P.S.R. ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Sevalpatti (P.O), Sivakasi -626140.

Tamil Nadu

LABORATORY MANUAL

191ME37 – METROLOGY AND MEASUREMENTS LABORATORY

(For Third semester B.E. Mechanical Engineering students)

DEPARTMENT OF MECHANICAL ENGINEERING

(2020-2021)

P.S.R. ENGINEERING COLLEGE
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191ME37
METROLOGY AND MEASUREMENTS LABORATORY

PREPARED BY
Mr. G. Uthayakumar, Associate Professor
Mr. S. Durairaj, Assistant Professor

Head Of the Department
Department of Mechanical Engineering
P.S.R. Engineering College
Sevalpatti, Sivakasi - 626 140

APPROVED BY
Dr. H. KANAGASABAPATHY,
HOD/MECH.

DEPARTMENT
OF
MECHANICAL ENGINEERING

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P.S.R. Engineering College

Vision & Mission Statement

Vision

- To contribute to the society through excellence in technical education with societal values and thus a valuable resource for industry and the humanity

Mission

- To create an ambience for quality learning experience by providing sustained care and facilities
- To offer higher level training encompassing both theory and practices with human and social values
- To provide knowledge based services and professional skills to adapt tomorrow's technology and embedded global changes

Department of Mechanical Engineering

Vision & Mission Statement

Vision

- To provide broad-based education and training in mechanical engineering and its applications to enable the graduates to meet the demands in a rapidly changing needs in industry, academia and society

Mission

- To impart high quality technical education and training that encompasses both theory and practices with human and social values
- To equip the students to face tomorrows technology embedded global changes
- To create, explore, and develop innovations in mechanical engineering research

Department of Mechanical Engineering

Programme Specific Outcomes

PSO 1 - Apply the concepts of mathematics and science in mechanical systems

PSO 2 - Design and analyze components and systems for mechanical engineering applications

PSO 3 - Synthesis data and technical concepts for application to mechanical

Programme Outcomes of Mechanical Engineering

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SYLLABUS

191ME37	**METROLOGY AND MEASUREMENTS LABORATORY**	**L-T-P**	**C**
		0-0-3	**2**

Programme: B.E. Mechanical Engineering **Sem: 4** **Category: PC**

Aim: To learn the methods of handling different measuring instruments

Course Outcomes:

The students will be able to

CO1. Calibrate linear and angular measurement instruments

CO2. Check straightness, flatness using dial gauge

CO3. Measure screw and gear parameters

CO4. Handle vibration and displacement measuring instrument

CO5. Use the force and torque measuring tools

CO6. Learn different temperature measuring techniques

LIST OF EXPERIMENTS

1. Calibration of Vernier / Micrometer / Dial Gauge
2. Measurements using linear measurement tools/Vernier/Inside Micrometer/Depth gauge/Height Gauge (Checking Dimensions of part using slip gauges)
3. Measurements of Gear Tooth dimensions
4. Measurement of Angle using sine bar / sine center / tool maker's microscope
5. Measurement of straightness and flatness
6. Measurement of thread parameters
7. Setting up of comparators for inspection (Mechanical / Pneumatic / Electrical)
8. Measurement of Temperature using Thermocouple / Pyrometer
9. Measurement of Displacement
10. Measurement of Force Measurement of Torque Measurement of Vibration / Shock

Total Periods: 45

LIST OF EQUIPMENTS
(For a batch of 30 students)

1.	Micrometer	5 Nos.
2.	Vernier Caliper	5 Nos.
3.	Vernier Height Gauge	2 Nos.
4.	Vernier Depth Gauge	2 Nos.
5.	Slip Gauge Set	1 No.
6.	Gear Tooth Vernier	1 No.
7.	Sine Bar	2 Nos.
8.	Bevel Protractor	1 No.
9.	Floating Carriage Micrometer	1 No.
10.	Profile Projector	1 No.
11.	Mechanical Comparator	1 No.
12.	Temperature Measuring Setup	1 No.
13.	Displacement Measuring Setup	1 No.
14.	Force Measuring Setup	1 No.
15.	Torque Measuring Setup	1 No.
16.	Vibration / Shock Measuring Setup	1 No.

Evaluation Criteria & Marks	Continuous Assessment (30)			End Semester Examination	Total Marks
	Lab. Exercise (60%)	Model Exam (30%)	Attendance (10%)		
	18	9	3	70 [Min Pass: 35]	100 [Min Pass: 50]
Attendance Mark	90% and above – 10, 86-90% - 8, 81-85% - 6, 76-80% - 4, 75% - 2				
Grade Criteria	O(90-100), A+(80-89), A(70-79), B+(60-69), B(55-59), C(50-54), U (<50)-Fail				

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3				1				2				3			
CO2	3	3							2				3		1	
CO3	3	2			1				3							
CO4	3	2			2				3							1
CO5	3	3							3				1	2	1	
CO6	3	3							3				3		1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

LECTURE PLAN

191ME37	METROLOGY AND MEASUREMENTS LABORATORY	L-T-P	C
		0-0-3	2

Programme: B.E. Mechanical Engineering **Sem:** 4 **Category:** PC

Aim: To learn the methods of handling different measuring instruments

Course Outcomes:

The students will be able to

CO1. Calibrate linear and angular measurement instruments
CO2. Check straightness, flatness using dial gauge
CO3. Measure screw and gear parameters
CO4. Handle vibration and displacement measuring instrument
CO5. Use the force and torque measuring tools
CO6. Learn different temperature measuring techniques

LIST OF EXPERIMENT

Sl. No.	List of Experiment	Periods	Cumulative Periods
1	Study of Metrology	1	1
2	Calibration of Vernier Caliper	2	3
3	Calibration of Micrometer	3	6
4	Calibration of Dial Gauge	3	9
5	Measurement of chordal tooth thickness of a gear wheel using gear tooth vernier caliper	3	12
6	Measurement of angles using sine bar	3	15
7	Floating carriage micrometer	3	18
8	Measurement of dimension of specimen using vernier height gauge	3	21
9	Measurement of temperature using PRTD	3	24
10	Measurements of temperature using thermocouple	3	27
11	Measurement of torque using reaction type torque transducer	3	30
12	Force measurement	3	33
13	Vibration measurement	3	36
14	Measurement of screw thread parameters using optical profile projector	3	39
15	Measurement of screw thread parameters using tool maker's microscope	3	42
16	Measurement of depth and inner diameter of specimens	3	45
		TOTAL PERIODS	**45**

MODES OF DELIVERY

Course Name with Code	Course Content						
	Lab Manual	Viva Questions	PPT	Videos	Group Activity (Quiz, Case Studies and others)	Industrial Training/ Industrial visit	Mini Project
191ME37- Metrology and Measurements Laboratory	✓	✓	✓	✓	✓	✓	

General instructions to the students

- Do not touch anything with which you are not completely familiar. Carelessness may not only break the valuable equipment in the lab but may also cause serious injury to you and others in the lab.
- Follow instructions precisely as instructed by your supervisor.
- Do not start the experiment unless your setup is verified & approved by your supervisor.
- Do not leave the instruments unattended while in progress.
- Do not crowd around the equipment & run inside the laboratory.
- During experiments material may fail and disperse, maintain a safe distance from the experiment.
- If any part of the equipment fails while being used, report it immediately to your supervisor. Never try to fix the problem yourself because you could further damage the equipment and harm yourself and others in the lab.
- As far as possible highly finished surfaces should not be touched by hand because the natural acids on the skin are likely to corrode the surfaces and also the temperature of the body may upset the dimensions of precision instruments.
- Keep the work area clear of all materials except those needed for your work and cleanup after your work.

INDEX PAGE

Ex. No.	Name of the Experiment	Date		Marks Obtained	Signature
		Conduction	Submission		

INTRODUCTION OF METROLOGY

Introduction

Metrology is a science of measurements and the measurement is the language of science. It is divided depending upon the quantity like metrology of length, metrology of time etc., Also, it is divided depending upon the field of application as Industrial metrology, Medical metrology etc.,

Metrology is mainly concerned with

1. Establishing the units of measurements, reproducing these units in the form of standards and ensuring the uniformity of measurement.
2. Developing methods of measurement
3. Analyzing the accuracy of methods of measurement, reaching into the causes of measuring errors and eliminating these.
4. Design, manufacturing and testing of gauges of all kinds
5. measuring instruments and devices

Dynamic Metrology:

It is concerned with measuring small variations of continuous nature: Ex: Temp, pressure

Legal Metrology:

It is concerned with units of measurement, methods of measurement and the measuring instruments, in relation to the statutory technical and legal requirements. It is directed by National Organization is called National Service of Legal Metrology (NSLM). Its object is to maintain uniformity of measurement throughout the world.

Function of Legal Metrology are – to ensure conservation of national standards, to guarantee their accuracy by comparison with international standards, to impart proper accuracy to the secondary standards of the country by comparison with national standards and to carryout technical and scientific works.

Deterministic Metrology:

This is a new philosophy is which, part measurement is replaced by process measurement. In deterministic metrology, full advantage is taken of the deterministic nature of production machines and all of the manufacturing sub-systems are optimized to maintain deterministic performance within acceptable quality levels.

Passive Metrology:

Checking the components by using gauges is Passive metrology.

Active Metrology:

Checking the gauges with instruments is Active metrology.

Need of Inspection:

Inspection can be defined as the process of checking the materials, whether they satisfy design standards. The need of inspection can be summarized as:

- To ensure that the part confirms to the established standard
- To meet the interchange ability of manufacture
- To maintain customer relation by ensuring that no faulty product reaches the customers
- Helps purchase of good quality raw materials, tools, equipment etc.,
- It gives necessary steps, so as to produce acceptable parts and reduce scrap

Physical Measurements:

It is defined as the act of deriving quantitative information about a physical object or action by comparison with a reference.

There are 3 important elements of measurement:

1. Measurandss – physical quantity or property like length, angle etc., being measure
2. Comparison (or) Comparator – the means of comparing measured with some reference to render a judgment
3. Reference: The physical quantity or property to which quantitative comparisons made.

Ex: Surface Table (Measurand), Scale or steel rule (Reference), Comparison by eye (Comparator)

Measuring System:

A measuring system is made of five basic elements (SWIPE). These are

Standard	-	S
Work piece	-	W
Instrument	-	I
Person	-	P
Environment	-	E

Measuring Instruments:

These are measuring devices that transform the measured quantity or a related quantity into an indication or information. It can indicate either directly the value of the measured quantity or only indicated its equality to a known measure of the same quantity (equal arm balance, or null detecting galvanometer).

CHARACTERISTICS OF MEASURING INSTRUMENTS (DEFINITIONS):

Measuring Range:
It is the range of values of the measured quantity. The error does not exceed the maximum permissible error. It is limited by the maximum capacity (upper limit) and minimum capacity (minimum limit). It may or may not coincide with the range of scale indication.

Scale Interval:
It is the difference between two successive scale marks in units of the measured quantity. It is an important parameter that determines the ability of the instrument to give accurate indication of the value of the measured quantity.

Discrimination:
It is the ability of the measuring instrument to react to small changes of the measured quantity.

Hysteresis:
It is the difference between the indications of a measuring instrument when the same value of the measured quantity is reached by increasing or by decreasing that quantity. It is due to the presence of dry friction as well as to the properties of elastic elements. It results in the loading and unloading curves of the instrument being separated by a difference called the Hysteresis error. Hysteresis results in the pointer not returning completely to zero when the load is removed. Hysteresis in materials is due to presence of internal stresses. It reduced by proper heat treatment.

Response Time:
It is the time which elapses after a sudden change in the measured quantity until the instrument gives an indication differing from the true value by an amount less than a given permissible error. It is an exponential curve. It the inertia forces are not negligible; we get second order response. There are 3 possibilities. Those are Over damped system, under damped system and critically damped.

Bias:
It is the characteristics of a measure or a measuring instrument to give indications of the value of a measured quantity whose average differs from the true value of that quantity.

Inaccuracy:
It is the total error of a measure or measuring instrument under specified conditions of use and including bias and repeatability errors. This inaccuracy is called the “Uncertainty of measurement”.

Accuracy Class:
Measuring instruments are classified into accuracy classes according to their metrological properties. There are two methods for classifying instruments into accuracy classes.

- Expressed by a class ordinal number that gives an idea but no direct indication of the accuracy. (Ex: block gauges 0, 1, 2, etc.)
- Expressed by a number stating the maximum permissible inaccuracy as % of the highest indication given by the instrument. (Ex: ±0.2 ie., 0.2 for 0 – 100)

Precision:
It is the repeatability of the measuring process. It refers to the group of measurements for the same characteristics taken under identical conditions. If the instrument is not precise it will give different results for the same dimension when measure again and again.

Accuracy:
It is the agreement of the result of measurement with the true value of the measured quantity. For good accuracy avoid errors in manufacture and in measuring those errors during inspection. Highly accurate instrument possesses both great sensitivity and consistency. But the instrument which is sensitive and consistence need not necessarily be accurate. Higher the accuracy, higher will be the cost. According to the thumb rule, the instrument accuracy is more than component accuracy. In calibration, accuracy of master instrument is more than instrument accuracy (approximately by 10 times).

Error:
Error is the difference between true value and the measured value. It the error is less, accuracy will be more.

Repeatability:
It is the ability of the measuring instrument to give the same value every time the measurement of a given quantity is repeated, when the measurement are carried out - by the same observer, with the same instrument, under the same conditions, without any change in location, without change in method of measurement. And the measurements are carried out in short intervals.

Sensitivity:
Sensitivity refers to the ability of measuring device to detect small differences in quantity being measured. It is ratio of the scale spacing to the scale division value. It is also called amplification factor or gearing ratio. It may by constant (linear scale) or variable (non-linear scale) along the scale.
High sensitivity instruments may lead to drifts due to thermal or other effects and less repeatable or less precise.

Readability:
Readability refers to the ease with which the reading of a measuring instrument can read. It is the susceptibility of a measuring device to have its indications converted into meaningful number. Fine and widely spaced graduation lines improve the readability. By using magnifying devices, the readability improves.

Magnification:
Magnification means increasing the magnitude of output signal of measuring instrument many times to make it more readable. The magnification is possible on mechanical, pneumatic, optical, electrical principles or combination of these.

Reproducibility:
Reproducibility is the consistency of pattern of variation in measurement i.e., closeness of the agreement between the result of measurement of the same quantity, when by different observers, by different methods, using different instruments, under different conditions, locations, times etc.,,

Calibration:

The calibration of any measuring system is very important to get meaningful results. It measures the quantity in terms of standards unit. It is carried out by making adjustments such that readout device produces zero output for zero measured input. It should display an output equivalent to the known measured input near the full scale input value.

Accuracy of the instrument depends upon the calibration. Calibration depends upon the severity of use, environmental conditions and accuracy of measurement required etc.,

Traceability:

Concept of establishing a valid calibration of a measuring instrument of measurement standard by step by step comparing with better standards up to acceptable specified standards

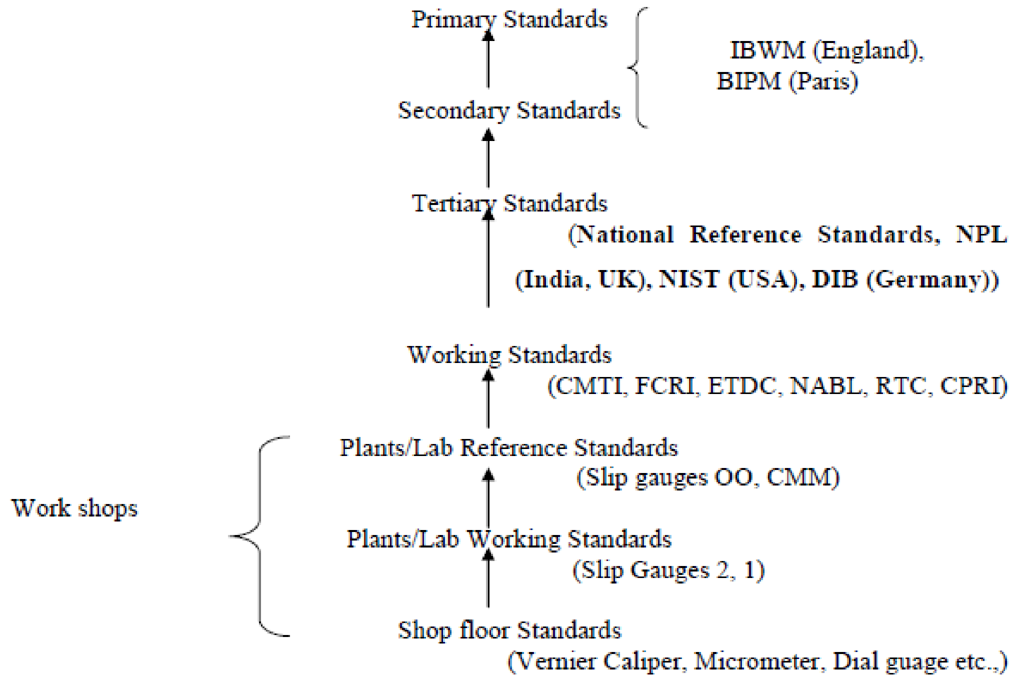
Uncertainty:

Uncertainty is a parameter to quantify the reliability of mesurand. Uncertainty of measurement determines the measurement capability of a laboratory.

STANDARD:

A standard is defined as something that is setup and established by authority as rule for measurement of quantity, weight, extent, value or quality etc., any system of measurement must be related to known standard otherwise the measurement has no meaning. The role of standards is to support the system which makes uniform measurement throughout the world and helps to maintain interchangeability in mass production.

Sub-Division of Standards:



Measurement:

In industries, various quantities like length, width and other parameters are expressed in meaningful numbers by comparing them with standards. This result of quantitative comparison of unknown magnitude with the pre-determined standard is called measurement.

Gauging:

Gauging is the method of checking the dimensions of manufactured parts and it does not indicate the actual value of the inspected dimension on the work and also used for determining as to whether the inspected parts are made within the specified limits.

SOURCES OF ERRORS:

Error is the difference between the actual value and the indicated value of the measured quantity. Errors may be classified in the following ways:

I. a) Static Errors – result from the physical nature of various components of the measuring system Ex: Internal imperfections, environmental effects, calibration effects, reading errors etc.,

b) Dynamic Errors – result by time variations in the measurand like inertia, clamping friction or other physical constraints in the measuring system.

II. Controllable or systematic or fixed errors:

- Calibration errors
- Ambient conditions
- Stylus pressure
- Random or accidental errors

III. Illegitimate Errors:

- Blunders or mistakes
- Computational errors
- Chaotic errors

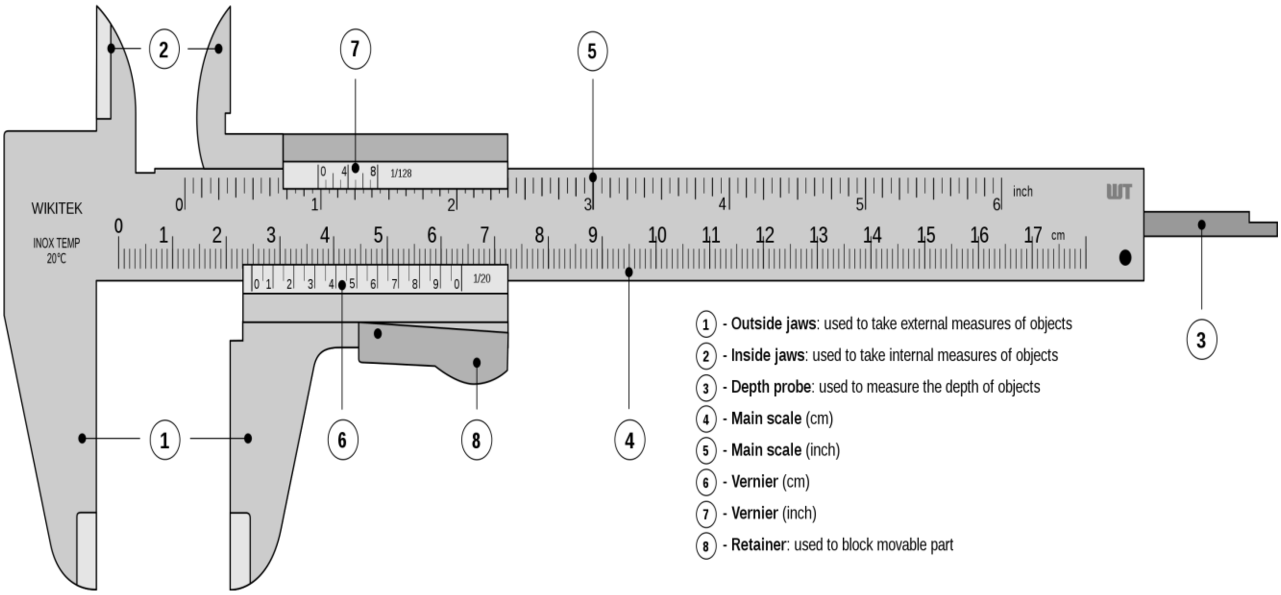


Figure 1 Vernier Caliper

Tabulation:

Sl. No.	**Nominal Dimension (ND) mm**	**Main Scale Reading (MSR) in mm**	**Vernier Scale Coincidence (VSC)**	**Measured Dimension (MD) mm**	**Error =MD-ND mm**
				Average Error	

Range =
Span =
Least Count =
Scale =
Zero Error =
Zero correction =

EX.NO: **CALIBRATION OF VERNIER CALIPER**
DATE:

Aim:

To calibrate the given vernier caliper using slip gauge as standard specimen.

Apparatus Required:

- Vernier Caliper
- Set of Slip gauges

Formula Used:

MD = MSR + (VSC x LC)

where,

MD	–	Measured Dimension
MSR	–	Main Scale Reading
VSC	–	Vernier Scale Coincidence
LC	–	Least Count
ZC	–	Zero Correction

Description:

The principle of vernier caliper is that when two scales or divisions slightly different in size are used, the difference between them can be utilized to enhance the accuracy of measurement. The vernier caliper essentially consists of two steel rules namely main scale and vernier scale and vernier scale can slide over the main scale. The main scale is engraved on a solid L-shaped frame and the vernier scale has got 50 divisions. One end of the frame contains a fixed jaw, which is shaped into a contact tip at its extremity. A sliding jaw which moves along the guiding surfaces provided by the main scale is coupled to a vernier scale. The sliding jaw at its left extremity contains another measuring tip. When two measuring tip surfaces are in contact with each other, the scale shows zero reading. The linear adjustment of the movable jaw can be done by the adjusting screw.

Procedure:

1. find out the least count of the Vernier caliper.
2. Select a standard slip gauge and place it between the fixed and movable jaws of the Vernier caliper.
3. Note down the Main scale reading.
4. Note down the Vernier scale Coincidence and find out the Measured Dimension.
5. Repeat the above steps for different slip gauge combinations and tabulate the error.

Result:

Error =

Mark	
Signature of the staff	

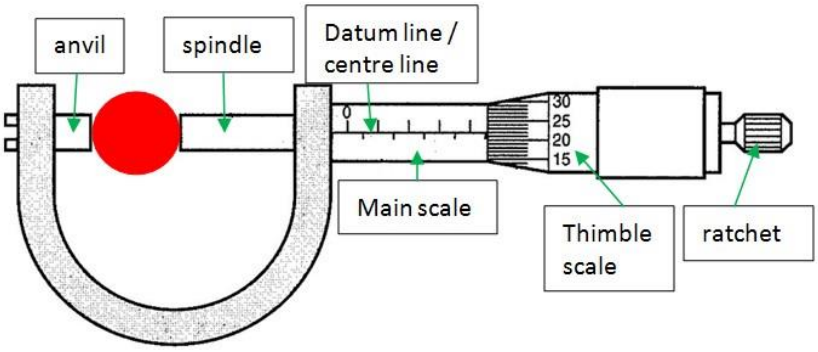


Figure 2 Micrometer

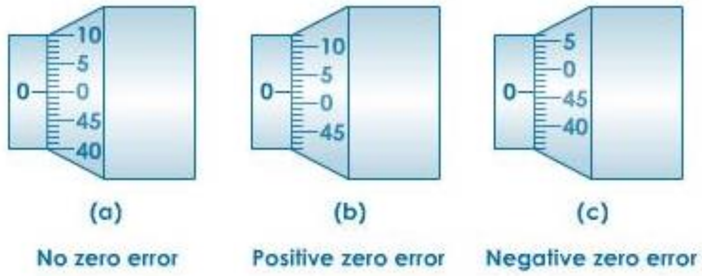


Figure 3 Types of error in Micrometer

Tabulation:

Sl. No.	Nominal Dimension (ND) mm	Main Scale Reading (MSR) in mm	Pitch Scale Coincidence (PSC)	Measured Dimension (MD) mm	Error =MD-ND mm
				Average Error	

Range =

Span =

Least Count =

EX.NO: **CALIBRATION OF MICROMETER**
DATE:

Aim:

To calibrate a given micrometer using slip gauge as standard specimen

Apparatus Required:

- Micrometer
- Set of slip gauges

Formula Used:

MD = MSR + (PSC x LC)

where,

MD	–	Measured Dimension
MSR	–	Main Scale Reading
PSC	–	Pitch Scale Coincidence
LC	–	Least Count
ZC	–	Zero Correction

Description:

The micrometer essentially consists of an accurate screw having about 10 or 20 threads per cm and revolves in a fixed nut. The end of the screw forms one measuring tip and other measuring tip is constituted by stationary anvil in the base of the frame. The screw is threaded for certain length and is plain afterwards. The plain portion is called sleeve and its end is the measuring surface. The spindle is advanced or retracted by turning a thimble which is connected to the spindle. The spindle is a slide fit over the barrel and barrel is the fixed part attached with the frame. The barrel is graduated in units of 0.05 cm. The thimble has got 25 divisions around its periphery on circular portion. A locknut is provided for locking a dimension by preventing motion of spindle. Ratchet stop is provided at the end of the thimble cap to maintain sufficient and uniform measuring pressure so that standard conditions of measurement are attained. Ratchet stop consists of an overriding clutch held by a weak spring. When the spindle is brought into contact with the work at correct measuring pressure, the clutch starts slipping and no further movement of the spindle takes place by rotation of ratchet.

Procedure:

- Check the micrometer for the smooth running over its whole range.
- Clean the anvil and spindle carefully.
- Close the anvil and spindle and note the zero error
- Calculate the least count.
- Determine the progressive error, of the micrometer by choosing standard slip gauges for the whole range (0-25mm). Let the increment in the initial and final range be kept as small as possible.
- Determine the periodic error of the micrometer

Result:

Error =

Mark	
Signature of the staff	

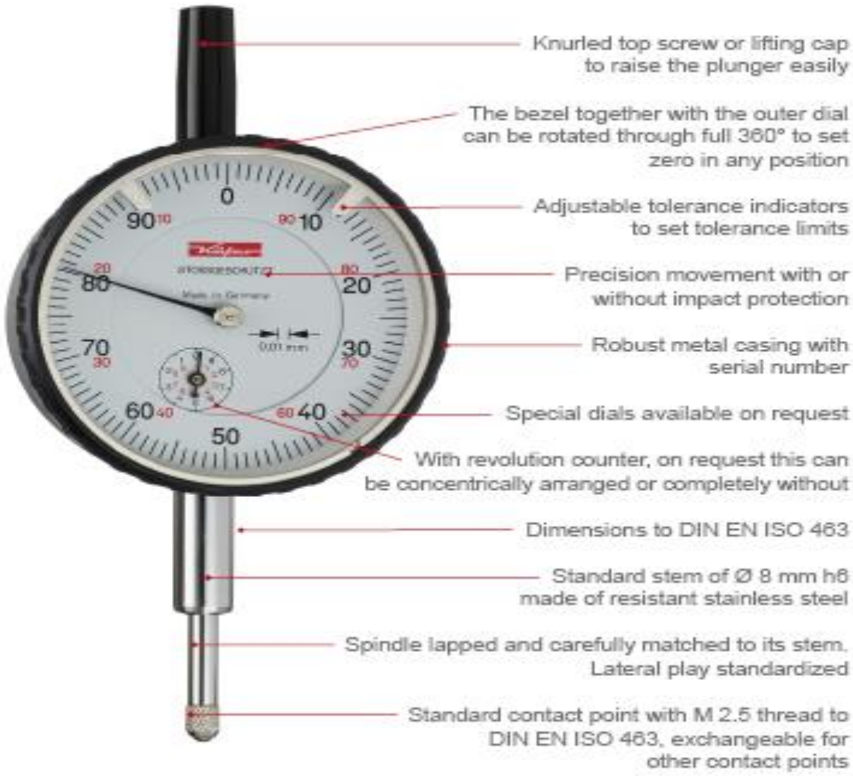


Figure 4 Dial Gauge

Tabulation:

Sl. No.	**Slip Gauge Reading (S) mm**	**Observed Value (O) mm**	**Error = S – O mm**
		Average Error	

Range =

Span =

Least Count =

=

EX.NO: **CALIBRATION OF DIAL GAUGE**
DATE:

Aim:
To calibrate the given dial gauge using slip gauge.

Apparatus Required:
- Dial gauge
- Slip gauge
- Magnetic Base

Theory:
Both micrometer and vernier scale instruments are capable of direct reading. There are, however another range of instruments used in the measurement of components. They are collectively known as comparators. One such comparator is a dial test indicator (or) dial gauge indicator (or) clock gauge.

The DTI is a mechanical device for sensing linear variation. It measures the displacement of its plunger or a stylus on a circular dial by means of a rotating pointer. Generally it consists of a rack and pinion mechanism. The main scale is graduated into equal divisions. One complete revolution of the pointer corresponds to 1mm of plunger movement. Hence it is obvious that pointer movement from mark 10 to mark 20 or mark 20 to mark 30 and so on indicates a plunger movement of 0.1 mm.

This type of instrument has a longer plunger movement and is scaled with a secondary scale and pointer (or a smaller dial) to indicate the number of complete revolutions turned through. One revolution is equivalent to 1mm of the plunger movement. This secondary scale is also popularly known as revolution counter.

To enable the instrument to be zero for any convenient position, the main scale can be rotated and locked into place using the scale locking screw (bevel clamp) indicated in figure.

Procedure:
- Initially set the pointer of the dial gauge at zero reading.
- When the platform and tip of the plunger are in perfect touch with each other, lift the plunger and place a selected slip gauge.
- After placing the slip gauge between the plunger and platform, find the error.
- Likewise place selected slip gauges and tabulate the readings.

Result:

Mark	
Signature of the staff	

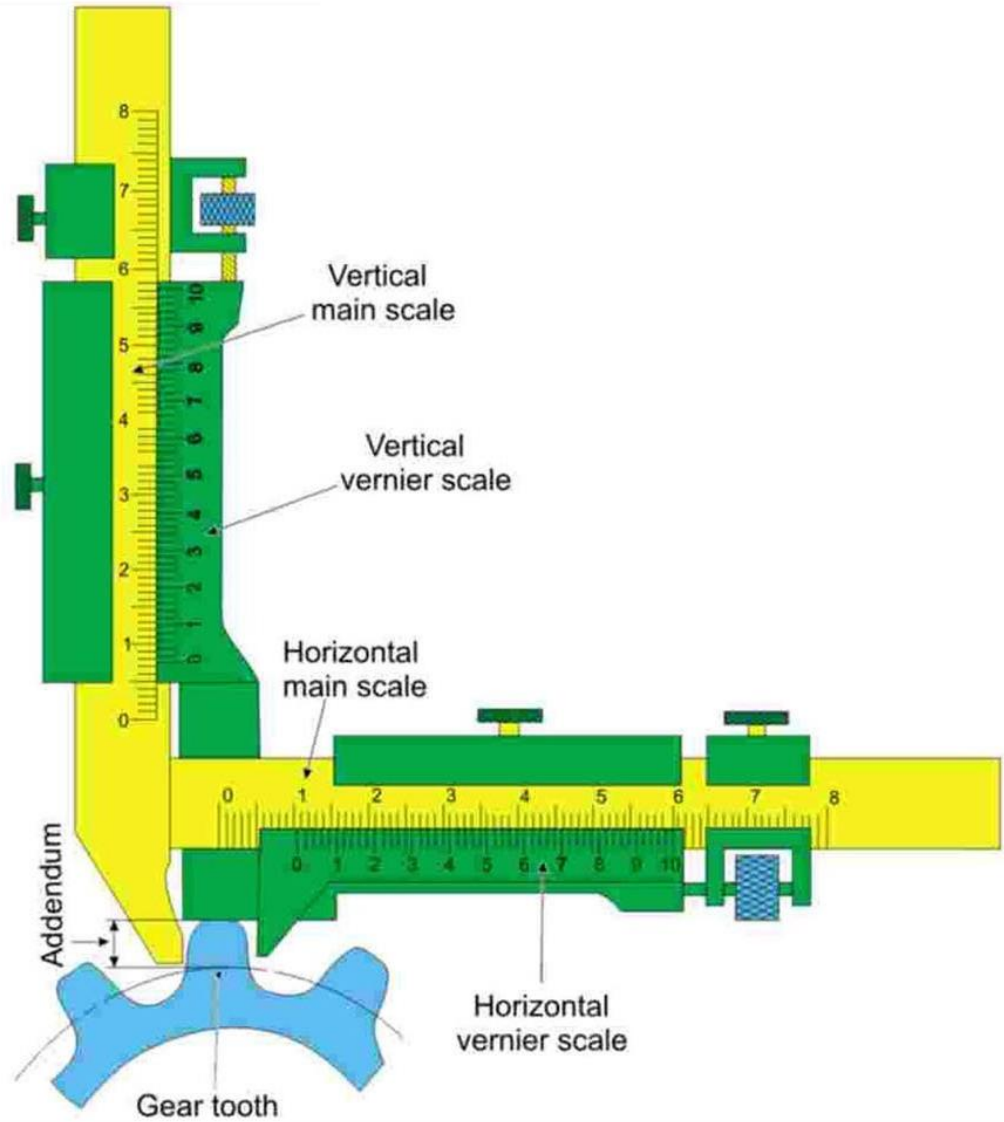


Figure 5 Gear tooth Vernier Caliper

Tabulation:

Specimen No.	No. of teeth	Height of chordal addendum mm	Trial No.	Chordal thickness value mm	Average mm

EX.NO: **MEASUREMENT OF CHORDAL TOOTH THICKNESS OF A**
DATE: **GEAR WHEEL USING GEAR TOOTH VERNIER CALIPER**

Aim:

To measure the chordal tooth thickness of a given gear wheel using a gear tooth vernier caliper.

Apparatus Required:

- Gear tooth vernier
- Spur gear specimen.

Description:

Gear tooth vernier consists of two vernier caliper namely horizontal and vertical slides. It is based on the principle of vernier caliper. The thickness of a tooth at pitch line and addendum are measured independently by adjusting the slide screws on a graduated beam.

Theory:

Theoretical value of chordal thickness and chordal addendum of a gear tooth can be found using the following expressions.

Chordal thickness W = T x M x sin (90/T)

Chordal Addendum d = M + [[(T x M)/2][1-cos(90/T)]]

Where M = Module, T = No. of teeth

Procedure:

- Count the number of teeth on the gear wheel.
- Find the outer diameter of the gear wheel using a vernier caliper.
- Calculate the module of the gear using expression

  Module (M) = Outer diameter / (No. of teeth +2)
- Calculate the chordal addendum using the formula given above.
- Set the chordal addendum value in the vertical scale of the vernier gear tooth vernier caliper.
- Now the vernier scale is made to rest on the top of the tooth under test.
- The jaw of horizontal vernier is made to touch the sides of the tooth which will automatically be on the pitch line.
- Note the reading on the horizontal vernier which will give the value of chordal thickness.
- Repeat the same for some other tooth on the wheel and calculate the average of the values.

Result:

Mark	
Signature of the staff	

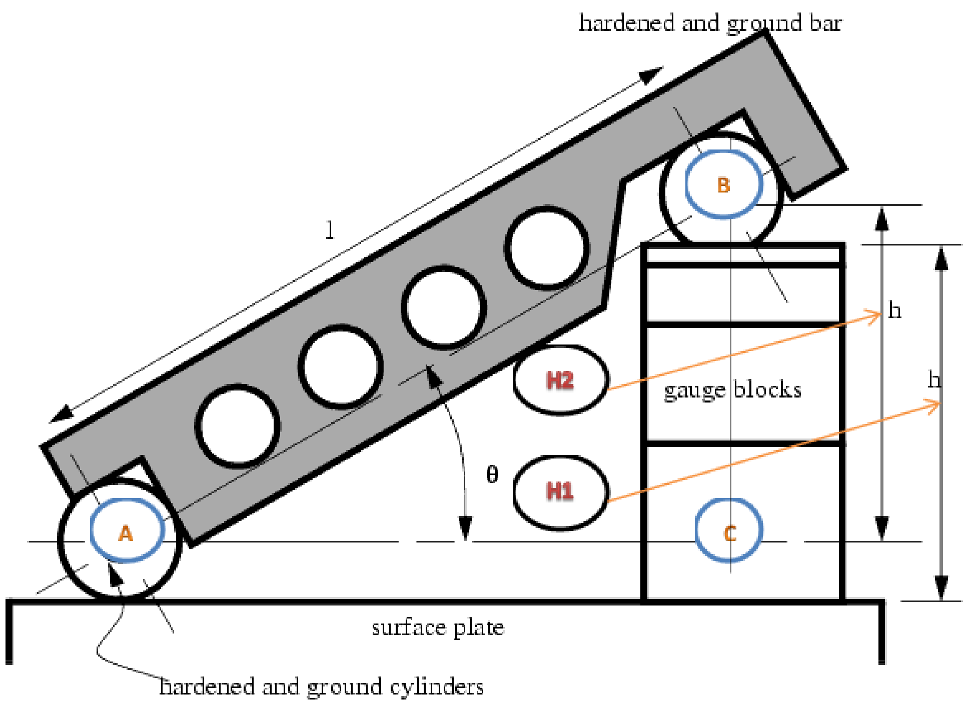


Figure 6 Sine bar

Tabulation:

Sl. No.	Specimen No.	Slip gauge reading		Taper angle of the plate
		Height of slip gauge (h) mm	Length of sine bar (l) mm	

EX.NO: **MEASUREMENT OF ANGLES USING SINE BAR**
DATE:

Aim:

To estimate the taper angle of the given work piece using a sine bar

Apparatus required:

- Sine bar
- Slip gauge
- Dial gauge with stand
- Surface plate

Theory:

The sine bar is one of the most widely used instruments for precision measurement of angles. It consists of a rectangular section bar of suitable grade steel having accurate ground pin of equal diameter. The sine bar works on the principle that in a right angled triangle if the length of the hypotenuse is kept constant, the sine of the different angles can be obtained by varying the length of the of the perpendicular.

$$\theta = \sin^{-1}(h/l)$$

Where h = height of slip gauge in m

l = centre to centre distance of the rollers of the sine bar in m.

Procedure:

- Clean the surface plate, sine bar and work piece thoroughly.
- Place the sine bar piece on the work piece placed on the surface plate.
- Add slip gauges at the bottom of any of the rollers in the sine bar to make the surface of the bottom of sine bar flat on the work piece.
- Note the height of the slip gauge.
- Calculate the angle of the work piece using the formula given above.

Result:

Taper angle of the given work piece =

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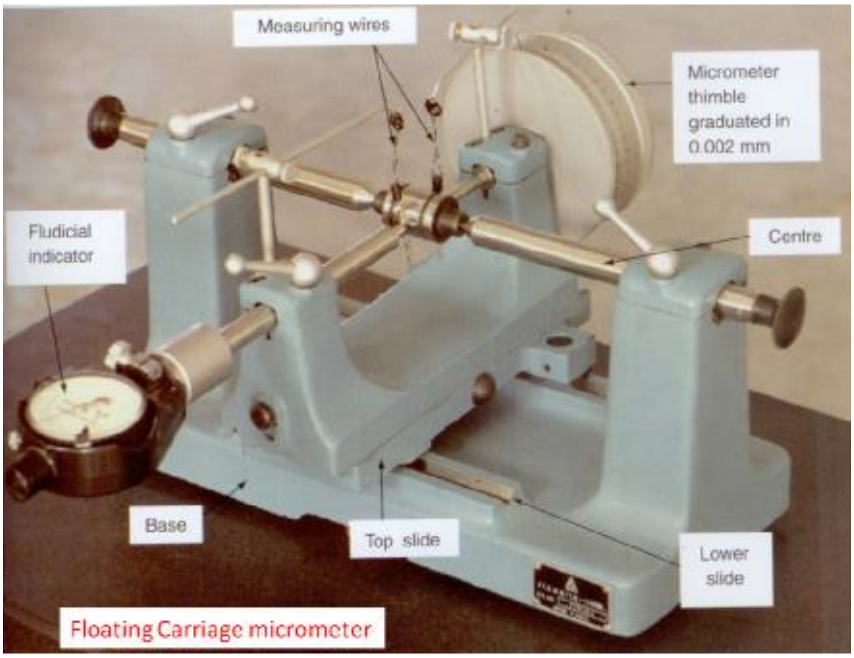

Figure 7 Floating Carriage Micrometer

Observation:

Master Reading =
Major diameter =
Effective Diameter = T + P
M = Dimension over the wire

d =

T = (R – S) + master reading
=

P = 0.866 * pitch – wire diameter
=

E = T + P
=

EX.NO: **FLOATING CARRIAGE MICROMETER**
DATE:

Aim:

To measure the major diameter and effective diameter of the given screw thread using floating carriage micrometer.

Apparatus Required:

- Floating carriage micrometer
- Screw thread
- Standard Cylinder
- Wires

Theory:

The diameter of imaginary cylinder which just embraces the crest of the external thread or root of an internal thread is called major diameter. The diameter of the setting master cylinder should be nearly same as the diameter of thread gauge. The advantage of using setting master gives similar contact at anvils and reduces error in measurement. The setting master is held between centres. Take the reading of the diameter, say this reading R_1. The master cylinder is then replaced by a threaded work piece and again second reading is taken, say this reading is R_2. It is the addition of R_1 and R_2. The positive and negative values are determined by relative size of master and two work pieces.

Procedure:

- Make sure the balls are placed on the bottom properly and place the floating top on assembly.
- Fix the dial gauge to zero reading.
- Move the thimble of the micrometer such that the spindle and anvil touch each other and ensure zero reading of the dial gauge.
- Set the zero reading in the digital reading placed on the top.
- Fix the master piece between the anvils and move the micrometer such that anvil and spindle of the micrometer touches each other and note down the digital reading by ensuring there is no deflection on the dial gauge.
- Now place the screw thread whose effective diameter is to be measured in between the anvil and spindle and place the wires in between the opposite faces of the screw thread and note down the digital readings by ensuring there is no deflection in the dial gauge.

Result:

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Signature of the staff	

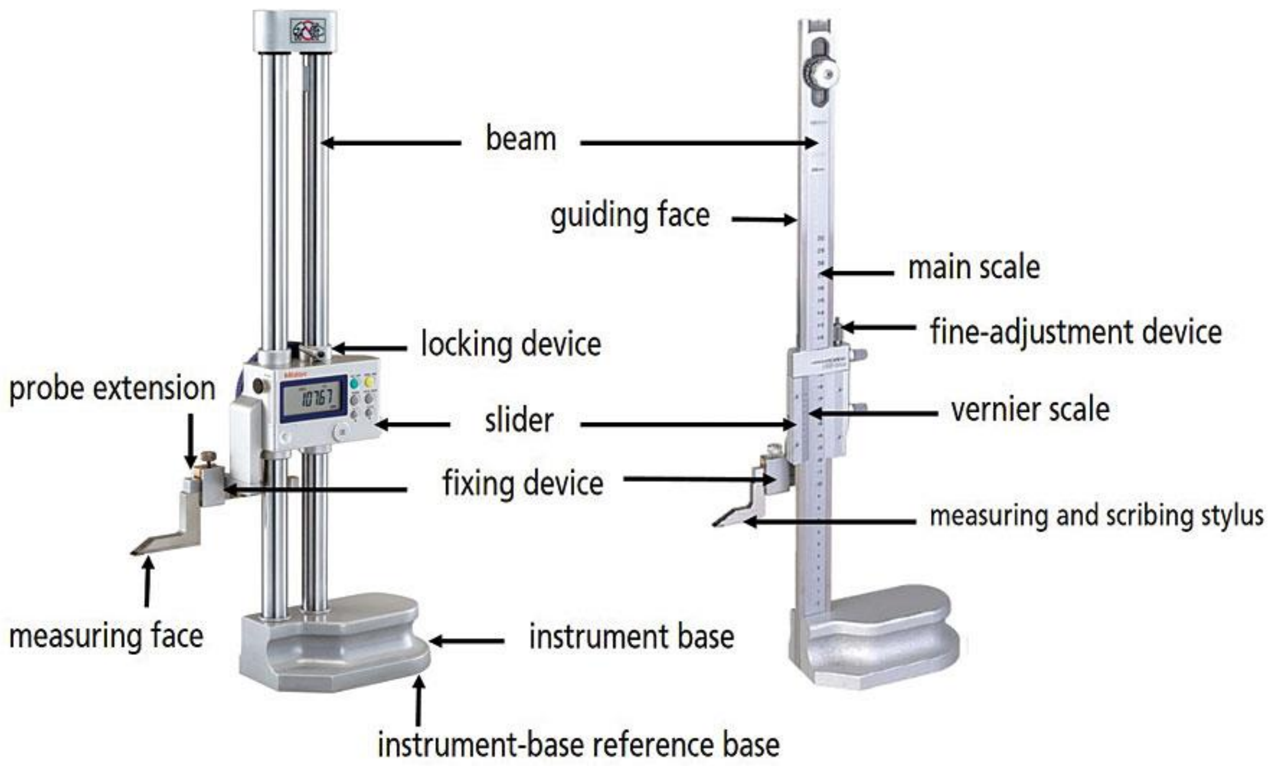

Figure 8 Vernier Height Gauge

Tabulation:

Specimen No.	Trial No.	Main Scale Reading mm	Vernier Scale Coincidence	Total Reading= MSR + (VSC x LC) mm	Average mm

Range =

Span =

Least Count =

Zero Error =

s

EX.NO: **MEASUREMENT OF DIMENSION OF SPECIMEN USING VERNIER HEIGHT GAUGE**
DATE:

Aim:

To measure the dimensions of a specimen using Vernier height gauge

Apparatus Required:

- Vernier Height Gauge
- Specimen
- Surface plate

Description:

Vernier height gauge works on the principle that when two scale divisions slightly different in sizes are used, then the difference can be utilized to enhance the accuracy of measurement. It consists of two scales, the main scale and the vernier scale which will be engraved on the slider which slides throughout the main scale. This is also a vernier caliper but attached with a special base block and other attachments. The whole assembly is made in such a way to measure height of parts. A removable clamp is attached between measuring jaws and vernier. Both the upper and lower end of measuring jaws is parallel to the base of vernier height gauge. A scriber attachment is fitted to mark or scribe lines on the parts where required. The surface of surface plate is the datum or reference while doing measurements.

Procedure:

- Wipe the Vernier height gauge and specimen using a soft cloth.
- Check the Vernier height gauge for zero error.
- Loosen the locking screw and expand the measuring jaw to the approximate size of specimen.
- Place the specimen between the surface plate and the measuring jaw.
- Lock the locknut at the correct position.
- Note down the main scale and vernier scale readings.
- Repeat the procedure for various positions of the specimen.
- Tabulate the measured readings.

Result:

Height of the given specimen 1 =

Height of the given specimen 1 =

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Signature of the staff	

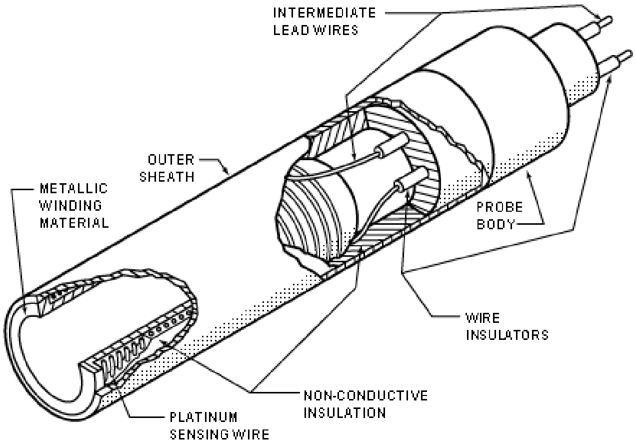

Figure 9 Platinum Resistance Temperature Detector

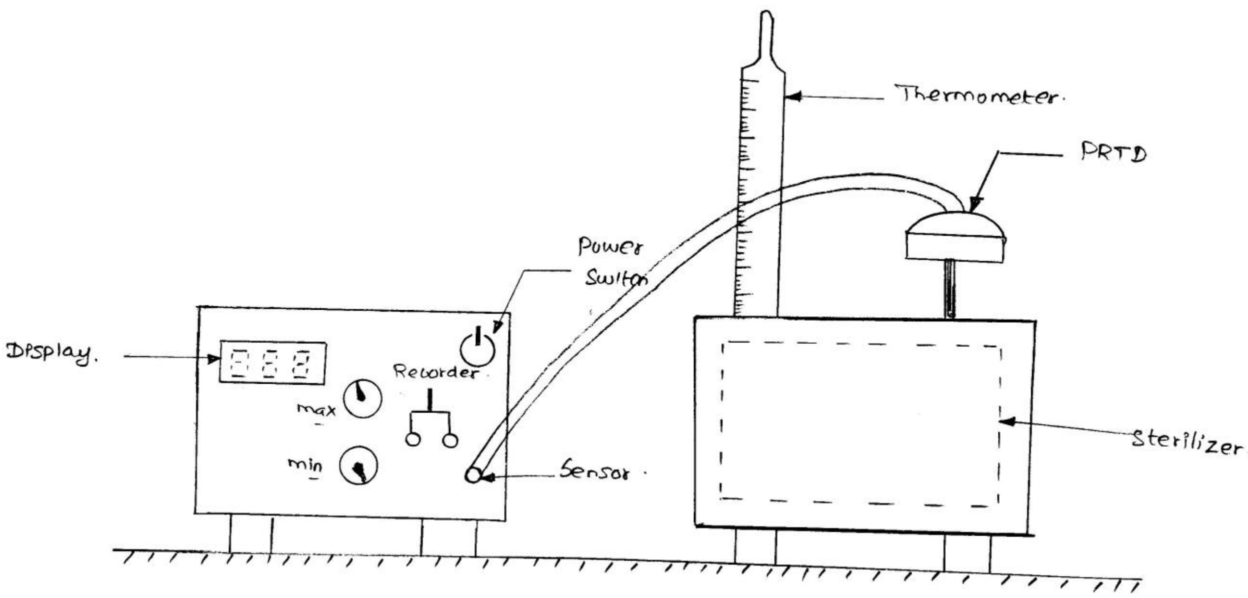

Figure 10 Platinum Resistance Temperature Detector setup

EX.NO: **MEASUREMENT OF TEMPERATURE USING PRTD**
DATE:

Aim:

To measure temperature using a PRTD

Apparatus Required:

- Temperature transducer
- Digital temperature indicator
- Thermometer
- Electric sterilizer

Description:

A glass or a metal tube has a ceramic mandrel on which resistance wire is wound. The lead wires of the resistance wire project out of the ceramic mandrel. This arrangement becomes the resistance thermometer. The leads of the resistance thermometer are connected to a wheat stone bridge. The glass or metal tube is evacuated or filled with inert gas to protect the resistance wire sensing elements from moisture.

Procedure:

- Select a PRTD.
- Connect a PRTD to the sensor socket provided at the front panel.
- Minimum position is set to read ambient temperature in PRTD.
- Insert the PRTD in the hot bath. Heat the water in the hot bath using electrical energy.
- The display shows the temperature of the hot batch directly in centigrade.
- If necessary, adjust the position for maximum level for temperature calibration.
- Note down the readings in PRTD and thermometer for a fixed span of drop in temperature.
- Note the thermometer and PRTD readings for fixed intervals of time.

Tabulation 1:
Drop in temperature = 2^0C

Sl. No.	Thermometer Reading (^{o}C)	Platinum Resistance Thermometer reading (^{0}C)

Tabulation 2:
Drop in temperature for time = 2 min

Sl. No.	Thermometer Reading (^{0}C)	Platinum Resistance Thermometer reading (^{0}C)

Result:

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Signature of the staff	

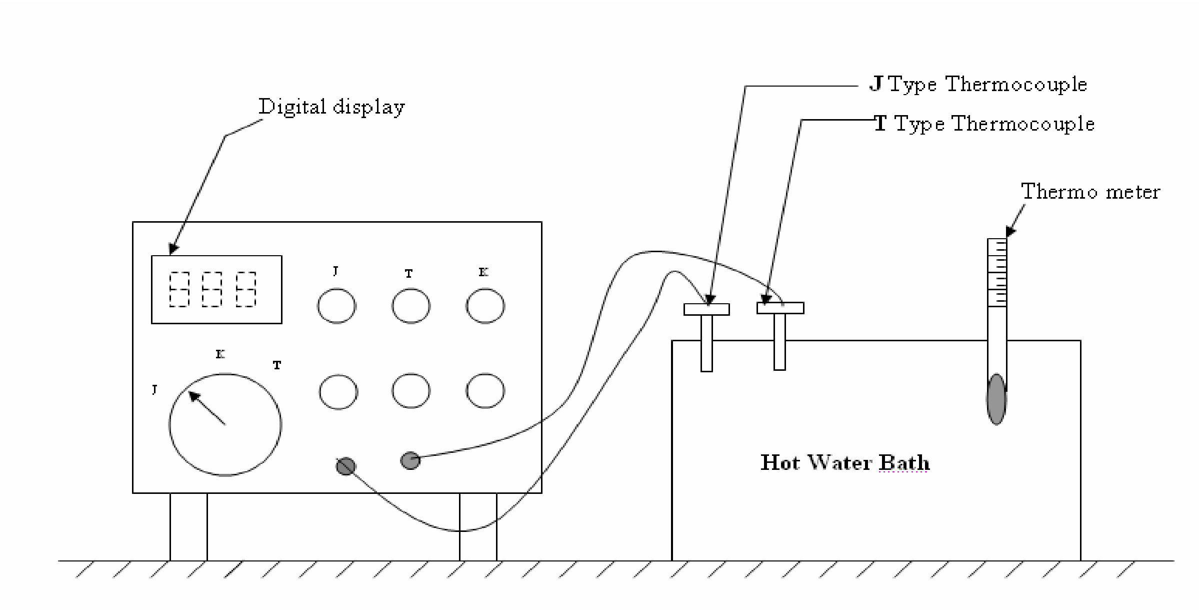

Figure 11 Measurements of temperature using thermocouple setup

Tabulation 1:

Drop in temperature = 2^0C

Sl. No.	Thermometer reading ^0C	J-Type Reading ^0C

Tabulation 2:

Drop in temperature for time = 2 min

Sl. No.	Thermometer reading ^0C	J-Type Reading ^0C

EX.NO: **MEASUREMENTS OF TEMPERATURE USING THERMOCOUPLE**
DATE:

Aim:

To measure temperature using J, K, T thermocouple transducer and a digital temperature indicator.

Apparatus Required:

- J,K,T Thermocouples
- Temperature Transducer
- Digital Temperature Indicator
- Thermometer
- Electric Sterilizer

Principle:

The principle used in thermocouples is called as the "Principle of thermo-electricity" or Seebeck effect. It states that "when two conductors of different metal A and B are joined together at one end to form a junction, and this junction is heated to a higher temperature with respect to the free ends, a voltage is developed at the free ends and if these two conductors of metals at the free ends are connected, then the emf setup will establish a flow of current".

Description:

The main parts of a thermocouple arrangement used to measure temperature are as follows. The thermocouple hot junction J_H will be introduced into the place where temperature is to be measured. The thermocouple cold junction J_C is maintained at a constant reference temperature. A voltage measuring instrument (which is usually millivoltmeter) is connected to the free ends of the thermocouple.

Procedure:

1. Select J/T type thermocouples using selector switch.
2. The selected thermocouple is connected to the sensor socket provided at the front panel.
3. Minimum potentiometer is set to read ambient temperature in display.
4. Keep the J/T type thermocouples inside the hot bath.
5. Heat the water in the hot bath using electrical energy.
6. The display shows the temperature in the hot bath directly in ^{o}C.
7. If necessary, adjust maximum point for maximum level temperature calibration.
8. Note indicator and thermometer readings for a fixed span of drop in temperature and for fixed intervals of time.

Result:

Mark	
Signature of the staff	

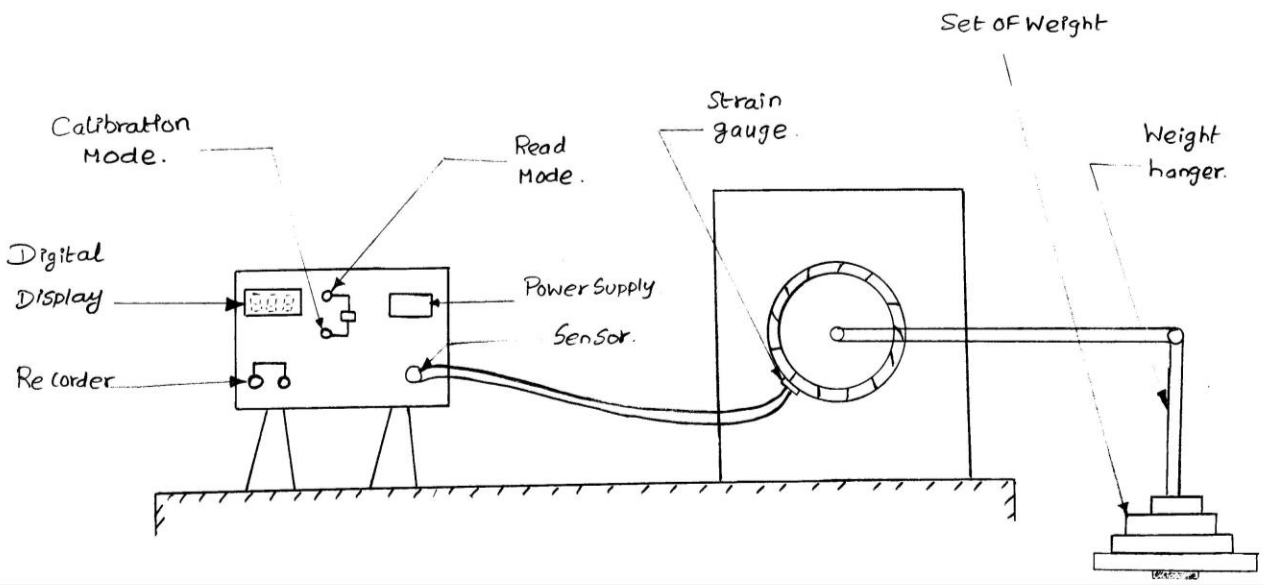

Figure 12 Measurements of torque using reaction type torque transducer setup

Tabulation:

Sl. No	Loading Condition				Unloading Condition			
	Applied load kg	Actual Torque kg-m	Indicated Torque kg-m	% of error	Applied load kg	Actual Torque kg-m	Indicated Torque kg-m	% of error

Model Calculation:

$$\% \text{ Error} = \frac{\text{Actual torque} - \text{Indicated torque}}{\text{Actual torque}} \times 100$$

Loading

Unloading

EX.NO: **MEASUREMENT OF TORQUE USING REACTION TYPE TORQUE TRANSDUCER**
DATE:

Aim:

To measure the torque generated for different loads by using a reaction type torque transducer.

Apparatus Required:

- Torque Transducer
- Digital Torque Indicator
- Dead Weights

Equipment Description:

Torque transducers convert twisting force to electrical signal. The sensor installed on fixed shafts is similar to load cells. A reaction type torque transducer system consists of a mechanical element and a sensor. A shaft with four strain gauges is mounted on two perpendiculars 45^0 helix is bent. Thus the two perpendicular 45^0 helix determines the principal stress and strain direction for a shaft of the reaction type torque sensor in the form of bridge. One end of the shaft is fixed and the other end is having a disc attached with the fulcrum arm of 1m length so that the obtained torque is in kg-m. This deflection caused by the strain gauge gives the O/P in mV. It is fed to the signal conditioner which is a sophisticated differential amplifier. This amplifies O/P to A/D converter and the display shows the torque directly in kg-m.

Procedure:

- Connect the sensor to the instrument using connection cable.
- Plug the main chord to the main supply and switch on the instrument.
- Keep the READ/CAL switch in read position and adjust the read potentiometer till the display shows 0.00
- Keep the READ/CAL switch to CAL position and turn the CAL potentiometer till the display reads 10.00.
- Keep the READ/CAL switch in READ position and ensure that it reads 0.00.
- Apply the loads to the fulcrum ends by adding dead weight in steps of 1 kg until 10 kg and removing weights in steps of 1 kg until there is no dead weight on the platform.
- Tabulate the display readings for each addition and removal of dead weights.

Result:

Inference:

Mark	
Signature of the staff	

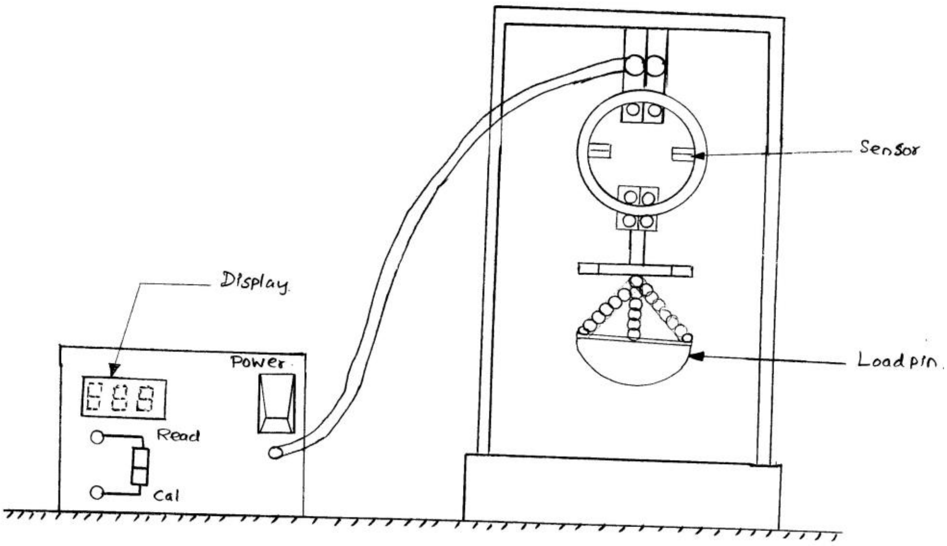

Figure 13 Force measurement setup

Tabulation:

Sl. No.	Loading			Unloading		
	Applied Force N	Indicated Force N	% Error	Applied Force N	Indicated Force N	% Error

Model Calculation:

Loading

Unloading

EX.NO: **FORCE MEASUREMENT**
DATE:

Aim:

To determine the applied force by using a force measurement instrument.

Apparatus Required:

- Force measuring setup
- Measuring weights

Procedure:

- Connect the setup to a power line and switch on the instrument.
- Adjust the zero potentiometer till the display unit reads zero.
- Change the READ/CAL switch to CAL position using toggle switch.
- Adjust the CAL potentiometer till the display unit reads 250.
- Change the READ/CAL switch to READ position using toggle switch and ensure it to read zero again.
- Apply the load on the pan and note down the readings of force in N during loading and unloading.

$$\% \text{ Error} = \frac{\text{Applied force} - \text{Indicated force}}{\text{Applied force}} \times 100$$

Result:

Inference:

Mark	
Signature of the staff	

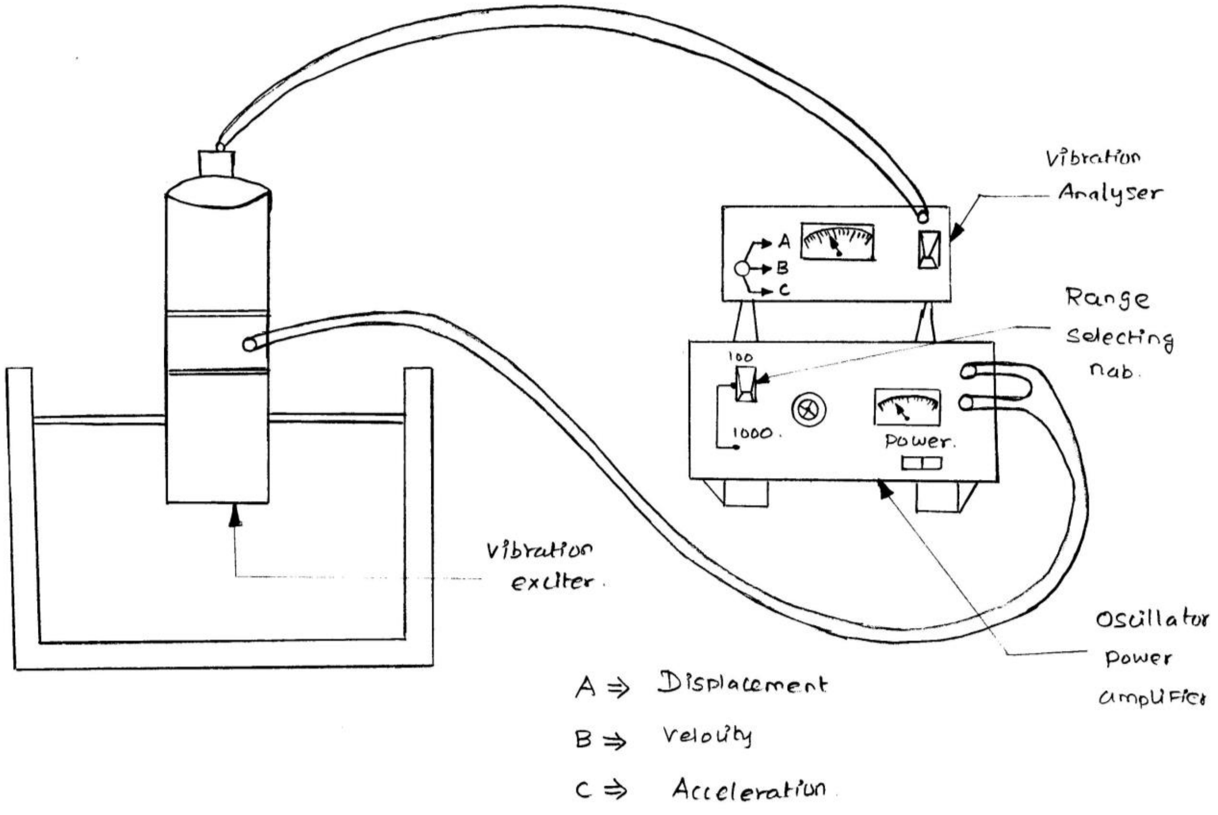

Figure 14 Vibration measurement setup

Tabulation:

Sl. No.	FREQUENCY Hz	DISPLACEMENT micron	VELOCITY mm/s	ACCELERATION mm/s^2

EX.NO: **VIBRATION MEASUREMENT**
DATE:

Aim:

To measure displacement, velocity and acceleration for different excitation frequencies.

Apparatus Required:

- Oscillator Power amplifier
- Vibration exciter
- Vibration Analyzer

Equipment Description:

Vibration Exciter: Vibration exciter is an electro dynamic type device. It consists of a powerful magnet placed centrally surrounding which is a suspended exciter coil. This assembly is enclosed by high permeability magnetic circuit for optimum performance. When an electrical current is passed through the exciter coil, a magnetic field is created around the coil and it interacts with the field due to the central permanent magnet. This results in the upward and downward movement of the suspended coil. Thus by controlling the amount of current the amplitude of vibration is controlled.

Power amplifier: Power amplifier is the control unit for the exciter. This unit consists of a tunable sine wave oscillator, a power amplifier to inject current to exciter coil and protection circuit.

Piezo-electric Transducer: A piezo-electric crystal produces an emf when they are deformed. The displacement to be measured is applied to the crystal. This causes deformation which produces an emf. The piezo-electric material includes Rochellle salts, ammonium dihydrogen phosphate, quartz and ceramics.

Vibration Analyzer: The vibration analyzer consists of display unit and a selector switch to display the vibration parameters.

Procedure:

- Connect the instrument to a 230V, power supply through the cable provided. Switch on the instrument, the display glows to indicate that the power is on.
- Set the frequencies of vibration for exciter and note down the corresponding values of displacement, velocity and acceleration using the selector switch.
- Repeat the procedure for various excitation frequencies and tabulate all the readings.

Graph:

Plot the graph by taking frequency along X-axis and vibration parameters along Y-axis.

Result:

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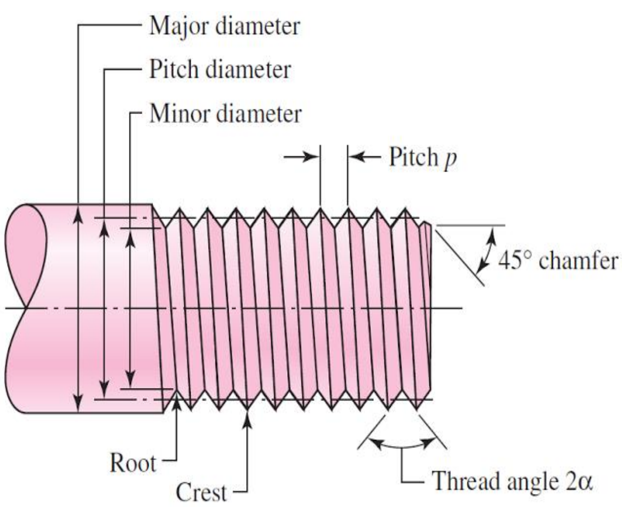
Signature of the staff	

Figure 15 Optical Profile Projector setup



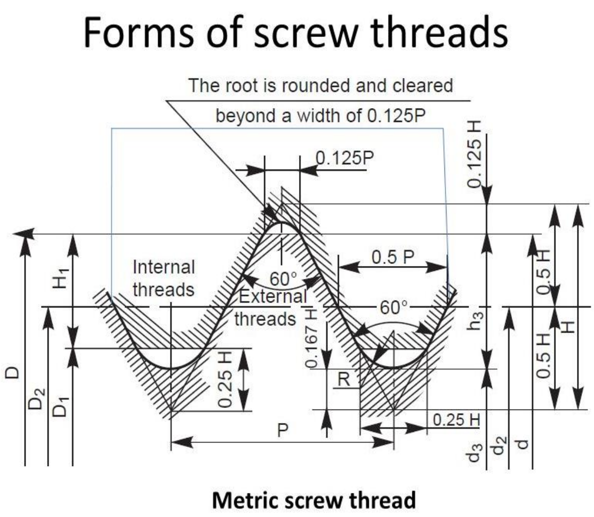


Figure 16 Screw thread

EX. NO.: **MEASUREMENT OF SCREW THREAD PARAMETERS USING**
DATE: **OPTICAL PROFILE PROJECTOR**

Aim:

To measure the pitch, major diameter, minor diameter and the thread angle of the given screw thread using optical profile projector

Apparatus Required:

- Optical profile projector
- Screw thread

Theory:

Screw Thread Parameters:

- Crest: It is the top surface joining the two sides of a thread. It may be rounded or flat.
- Root: It is the bottom surface joining the sides of adjacent thread. It may be rounded or flat.
- Flank: The surface of the thread, which connects the crest with the root.
- Pitch: It is the distance measured parallel to its axis between corresponding points on adjacent thread.
- Lead: It is the distance by which a screw thread advances axially in one revolution.
- Thread angle: It is the angle between the flanks of a thread measured on an axial plane.
- Flank angle: It is the angle between the flank of a thread and a plane perpendicular to the axis, measured in axial plane.
- Major Diameter: It is the perpendicular distance between the crests of opposite teeth.
- Minor Diameter: It is the perpendicular distance between the roots of opposite teeth.
- Thread Depth: It is the perpendicular distance between the crest and root of a tooth.

Description:

The profile projector consists of

A. A projector having a light source, a condenser, a collimating lens to direct the light passed into the optical system.
B. A work holding table which is of movable type.
C. A projector optic including both mirrors and lenses;
D. A screen where the image is projected.
E. Two micrometers of the range of 0 to 25mm, which enable to measure in horizontal as well as in vertical planes.

Observation:
Least count of micrometer 1 =
Least count of micrometer 2 =
Least count of circular scale =

Tabulation:

Pitch

Sl. No.	Initial micrometer reading IM mm	Final micrometer reading FM mm	Pitch FM - IM mm

Major diameter

Sl. No.	Initial micrometer reading IM mm	Final micrometer reading FM mm	Major diameter FM - IM mm

Procedure:

- Place the screw thread piece between the anvils provided on the work holding table.
- Adjust the table by moving the circular lever provided on the sides to get a proper view of the screw thread.
- Fix the cross line chart on the screen by making sure that ‘0’ of main scale coincides with the ‘0’ of vernier scale on the angular template provided on the screen.
- Find the least count of the micrometers and the optical screen.

Major diameter measurement:

- Rotate micrometer head for Y-direction to rest the horizontal dotted line of crosswire on the top of a crest of a thread and note the micrometer reading.
- Again rotate the micrometer head to move the speciment such that horizontal dotted line of crosswire rests on the top of the opposite crest of the thread and note the micrometer reading.
- Calculate the difference between the above two readings which will give the major diameter.
- Repeat the above for any other set of crests and calculate the average.

Minor diameter measurement:

- Rotate micrometer head for Y-direction to rest the horizontal dotted line of crosswire on the root of a thread and note the micrometer reading.
- Again rotate micrometer head to move the speciment such that horizontal dotted line of crosswire rests on the top of the opposite root of the thread and note the micrometer reading.
- Calculate the difference between the above two readings which will give the minor diameter.
- Repeat the above for any other set of roots and calculate the average.

Pitch measurement:

- Rotate micrometer head for X-direction to rest the vertical dotted line of crosswire on the crest of a thread and note the micrometer reading.
- Again rotate micrometer head to move the speciment such that vertical dotted line of crosswire rests on the top of the adjacent crest of the thread and note the micrometer reading.
- Calculate the difference between the above two readings which will give the pitch.
- Repeat the above for any other set of adjacent crests and calculate the average.

Thread angle measurement:

- Find the least count of the angular scale provided on the screen.
- Rotate the Y- axis to align with the flank of a chosen thread by rotating the adjusting knob provided by the side of the screen and note the initial angle.
- Again rotate the Y- axis to align with the opposite flank of the adjacent thread by rotating the adjusting knob provided by the side of the screen and note the angle.
- Calculate the difference between the above two readings which will give the thread angle.
- Repeat the above for any other set of adjacent flanks and calculate the average.

Tabulation:

Minor diameter

Sl. No.	Initial micrometer reading IM mm	Final micrometer reading FM mm	Minor diameter FM - IM mm

Thread angle

Sl. No.	Initial circular reading IR Degree-min	Final circular reading FR Degree-min	Thread angle FR - IR Degree-min

Result:

Thus the pitch, major diameter, minor diameter and the thread angle of the given screw thread is measured by using optical profile projector

Major diameter of screw thread =
Minor diameter of screw thread =
Pitch of screw thread =
Thread angle of screw thread =

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Signature of the staff	

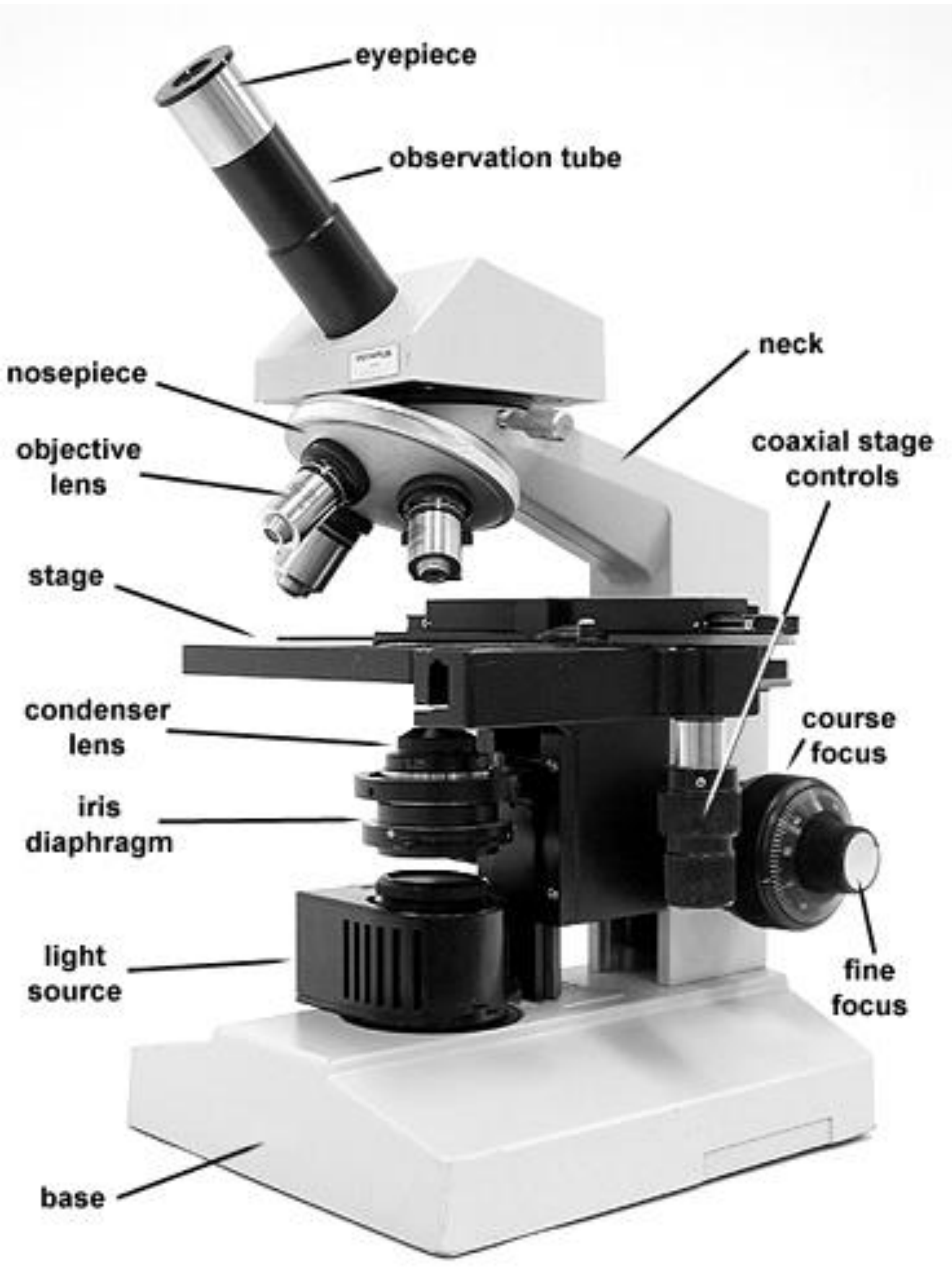


Figure 17 Tool Maker's Microscope

EX. NO.: **MEASUREMENT OF SCREW THREAD PARAMETERS**
DATE: **USING TOOL MAKER'S MICROSCOPE**

Aim:

To measure the pitch, thread angle and depth of the given screw thread using tool maker's microscope

Apparatus Required:

- Tool maker's microscope.
- Screw thread

Description:

The Tool Maker's Microscope (TMM) essentially consists of the cast base, the main lighting unit, the upright with carrying arm and the sighting microscope. The rigid cast base is resting on three foot screws by means of which the equipment can be leveled with reference to the built-in spirit level. The base carries the co- ordinate measuring table which consists of two measuring slides: one each for directions X and Y and a rotary circular table provided with the glass plate. The slides on precision balls in hardened guide ways warranting a reliable travel. Two micrometer screws each of them having a measuring range of 0 to 25mm permit the measuring table to be displaced in the directions X and Y. The range of movements of carriage can be widened up to 75 mm in the X direction and up to 50mm in the Y direction with the use of gauge blocks. The rotary table has been provided with 360° degree graduation and with a 60 minute vernier. The rotary motion is initiated by activation of knurled knob. Slots in the rotary table serve for fastening different accessories and completing elements. The sighting microscope has been fastened to column with a carrier arm. The carrier arm can be adjusted in height by means of rack. The main lighting unit has been arranged in the rear of the cast base and equipped with projection lamp where rays are directed via stationary mounted mirror through table glass plate into the sighting microscope.

Procedure:

- Calculate the least count of the micrometers and angular reading provided on the viewing table.
- Place the given specimen on the glass table plate.
- Switch on the projection lamp.
- Viewing through the eyepiece, rotate the knob for moving carrier arm on column to get a sharp image of the specimen kept on the glass plate.
- Position the specimen such that the table movement in X direction is parallel to the direction of the pitch measurement.
- Check this by ensuring the crosswire touching the crests of all the teeth during table movement in X direction.

Observation:

Least count of micrometer 1 =
Least count of micrometer 2 =
Least count of circular scale =

Tabulation:

Pitch

Sl. No.	Initial micrometer reading IM mm	Final micrometer reading FM mm	Pitch FM - IM mm

Depth of thread

Sl. No.	Initial micrometer reading IM mm	Final micrometer reading FM mm	Depth of thread FM - IM mm

Thread angle

Sl. No.	Initial circular reading IR Degree-min	Final circular reading FR Degree-min	Thread angle FR - IR Degree-min

Pitch Measurement:

- Rotate micrometer head for X-direction to rest the vertical dotted line of crosswire on the crest of a thread and note the micrometer reading.
- Again rotate micrometer head to move the specimen such that vertical dotted line of crosswire rests on the top of the adjacent crest of the thread and note the micrometer reading.
- Calculate the difference between the above two readings which gives the pitch.
- Repeat the above for any other set of adjacent crests and calculate the average.

Depth of thread Measurement:

- Rotate micrometer head for Y-direction to rest the horizontal dotted line of crosswire on the crest of a thread and note the micrometer reading.
- Again rotate micrometer head to move the specimen such that horizontal dotted line of crosswire rests on the root of the thread and note the micrometer reading.
- Calculate the difference between the above two readings which will give the depth of thread.
- Repeat the above for any other set of crest and root and calculate the average.

Thread angle measurement:

- Rotate the crosswire by the silver colour knob located behind the eye piece to match the flank of the thread with the cross wire.
- Make use of both micrometer head for X and Y direction to move the flank and note down the angle by viewing through the lens below the eye piece.
- Now rotate only the cross wire to match the opposite flank and note down the angle.
- Calculate the difference which gives the thread angle.
- Repeat the above for any other set of opposite flanks and calculate the average.

Result:

Thus the pitch, thread angle and depth of the given screw thread is measured using tool maker's microscope

Pitch of the given screw thread =
Depth of the given screw thread =
Thread angle of the given screw thread =

Mark	
Signature of the staff	

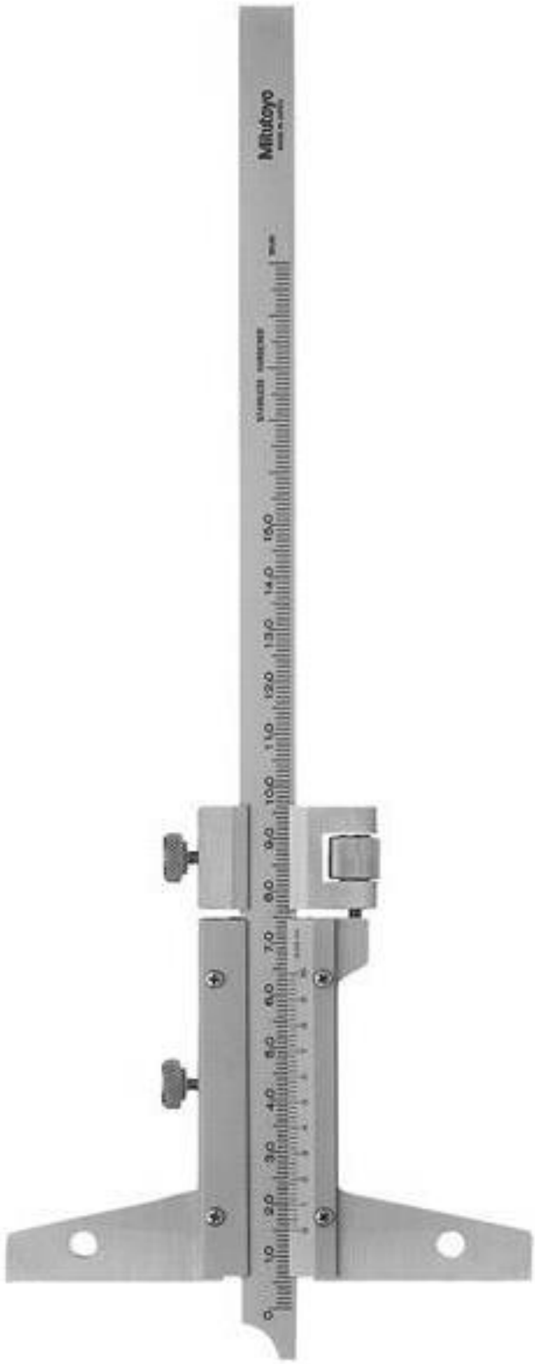


Figure 18 Vernier Depth Gauge

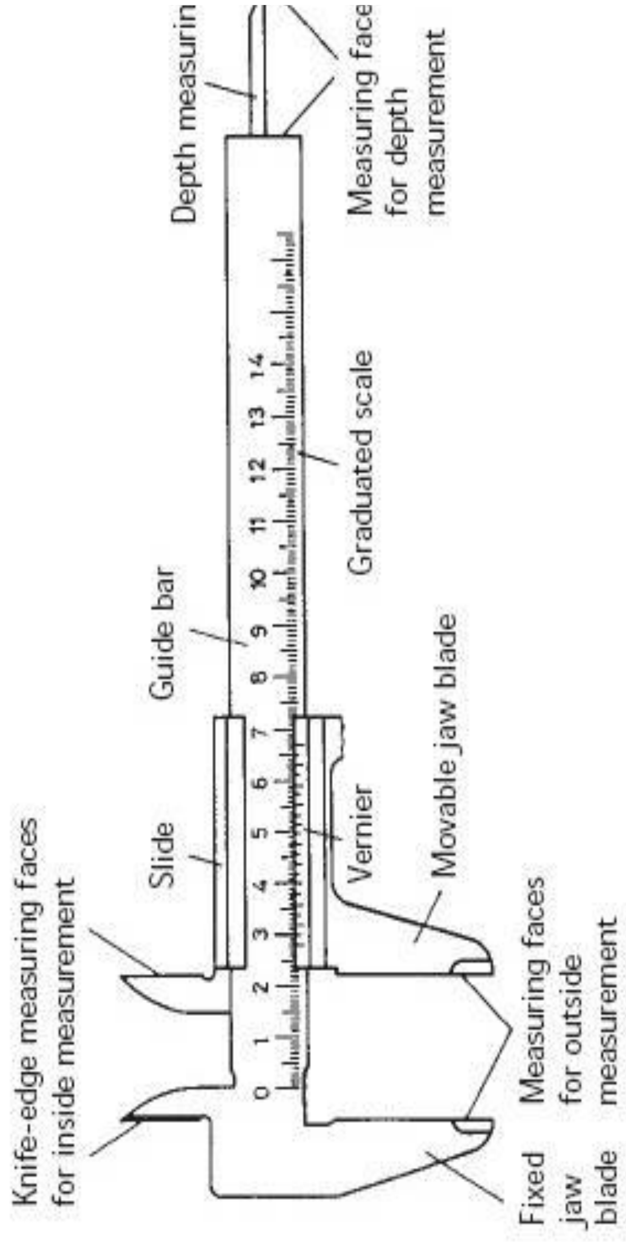


Figure 19 Vernier Caliper

EX.NO: **MEASUREMENT OF DEPTH AND INNER DIAMETER OF SPECIMENS**
DATE:

Aim:

To measure the depth, thickness, outer and inner diameter using Vernier caliper, Vernier depth gauge and inside micrometer.

Apparatus Required:

- Vernier caliper
- Vernier depth gauge
- Inside micrometer
- Surface Plate

Vernier Caliper

Vernier caliper has two scales namely the main scale and Vernier scale. The Vernier scale moves along main scale. The caliper is placed on the object to be measured and the fine adjustment screw is rotated until the jaw fits tightly against the specimen.

Procedure:

- Check the Vernier caliper for zero error
- Expand the depth measuring scale to approximate size and place it inside the specimen such that it touches the scale touches the surface plate.
- Adjust the lock nut for correct position.
- Note down the main scale and Vernier scale readings and tabulate them.

Vernier Depth Gauge

It consists of a triangular base, extension rod and plunger. The reading is indicated by an indicator at the main scale and Vernier scale. The length of the rod can be moved by adjusting screw.

Procedure:

- Place the triangular base on the surface plate.
- Place the base of the depth gauge through the hole and displace the scale upwards and note the main scale and Vernier scale readings
- Repeat the above procedure for different positions and note the readings

Figure 20 Inside Micrometer

Observation 1:

Vernier depth gauge:

Range =

Least count =

MSR =

VSR =

Total reading =

Observation 2:

Vernier caliper:

Range =

Least count =

MSR =

VSR =

Total reading =

Observation 3:

Vernier Caliper:

Range =

Least count =

MSR =

PSR =

Total reading =

Observation 4:

Inside Micrometer:

Range =

Least count =

MSR =

PSR =

Total reading =

Inside Micrometer:

It is used for measuring internal dimensions. It has mainly four parts such as measuring head, extension rod, spacing collar and handle. The range of instrument can be varied by using different lengths of extension rods and spacing collars. The ranges are (5 – 30), (25-150), (150-300) mm. The extension rods are made of hardened material and measuring faces are brazed with tungsten. The measuring faces are lapped to ensure high precision and good surface finish.

Procedure:

- Check the micrometer for zero error using a standard 5mm standard specimen.
- Place the specimen with one end touching the anvil and move the adjustable spindle to the approximate size of specimen such that it is locked between the spindle and the anvil.
- Note down the main scale reading and pitch scale divisions.
- Repeat the above procedure for different parts of the specimen and the tabulate the readings.
- Calculate the values for each reading and the average of the values is taken as the final value.

Result:

Thus the depth and inner diameter of the given specimen are measured by using Vernier caliper, Vernier depth gauge and inside micrometer.

Depth of specimen using depth gauge =
Depth of specimen using vernier caliper =
Inner diameter of the specimen using inside micromer =
Inner diameter of the specimen using vernier caliper =

Mark	
Signature of the staff	

VIVA VOCE QUESTIONS

1. What is metrology?

Metrology is the science of measurement. Metrology includes all theoretical and practical aspects of measurement. Metrology is the process of making extremely precise measurements of the relative positions and orientations of different optical and mechanical components. Metrology is concerned with the establishment, reproduction, conservation and transfer of units of measurement & their standards.

2. What are the objectives of metrology?

- To provide accuracy at minimum cost.
- Thorough evaluation of newly developed products, and to ensure that components are within the specified dimensions.
- To determine the process capabilities.
- To assess the measuring instrument capabilities and ensure that they are adequate for their specific measurements.
- To reduce the cost of inspection & rejections and rework.
- To standardize measuring methods.
- To maintain the accuracy of measurements through periodical calibration of the instruments.
- To prepare designs for gauges and special inspection fixtures

3. What is calibration?

Calibration is the comparing of an unknown measurement device against equal or better known standard under specified conditions. Every measuring system must be provable. The procedure adopted to prove the ability of a measuring system to measure reliably is called ‘calibration’.

4. Give the importance of calibration.

- Assurance of accurate of measurements
- Ability to trace measurements to international standards
- International acceptance of test/calibration reports
- Consumer protection (legal metrology)
- Correct diagnosis of illness (medical reports)
- Meeting the requirements of ISO 9000 & 17025

5. What is a load cell?

A Load cell is a transducer that is used to convert a force into an electrical signal. This conversion is indirect and happens in two stages. Through a mechanical arrangement, the force being sensed deforms a strain gauge. The strain gauge measures the deformation (strain) as an electrical signal, because the strain changes the effective electrical resistance of the wire.

6. List the various linear measuring instruments.

a) Scale b) Vernier Calipers c) Height Gauge d) Micrometer etc.

7. Define an error.

Error may be defined as the difference between the best measured or indicated value and the true or actual value. No measurement can be made without errors at all times i.e. 100% accurate measurements cannot be made at all the times. Classified in different ways, they are: Systematic error, Random errors and illegitimate errors.

8. Define Standard with an example.

“Something that is set up & established by an authority as a rule of the measure of the quantity, weight, extent, value or quality” Ex: A meter is a standard established by an international organization for the measure of length.

9. Define measurements. Mention different methods of measurements.

Measurement is a process or an act of comparing a quantitatively an unknown magnitude with a predefined standard. For Example, consider the measurement of a length of a bar. We made use of a scale/ steel rule (i.e. a standard). It is a collection of quantitative data. A measurement is a process of comparing a quantity with a standard unit. Since this comparison cannot be perfect, measurements inherently include error. There are two methods of measurement: 1) direct comparison with primary or secondary standard & 2) indirect comparison through the use of calibrated system.

10. What is L.V.D.T? What is its application?

The linear variable differential transformer (LVDT) (also called just a differential transformer) is a type of electromechanical transformer used to convert linear displacement into electrical signal. Although the LVDT is a displacement sensor, many other physical quantities can be sensed by converting displacement to the desired quantity via thoughtful arrangements.

11. Explain the principle of working of a L.V.D.T

The LVDT converts a position or linear displacement from a mechanical reference (zero, or null position) into a proportional electrical signal containing phase (for direction) and amplitude (for distance) information.

12. What is Precision?

Precision of an instrument indicates its ability to reproduce a certain reading with a given accuracy. It is the degree of agreement between repeated results.

13. Define sensitivity.

Sensitivity is the ratio of the magnitude of the output quantity (response) to the magnitude of input quantity. Ex: 1 mV recorder might have a 10 cm scale. Its sensitivity would be a 10 cm/mV. Assuming that measurement is linear all across the scale.

14. Define Linearity.

A measuring system is said to be a linear if the output is linearly proportional to the input.

15. Define Repeatability.

Repeatability is defined as the ability of a measuring system to reproduce output readings when the same input is applied to it consecutively under the same conditions & in the same directions.

16. Define Hysteresis.

An instrument is said to exhibit hysteresis when there is a difference in readings depending on whether the value of the measured quantity is approached from higher value or from a lower value. Hysteresis is a phenomenon which depicts different output effects when loading and unloading.

17. Define Resolution or Discrimination.

Resolution is defined as the smallest increment of input signal that a measuring system is capable of displaying or Measurement resolution which is the smallest change in the underlying physical quantity that produces a response in the measurement.

18. Define Accuracy.

Accuracy of an instrument indicates the deviation of the reading from a known input.

19. Define least count.

It is the smallest difference between two indications that can be detected on the instrument scale.

20. Define Readability & Threshold.

Readability indicates the closeness with which the scale of the instrument may be read. Ex: an instrument with 30 cm scale has a higher readability than that of a 15 cm scale. Threshold: If the instrument input is increased very gradually from zero, there will be some minimum value of input below which no output change can be detected. This minimum value defines the threshold of the instrument.

21. Define system response.

System response: Response of a system may be defined as the ability of the system to transmit & present all the relevant information contained in the input signal & to exclude all others. If the output is faithful to input, i.e. the output signals have the same phase relationships as that of input signal, the system is said to have good System response. If there is a lag or delay in output signal which may be due to natural inertia of the system, it is known as ‘measurement lag’. “Rise time” is defined as the time taken for system to change from 5% to 95% of its final value. It is measure of the speed of response of a measuring system and a short rise time is desirable.

22. Define Discrepancy.

The difference between two indicated values or results determined from a supposedly fixed time value.

23. True value (vt) or Actual value (va)

It is the actual magnitude of the input signal to a measuring system which may be approximated but never truly be determined.

24. Indicated value (vi) or Measured value (vm)

The magnitude of the input signal indicated by a measuring instrument is known as a indicated value.

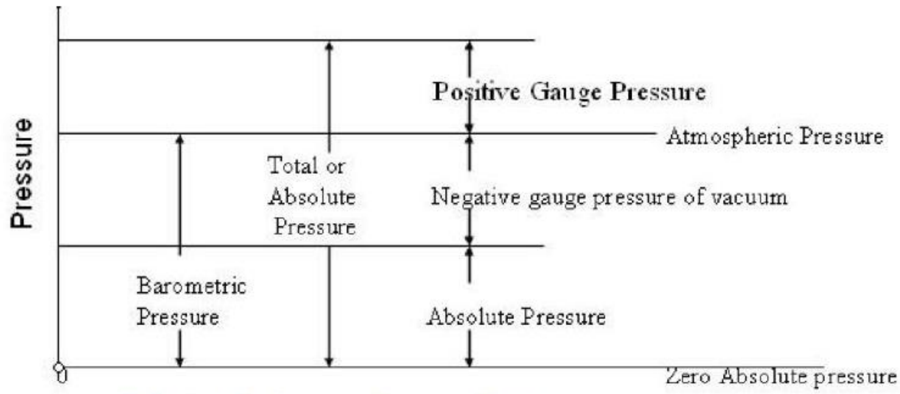
25. Define measure.

It means, to determine the dimension, quantity or capacity of something.

26. Define result.

It is obtained by making all known corrections to the indicated value.

27. Give the relationship among the different types of pressures and its definitions.



Relationship between Pressure Terms

Atmospheric Pressure: It is the pressure exerted by the earth's atmosphere and is usually measured by a barometer. At sea level. Its value is close to 1.013 x 10^5 N/m^2 absolute and decreases with altitude.

Gage Pressure: It represents the difference between the absolute pressure and the local atmosphere pressure Vacuum It is an absolute pressure less the atmospheric pressure i.e. a negative gage pressure.

Static and Dynamic pressures: If a fluid is in equilibrium, the pressure at a point is identical in all directions and independent of orientation is referred as pressure. In dynamic pressure, there exists a pressure gradient within the system. To restore equilibrium, the fluid flows from regions of higher pressure t regions of lower pressure. Pressure is the force per unit area.

Gauge pressure: It is the system pressure which is measured with the pressure gauge, a device to measure the pressure. Atmosphere pressure: It is the pressure exerted by the air molecules on the object. This atmospheric pressure is measured with the help of Barometer.

Absolute Pressure: It is the pressure measured with reference to the Zero pressure or perfect vacuum. It represents the summation of atmospheric pressure and gauge pressure. Hence,

Absolute pressure = Gauge pressure + Atmospheric pressure

28. How do you define yard?

Yard is defined as distance between the two central traverse lines of the gold plug when the temperature of the bar is at 62º F (Imperial Standard yard).

29. What is thermocouple? Where are they used?

If two dissimilar metals are joined, an emf exists which is a function of several factors including the temperature. When junctions of this type are used to measure temperature, they are called as thermocouples.

30. What are slip gauges?

Slip gauges a very accurately ground block of hardened steel used to measure a gap with close accuracy: used mainly in tool-making and inspection.

31. What is Tolerance?

It is the difference between the upper limit and the lower limit of a dimension. It is impossible to make anything to an exact size, therefore it is essential to allow a definite tolerance. It is also the maximum permissible variation on every specified dimension.

32. What are Limits?

The maximum and minimum permissible sizes within which the actual size of a component lies are called Limits.

33. Define fits.

The relationship existing between two parts, shaft and hole, which are to be assembled, with respect to the difference in their sizes is called fit.

34. What is Range?

Range represents the highest possible value that can be measured by an instrument *or* Range is the difference between the largest & the smallest results of measurement.

35. What is loading effect?

Loading effect: The presence of a measuring instrument in a medium to be measured will always lead to extraction of some energy from the medium, thus making perfect measurements theoretically impossible. This effect is known as ‘loading effect’ which must be kept as small as possible for better measurements. For ex, in electrical measuring systems, the detector stage receives energy from the signal source, while the intermediate modifying devices and output indicators receive energy from auxiliary source. The loading effects are due to impedances of various elements connected in a system.

36. What is comparator?

Comparator is a precision instrument used for comparing dimensions of a part under test with the working standards. It is an indirect type of instrument and used for linear measurement. If the dimension is less or greater than the standard, then the difference will be shown on the dial. It gives only the difference between actual and standard dimension of the work piece.

37. Name the different types of comparator?

Mechanical Comparator, Pneumatic Comparator, Optical Comparator, Electrical Comparator, Electronic Comparator and Combined Comparator (ex: mechanical –optical comparator).

38. What are advantages and disadvantages of mechanical comparator?

Advantages of Mechanical Comparator

- They do not require any external source of energy.
- These are cheaper and portable.
- These are of robust construction and compact design.
- The simple linear scales are easy to read.
- These are unaffected by variations due to external source of energy such air, electricity etc.

Disadvantages

- Range is limited as the pointer moves over a fixed scale.
- Pointer scale system used can cause parallax error.
- There are number of moving parts which create problems due to friction, and ultimately the accuracy is less.
- The instrument may become sensitive to vibration due to high inertia.

39. What is a sine bar?

Sine bar is a high precision & most accurate angle measuring instrument. It is used for measurement of an angle of a given job or for setting an angle. They are hardened and precision ground tools for accurate angle setting. It can be used in conjunction with set of angle gauges and dial gauge for measurement of angles and tapers from horizontal surface.

40. What is a sine center?

These are used in situations where it is difficult to mount the component on the sine bar. It is basically used for conical work pieces. It is the extension of sine bars where two ends are provided on which centers can be Clamped. These are useful for testing of conical work centered at each end, up to 60°.

P.S.R. ENGINEERING COLLEGE

SEVALPATTI - 626 140
SIVAKASI
Virudhunagar District.

BONAFIDE CERTIFICATE

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by T. SATHYA BAMA

Roll No 18ME070 *in the* 16IME48 - Metrology & measurements

Laboratory of this College during the academic year 2019 - 2020.

R. 17/3/2020

Staff - in - Charge

18/3/2020

Head of the Department

Head of the Department
Department of Mechanical Engineering
P.S.R. Engineering College
Sevalpatti, Sivakasi - 626 140

Register No. 1806070.

Submitted for the Practical Examination held on 25/3/2020 (Oral examination)

25/3/2020

Internal Examiner

HoD/Mech.

External Examiner

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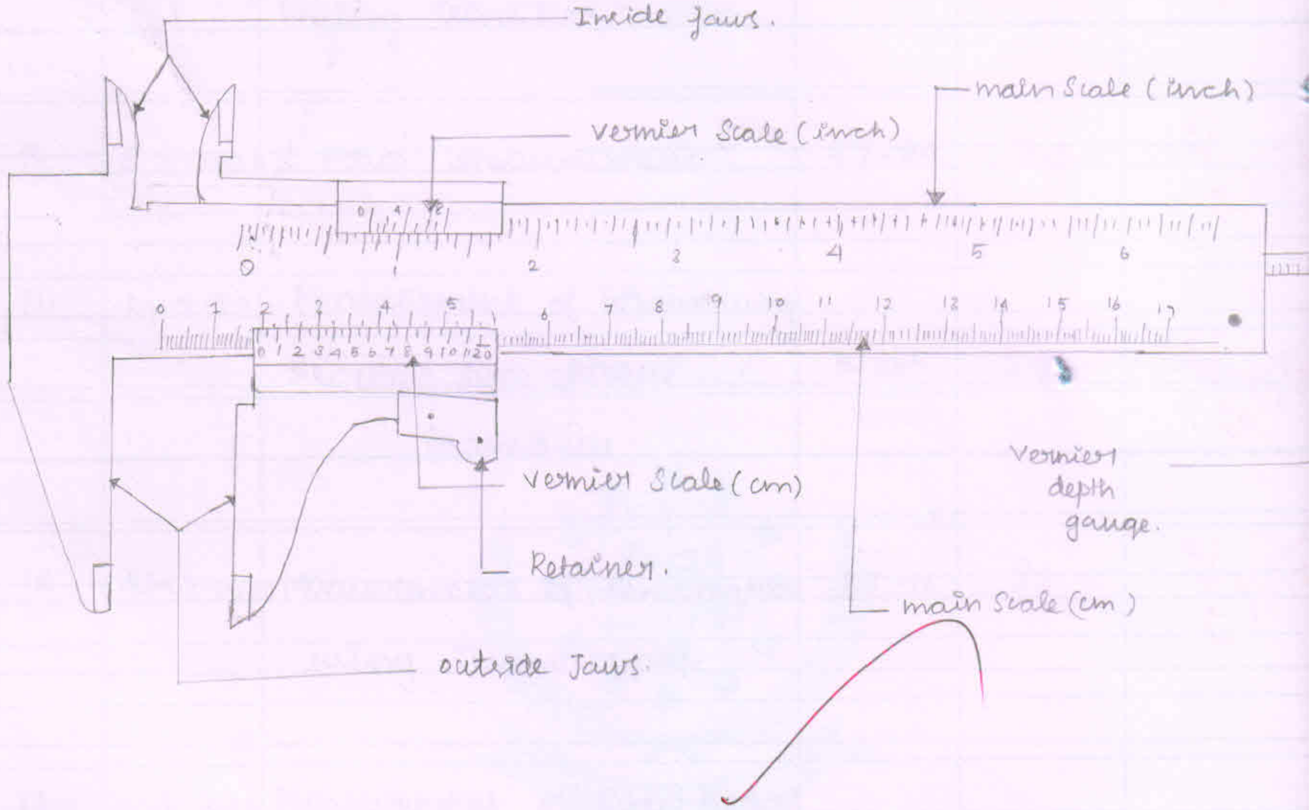
Completed
17/3/2020

VERNIER CALIPER:-



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Date : 22.11.19

CALIBRATION OF VERNIER CALIPER

AIM :-

TO calibrate the given vernier caliper using slip gauge as standard specimen.

Apparatus Required :

Vernier caliper.
Set of slip gauges.

Formula used :

$$MD = MSR + (VSC \times LC) + ZC$$

Where, MD = Measured Dimension
MSR = Main Scale reading
VSC = Vernier Scale coincidence
LC = Least count
ZC = Zero correction.

Description :-

The principle of vernier caliper is that when two scales or divisions slightly different in size are used, the difference between them can be utilized to enhance the accuracy of measurement. The vernier caliper essentially consists of two steel rules namely main scale and vernier scale and vernier scale can slide over the main scale. The main scale is engraved on a solid L-shaped frame and the vernier scale has got 50 divisions.

OBSERVATION:-

Range = 0-150 mm

Span : 150 mm

Least count : value of 1 main Scale reading / Total No. of Vernier Scale division

= 1/50 = 0.02 mm

Zero error : 0

Zero correction : 0

Tabulation:-

Sl. No.	Nomial Dimension (ND) mm	Main Scal Reading (MSR) in mm	Vernier Scale coincidence (VSC)	Measured Dimension (MD) mm	Error = MD-ND mm.
1.	1.03	1	4	1.08	0.05
2.	1.14	1	9	1.18	0.04
3.	1.42.	1	20	1.4	-0.02
4.	7.5	7	28	1.56	0.06
5.	10	10	-	10	0
				Average error	0.026.

One end of the frame contains a fixed jaw, which is shaped into a contact tip at its extremity. A sliding jaw which moves along the guiding surfaces provided by the main scale is coupled to a vernier scale by the main scale is coupled to a vernier scale. The sliding jaw at its left extremity contains another measuring tip. when two measuring tip surfaces are in contact with each other, the scale shows zero reading. The linear adjustment of the movable jaw can be done by the adjusting screw.

Procedure :-

Check the vernier caliper for zero error.

Select a standard slip gauge and place it between the fixed and movable jaws of the vernier caliper.

Note down the main scale reading

Note down the vernier scale coincidence and findout the measured dimensions.

Repeat the above steps for different slip gauge combinations and tabulate the error.

CALCULATION :-

(i) MSR = 1mm ; VSC = 4 ; LC = 0·02 mm.

MD = MSR + (VSC × LC) + ZC.

= 1 + 0·08 + 0

= 1·08 mm.

Error = MD - ND

= 1·08 - 1·03

= 0·05 mm.

(ii) MSR = 1 mm ; VSC = 20 ; LC = 0·02 mm

MD = 1·5 + (0·4) + 0

= 1·9 mm

error = MD - ND

= 1·42 - 1·42

= -0·02 mm

(iii) MSR = 10mm ; VSC = - ; LC = 0·02 mm

MD = 10 + (0 × 0) + 0

= 10 mm

Error = MD - ND

= 10 - 10

= 0 mm.

Exp. No.:
Date :

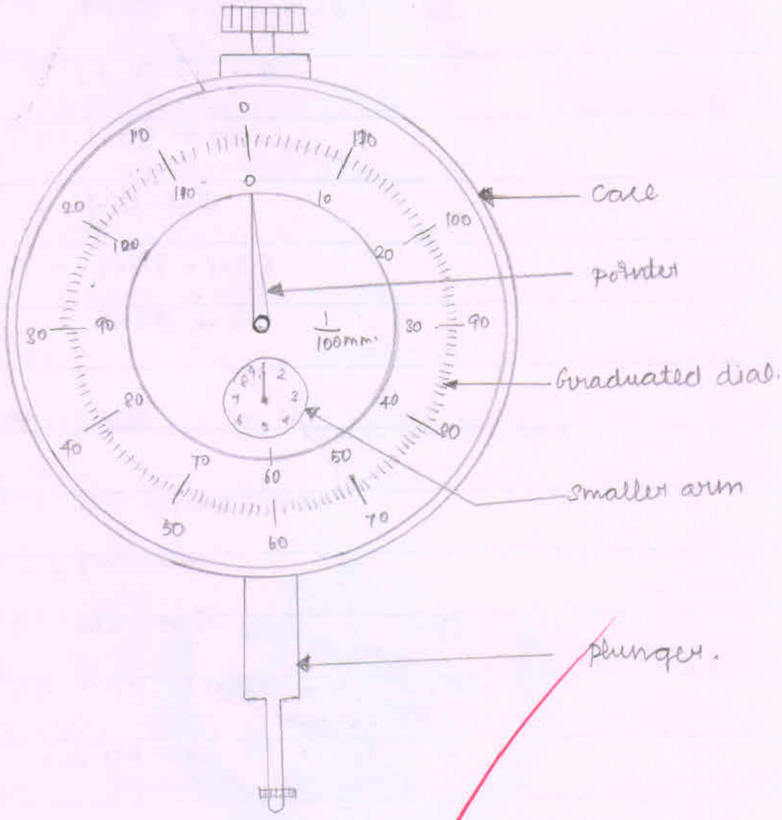
Result :-

Thus the calibration of the given vernier caliper using slip gauge was successfully calculated.

29/11/19

PRACTICAL EVALUATION	
Observation (10)	8
Calculation / Result (10)	8
Viva (10)	8
Total Marks (30)	24
Signature of Faculty	

DIAL GAUGE



CALIBRATION OF DIAL GAUGE

AIM:

To calibrate the given Dial gauge using Slip gauges.

Apparatus required:

Dial gauges,
Slip gauges,
Magnetic base.

Theory:

Both micrometer and vernier Scal instruments are capable of direct reading. There are, collectively known as comparators. One such comparator is a dial gauge indicator (or) clock gauge.

The DTI is a mechanical device for sensing linear variation. It measures the displacement of its plunger or a stylus on a circular dial by means of a rotating pointer. Generally into equal divisions. One complete revolution of the pointer corresponds to 1mm of plunger movement. Hence it is obvious that pointer movement from mark 10 to mark 20 or mark 20 to mark 30 and so on indicates a plunger movement of 0.1 mm

This type of instruments has a longer plunger movement and is scaled with a secondary

OBSERVATION :-

Range = 0-25 mm

Span = 25 mm.

Least count = value of main scale division / Total No. of Secondary Scale division

= 1/100 = 0.01 mm.

Zero error = Nil

Zero correction : Nil.

Tabulation:-

Sl. NO	Slip gauge reading (S) mm	Observed value (O) (mm)			Error = S-O mm
		MS	SS	O.V	
1.	1.05	1	8	1.08	-0.03
2.	1.15	1	18	1.18	-0.03
3.	1.31	1	34	1.34	-0.03
4.	1.47	1	49	1.49	-0.02
5.	1.90	2.	92.	2.92.	-1.02.
				Average error	-0.226

Scale and pointer to indicate the number of complete revolution. is equivalent to 1 mm of the plunger movement. This secondary scale is also popularly known as revolution counter.

To enable the instrument to be zero for any convenient position, the main scale can be rotated and locked into place using the scale locking screw indicated in figure.

Procedure :

Initially set the pointer of the dial gauge at zero reading.

When the platform and tip of the plunger are in perfect touch with each other, lift the plunger. and place a selected slip gauge.

After placing the slip gauges between the plunger and platform, find the error.

Likewise place selected slip gauges and tabulate.

CALCULATION:

1) Main Scale reading = 1 mm.

Secondary Scale reading = 8

Least Count = 0·01 mm.

Observed value = MSR + (S·S × LC) + ZC.

= 1 + (8 × 0·01) + 0

= 1·08 mm.

Error = S−O = 1·05 − 1·08 = −0·03 mm.

3). Main Scale reading = 1 mm

Secondary Scale reading = 34

Observed value = MSR + (S·S × LC) + ZC.

= 1 + (34 × 0·01) + 0

= 1·34.

Error = S−O = 1·31 − 1·34

= −0·03 mm.

Exp. No.:

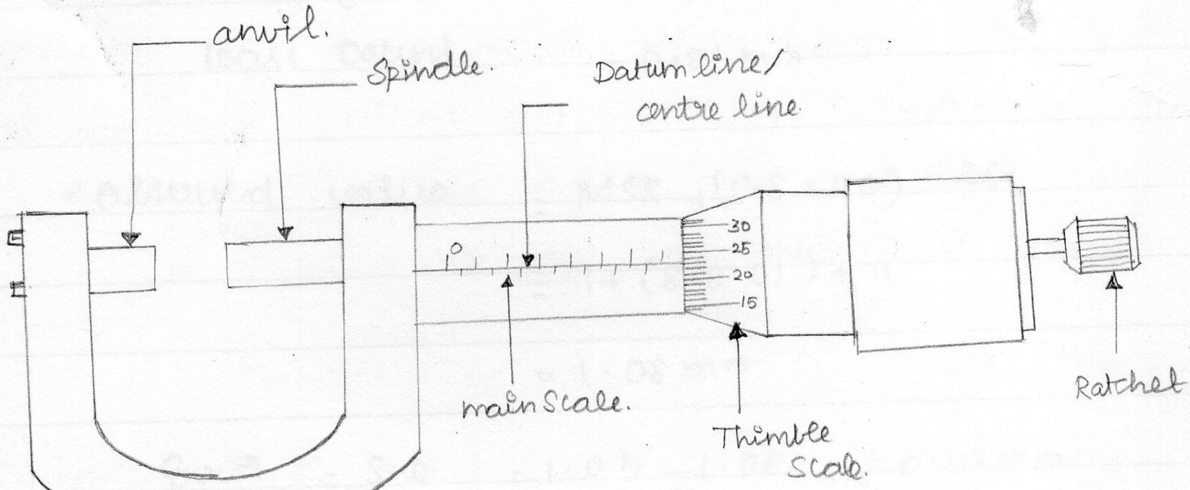
Date :

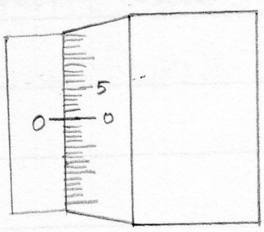
Result:

6/12/19 Thus the calibration of the dial gauge using slip gauges was succesfully calculated.

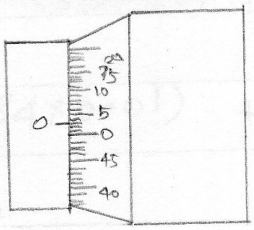
PRACTICAL EVALUATION	
Observation (10)	9
Calculation / Result (10)	9
Viva (10)	9
Total Marks (30)	27
Signature of Faculty	

MICRO METER:

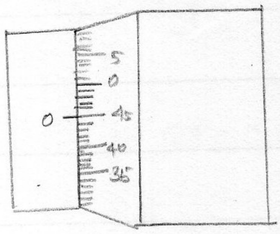




No zero error.



Positive zero error.



Negative zero er

CALIBRATION OF MICROMETER.

AIM :-

To calibrate a given micrometer using slip gauges as standard specimenn.

Apparatus Required:

Micrometer,
Set of slip gauges.

Formula to be used:

$$MD = MSR + (PSC \times LC) + ZC$$

Where,

MD = Measured Dimension,
MSR = Main Scale Reading,
PSC = Pitch Scale coincidence
LC = Least count
ZC = Zero correction.

Description:

The micrometer essentially consists of an accurate screw having about 10 or 20 threads per cm and revolves in a fixed nut. The end of the screw forms one measuring tip and other measuring tip is constituted by stationary anvil. in the base of the frame. The screw is threaded for certain length and and is plain afterwards.

OBSERVATION :

Range = (0-25) mm

Span = 25 mm

$$\text{Least count} = \frac{\text{value of 1 main Scale reading}}{\text{Total No. of pitch Scale division}}$$

$$= \frac{0.5}{50} = 0.01 \text{ mm}$$

Zero error : -2 mm

Zero correction = +0.02.

Tabulation:

Sl. No.	Nominal Dimension (ND) mm.	Main Scale reading (MSR) in mm	Pitch Scale coincidence PSC	Measured Dimension (MD) mm	Error = MD mm.
1.	1.01	1	49	1.51	0.5
2.	1.33	1	32	1.34	0.01
3.	1.37	1	36	1.38	0.01
4.	1.60	1	9	1.11	-0.49
5.	4.5	4	48	4.0096	-0.4904
				Average error	-0.092.

The plain portion is called sleeve and its end is the measuring surface. The spindle is advanced or retracted by turning a thimble which is connected to the spindle.

The spindle is slide fit over the barrel and barrel is the fixed part attached with the frame. The barrel is graduated in units 0.05 cm. The thimble has got 25 divisions around its periphery on circular portion. A locknut is provided for locking a dimension by prevented motion of spindle. Ratchet stop is provided at the end of the thimble cap to maintain sufficient and uniform measuring pressure so that standard conditions of measurements are attained.

Ratchet stop consists of an over riding clutch held by a weak spring. When the spindle is brought into contact with the work the correct measuring pressure, the clutch starts slipping and no further movement of the spindle takes place by rotation of ratchet.

Procedure:

Check the micrometer for the smooth running over its whole range.

Clean the anvil and spindle carefully.

Close the anvil and spindle and note the zero error.

Calculate the least count.

CALCULATION:

i) $MD = MSR + (PSC \times LC) + ZC$

MSR = 1 mm ; PSC = 49 mm ; LC = 0.01 mm ; ZC = +0.02 m

$MD = 1 + (49 \times 0.01) + 0.02$

$MD = 1.51$ mm

Error = MD - ND

$= 1.51 - 1.01$

$= 0.5$ mm.

iii) $MD = MSR + (PSC \times LC) + ZC.$

MSR = 1 mm ; PSC = 36 ; LC = 0.01 mm ; ZC = +0.02 m

$MD = 1 + (36 \times 0.01) + 0.02.$

$= 1.38$ mm

Error : MD - ND

$= 1.38 - 1.37$

$= 0.01$ mm.

Exp. No.:
Date :

Determine the progressive error, of the micrometer by choosing standard slip gauges for the whole range (0-25 mm). Let the increment in the initial and final range be kept as small as possible.

Determine the periodic error of the micrometer.

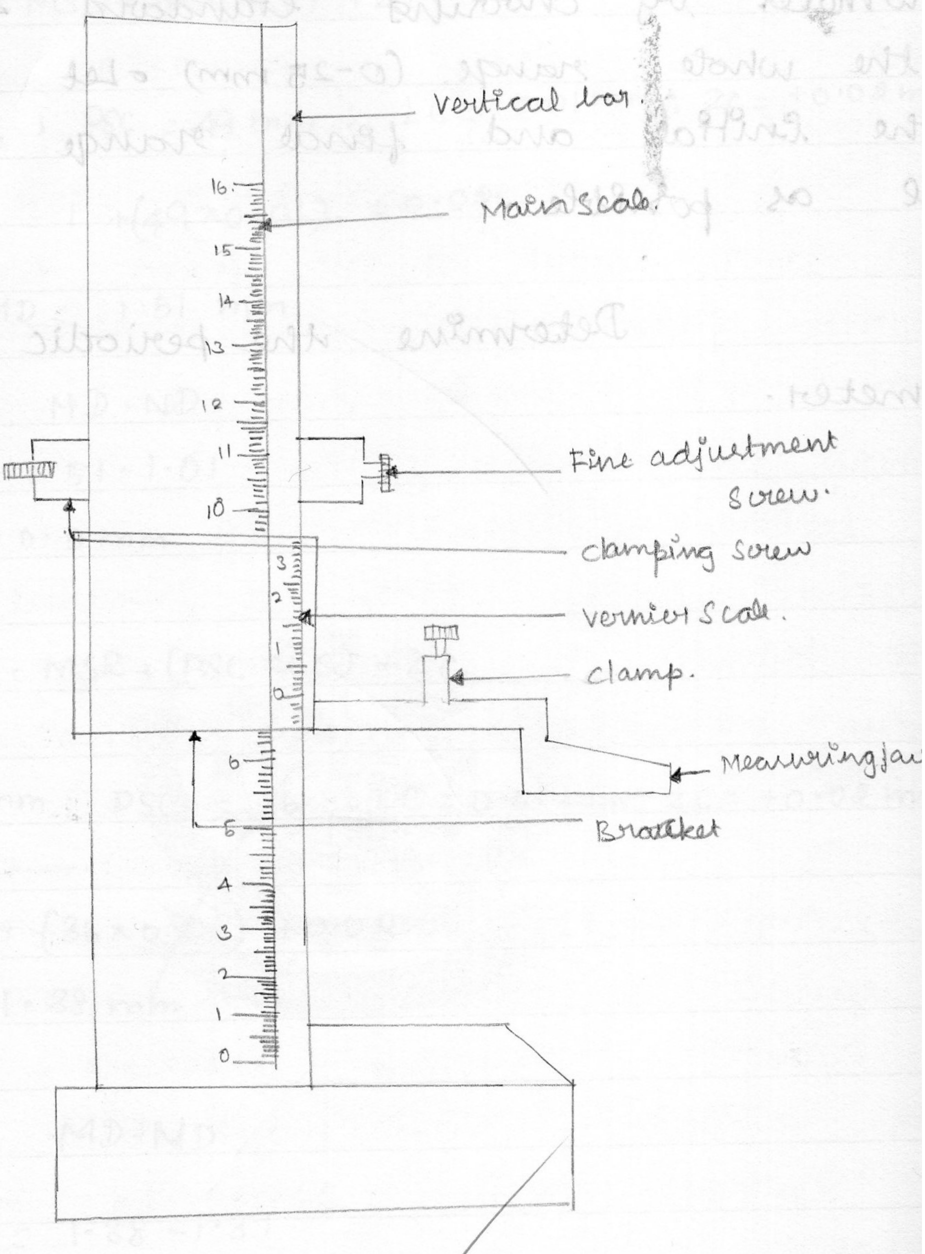
Result:

Thus the micrometer was calibrated by using standard slip gauges.

13/12/14

PRACTICAL EVALUATION	
Observation (10)	10
Calculation / Result (10)	9
Viva (10)	9
Total Marks (30)	28
Signature of Faculty	✓

Vernier height Gauge.



MEASUREMENT OF DIMENSION OF SPECIMEN USING VERNIER HEIGHT GAUGE.

AIM:

To measure the dimensions of a specimen using vernier Height gauge.

Apparatus requirements:

Vernier Height gauge.
Specimen
Surface plate.

Description:

Vernier Height gauge works on the principle that when two scale divisions slightly different in sizes are used, then the difference can be utilized to enhance the accuracy of measurement. It consist of two scales, the main scale. This is also a vernier scale but attached with a special base block and other attachments.

The whole assembly is made in such a way to measure height of parts. A removale clamp is attached between measuring jaws and vernier. Both the upper and lower end of measuring jaws is parallel to the bas of vernier height gauge. The surface of surface plate is the datum or reference while doing measurements.

OBSERVATION:

Range - 0-300 mm

Span - 300 mm

Least count : $\frac{\text{Value of one scale division}}{\text{Total No. of Vernier Scale}}$

= 1/50 = 0.02 mm

Zero error = Nil

Specimen No.	TRIAL NO.	Main Scale Reading mm	Vernier Scale coincidence	Total Reading = MSR + VSC×LC. mm	Average mm
1.	1.	50	8	50.16	50.39
	2.	50	31	50.62	
2.	1.	15	5	15.1	15.15
	2.	15	10	15.2.	

Exp. No.:
Date :

Procedure:

Wipe the vernier height gauge and specimen using a soft cloth.

Check the vernier height gauge for zero error.

Loosen the locking screw and expand the measuring jaw to the approximate size of specimen.

Place the specimen between the surface plate and the measuring jaw.

Lock the locknut at the correct position of the specimen.

Tabulate the measured readings.

CALCULATION :-

1) · (i) TR = MSR + (VSC × LC)

MSR = 50 mm ; VSC = 8 ; LC = 0·02 mm

= 50 + (8 × 0·02)

= 50·16 mm.

(ii) TR = 50 + (31 × 0·02)

MSR = 50 mm ; VSC = 31 ; LC = 0·02 mm

= 50 + 0·62

= 50·62 mm.

2). (i) TR = MSR + (VSC × LC)

MSR = 15 mm ; VSC = 5 LC = 0·02 mm

TR = 15 + 5 × 0·02

= 15 + 0·1

= 15·1 mm.

(ii) TR = MSR + (VSC × LC)

MSR = 15 mm ; VSC = 10 LC = 0·02 mm.

= 15 + (10 × 0·02)

= 15·2 mm.

Exp. No.:
Date :

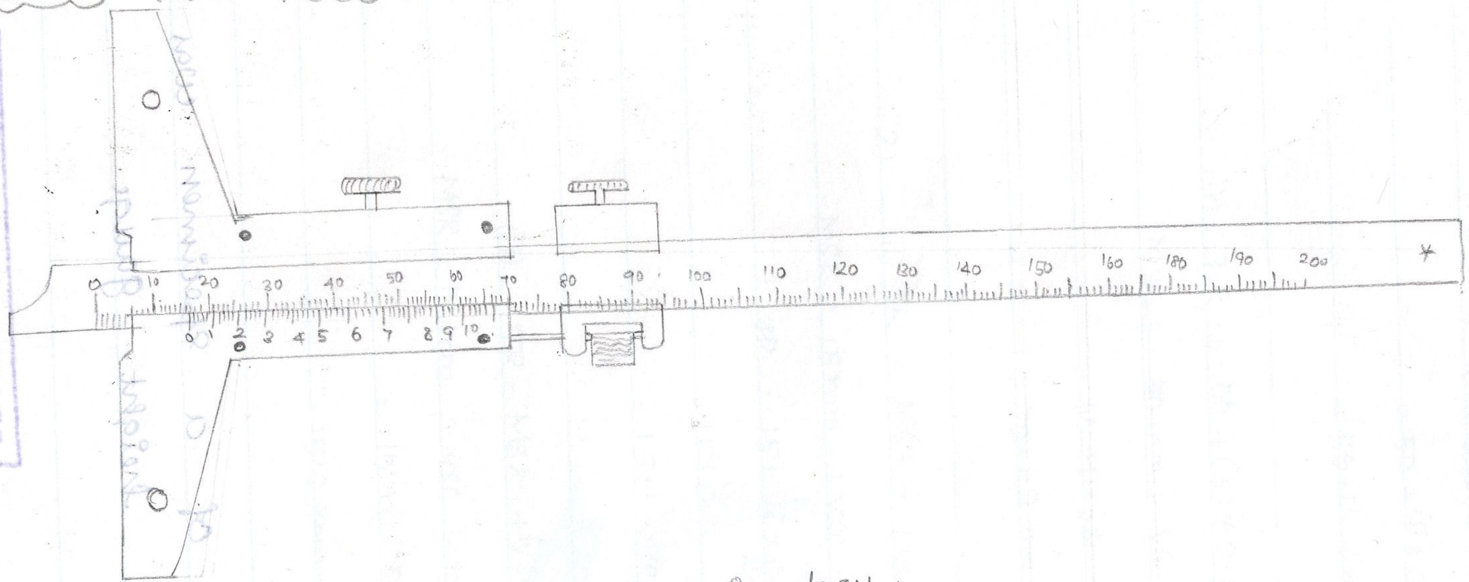
Result :-

Thus the dimension of a specimen was measured by using vernier height gauge.

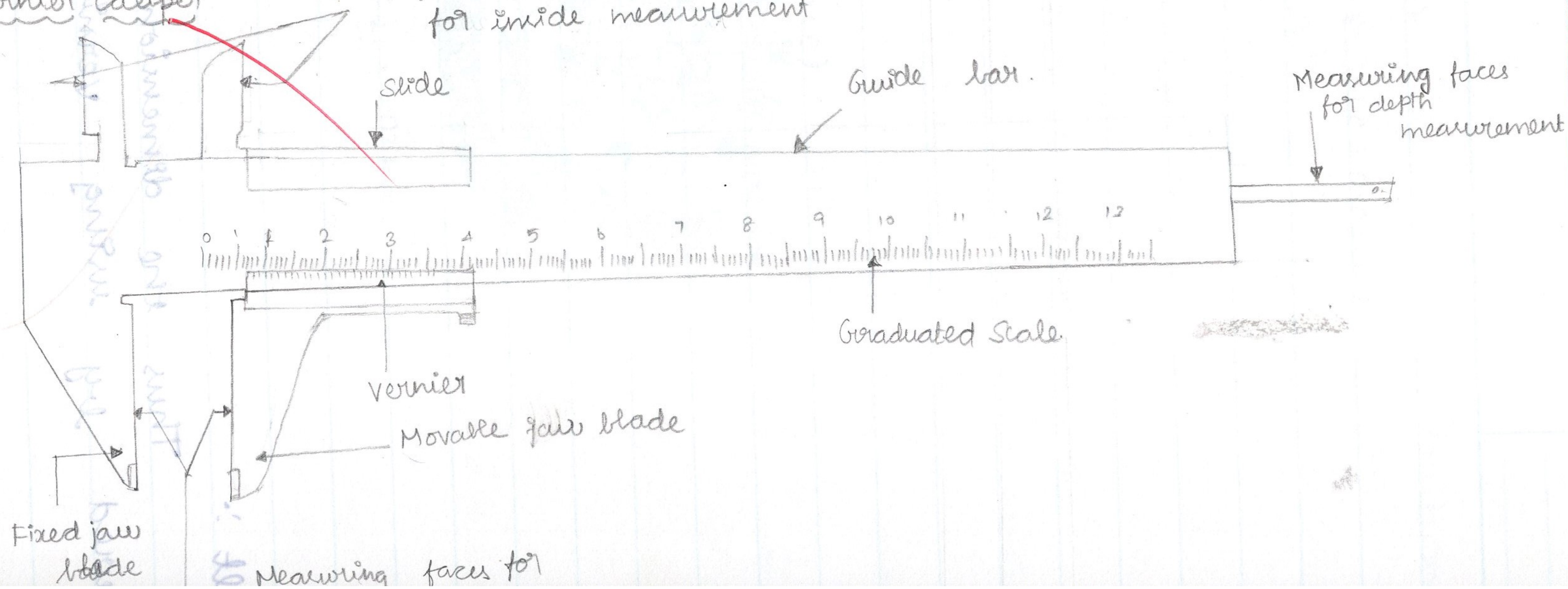
20/12/19

PRACTICAL EVALUATION	
Observation (10)	8
Calculation / Result (10)	8
Viva (10)	8
Total Marks (30)	24
Signature of Faculty	

Vernier Depth Gauge:



Vernier caliper



Exp. No.: 5
Date : 20.12.19

MEASUREMENT OF DEPTH AND INNER DIAMETER OF SPECIMENS

AIM :-

To measure the depth, thickness, outer and inner diameter using vernier caliper, vernier depth gauge and inside micrometer.

Apparatus Required:

Vernier caliper
Vernier depth gauge.
Inside micrometer
Surface plate.

Vernier caliper:

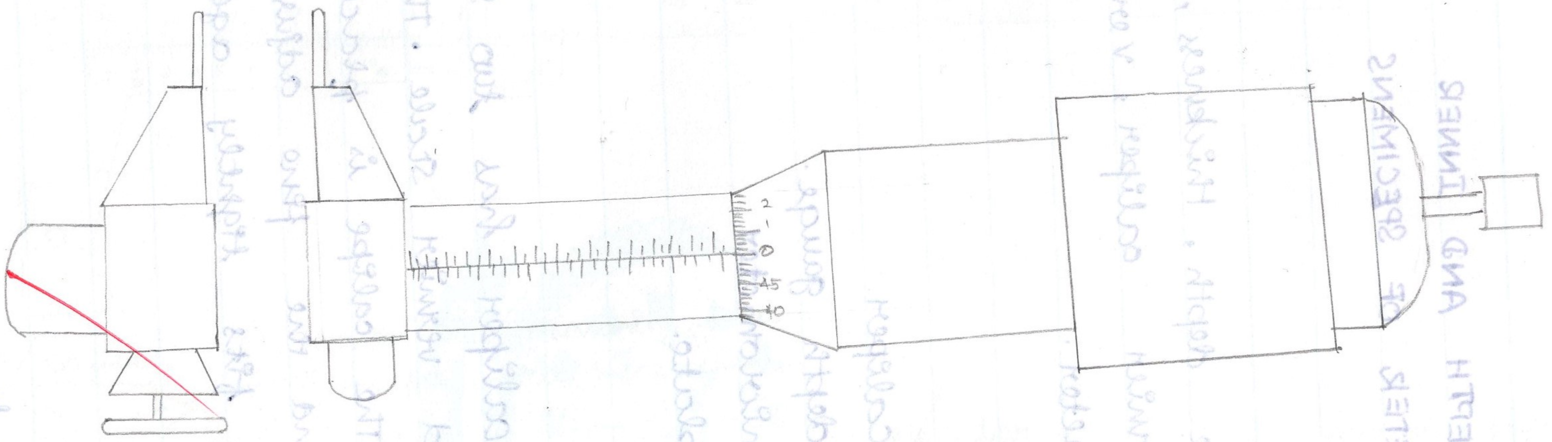
Vernier caliper has two scales namely the main scale and vernier scale. The vernier scale moves along main scale. The calipe is placed on the object to be measured and the fine adjustment screw is rotated until the jaw fits tightly against the specimen.

Procedure:

The vernier caliper was checked for zero error.

The depth measuring scale was extended to approximate size and it was placed inside the specimen such that it was touched the scale touched surface plate.

INSIDE MICROMETER



The locknut was adjusted for correct position

The main scale and vernier scale reading were noted down and then tabulated.

Vernier depth gauge:

It consists of a triangular base, extension rod and plunger. The reading is indicated by an indicator at the main scale and vernier scale. The length of the rod can be moved by adjusting screw.

Procedure:

The triangular base was placed on the surface plate.

The base of the depth gauge was placed the through hole and the scale displaced upwards and main scale readings were noted.

The above procedure was repeated for ~~difficult~~ different position and reading were noted.

Inside Micrometer:

It is used for measuring internal dimensions. It has mainly four parts such as measuring head, extension rod, spacing rollers and handle. The range of instrument can be varied by using different lengths of extension rods and spacing collars. The ranges are (5-30), (25-100) (150-300) mm. The extension rods are made hardened materials and measuring

OBSERVATION : 1

VERNIER DEPTH GAUGE

Range = 0-150 mm

Least count = Value of one main scale division / Total No. of vernier scale division.

= 0.02 mm.

MSR = (i) 70 (ii) 70

VSR = (i) 10 (ii) 4

Total reading = 70.14 mm

OBSERVATION : 2

VERNIER CALIPER.

Range = 0-150 mm.

Least count = Value of one main scale division / Total No. of vernier scale division.

= 0.02 mm

MSR = (i) 71 (ii) 71

VSR = (i) 45 (ii) 41

Total reading = 71.86 mm

CALCULATION:

1). MD = MSR + (VSC × LC) + ZC.

(i) MD = 70 + (10 × 0.02) + 0

= 70.2 mm

(ii) MD = (70 + 4 × 0.02) + 0

= 70 + 4 × 0.02

= 70.08 mm

2). MD = MSR + (VSC × LC) + ZC

(i) MD = 71 + (45 × 0.02) + 0

= 71.9 mm.

(ii) MD = 71 + (41 × 0.02) + 0

= 71.82 mm.

faces are brazed with tungsten. The measuring faces are lapped to ensure high precision and good surface finish.

Procedure:

The micrometer was checked for zero error using a standard 5mm standard specimen.

The specimen was placed with one end touching the anvil and adjustable spindle was moved to the approximate size of specimen such that it is locked between the spindle and anvil.

The above procedure was repeated for different parts of the specimen and the tabulate the reading.

The values was calculated for each reading and average values were taken as a final value.

OBSERVATION -3

VERNIER CALIPER

Range = (0-150) mm

Least count = value of one main Scal division / Total No.of vernier Scale division.

= 0.02 mm

MSR = (i) 14 (ii) 14

VSR = (i) 2 (ii) 20

Total reading = 14.21 mm.

OBSERVATION-4

INSIDE MICROMETER

Range = 0-25 mm

least count = value of 1 maine scal divi / Total No.of pitch scal division

= 0.01 mm

MSR = (i) 15 (ii) 15

PSR = (i) 4 (ii) 15

Total reading = 14.795 mm

Zero error = +30

Zero correction = -0.3 mm.

CALCULATION :-

1). (i) MD = MSR+(VSC x LC) + ZC.

∵ MSR = 14 ; VSC = 2 ;

MD = 14 +(2 x 0.02)

= 14.02.

(ii) MSR = 14 ; VSC = 20

MD = 14 +(20 x 0.02)

= 14.4 mm.

2). (i) MD = MSR +(PSC x LC) + Z.

∵ MSR = 15 ; PSC = 4

MD = 15 +(4 x 0.01) -0.3

= 14.74 mm.

ii) MSR = 15 ; PSC = 15

MSR = 15 +(15 x 0.01) -0.3

MSR = 14.85 mm.

PRACTICAL EVALUATION	
Observation (10)	9
Calculation / Result (10)	9
Viva (10)	9
Total Marks (30)	27
Signature of Faculty	

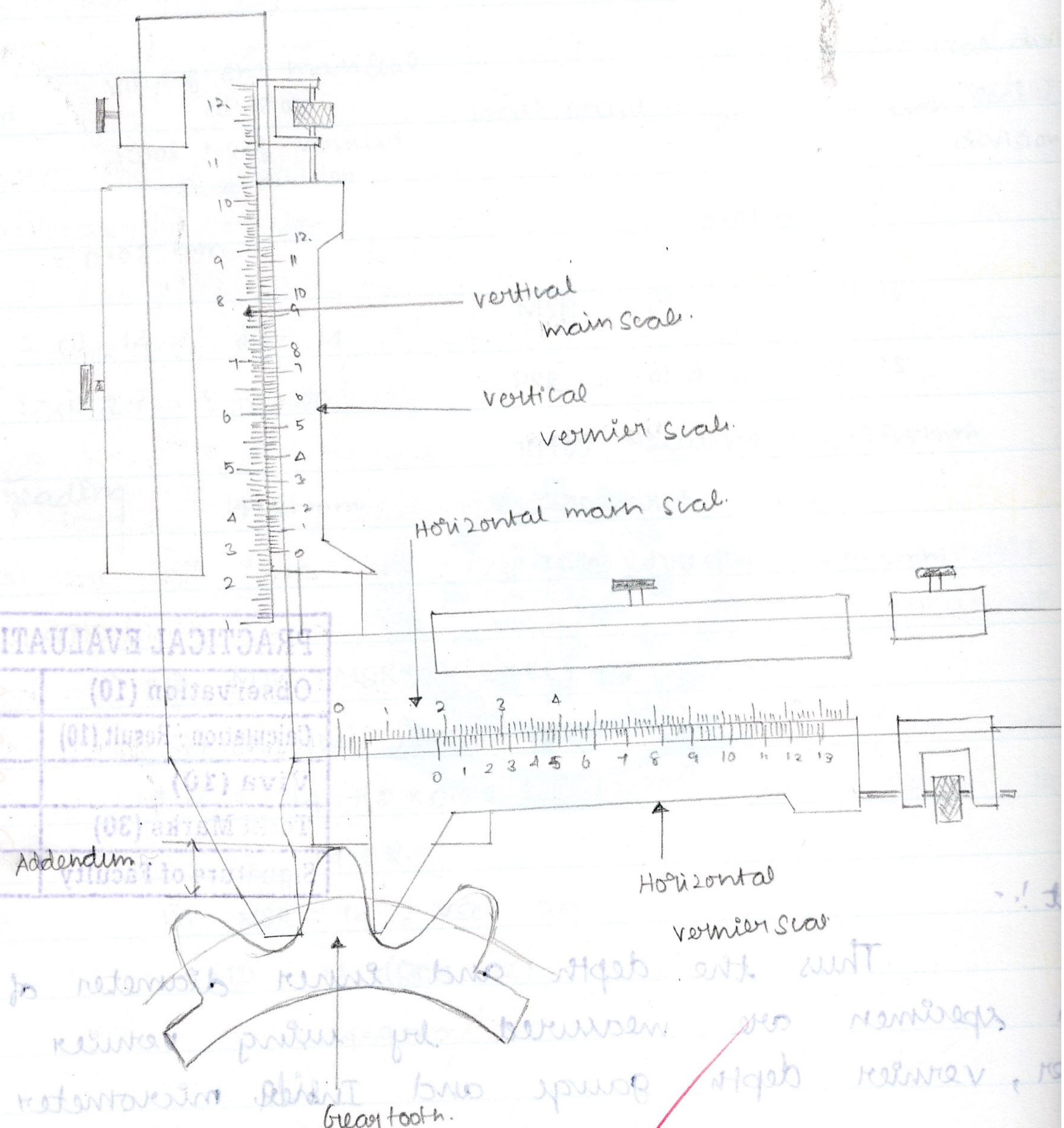
Result :-

Thus the depth and inner diameter of the given specimen are measured by using vernier caliper, vernier depth gauge and Inside micrometer

Depth of the specimen using depth gauge : 70·14 mm
Depth of the specimen using vernier caliper : 71·86 mm
Inner diameter of the specimen using Inside micrometer = 14·21 mm
Inner diameter of the specimen using vernier caliper = 14·795 mm.

3/1/20

Gear tooth vernier caliper.



MEASUREMENT OF CHORDAL TOOTH THICKNESS OF A GEAR WHEEL USING GEAR TOOTH VERNIER CALIPER.

AIM:

To measure the chordal tooth thickness of a given gear wheel using a gear. tooth vernier caliper

Apparatus Required:

Gear tooth vernier
Spur gear speciment.

Description:

Gear tooth vernier consists of two vernier caliper namely horizontal and vertical slides It is based on the principle of vernier caliper. The thickness of a tooth at pitch line and addendum are measured independently by adjusting the slide was screws on graduated beam.

Theory:

Theoretical value of chordal thickness and chordal addendum of a gear tooth can be found using the following expressions.

Chordal thickness $W = T \times M \times \sin(90/T)$

Chordal Addendum $d = M + [(T \times M)/2][1 - \cos(90/T)]$

where, M = Module, T = No. of teeth.

TABULATION:

Specimen No.	Number of teeth	Height of chordal addendum mm	Trial No.	Chordal thickness value mm	Average mm.
1.	50 (S)	1.615	1	2.6	2.51
			2.	2.8	
			3.	2.15	
2.	60 (S)	1.599	1.	2.14	2.25
			2.	2.21	
			3.	2.40	

PROCEDURE :-

The number of teeth was counted on the gear wheel.

The outer diameter of the gear wheel was found using a vernier caliper

The module of the gear was calculated by using expression.

Module(M) = Outer Diameter (No of teeth + 2)

The chordal addendum was calculated using given above formula.

The chordal addendum value was setted in the vertical scale of vernier gear tooth vernier caliper.

Now the vernier scale is made to rest on the top of the vernier gear tooth under rest.

The jaw of horizontal vernier is made to touch the sides of the tooth which will automatically be on the pitch line.

The reading on horizontal vernier which will give the value of chordal thickness was noted

The same for some other tooth on the wheel ~~are~~ was repeated. The average of the values are calculated.

CALCULATION:-

1. Chordal thickness (W) = $(T \times M \times \sin(90/T))$

$$M = \frac{\text{Outer diameter}}{\text{No. of teeth} + 2} = \frac{82}{50+2} = 1.576 \text{ mm}$$

$W = 50 \times 1.576 \times \sin(90/50)$

$W = 78.8 \times 0.03$

$W = 2.364$ mm

Chordal addendum) $d = M + [(T \times M/2)(1 - \cos(90/T))]$

$= 1.576 + \left[\left(50 \times \frac{1.5676}{2}\right)\left(1 - \cos 90/50\right)\right]$

$= 1.576 + [(50 \times 0.7885)(1 - 0.099)]$

$= 1.576 + 0.0394$

$d = 1.6154$ mm

2). Chordal thickness $W = (T \times M \times \sin(90/T))$

$$M = \frac{98}{60+2} = 1.58 \text{ mm}$$

$W = (60 \times 1.58) \times \sin(90/60)$

$W = 2.4825$ mm

Chordal Addendum $d = M + [(T \times M/2)(1 - \cos 90/T)]$

$= 1.5804 + (60 + (1.58/2) \cdot (1 - \cos 90/6$

$= 1.5806 + 0.01896$

$d = 1.59956$ mm.

Exp. No.:
Date :

Result :-

Thus the gear wheel was calculated by using standard tooth vernier caliper.

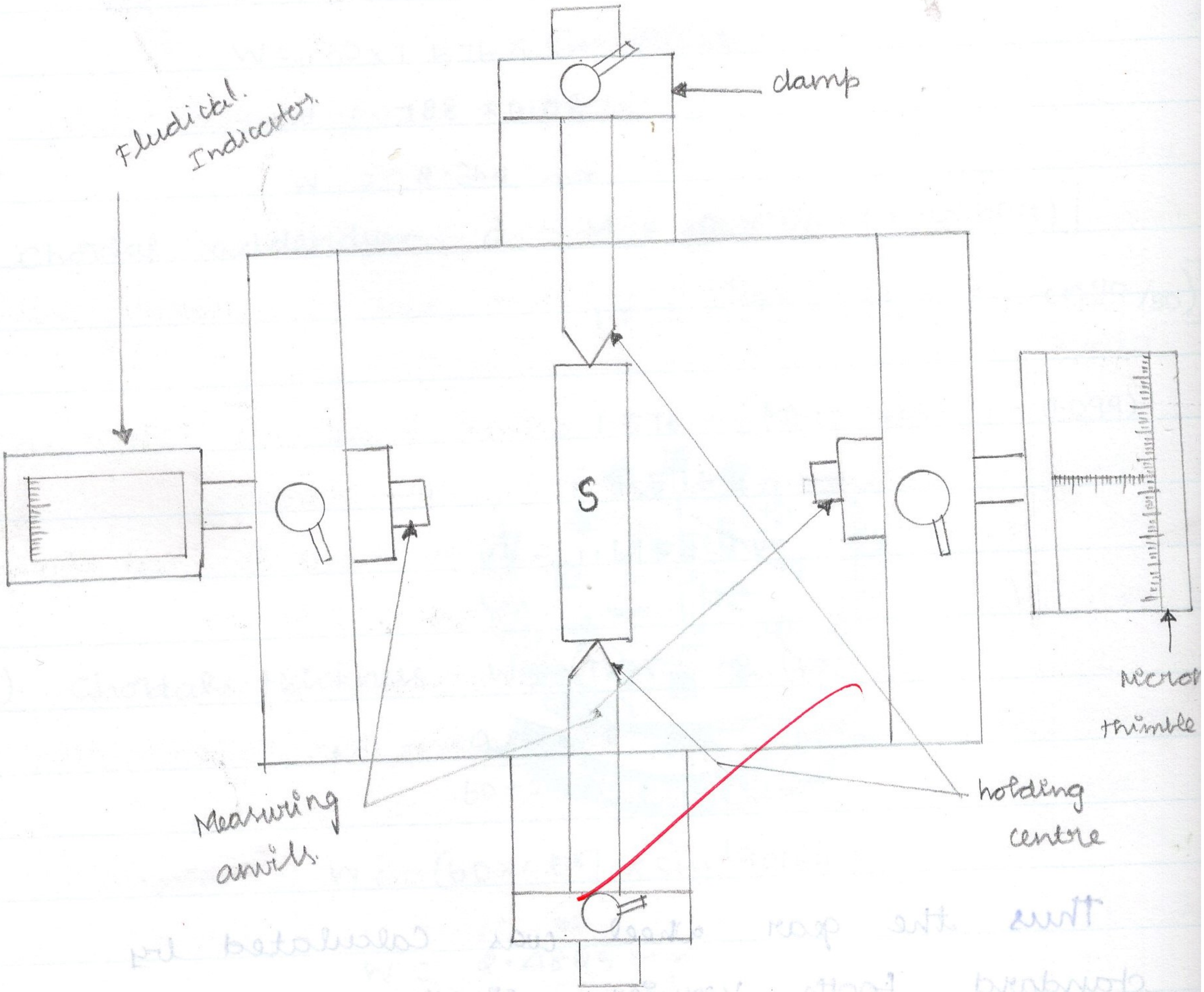
(i) Chordal thickness of specimen (i) = 2.51 mm

(ii) Chordal thickness of specimen (ii) = 2.25 mm.

24/1/20

PRACTICAL EVALUATION	
Observation (10)	9
Calculation / Result (10)	9
Viva (10)	9
Total Marks (30)	27
Signature of Faculty	

Floating carriage Micrometer:-



Exp. No.: 7
Date: 24.01.2020

FLOATING CARRIAGE MICROMEETER

AIM:

To measure the major diameter and effective diameter of the given Screw thread using floating carriage micrometer.

Apparatus Required:

Floating carriage micrometer
Screw thread
Standard cylinder
wires.

THEORY:

The diameter of imaginery cylinder which just embraces the crest of the external thread or root of an internal thread is called major diameter. The diameter of the setting master cylinder should be nearly same as the diameter of thread gauge. The advantage of using setting master gives similar contact at anvils and reduces error in measurement. The setting master is held between centres. Take the reading of the diameter, say this reading is R_2. It is the addition by the threaded workpiece and again second reading is taken, say this reading is R_2. It is the addition of R_1 and R_2. The positive and Negative values are determined by relative size of master and two workpieces

OBSERVATION :-

Master reading = 14.022 mm

Master reading with wire (R) = 16.779 mm

Major reading = 16.359 mm

Major reading with wire (S) = 17.319 mm

Effective diameter = T + P

M = Dimension over the wire

d = 1.350 mm

T = (R ~ S) + master reading

= (17.319 − 16.779) + 14.022.

T = 14.562 mm

P = (0.866 x pitch) − wire diameter

= (0.866 X 2.04) − (1.350)

P = 0.41664 mm

Effective Diameter = T + P

= 14.562 + 0.41664

Effective Diameter = 14.978 mm.

PROCEDURE:-

Make sure the balls are placed on the bottom properly and place the floating top on assembly.
The dial gauage was fixed to zero reading.
the timple of the micrometer was moved such that the spindlle and anvile was toutched each other and ensure zero reading of the dial gauge.

the zero reading was setted in the digital reading placed on the top.

The master piece was fixed between the anvils and micrometer was moved such that the anvil and spindle of micrometer touches eache other and the digital reading was noted down by ensuring there is no deflection on the dial gauge.

The screw thread was placed over the effective diameter is to be measured in between the anvil and spindle and place the wires in between the opposite faces of the screw thread and notedown the digital readings by ensuring there is no deflection in the dial gauge.

PRACTICAL EVALUATION	
Observation (10)	9
Calculation / Result (10)	8
Viva (10)	8
Total Marks (30)	25
Signature of Faculty	

RESULT :-

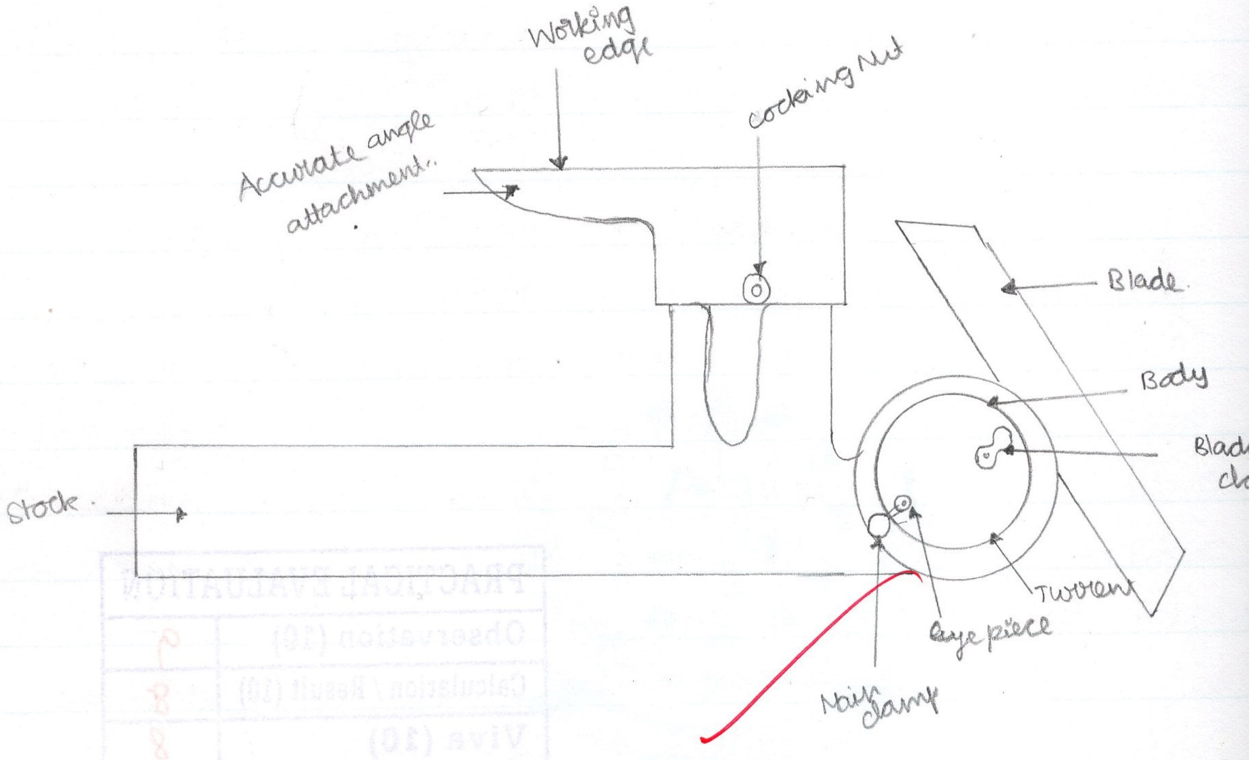
Thus the major diameter and effective diameter of the given screw thread is measured by using floating carriage micrometer.

i) Effective Diameter = 14.978 mm.

ii) Major Diameter = 16.359 mm.

31/01/26

BEVEL PROTRACTOR :-



MEASUREMENT OF ANGLES USING BEVEL PROTRACTOR

AIM :

To measure the angle between faces of a specimen using a Bevel protractor.

APPARATUS REQUIRED :

Bevel protractor

Specimen.

THEORY :

The bevel protractor is used for measuring and angle accurately and precisely with in few minute. It consists of adjustable blade attachment in the main body and vernier caliper scale. The adjustable blade is capable of rotating freely under the main scale is enlarged on the body of the instrument and can be placed in any position. The Protractor is graduated and a complete scale from 0° to 90° to 0° the fixed scale is divided into degrees.

PROCEDURE :

The workpiece was cleaned before measurement. The specimen was placed in between the blades such that any one surface of the angle workpiece noted with the base of the bevelprotractor.

Keeping the references, the blades were adjusted with respect to the base of the bevel protractor such that protractor was madto coinci

TABULATION :-

S.I NO.	Specimen No.	Main Scale reading	Vernier Scale coincidence	Total reading = MSR + (VSC×LC)	Average
1.	1	48	4	48°20′	48°45′
		49	2	49°10′	
2.	2.	59	6	59°30′	59°40′
		59	10	59°50′	

Least count:-

$$\text{Least count} = \frac{\text{One main scale division}}{\text{No. of division vernier scale}}$$

$$= \frac{1^\circ}{12}$$

$$= \frac{1}{12} \times 60 = 5 \text{ minutes.}$$

to coincide with the surface of the workpiece was to be measured.

The position of the blades were adjusted in such a manner that the blades had minimum contact area.

The main scale reading was noted by making the division the coincide scale with the zero of the vernier scale.

Vernier scale coincide was noted on the side of direction of the specimen.

The average of all the reading were calculated

MODEL CALCULATION :-

1). (i) Total reading = MSR + (VSC × LC)

= 48 + (4 × 5')

= 48° 20'

(ii) Total reading = MSR + (VSC × LC)

= 49 + (2 × 5')

= 49° 10'

2). (i) Total reading = MSR + (VSC × LC)

= 59 x (6 × 5')

= 59° 30'

(ii) Total reading = MSR + (VSC × LC)

= 59 + (10 × 5')

= 59° 50'

Exp. No.:		Page No.: 49
Date :		

PRACTICAL EVALUATION	
Observation (10)	8
Calculation / Result (10)	8
Viva (10)	8
Total Marks (30)	24
Signature of Faculty	R

Result :

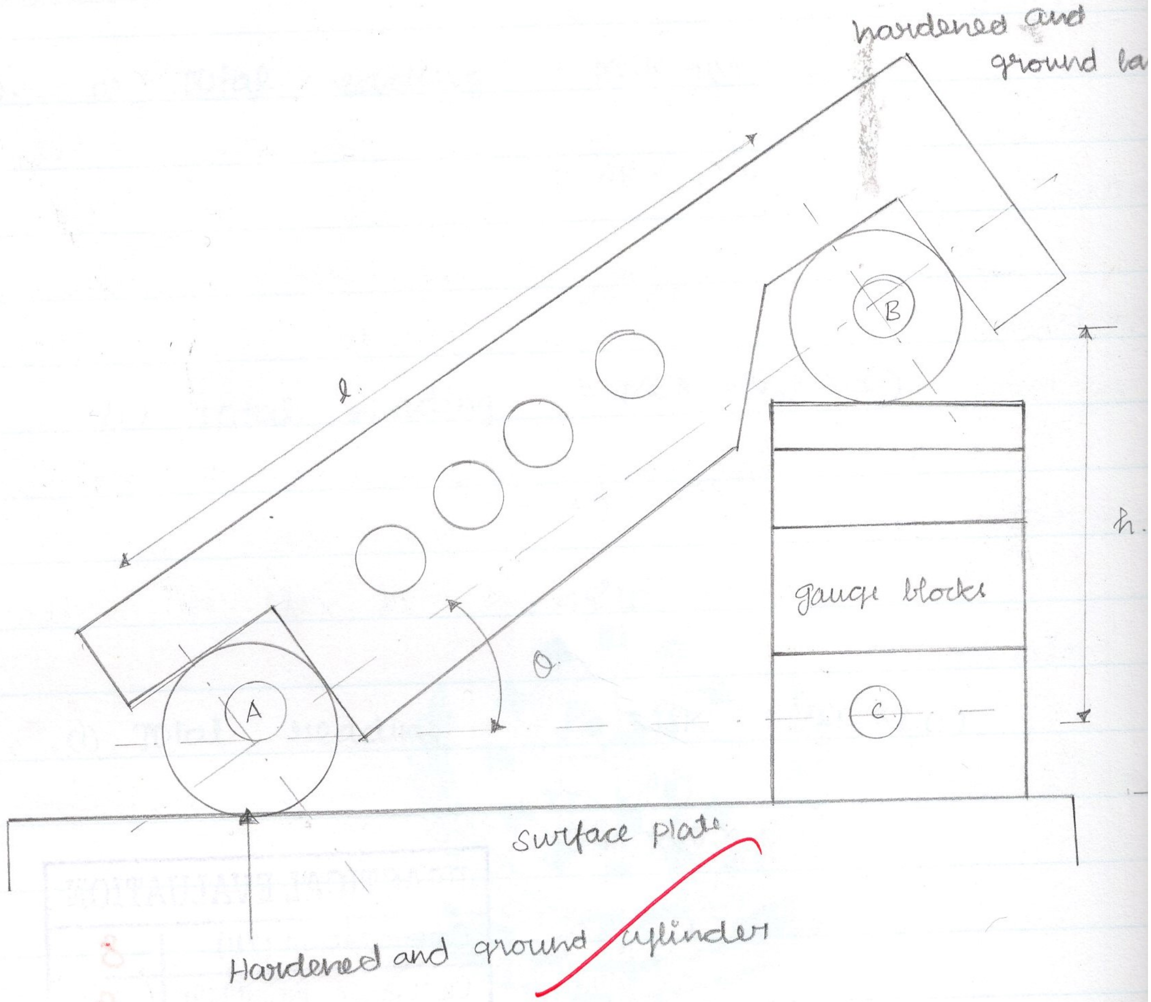
Thus the angle of the specimen are measured using a bevel protector.

Angle of specimen (1) = 48° ~~45'~~

Angle of specimen (2) = 59° ~~40'~~

R 7/2/26

Sine bar.



hardened and ground la
l
h.
B
gauge blocks
θ
A
C
Surface plate
Hardened and ground cylinder

Exp. No.: 9
Date : 7.9.2020

MEASUREMENT OF ANGLES USING SINE BAR.

AIM :

To estimate the taper angles on the given work piece using a sine bar.

APPARATUS REQUIRED:-

Sine bar,
Slip gauge,
Dial gauge,
Surface plate.

THEORY :-

The sine bar is one of the most widely used instruments for precision measurements of angles. It consists of a rectangular section bar of suitable grade steel having accurate ground pin of equal diameter. The sine bar works on the principle that in a right angled triangle. if the principle that in a right angled trinange if the length of the hytenuse is kept constant. the sine bar of the different angle canstant. The sine bar of the different angle can be obtained by varing the length of the perpentiailar

$$\theta = \sin^{-1} (h/L)$$

h = height of the slip gauge in m
L => centre to centre distance of the rollers of the sine bar in m.

TABULATION:-

SNO	Specimen No.	Slip gauges readings		Taper angle of the pl[...]
		Height of slip gauge (h)(mm)	Length of sine bar(L) (mm)	
1.	1	36.90	200	10°37′
2.	2	32.5	200	9°21′

MODEL CALCULATION:-

1). $\theta = \sin^{-1}(h/L)$

$h = h_2 - h_1$

$h_2 = 40 + 6 + 1.90 = 47.90$ mm

$h_1 = 8 + 3 = 11$ mm.

$h = h_2 - h_1$

$= 36.90$ mm

$\theta = \sin^{-1}(h/L)$

$= \sin^{-1}(36.90/200)$

$\theta = 10°37′$

PROCEDURE :

Clean the surface plate, sine bar and workpiece thoroughly.

Place the circular piece on the workpiece placed on the ~~surfaced plate~~

Add slip gauges at the bottom of any of the rollers in the sinebar to make the surface of the bottom of sine bar flat on the workpiece.

The height of the slip gauges was noted.

The angle of the workpiece was calculated by using above formula.

2). $\theta = \sin^{-1}(h/L)$

$h = h_2 - h_1$

$h_2 = 50\ mm$

$h_1 = 9 + 8.5 = 17.5\ mm$

$h = h_2 - h_1$

$\theta = \sin^{-1} 32.5/200.$

$\theta = 9°21'$

Exp. No.:		Page No.: 55
Date :		

PRACTICAL EVALUATION	
Observation (10)	7
Calculation / Result (10)	7
Viva (10)	7
Total Marks (30)	21
Signature of Faculty	R

RESULT :

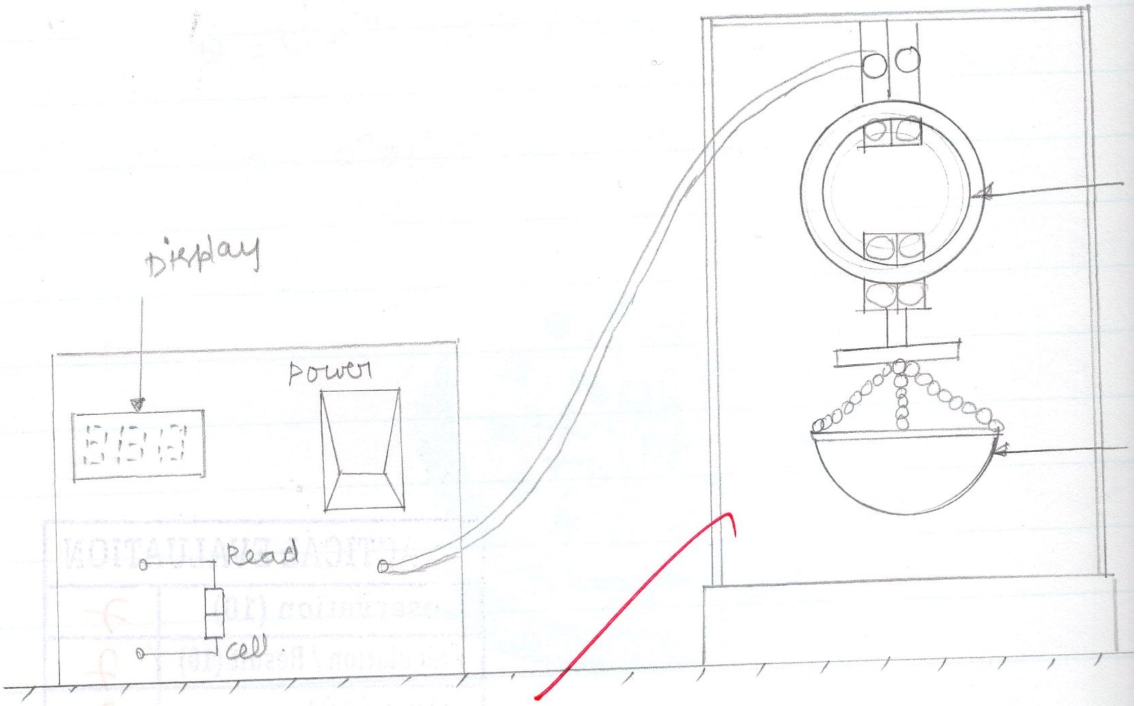
Thus the taper angle was calculated by using sine bar

Taper angle of the given specimen (1) = $10^{\circ} 37'$

Taper angle of the given specimen (2) = $9^{\circ} 21'$

R 8/2/26

FORCE MEASUREMENT SETUP:-



Exp. No.: 10
Date: 8.2.20

FORCE MEASUREMENT

AIM :-

TO determine the applied force by using a force measurement instrument.

Apparatus Required :-

Force measuring setup
Measuring weights.

PROCEDURE :-

The setup to a power line and switch on the instrument is connected.

The zero potentiometer till the display unit reading zero.

The READ / CAL switched ON CAL position using taggle switched.

The READ / CAL switched to CAL position. using ensure. to its zero again.

The CAL potentiometer till the display unit reads 250

The load applied on the pan and the readings M during of force is noted down loading and unloading.

$$\% \text{ Error} = \frac{\text{Applied force} - \text{Indicated force}}{\text{Applied force}} \times 100$$

TABULATION:

S.No.	Loading			Unloading		
	Applied force N	Indicated force N	% error	Applied force N	Indicated force N	%. e
1.	9.81	1 × 9.81 9.81	0	9.81	9.81	0
2.	19.62	2 × 9.81 19.62	0	19.62	19.62	0
3.	29.43	3 × 9.81 29.40	0	29.43	29.43	0
4.	39.24	4 × 9.81 39.24	0	39.24	39.24	0
5.	49.05	5 × 9.81 49.05	0	49.05	49.05	0

MODEL CALCULATION:

$$\% \text{ Error} = \frac{\text{Applied force} - \text{Indicated force}}{\text{Applied force}} \times 100$$

$$= \frac{29.43 - 29.43}{29.43} \times 100$$

$$= 0$$

Exp. No.:
Date :

PRACTICAL EVALUAT

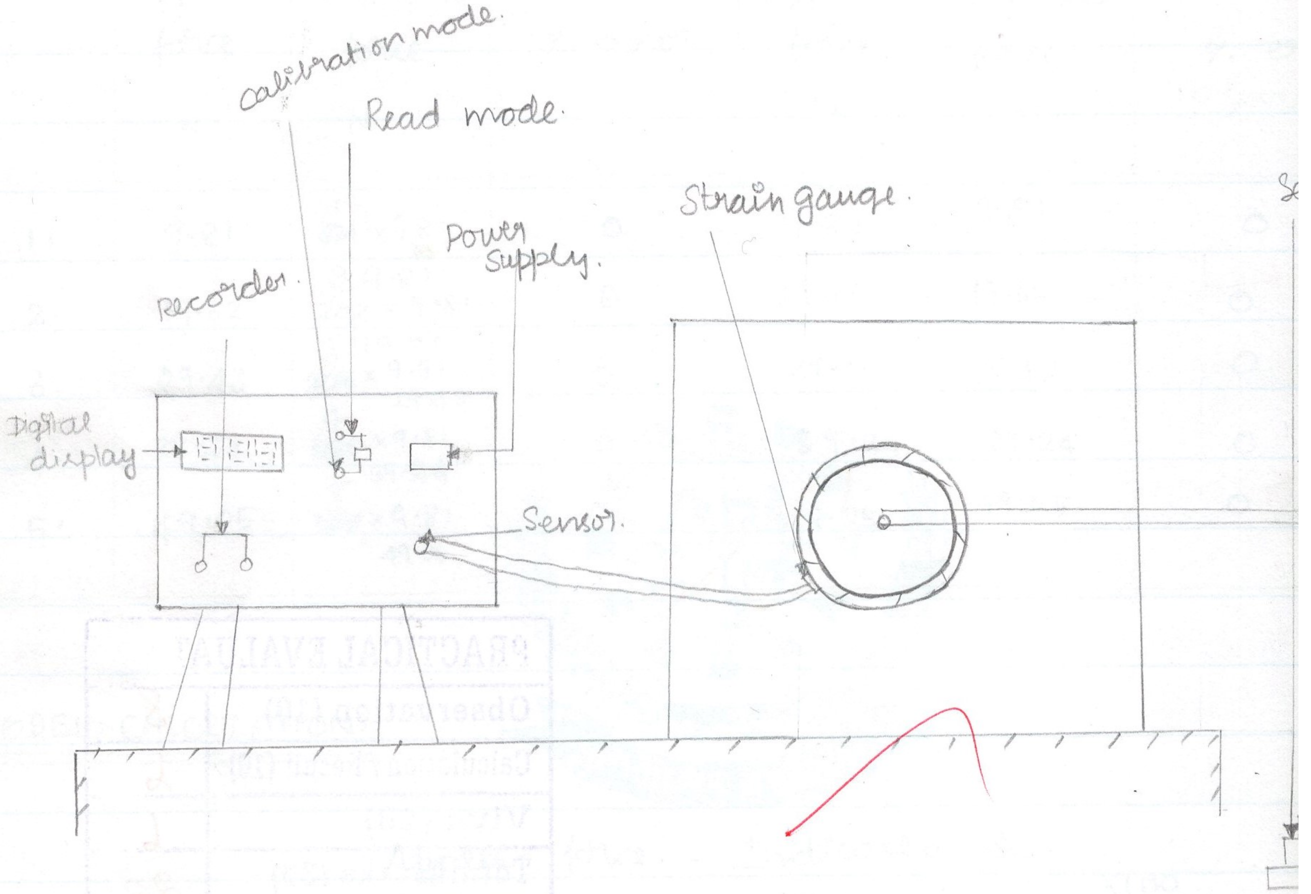
Observation (10)	8
Calculation / Result (10)	6
Viva (10)	6
Total Marks (30)	20
Signature of Faculty	

RESULT :-

Thus the applied force by using the force measurment Instrument was calculated.

14/2/26

MEASUREMENT OF TORQUE USING REACTION TYPE TORQUE TRANSDUCER Setup



Exp. No.: 11
Date : 14.2.2020

MEASUREMENT OF TORQUE USING REACTION TYPE TORQUE TRANSDUCER

AIM:

To measure the torque generated for different loads by using a reaction type torque transducer.

Apparatus required:

Torque Transducer,
Digital Torque indicator,
Dead weights.

Equipment Description:-

Torque transducer convert twisting force to electrical signal. The sensor installed on fixed Shafts is similar to load cells. A reaction type torque transducer system consists of a mechanical element and a sensor. A shaft with four strain gauges is mounted on two perpenticulars 45° helix is bent. Thus the two perpenticular 45° helix determines the principal stress and strain direction for a shaft of the reaction type torque sensor in the form of bridge.

One end of the shaft is fixed and the other end of is having a disc attached with the fulcrum arm of 1m length so that the obtained torque is in kg-m. This deflection caused by the strain gauge gives the O/P in mV

TABULATION:-

S.NO.	Loading				Unloading		
	Applied load kg	Actual torque kg-m	Indicated torque kg-m	% of error	Applied load kg	Actual torque kg-m	Indicated torque kg-m
1.	1	0·6	0·151	74·8	1	0·6	0·151
2.	2	1·2	0·308	74·8	2	1·2	0·302
3.	3	1·8	0·453	74·8	3	1·8	0·453
4.	4	2·4	0·605	74·8	4	2·4	0·605
5.	5	3·0	0·757	74·8	5	3·0	0·757

PROCEDURE :

Connect the sensor to the instrument using connection cable.

Plug the main chord to the main supply and switch on the instrument.

Keep the READ/CAL switch to CAL position and adjust the read potentiometer till the display shows.

Keep the READ/CAL switch in READ position and ensure that it reads 0.00

Apply the READ/CAL switch in READ position and ensure that it reads. fulcrum ends by adding dead weight in steps of 1 kg until 10 kg and removing weight in steps of 1 kg until there is no dead weight on the platform.

Tabulate the display reading for each addition and removal of dead weights.

Exp. No.:
Date :

PRACTICAL EVALUATION	
Observation (10)	7
Calculation / Result (10)	7
Viva (10)	7
Total Marks (30)	21
Signature of Faculty	[signature]

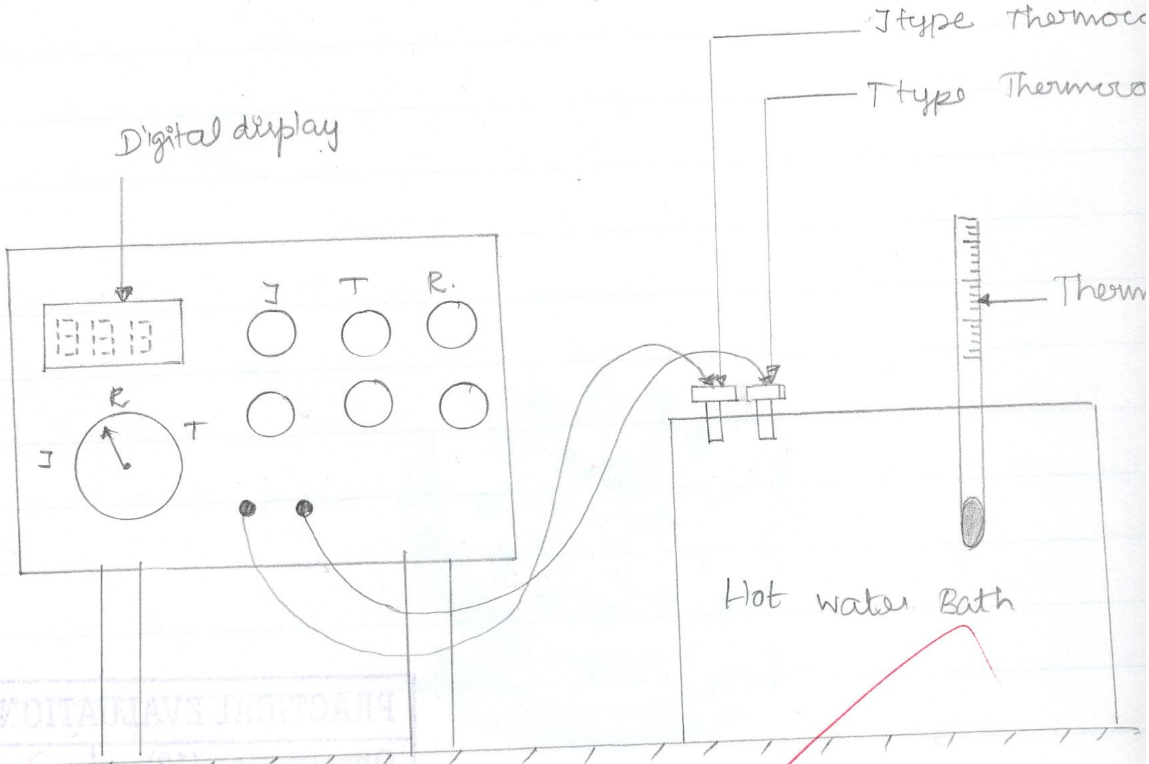
RESULT:-

Thus the torque generated for different loads by using a reaction type torque transducer.

[signature] 28/2/22

MEASUREMENTS OF TEMPERATURE USING THERMOCOUPLE

SETUP



MEASUREMENTS OF TEMPERATURE USING THERMOCOUPLE

AIM :-

To measure temperature using J, K, T thermocouple transducer and a digital temperature indicator.

Apparatus required :-

J, K, T, thermocouples,
Temperature Transducer,
Digital temperature indicator.
Thermometer.
Electric Sterilizer

PRINCIPLE :-

The principle used in thermocouples. is called as the "Principle of thermo-electricity" or. seeback effect It states that "when two conductors of different metal A and B are joined together at one end to form a junction, and this junction is heated to a higher with respect to the free ends, a voltage is developed at the free ends. if these two conductor of metals at the free ends are connected, then the emf setup will establish a flow of current

DESCRIPTION:-

The main parts of a thermocouples. arrangement used to measure temperature. temperature are as follow The termocouple. hot junction J_H will be introduced into the place where temperature is to be. measured.

TABULATION : 1

Drop in temperature = 2° c.

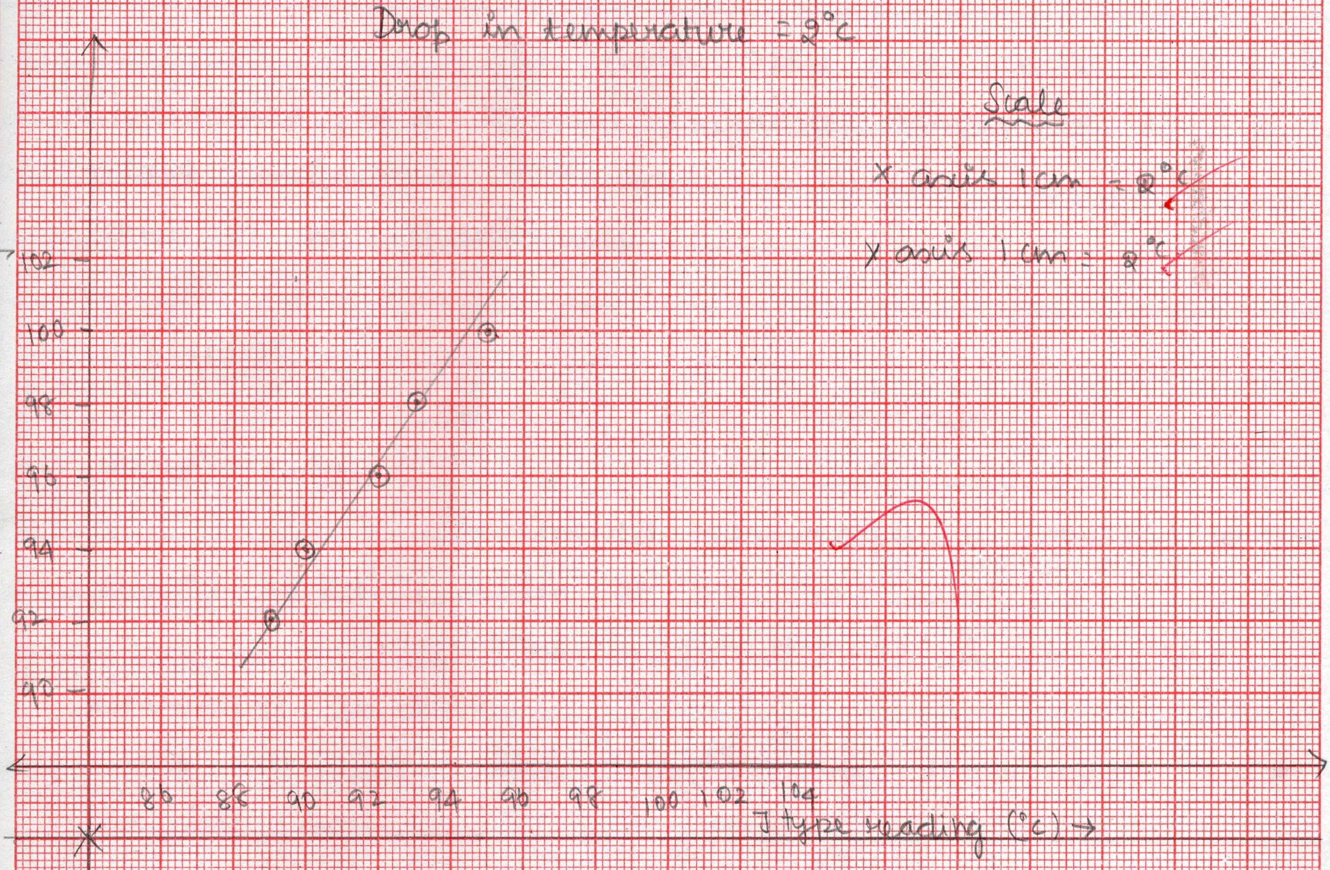
S.NO	Thermometer reading °c	J-type Reading °c
1.	100	95
2.	98	93
3.	96	92
4.	94	90
5.	92	89

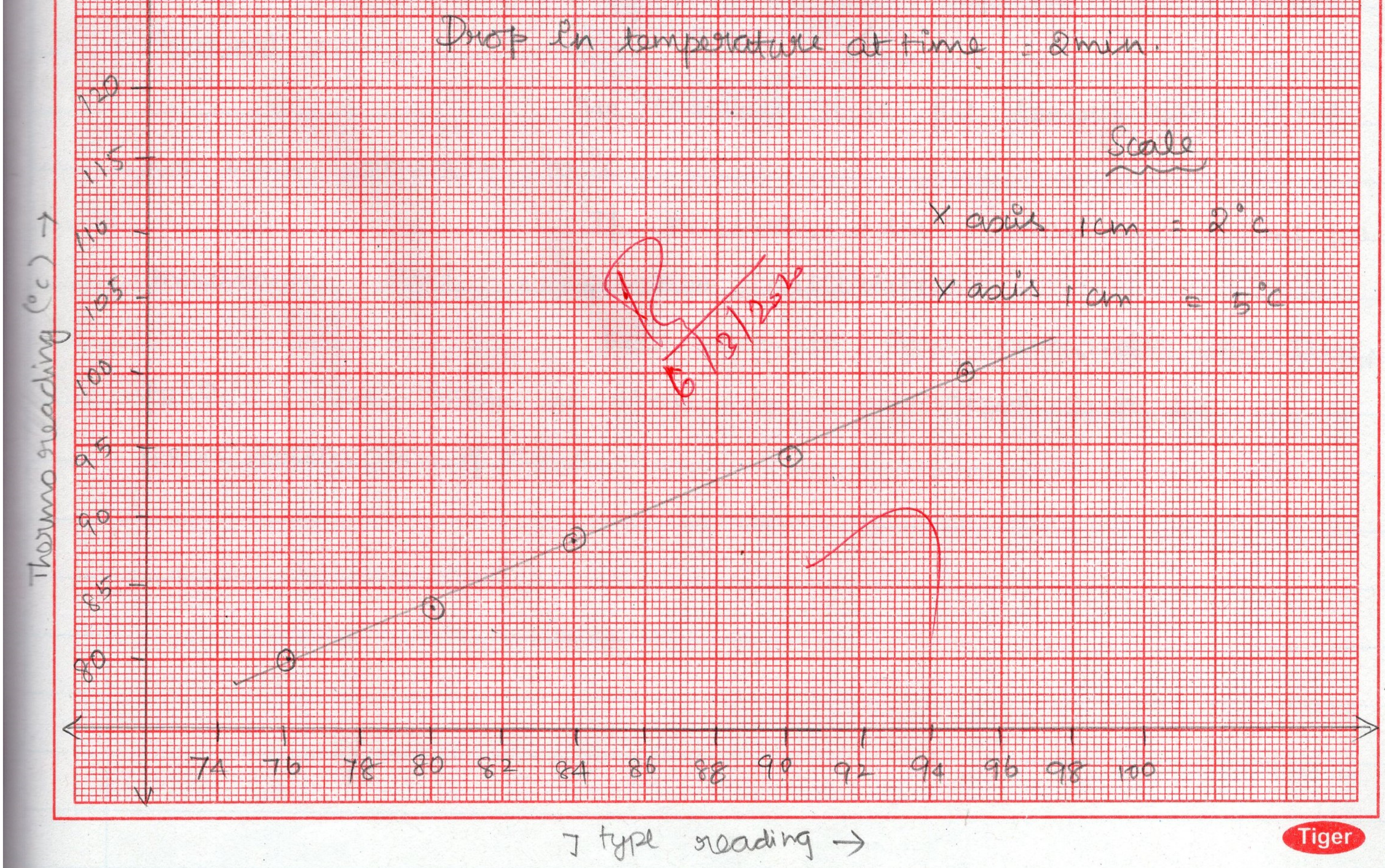
TABULATION - 2.

Drop in temperature for time = 2 min.

Sl NO	Thermometer reading	J-type Reading °c
1.	100	95
2.	94	90
3.	88	84
4.	84	80
5.	86	76

Ex NO: 12
28.2.2020





Exp. No.:
Date :

The thermocouples cold junction Jc is maintained at a constant reference temperature. A voltage measuring instrument is connected to the free ends of the thermocouples.

PROCEDURE :-

Select J/T type thermocouples using selector switch.

The selected thermocouples is connected to the sensor socket provided at the front panel.

Minimum potentiometer is set to read temperature in display.

Keep the J/K type thermocouple inside the hot bath.

Heat the water in the hot bath using electrical energy.

The display that the temperature in the hot bath directly in °C.

If necessary, adjust minimum point for maximum level temperature calibration.

Note indicator and thermometer readings for a fixed span of drop in temperature and for fixed intervals of time.

Exp. No.:
Date :

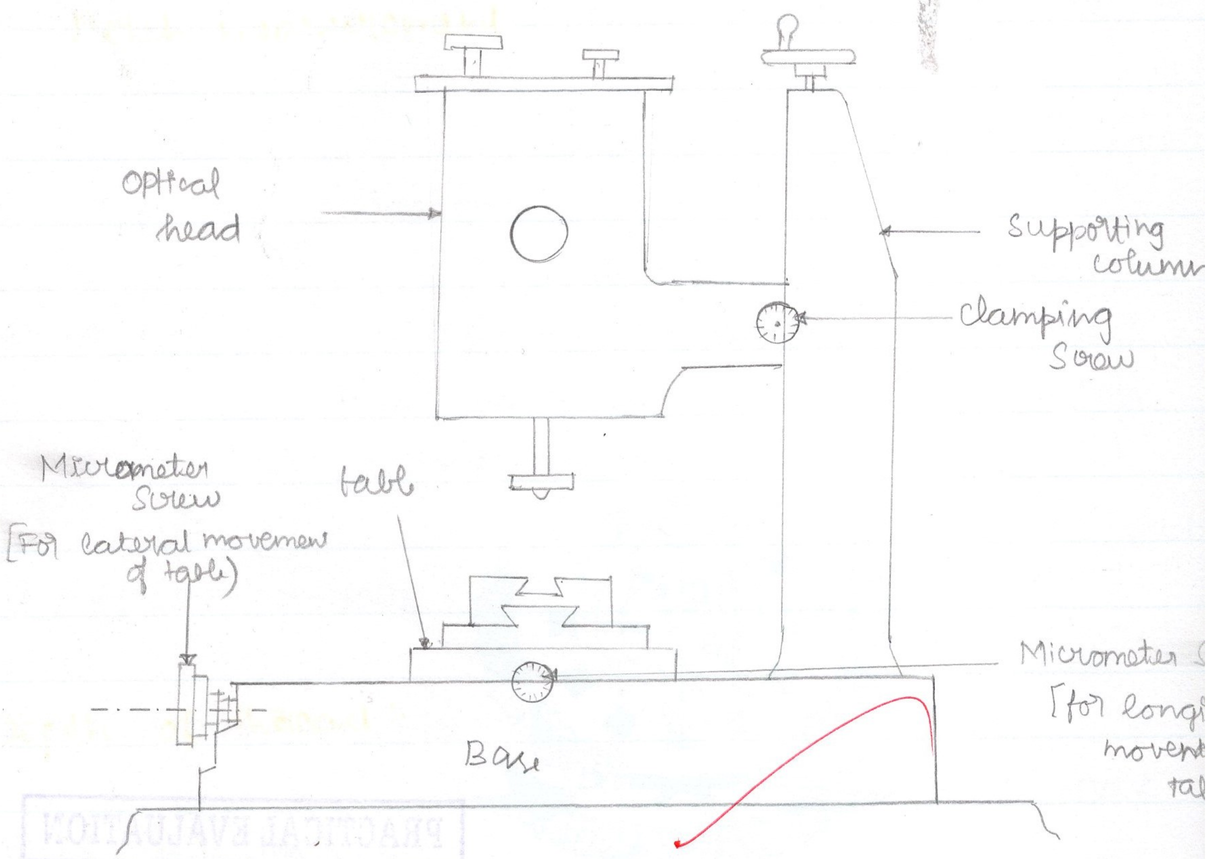
Page No.: 41

PRACTICAL EVALUATION	
Observation (10)	8
Calculation / Result (10)	8
Viva (10)	8
Total Marks (30)	24
Signature of Faculty	[signature]

RESULT :-

Thus the measurement of temperature using thermocouple was calculated.

TOOL MAKER's MICROSCOPE:-



Exp. No.: 13
Date : 6.3.2020

MEASUREMENT OF SCREW THREAD PARAMETERS USING TOOL MAKER'S MICROSCOPE

AIM:-

TO measure the pitch, thread angle and depth of the screw thread using tool maker's microscope.

Apparatus required:-

Tool maker's microscope.
Screw thread.

Description:-

The tool maker's microscope essentially consist of the cast base, the main lighting unit, the upright with carrying arm and the lighting microscope. The rigid cast base is resting on three foot screws by means of which the equipment can be levelled with reference to the built-in spirit level.

The base carries the co-ordinate measuring table which consisted of two measuring slides; one each for directions x and y and a rotary circular table provided with the glass plate. The slides on precision balls in hardened guide ways warranting a reliable travel. Two micrometer screws each of them having a measuring range of 0 to 25mm permit the measurement table to be displaced in the direction x and y. The range of 25mm permit the measuring table to be displaced in the direction x and y.

OBSERVATION:

Least count of micrometer 1 : 0·01 mm

Least count of micrometer 2 : 0·01 mm

Least count of circular Scale = 1°/10 = 60'/10 = 6'

Tabulation:

Pitch measurement.

S.I. NO	Initial micrometer reading IM (mm)	Final micrometer reading (mm) FM	Pitch = FM - IM mm
1.	18 + [37 × 0·01] = 16·37	21 + [9 × 0·01] = 21·09	4·72
2.	16 + [3 × 0·01] = 16·03	18 + [37 × 0·01] = 18·32	2·29
		Average	3·505 mm

Depth of thread:

S.NO	Initial Micrometer Reading IM (mm)	Final micrometer Reading FM (mm)	Depth of thread = FM - IM mm
1).	6 + [32 × 0·01] = 6·32	7 + [6 × 0·01] = 7·06	0·74
2).	5 + [7 × 0·01] = 5·07	7 + [37 × 0·01] = 7·37	2·3
		Average.	1·52 mm

The carrier arm can be adjusted in height by means of rack. The main lighting unit has been arranged in the rear of the cast base and equipped with projected lamp where rays are directed via stationary mounted mirror through table glass plate into the sighting microscope.

PROCEDURE:

Calculate the least count of the micrometers and angular provided on the viewing table.

Place the given specimen on the glass table plate.

Switch on the projection lamp

Viewing through the eyepiece, rotate the knob for moving carrier arm on column to get a sharp image of the specimen kept on the glass plate.

Position the specimen such that the table movement in x direction is parallel to the direction of pitch measurement.

Check this by ensuring the crosswire touching the crests of all the teeth during table movement in x direction

Pitch measurement:

Rotate micrometer head x direction of test the vertical dotted line of crosswire on the crest of a thread and note the micrometer reading

Calculate the difference between the above two reading which gives the pitch.

adjacent and Repeat the above for any other set of Calculate the average.

Thread angle :-

Sl. NO.	Initial circular reading (IR) Degree - min	Final circular reading (FR) Degree - min	Thread angle FR - IR Degree - m
1.	0	35° × 2 = 70°	70°
2.	0	32° × 2 = 64°	64°
		Average	67°

Depth of thread measurement:

Rotate micrometer head for y direction to rest the horizontal dotted line of crosswire on the crest rests of the thread and note the micrometer reading.

Calculate the difference between the above two readings which gives the pitch.

Repeat the above for any other set of adjacent crests and calculate the average.

Thread angle measurement:

Rotate the cross wire by the silver colour knob located behind the eye piece to match the flank of the thread with the cross wire.

Now rotate only the cross wire to match the opposite flank and note down the angle.

Calculate the difference which gives the thread angle.

Repeat the above for any other set of opposite flanks and calculate the average.

Exp. No.:
Date :

PRACTICAL EVALUATION	
Observation (10)	8
Calculation / Result (10)	7
Viva (10)	7
Total Marks (30)	22
Signature of Faculty	R

RESULT :-

Thus the pitch, thread angle and depth of the given screw thread is measured using tool maker's microscope.

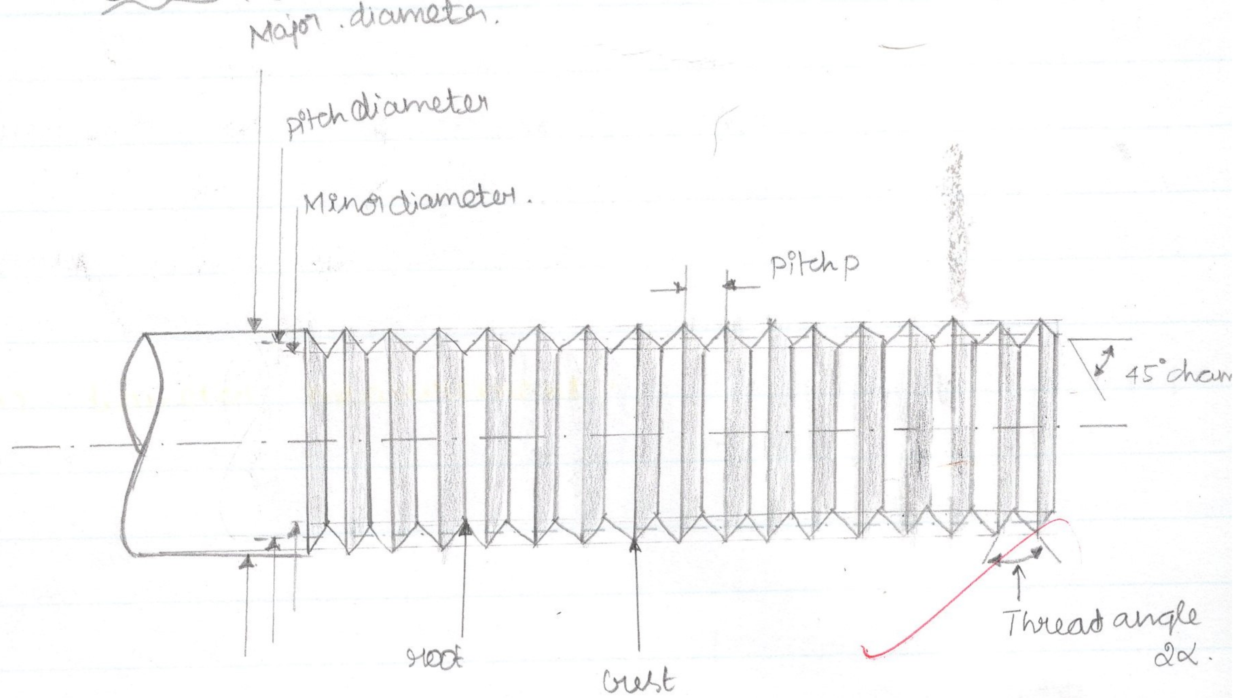
Pitch of the given screw thread : 3.505 mm

Depth of the given screw thread : 1.52 mm

Thread angle of the given screw thread : 67°

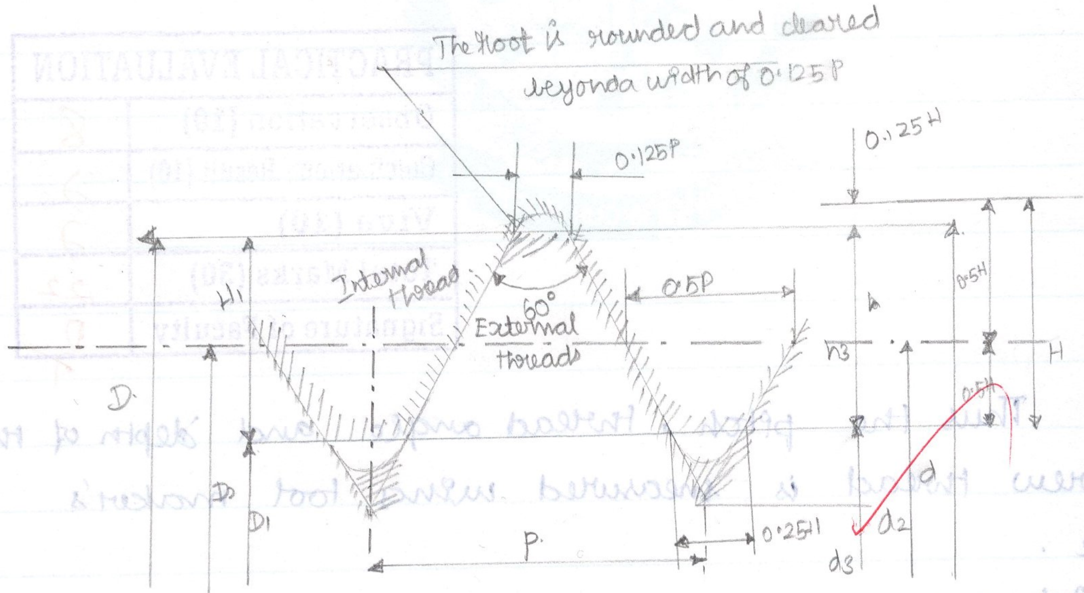
R 13/3/23

SCREW THREAD:



Forms of Screw thread

Metric Screw thread;



MEASUREMENT OF SCREW THREAD PARAMETERS USING OPTICAL PROFILE PROJECTOR.

AIM :-

To measure the pitch, major diameter and minor diameter and thread angle of the given screw thread using optical profile projector.

Apparatus required:-

Optical profile projector.
Screw thread.

THEORY:-

Crest :- It is the top surface joining the two sides of a thread. It may be rounded or flat.

Root :- It is the bottom surface joining the sides of adjacent thread. It may be rounded or flat.

Flank :- The surface of the thread, which connects the crest with the root.

Pitch :- It is the distance measured parallel to its axis between corresponding points on adjacent thread and thread.

Lead :- It is the distance by which a screw thread advances axially in one revolution.

Thread angle :- It is the angle between the flanks of a thread measured on an axial plane.

Flank angle :- It is the angle between the flank of a thread and a plane perpendicular to the axis, measured in axial plane.

Major diameter measurement:-

S.NO.	Initial micrometer reading (IM) mm	Final micrometer reading (FM) mm	Major diam FM-IM mm
1.	0+(2×0·01) = 0·02	3 + [36×0·001) = 3·36	3·34
2.	0+(21×0·01) = 0·21	3 + [7×0·01] = 3·07	2·86
		Average.	3·1 mm

Major Diameter: It is the perpenticular distance between the crests of opposite teeth.

Minor Diameter: It is the perpenticular distance between the root of opposite teeth.

Thread depth : It is the perpenticular between the crest and root of a teeth.

Description:

The profile projector consists of

A). A projector having a light source, a condenser a collimating lens to direct the light passed into the optical system.

B). A work holding table which is of movable type.

C) A projector optic including both mirrors and lenses.

D). A screen where the image is projected.

E). Two micrometer & the range of 0 to 25mm which enable to measure in horizontal as well as vertical planes.

Procedure:

Place the screw thread piece between the anvils provided on the work holding table.

Adjust the table by moving the circular lever provided on the sides to get a proper view of the screw thread.

Fix the cross line chart on the screen by making sure that '0' of main scale coincides with the '0'

Minor diameter measurement:

S.NO	Initial micrometer reading (IM) mm	Final micrometer reading (FM) 'mm'	Minor diam FM-IM (mm
1.	0 + (18 × 0.01) = 0.18	3 + (28 × 0.01) = 3.28	3.1
2.	0 + (20 × 0.01) = 0.2	3 + (20 × 0.01) = 3.2	3.0
		Average.	3.05 mm.

vernier scale on the angular template provided on the screen.

Find the least count of the micrometers and the optical screen.

Major diameter Measurement:

Rotate micrometer head for y direction to rest the horizontal dotted line of crosswire on the top of a crest of a thread and note the micrometer reading.

Again rotate the micrometer head for y direction to rest the horizontal dotted line of crosswire on the moving the specimen such on the line of crosswise crests on the top of the opposite crest of the thread and note the micrometer reading.

Calculate the difference between the above two reading which will give the minor diameter.

Minor diameter Measurement:

Rotate micrometer head for y direction the rest the horizontal dotted line of crosswire on the root of the thread and note the micrometer reading.

Again rotate micrometer head to move the specimen such that horizontal dotted line of crosswire rest on the top of the opposite root of the thread and note the micrometer reading

Exp. No.:
Date :

Calculate the difference between the above two readings which will given the minor diameter.

Repeat the above for any other set of roots and calculate the average.

PRACTICAL EVALUATION	
Observation (10)	8
Calculation / Result (10)	8
Viva (10)	8
Total Marks (30)	24
Signature of Faculty	[signature]

Result:-

Thus the major diameter, minor diameter of the given screw thread is measured by using optical profile projector.

Major diameter of screw thread : 3.1 mm
Minor diameter of Screw Thread : 3.05 mm

[signature] 17/3/2022

P.S.R. ENGINEERING COLLEGE
(Autonomous Institution, Affiliated to Anna University, Chennai)
Sevalpatti, Sivakasi – 626140
Department of Mechanical Engineering

ATTAINMENT VALUE OF LABORATORY OUTCOMES

161ME48 - METROLOGY AND MEASUREMENTS LABORATORY

Course Outcomes:

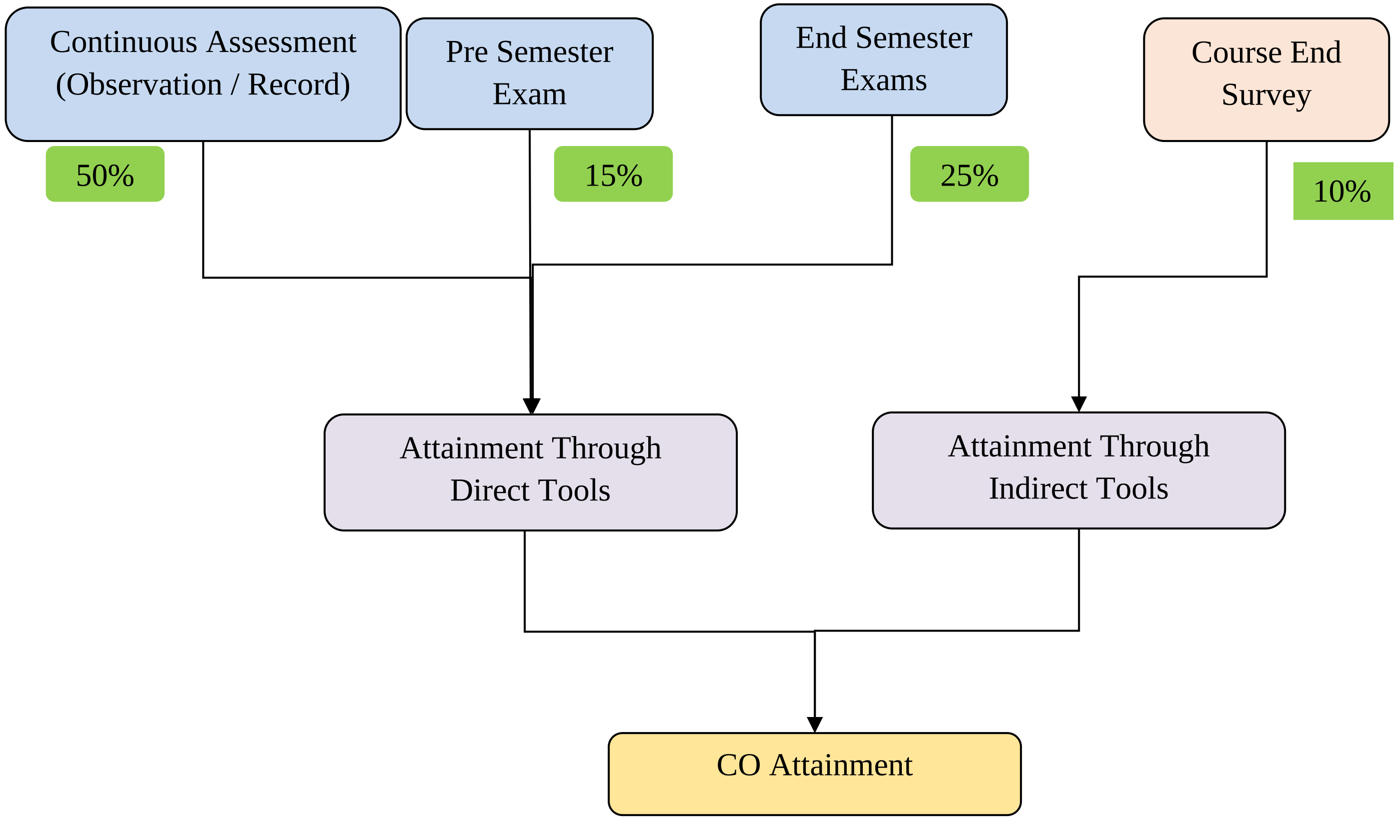
The students will be able to

- CO1. Calibrate linear and angular measurement instruments
- CO2. Check straightness, flatness using dial gauge
- CO3. Measure screw and gear parameters
- CO4. Handle vibration and displacement measuring instrument
- CO5. Use the force and torque measuring tools
- CO6. Learn different temperature measuring techniques

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3				1				2				3			
CO2	3	3							2				3		1	
CO3	3	2			1				3							
CO4	3	2			2				3							1
CO5	3	3							3				1	2	1	
CO6	3	3							3				3		1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE OUTCOMES ATTAINMENT – PRACTICAL COURSES



[Reference from Evaluation Manual]

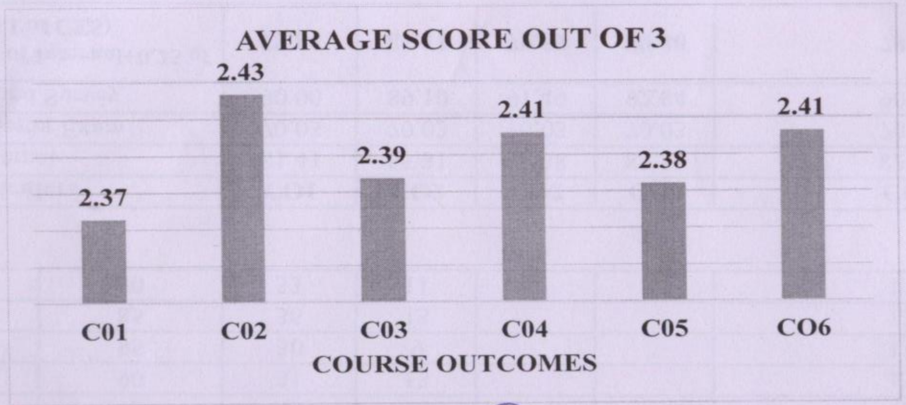
Evaluation of Course Outcomes				
Course Code & Name	: 161ME48 METROLOGY AND MEASUREMENTS LABORATORY			
Course Teacher	: Mr.G.Uthayakumar & Mr.R.Dinagaran			
Year / Semester	: II/IV/ I & II			
Academic Year	:2018-19	EVEN	Batch	2017-2021

Course End Survey

Course Outcomes	Marks obtained for Course Outcome					Total No of Students	Score	
	5	4	3	2	1		Net	100
CO1	80	41	13			134	603	90.00
CO2	75	45	14			134	597	89.10
CO3	90	31	13			134	613	91.49
CO4	95	30	9			134	622	92.84
CO5	85	36	13			134	608	90.75
CO6	90	33	11			134	615	91.79

Particulars	CO1	CO2	CO3	CO4	CO5	CO6
Internal	81.41	85.31	82.38	83.51	82.31	83.72
End Semester Exam	70.03	70.03	70.03	70.03	70.03	70.03
Course End Survey	90.00	89.10	91.49	92.84	90.75	91.79
Attainment (0.65 of Internal+0.25 of ESE + 0.1 of CES)	78.86	81.11	79.59	80.40	79.47	80.42

Course Outcomes	C01	C02	C03	C04	C05	CO6
Average Score Out of 5	3.94	4.06	3.98	4.02	3.97	4.02
Average Score Out of 3	**2.37**	**2.43**	**2.39**	**2.41**	**2.38**	**2.41**



Signature of the Course Tutor | **Signature of the Course Co-ordinator/Moderator** | **Head of the Department**

161ME48 METROLOGY AND MEASUREMENTS LABORATORY

CO- PO Mapping

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3				1				2				3			
CO2	3	3							2				3		1	
CO3	3	2			1				3							
CO4	3	2			2				3							1
CO5	3	3							3				1	2	1	
CO6	3	3							3				3		1	1

Internal CO- PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	81.41				81.41				81.41				81.41			
CO2	85.31	85.31							85.31				85.31		85.31	
CO3	82.38	82.38			82.38				82.38							
CO4	83.51	83.51			83.51				83.51							83.51
CO5	82.31	82.31							82.31				82.31	82.31	82.31	
CO6	83.72	83.72							83.72				83.72		83.72	83.72

External CO- PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	70.03				70.03				70.03				70.03			
CO2	70.03	70.03							70.03				70.03		70.03	
CO3	70.03	70.03			70.03				70.03							
CO4	70.03	70.03			70.03				70.03							70.03
CO5	70.03	70.03							70.03				70.03	70.03	70.03	
CO6	70.03	70.03							70.03				70.03		70.03	70.03

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Internal	83.1	83.5			82.7				83.1				83.4	82.3	83.8	83.6
External	70.03	70.03			70.03				70.03				70.03	70.03	70.03	70.03

Signature of the Course Tutor | **Signature of the Course Co-ordinator/Moderator** | **Programme Co-ordinator** | **Head of the Department**

Evaluation of PO & PSO	
Course Code & Name	: 161ME48 METROLOGY AND MEASUREMENTS LABORATORY
Year / Semester	: II/IV
Direct Tool	: Program Outcomes (POs) & Program Specific Outcomes (PSOs)

Table 3. Average attainment score of Course Outcomes based on Program Outcomes (POs) & Program Specific Outcomes (PSOs)

Attainment of POs & PSOs from a Course considering all the Direct tools

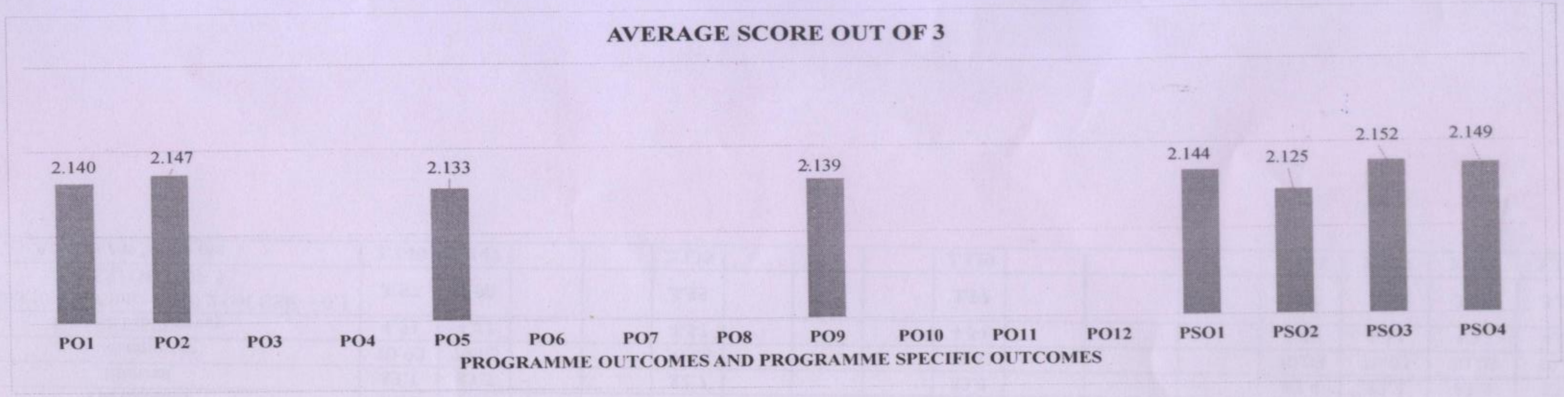
Course End Survey from CO Attainment

Course Outcomes	Survey Score
C01	90.00
C02	89.10
C03	91.49
C04	92.84
C05	90.75
CO6	91.79

CO- PO - PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C01	90.00				90.00				90.00				90.00			
C02	89.10	89.10							89.10				89.10		89.10	
C03	91.49	91.49			91.49				91.49							
C04	92.84	92.84			92.84				92.84							92.84
C05	90.75	90.75							90.75				90.75	90.75	90.75	
CO6	91.79	91.79							91.79				91.79		91.79	91.79
Score	**4.51**	**4.51**			**4.57**				**4.51**				**4.46**	**4.54**	**4.53**	**4.62**

Particulars	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Internal	83.1	83.5			82.7				83.1				83.4	82.3	83.8	83.6
Endsemester	70.03	70.03			70.03				70.03				70.03	70.03	70.03	70.03
Course End Survey	4.51	4.51			4.57				4.51				4.46	4.54	4.53	4.62
Attainment (0.65 of Internal+0.25 of ESE + 0.1 of CES) OUT OF 5	**3.57**	**3.58**			**3.55**				**3.57**				**3.57**	**3.54**	**3.59**	**3.58**
Attainment Value out 3	**2.140**	**2.147**			**2.133**				**2.139**				**2.144**	**2.125**	**2.152**	**2.149**



Signature of the Course Tutor	Signature of the Course Co-ordinator/Moderator	Programme Co-ordinator	Head of the Department