GOVTCO-EDPOLYTECHNIC

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LAB MANUAL

Branch:MechanicalEngineering

Year&Semester:2nd Year/4th Semester

INDUSTRIAL MEASUREMENT & CONTROL (2037463(037)) (Lab)

CONTENTS

PracticalNo.1:DisplacementmeasurementusingLVDT

I PracticalSignificance

LVDT ispassivetransducer basedonmutualinductance principle.It isusedtomeasure linear displacement. It is used as secondary transducer for measurementpressure using bourdon tube. This practical help you to measure displacement usingLVDT.

II RelevantProgramOutcomes(POs)

1. **Discipline knowledge**: Apply Electrical Engineering/Industrial Electronicsknowledgetosolvebroad-basedElectricalEngineering/Industrial Electronicsrelatedproblems.
2. **Experiments and practice:** Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Selecttherelevanttransducersformeasuringvariousparameters.

IV PracticalOutcome

a)UseLVDTtomeasuredisplacement.

V CompetencyandPracticalSkills

This practical is expected to develop the following skills for the industryMaintaindifferenttransducersusedformeasurementofvariousparam eters.

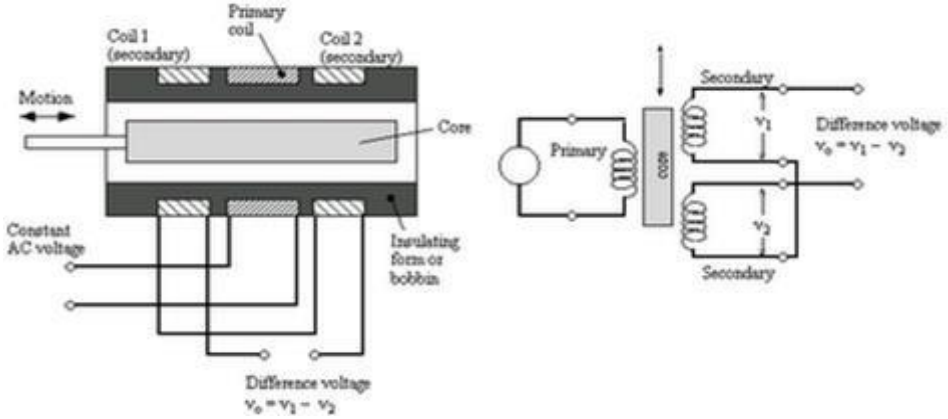
a) UseC.R.O
b) Usemultimeters
c) Connectionskills

VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

LVDT"LinearVariableDifferentialTransformer"ismostwidelyusedinductivetransducer totranslatelinearmotionintoelectricalsignals.



Construction of LVDT :LVDT consists of a cylindrical former where it is surrounded byone primary winding in centre of the former and the two secondary windings connected inseriesopposition.Thenumberofturnsinboththesecondarywindingareequal,butareseriesopositetoeachother.

WorkingofLVDT(LinearVariableDifferentialTransformer):The LinearVariableDifferential Transformer works on the principle of electromagnetic induction. When we givesupply to the primary winding of the LVDT, a current starts flowing through the primarywinding. Due to magnetic property of current, the magnetic lines of force starts flowingaround the primary coil, thus a magnetic field is set up around the primary winding. As ingeneral transformers, due to magnetic effect of primary winding, an e.m.f. is also set up insecondary winding when the magnetic lines of force of primary winding cuts (come acrosscontact)theironrodandsecondarywinding.Thise.m.f.causesacurrenttoflowinsecondarywindingandthiswholeprocessisknownasmutualinductance.

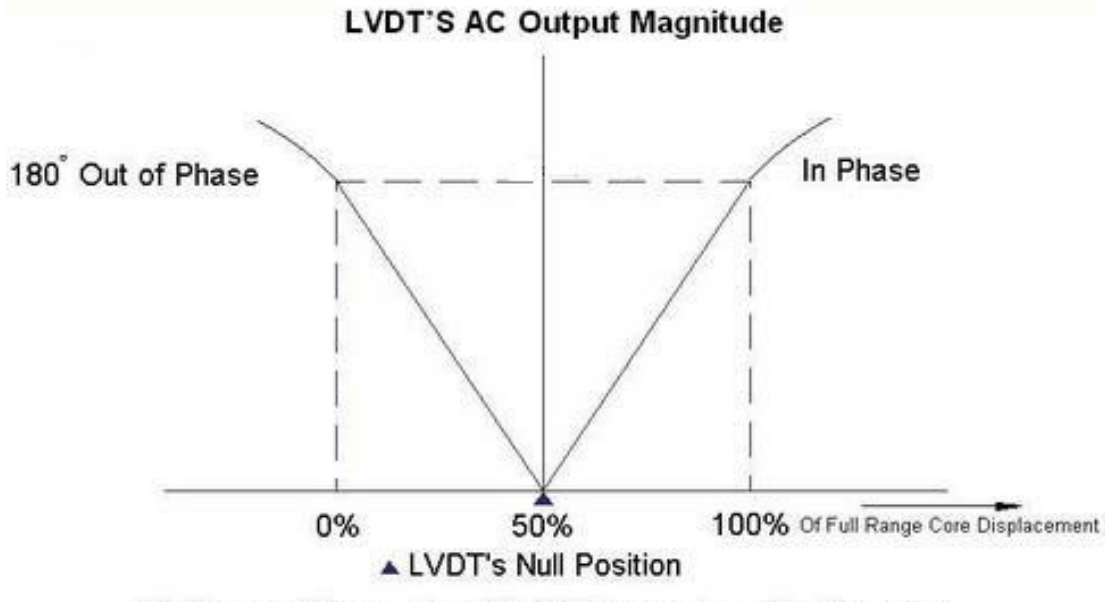
Case 1 (When the rod is placed in Center i.e. Area of contact of iron rod is same with bothsecondarycoils):

When the iron rod is placed in center of both secondary coils then the area of contact of ironrodbetweentwosecondarywindingsisequal,thentheequalamountofe.m.f.isdevelopedinthebothcoils.

Case 2(When the Rod is moved towards the right to the coil S2): When the rod is moves tothe right side towards the secondary coil 2 then the area of contact of rod is larger withsecondary coil S2 as compared to coil S1. Therefore, more amount of magnetic field cuts thecoilS2andthusmoree.m.f.willbeinducedinthesecondarycoilS2.

Case 3(When Iron Rod is moved towards the left, to coil S1): When the iron rod is movedtowards the coil S1 that is to left side then the contact area of secondary coil S1 will be largerthancoilS2.Thusmoree.m.f.willbeinducedinsecondarycoilS2.

CharacteristicsofLVDT



AC Output of Conventional LVDT Versus Core Displacement

VIII ExperimentalSet-up

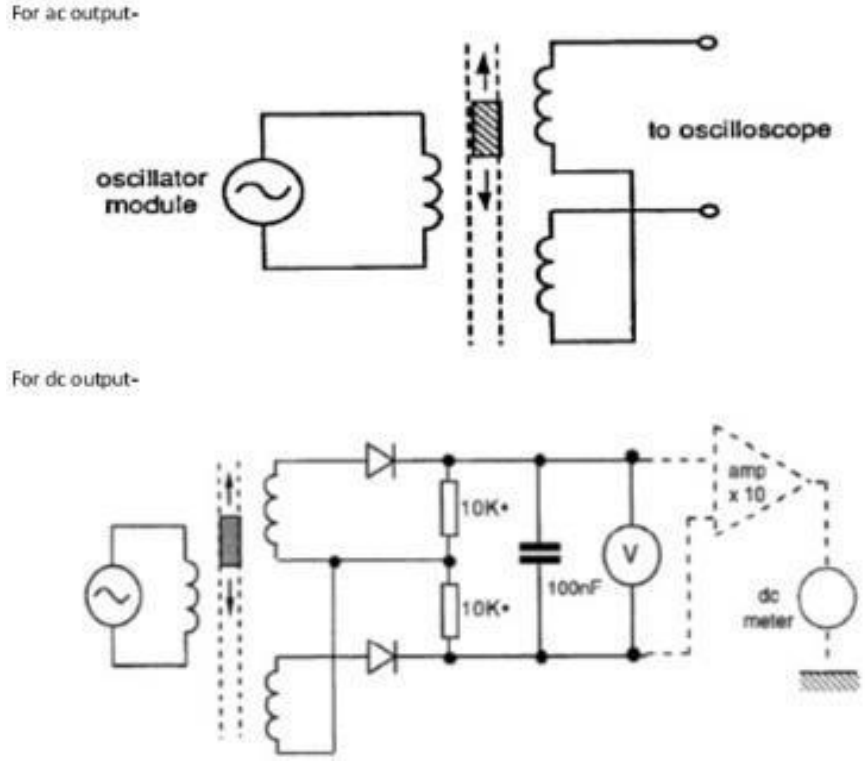


Figure:LVDTexperimentalsetup

IX Resourcesrequired

Sr.No.	Particulars	Specification	Quantity	Remark
1	**LVDT trainerkit-**	Displacement range+/- 20 mm.Accuracyof+/- 2%PrimaryExcitation 4KHZand1Volt,RMSOutput:Digitaldisplayof+/-20mm	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram.
2. ConnectLVDTsetupasindiagram.
3. Switchonthepowersupply.
4. ManuallydisplacethecoreofLVDTby1mm.
5. Recordthedigitaldisplayindicationw.r.tdisplacement.
6. RecordtheoutputvoltageV1usingDMMinobservationtable.
7. CrosscheckoutputvoltageV1usingC.R.O.
8. Repeatthesteps4to7for5timeswithanintervalof1mmplacementonbothsideofcenterpositionofcore.
9. Plotthegraphofdisplacementvsoutputvoltage.

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed((Useblanksheetprovidedifspacenotsufficient**)**

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XIII Resourcesused

Sr. No.	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
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XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr.No.	Displacement	Indicationondigital display	Outputvoltage
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2			
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XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedparts a)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)((Actions/decisionstobetakenbasedontheinterpretationofresults)

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmore such questions so as to ensure the achievement of identified CO. Write answersofminimum threequestions.

1. Statetheoutputvoltagewhenthecoreisatcenterposition
2. StatethemaximumlinearrangeofLVDT.
3. StatetheinputvoltageisappliedtoprimarywindingofLVDT.
4. StatetheoutputvoltageisobtainedatsecondarywindingofLVDT.

[SpacetoWriteAnswers]

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Scale
X-axis -
Y-axis -

PracticalNo.2:Weightsmeasurementusingstraingauge

I PracticalSignificance

A Strain Gauge is passive transducer which resistance change as per applied pressure.The strain gauge is used as Load Cell in weighing machine. In this practical studentwillablemeasurethepressure(weight) appliedon straingauge.

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowledgetosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.

2. **Experiments and practice**: Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Selecttherelevanttransducersformeasuringvariousparameters.

IV PracticalOutcome

a) Usethestraingaugetomeasureweights.

V CompetencyandPracticalSkills

This practical is expected to develop the following skills for the industryMaintaindifferenttransducersusedformeasurementofvariousparameters.

a) Usemultimeters
b) Connectionskills

VI RelevantAffectivedomain

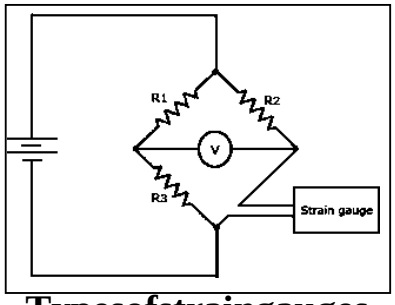
a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

Strain gauge is a resistive transducer whose resistance changes when subjected tostress (due tochange in length,area andresistivity).Whengauge is subjected topositivestressitslengthincreaseswhileitsareacrosssectiondecreasessinceresistance of conductor is directly proportional to length and inversely proportional toareaofcrosssection,resistancetogaugeincreasesthischangeinresistanceismeasured bywheatstone bridge.

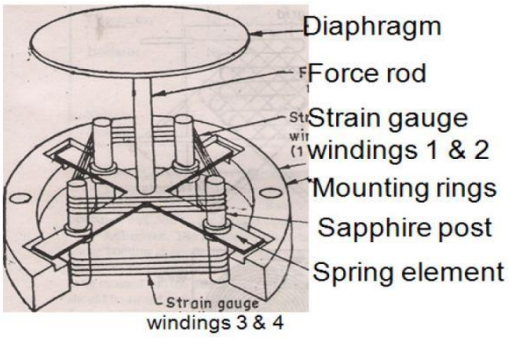
Gaugefactor: Sensitivityorgaugefactorisdefinedasratioofunitchangeinresistancetounitchange inlength

$$G.F=\frac{\Delta R/R}{\Delta L/L}$$



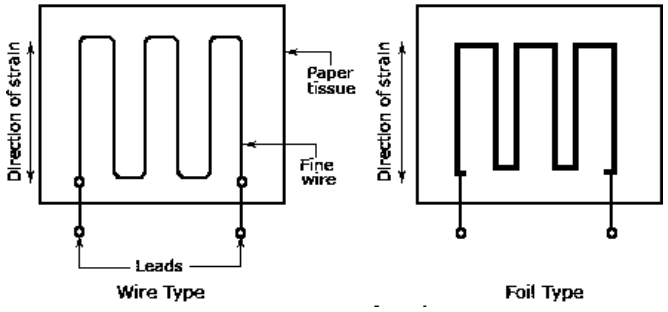
Typesofstraingauges

a. Unbonded



b. Bonded

Bonded Type Strain gauges-Wire and Foil types



VIII ExperimentalSet-up

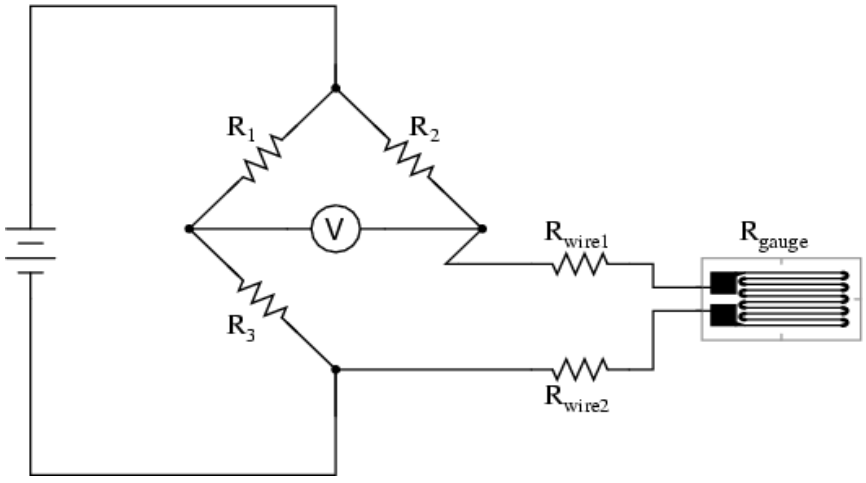


Figure:StrainGaugeexperimentalsetup

IX Resourcesrequired

Sr. No.	Particulars	Specification	Quantity	Remark
1	**Strain gauge trainerkit**	Straingagesof350ohms,Accuracy: +/- 1%PowerSupply230Vac,maximumof5-kgload,Digitalindication	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram
2. Connectstaingaugesetupasindiagram.
3. Switchonthepowersupply
4. Provideweightof1kgonstraingaugeplatform
5. Increasetheweightsinstepsof1kg
6. Recordtheoutputondigitaldisplay
7. RecordtheoutputvoltageV_1usingDMMinobservationtable.
8. Repeatthesteps5to6for5timeswithaninterval
9. PlotthegraphofweightsVsoutputvoltage

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Useblanksheetprovidedifspacenotsufficient)

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XIII Resourcesused

Sr. No.	NameofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
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XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr.No.	Weightskg	IndicationonDigital display	OutputvoltageV1
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5			
6			
7			
8			
9			
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XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedparts a)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)((Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmore such questions so as to ensure the achievement of identified CO. Write answersofminimum threequestions.

1. Statetheoutputvoltagewhennoweightisappliedontheplatform.
2. Statethemaximumrangeofstraingauge.
3. Statethetypeofstraingaugeusedinpractical.
4. Statethetypeofmaterialusedinstraingaugeinpracticalsetup.

[SpacetoWriteAnswers]

PracticalNo.3:Pressuremeasurementusingbourdontube

I PracticalSignificance

In the industry environment ElectricalEngineering/IndustrialElectronics diplomagraduateare expectedtohandle varioustransducersfor measurementof processparameters such as temperature, pressure, level, flow, displacement etc. The pressuremeasurement can be done directly or indirectly. The bourdon tube is one of thetransducerisusedtomeasure pressureTherefore thispracticalwillhelpyoutomeasurethepressureusingbourdontube.

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowledg etosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.
2. **Experiments and practice**: Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Selecttherelevanttransducersformeasuringvariousparameters.

IV PracticalOutcome

a)UseBourdontubepressuregaugetomeasurepressure.

V CompetencyandPracticalSkills

This practical is expected to develop the following skills for the industryMaintaindifferenttransducersusedformeasurementofvariousparam eters.

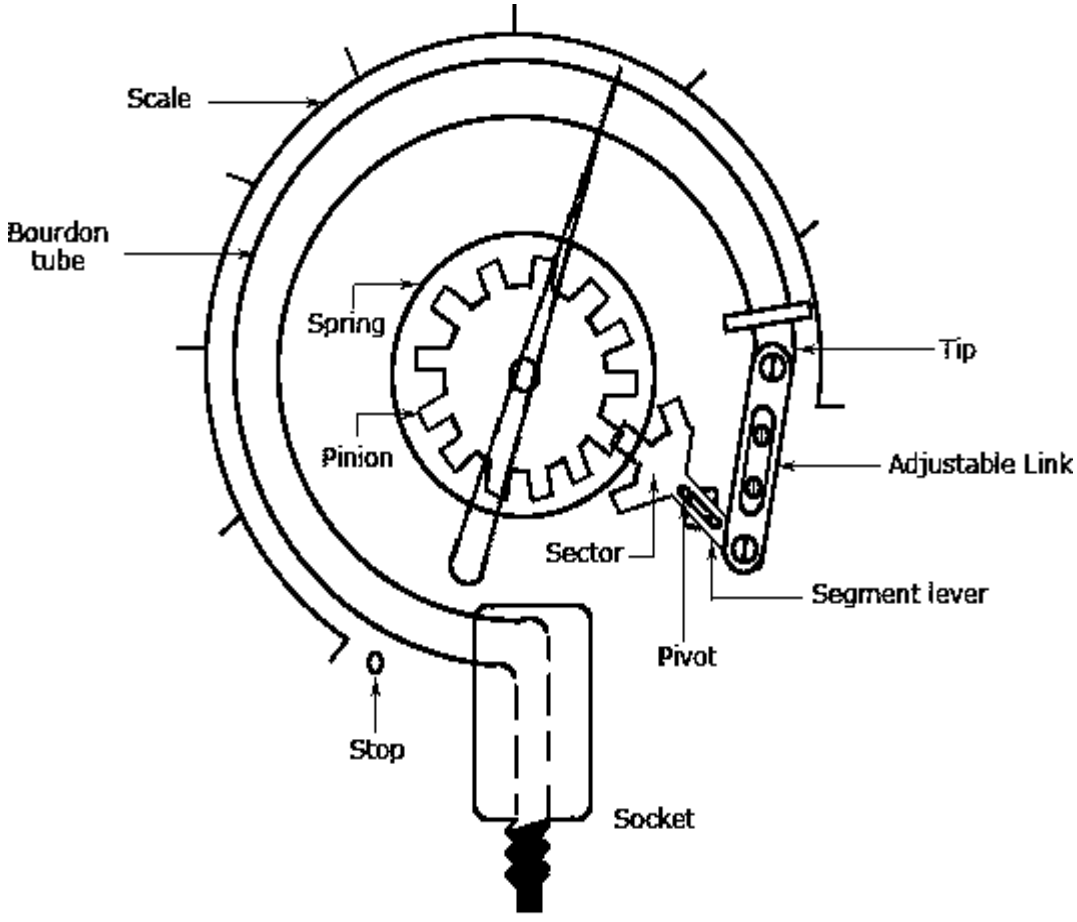
a) Usemultimeters
b) Connectionskills

VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

BourdonTubeisknownforitsveryhighrangeofdifferential pressuremeasurement in the range of almost 100,000 psi (700 MPa). It is an elastic typepressure transducer. A C type bourdon tube consist of long thin wall cylinder of non-circular cross section, sealed at one end and made up of material such as phosphorousbronze, steel, berylliumcopper,and attach by light line mechanism which operatesthe pointer. The other end of the tube is fixed and is open for application of pressurewhich is to be measured. The tube is soldered to a socket at the base through whichpressureconnectionis tobemade.



Bourdon Tube Pressure Gauge

Working

As the fluid pressure enters the bourdon tube, it tries to be reformed and because of afree tip available, this action causes the tip to travel in free space and the tubeunwinds.Thesimultaneousactionsofbendingandtensionduetotheinternalpressuremakeanon-linearmovementofthefreetip.Thistravelissuitableguidedandamplified for the measurement of the internal pressure. But the main requirement ofthe device is that whenever the same pressure is applied, the movement of the tipshould be the same and on withdrawal of the pressure the tip should return to theinitialpoint.

VIII ExperimentalSetup

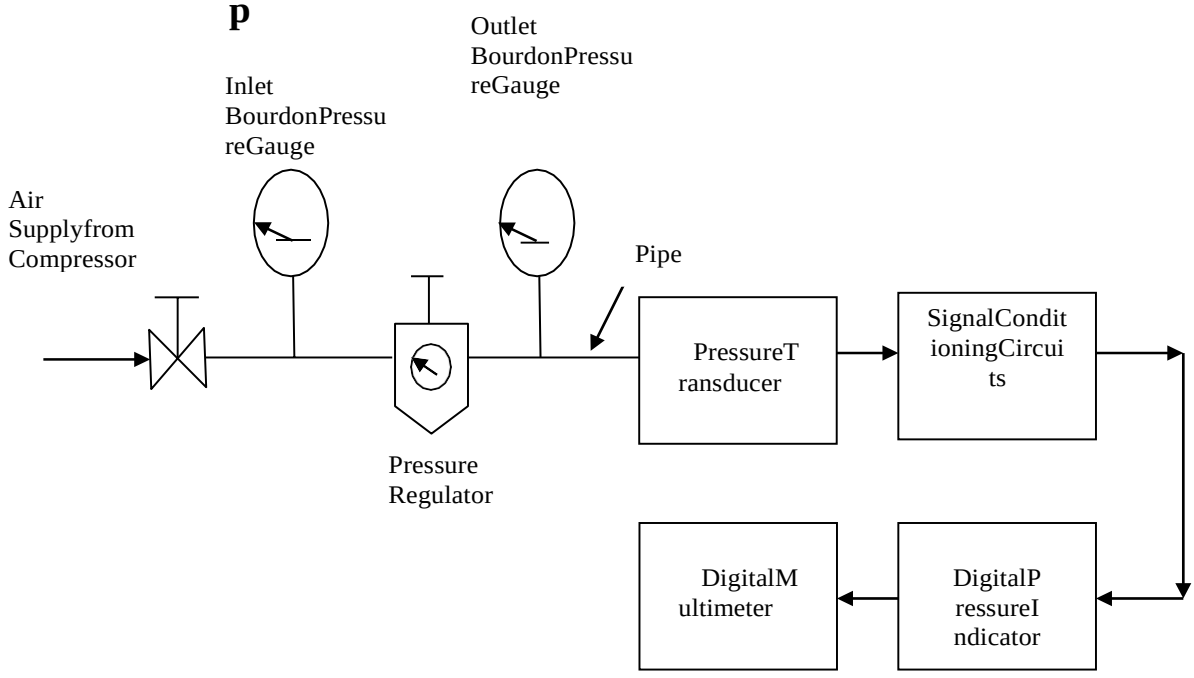


Figure:Pressuremeasurementsetup

IX Resourcesrequired

Sr. No.	Particulars	Specification	Quantity	Remark
1	**Bourdon tubepressure gauge**	Inputpressurerange0–50psi.Accuracyof +/-2%.Dialgaugeindicationintherange 0to50psiandDigitaldisplay.	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram
2. Connectpressuremeasurementsetupasindiagram.
3. Switchonthepowersupply
4. Providepressureof5psiwithcompressor.
5. Increasethepressureinstepsof5psi
6. Recordtheoutputpressureondialgauge
7. Recordtheoutputpressureondigitaldisplay
8. Repeatthesteps4to7for5times.

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Useblanksheetprovidedifspacenotsufficient**)**

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XIII Resourcesused

Sr. No	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
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XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr.No.	Pressureondialgauge	PressureIndicationonDigital Display
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XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)((Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmore such questions so as to ensure the achievement of identified CO. Write answersofminimum threequestions.

1. Statetheoutputpressurewhennopressureisappliedfromcompressor.
2. Statethemaximumrangeofpressuremeasurement.
3. Statethetypeofbourdontubeusedinpractical.
4. Statethetypeofmaterialusedinbourdontube.

[SpacetoWriteAnswers]

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PracticalNo.4:Pressuregaugecalibrationusingdeadweighttester

I PracticalSignificance

In the industry environment ElectricalEngineering/IndustrialElectronics diplomagraduateare expectedtohandle varioustransducersfor measurementof processparameters such as temperature, pressure, level, flow, displacement etc. The deadweight tester apparatus is used for measurement of high steady pressure as well ascalibrationpurposeforknownpressurequantity.Thereforethispracticalwillhelpyout ocalibrategivenpressureusingdeadweighttester.

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowledg etosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.
2. **Experiments and practice**: Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Maintainthedifferenttypesofpressuretransducers

IV PracticalOutcome

a)Calibratethebourdontubepressuregaugeusingdeadweighttester.

V CompetencyandPracticalSkills

This practical is expected to develop the following skills for the industryMaintaindifferenttransducersusedformeasurementofvariousparam eters.

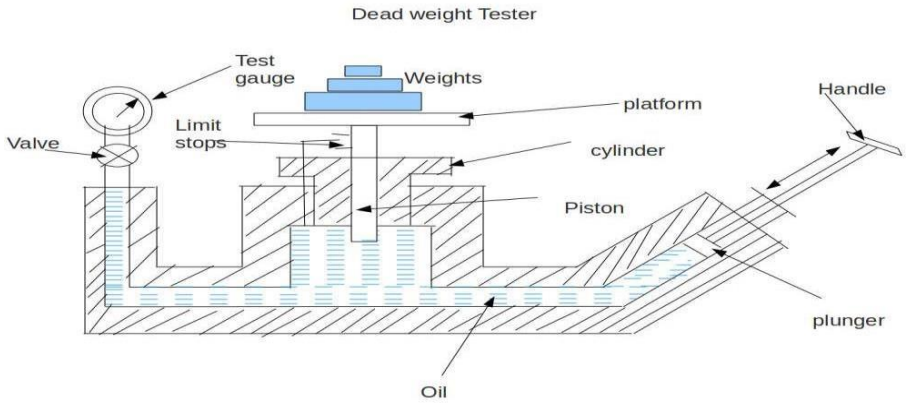
a) UseDeadweighttester
b) PressureGauge
c) Connectionskills

VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

DeadWeightTesterisusedformeasurementofhighsteady pressure,andforchecking bourdon type of gauge. In the practical form, it is often used as a standard ofpressure measurement. In this type of instrument the force produce on the piston onknownareaismeasureddirectlybyweightitwillsupport



Operation

The dead weight tester is basically a pressure producing and pressure measuringdevice. It is used to calibrate pressure gauges. The following procedure is adopted forcalibratingpressuregauges.Calibrationofpressuregaugemeansintroducinganaccurately known sample of pressure to the gauge under test and then observing theresponseofthe gauge.Inordertocreatethisaccuratelyknownpressure,thefollowingstepsarefollowed.
Thevalveoftheapparatusisclosed.

A known weight is placed on the platform. Now by operating the plunger, fluidpressureisappliedtotheothersideofthepistonuntilenoughforceisdevelopedtolift the piston-weight combination. When this happens, the piston weight combinationfloatsfreelywithinthecylinderbetweenlimitstops.
In this condition of equilibrium, the pressure force of fluid is balanced against thegravitationalforceoftheweightsplusthefrictiondrag.

Therefore,PA=Mg+FHence
: P = Mg + F /
Awhere,P=pressure
M=Mass;Kg
g=Accelerationduetogravity;m/s²F
= Frictiondrag;N
A=Equivalentareaofpiston–cylindercombination;m²
ThusthepressurePwhichiscausedduetotheweightsplacedontheplatformiscalculated.
AftercalculatingP,theplungerisreleased.

Now the pressure gauge to be calibrated is fitted at an appropriate place on the deadweight tester. The same known weight which was used to calculate P is placed on theplatform. Due to the weight, the piston moves downwards and exerts a pressure P onthe fluid. Now the valve in the apparatus is opened so that the fluid pressure P istransmitted to the gauge, which makes the gauge indicate a pressure value. Thispressure value shown by the gauge should be equal to the known input pressure P. IfthegaugeindicatessomeothervalueotherthanPthegaugeisadjustedsothatitreadsavalueequaltoP.Thusthegaugeiscalibrated.

VIII ExperimentalSet-up

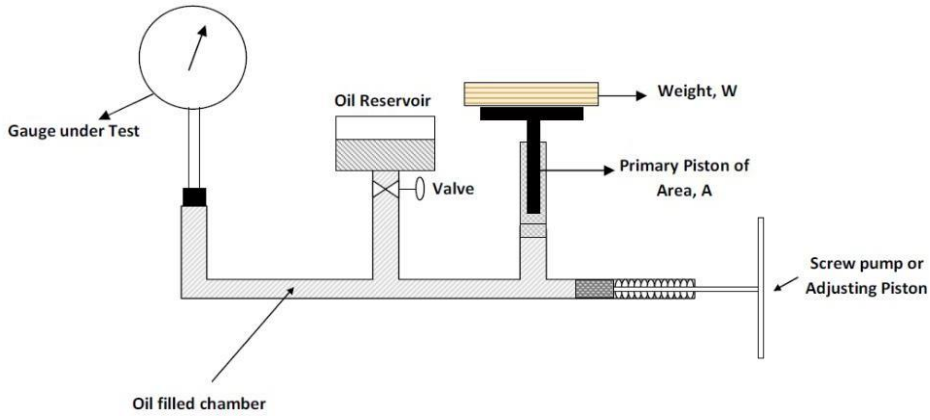


Figure:DeadWeightTesterexperimentalsetup

IX Resourcesrequired

Sr. No.	Particulars	Specification	Quantity	Remark
1	**Dead weight tester**	Inputrange0-10kg,Outputondialgauge0–10kg/cm^2	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram
2. Checktheoillevelinthereservoir.
3. Opencheckvalve.
4. Rotatedisplacementpumpclockwiseandanti-clockwisetwotothreetimesforremovingairbubbles.
5. Closecheckvalve.
6. Placethestandardweights0.5kg/cm^{2}onweighingplatform
7. Observetheoutputpressureingauge.
8. Recordthepressureinobservationtable.
9. Increasetheweightsinrange0.5kg/cm^2
10. Repeatthesteps6to9for5times.

XI Precautionstobefollowed

1. Ensureproperconnectionsaremadeasperthesetup.
2. Ensuretightfittingofbourdongauge.

XII Actualprocedurefollowed(Tobewrittenbystudents)(Useblanksheet providedif spacenotsufficient)

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XIII Resourcesused

	NameofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
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XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr.No.	StandardWeightskg/cm^2	Pressuregaugeindication kg/cm^2
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9		
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XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)((Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmoresuchquestionssoastoensuretheachievementofidentifiedCO.Writeanswersofminimum threequestions.

1. Statetheoutputpressurewhennoweightisappliedontheplatform.
2. Statethemaximumpressurerangeofdeadweighttester.
3. Statetheerrorobserved.
4. Statethepurposeofcheckvalve.

[SpacetoWriteAnswers]

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PracticalNo.5:Flowmeasurementusingrotameter

I PracticalSignificance

Rotameter is one of important instrument used by industry. The Rotameter have beenin use for fluid flow measurement.It belongs to a class of variable area flow meters.Thisvariableareaprincipleconsistsofthreebasicelements:Auniformlytapered flowtube, a float, and a measurement scale. Therefore this practical will help you tomeasuretheflowusingRotameter.

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowledg etosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.
2. **Experiments and practice**: Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Maintainthedifferenttypesofflowtransducers.

IV PracticalOutcome

a)UseRotameterforflowmeasurement.

V CompetencyandPracticalSkills

ThispracticalisexpectedtodevelopthefollowingskillsfortheindustryMaintai nthedifferenttypesofflowtransducers.

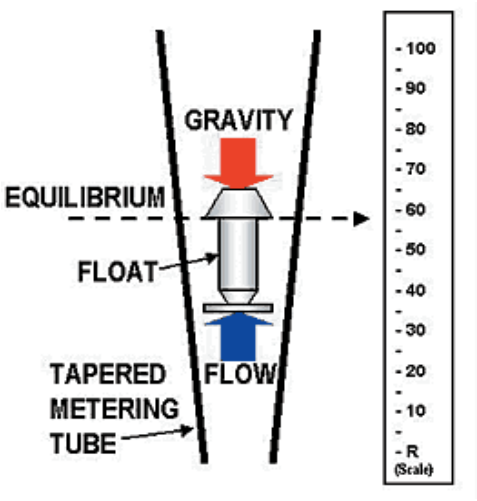
a)Connectionskills

VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

Rotameter: It is a variable area flow meter used for flow measurement. It consist ofvertical tapered tube with a float which is free to move up and down within the tube.The free area between float and inside wall of the tube forms an annular orifice. Thetube is mounted vertically with the small end at the bottom. The fluid to be measuredenters the tube from the bottom and passes upwards around the float and exit at thetop.



OperatingPrinciple

Itsoperatingprincipleisbasedonafloatofgivendensity'sestablishinganequilibriumposition where, with a given flow rate, the upward force of the flowing fluid equalsthedownward forceof gravity.

Rotameters are the most widely used type of variable-area (VA) flow meter. In thesedevices, the falling and rising action of a float in a tapered tube provides a measure offlow rate as shown in Figure. Rotameter are known as gravity-type flow metersbecause they are based on the opposition between the downward force of gravity andtheupwardforceofthe flowingfluid.Whentheflowisconstant,thefloatstaysinoneposition that can be related to the volumetric flow rate. That position is indicated on agraduated scale. It can be used to measure the flow rates of most liquids, gases, andsteam.Thematerialsofconstructionincludestainlesssteel,glass,metal,andplastic.

The tapered tube's gradually increasing diameter provides a related increase in theannular area around the float, and is designed in accordance with the basic equationforvolumetricflowrate:

where :

$$Q = kA\sqrt{gh}$$

- Q •=volumetricflowrate,e.g.,gallonsperminute
- k •=aconstant
- A •=annulararеabetweenthefloatandthetubewall
- g •=forceofgravity
- h •=pressuredrop(head)acrossthefloat

WithhbeingconstantinaVAmeter,wehaveAasadirectfunctionofflowrateQ.

VIII ExperimentalSet-up

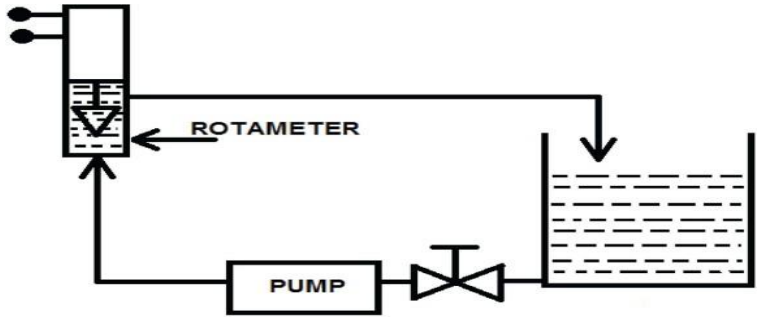


Fig.1.FlowMeasurementSetup

IX Resourcesrequired

Sr.No.	Particulars	Specification	Quantity	Remark
1	**Rotameter flowmeasurement setup**	Range 0-1000LPH, Glass tubebody,BobMaterial-SS,connection1'',Mountinginlet bottomtopoutlet.	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram
2. ConnectRotametermeasurementsetupasindiagram.
3. Fillthesumptankwithwater.
4. Switchonthepowersupply.
5. Startthepumpandensureflowratethroughpipeline
6. MeasureflowrateindicationontheRotameter.
7. Changevalvepositionforincreasingflowrateinpipeline.
8. Recordflowrateinobservationtable.
9. Repeatthesteps6to8for5to6readings.

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Useblanksheetprovidedifspacenotsufficient)

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XIII Resourcesused

Sr. No.	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
1					
2					
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XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr.No.	Flowrateonindicator	Calculatedflowrate
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)((Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmoresuchquestionssoastoensuretheachievementofidentifiedCO.Writeanswersofminimum threequestions.

1. StatemountingpositionofRotameterdeviceusedforflowmeasurement.
2. Statethemaximumrangeofflowratemeasurement.
3. Statethetypeofflowmeasurementusedinpractical.
4. StatethetypeofmaterialusedinRotameterinpracticalsetup.

[SpacetoWriteAnswers]

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PracticalNo.6:MeasurementoftemperatureusingRTD

I PracticalSignificance

In the industry environment ElectricalEngineering/IndustrialElectronics diplomagraduateare expectedtohandle varioustransducersfor measurementof processparameterssuchastemperature,pressure,level,flow,displacementetc.RTD(Resistance Temperature Detector) is most linear passive temperature transducer. Pt-100 is most common low cost RTD. It is made up of platinum and it have 100 Ohmresistanceat0^{o}temperature.Thispracticalwillhelpyoutousetomeasurethetemperatureusing RTD for given liquid

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowledgetosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.
2. **Experimentsandpractice**:Plantoperformexperimentsandpracticestousetheresults to solve broad-based Electrical Engineering/Industrial Electronicsproblems.

III RelevantCourseOutcomes

a)Maintainthedifferenttypesoftemperaturetransducers.

IV PracticalOutcome

a)UseRTDtomeasuretemperature

V CompetencyandPracticalSkills

ThispracticalisexpectedtodevelopthefollowingskillsfortheindustryMaintainthedifferenttypesoftemperaturetransducers.

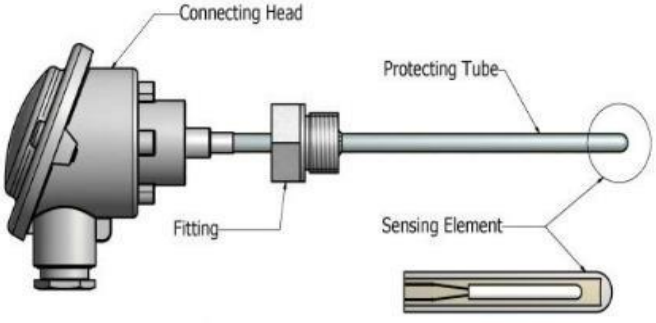
a) Useofmultimeter
b) Connectionskills

VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

Resistance Temperature Detector (RTD): The resistance of certain metals changeswith a temperature change. With the increase of temperature electrical resistance ofcertainmetalincreaseindirectproportiontotheriseoftemperature.

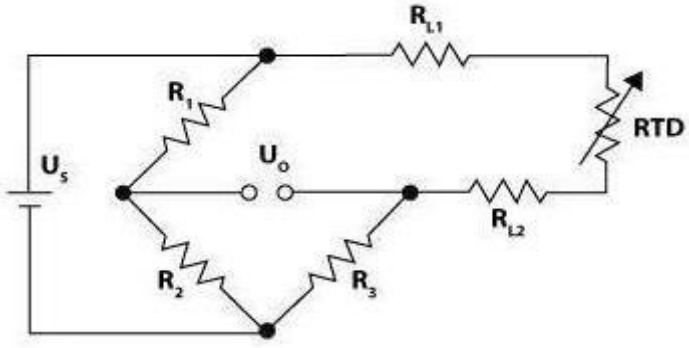


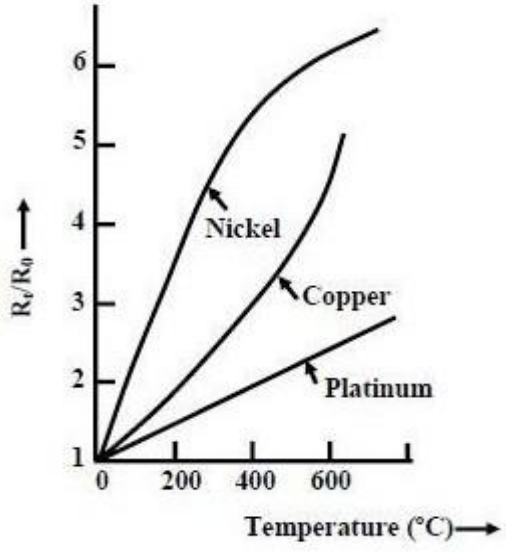
In **RTD** devices; Copper, Nickel and Platinum are widely used metals. These three metals are having different resistance variations with respective to the temperature variations. That is called resistance-temperature characteristics. Platinum has the temperature range of 650oC, and then the Copper and Nickel have 120oC and 300oC respectively. The figure shows the resistance-temperature characteristics curve of the three different metals. For Platinum, its resistance changes by approximately 0.4 ohms per degree Celsius of temperature.

The construction is typically such that the wire is wound on a form (in a coil) on notched mica cross frame to achieve small size, improving the thermal conductivity to decrease the response time and a high rate of heat transfer is obtained. In the industrial RTD's, the coil is protected by a stainless steel sheath or a protective tube.

In RTD, the change in resistance value is very small with respect to the temperature. So, the RTD value is measured by using a bridge circuit. By supplying the constant electric current to the bridge circuit and measuring the resulting voltage drop across the resistor, the RTD resistance can be calculated. Thereby, the temperature can be also determined. This temperature is determined by converting the RTD resistance value using a calibration expression.

$$R_t = R_0[1+ \alpha\ (t - t_0)]$$





VIII ExperimentalSet-up

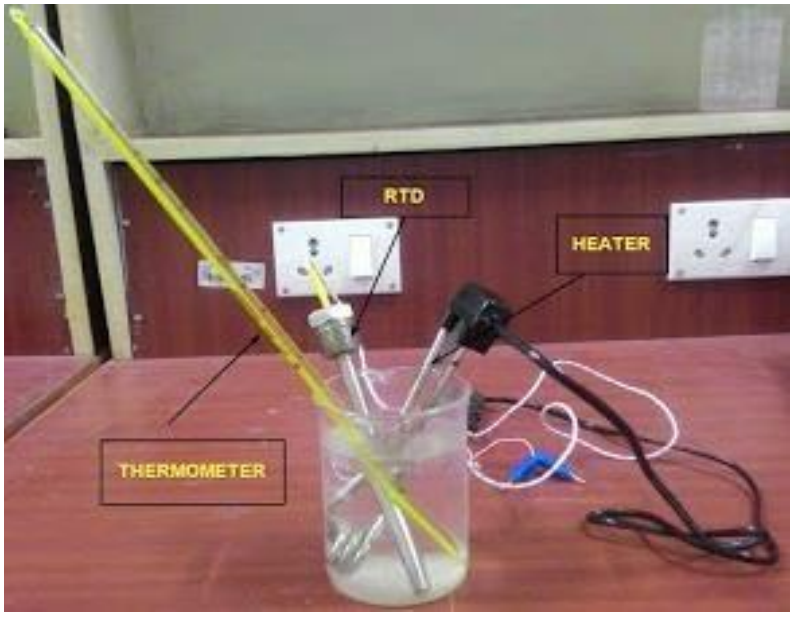


Fig.1.TemperatureMeasurementSetup

IX Resourcesrequired

Sr. No.	Particulars	Specification	Quantity	Remark
1	**RTD**	Pt100	01	
2	**TempBath**	2KW,230VAC	01	
3	**Digital Temperature indication**	0^0C to200^0C,accuracyof +/-1%	01	
4	**MercuryThermometer**	0to300^0C	01	
5	**DigitalMultimeter**	0-200Ω	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram.
2. ConnectsetupfortemperaturemeasurementwithRTD.
3. PlacetheRTD,thermometer,immersionheaterintemperaturebath.
4. Recordtheroomtemp.withmercurythermometer
5. Recordtheoutputresistancewithmultimeterforroomtemperature.
6. Switchonthepowersupplyofheater.
7. Notedownthetemperatureforevery5degreetemperaturerise.
8. Recordthetemperatureusingmercurythermometer.
9. Recordtheoutputresistanceusingmultimeter.
10. Completetheobservationtable.
11. Repeatthesteps7to10for10readings.
12. PlotthetemperatureVsresistancegrap

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Useblanksheetprovidedifspacenotsufficient**)**

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XIII Resourcesused

	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsuffi cient)

Sr.No.	Temperature^{0}C	Resistance(Ω)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)(Actions/decisionstobetakenbasedontheinterpretationofresults).

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PracticalNo.7:Measurementoftemperatureusingthermocouple

I PracticalSignificance

In the industry environment ElectricalEngineering/IndustrialElectronics diplomagraduateare expectedtohandle varioustransducersfor measurementof processparameterssuchastemperature,pressure,level,flow,displacementetc.Thermo couple is most useful active temperature transducer. It work based on Seebeck and Peltier effect. Since it is active transducer designing of signal conditioner iseasy. This is mostly used to measure the temperature above 300° C. This practical willhelp youtousetomeasuretemperatureusingthermocoupleforgivenliquid.

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowled getosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.
2. **Experiments and practice**: Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Maintainthedifferenttypesoftemperaturetransducers.

IV PracticalOutcome

a)UseThermocoupletomeasuretemperature

V CompetencyandPracticalSkills

Thispracticalisexpectedtodevelopthefollowingskillsfortheindustry Maintai nthedifferenttypesoftemperaturetransducers.

a) Useofmultimeter
b) Connectionskills

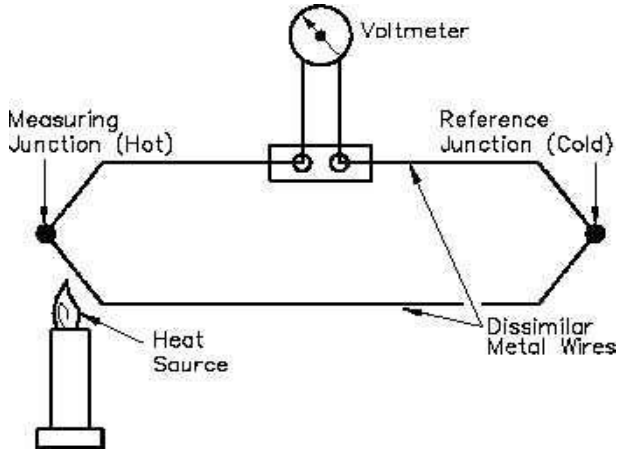
VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

Thermocouple: Athermocoupleisadevicemadebytwodifferentwiresjoinedatoneend ,calledjunctionend or measuringend.Thetwowiresarecalled thermoelements or legs of the thermocouple: the two thermo elements are distinguished aspositiveandnegativeones.Theotherendofthethermocoupleiscalledreferenceend
The junction end is immersed in the environment whose temperature T2 has to bemeasured, which can be for instance the temperature of a furnace at about 500°C,whilethereferenceendisheldatadifferenttemperatureT1,e.g.atambienttemper ature.
Thermocoupleswillcause anelectric currentto flow inthe attached circuitwhen subjected to changes in temperature. Theamountofcurrentthatwillbeproducedisdependentonthetemperaturedifferencebet weenthemeasurement

And
referencejunction;thecharacteristicsofthetwometalsused;andthecharacteristicsoftheattachedc ircuit.



Heating the measuring as shown in above figureSimple Thermocouple Circuit junctionon the thermocoupleproducesa voltagewhichisgreater than the voltage across thereferencejunction. The difference between the two voltages is proportional to t h e dDifferenceintemperatureandcanbemeasuredonthevoltmeter(inmillivolts).

VIII ExperimentalSet-up

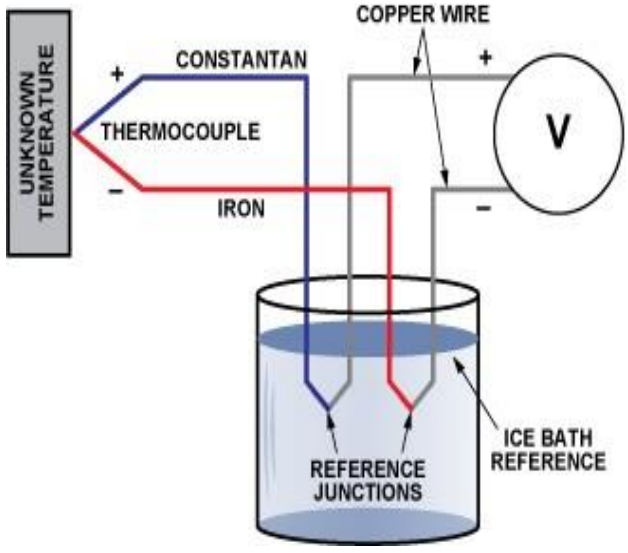


Fig.1.TemperatureMeasurementSetup

IX Resourcesrequired

Sr.No.	Particulars	Specification	Quantity	Remark
1	Thermocouple	Thermocouple K Type: Temp range0-200^{0}C	01	
2	TempBath	2KW,230VAC	01	
3	Digital Temperature indication	0^{0}C to200^{0}C,accuracyof +/- 1%	01	

4	DigitalMultimeter	0-200mV	01	
5	Mercury Thermometer	0to300^{0}C	01	
6	Compensatingcable	2wire,0.5mm^2	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram.
2. Connectsetupfortemperaturemeasurementwiththermocouple.
3. Placethethermocouple,thermometer,immersionheaterintemperaturebath.
4. Recordtheroomtemp.withmercurythermometer
5. Recordtheoutputvoltagewithmultimeterforroomtemperature.
6. Switchonthepowersupplyofheater.
7. Notedownthetemperatureforevery10degreetemperaturerise.
8. Recordthetemperatureusingmercurythermometer.
9. Recordtheoutputvoltageusingmultimeter.
10. Completetheobservationtable.
11. Repeatthesteps7to10for10readings.
12. PlotthetemperatureVsvoltagegraph

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Tobewrittenbystudents)(Useblanksheet providedif spacenotsufficient)

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XIII Resourcesused

	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr.No.	Temperature^{0}C	Voltage(mV)
1		
2		
3		
4		
5		
6		
7		
8		
9		
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XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)((Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmore such questions so as to ensure the achievement of identified CO. Write answersofminimum threequestions.

1. Statetheoutputvoltagewhentwoterminalsareshortofthermocouple.
2. Statetheoutputwhenoneoftheelementsbecomesopen.
3. Statetheoutputvoltageatroomtemperature.

PracticalNo.8:CalibrationofRTD

I PracticalSignificance

In the industry environment ElectricalEngineering/IndustrialElectronics diplomagraduateare expectedtohandle varioustransducersfor measurementof processparameters such as temperature, pressure, level, flow, displacement etc. Calibration isoneofimportantprocessinmeasuringinstrument.Calibrationoftransduceraswellass ystemisessential.CalibrationofRTDwithstandardtemperaturemeasurementsystem can be done. Therefore this practical will help you to calibrate the given RTDtemperaturemeasuringinstrument.

II RelevantProgramOutcomes(POs)

1. **Disciplineknowledge**:ApplyElectricalEngineering/IndustrialElectronicsknowledg etosolvebroad-basedElectricalEngineering/IndustrialElectronicsrelatedproblems.
2. **Experiments and practice**: Plan to perform experiments and practices to use theresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a)Maintainthedifferenttypesoftemperaturetransducers.

IV PracticalOutcome

a)CalibrateRTDtemperaturemeasuringinstruments

V CompetencyandPracticalSkills

ThispracticalisexpectedtodevelopthefollowingskillsfortheindustryMaintai nthedifferenttypesoftemperaturetransducers.

a) Useofmultimeter
b) Connectionskills

VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaincleanlinessoftransducersetup.

VII MinimumTheoreticalBackground

Calibration: It is the comparison of specific values of input and output of the systemcorresponding to reference standard. It offers guarantee that instrument works as perspecification of manufacturer. It removes errors in measurement system and givesaccuracyofinstrumentasperspecification

VIII ExperimentalSet-up

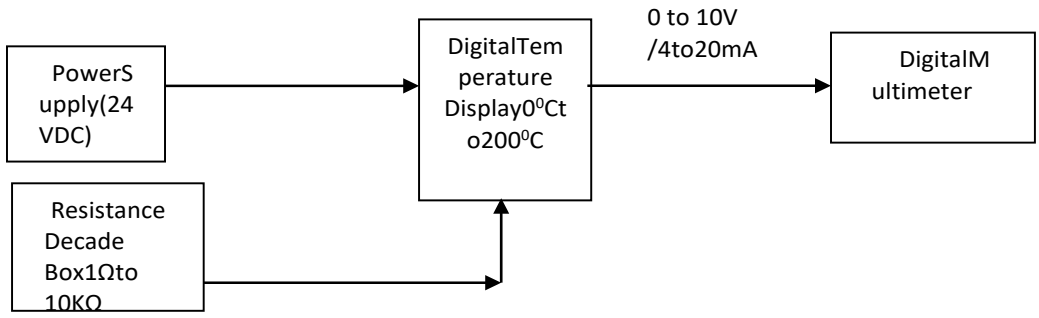

Fig.1.CalibrationofTemperaturemeasurement

systemIX Resourcesrequired

Sr.No.	Particulars	Specification	Quantity	Remark
1	RTD	PT100	01	
2	TempBath	2KW,230VAC	01	
3	Digital Temperature indication	0^{0}C to200^{0}C,accuracyof +/- 1%	01	
4	Mercury Thermometer	0to300^{0}C	01	
5	DigitalMultimeter	0-200Ω	01	
6	DecadeBox	1Ωto10KΩ	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram.
2. ConnecttemperaturecalibrationsetupforRTD.
3. Switchonthepowersupply.
4. Provide100Ωresistancefromdecadeboxtotemperatureindicator.
5. Recordthetemperatureindicationandoutputvoltage.
6. Ifanydeviationfrom0^{0}Cadjustzerooftemperatureindicator
7. Provide maximum 175Ω resistance from decade box to temperatureindicator(175Ωcorrespondingto200^{0}CfromstdRTD(Pt100)chart)
8. Recordthetemperatureindicationandoutputvoltage.
9. Ifanydeviationfrom200^{0}Cadjustspanoftemperatureindicator
10. Repeatstep7to9forevery25%,50%and75%temperaturerisewithrespecttomaxtemp(200^{0}C).

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Useblanksheetprovidedifspacenotsufficient**)**

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XIII Resourcesused

	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr. No.	Temperature	Resistance	Temperature Indicator	Output voltage	Deviation intemperature

XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)(Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note: Below given are few sample questions for reference. Teachers must designmoresuchquestionssoastoensuretheachievementofidentifiedCO.Writeanswersofminimum threequestions.

1. Statetheneedforzeroadjustment.
2. Statetheneedforspanadjustment
3. Statetheoutputresistanceat200^{0}C.
4. Statetheoutputresistancevaluesattemperature00C,500C,1000C,1500CfromStd Pt100chart.

[SpacetoWriteAnswers]

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XX References/SuggestionsforfurtherReading

Sr. No.	TitleofBook	Author	Publication
1	Electrical andElectronic Measurements and Instrumentation	Sawhney,A.K.	DhanpatRaiandSons,N.Delhi201;ISBN:9788177001006
2	Industrial Instrumentation andControl	Singh,S.K.	McGrawHillPublishing;N.Delhi2010;ISBN:9780070678200

XXI SuggestedAssessmentScheme

PerformanceIndicators		Weightage(%)
Processrelated:15Marks		**60%**
1	IdentifythepracticalsetupofRTD	10%
2	Connectionofcompletemeasurementsystem.	20%
3	Applyincreaseinresistancetotemperatureindicator	10%
4	Observationofoutputtemperatureandvoltage.	10%
5	Workinginteam.	10%
Productrelated:10Marks		**40%**
1	Answerstopracticalrelatedquestions.	30%
2	Submissionofreportintime.	10%
Total:25Marks		**100%**

NameofStudentTeamMembers

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4……..

5……..

MarksObtained			Datedsignof Teacher
Process Related(15)	Product Related(10)	Total(25)	

PracticalNo.9:Calibrationofthermocouple

I PracticalSignificance

In the industry environment ElectricalEngineering/IndustrialElectronics diplomagraduateare expectedtohandle varioustransducersfor measurementof processparameters such as temperature, pressure, level, flow, displacement etc. Calibration isoneofimportantprocessinmeasuringinstrument.Calibrationoftransduceraswellass ystemisessential.Calibrationofthermocouplewithstandardtemperaturemeasurement system can be done. Therefore this practical will help you to calibratethegiventhermocouple.

II RelevantProgramOutcomes(POs)

PO 2. Discipline knowledge: Apply Electrical Engineering/Industrial Electronicsknowledge to solve broad-based Electrical Engineering/Industrial Electronics relatedproblems.

PO 3. Experiments and practice: Plan to perform experiments and practices to usetheresultstosolvebroad-basedElectricalEngineering/IndustrialElectronicsproblems.

III RelevantCourseOutcomes

a) Maintainthedifferenttypesoftemperaturetransducers.

IV PracticalOutcome

a) CalibrateThermocoupletemperaturemeasuringinstruments

V CompetencyandPracticalSkills

ThispracticalisexpectedtodevelopthefollowingskillsfortheindustryMaintai nthedifferenttypesoftemperaturetransducers.

a) Useofmultimeter
b) Useofmillivoltsource
c) Connectionskills

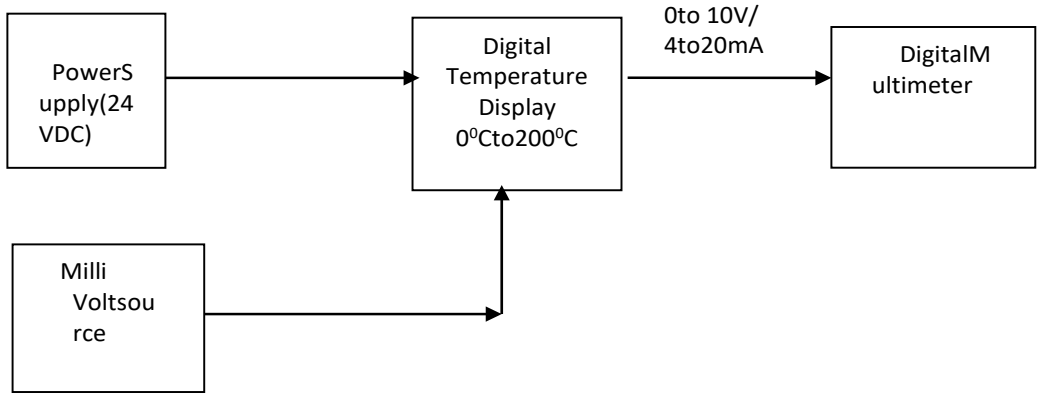
VI RelevantAffectivedomain

a) Followsafetypractices.
b) Maintaintoolsandequipment.

VII MinimumTheoreticalBackground

Calibration: It is the comparison of specific values of input and output of the systemcorresponding to reference standard. It offers guarantee that instrument works as perspecification of manufacturer. It removes errors in measurement system and givesaccuracyofinstrumentasperspecification

VIII ExperimentalSet-up



IX Resourcesrequired

Sr. No.	Particulars	Specification	Quantity	Remark
1	Thermocouple	Ktype	01	
2	TempBath	2KW,230VAC	01	
3	DigitalTemperature indication	0^0Cto200^0C,accuracyof+/-1%	01	
4	Mercury Thermometer	0to300^0C	01	
5	Digital Multimeter	0-200mV	01	
6	Millivolt source	0-100mV	01	

X Procedure

1. Identifythecomponentofgivensetupdiagram.
2. Connecttemperaturecalibrationsetupforthermocouple.
3. Switchonthepowersupply.
4. Provide0mVvoltagefrommillivoltsourcetotemperatureindicator.
5. Recordthetemperatureindicationandoutputvoltage.
6. Ifanydeviationfrom0^0Cadjustzerooftemperatureindicator
7. Provide maximum 10.78mV from milli volt source to temperatureindicator(10.78mVcorrespondingto200^0CfromStdthermocouplechart)
8. Recordthetemperatureindicationandoutputvoltage.
9. Ifanydeviationfrom200^0Cadjustspanoftemperatureindicator
10. Repeatstep7to9forevery25%,50%and75%temperaturerisewithrespecttomaxtemp(200^{0}C).

XI Precautionstobefollowed

1. Ensurethatproperconnectionsaremadeasperthesetup.
2. Ensurepropersettingofdevicesused.
3. Ensurethepowerswitchisinoffconditioninitially.

XII Actualprocedurefollowed(Useblanksheetprovidedifspacenotsufficient)

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XIII Resourcesused

Sr. No.	Name ofResource	BroadSpecifications		Quantity	Remark
		Make	Details		
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2					
3					

XIV Precautionsfollowed

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XV ObservationsandCalculations(Useblanksheetprovidedifspacenotsufficient)

Sr. No.	Temperature	Millivolt	Temperature Indicator	Output voltage	Deviationin temperature

XVI Results

1. Nameofidentifiedtransducera)……
2. Namesofidentifiedpartsa)……b)……c)……d)……

XVII Interpretationofresults(Givemeaningoftheaboveobtainedresults)

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XVIII Conclusions(ifany)(Actions/decisionstobetakenbasedontheinterpretationofresults).

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XIX PracticalRelatedQuestions

Note*: Below given are few sample questions for reference. Teachers must designmoresuchquestionssoastoensuretheachievementofidentifiedCO.Writeanswersof minimumthreequestions.*

1. Statetheneedforzeroadjustment.
2. Statetheneedforspanadjustment
3. Statetheoutputmillivoltat200^{0}C.
4. Statetheoutputmillivoltvaluesattemperature0^{0}C,50^{0}C,100^{0}C,150^{0}CfromStdthermocouple(typeused inpracticalsetup)chart.

[SpacetoWriteAnswers]

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