

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 (An Autonomous Institution, Affiliated to Anna University, Chennai) Sevalpatti (P.O), Sivakasi -626140. Tamil Nadu.



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191ME37 METROLOGY AND MEASUREMENTS LABORATORY

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DEPARTMENT OF MECHANICAL ENGINEERING

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P.S.R. Engineering College

<u>Vision</u>

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

<u>Mission</u>

- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.
- 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.
- 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.
- 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.

PSREC/MECH/191ME37/ Metrology and Measurements Laboratory/2020 - 21

SYLLABUS

191ME37 METROLOGY AND MEASUREMENTS LABORATORY L-T-P C

0-0-3 2 **Programme: B.E.** Mechanical Engineering Sem: **Category:** PC 4 To learn the methods of handling different measuring instruments Aim: **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

>

1

(For a	batch	of 30	students)
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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	Continuo	us Assessment	End Semester					
	Lab. Exercise (60%)	Model Exam (30%)	Attendance (10%)	Examination	Total Marks			
	18	9	3	70 [Min Pass: 35]	100 [Min Pass: 50]			
Attendance Mark	90% and above –	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	Fregram Outcomes (105)							Program Specific Outcomes (PSOs)								
Outcomes	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)

Sem:

4

LECTURE PLAN

METROLOGY AND MEASUREMENTS 191ME37 L-T-P С LABORATORY 2

0-0-3

PC

B.E. Mechanical Engineering **Programme:** To learn the methods of handling different measuring instruments

Category:

Aim:

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				

MODES OF DELIVERY

	Course Content						
Course Name with Code	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.

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INDEX PAGE						
Ex.		Da	ate	Marks	G1	
No.	Name of the Experiment	Conduction	Submission	Obtained	Signature	

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	-	Ι
Person	-	Р
Environment	-	Е

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

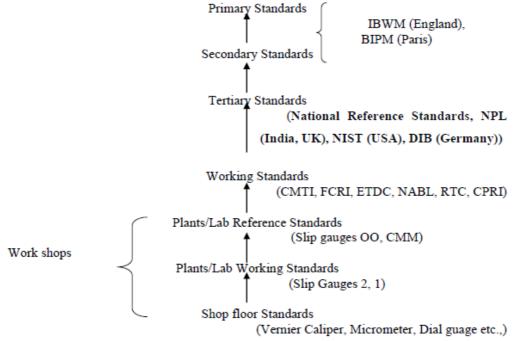
Uncertainty:

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.

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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.,

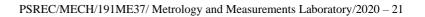
b) Dynamic Errors – result by time variations in the measurand like inertia, clamping friction or other physical constraints in the measuring system.

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



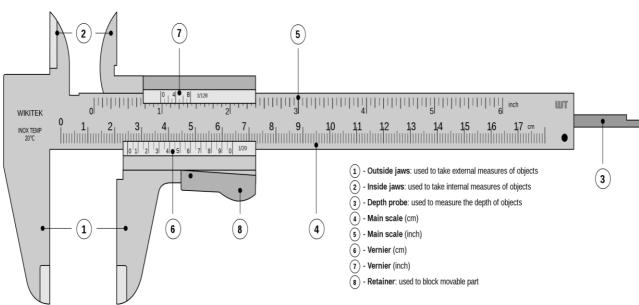


Figure 1 Vernier Caliper

Tabulation:

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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	=

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:

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

where,

MD	_	Measured Dimension
MSR	_	Main Scale Reading
		e
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	

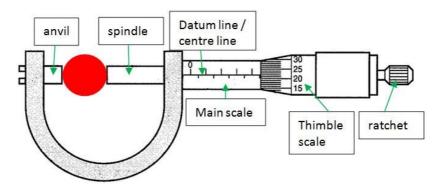


Figure 2 Micrometer

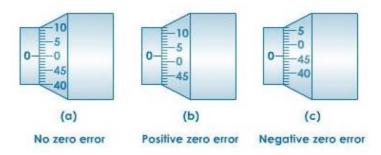


Figure 3 Types of error in Micrometer

Tabulation:

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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	=

CALIBRATION OF MICROMETER

Aim:

To calibrate a given micrometer using slip gauge as standard specimen

Apparatus Required:

- Micrometer
- Set of slip gauges

Formula Used:

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

where,

MD–Measured DimensionMSR–Main Scale ReadingPSC–Pitch Scale CoincidenceLC–Least CountZC–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	

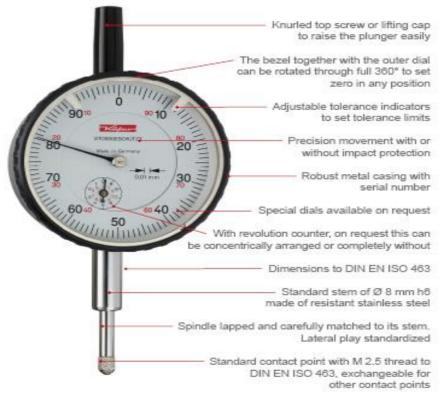


Figure 4 Dial Gauge

Tabulation:

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

Range	=
Span	=
Least Count	=
	_

CALIBRATION OF DIAL GAUGE

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.

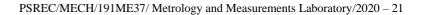
To enable the instrument to be zero for any convenient position, the main scale can be rotated and locked into place using the scale locking screw (bevel clamp) indicated in figure.

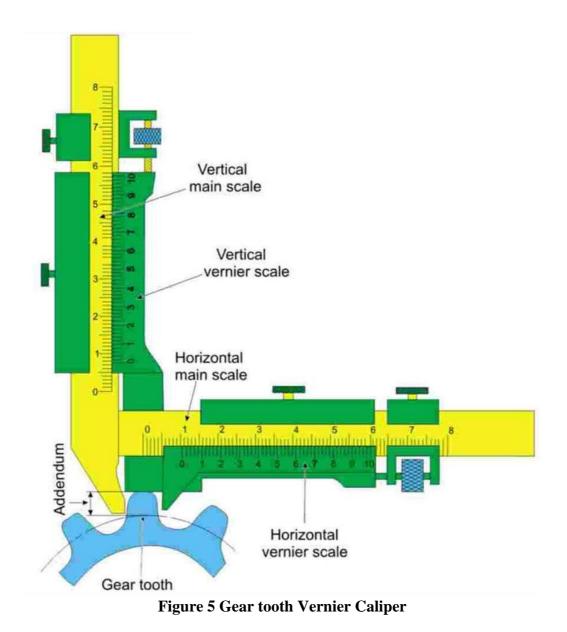
Procedure:

- 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	





Tabulation:

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

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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 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 $W = T \ge M \ge \sin (90/T)$ Chordal Addendum $d = M + [[(T \ge M)/2][1-\cos(90/T)]]$ 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:

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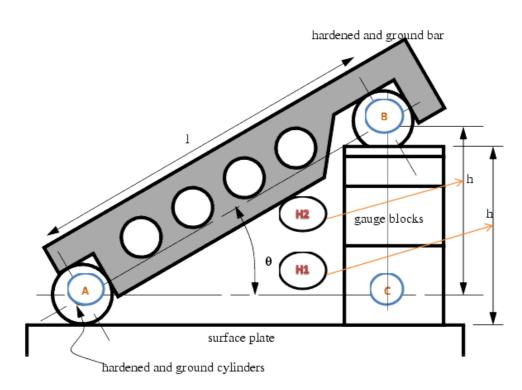


Figure 6 Sine bar

Tabulation:

>

		Slip gaug		
Sl. No.	Specimen No.	Height of slip gauge (h) mm	Length of sine bar (1) mm	Taper angle of the plate

MEASUREMENT OF ANGLES USING SINE BAR

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.

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

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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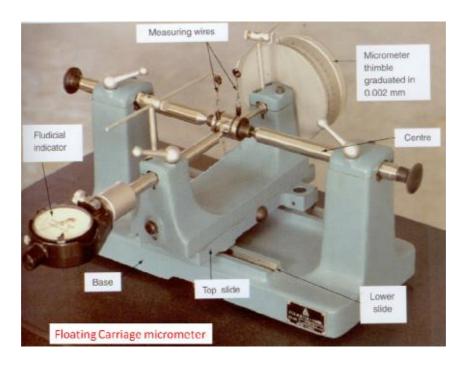


Figure 7 Floating Carriage Micrometer

Observation:

>

Master Reading Major diameter Effective Diameter M	= = = T + P = Dimension over the wire
d	=
Т	= (R - S) + master reading $=$
Р	= 0.866 * pitch – wire diameter =
E	= T + P =

FLOATING CARRIAGE MICROMETER

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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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 =

MEASUREMENT OF DIMENSION OF SPECIMEN USING VERNIER HEIGHT GAUGE

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:

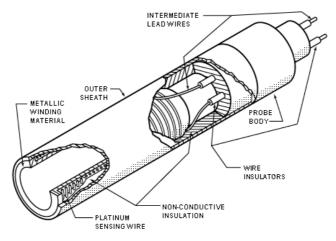
- Wipe the Vernier height gauge and specimen using a soft cloth.
- Check the Vernier height gauge for zero error.
- Loosen the locking screw and expand the measuring jaw to the approximate size of specimen.
- Place the specimen between the surface plate and the measuring jaw.
- Lock the locknut at the 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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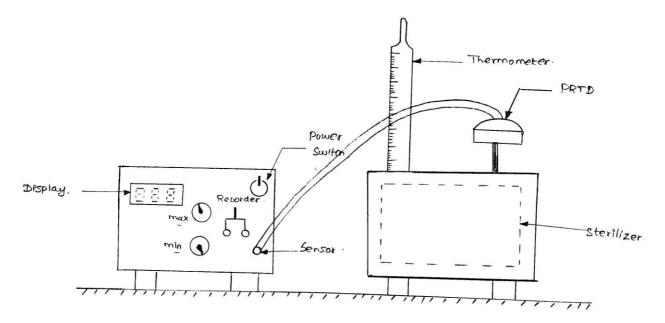


Figure 10 Platinum Resistance Temperature Detector setup

MEASUREMENT OF TEMPERATURE USING PRTD

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:

5

Drop in temperature = $2^{\circ}C$

Sl. No.	Thermometer Reading (°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)

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Result:

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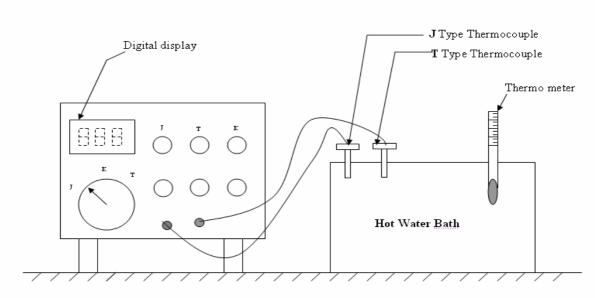


Figure 11 Measurements of temperature using thermocouple setup

Tabulation 1:

>

Drop in temperature = $2^{\circ}C$

-	ature - 2	•	
	Sl. No.	Thermometer reading ⁰ C	J-Type Reading ⁰ C

Tabulation 2:

Drop in temperature for time = $2 \min$

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

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 °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:

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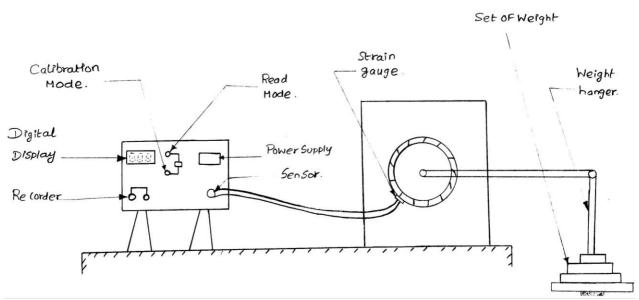


Figure 12 Measurements of torque using reaction type torque transducer setup

Tabulation:

5

		Loading Condition			τ	Unloading	Condition	
S1.	Applied	Actual	Indicated	% of	Applied	Actual	Indicated	% of
No	load	Torque	Torque		load	Torque	Torque	
	kg	kg-m	kg-m	error	kg	kg-m	kg-m	error

X 100

Model Calculation:

Actual torque – Indicated torque

% Error =

Actual torque

Loading

Unloading

EX.NO: DATE:

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 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.

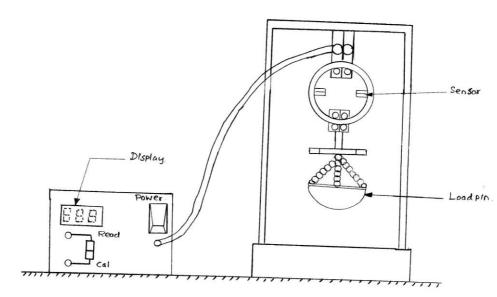
Procedure:

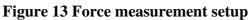
- Connect the sensor to the instrument using connection cable.
- Plug the main chord to the main supply and switch on the instrument.
- Keep the READ/CAL switch in read position and adjust the read potentiometer till the display shows 0.00
- Keep the READ/CAL switch to CAL position and turn the CAL potentiometer 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:

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Tabulation:

>

	Loading		Unloading			
Sl. No.	Applied	Indicated		Applied	Indicated	
51. 110.	Force	Force	% Error	Force	Force	% Error
	Ν	Ν		Ν	Ν	

Model Calculation:

Loading

Unloading

EX.NO: DATE:

FORCE MEASUREMENT

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.

Applied force – Indicated force

% Error

Applied force x 100

Result:

Inference:

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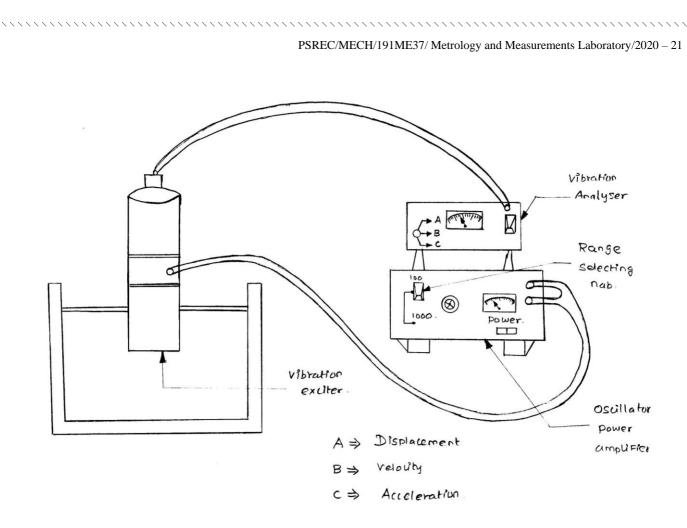


Figure 14 Vibration measurement setup

Tabulation:

>

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

EX.NO: DATE:

VIBRATION MEASUREMENT

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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Figure 15 Optical Profile Projector setup

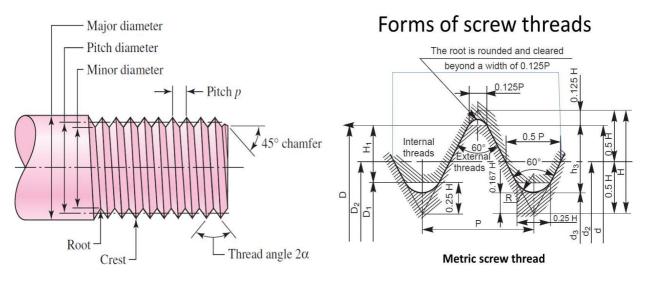


Figure 16 Screw thread

EX. NO.: DATE:

MEASUREMENT OF SCREW THREAD PARAMETERS USING 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.

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Observation:

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

Tabulation:

Pitch

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

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Tabulation:

>

Minor diameter

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

Thread angle

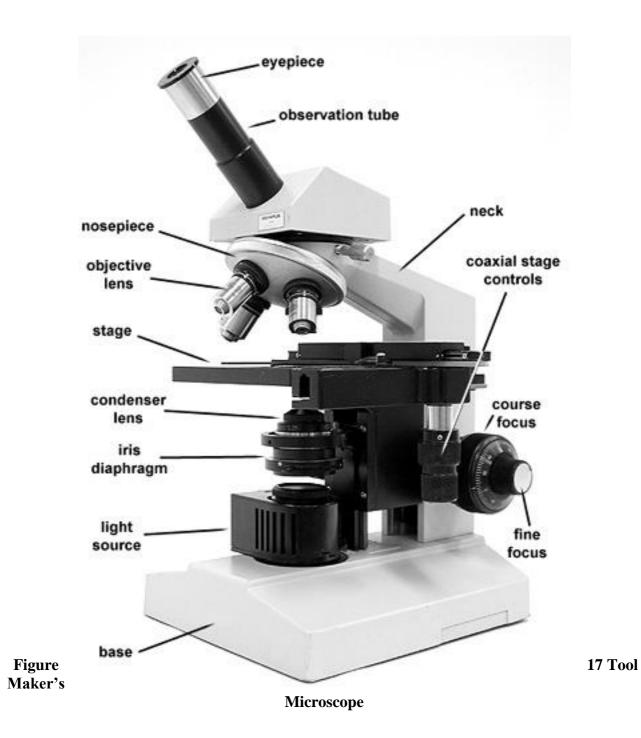
Sl. No.	Initial circular reading IR	Final circular reading FR	Thread angle FR - IR
110.	Degree-min	Degree-min	Degree-min

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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EX. NO.: DATE:

MEASUREMENT OF SCREW THREAD PARAMETERS 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.

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Observation:

5

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

Tabulation:

Pitch

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

Depth of thread

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

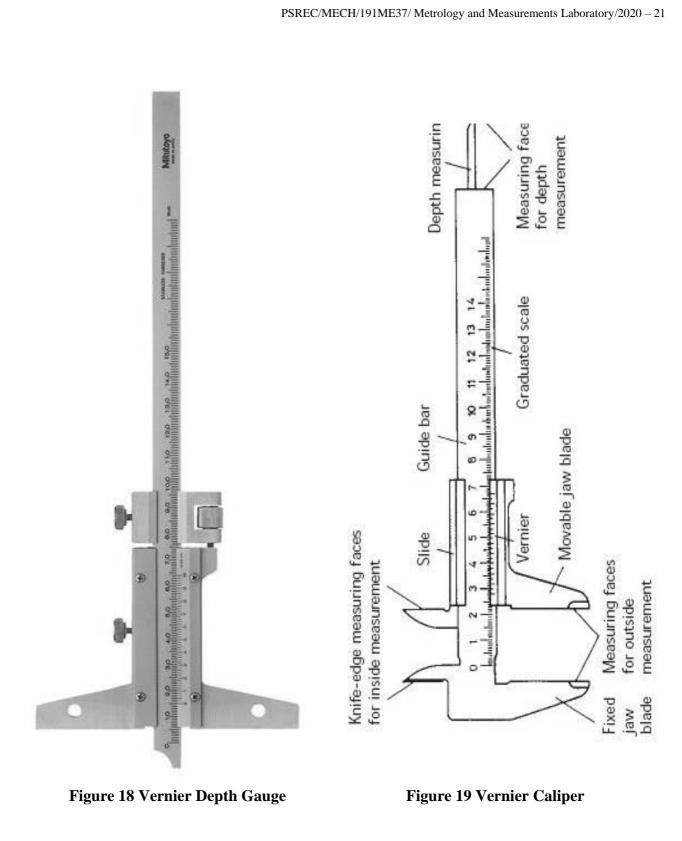
- Rotate the crosswire by the silver colour knob located behind the eye piece to match the flank of the thread with the cross wire.
- Make use of both micrometer head for X and Y direction to move the flank and note down the angle by viewing through the lens below the eye piece.
- Now rotate only the 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=

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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

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Figure 20 Inside Micrometer

Observation 1: **Observation 2:** Vernier depth gauge: Vernier caliper: Range Range = =Least count Least count = = MSR MSR = = VSR VSR = = Total reading Total reading = =

Observation 3:		Observation 4:	
Vernier Caliper:		Inside Micrometer:	
Range	=	Range	=
Least count	=	Least count	=
MSR	=	MSR	=
PSR	=	PSR	=
Total reading	=	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 =

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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.

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.

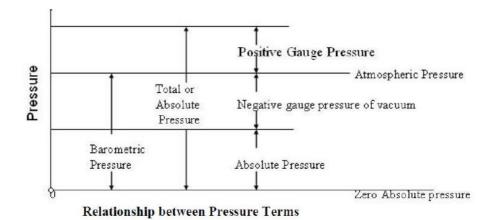
25. Define measure.

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.



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 $1.013 \times 10^5 \text{ N/m}^2$ 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 62° 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

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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° .

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BONAFIDE CERTIFICATE

Certified that this is a Bonafide Record of work done

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Submitted for the Practical Examination held on 2013 2020 (Oral Osometec)

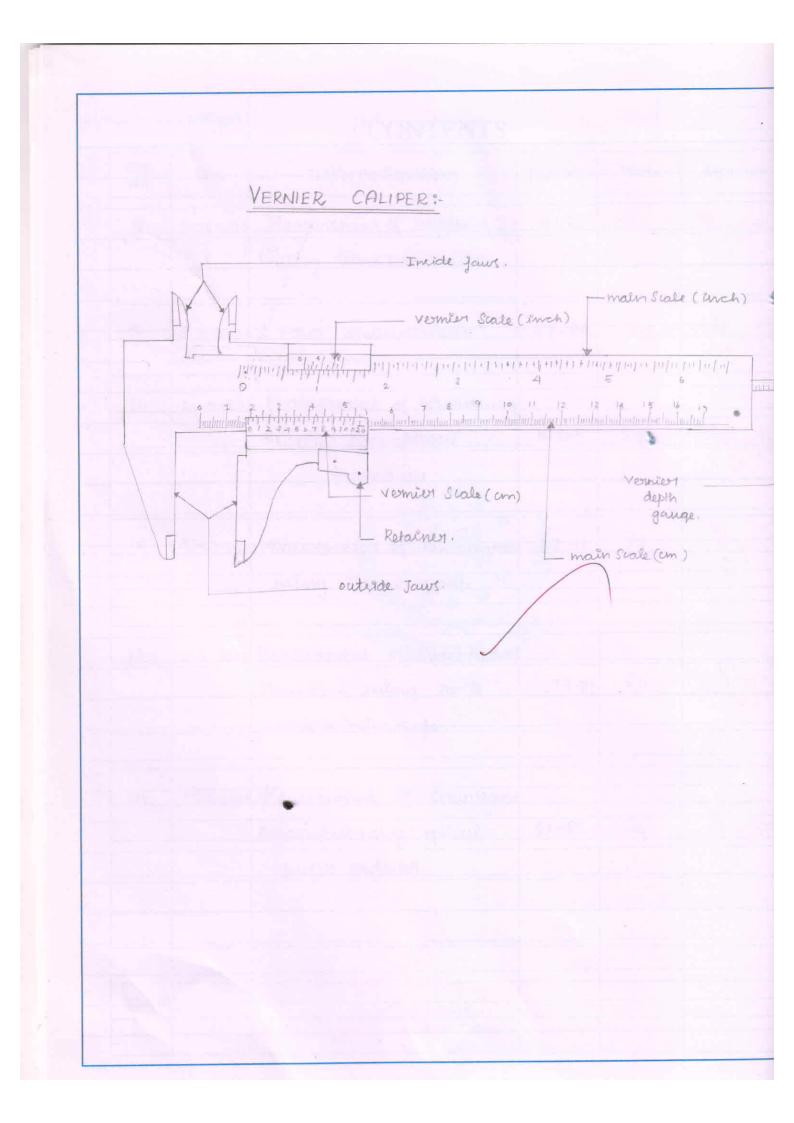
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Exp. No.: 1. Page No.: 1 Date: 22-11-19 MOLTAVARIAN CALIBRATION OF VERNIER CALIPER In million AIM :-To calibrate the given vernier caliper using slip gauge as Standard specemen. Appartatus Required: Vernier caliper, Tabulation Set of slip gauges. Formula used: MD = MSR + (VSC × LC) + ZC where , MD = Measured Demension MSR : Mach Scale reading VSC = Vernier Scale coincidence LC = reast count 2C = Zero correction. Description :-The principle of vernier caliper is that when two scales or divisions slightly different in slige. are used, the difference between them can be utilized to enhance the accuracy of measurent. The vernier Caliper exentially concrete of two steel rules namely main Scale and vormer state and vomier Scale can elede over the main scale. The main scale is engraved on a goted L-shaped frame and the verning. Scale has got 50 divisions.

OBSERVATION :

Range 9 1= 0-150 mm v 70 NOTTABILAD

Span : 150 mm value of: Least count : I main Scale reading

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= 1/50 = 0.02 mm

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Zero correction = 0 , Mapleo Marrie V

Tabulation :

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Exp. No .:. Page No.: 3 Date :_ CALCULATION One end of the frame contains a fisced jaw, which is khaped into a contact tip at its. extremity. A slidling jour which noves along the guiding surfaces. provided by the main scale is coupled to a verticer scale by the main scale is coupled to a. verneer stale. The reliding jaw at its left extremity contains another measuring tep. when two maswing 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 verneer caliper for zero everoy. Select a standard slip gauge and place It between the fixed and movable faws of the vernier Caliper. Note down the main Scale reading Note down the verniler scale coincidence and findout the meanwed dimensions. Repeat the above steps for defferent Rep gauge combinations and tabulate the evior.

8. CALCULATION :i) MSR = 1mm; VSC = 4; LC = 0.02 mm. $MD = MSR + (VSC \times LE) + ZC \cdot$ 0+ 2000 + 1 = 1+ 000 + 0 = 1008 mm. MANNA - WAI IN , LOUBINONA - 2000 NUM Eguton = MD-ND = 1.08-1.03 $\frac{1}{2} = 0.05 \text{ mm}$ (ii) MSR = 1mm; VSC = 20; LC = 0.02 mm MD = 1.5 + (0.4) + 0= 109 mm : wuboove COULD = NID - ND - fourier and share = 1.42 - 1.42 Solice on standard bills brander of tools between the fried and movable fours of the verinites (W) MSR = 10mm ; VSC = ; LC = 0.02 mm Note down the makin scale moder $MD = 10 + (0 \times 0) + 0$ = 10 mm tolling barrison at Joshir Equid = MD-ND LADRAS MEL = 10-10 2 Omm.

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Exp. No.: 2. Page No.: 7 Date : 29.11.19 CBSERVATION : CALIBRATION OF DIAL GAUGE And count - there have AIM: To calibrate the given Deal gauge using Slip gauges. Apparatus sequised: Dial gauges, Slep gauges, and mitanda and Magnetic base. nottolellat Theory : Both micrometer and vernier scal instruments are capable of direct reading. There are, collectively known as comparators tone euch comparator is a dial gauge indicator (09) Elock gauge. The DTI is a mechanital device for sensing linear variation. It measures the displacement of its plunger of a stylus on a circular deal by means of a grotating pointer. Gunerally into equal devisions. One complete surolution of the pointer coverponds to Imm of plunger movement. Hence It is obvious that pointer movement from mark 10 to mark 20 of mark 20 to mark 30 and so on indicates a plunger movement of 0°1 mm This type of instruments has a longor. plunger movement and is scaled arth a recondury

OBSERVATION :

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Range = 0.25 mm. Span : 25 mm. Least count = $\frac{Value ob}{1 malen Scale division}$ Total No of Secondary Scale division = $\frac{1}{100} = 0.01 \text{ mm}$. Sallypere withtoget

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Tabulation :

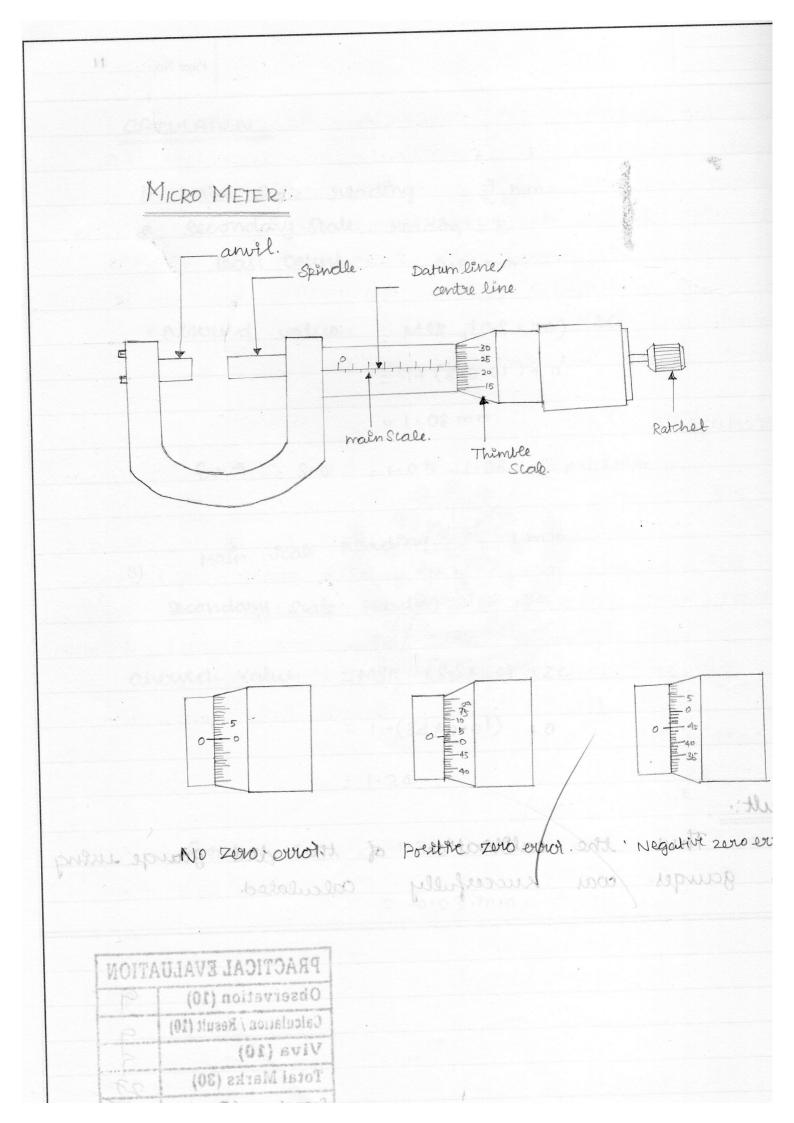
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Exp. No .:... Page No.: 9 Date :__ Scale and pointer to Endicate the number of complete revolution, is equivalent to 1 mm of the. plunger movement. This secondary, scale is also popularly known as revolution counter. To enable the encloument to be 2010 for any conversiont possition, the main scale can be notated and locked ento place wing the scale. locking Source indicated en figure. Procedure : Initfally set the purner of the dial gauge at 2010 reading. when the platform and typ of the plunger are in perfect touch with each other, lift the plunger and place a relected elep gauge. After placing the elep gauges between the plunger and platform, find the ouror. Iskan to place relected Risp gauger and tabulate. ASH 121 - 1-2 - 10147 - - 0-03 - MMA

CAICULATION: at a statistic of the technology the als uplete sevolution is aquinalenter to 1 mm of the 1) Main Scale reading = 1 mm. . secondary stale reading = 8 pour count = 0.01 mm I any courrelation possifions the main scal on he observed value _ MSR + (S-S × LC) + 2C. = 1+ (8×0·01) + 0 = 1.08 mm. : eruber -0.03 mm Main Scale reading - 1 mm 3). + 193 secondary scale reading = 34 and but up After placeng I the elep gauges between Observed value = MSR -(S·S×LC) + ZC. $= 1 + (34 \times 0.01) + 0$ a of noi - 1.34 Covor = 5-0 = 1.31 - 1.34 = -0.03.mm.

Exp. No.:... Page No.: 11 Date :___ Result: Thus the callbratton of the deal gauge using enccerfully Calculated. elep gauges coas **PRACTICAL EVALUATION Observation (10)** 9 Calculation / Result (10) 9 Viva (10) 5 Total Marks (30) 28 Signature of Faculty



Exp. No.: 3 Page No.: 13 Date : 6.12.19 BSFRVATIAN : CALIBRATION OF MICROMETER. some of more to even AIM :-To ralibuate a given incommeter wing slep gauges as standard specemenn. Apparatus Required: Meurometer, Set of elip gauges. Formula to be used: 1 abulation: MD = MSR + (PSC XLC) + ZC where, can doi MD = pleasured Demension, MSR: Marn Scale Reading, PSC = Patch Scale concedence LC = Least count ZC = Zero cogrection. Description: The micrometer essentfally concets. of an accurate Screw having about 10 or 20 threads per and revolves in a forced nul. The end of the solew forms one meanwiling tip and other meanwring. tip is construited by Stattonary anole on the bare of the frame The sure is threaded for certain length and and es. plain afterwards.

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Exp. No.:... Page No.: 15 Date :___ CALCULATION .. The plain portion is called eleeve and its end is the measuring surface. The spende is advanced of retracted by twining a frimble which is connected to the yendle. The spende is seede fft overthe parriel and barriel is the forced part attached arth the prame . The barrel is graduated in units 0.05 cm, the thimble has got as divisions. around its perephery on cercular portion. A lockmut i provoidea for locking a dimension by prevented notion. of spindle. Ratchet stop is provided at the end of the thimble ap to maintain sufficient and uniform measuring preserve. So that etandard condifions of measurements are attained. Ratchet stop connects of an over realing dutch held by a weak spring. when the yendle is prought ento contact with the work the correct meanwring pressure, the clutch. starts allepping and no fulther movement of the spindle takes. place by notation of Matchet. Procedure: Check the micrometer for the emooth. sunning over ets whole grange. Clean the and spends carefully. close the and and spende and mote the zero virog. Calculate the least count.

CALCULATION

The plain portant is called show 1) MD = MSR+ (PSCXLC) + ZC provided of protocology by torushing MSR= 1mm; PSC = 49 mm; LC = 0.01 mm; 2c = +0.02 n MD = 1 + (49 × 0.01) + 0.08. et and homen is i ti burror Goorog - MD-ND, work of which the stress pebborrord is transition . 10.1-12: marting it provoked postone bot = 0.5 mm. 120 docuserents to prestal spindle Rotaret stop 3 provided at their owned (iii) $MD = MSR + (PSC \times LC) + 2C.$ sum menureng pressure so trats standard MSR = 1 mm; PSC = 36; LC = 0.01 mm; ZC = +0.02 m Ratchest styp converti of now and $MD = 1+ (36 \times 0.01) + 0.02.11$ wow out this = 10.38 mm one un puors, a abrille Couron : MD-ND and build publications = 1.38-1.3702 Mahol allowing

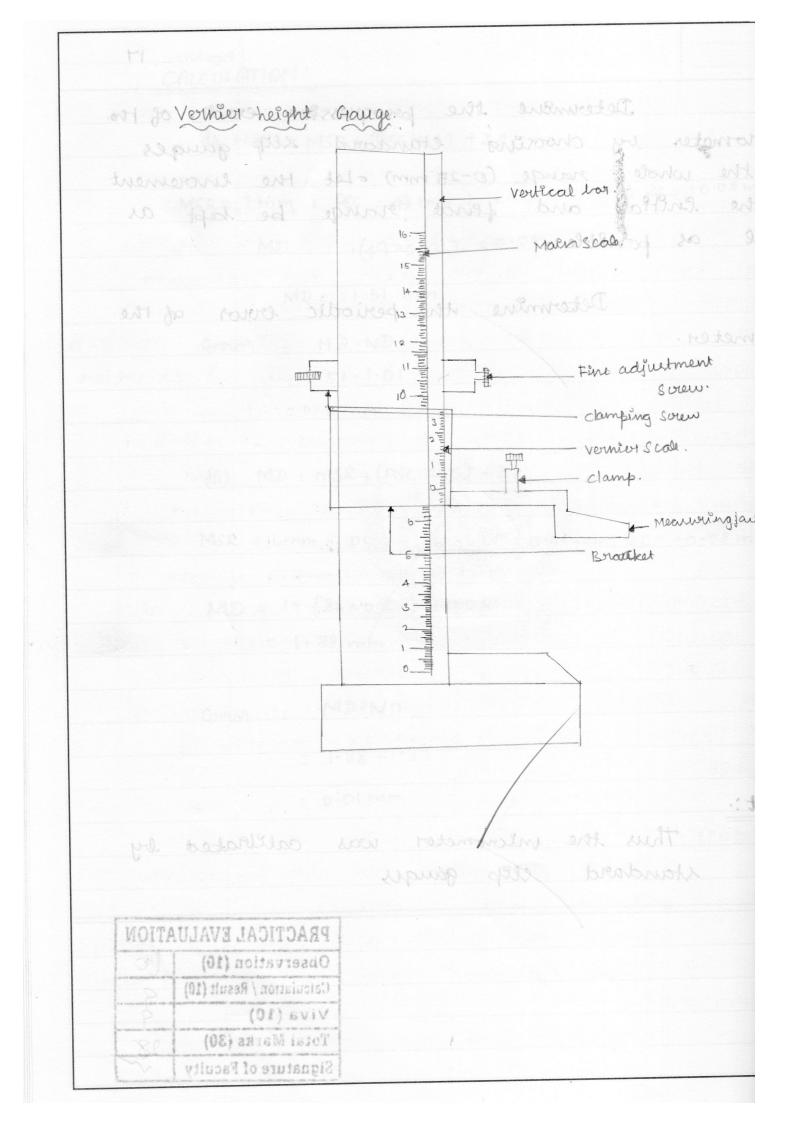
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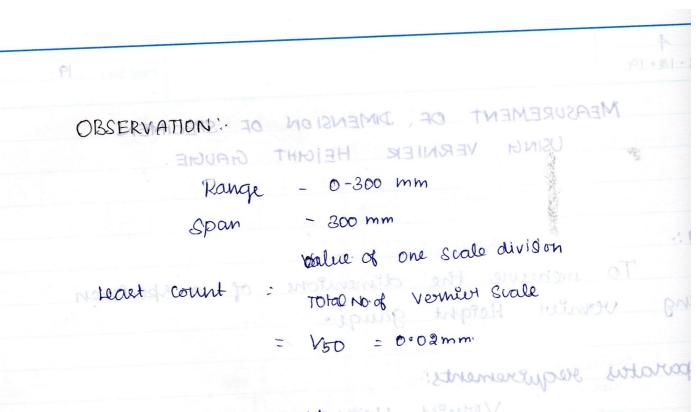
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calculate the plant count

Exp. No.: Page No.: 17 Date : Determent the progressive error, of the. micrometer by choosing etandard klip gauges for the whole range (0-25 mm) olet the enciement En the Enittal and final range be kept as small as possible. Determine the periodic every of the micrometer. Result: Thus the micrometor was callbrated by using standard ellip gauges PRACTICAL EVALUATION Observation (10) AD Calculation / Result (10) Viva (10) 9 Total Marks (30) Signature of Faculty



Exp. No.: Page No.: 19 Date : 13.18.19 MEASUREMENT OF DIMENSION OF SPECIMEN USING VERNIER HEIGHT GAUGE. AIM : To measure the dimensions of a specemen wing vernier Height gauge. Appartatus requirements: Verneer Height gauge. Speamen Swiface plate. Descreption: Vernier Height gauge works on the principle that conen two scale deversons slightly different in rizes are used, then the difference. can be utilized to enhance the accuracy of. measurement. If concert of two scales, the marn. Scale. Thes. is also a verifier scale but attached. with a special base block and other attachments. The whole areembles is made in euch a way to measure height of parts. A removale. damp is attached between meacuring jours and wernier. Both the upper and lower end of measuring gaus is parallel to the bas of Vender helght gauge. The swiface of surface plate is the dature or reference while doing measurements



2010 orden puer Nilaport Horne vors

			ce prate		
Specimen No.	TRIAL NO .	Main Scale Reading	Venuer Scale coincidence	MSR + VSCXLC.	Averac
	1 18 M		ing the gai	DH Homm	
ghtly	1. 50	50	two 8sead	50°16 tout	- 50.3
VANDADAKI	30 8 32	00 50M2	enplace		he h
inaly.	let a	Crafe.	N	15.1 203 ALT	
Nows N	2 2V	om 15th	program	15.2.	117
	ornova Jaws	DOLANISON	between on	Both the upt	ú. d • to2
raint	of Ve		422 . to	gaun es para uge The surge	t gou

Exp. No.: Page No.: 21 Date :... Perocedure. Wipe the vomen height gauge and specemen using a roll doth. Check the vernier height gauge. for 200 longon. Loosen the locking sorew and expand the measuring your to the approximate Rize of Specimen. Place the specimen between the ewiface plate and the meaning faw. Lock the locknut at the correct possition of the specimen. Tabulate the measured readings. FRVICE IS OUR MOTTO + SEM - STT (10)

CALCULATION :.

i) \cdot ∂ TR = MSR $+(VSC \times LC)$ MSR = 50 mm; VSC = 8; LC = 0.02 mm

edure.

men uchig

 $= 50 + (8 \times 0 \cdot 02)$

Spuelos 56.16 mm. Sakar and abar

(i)
$$TR = 50 + (31 \times 0.02)$$

MSR = 50 mm; VSC = 31; LC = 0.02 mm

 $250 \cdot 62 \text{ mm} \cdot 2.$

2). (i) TR = MSR + (VSC XLC)

MSR : 15 mm ; VSC : 5 LC: 0.02 mm

a plote and the measuring james of

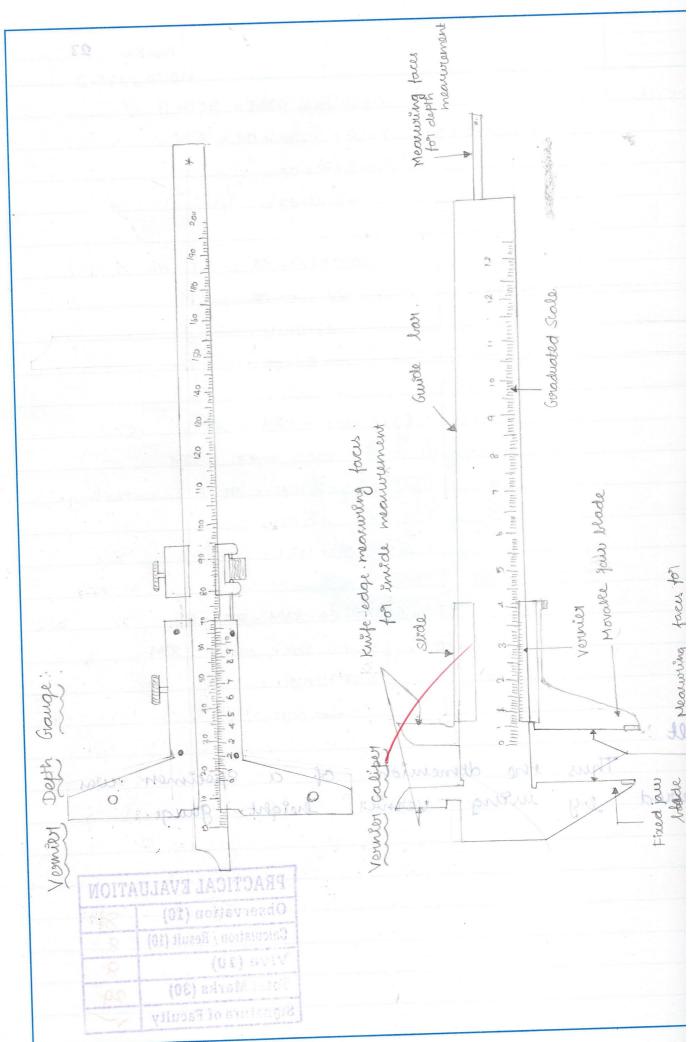
 $TR = 15 + 5 \times 0.02$

= 15+0.1

= 15.1 mm.

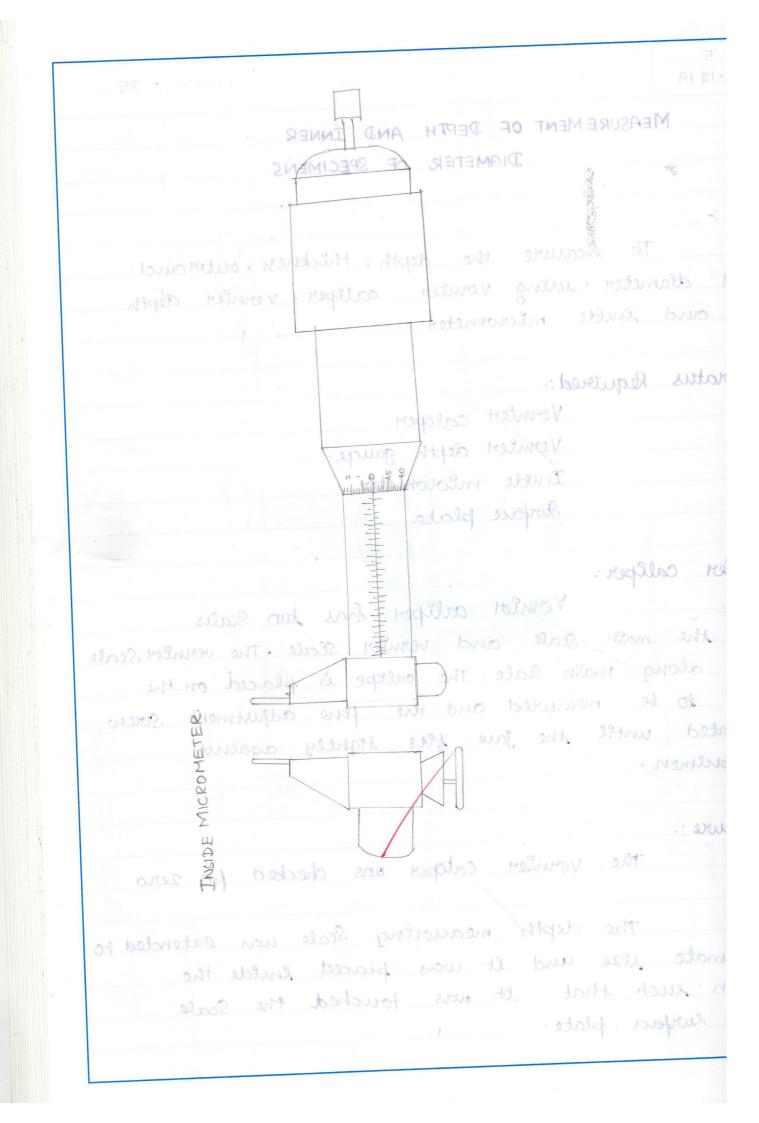
(i) TR = MSR + (VSCXLC), MSR = 15 mm : VSC = 10 / LC = 0.02 mm. = 15+(10 ×0.02) = 15.2 mm

Exp. No.: Page No.: 23 Date :____ Result :-Thus the demension of a specimen was measured by wing vernier height gauge. PRACTICAL EVALUATION Observation (10) Calculation / Result (10) 8 Viva (10) 8 Total Marks (30) 29 Signature of Faculty



•

Exp. No.: 5 Page No.: 25 Date : 20.12.19 MEASUREMENT OF DEPTH AND INNER DIAMETER OF SPECIMENS AIM :-To measure the depth, thickness, outer and enner déameter using vornier caliper, vornier dépth gauge and energe micrometer. Apparatus Required: Vomiet caleper Vernier depth gauge. Inede micrometer Swiferce plate. Vornier callper: Vouver caliper has two scales nanely the math scale and vernier scale. The verniter scale. moves along main stale. The callipe is placed on the. object to be measured and the ferro adjustment streev is stotated until the jaw fits fightly against the epicimen. P. groceduse . The vornier catiper was checked for zero 2919109. The depth measuring Scale was extended to approximate size and it way placed inside the specimen such that it was touched the Scale fouched surface plate.



xp. No.:ate :	Page No.: 27				
	adjusted for coved				
poretron	nagunar per collect				
	d vernier scale				
seading were noted down and					
and least carint : drivion union of carine					
Verniter depth gauge:	Total No. of Vertuil				
It consists of	a triangular lare,				
extension nod and plunger. The					
indicated by an indicator at H					
verneer scale. The length of the					
by adjusting some					
ONEERING					
Porocedure:	- CALOVI, ATTAKUL ISVA				
The triangular ba	se was placed on the.				
surface plate.					
The base of the depth gauge was					
placed the through note and	placed the through note and the scale displaced				
apwards and marn Scale read	ings, were noted.				
The above proced	lure was repeated for.				
difficult different possitions and	reading were noted.				
2R+ (VSC(KLC) + 2C	M = GM (C				
Inside Micrometer:					
	measering internal				
dimensions. It has malkely four parts such as					
measuring head, extension stoch, eta					
The signage of enclosument can	•				
difference lengths of outencion so					
The stanges. are (5-30), (25-100) (11	ro-300) mm . The extension				
stock are made hardened materi					

•

OBSERVATION : 1	OBSERVATION: 2
VERNIER DEPTH GAUGE	VERNIER CALIPER
	non
Range = 0-150 mm bus of	Rangle = 0-150 mm.
Least court = Total NO. of vermeer Scale division.	least count : division Total No. of verniers division.
the of a mm soo for lare	
MSR = 10 70 9 10 10	MSR = (0.71)
VER DING - 10 10 MODE 421H to	VSRosibili= (i) 45 (ii) 4hadros
the stod can be moved	ver scale. The length of
Total reading = 70-14 mm	Total reading = 71.86 mm
·	
CALCULATION:	edure:
MD -MSR + (VSC X	(LC) + ZC. et ant
(i) MD = 70 -	$+(10 \times 0^{\circ} 02) + 0$
vous gauge aldes = 270.	2 mm evol ert
and the and dicher a	4×0.02 + 0 would get be 4×0.02 at any bus abru 100 mm (100 mm (
+07 =	a survis ant
30.07 = seading crore noted	will different possition of
2), $MD = MSR + (1)$	SC(XLC) + ZC
17 = meanering Risenting	+(45 x0.02) +0
forthe poorts such as	moren . It has marridge
Theread bus we dive MD Bases 7	1+(41 ×0.02)+00 1000. print
gen be verried by ailing	sconge of Engenument 28,
stock and spacing what	nera langthe of extension
(150-200) mm othe ontomin	samply and (2-30), (25-100
actoricely and measuring	are made fraudened + m

Exp. No.: Page No.: 29 Date : faces are brazed with tungsten. The measuring faces. are lapped to ensure high precision and good ewiface finish. sant count is value of Procedure: The micrometer was checked for zero eviter using a standard 5mm standard specimen. The specimen was placed with one end touching the anvil and adjustable spindle was moved to the approximate Rize of specimen such that It is locked between the spindle and and. The above procedure and repeated for different parts of the specimen and the tabulate the reading. The values was calculated for each. reading and average values were faken as a. fenal value.

Enge No. 24	
	OBSERVATION-A
VERNIER CAUPER	INSIDE MICROMETER
	lapped to ensure sign
Range = (0-150) mm	Range = 0-25 mm and 200
least cound = value of one main Scal division Total NO.07 vernier	value of imaine scale div lecut count = Total No. of pitch Scal division
= 0.00 mm $= 0.000 mm$	MSR = (i) 15 (i) 15 $PSR = (i) 4 (i) 15$
apindly and another lot	Total reading = 14.295mm
Total reading = 14.21 mm.	72910 e90109 = +30
	Zero correction = -0.3mm.
CALCULATION :	seadeng. preboes
). W MD = MSR+{V	$SC \times LC) + Z C.$
= MSR = 14) VS	en = 124; porous pus pus
$M D = 14 + (2 \times 0.0)$	il value.
= 14.02.	
(i) MSR = 14 ; VS	c = 20
$MD = 14 + (20 \times 0)$	0.02)
= 14.4 mm	e
2). (1) MD = MSR + (PSC)	KLC) + 2.
: MSR = 15 ; "	osc≈ 4
$MD = 15 + (4 \times$	0.01) -0.3
= 14.74 m	nm.
it) MSR = 15 ; PSC	2 = 15
MSR = 15 + (15×	0.01) -0.3
MSR = 14.85	5 mm.

Exp. No.:... Page No.: 3) Date : PRACTICAL EVALUATION Observation (10) Gaiculation / Result (10) Viva (10) SERVICE IS OUR MOT Total Marks (30) Signature of Faculty Regult !.-Thus the depth and enner diameter of the given specimen are measured by using venicer caliper, vernier depts gauge and Inside micrometer Depth of the specimen wing depth gauge: 70.14 mm Depth of the specimen thing vouler calleper: 71.86 mm Inner diameter of the specimen. wing Thefde micrometer = 14.21 mm Inner diameter of the specimen wing vernier caliper = 14,795mm.

Grean tooth vernier caliper 「なたいわしい THE REAL PROPERTY AND A DECEMBER OF A DECEMB 12. 1 3/31 3 3333 vertical main scale. Æ 87 vertical vernier scale With Street 5 - 4 2 Horizontal main scal. 4 Et o (approx RACTICAL EVALUATION Observation (10) (0E) az Addendum . Horizontal vernier scar Thus the depth Nº Brito KIN djogration of the Horness are measured prover pet Kerner et , verment deptin gourge and Itilitide michaenter the of the specimen survey depth goings: To 14 mm the of the spectmen willing verwent callport: 71.86 mm * diameter of the specimen using Instell micrometer A diameter of the specimen unling vernies

6 Exp. No.:..... Page No.: 33 Date : 3.1.2020 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 vornier caliper Apparatus Required: Gear tooth vernier Spur gear speciment. Description : Gear tooth vernier concrets of two vernier callper namely how ontal and vertical relations it is based on the principle of vernier callper. The thickness of a tooth at pitch eine and addendum are measured Endependently by adjusting the clide 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= TXM X xin (90/T) choidal Addendum d = M + [(TXM)/2] [1-cos (TO/T)] where, M= Module, T= NO. of teeth.

TABULATION !- MUNICIPALITY AND A MOUNTONIO gean wheel willing a gean tooth vorment callepart

Specimen NO ·	Number of teeth	chordal addendum	Torial	Chordal thickness value mm	Average
		Yø	,	2.6	ůbHron :
1. vourier	50 (3)	1.615	123234	Sucar 3. South	2051
		up.cdl _ secu	3.	2.15 B	- Ancumu
	measura	calepsy . Th nduin: are	Abby. 10	2.14 1540 5	to alo
2.	60(3)	08 2000 el 1.599	2.	protunito, gu	a 25
			3 -	2•40	
				The Rectfeel value induen of a following enjo	ubbo J

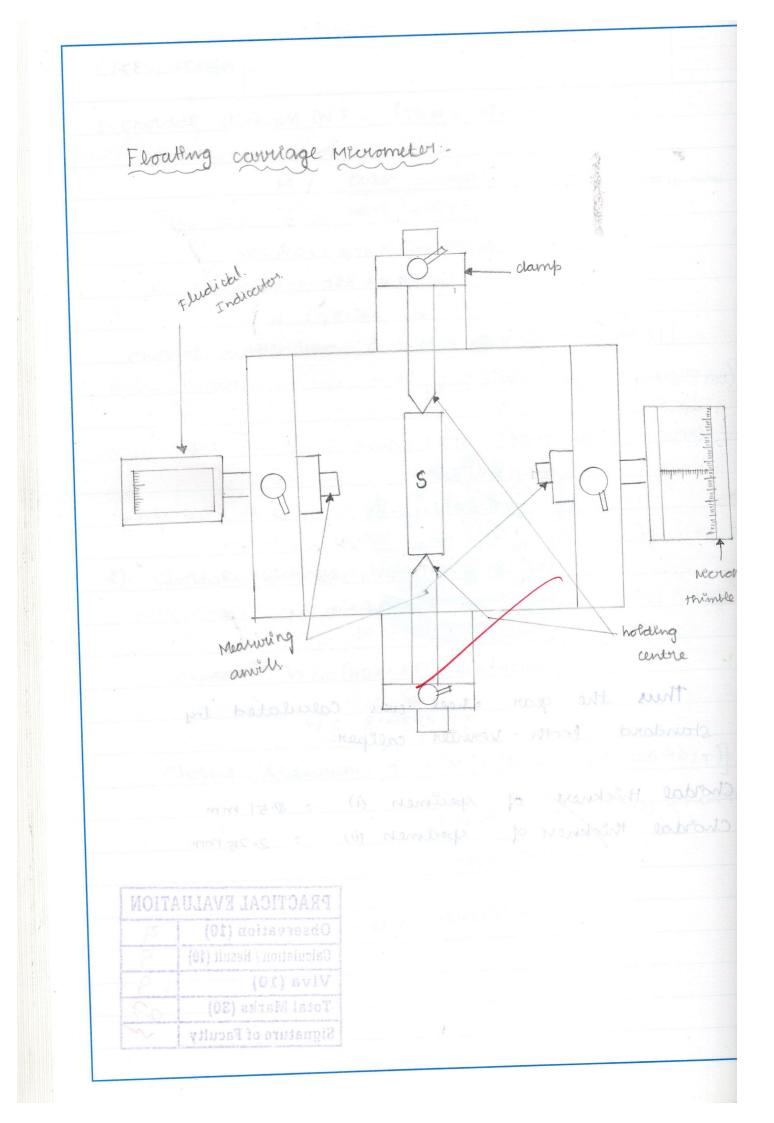
Chardeal Huickness W= TXM X Lim (90/T) Chardeal Addendium d= M+[(TXM)/2][[-005 (E0/T)]] Nhere, M-Module J=NOUS Leeth

No.:	Page No.: 35					
PROCEDURE: ((TOP) MAXMAT) = (· chardol IBakiness (W					
the number of teeth ar	The number of teeth was counted on the					
gear wheel						
The outer diameter of the glar wheel was						
found using a vernier caliper	•					
The madule of the gear is						
wing expression.	-					
Module(M) = Outer Diameter (A	10 of teeth+2)					
The choldal addendum e	•					
Given above formula.						
The chordal addendum	value was setted int					
Voutide Scale of vourier gear tooth verni						
Now the vomeer sale is mode to rest on the						
top of the vernier gear tooth under next.						
The jaw of horizontal vernier is made to						
fouch the cledes of the tooth which will automatically						
be on the pitch line wire is our morro and						
The reading on horizontal vernier which						
will give the value of chordal thickne						
The same for some other tooth on the						
wheel an was repeated. The average						
a o cul artod						
Columned (Charles 1 - 1 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -						
1 \$ 810 0 t 3088.1 -						
d= 1.59956 mm						
-						

CALCULATION :

1. chordal thickness (W) = (TXHX Rin (90/T)) $M = Outer diameter = \frac{82}{50+2} = 1.7576 \text{ mm}$ No of teeth + 2. 50+2 = 1.7576 mmW= 50×1.576×Sm (90/50) minuer & puller The matule of the EO.OX 88 TS = Wallated By W = 2.304 mm Chordal addendum $d = M + [(T \times M/2)(1 - cos(90/T)]$ = 1.576 + (50 x 1.5676) (1- cos 90 /50) and mi balter sour autor multi-21.576 + ((50 x0.7885) (1 - 0.099)] 10576+0.0394 00 Ja 2002 at no tear of about i d= 21.6154. mm situal of the version geos took under security. 2). chordal. thickness w= (TXM x Sim (90/T)) $\frac{198}{60+2} = 1.58 \text{ mm} = 1000 \text{ eft}$ 101 million W = (60×1.58) × sin (90/60) W = $2 \cdot 4825$ mm Chordal Addendum d = M + [(T × M/2) (1-605 90/T)] = 1.5804 + (60 + (1.58/2) · (1-00) 90/6 = 1.5806+ 0.01896 d = 1.59956 mm.

Exp. No.:.... Page No.: 37 Date :____ SERVICE IS OUR MOT Result :-Thus the gear wheel was calculated by using standard footh vernier caliper. i) Chordal thickness of specimen (i) = 2.51 mm (ii) Chordal thickness of specimen (ii) : 2.25 mm. PRACTICAL EVALUATION Observation (10) Calculation / Result (10) Viva (10) Total Marks (30) Signature of Faculty



Exp. No.: 7 Page No.: 39 Date : 24.0 1.2020 FLOATING CARRIAGE MICROMETER 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, services (R ~ S) & marking - Balank THEORY :-The diameter of imaginery aylender which just embraces the orest of the esternal thread or. good of an internal thread is called major diameter The diameter of the setting master cylinder should It nearly same as the diameter of thread gauge. The advantage of using setting marter gives similar. contact at anvils, and reduces everol in measurement the retting maxter, is held between centeres. Take the reading of the diameter, Say this reading is R2. It is the addition by the threaded workpied and again Second neading is taken, say this reading is R.2. It is the addition of Rr and Rg. The positive and Negative values are determined by relative size of marter and two workeppear

FLOATING CARRIAGE MICROMETER

OBSERVATION: Master reading = 14.022 mm Master reading with wre (R) = 16.779 mm Major reading = 16.359 mm Major reading with wre (S) = 17.819 mm

Effective diameter = 7 +p.

M = Dimension over the use

a = 1.350 mm ulps bushnets

7 = (R~S) + marter reading

= (17.319 - 10.779) + 14.002 T = 14.562 mm $P = (0.866 \times \text{pitch}) - \text{utale diameter}$ $= (0.866 \times 2.04) - (1.350)$

Utemperenter and read between contract to the

Effective Diameter = T + P= $14 \cdot 562 + 0 \cdot 41664$

buo nethand jo sela villable pri suitable pri

Exp. No.:... Page No.: _____ Date :.... PROCEDURE: Make sure the balls are placed on the bottom properly and place the floating top on assentity The dial gamage was fisced to zero reading. the timpble of the micrometer was moved euch that the spindle and anvile was touched each other and energie zero grading of the dial gauge. the zero reading was setted in the. digital reading placed on the top. The marter piece was fixed between the anoils and micrometer was moved ruch that the anivil. and spendle of meriometer touches eache other and the digital reading was noted down by enswing there is no deflection on the dial gauge. the screw thread was placed over the effective diameter is to be meanined in between the anvil and spender and place the cires in between. the opposite faces of the Sour thread and notedown. the digital readings by encuring there is no deflection in the dial gauge.

Exp. No.:____ Page No.: 42 Date :.... PRACTICAL EVALUATION Observation (10) 9 Calculation / Result (10) 8 Viva (10) 8 Total Marks (30) 25 Signature of Faculty RESULT :-Thus the major drameter and effective drameter of the given revew thread is measured by meng floatting carriage micrometer. 2) Effective Diameter = 14.978 mm. di) Major Diameter = 16.359 mm.

のないないないないない BEVEL PROTRACTOR : Working codeing mut Accustate angle attachinent. Blade. 6 Bady Blad 60 de stock .__ Tworen aye piece Naisanny Thus the major drameter and effective drameter canviage micrometer.

8. Exp. No.:..... Page No.: 45 Date : 31.1.2020 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 precely alth in few minuite It conserts of adjustable brade altachment in the main body and vernier calipsy seal. The adjustable. blade is capable of natating preely under the main scale is enlarged on the body of the instrument and can be placed in any position. The protocactor is graduated and a complete scale from o° to 90° to 0° the forced scale is divided into degrees. PROCEDURE : The workprece was cleaned wefore measurempin The specimen was placed in between the blades such that any one swiface of the angle workeptere noted with the lase of the bevelporotoractor, Keeping the references. The blades were adjusted with respect to the base of the bevel protocotor such that protocotor was made come

DEASUREMENT OF ANGLES USING

いたのないないない

TABULATION :.

ИО. 8.I	Specimen No .	Main Scale seading	vonner Scale coincidence	Total meading = MSR + (VSC×LC)	1
	1	48	Alasta	48°20'	- 48°45
1.	1	49	R	49°10'	
0	anorma	1 21 NB 2	markon , w	59°301	- 59° 40
Nio	in the m	1/2 15grando	success and	W59°50'	- A - Change
	er	duden to	Hind proly	where of events	is cope
1	art coun	ody a theit	HOhemain a	frale division	Scolo i an lie
0	Least	count of a	10.01 division	vomier stale	iduated fried
) Q		
nore	le maar	claimed with	1 × 60 = 5	minutes.	
	espue	face of the	y one ever	ch that an	edes su

e moted upper the have of the heudportsactor. Keepeing the inferences, the header adjusted with suspect, to the lose of the isoterador and that bectorated in an madro and

Exp. No.: Page No.: ______ Date :____ to coincide with the curface of the workpiece was to be meanwied. The position of the blades were adjusted in such a mamper that the blades had minimum contact area. The main Scale. reading was noted by making the division the concide scale with the Zero of the vernier Scale. Vennier scale coincide was noted on the edde of direction of the specimen. The average of all the reading were calculated 2) I TOTOL PRODUCT A DETAIL TREEXED o d Pa

MODEL CALCULATION: ON DOUDPOUD ON MICH ODDA D. i TOtal reading = MSR + (VSC XLC) 12 and 12 and = 48 + (4×5') batom and a probable of success = 48° 20' (i) Total neading = MSR + (VSC XLC) $= 49 + (2 \times 5')$ pribrie ent lo p=4910' = MSR + (VSC × LC) 2). (i) Total reading = 59 x (0 x 5') = 59° 30' (ii) Total reading = MSR + (VSCXLC) = 59+ (10×5') - 59 50'

Exp. No.:.... Page No.: 49 Date :..... PRACTICAL EVALUATION Givernation (10) 8 Calculation / Result (10) 8 Viva (10) 8 Total Marks (S0) 24 Signature of Faculty Result :. Thus the angle of the specimen are meanwred ming a vevel protector Angles of specimen (1) = 48° 451 Angles of specimen (2) = 59° 40'

sine bar. hardened and ground la B Q h gauge blocks 0 A CC. swiface plate. Handened and ground aplinder Thus the angle of the specimum are

Exp. No.: 9 Date : 7.9.2020 Page No.: 57 MEASUREMENT OF ANGILES USING SINE BAR. AIM : DID IS DI the gauges searcherings To estimate the taper angles on the given aok piece with a lene lar. Apparatus REQUIRED: Sine bay, Slep gauge, Dial gauge, Swiface plate. THEORY : The sine bar is one of the most addely wed instruments for precision measurements of angles. It consists of a rectangular section bar of subtable grade steel having accurate ground pin of equal diamater. The sine war works on the prenciple that in a right anglest triangle if the premaple that in a sight angled bringinge if the beingth of the hyterice is kept combant, the RENC bar of the different angle canetant . The sine last of the defferent angle can be obtained by voving the length of the. perpentalar @ - 2° (h/2.) h = height of the keep gauge in m L =) Centre to centre destance of the mollers of the serve las in m.

TABULATION: MONON DURA DELIDINA DO TAMADORADA

	Specemen	Slep gauges	readings	Tapur angl
SNO	No No	Height of Slep gauge (h)(mm)	longth of sine bar(L) (mm)	of the pb
].	1	36.90	200 ADA	10°37 /
			gauge.	1502 (19° 2 1'
2.	2	32.5		

MODEL CALCULATION: 10 010 20 Not South South Englanding for precession measurements of angles. Aust). Do Over Ren To (Y2) ostupulation of a tall Steel thanking accurate integht = mit of equal tout upsonha = 40+6+1090 = 47.90 mm a mithant utgesting suff 8+82 = 11 mm. to soprise thiple angled Estimating the lingth of = HA Instance rept constant. His is commo p. 35 = of the different constant. The she have of the deflerent angle int por Epusen (Ch/2) pulsion of baracho = sin -1 (36.90/200) @ : 10° 37' A = height of the weep goings in

of the same boy an m.

Exp. No.:..... Page No.: 53 Date :.... PROCEDURE : deap the surface plate, since bar and Norkpille thoroughly. Place the eghelar piece on the Workpiere on the surfaced plate placed Add Elip gauges at the lottom of any of the gollers in the centrar to make the ewiface. the bottom of elle bar flat on the workpiero. O The pergent of the klip gauges was Noted The angle of the workpiece was calculated by using above formula.

a). O: sen - (A/L) 53 $h = h_2 - h_1$ ha = 50 mmThore aduly T hig = 9 + 8:5 = 17:5 mm prus ja motial an= to H2-h, half basspure $\Theta = \Omega^{-1} 32.5/200$. on the workpiero detact now experies of 219° 21' to supply with The angle of the Betalinlas now sidest

. No.:		Page No.: 55
And		
To receive the	and which have	
Adres monuments back bustonesses		
		·
Appriates prosteed.		
1 DO Foral man	alice setup	8/
and the second sec	Welger Ca	
· · · · · · · · · · · · · · · · · · ·		
PROCEDURE		
CHEERING		
	agrand ¹¹¹	
		-ma - Anglan
Strakes	ACTICAL EVA	LUATION
SEDIO	Oservation (10	
SERVICE IS OUR	Galculation / Result	(10) 2 2
	Total Marks (30)	21
2	Signature of Facu	A CONTRACTOR
RESULT :		
wing erse. bar	angle was cal	callated. by
distring this but		
Tabon angle of the	given sporimon	$(1) = 10^{\circ}3$
Taper angle of the of the	given specimon	(2) = 9° 21
Z 2 m mpor care o me		
	ten kona	

States and the second FORCE MEASUREMENT SETUP: C prepary power Read 0 Tcell.

Exp. No.: 10 Page No.: 57 Date : 8 . 2 . 2 0 FORCE MEASUREMENT AIM :-To determine the applied force by using a force meanwrement instrument. Apparatus Required: Force measuring setup 13-2 11 Measuring weights 19.62 PROCEDURE :- SAPA PAPE the retup to a power serve and rustch on the inequiment is connected. The 2010 potentiometer tell the display unit reading zero. The READ/CAC ensitched ON CAL portion using taggle custoned, AVICE IS OUR MOTH The READICAL endtched to CAL partion. wing encute. to its 2016 again. Pours The CAL potentiometer feel the deeplay unet reads 250 many SARS - SARS -The load applied on the pain and the readings in during of force is noted down loading and unloading. % Error = Applied force - Indicated free x100. Applied force

MEASUREMENT TABULATION : Unloading Loading SI'NO. Applied Applied Indicated Indicated 9. 00109 force force force force 9. 0 witor ROUN NO N N N 9.81 1001 × 9.81 9.81 0 WOOD 9.81 1. 29.81 102 × 9.81 19.62 19-62 0 0 19-62 2. 3 19.62 0 202 9.81 29-43 2943 0 29.43 3. 4004 × 9.81 39.24 89.24 0 0 39.24 5 39-24 4. 49.05 0 49.05 509 × 9.81 0 49.05 5. 49.05 MODEL CALCULATION: BANDRUD DASS CADD Appleed force - Indicated force X100 Applied force. 1. 50009 29.43 - 29.43 ×100 29.43 20 1 1. Erecon = Appleed force - Indeated force x100 Applied force

MEASOREMAND MALERADO	· .	Page No.: 59
MEASOREMINES 1000000000000000000000000000000000000		
	Although Charles and	
Sector States and		
	11. (1997) 28 A 97	
A MARINE A M		
To measure the total	and the second	
Caller And	<u>201 – D'Arako Jan</u>	
Approvatus required	· · · · · · · · · · · · · · · · · · ·	
How The Transien	and the second sec	
Dimit Talais	Leader Contraction	
used . De Carolina		
Service And		
Test the man is the parent of the off		1
	- Big and	
Этганая		
	Observation (10)	e
SERVICE IS OUR MOT	Calculation / Result (1	
CE IS OUR W	Viva (10)	
and a sense strate water a	Total Warks (30)	
mounted on two porparticulous	Signature of Facult	
RESULT :-	Section March	1
Thus the appleed for measurment Instrument was	e by using	the force
meakwiment Instrument was	Calculated	Å
010 000		
1 22	Harlos and	
X	difference some	
a a a a a a a a a a a a a a a a a a a		
and and a state of the state of		
CERO OTP See KNV		

MEASUREMENT OF TORQUE USING REACTION TYPE TORQUE TRANBDUCER Setup callebration mode. Read mode. Strain gauge. Power Supply. Recorder Diashal diuplay EIEIEI SF I Sensol. 1.1 Thus the appleed force by using the force remard Instrument Was calculated

Exp. No.: 11 Date : 14.2.2020		Page No.: 61
MEASUREMENT OF TORQUE US	SING REACTION	
TYPE TOF	RQUE TRANS	SDUCER
Administra Contra		
<u>AIM:</u>	nd at the	TABULAN ON
To measure the torge		
loads by tiring a reaction ty	pe torque	transducer.
Apparatus required:		Land Land
Tolque Transduc	wi, day	lowing being ange
Digstal Totque :	ndicator,	Line (nove)
Dead weights.	ends to inte	adding an Pt the
CINEERING	Q.151 70	0.6
Equipment Dercription:	130 9 68 m	e le c
Torque doic	anducer ,	convert tugetping
force to electrical rignal. The re	ensor end	talled on fisced
Shafts is remilar to load cells		
toransducer system consists of a		
and a renson. A shaft with for		•
mounted on two perpenticulars A	s' helez.	es bent. Thus the
two perpenticular 45° helix det		
stress and strain direction for	a shaft	of the seaction type
Advance sensol in the form of de	,	
One and of t	he chaft i	fisced and the
Other end of is having a dire att		•
at un of I'm length so that the		
kg-m. This deflection caused by	. the storan	gauge gives
the O/P in mV		

TABULATION ... To manute the toloque generated for defferent. by theng a reaction type torque tought.

		Loading	Ð			unload	ing
S+10.	Applied load kg	Actual torque kg-m	Indicated forque kg-m	y- 06 60101.	Applied load leg	Actual torane kg-m	Indicated torave kg-m
1.	T.	0.6	Q.151	74.8	1	0.9	0.151
2.	2	1.2	0.30 9	74.8	2 - 100	1.2. O.C.	0,302
3	3	acriment	0.453	74.8	Uprot 3	1.8	0 • 453
4.0	prot aq	2:4:45	0.605	74.8	N42 0	204	0.605
5.	ingmol	3:0	100.75-71 Minuthi	74.8.	15 Sino	3.0	0.757

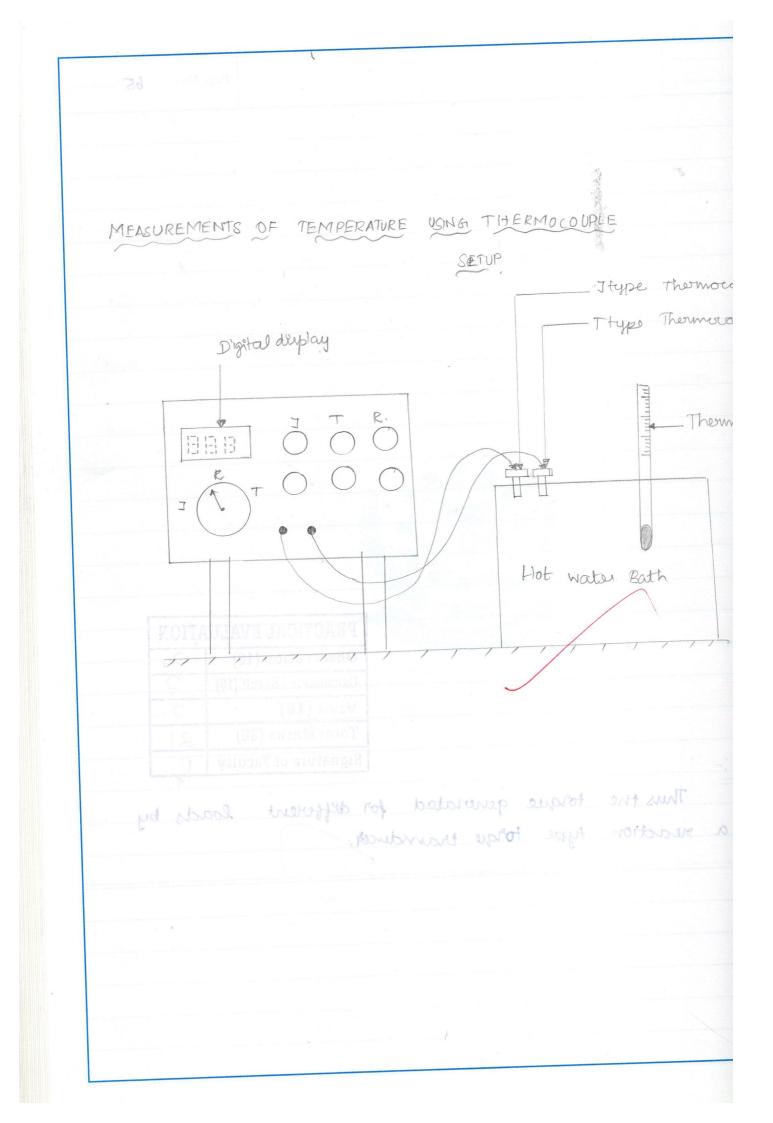
et our loss porportheulants as helps to bent the the operatication as helps determined the porthelps and strain direction for a thapt of the solution type escaped in the form of hidge.

One and of the shaft is proved and the end of its howing a disk attached with the following of im length so that the obtained torque is in . This deflection caused the the shown gauge gives in my

Exp. No .:... Date :

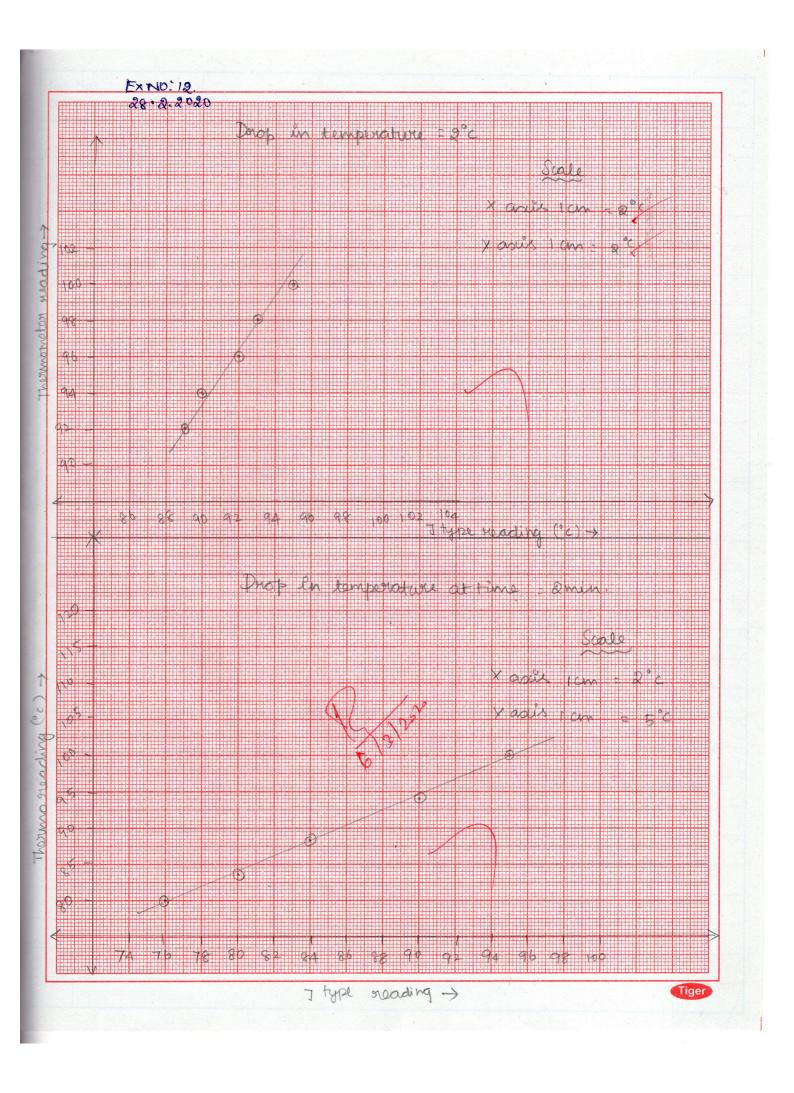
PROCEDURE ! . Connect the eenso to the instrument wring connection calle. Plug the main choird to the main supply and Suitch on the instrument keep the READ/CAL Supter to CAL position and adjust the read potentiometer till the display shows. keep the READ/CAL surtch in READ position and enure that it yeads 0.00 Apply the READICAL auften in READ position and envoue that it reads for our ends by adding dead artight in steps of 1 kg until 10 kg and removing weight In steps of a kg until there is ho dead weight on the platform. tabulate the display reading for each addition and removal of dead weights.

xp. No.:			Pa	ge No.:
	NILLA STORAMENTE	the treatment		
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	and a	states in the second		3
and the second s	in word the second			
Approximite	a symposic			
		a state and a second		
	·	i dan manan ar Terrena ar		
	· 1.			
9	They are	un indian in in		
		MEERING		
	. Si	1/1-RY N	A.	
	Ne la la	Read and		
		A ANALAS	7	
		SERVICE IS OUR MOTTO	PRACTICAL EVA	LUATION
			Observation (10)	2
	je Clanch - d - j Kiling	Vet and and	Calculation / Result (1	
al cond had	fugeton 1	and the second for	Viva (10) Total Marks (30)	7
	ice a techniqu	G. Just of the	Signature of Facul	
RESULT :-	<u>kan kan kan in</u>		", THE TANK CONSIGNED AND A THE WEST OF MALE AND A DATA AND AND AND AND AND AND AND AND AND AN	
<u> </u>	Thus the torqu	le generated f torque transdu	or defferent	loads by
using a g	reaction type	torque transdu	cer:	
2 AN				1.5
28/1				
	long) to be set	harran an harran h		
	ustatuje kao se skol	in internation		
	n Antonio antonema	di habeya tani ji k	<i>b</i>	
			E.	



$\frac{12}{28 \cdot 2 \cdot 20 \cdot 20}$		Page No.: 67
	<u>t;</u>)	TAROLATICK
MEASUREMENTS OF TEN	PERATURE USING THE	ERMOCOUPLE
		and a second
AIM >		
To measure temp	zerature uning ?	[, K, T thermocor
toranducer and a digital t		
e P	001	
Apparatus sequired:		
J, K, T, thom	mocouples,	а.
Temperature	Toranducer,	N
Digital te	mperature indicator.	
Thermometer		
Electric St	erter 201	
PRINCIPLE:	S. M. I.	
The principle i	used en thermoco	uples. is called
as the "Principle of thermo.		
It states that " when two		
B are goined together at 0		
and this function is heated		
free ends, a voltage & du		
if these two conductor a		
are connected, then the emp		•
of cuotrent op	2	
DESCRIPTION -	88	
	nots. of a thermotor	when anapana
used to measure tempera		
The remocouple. Lot janct		
into the place where temper		
in the pune would accorpore	mule as to rec. me	

TABULATION :1 Drop in temperature = 2° c. Thermometer J-type mon SINO. AT PROVINCIONAL reading °c Reading °c hus Heart 95 100 1. burinpor with 98 your rest , 193 T 2. Braineducer , Temperature 92 2 rotalibrig 6 weter contact of 8 Invertin 90017 4. 94 ps 32 ras 89 92 5. . The peremetries used en stremmocouples. is called tooffortABULATION - 2.0 "privetable animant p algorise?" Derop in temperature for time = 2 min-120050R e NOHONNA LJ-type is nothing 3 Thormometer 1 Is led to the reading Reading of NO 1 ADA endr. 1095 bries wit of metabol at the face and ownected , then the emp setup well established a fear 90 94 2. 84 88 3. when posts of a thermocorright. coursingement 80 ation tartiseration + are a follow bot junction in well be introduced 76. ranks a 861 ch martin bar 5:



Exp. No .:.. Page No.: 69 Date : The thermocouples cold junction Jc i maentaines at a constant reference temperateure. A voltage measuring intrument pronnected to the free ends of the thermocouply. PROCEDURE -Seled J/T type themocouply wing relector english. The relected thermocouple. 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 invide the hot bath. Heat the water in the hot bath wing electrical energy. The desplay that the temperature in the Bot bath derectly in °c. If necessary, adjust minimum -point for maximum level temperature callibration. Note indicator and thermomoter. readling for a forces upon of drop in temperature and for. fred Entervali of Hime.

No.:		Page No.: <u>41</u>
		rage 110
ADM 1		
no magazine service se	and a second second	3
data in the first Status structure in the		
Approximities Requirements		
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	hailmen here all	<u>a Milan II. An Maria.</u> T
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SERVICE IS OUR MOTTO	PRACTICALE	CANADAR CONTRACTOR AND
	Observation (CONTRACTOR AND A CONTRACT
	Galestation / Rost	CALLON AND DESCRIPTION OF THE REPORT OF THE PARTY OF THE
	Viva (10) Total Marks (3	
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RESULT :-	Signature of Fa	curry K
Thus the mequinement of	temperative	e unino
thermocouple was calculated.		
me moet opte was commenced :	/	
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Al 2		anato in tangén
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		

TOOL MAKER'S MICROSCOPE: A State of the second second T optical Supporting column head clamping Sorow Ei Merconeter tabl Sorew (For lateral movement of table) Micrometer S [tor longi Base movent tal Thus the measurement of temperature wiling Salculeted.

Exp. No.: 13 Date : 6. 3.2020

Page No.: 73

1 Month Outo

MEASUREMENT OF SCREW THREAD PARAMETERS

USING TOOL MAKER'S MICROSCOPE

AIM:

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

Apparatus required:

Tool maker's neuroscope.

Sorew thread.

Descreption: Descreption :-

The tool maker; necroscope essentially convex of the cast base, the mater lighting whit, the upstight with coverying arm and the righting microscope. The negra part base is nexting on three foot sours by means of which the equipment can be leveled with suference to the built in spilt level.

The take carries the co-ordinate meanwring fable which consisted of two meanwring electrs; one each for directions × and y and a rotary circular table provided with the glass plate. The elides on presicion balls in paridened guide ways avairanting a relevable toravel, two meanometer . Sources each of them barling a meanwring orange of 0 to 25mm perint the meanoment table to be displaced in the direction × and y. The mange of 25mm permit the meanwring table to be displaad in the direction. × and y.

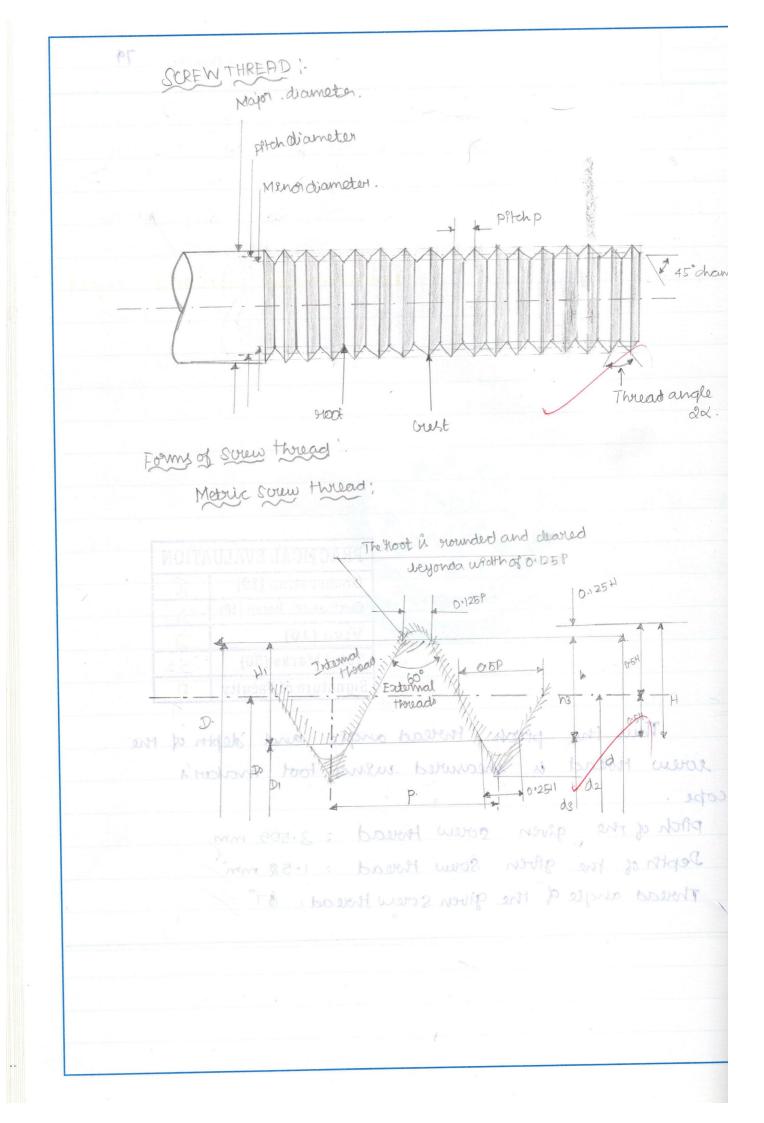
OBSERVATION . Least count of micrometer 1: 0.01 mm Least count of micrometer 2: 0:01 mm least count of circular Scale = 1°/10 = 60'40 = 6' Tabulation !. Petch measurement. Initial micrometer Final micrometer Ditch = FM-IN S.T. reading Heading mm (mm) FM NO (mm) TM 18+ [37×0·01] = 16·37 21+ [9×0·01] = 21.09 4.72 1. 2. 16 + [3x0.0] = 16.03 18 + [27 x0.01] = 18.32 2.29 tool makers increation of 3.505 mm the uptrave in printing Average Depth of thereard : possion methods and bus musy in to impor Final micrometer Depth of Hours S.NO IniHal Micrometer Reading FM Down Map = FM -IM Reading IM (mm) (mm) mm $6 + [32 \times 0.01] = 6.32 - 7 + [6 \times 0.01] = 7.06 0.74$ U. Biv desceteons x and y and a schooly circula ON particion halls in providence 2). 5+ [7×0·01]=5·07 , ++[37×0·01]=7.37 2.3 were a mourring mothering ent is persigned and a berage what 1:52m * The skinge of scinn permit in meaning table dipplaced in the direction. I could y

Exp. No .:. Page No.: 75 Date :... The carrier arm can be adjusted in height by mean of rack. The main lightling unit has been arranged in the rear of the cast bare and equipped with projected lamp where gays are directed via estationary mounted means Howing table glass plate into the regiting microscope. PROCEDURE Calculate the least court of the micrometers. and angular provided on the vieweng table. place the green specemen on the glass fable plate. suptch on the projection lamp Viewing through the eyepiers, notate the knob for moving courses aring an column to get a sharp Image of the specimen kept on the glass plate. possition the specemen such that the table movement in x direction is percalled to the direction of petch measurement, check the by enturing the crossin. fourching the overta of all the teeth during table movement in x direction Pitch measurement: Rotate micrometry head × direction of tere the vertical dotted less of anossinere on the orest of a thread and note the micrometa reading Calculate the difference between the above two reading which gives the pitch. Repeat the above for any other net of adjacent and Calculate the average.

The case in heren can be adjusted in heren means of mark the main regar and that been arranged the secon of the coust some and equipped with peroperturbing Thread, congle - monthered on based and have a even igh failed quite plate and the ighting microsoge Final ancular Thread angl Inetial circular S.I reading (IR) reading (FR) FR-IR NO' Degree -m Degree - min Degree-min Place the griter hyperit is many and the grant table to be $35 \times 2 = 76^{\circ}$ if Sultar on the projection lamp 0 if 70° lamp. prove of the of multiple 32 x 2 = 64 ultros (million 64 or of 2. specimen keys on the glass plate. and of the and all interaction planismake 12 67° to work which to the developer in and of acts Then by examining the Chargerian. wind the ourse of all the teeth during table movement dimention. Rolate michaneter thead & denedrom of texts is renteral dated seve of anorsinger on the onext of a thread mobal pero micromitero areadento Calculate the difference between the to such and analy and along the pitch. needs and performent and allove por any other set of lette the average.

Exp. No.:... Page No.: 77 Date :___ Depth of thread measurements. Rotate mechanity head for y disudion to sust the horizontal dotted eine of crosscire on the orest rests of the thread and note the micrometer reading. coculate the difference between the above two readings which gives the pitch. Repeat the above for any other set of adjacent vierts and calculate the average. Thread angle measurement: Rotate the closs agre by the extrem colourknot located behind the eye place to match the plank of the thread with the cross where. Now notate only the crossause 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.: Page No.: 79 Date :____ **PRACTICAL EVALUATION** Observation (10) Calculation / Result (10) Viva (10) Total Marks (30) 22 Signature of Faculty RESULT :-Thus the petch, thread angle and depth of the given forew twead is measured wing tool maker's microscope. pitch of the given solew Horead : 3.505 mm Depth of the given sow Horead : 1.52 mm Thread angle of the given screw thread: 67°



Exp. No.: 14 Page No.: 81 Date: 1203.2020. MEASUREMENT OF SCREW THREAD PARAMETERS USING OPTICAL PROFILE PROJECTOR. AIM :-To measure the pitch., major diameter and minor diameter and twead angle of the given sour thread wing optical profile projector. Apparatus requised: Optical profile projector. mini Screw thread. THEORY : S.S. JAN. ON BOARD 13 Qaia (10.0x8)+0 Creet: - It is the top surface joining the two sides. of a thread. It may be rounded on flat. Root: It is the bottom ewiface joining the erdes of adjacent thread. If may be sounded of flat. Flank: The surface of the twead, which connect. the overst with the noot pitch - It is the distance meanwhed parallel to ets. asis between coverponding points on adjacent thread. and shread. lead :. It is the distance by which a voien thread advances areally in one genolution. Thread angle: It is the angle between the panks of a thread measured on an axial plane. Flank angle: It the the angle between the flank of a thread and a plane perpendicular to the axis, measured In asilal plane.

meters the pitch . major diameter and Major diameter measurement: no possil but todampible optimal propile projector Major diam Initial mecromoter Final micrometer SNO reading (IM) FM-IN seading (FM) mm hm mm 3.34 3+[36*0.001)=3:36 0+(2x0.01)=0.02 1. may be subunded of thread. 3 + [7×0.0] = 3.07 2.86 0+(21×0.01) = 0.21 2. Hosed , which course 3.1 mm Average. It is the distance by which a rough Have a ances assally in one queching will It is the angle between the panks on an analal plana DO.WAT. d and a polare porperultarian to the azer, meaning

Exp. No.:... Page No.: 8,3 Date :... Major, Diameter: It is the perpenticular distance between the orests of opposite teeth. Menor Diameter: It is the perpenticular distance between the good of opposite teeth. Thread depth : It is the operpenticular between the orest and root of a teeth. there was some not should be some MI Description: M Additional Done Matching of the The profile projector converts of A). A projector having a light source, a condemu a collimating lens to direct the light passed that the optical eystem. 109000 (1000x 8)+0 B). A work holding table which is of movable type . c) A projector optic encludency both misrion and lenkes. 2. 0:1100×08+011:0.8 D). A soreen where the emage is projected. E). Two micrometer of the sange of oto 25mm Which enable to measure in hopezontal as well as vertical planes. Procedure: Place the sores thread place between the anoils provided on the work hotding table. Adjust the table by moveny the concular Swor provided on the rides to get a proper view of the Sorew thread. Fra the cross line chart on the sorem by making sure that 'o' of main Scale coincides with the 'O'

More Dometer T+ is the perpenticular distance between creater of opposite teeth. MENGER DE Maker It is the perpendicular distance between shoot of question texts They do the the spectrules the the they they below the Menor diameter measurement; dissission ja bare bud Final micrometer M shot dian Inerfal mecrometa. SNO reading (IM) reading (FM) FM-IM (mn mm mm Elimating lars to direct the light passed that the 3.12 0+(18×0.01) - 0.18 3+(28×0.01) = 3.28 1 -A work hoteling take wheat a of marcula A projector optic encludence both misurar 0+(20×001)=0.2 3+(20×001)=2.8 3 Divid 2. A screen where the smade is protected. O HOD SUMMED OF OPO 35MM to Use a longer the Average whom 3.05 mm innolo Place the sureus thread place between the perovided on the work hoteling jourse Adjust the table by moverng she clicular perovided on the rider to get a peropen view of the Fin the cross lime oncout on the column by I sure that o of making scale colonides with the o

Exp. No.:... Page No.: 85 Date :... Vernier Scale. On the angular template provoided on the Screan. Find the least count of the micrometers and the optical surein. Mayor diameter Measurement: Rotate micrometer head for y desection to sleet the housantal dotted lene of crossinger on the top of a crest of a thread and note the micrometer reading. Agein notate the micrometer head for y direction to next the horizontal dotted line of Otosquire on the moving the speciment such on the line of crossivity create on the top of the appointe creet of the thoughd and note the micromotor reading Calculate the difference between the above few o reading which will give the minor diameter. Menor diameter Measurement. Rotate micrometer head for y direction the sent the provisorital dotted line of crossing on the good of the thread and note the micrometer reading Again grotate micrometer head to move the specimon such that holizontal dotted line of crossing next on the top of the opposite goot of the thread and note the micrometer grading

Exp. No.:... Page No.: 87 Date :____ Calculate the difference bottomen the about two greadings which will griven the menor diameter Repeat the about for any other set of roots and calculate the average PRACTICAL EVALUATION Observation (10) 8 Calculation / Result (10) SERVICE IS OUR MOTTO 8 Viva (10) 8 Total Wayss (30) 24 Signature of Faculty Result : Thus the major diameter, minor diametry of the given acrew thread is measured by energy optical profile projector. Major diameter of ecrew thread : 2.1 mm Mind diameter of sorew thoread : 3.05 mm



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:

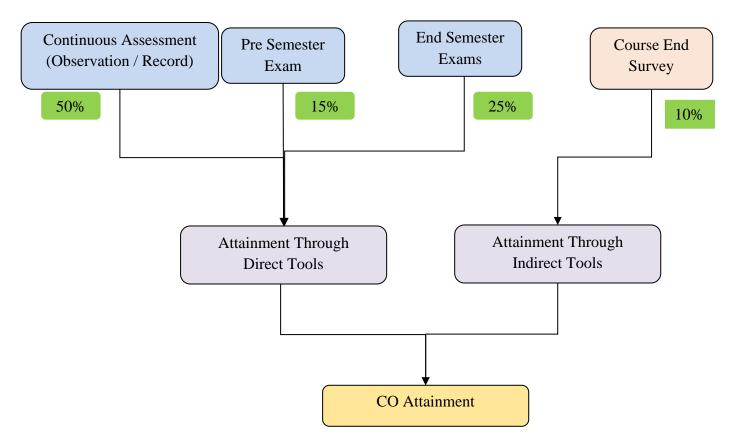
The students will be able to

- 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				ł	Progr	am O	utcor	nes (l	POs)						Specif s (PSC	
Outcomes	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]

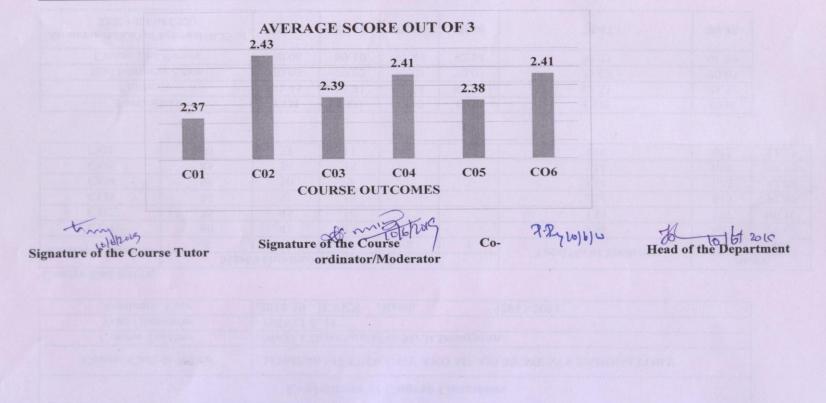
	Evaluation of Course Outcomes
Course Code & Name	: 161ME48 METROLOGY AND MEASUREMENTS LABORATORY
0	· Ma C Hild and a W D D'
Course Teacher	: Mr.G. Utnayakumar & Mr.K.Dinagaran
Year / Semester	: Mr.G.Uthayakumar & Mr.R.Dinagaran : II/IV/ I & II

Course End Survey

Course Outcomes	Mar	ks obtained	for Cours	e Outcome		TALIN COLL	Sc	ore
course outcomes	5	4	3	2	1	Total No of Students	Net	100
CO1	80	41	13	A Part		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



Course		1			P	rogram Ou	tcomes (PC	(s)				1	Progra	m Specific	Outcomes	(PSOs)
Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		Real Property in		1	No.			2				3			1001
CO2	3	3		A STATE OF					2				3		1	
CO3	3	2			1				3							
CO4	3	2			2				3					1		1
C05	3	3							3				1	2	1	1
CO6	3	3					10.7		3				3	4	1	1

161ME48 METROLOGY AND MEASUREMENTS LABORATORY CO- PO Mapping

						Inte	rnal CO-1	PO Mappi	ng							
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C01	81.41				81.41				81.41				81.41			
CO2	85.31	85.31	0.87181						85.31				85.31		85.31	
CO3	82.38	82.38			82.38				82.38				OUID I		00.01	
CO4	83.51	83.51			83.51				83.51							83.51
CO5	82.31	82.31							82.31	No. Contraction			82.31	82.31	82.31	05.51
CO6	83.72	83.72							83.72				83.72	02.01	83.72	83 72

External CO- PO Mapping

СО	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			1001
CO2	70.03	70.03							70.03				70.03		70.03	
CO3	70.03	70.03			70.03				70.03						10.05	
CO4	70.03	70.03			70.03				70.03							70.03
CO5	70.03	70.03				NU CENTRA			70.03				70.03	70.03	70.03	10.05
CO6	70.03	70.03	-			10.000			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		1		83.1				83.4	82.3	83.8	83.6
External	70.03	70.03			70.03	0			70.03				70.03	70.03	70.03	70.03

R.R. 6/6/4/ Programme Co-ordinator

Head of the Department

Signature of the Course Signature of the Quese Co-ordinator/Moderator

my

Tutor

						E	valuati	on of Po	0 & PS	0								
	C	ourse Code &	& Name	: 161M	E48 MI	TROL	OGY A	ND ME	ASURI	EMENT	IS LAB	ORATO	RY					
		Year / Se	emester	: II/IV	121.21		1.10/3		12.					14		110		
		Dire	ect Tool	: Progr	am Out	comes (POs) &	Progra	m Spec	ific Ou	tcomes	(PSOs)						
ourse Enu Su Attair	rvey from CO	CO- PO		1 1		s & PS(Os from	a Cour	se cons	idering	all the l	Direct to	ols					
	esSurvey Score	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	90.00	C01	90.00				90.00				90.00				90.00			
C01				00.10	1.						89.10	Constant of the second			89.10		89.10	
C01 C02	89.10	C02	89.10	89.10							02.10	A Charles and a						
	89.10 91.49	C02 C03	89.10 91.49	89.10 91.49			91.49		-		91.49							
C02							91.49 92.84											92.84
C02 C03	91.49	C03	91.49	91.49			20.00.00				91.49				90.75	90.75	90.75	
C02 C03 C04	91.49 92.84	C03 C04	91.49 92.84	91.49 92.84			20.00.00				91.49 92.84				90.75 91.79	90.75	90.75 91.79	92.84

Particulars	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Internal	83.1	83.5			82.7		70 /		83.1				83.4	82.3	83.8	83.6
Endsemester	70.03	70.03			70.03	in the second	1001151	16 04	70.03	D.C.O.M.	MARK STATES		70.03	70.03	70.03	70.03
Course End Survey	4.51	4.51			4.57		N. MARINE	States -	4.51	DY L. M.	units (Sill)	1,596.3	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		A Station		2.139				2.144	2.125	2.152	2.149

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