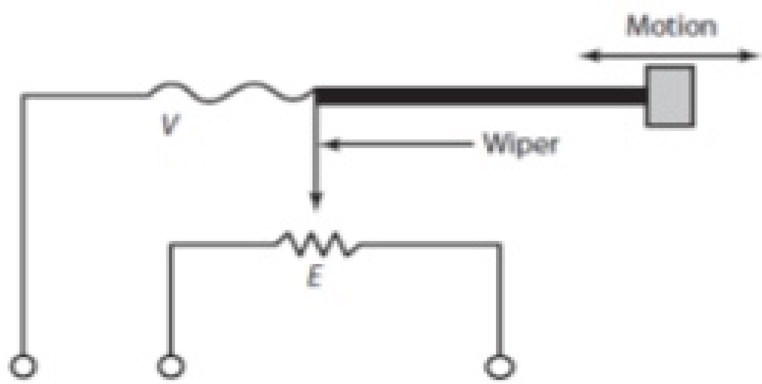
Procedure:

1. Arrange all the instruments respectively.
2. With the help of Set knob adjust the zero reading.
3. Set the range with the help of Span knob.
4. Place the weight in the pan.
5. Measure the value of voltage from Digital Voltmeter.
6. Repeat the procedure.
7. Compare actual and displaced values.
8. Plot the graph (Voltage vs Torque).
9. Place unknown mass and measure the voltage.
10. Obtain the value of torque from the graph for the obtained voltage

RESULT : Hence the torque obtained for the unknown weight is **_______**N-m.

EXP:4

DISPLACEMENT MEASUREMENT USING POTENTIOMETRIC TRANSDUCER


Motion
V
Wiper
E

EX.NO: 4 DISPLACEMENT MEASUREMENT USING POTENTIOMETRIC TRANSDUCER

Aim:

Calibration of position transducer and plot displacement/ voltage characteristics curve.

Apparatus used:

Displacement transducer.

Theory:

A displacement transducer using variable resistance transduction principle can be manufactured with a rotary or linear potentiometer. A potentiometer is a transducer in which a rotation or displacement is converted into a potential difference. As shown in the figure, the displacement of the wiper of a potentiometer causes the output potential difference obtained between one end of the resistance and the slider. The position of the slider along the resistance element determines the magnitude of the electrical potential. The voltage across the wiper of linear potentiometer is measured in terms of the displacement, *d*, and given by the relationship

$$V = E\frac{d}{L}$$

E is the voltage across the potentiometer, and L is the full-scale displacement of the potentiometer.

TABULATION:

Sl.No	L(mm)	Vout

Procedure:

1. Connect the panel sockets to ±12V and 0C to a regulated power supply.
2. Connect the digital voltmeter between the socket +Vref and ground.
3. Switch the regulated power supply on.
4. Calibrate the terminal RV1 until the digital Voltmeter goes to +8.00V (calibration of the voltage +Vref).
5. After calibration, connect the digital voltmeter between test point 3 and ground.
6. Vary the slider distance (from the zero position) with steps of about 2 mm and observe both the relevant reference distance on the graduated scale and the output voltage.
7. Tabulate the readings.
8. Plot readings on a graph.

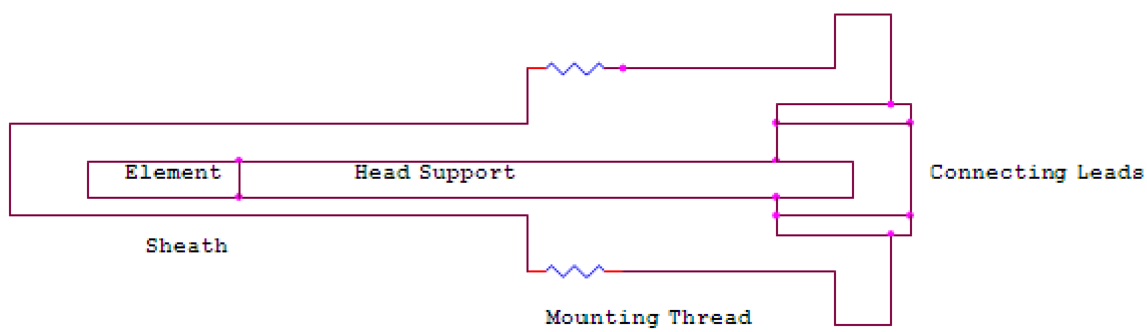
RESULT:

Thus the displacement transducer was studied and graph was plotted.

EXP:5

MEASUREMENT OF TEMPERATURE USING RTD

CIRCUIT DIAGRAM:



EXP.NO:5 MEASUREMENT OF TEMPERATURE USING RTD

AIM: -

Measurement of temperature using RTD.

APPARATUS REQUIRED: -

RTD kit, heating arrangement, Ice, Thermometer.

PRECAUTIONS: -

• Handle all equipments with care.

• Make connections according to the circuit diagram.

• Take the readings carefully.

• The connections should be tight.

THEORY: -

This type of transducer is used for temperature measurement. Here the basic concept used is that electrical resistance of different metal changes in accordance with the temperature i.e. for temperature measurement. Principle used is that the resistance of a conductor changes in proportion with the change in temperature. The unknown temperature is determined in terms of electrical resistance of the conductor, which senses the temperature. The change in resistance of this device is precisely determined either by bridge circuit orby ohmmeter. Resistance of a conductor changes with change in temperature. This property is used for the measurement of temperature and each transducer is called Resistive Thermometer and falls in the category of electrical resistive transducer. The variation of resistance 'R' with temperature 'T' can be presented as: R=R(1+aT+aT+…)2012 Where R resistance at 0 C 0 0a,a constant12. Generally the metals used are Platinum. This is used because of following features:

1. Platinum provides good stability and accuracy.
2. It can operate on wide range of temperature.
3. It has good linearity over wide temperature range.
4. Less errors during operation.

OBSERVATION TABLE:

Sl. No.	Temperature	Display Reading RTD (mv)

PROCEDURE: -

1. Connect the input power supply to main power.
2. Switch on the power supply, the red LED will glow.
3. Connect the RTD source/sensor at a pin connector & 100 C temperature is calibrated.

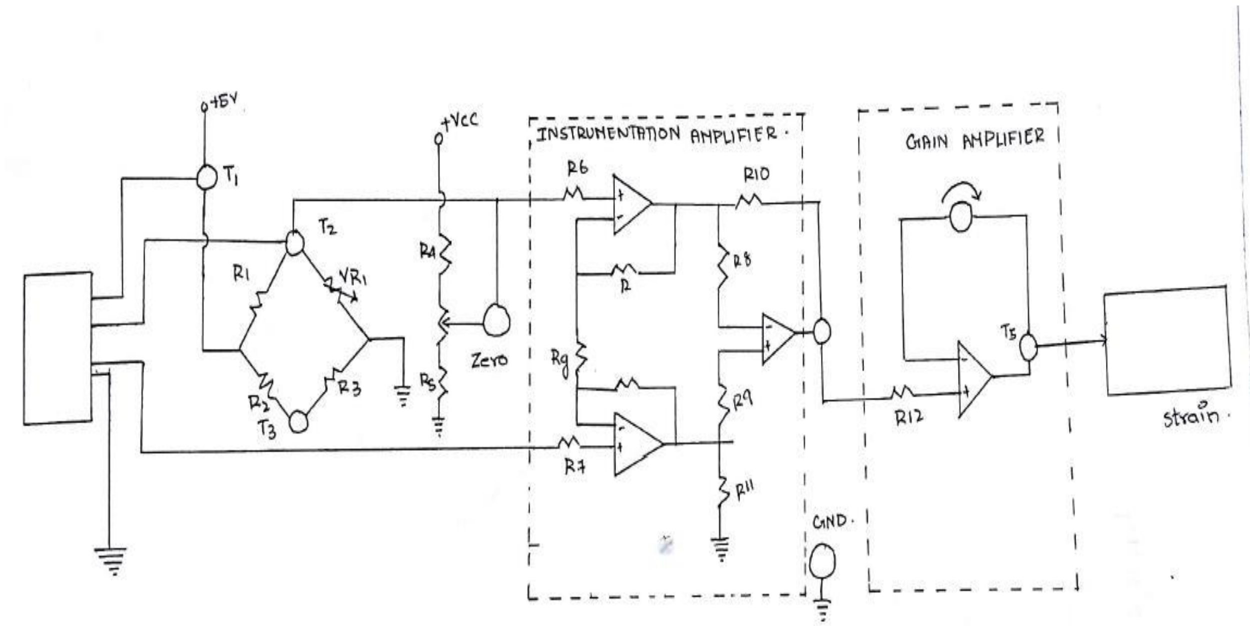
RESULT: -

We have measured the temperature with RTD and verified that the boiling point of water is 100C.

EXP:6

MEASUREMENT OF TEMPERATURE USING THERMOCOUPLE.

CIRCUIT DIAGRAM FOR THERMOCOUPLE:



EXP N0: 6 MEASUREMENT OF TEMPERATURE USING THERMO COUPLE

AIM:

To find the temperature using Y-type thermo couple.

EQUIPMENT

S.No	Apparatus	Range	Quantity
1	Y- type thermo couple	-	1
2	ON/OFF controller	-	1
3	Water heater	-	1
4	Multimeter	-	1
5	Voltmeter	(0-5)V	1

THEORY:

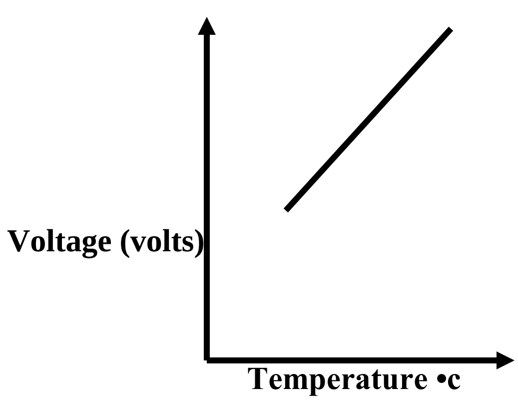
When two different metals having different work functions are placed together, a voltage is generated at a junction which is nearly proportional to temperature. This temperature junction is called a thermocouple. This principle is used to convert heat energy into electrical energy at the junction of two conductors.

The heat at the junction is produced by the electrical current flowing in the heater element while the thermocouple produces an emf at its output terminals which can be measured with the help of PMMC instrument .The emf produced is proportional to the temperature and hence to the rms value of the current. Therefore the scale of the PMMC instrument can be calibrated to read the current passing through the heater. The thermocouple type of instruments can be used for both DC and AC appliances.

TABULATION:

S.No	TEMPEERATURE in C	VOLTAGE in Volt

MODEL GRAPH:



PROCEDURE:

1) Connections are made as per the circuit diagram
2) After controlling the temperature for various values of temperature increases the voltages equivalent values are noted.
3) The graph is plotted between the voltage and temperature.

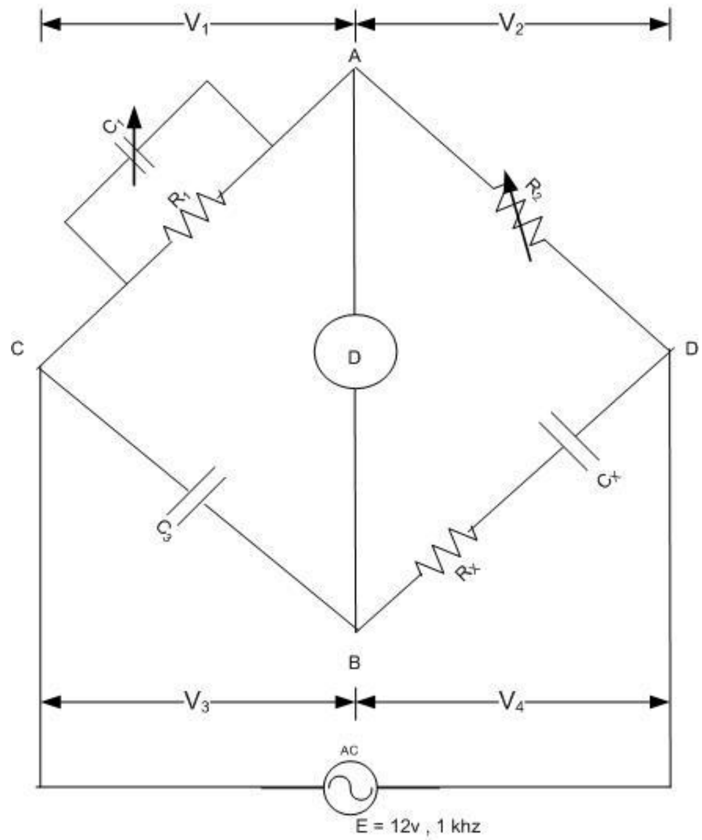
RESULT

Thus the temperature was found using Y type thermo couple

EXP.NO:7

MEASUREMENT OF CAPACITANCE USING SCHERING BRIDGE

Capacitance measurement by Schering's Bridge



D => Detector
C_x => Capacitance to be determined
R_x => Series resistance
C_3 => Standard capacitance
C_1 => Variable capacitance
R_1 => Non-Inductive resistance
R_2 => Variable Non-Inductive resistance

EXP.NO:7 MEASUREMENT OF CAPACITANCE USING SCHERING BRIDGE

AIM:

To find the unknown capacitance value using Schering Bridge kit.

EQUIPMENT:

S.No	Apparatus	Range	Quantity
1	Schering Bridge kit	-	1
2	Multimeter	-	1
3	Unknown capacitance	-	1
4	Connecting wires	-	As required
5	CRO(cathode ray oscilloscope)	-	1
6	Function generator	-	1
7.	DCB(Decade capacitance box)	-	1
8.	Resistance	(470 Ω ,10 Ω)	Each 1 no.

THEORY:

It is an A.C. bridge used for measurement of unknown capacitance of a capacitor. Here one ratio arm has R1 parallel to G, the other ratio arm has variable resistor R2. In the third arm we have pure capacitor, has a very stable value and very small electric field for insulation measurement. This bridge is used to measure the quality of capacitor. The storage factor is defined as the ratio of power stored in element to the power dissipated.

TABULATION:

Resistance R_1 (kΩ)	Resistance R_2 (kΩ)	Given Capacitance C_x(μF)	Given Capacitance C_1 (μF)	Obtained Capacitance C_x (μF)	Quality Factor $X\ 10^{-9}$

PROCEDURE:

1. Connections as per the circuit diagram.
2. Set the value of given capacitance.
3. Set the fixed resistance R2.
4. Vary the resistance value or R1.
5. Switch off the kit removes the terminals from R1 & measure R1.
6. Calculate capacitance and quality factor.

Formula Used :

$C_x = (R1 / R2)\, C_2$

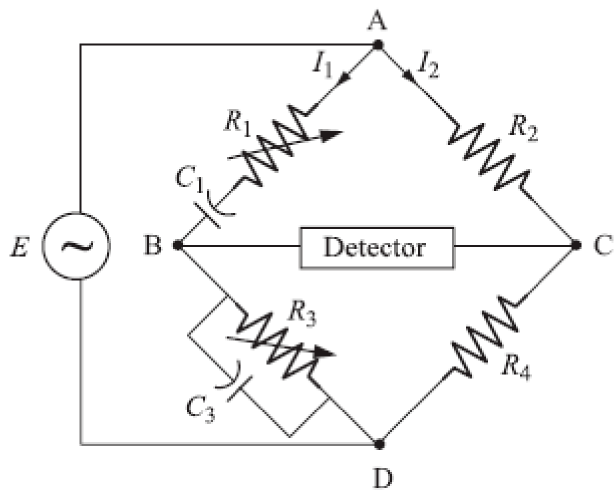
Quality Factor (Q) = $2\pi f \left(\frac{C_1}{R_1} \right)$

RESULT:

The value of unknown capacitance was found experimentally by using the Schering bridge. Unknown Capacitance, Cx =

EXP:8

MEASUREMENT OF FREQUENCY USING WEIN BRIDGE


A
I_1
I_2
R_1
R_2
C_1
E
B
Detector
C
R_3
C_3
R_4
D

EXP NO:8 MEASUREMENT OF FREQUENCY USING WEIN BRIDGE

AIM:

To measure frequency by Wien's bridge

Apparatus Required:

1. Wien`s Bridge Trainer
2. Multi meter
3. 2mm Patch cords

Theory:

In this bridge circuit, there is a lead-lag network. Balancing of the bridge is easier because satisfying the phase angle equality condition can be achieved. This bridge can also be used to determine the frequency of the AC input in terms of the component values of the bridge circuit. In this AC bridge, there is no inductor. Inductive losses because of stray fields cause problems in balancing of the bridge. Owing to the absence of L in the circuit, this can be effectively used for determining the frequency f of the AC input..

TABULATION:

Sl.No	R1	R2	C1	C2	f

CALCULATION:

$$f = \frac{1}{2\pi\sqrt{R_1 R_3 C_1 C_3}}$$

Procedure:

1. Connect mains cord to the Trainer.

2. Connect terminal 1 to 4(for evaluating unknown capacitance Cx1).

3. Rotate variable resistance R1 towards anti clockwise direction.

4. Select Frequency Selector f or any desired range of frequency.

· 100 Hz to 1 kHz

· 1 kHz to 10 kHz

· 10 kHz to 60 kHz

5. For example 2 kHz frequency, select frequency select or between the ranges1 kHz-10 kHz.

6. Use Frequency Variable knob to set 2 kHz frequency on display screen.

7. Connect terminal 19 to 6 and 20 to 7.

8. Now switch ‘On’ the power supply.

9. Set toggle of null detector towards ‘on’ condition.

10. Vary Amplitude Variable f or enough sound of speaker.

11. Vary resistance R1 towards clockwise direction slowly. (Sound diminishes). Keep varying R1 until you get very low sound or null sound (null condition).

12. Now remove the patch cord between terminal 1 & 4 and record the value of R1 in the observation table using multimeter.

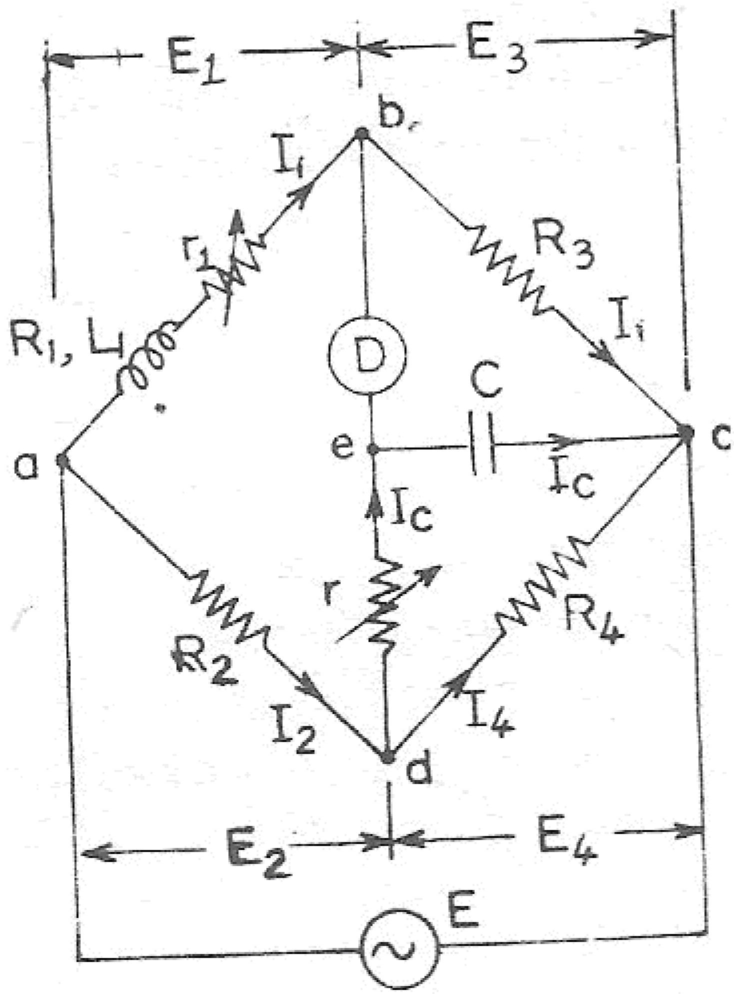
RESULT:

The value of unknown frequency was found experimentally by using the Werin’s bridge.

EXP:9

MEASUREMENT OF INDUCTANCE USING ANDERSON BRIDGE

CIRCUIT DIAGRAM FOR ANDERSONS BRIDGE:



EXP NO: 9 MEASUREMENT OF SELF INDUCTANCE USING ANDERSON'S BRIDGE

AIM:

To find the unknown self inductance of the coil using Anderson's Bridge.

APPARATUS REQUIRED:

SL.No	Apparatus	Quantity
1.	**Anderson's Trainer kit**	**1**
2.	**CRO**	**1**
3.	**Decade Inductance Box**	**1**
4.	**Connecting wires**	**As required**

THEORY:

In the Anderson's bridge trainer, the value of the resistance R_2, R_3 & R_4 are 300 ohms each. For these values of resistance the range of inductance that can be measured is 150 mH to 350 mH. To measure any other value of inductance the resistance r & r_1 have to be correspondingly changed either by increasing or decreasing the resistance. The resistance in any of the arms of the bridge is increased by externally connecting some resistance in series or decreased by connecting in parallel for which the provision has been given in the trainer. The bridge consists of a built in power supply, 1 kHz oscillator & a detector.

Balance equations:

Let

L_1=self-inductance to be measured

R_1=resistance of self-inductor

r_1=resistance connected in series with self-inductor

R, R_2. R_3, R_4 = known non-inductive resistances

C=fixed standard capacitor

At balance I_1=I_3 and I_2=Ic+I_4

TABULATION:

Sl. No	R(Ω)	r_1(Ω)	R_2(Ω)	R_3 (Ω)	R_4(Ω)	R_1(Ω)	$Q=\frac{\omega L_1}{R_1}$	L_1(mH)		%Error
								True	Measured	

Calculations:

% Error = ((True value-Measured value)/True value)*100

$$I_1R_3 = I_C \times \frac{1}{j\omega C} \therefore I_C = I_1 j\omega C R_3$$

Writing the other balance equations:

$$I_1(r_1+R_1+j\omega L_1) = I_2R_2 + I_C r \quad and \quad I_C\left(r+\frac{1}{j\omega C}\right) = (I_2 - I_C)R_4$$

Substituting the value of I_C in the above equations, we have

$$I_1(r_1+R_1+j\omega L_1) = I_2R_2 + I_1 j\omega C R_3 r \quad and \quad I_1(r_1+R_1+j\omega L_1 - j\omega C R_3 r) = I_2R_2 \text{ ——— } (1)$$

$$and \; j\omega C R_3 I_1\left(r+\frac{1}{j\omega C}\right) = (I_2 - I_1 j\omega C R_3)R_4 \; or \; I_1(j\omega C R_3 r + j\omega C R_3 R_4 + R_3) = I_2R_4 \text{ ——— } (2)$$

From equations (1) and (2), we obtain

$$I_1(r_1+R_1+j\omega L_1 - j\omega C R_3 r) = I_1\left(\frac{R_2R_3}{R_4} + \frac{j\omega C R_2 R_3 r}{R_4} + j\omega C R_3 R_2\right)$$

Equating the real and imaginary parts

$$R_1 = \frac{R_2R_3}{R_4} - r_1 \text{ ——————— } (3)$$

$$and \; L_1 = C\frac{R_3}{R_4}\left[r(R_4+R_2) + R_2R_4\right] \text{ ——————— } (4)$$

Procedure:

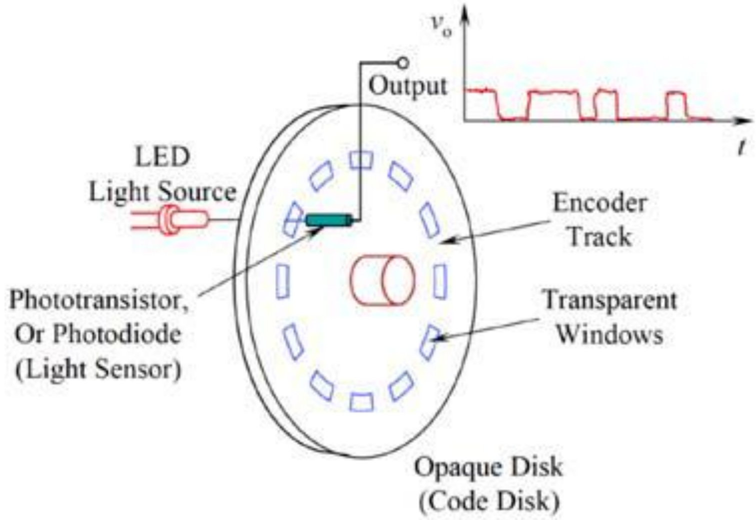
1. Switch on the trainer & connect the unknown inductance in the arm marked R_1.
2. Observe the sine wave at the secondary of the isolation transformer by using CRO.
3. Vary the resistance R from minimum position in a clockwise direction.
4. Connect the CRO between the ground & the output point and check for the balance condition.
5. For further fine balance vary the resistance r_1 which will compensate for the resistive component of the inductor.
6. Remove the wiring and measure the values of R and r_1 using DMM.
7. The above steps are repeated for different values of unknown inductance.

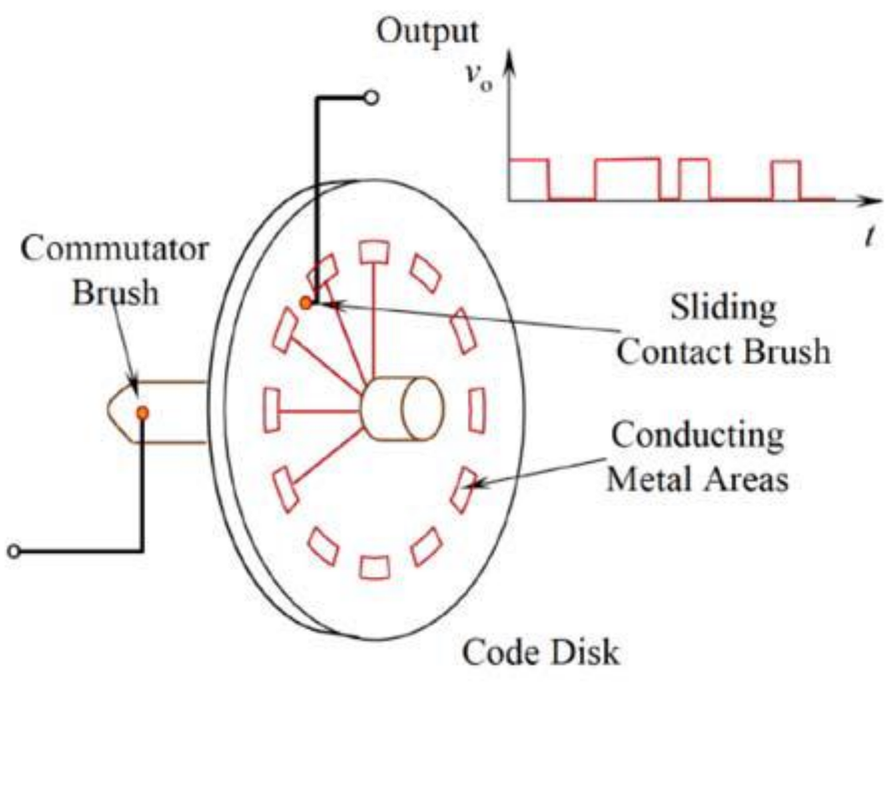
Result:

Thus the unknown inductance has been found using Andersons Bridge.

EXP:10

DIGITAL TRANSDUCER – SHAFT ANGLE ENCODER


v_o
Output
t
LED
Light Source
Encoder
Track
Phototransistor,
Or Photodiode
(Light Sensor)
Transparent
Windows
Opaque Disk
(Code Disk)


Output
v_o
t
Commutator
Brush
Sliding
Contact Brush
Conducting
Metal Areas
Code Disk

EXP:10 DIGITAL TRANSDUCER – SHAFT ANGLE ENCODER

AIM:

To study Digital Transducer – Shaft Angle Encoder

APPARATUS:

Digital Transducer

ENCODER:

Encoder is any transducer that generates a coded (digital) reading of a measurement

Shaft Encoders:

Shaft encoders are digital transducers that are used for measuring angular displacements and angular velocities.

Encoder Types:

Shaft encoders can be classified into two categories depending on the nature and the method of interpretation of the transducer output:

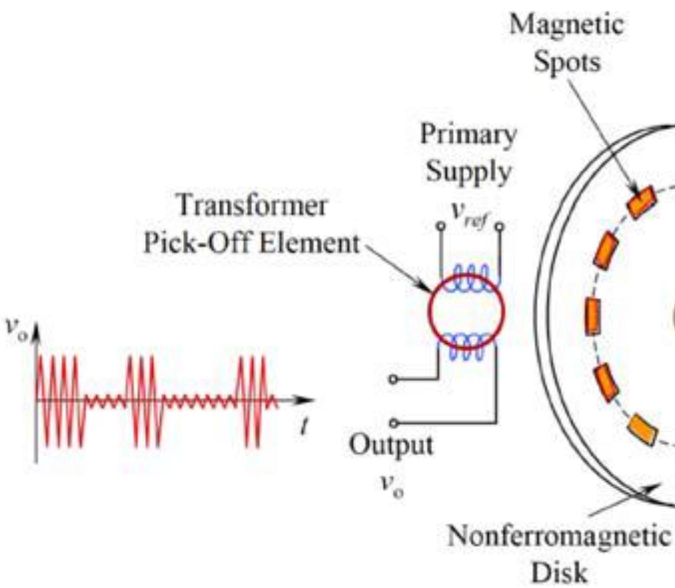
1. Incremental encoders and
2. Absolute encoders.

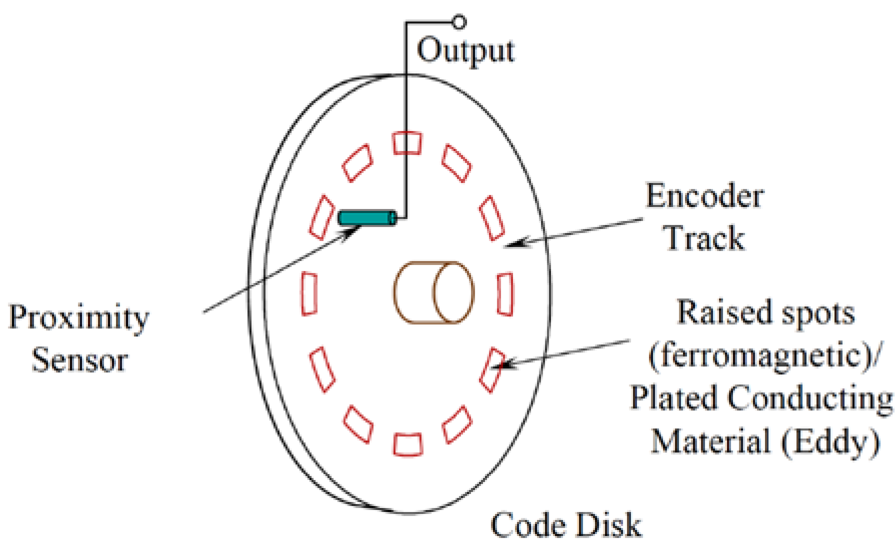
Incremental Decoders:

The output of an incremental encoder is a pulse signal, which is generated.when the transducer disk rotates as a result of the motion that is measured. By counting the pulses or by timing the pulse width using a clock signal, both angular displacement and angular velocity can be determined. With an incremental encoder, displacement is obtained with respect to some reference point which can be the home position of the moving component. The index pulse count determines the number of full revolutions.

Absolute Decoders:

An absolute encoder (or whole-word encoder) has many pulse tracks on its transducer disk. When the disk of an absolute encoder rotates, several pulse trains—equal in number to the tracks on the disk—are generated simultaneously. At a given instant, the magnitude of each pulse signal will have one of two signal levels (i.e., a binary state), as determined by a level detector (or edge detector). This signal level corresponds to a binary digit (0 or 1). Hence, the set of pulse trains gives an encoded binary number at any instant. The windows in a track are not equally spaced


Magnetic Spots
Primary Supply
v_{ref}
Transformer Pick-Off Element
v_o
t
Output v_o
Nonferromagnetic Disk


Output
Encoder Track
Proximity Sensor
Raised spots (ferromagnetic)/ Plated Conducting Material (Eddy)
Code Disk

but are arranged in a specific pattern to obtain coded output data from the transducer. The pulse windows on the tracks can be organized into some pattern (code) so that the generated binary number at a particular instant corresponds to the specific angular position of the encoder disk at that time

Four techniques of transducer signal generation may be identified for shaft
encoders:

1. Optical (photosensor) method
2. Sliding contact (electrical conducting) method
3. Magnetic saturation (reluctance) method
4. Proximity sensor method

Optical method:

Since the light from the source is interrupted by the opaque regions of the track, the output signal from the photosensor is a series of voltage pulses.This signal can be interpreted (e.g., through edge detection or level detection) to obtain the increments in the angular position and also the angular velocity of the disk.

Sliding Contact Encoder

In a sliding contact encoder, the transducer disk is made of an electrically insulating material. Circular tracks on the disk are formed by implanting a pattern of conducting areas These conducting regions correspond to the transparent windows on an optical encoder Disk. All conducting areas are connected to a common slip ring on the encoder shaft. A constant voltage is applied to the slip ring using a brush mechanism. A sliding contact such as a brush touches each track, and as the disk rotates, a voltage pulse signal is picked off by it.The pulse pattern depends on the conducting & non-conducting pattern on each track, as well as the nature of rotation of the disk. The signal interpretation is done as it is for optical encoders.A transducer's accuracy is very much dependent on the precision of the conducting patterns of the encoder disk

Magnetic Saturation Method:

A magnetic encoder has high-strength magnetic regions imprinted on the encoder disk using techniques such as etching, stamping, or recording (similar to magnetic data recording).

These magnetic regions correspond to the transparent windows on an optical encoder disk.

The signal pick-off device is a micro-transformer, which has primary and secondary windings on a circular ferromagnetic core. This pick-off sensor resembles a core storage element in a historical mainframe computer. A high-frequency (typically 100 kHz) primary voltage induces a voltage in the secondary windings of the sensing element at the same frequency, operating as a transformer. A magnetic field of sufficient strength can saturate the core, however, thereby significantly increasing the reluctance and dropping the induced voltage. By demodulating the induced voltage, a pulse signal is obtained

Proximity Sensor Method:

A proximity sensor encoder uses a proximity sensor as the signal pick-off element. For example, a magnetic induction probe or an eddy current probe (recall chapter 5). In the magnetic induction probe, for example, the disk is made of ferromagnetic material.The encoder tracks have raised spots of the same material. As a raised spot approaches the probe the flux linkage increases due to the associated decrease in reluctance. This raises the induced voltage level. The output voltage is a pulse-modulated signal, which is then demodulated, and the resulting pulse signal is interpreted. Instead of a disk with a track of raised regions, a ferromagnetic toothed wheel may be used along with a proximity sensor placed in a radial orientation. In principle, this device operates like a conventional digital tachometer. If an eddy current probe is used, the pulse areas in the track have to be plated with a conducting material.

RESULT:

Thus the digital transducer was studied.