POORNIMA
COLLEGE OF ENGINEERING

ISI-6, RIICO Institutional Area, Sitapura, Jaipur-302022, Rajasthan

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Metrology Lab Manual

(Lab Code: 8ME4-22)

8th Semester, 4th Year

Department of Mechanical Engineering

Session: 2021-22

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TABLE OF CONTENT

VISION & MISSION

INSTITUTE VISION & MISSION

VISION

- To create knowledge based society with scientific temper, team spirit and dignity of labor to face the global competitive challenges

MISSION

- To evolve and develop skill based systems for effective delivery of knowledge so as to equip young professionals with dedication & commitment to excellence in all spheres of life

DEPARTMENT VISION & MISSION

VISION

- To be recognized for quality education in the field of Mechanical Engineering and identified for its innovation & excellence

MISSION

- To provide education that transforms students through rigorous teaching and thought process to fulfill the needs of the society and industry
- To collaborate with leading industry partners and other academic & research institutes around the world to strengthen the education and research ecosystem.
- To prepare students with life-long learning for their career by fostering in them the ethical & technical capabilities pertinent to mechanical & allied engineering.

RTU SYLLABUS AND MARKING SCHEME

8ME4-22: METROLOGY LAB	
Credit: 1	**Max. Marks: 50 (IA:30, ETE:20)**
0L+0T+2P	**End Term Exam: 2 Hours**

S. No.	**NAME OF EXPERIMENTS**
1	Study of various measuring tools like Dial Gauge, Micrometer, Vernier Caliper and Telescopic Gauges
2	Measurement of angle and width of a V-groove by using Bevel Protector
3	To measure a gap by using Slip Gauges
4	Measurement of angle by using Sine Bar
5	Study and use of surface roughness instrument (Taylor Hobson make) Inspection of various elements of screw thread by Tool makers microscope and optical projector.
6	Measurement of gear tooth thickness by using gear Tooth Vernier Caliper
7	To check accuracy of gear profile with the help of Profile Projector
8	To determine the effective diameter of external thread by using Three Wire Method
9	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat
10	To plot the composite errors of a given set of gears using composite gear tester
11	Measurement of coating thickness on electroplated part and paint coating on steel and non-ferrous material using coating thickness gauge.
12	Study and use of hardness tester for rubber and plastics
13	To check the accuracy of a ground, machined, and lapped surfaces (a) flat surface (b) cylindrical surface
14	To compare & access the method of small-bore measurement with the aid of spheres

EVALUATION SCHEME

I+II Mid Term Examination			**Attendance and performance**			**End Term Examination**			**Total Marks**
Experiment	**Viva**	**Total**	**Attendance**	**Performance**	**Total**	**Experiment**	**Viva**	**Total**	
15	5	20	5	15	20	15	5	20	50

DISTRIBUTION OF MARKS FOR EACH EXPERIMENT

Attendance	**Record**	**Performance**	**Total**
2	3	5	10

LAB OUTCOME AND ITS MAPPING WITH PO & PSO

LAB OUTCOMES

After completion of this course, students will be able to –

8ME4-22.1	Apply the principle of metrology for measuring various parameters like length, height, threads, angle, displacement, flatness, roughness, etc., by using different measuring instruments.
8ME4-22.2	Investigate the force generated on the work piece during various machining operations.
8ME4-22.3	Appraise the learning and skills of measurement and metrology to make project in a team.

LO-PO-PSO MAPPING MATRIX OF COURSE

LO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
8ME4-22.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-
8ME4-22.2	-	2	-	-	-	-	-	-	-	-	-	-	2	2	-
8ME4-22.3	-	-	-	-	-	-	-	2	2	2	-	2	2	2	-

PROGRAM OUTCOMES (POs)

PO1	**Engineering knowledge :** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**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.
PO3	**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.
PO4	**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.
PO5	**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.
PO6	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.
PO7	**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.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**Life-long 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1	Design, analyze and innovate solutions to technical issues in Thermal, Production and Design Engineering.
PSO2	Exhibit the knowledge and skills in the field of Mechanical & Allied engineering concepts.
PSO3	Apply the knowledge of skills in HVAC&R and Automobile engineering.

RUBRICS FOR LAB

Laboratory Evaluation Rubrics:

S. No.	Criteria	Sub Criteria and Marks Distribution			Outstanding (>90%)	Admirable (70-90%)	Average (40-69%)	Inadequate (<40%)
		Mid-Term	End-Team	Continues Evaluation				
A	PERFORMANCE (PO1, PO8, PO9)	Procedure Followed M.M. 50 = 3 M.M. 75 = 4 M.M. 100 = 6	Procedure Followed M.M. 50 = 3 M.M. 75 = 4 M.M. 100 = 6	Procedure Followed M.M. 50 = 1 M.M. 75 = 2 M.M. 100 = 2	• All possible system and Input/ Output variables are taken into account • Performance measures are properly defined • Experimental scenarios are very well defined	•Most of the system and Input/ Output variables are taken into account • Most of the Performance measures are properly defined • Experimental scenarios are defined correctly	• Some of the system and Input/ Output variables are taken into account • Some of the Performance measures are properly defined • Experimental scenarios are defined but not sufficient	•System and Input/ Output variables are not defined • Performance measures are not properly defined • Experimental scenarios not defined
		Individual/Team Work M.M. 50 = 3 M.M. 75 =4 M.M. 100 = 6	Individual/Team Work M.M. 50 = 3 M.M. 75 =4 M.M. 100 = 6	Individual/Team Work M.M. 50 = 1 M.M. 75 = 2 M.M. 100 = 2	•Coordination among the group members in performing the experiment was excellent	•Coordination among the group members in performing the experiment was good	•Coordination among the group members in performing the experiment was average	•Coordination among the group members in performing the experiment was very poor
		Precision in data collection M.M. 50 = 3 M.M. 75 = 4 M.M. 100 = 6	Precision in data collection M.M. 50 = 3 M.M. 75 = 4 M.M. 100 = 6	Precision in data collection M.M. 50 = 2 M.M. 75 = 2 M.M. 100 = 4	•Data collected is correct in size and from the experiment performed	•Data collected is appropriate in size and but not from proper sources.	•Data collected is not so appropriate in size and but from proper sources.	•Data collected is neither appropriate in size and norfrom proper sources
B	LAB RECORD/WRITTEN WORK (PO1, PO8, PO10)	NA	NA	Timing of Evaluation of Experiment M.M. 50 = 3 M.M. 75 = 4 M.M. 100 = 6	• On the Same Date of Performance	• On the Next Turn from Performance	• Before Dead Line	• On the Dead Line
		Data Analysis M.M. 50 = 3 M.M. 75 =5 M.M. 100 = 6	Data Analysis M.M. 50 = 3 M.M. 75 =5 M.M. 100 = 6	Data Analysis M.M. 50 = 2 M.M. 75 = 3 M.M. 100 = 4	•Data collected is exhaustively analyzed & appropriate features are selected	•Data collected is analyzed & but appropriate features are not selected	•Data collected is not analyzed properly. •Features selected are not appropriate	•Data collected is not analyzed & the features are not selected

		Results and Discussion M.M. 50 = 3 M.M. 75 =5 M.M. 100 = 6	Results and Discussion M.M. 50 = 3 M.M. 75 =5 M.M. 100 = 6	Results and Discussion M.M. 50 = 2 M.M. 75 = 3 M.M. 100 = 4	• All results are very well presented with all variables • Well prepared neat diagrams/plots/ tables for all performance measured • Discussed critically behavior of the system with reference to performance measures • Very well discussed pros n cons of outcome	• All results presented but not all variables mentioned • Prepared diagrams /plots/ tables for all performance measured but not so neat • Discussed behavior of the system with reference to performance measures but not critical • Discussed pros n cons of outcome in brief	• Partial results are included • Prepared diagrams /plots/ tables partially for the performance measures • Behavior of the system with reference to performance measures has been superficially presented • Discussed pros n cons of outcome but not so relevant	• Results are included but not as per experimental scenarios • No proper diagrams /plots/ tables are prepared • Behavior of the system with reference to performance measures has not been presented • Did not discuss pros n cons of outcome
C	**VIVA (PO1, PO10)**	Way of presentation M.M. 50 = 2.5 M.M. 75 = 4 M.M. 100 = 5	Way of presentation M.M. 50 = 2.5 M.M. 75 = 4 M.M. 100 = 5	Way of presentation M.M. 50 = 2 M.M. 75 = 3 M.M. 100 = 4	• Presentation was very good	• Presentation was good	• Presentation was satisfactory	• Presentation was poor
		Concept Explanation M.M. 50 = 2.5 M.M. 75 = 4 M.M. 100 = 5	Concept Explanation M.M. 50 = 2.5 M.M. 75 = 4 M.M. 100 = 5	Concept Explanation M.M. 50 = 2 M.M. 75 = 3 M.M. 100 = 4	• Conceptual explanation was excellent	• Conceptual explanation was good	• Conceptual explanation was somewhat good	• Conceptual explanation was Poor
D	**ATTENDANCE**	NA	NA	**A**ttendance M.M. 50 = 5 M.M. 75 =8 M.M. 100 =10	• Present more than 90% of lab sessions	• Present more than 75% of lab sessions	• Present more than 60% of lab sessions	• Present in less than 60% lab sessions

LAB CONDUCTION PLAN

Total number of Experiments - 10

Total number of turns required - 10

Number of turns required for:-

Experiment Number	Scheduled Week
Experiment -1	Week 1
Experiment -2	Week 2
Experiment -3	Week 3
Experiment -4	Week 4
Experiment -5	Week 5
I Mid Term	**Week 6**
Experiment -6	Week 7
Experiment -7	Week 8
Experiment -8	Week 9
Experiment-9	Week 10
Experiment-10	Week 11
II Mid Term	**Week 12**

DISTRIBUTION OF LAB HOURS

S. No.	Activity	Distribution of Lab Hours	
		Time (180 minute)	Time (120 minute)
1	Attendance	5	5
2	Explanation of Experiment & Logic	30	30
3	Performing the Experiment	60	30
4	File Checking	40	20
5	Viva/Quiz	30	20
6	Solving of Queries	15	15

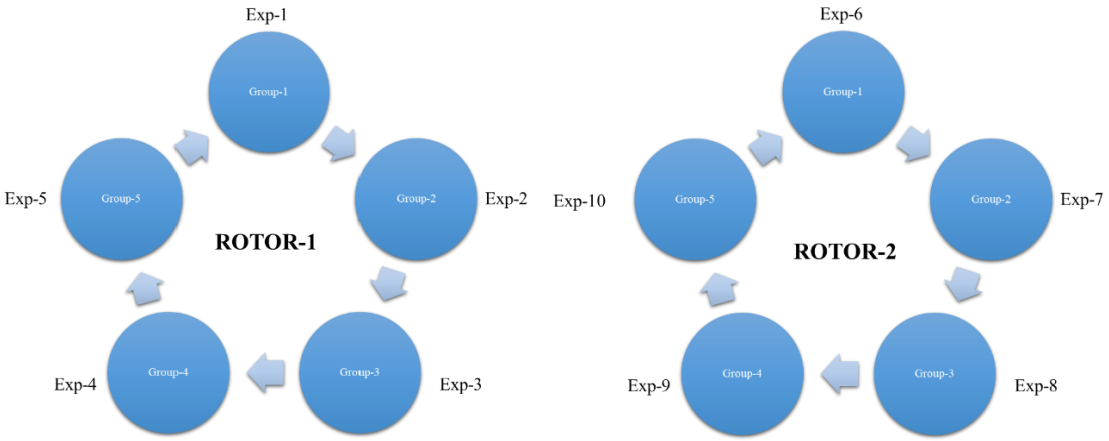
LAB ROTAR PLAN

ROTOR-1

Ex. No.	NAME OF EXPERIMENTS
1	Study of various measuring tools like Dial Gauge, Micrometer, Vernier Caliper and Telescopic Gauges
2	Measurement of angle and width of a V-groove by using Bevel Protector
3	To measure a gap by using Slip Gauges
4	Measurement of angle by using Sine Bar
5	Measurement of gear tooth thickness by using gear Tooth Vernier Caliper

ROTOR-2

Ex. No.	NAME OF EXPERIMENTS
6	To check accuracy of gear profile with the help of Profile Projector
7	To determine the effective diameter of external thread by using Three Wire Method
8	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat
9	To check the accuracy of a ground, machined, and lapped surfaces (a) flat surface (b) cylindrical surface
10	To compare & access the method of small-bore measurement with the aid of spheres



GENERAL LAB INSTRUCTIONS

DO'S

1. Enter the lab on time and leave at proper time.
2. Feel that practical are essentials to lay the foundation for understanding the subject.
3. Have knowledge of the theoretical background of each experiment.
4. Handling every equipment carefully.
5. Consult your teacher, or your friend who had already done the experiment before entering the lab. This will help you to overcome difficulties while doing the experiments.
6. Turn off the machines before leaving the lab unless a member of lab staff has specifically told you not to do so.
7. Make as many observations/readings as possible. Large number of data will eliminate random errors and systematic errors.
8. Calculations must be done meticulously. For this, the knowledge of using calculators and mathematical tables is essential.
9. If you get wrong result others than the expected one, study your observation thoroughly and find out where you went wrong. Repeat the experiment until you get the correct observation, leading to the correct and expected result.
10. If you notice any problem with machine/ equipment/tool, then please report it to lab staff immediately. Do not attempt to fix the problem yourself.

DON'TS

1. Don't neglect the importance of practical.
2. Don't be lazy in making observation. Avoid copying someone else's observation.
3. There should not be any distraction. Don't play with your friend or the apparatus while doing the experiment.
4. Don't damage the equipment.
5. Don't touch the moving parts of the machine.
6. Don't play with electric instruments.
7. If you are going to be away from your machine for more than 10 or 15 minutes, switch off before leaving. This is for the security of your experiment and to ensure that others are able to use the lab resources while you are not.
8. No food or soft drink is allowed in the lab or near any of the equipment. Aside from the fact that it leaves a mess and attracts pests. If you need to eat or drink, take a break and do so in the canteen.
9. Do not work in a laboratory wearing loose hair, loose clothing or dangling jewellery.
10. Don't wear rings, watches, bracelets or other jewellery that could get could get caught in moving machinery.
11. Do not eat food, drink beverages or chew gum in the laboratory.
12. Don't bring any external material in the lab, except your lab record, copy and books.

LAB SPECIFIC SAFETY RULES

1. While using lathe, ensure no loose cloths and hairs which can mess up
2. With spinning shaft and result in accident
3. While practicing foundry lab, take care molten material may not touch the body parts
4. While operation of shaper machine, don't keep the hand on the job.
5. While using grinder, ensure your body not in the plane of spin, in case of shattering, it may hurt you badly.
6. Always wear eye glasses so that no chip can enter your eye.
7. Take care while lifting heavy articles; it may fall on to your feet
8. While welding, always follow the instructions for safe welding.
9. Do not touch any rotating/ reciprocating parts of machine while operating it.

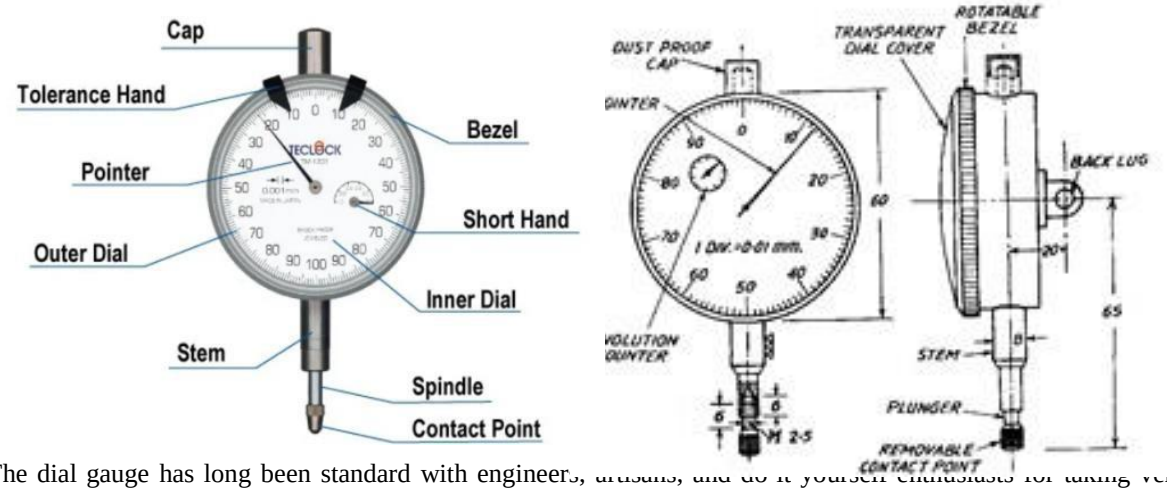
EXPERIMENT-1

OBJECTIVE

Study of various measuring tools like Dial Gauge, Micrometer, Vernier Caliper and Telescopic Gauge.

DIAL GUAGE

A dial gauge is a precision measurement commonly used to measure machined parts for production tolerances or wear. Dial gauges are capable of producing extremely fine measurement value s; increments of 0.00005 inch (0.001mm) may be possible with some gauges. Measurement inputs are transferred to the gauge via a plunger, hinged lever, or the jaws of a vernier. Plunger instruments are generally used in conjunction with a clamp or stand which holds the gauge in a fixed position in relation to the work piece. The work piece is then rotated or moved to take the measurements. Dial gauges are available with analogue needle and dial indicators or digital liquid crystal displays (LCDs).

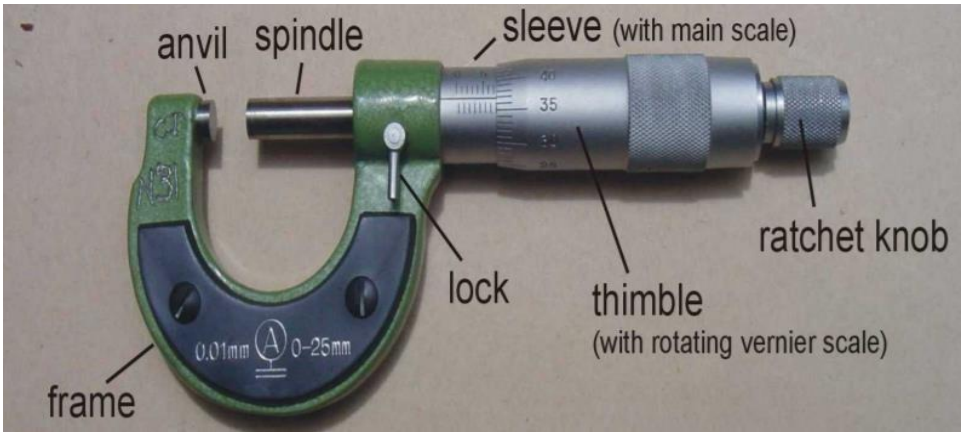


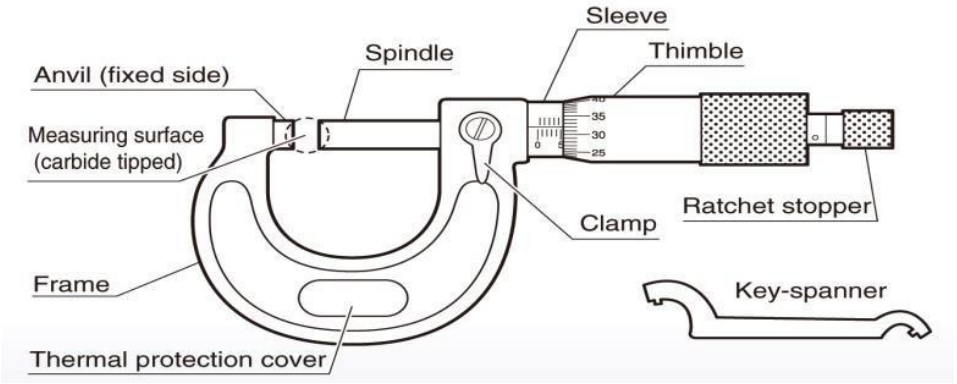
The dial gauge has long been standard with engineers, artisans, and do it yourself enthusiasts for taking very fine measurements on precision parts. High levels of accuracy are possible in extremely small increments with typical measurement ranges running from 0.015 inches to 12 inches' (0.25 —300 mm) in increments as small as 500 thousand of an inch (0.001mm). The rear two basic dial gauge formats; the first is the plunger or lever type gauge. In this case a spring-loaded plunger or lever at the bottom of the gauge transfers work piece surface height deviations to the gauge. The second type is the Vernier dial gauge which receives its measurement input from the movement of the jaws of a conventional venire. Plunger type dial 3auges are typically held in a fixed position while taking measurements. Specially designed weighted or magnetic clamps or stands are used to support the instrument while the work piece is rotated or moved. A Vernier type dial gauge utilizes the movement of the venires jaws as a measurement input. These gauges indicate measurements both on the dial and on the conventional Vernier scale. The Vernier type gauge is capable of producing very accurate measurements across the Vernier Standard inside and outside diameter and depth measuring ranges.

MICROMETER

The micrometer is a precision measuring instrument, used by engineers. Each revolution of the ratchet moves the spindle face 0.5mm towards the anvil face. The object to be measured is placed between the anvil face and

spindle face. The ratchet is turned clockwise until the object is 'trapped' between these two surfaces and the ratchet makes a 'clicking' noise. This means that the ratchet cannot be tightened anymore and the measurement can be read.





THE BASIC OPERATING PRINCIPLES OF A MICROMETRE ARE AS FOLLOWS

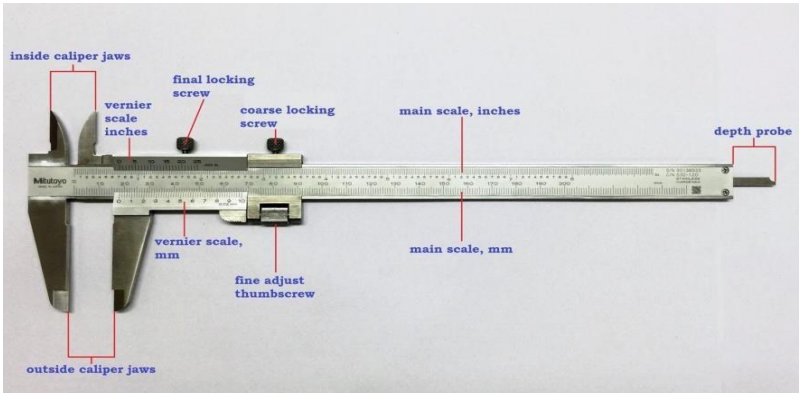
- The amount of rotation of art accurately made screw can be directly and precisely correlated to a certain amount of axial movement (and vice versa), through the constant known as the screw's lead. A screw's lead is the distance it moves forward axially with one complete turn (360°).
- With an appropriate lead and major diameter of the screw, a given amount of axial movement will be amplified in the resulting circumferential movement.

VERNIER CALIPER

The Vernier caliper is a precision instrument that can be used to measure internal and external distances extremely accurately. The example shown below is a manual caliper. This is more difficult than using a digital Vernier caliper which has an LCD digital display on which 'the reading appears. The manual version has both an imperial and metric scale. Manually operated Vernier caliper scan still be bought and remain popular because they are much cheaper than the digital version. Also, the digital version requires a small battery whereas the manual version does not need any power source.

The Vernier scale is constructed so that it is space data constant fraction of the fixed main scale. So, for a decimal measuring device each mark on the Vernier is spaced nine tenths of those on the main.If you put the two scales together with zero points aligned, the first mark on the Vernier scale is one tenth short of the first

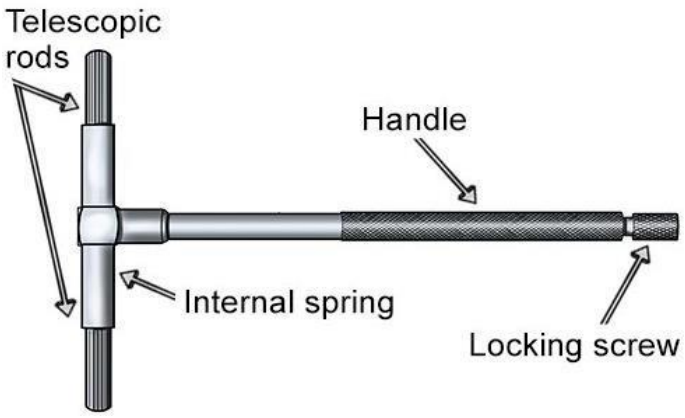
main scale mark, these cond. two tenths short, and soon up to the ninth mark which is misaligned by nine tenths. Only when a full ten marks are counted is there alignment, because the tenth mark is fen tenths a whole main scale unit short, and therefore aligns with the ninth mark on the main scale.



TELESCOPIC GAUGES

A telescopic gauge is a measuring tool with spring "loaded plunges used together with a micrometer to measure the inside of holes or bores. Telescoping gauges are made insets to measure from small to very large bores.

The telescoping gauge has a handle that is attached to two spring-loaded plungers. Using the handle, place the telescoping gauge into the bore. Release the lock screw on the handle. The spring-loaded plungers will come out and touch the side of the bore. Rock the gauge back forth to be sure it is square in the bore. Then turn the lock screw to lock the plungers in position. Remove the telescoping gauge from the bore. The exact size of the hole is found by measuring across the two ends of the plunger with an outside micrometer. Inside calipers can be used to measure any gap that their legs will fit into, and because those legs are not hardened (and also because the tool is so inexpensive), they can be ground thinner to fit into really narrow cracks. Still they are likely used most of the time to measure the inside diameter (I'd) of holes. Another tool that can be used for exactly the same purpose is telescoping gauge. Although its working ends are larger than those of an inside measurement as the I'd of a snap ring groove, the telescoping gauge is definitely preferable for gauging simple round holes because of its potentially greater level of accuracy. The advantages come from the construction of tool: it amounts to two straight legs, one of which telescopes into the other, working against a spring that tends to extend it. Part of the improvement in accuracy over calipers is provided by that spring, which automatically controls the gauging force. Another aid to accuracy is a handle attached exactly at right angles to the fixed leg.



CONCLUSIONS

Thus, we have studied various measuring tools like dial gauge, micrometer, Vernier caliper and telescopic gauges.

VIVA-VOCE QUESTIONS

1. When Vernier caliper is used?
2. How do you calculate the least count micrometer?
3. How do you calculate the least count of Vernier caliper?
4. Can you tell the industrial application of dial gauge?
5. What is the least count of dial gauge?
6. What is telescopic gauge?
7. What is the hardness of measuring faces of anvil and spindle?
8. What is the hardness of measuring jaws of Vernier height gauge made up of stainless steel?
9. How many divisions are graduated on thimble?
10. What is the accuracy range of stick micrometers?

EXPERIMENT-2

OBJECTIVE

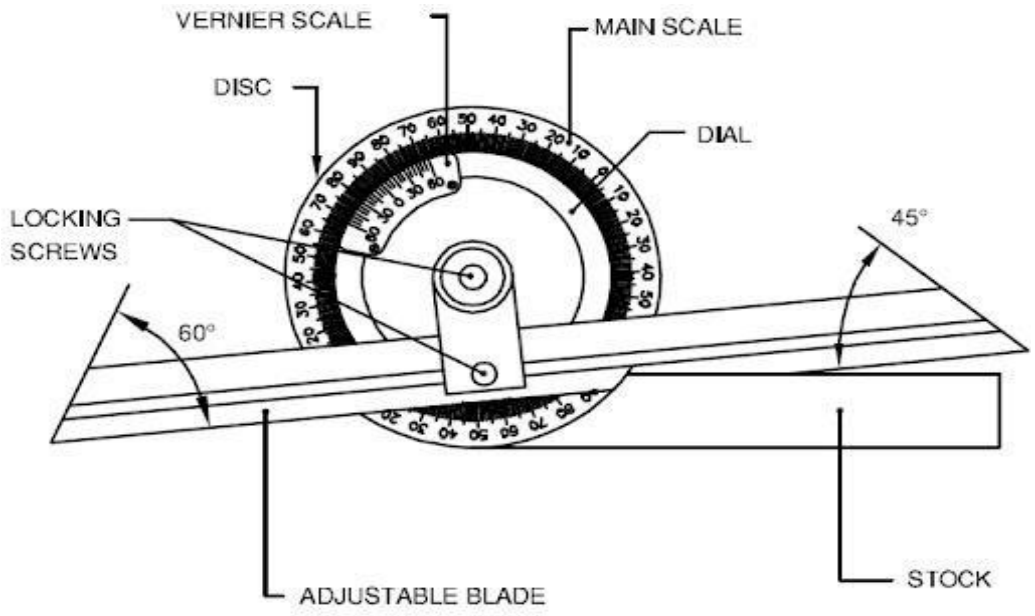
Measurement of angle and width of a V-groove by using bevel protector

APPARATUS

Combination sets, Bevel protector**.**

THEORY

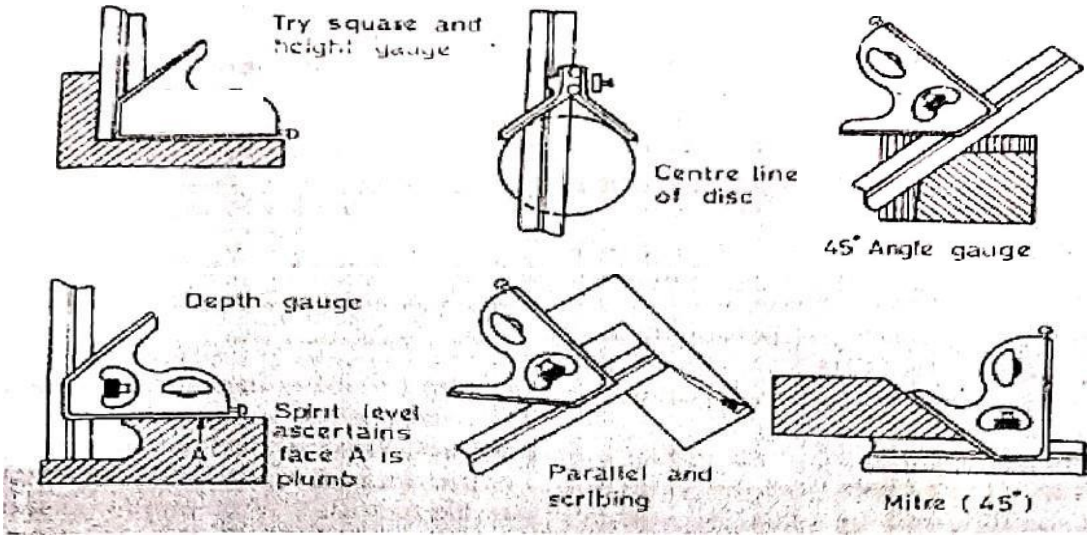
BEVEL PROTECTOR: It is use for measuring & lying out of angles accurately and precisely within 5 minutes. The protector dial is slotted to hold a blade which can be rotated with dial to the required angle and also independently adjusted to any desired length. The blade can be locked in any position.

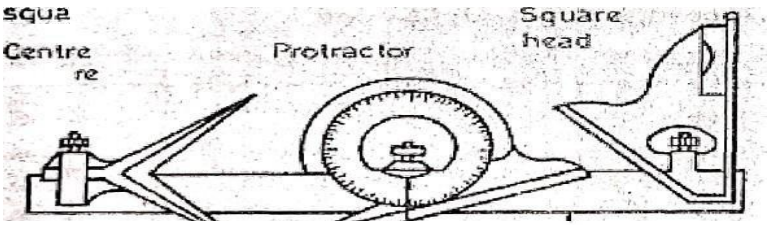


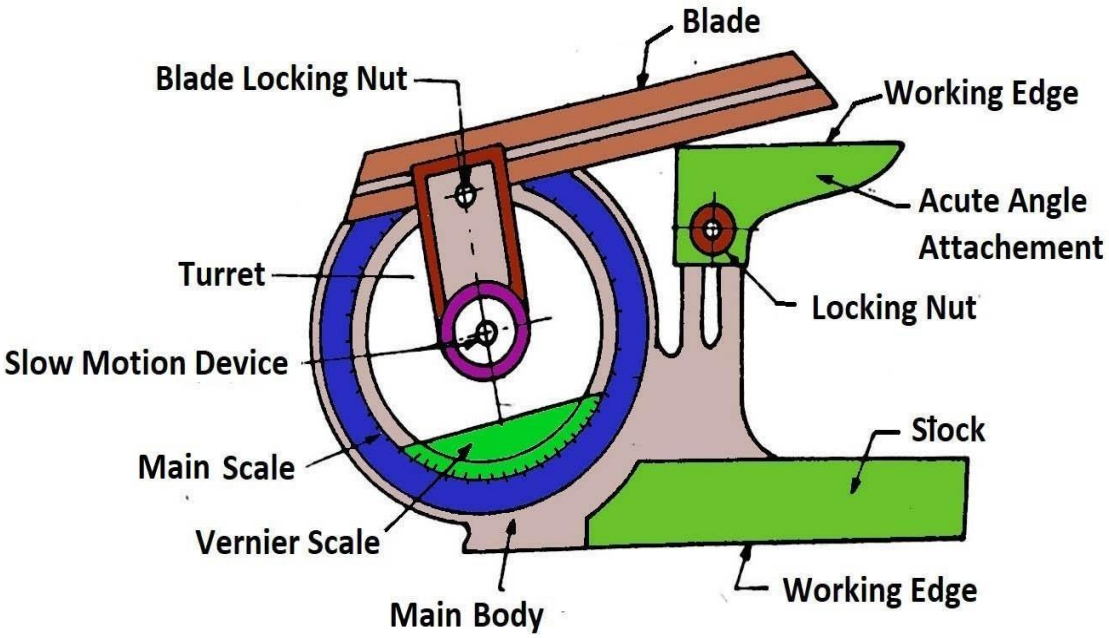
CHECKING OF UNKNOWN ANGLES: Many a times, angle of component to be checked is un known. In such a case it is necessary to first find the angle approximately with the help of a bevel protractor. Let the angle. Then the sine bar is set at an angle () and clamped to an angle plate. Next the work is placed on sine bar and clamped to Angle plate as shown in figure. Slip gauges are so arranged (according to deviation) that the sprite level is at center (the air bubble) If the deviation is noted down by the spirit level is h over a length '1' of work , then height of slip gauges by which it should be adjusted is equal to = h1

Combination Sets: -The combination set consists of scale, squaring-head, protractor and center-head. It consists of a heavy scale, which is grooved all along its length. It is on this groove that sliding squaring head is fitted. One surface of the squaring head is always perpendicular to the scale and its can be adjusted at any p1ace by the locking bolt and nut. The squaring head also contains a spirit level which is used to test the surfaces for parallelism. For laying out dove tails an included angle is also mounted on the scale. It can also slide to any position and be locked there.

A scribing point is also inserted into the rear of the base for scrubbing purposes. The squaring head and scale can be used for height and dept measurement, inside and outside squaring operation.







VIVA-VOCE QUESTIONS

1. How do you calculate least count of Vernier bevel protractor?
2. What are the parts of Vernier bevel protractor?
3. What is use of Vernier bevel protractor?
4. Write down the applications of bevel protractor.

5. What is the major difference between Sine bar, Bevel protractor & Clinometers?
6. Explain the principle of Wheatstone bridge.
7. What is the major difference between Sine bars, Bevel protractor?
8. Explain the use of Universal Bevel Protractor?
9. Define: i) Major Dia ii) Effective Dia iii) Pitch iv) Angle of Thread.
10. Explain the three uses of combination set.

EXPERIMENT-3

OBJECTIVE

To measure a gap with help of a slip gauges

EQUIPMENTS

- Slip gauge
- Work piece

THEORY

Slip gauges are the practical standard of length for use *in* the workpiece for work where a tolerance as low as .01 mm is needed. There are rectangular blocks of steel having a cross- section area of about 32 mm x 9 mm. After being hardened the blocks are finished to such a free degree of finish, flatness & accuracy that molecule cohesion takes place when the measuring faces of two or more block are slide or wring together.

According to their method of manufacturing slip gauges are classified as:

1. Cohesive type
2. Wring together type
3. Cohesive type slip gauge: it is machined tapped with high precision so as to obtain a mirror like polished surface. There are more accurate than the" wring together type" but their surfaces wear rapidly & they become under sized. Therefore, there should be used only as reference measures.
4. Wring together type slip gauge- these type slip gauge has a scratch pattern finish due lo circular motion in lapping. These possess in surface wearing than cohesion type slip gauge.

Grades of accuracy- There are 5 grades of accuracy

1. Calibrate grade: These are used only for checking other type of blocks (slip gauges). These are special gauges.

2 Grade [00]: these should be kept in standard room. These are used for highly precision work only like checking the error present in work piece slip gauge or grade2.

3 Grade [0]: These are commonly known as inspection gauge & use in confined to tool room or machine shop inspection.

4 Grade [1]: these are used for general work shop purpose. These are used in setting sine bar, sine table checking gap gauges.

5 Grades [ ]: these are workshop gauges. These are used for setting up machine tools, position willing cutter & checking mechanical width.

Gauges blocks are available in sets with steps of 10, 1, 0.1, & 0.001 mm on small size blocks the size is marked on the measuring face & large blocks are marked on a side surface. To select gauge blocks to make up a given size, the procedure is consider the smallest unit first in the given and to work through the value by moving to the left in the way 0.001mm is considered first, followed but 0.01mm, 0.001mm & lastly the whole multi meters. As a rule, the minimum number of gauges should be used to make up a given size generally 3 to 4 blocks are used. Slip gauges are available in sets of 46 pieces, 110 pieces & so on e. g. a set of 110 pieces consists of following sizes.

SIZE (mm)	INCREMENT (mm)	NO. OF PIECES
0.50 to 1.00	**0.50**	**2**
1.005	**-**	**1**
1.01 to 1.50	**0.01**	**50**
1.60 to 2.00	**0.10**	**5**
2.50 to 10.00	**0.50**	**16**
20.00 to 100	**10.00**	**9**

PROCEDURE

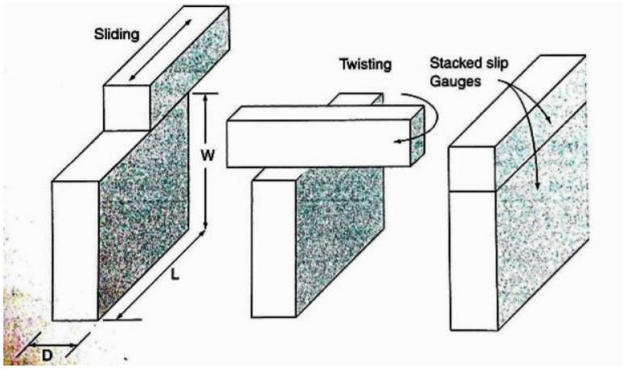
1. Take a workpiece on which slot is cut and we have to find the gap of that slot
2. Insert the slip gauges of various dimensions into the slot
3. Measure the gap of that slot by using slip gauges

RESULT

The dimension of given specimen work piece gap is..... mm.

PRECAUTION

- Careful when reading is being taken by slip gauges.
- Count slip gauges before starting reading and after taking readings.



VIVA-VOCE QUESTIONS

1. What are the uses of angle plate?
2. Can you explain the wringing?

3. Why the slip gauges are termed as ―End standard‖?
4. What is slip gauge?
5. What is the difference between slip gauge and pitch gauge?
6. What is the approximate size of slip gauges?
7. Why ceramic slip gauges is better than steel slip gauges?
8. What is the permissible gauge error for Grade 0?
9. How many grades or classes of slip gauges are present?
10. What is the applications of slip gauges?

EXPERIMENT-4

OBJECTIVE

To measure the taper angle of the given specimen using Sine bar

APPARATUS REQUIRED

Surface plate, Dial gauge with stand, Sine bar, Slip gauge, Bevel protractor & Specimen

SPECIFICATION

Sine bar:

Range:

Formula-

Taper angle 'θ'= $Sin^{-1}(H/L)$ in degrees

Where, H= the total height (thickness) of the slip gauges in mm

L = the standard length of the sine bar in mm = 200mm

PROCEDURE

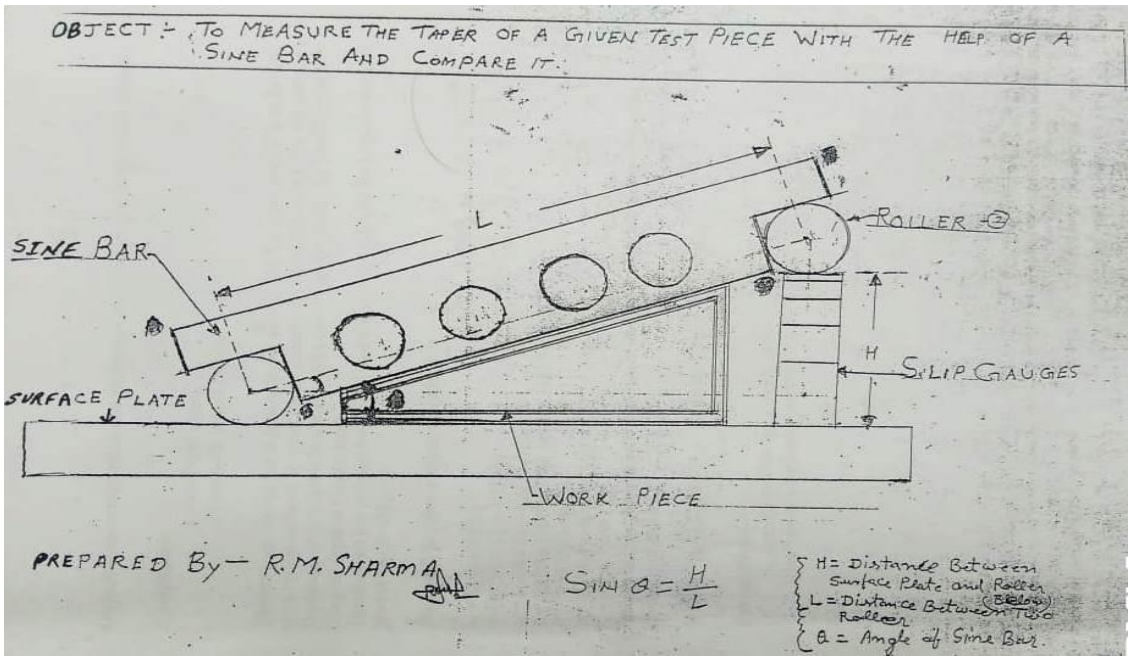
- The taper angle of the specimen is first found out approximately with the help of bevel protractor.
- The sine bar is set at this angle on the surface plate with the help of slip gauges as shown in figure
- The specimen is placed on the sine bar so that its top taper surface is parallel to the surface plate.
- The parallelism is checked and adjusted by increasing or decreasing the height level of the slip gauges, so that there should be no deflection in the long hand of the digital gauge when the spindle of the dial gauge is moved over the specimen surface.
- The total height (thickness) of the slip gauges is noted down.
- Trials reading are taken by placing the specimen at different points at different of the sine bar surface.

For small specimen:

Trial	Total height of the slip gauge reading (mm)
1	

For larger specimen:

Trial	H_1 (mm)	H_2 (mm)	H_2-H_1 (mm)
1			
2			
3			



RESULT

The taper angle of the given specimen is

Using bevel protractor = ...degrees

Using sine bar = ...degrees

VIVA-VOCE QUESTIONS

1. How do calculate taper angle of the specimen using bevel protractor?
2. Which material is used for making Sine Bar?
3. What is the difference between slip gauge and pitch gauge?
4. Explain how you measure minor and effective diameter.
5. Which is instrument used to find the effective diameter very accurately.
6. Name the instrument used to find the screw thread parameters.
7. What is error?
8. Mention the two important requirements of measurements
9. Why we use Sine bars to find angles?
10. What are the sources of errors in sine bars?

EXPERIMENT-5

OBJECTIVE

Measurement of chordal thickness of gear tooth by gear tooth Vernier Caliper.

EQUIPMENT

1 gear (work piece)

2 gear tooth Vernier calipers

THEORY

We use special Vernier calipers to measure the gear tooth. It is called tooth Vernier caliper. It is just like an ordinary Vernier caliper but it has two scales. (i) Horizontal scale which tells about the thickness of the gear tooth. (ii) Vertical scale tells about the depth of the gear tooth

Therefore, we can measure the chordal thickness of gear tooth with the help of measuring jaws of Vernier calipers.

Formula for theoretical calculation:

$W = 2R \sin(90/N)$

$D = R [1+2/N - \cos(90/N)]$

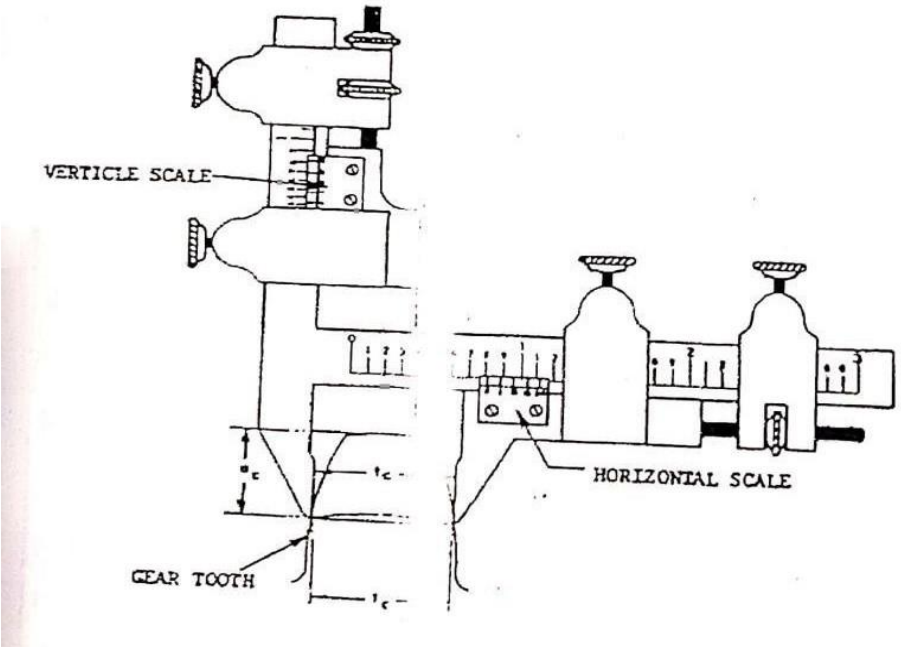
W= chordal thickness of gear tooth

D= depth of gear tooth on which w is taken

R= pitch circle radius

N= no of teeth on gear

We can find out the error by comparison of theoretical and actual values of chordal thickness of gear tooth.



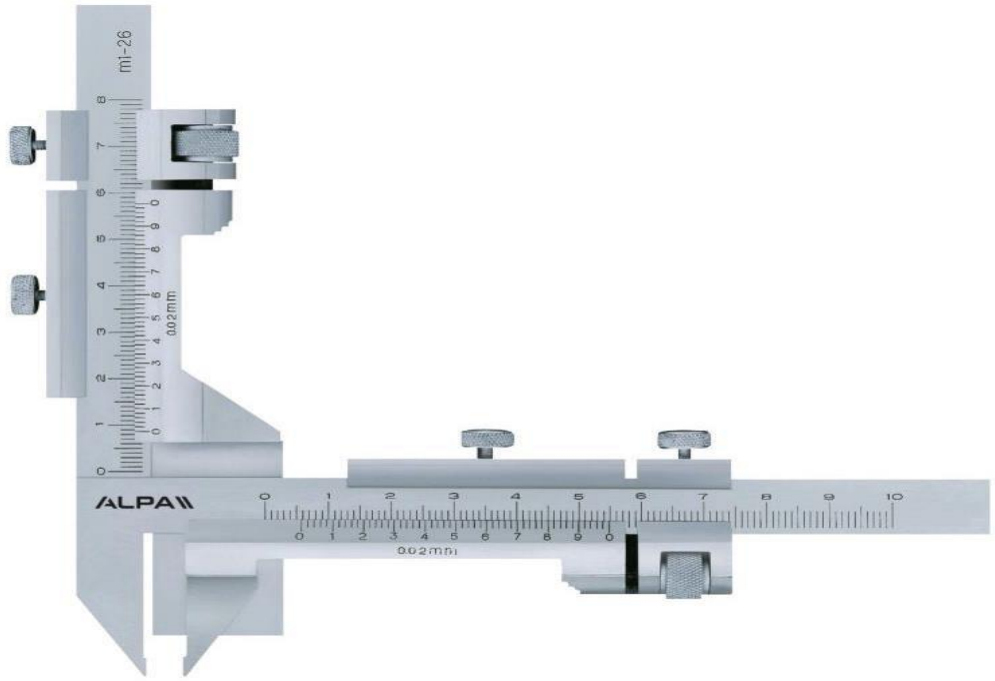
RESULT

The actual value for chordal thickness of gear tooth is …….

PRECAUTIONS

Be careful when reading is taken.

Don't press more jaws of Vernier calipers.



VIVA-VOCE QUESTIONS

1. Which type of Vernier calipers used to measure the gear tooth, tell the name of that?
2. How many scales are used in tooth Verniercaliper?
3. Define GO and NO GO gauges.
4. Name the types of gauges.
5. How will you measure the major diameter & minor diameter of internal thread?
6. What are the major errors in screw thread?
7. What are the major errors in gear tooth?
8. What is the effect of improper alignment of each tooth?
9. Which of the element is not determined by analytical inspection?
10. Explain the application of gear tooth Vernier calipers.

EXPERIMENT-6

OBJECTIVE

To check accuracy of gear profile with the help of profile projector

DESCRIPTION OF APPARATUS

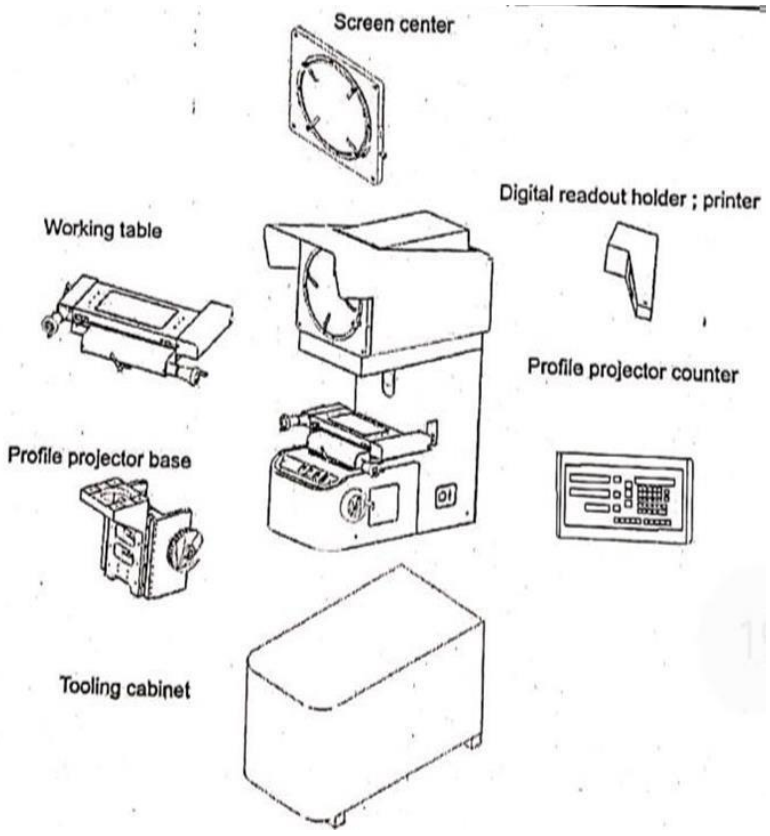
Operation profile projector model RPP-12 is a checking instrument, which allows its equipment to be perfectly suited to robust momentary requirements & wishes. The robust but simply construction

- Light Indicator
- Lamp Housing
- Lamp housing lightning screw
- Bulb holder assembly
- Focusing knob
- Condenser lens housing
- Table tilting knob
- Work table
- Place for objective/ dust cover
- Glass screen
- Strips for clamping drawing
- ON/OFF switch
- Wooden tray for components
- Wooden cabinet for lock & key
- Background cover
- Main body
- Base
- Bottom cover

PROCEDURE

- Place the profile projector at a suitable place where no direct light falls on the screen.
- Remove all packing material and open the cotton strip from instrument.
- Clean all the external parts gently with duster.
- Clean the objective and the glass screen with soft cotton/tissue.
- Base mirror is covered with tissue paper to protect its surface during transmit open the round cover at the back and remove the tissue paper gently.
- Do not touches the inside mirror edge. It is front coated. In case of finger marks or dust, remove it by cotton very softly and gently. Close the round cover by pushing.
- Connect the lead wire to 220-240V A.C main board.
- Ensure proper earthling on main board.
- Switch on the ON/OFF switch. Provided in front above the cabinet, the bulb will glow. The bulb is fixed inside the housing. It is a halogen bulb 240V – 150W through built in transformer.
- Open the black dust cover on top at the place of objective by pulling it.

- Insert the 25X objective lens in the hole
- Keep some specimen on stage
- Focus it by focusing knob up or down. The projection will appear on screen
- Repeat the serial no.10 is in case of 50X magnification
- On a screen two black strips are provided to hold the drawing for comparison purpose
- Centre holding device is provided for using the centre thread shaft etc. it can be fixed on work table by sliding into it & then light the thumb screen
- In case the threads in angle are to be checked table-fitting knob can be used it can till up to 10 on both sides
- Keep the instrument covered with dust cover. When the projector is not in use



USES

- Electric lamp filament, valve grids, similar object
- Small machine parts
- Fine wires, hairs, threads, Fibres
- Cutlery, razor blades micrometer blade
- Points of needles pin
- Moulding in ebonite

VIVA-VOCE QUESTIONS

1. What are the industrial applications of profile projector?
2. Can you tell the name of profile projector parts?
3. How do compare the shape or profile of relatively small gear with an accurate drawing.
4. What is one main scale division?

5. What is one Vernier scale division?
6. What is the least count?
7. What is the thread and explain different types of threads?
8. What is addendum?
9. What is dedendum?
10. Why Profile Projector is using?

EXPERIMENT-7

OBJECTIVE

To find the effective diameter of thread by a three-wire method.

EQUIPMENT LIST

- Thread work piece
- Wires
- Micrometer

THEORY

One of the most accurate methods of checking the pitch diameter is the three-wire method. The method consists in placing three shell diameters cylindrical in the thread method groove at opposite side of screw & measuring the distance w over the centre surface of the circle with an ordinary micrometer caliper having flat measuring faces. Three wires are required to prevent misalignment one measuring faces on the micrometer caliper. The pitch and effective diameter are calculated from the value w in the manner.

It is clear that

$W= p+2*AC+2*D/2$

where p= pitch or effective diameter & d= wire size

Now,

$AC+AD-CD = D/2\operatorname{cosec}\alpha/2-p/2 \cot \alpha/2$

Where α= thread angle p= pitch of threads

After simplification it can be see that,

$W=P+D(1+\operatorname{cosec}\alpha/2)-p/4\cot\alpha/2$

In case of I.S.O metric thread $\alpha=60$

$W=P+3D- 0.866P$

$P=W-3D+0.866P$

Here the diameter lies 0.3248 p inside the thread that is

$P=D-0.6496P$

Where D= outside diameter

$D=W-3D+1.5156P$

Thus, if the wire diameter d, the thread p & distance wave known, the pitch diameter of screw may easily by complete far the above relations.

For metric threads we should use following formula,

$M= E+Q$

M: it is the reading b/w top surface of wire put across the threaded portion

E: effective diameter

Q: $W(1+\operatorname{cosec}\theta)-p/2 \cot \theta$

W: wire diameter

P: pitch of thread

For metric thread $\theta=60$ degree & whit wrath $\theta= 55$ degree

E=M-Q

WIRE SIZE

Wire of any diameter can be used to measure to pitch diameter provided it makes contact on the true flank of the thread & provided the thread angle is correct. A wire of best size is one that makes contact with the flank of the thread at the pitch diameter. The effective diameter is calculated with the help of any wire touching the true flank of the thread will differ from that obtained by using the wire of best size. If there is error in angle or form of true thread. In case of best size wire the point B at which the wire touches the flank of the thread lies on the pitch line that is BC lies on the pitch line & that AB is perpendicular to flank position of the thread. If there are possibilities of thread angle being incorrect the wire of the best size should be used to determine effective diameter since such will be independent of any even in thread angle.

Now BC=p/4

From triangle ABC

AB=d/2=BC secα/2

Best size D=p/2 secα/2

From I.S.O metric thread

D=p/2 sec 30=0.5774p

PROCEDURE

1. To the set wire: two wires on the top of the threaded test piece & one wire on the bottom of the threaded test piece & find the distance between these parallel wire by micrometer. This reading is called N.
2. Find the diameter and pitch of the thread. Diameter is found in micrometer
3. D is for metric thread is 60
4. Find the effective diameter of thread

CALCULATION

M=E+Q

Where M= reading between top surface of the wire put across the threaded portion

E=effective diameter to be measured

Q= W(1+cosecθ)-p/2 cotθ

W= wire diameter using micrometer.

W1= …….

W2= …….

W3= …….

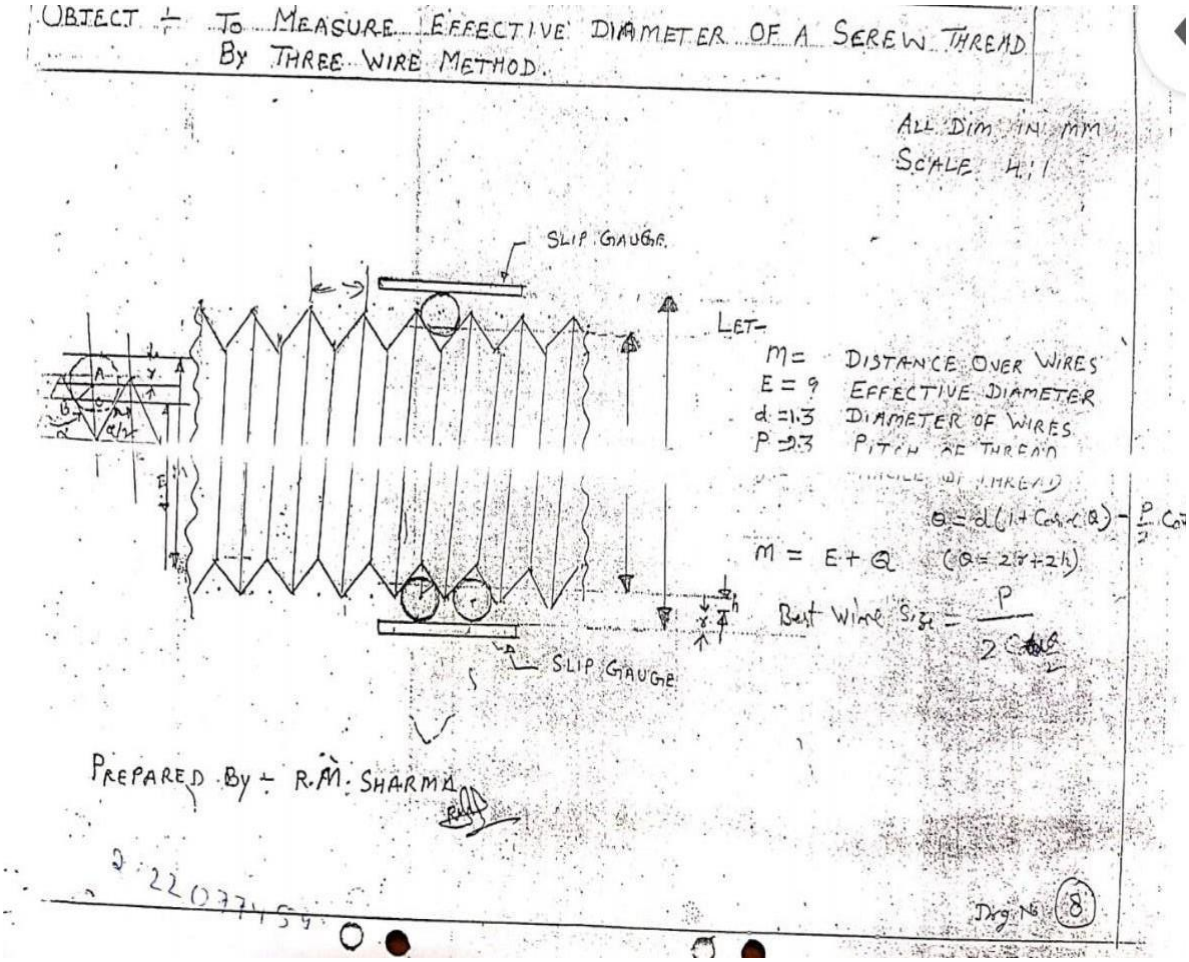
Mean diameter of wire W= [W1+W2+W3]/3

θ= …

pitch p= …

Q = ….

E = M- Q = ….



RESULT

The effective diameter of threaded test piece is ….

PRECAUTIONS

- Measurements of M using micrometer should be taken carefully.
- Wire should be set with contact to threaded portion & parallel to each other.
- Observation of the reading of micrometer should be done carefully.
- Diameter of wire can be checked two or more times & find diameter of wire should be used.

Viva-Voce Questions

1. What is meaning of best wire size.
2. Why we use micrometer in three wire method
3. What is difference between two wire and three wire methods of effective diameter measurement?
4. What is interferometry & how you get interference bands.

5. Define hole basis and shaft basis.
6. What is roughness and define Ra, Rz values?
7. What is plug gauge and thread gauge?
8. What is a cosine error?
9. What is the thread and explain different types of threads?
10. Where three wire method are using industries.

EXPERIMENT-8

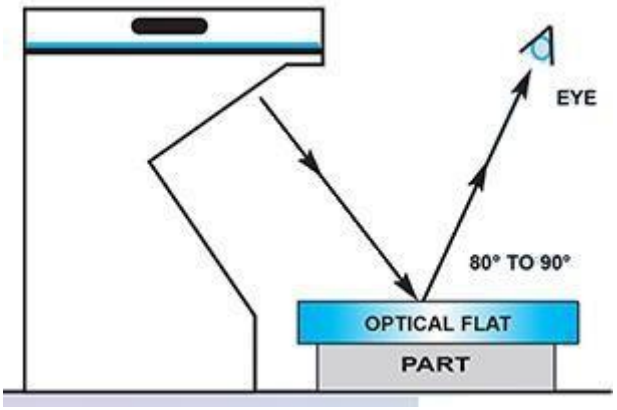
OBJECTIVE

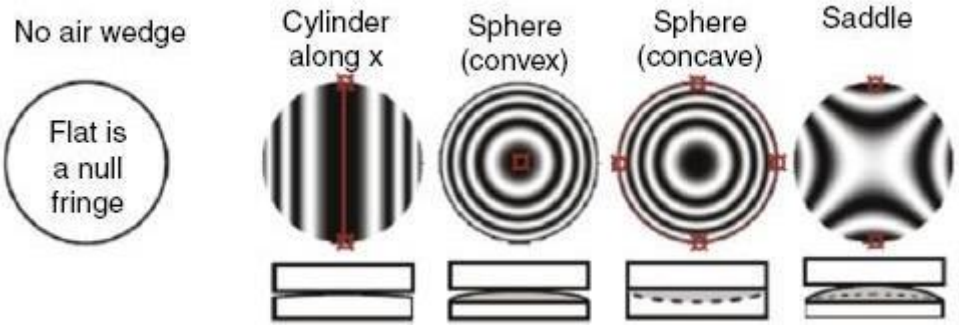
To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.

APPARATUS

The apparatus used for this experiment are as follows:

- Optical flat
- Monochromatic light
- Slip gauge

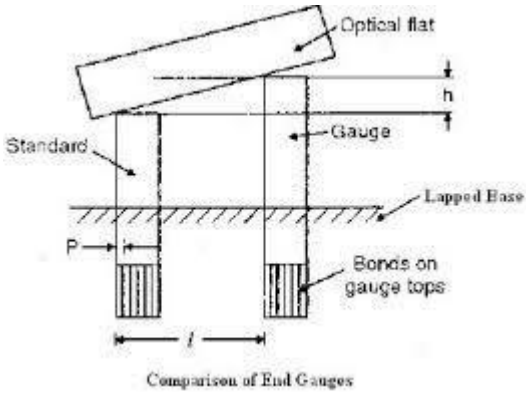




THEORY

Optical flats are cylindrical pieces 25-300 mm in diameter, with a thickness of about one-sixth of the diameter. They are made of transparent materials such as quartz glass, and sapphire; optical flats made up of quartz are more commonly used because of their hardness, low coefficient of expansion, and much longer useful life. One or both surfaces of optical flats may be highly polished. For measuring flatness, in addition to an optical flat, a monochromatic light source emitting light of a single wavelength is also required. The yellow-orange light radiated by helium gas is most satisfactory for use in an optical flat. Optical flats are used to test the flatness of lapped surfaces such as surfaces of gauge blocks, gauges, and micrometer anvils. When an optical flat is placed on the surface of a workpiece, it will not form an intimate contact but will be at a slight inclination to the surface, forming an air wedge between the surfaces.

If an optical flat is now illuminated by light rays from a monochromatic source, interference fringes will be observed. These are produced by the interference of light rays reflected, from the bottom face of the optical flat and the top face of the workpiece being tested, through the layers of air. An arrangement for measurement using an optical flat to determine height difference between two slip gauges is shown in fig.



Comparison of End Gauges

MONOCHROMATIC LIGHT

Monochromatic light is a form of energy propagated by electromagnetic waves, which may be represented by a sin curve. The high point of the wave is called a crest and the low point is called a trough. The distance between two crests or two troughs is called the wavelength λ. The time taken to travel across one wavelength λ is called the time period (T). The maximum disturbance of the wave is called the amplitude (A), and the velocity of transmission (λ /T) is called the frequency.

PROCEDURE

The experimental procedure involves the following steps:

- Clean the platform
- Switch on the monochromatic light
- Select two slip gauges and clean them
- Place the slip gauges and clean them
- Place the optical flat on the slip gauges
- Count the number of fringes in the slip gauges
- Substitute the value in the given formula
- Compare with the actual value

OBSERVATION

$H = \lambda LN/2l$

where λ = 0.0002794 mm, l is the width of the slip gauge in mm, L is the distance between the slip gauges in mm, and N is the number of fringes.

Viva-Voce Questions:

1. What you mean by Monochromatic light?
2. What is the procedure to check the flatness and surface defects with the help of monochromatic light and optical flat?
3. What do you mean by surface roughness?
4. What are the instruments used for measuring surface roughness?

5. What are the different operations where you can find out surfaceroughness?
6. What do you mean by flatness?
7. What are optical flats?
8. What is the material with which optical flats are made?
9. What is the applications of monochromatic light?
10. Which of the method is used for the determination of flatness when the surface is irregular?

EXPERIMENT-9

OBJECTIVE

Measurement of flatness and roundness of a given machine/ground/lapped flat and round surface respectively using Dial Gauge.

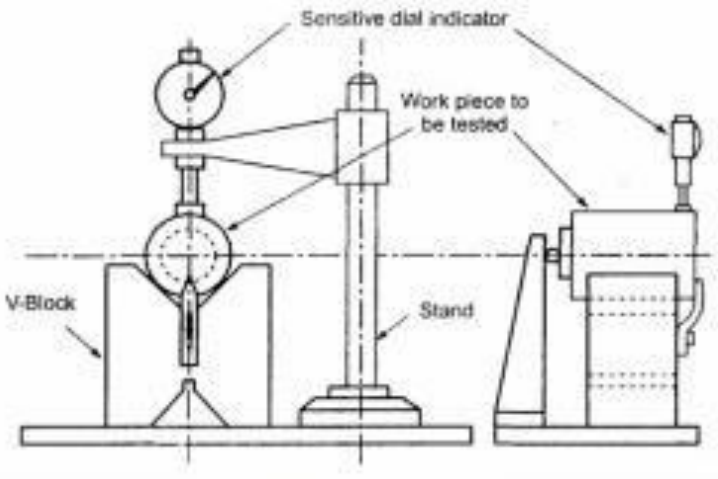
EQUIPMENT

We have to use following equipment while we are checking flatness and roundness.

- Work piece
- Dial Gauge

CHECKING OF ROUNDNESS OF WORK PIECE

1. Mount work piece into chuck.
2. Adjust the dial gauge on machine.
3. Rotate the work piece for checking its roundness.
4. Touch the dial gauge on the work piece surface and check the deflection of dial gauge.
5. Verify the roundness of work piece.



Testing of roughness of workpiece by using dial gauge

CHECKING THE FLATNESS OF TAILSTOCK GUIDE WAYS

1. To check the parallelism of tall stock guide in both the planes i.e. horizontal & vertical a block is placed on the guide ways.
2. The feeler of the indicator is touched on the horizontal & vertical s/f of the block.
3. The dial indicator is needed in the carriage & carriage is moved.
4. Any error is indicated by the pointer of the dial indicator.

PRECAUTION

1. Centering of work piece should be correct on machine.
2. Dial gauge should be on correct level.
3. Be care when reading is being taken.

VIVA-VOCE QUESTIONS

1. What is flatness error?
2. Which is provided in dial gauge to raise the plunger?
3. What is the relation between accuracy attained and range of travel in measurement with dial gauges?
4. What is the range of dial indicators?
5. How much operating pressure is required on a measuring head to obtain the zero reading in dial indicators?
6. What is the application of dial gauge and where it is using?
7. Which of the problem is generally occur in dial gauges?
8. Which is necessary for the working mechanism of dial indicators?
9. What is the purpose of lever attachment used in dial indicators?
10. Why a revolution counter is used in dial gauge?

EXPERIMENT-10

OBJECTIVE

Study and use of a bore gauge.

EQUIPMENT

1. Workpiece 2. Bore gauge 3.Surface plate

THEORY

Bore gauges are internal comparators and they are used for find out the value of diameter of deep holes. In this instrument there are two springs loaded hinged members. One is fixed tip and another is movable anvil. When we insert the anvil into hole, one tip is touched with the hole's surface and then the horizontal displacement will take place. This displacement is converted into vertical displacement with the help of magnifying lever. And it shows on the dial gauge. There is a vertical bar which moves into the tube.

For measuring different — different size holes there are extension rods and by which we can increase the measuring range of that bore gauge. The measuring range and measuring value depend on the dial gauge range. The bore gauge is also called cylinder gauge.

PRINCIPLE

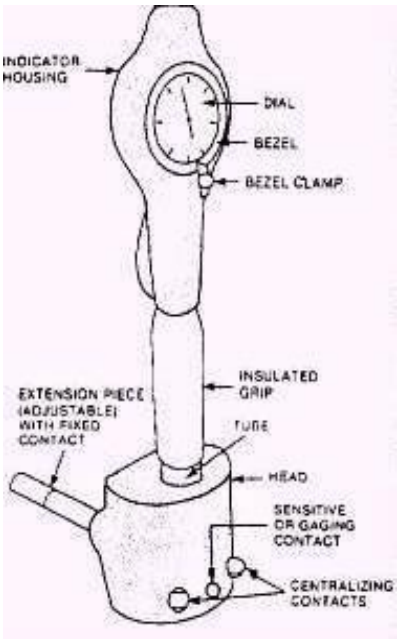
Principle of bore gauge dependent on the magnification lever, Magnification lever converts the horizontal distance into vertical distance.

OBSERVATION TABLE

Sr. No.	Least count of dial gauge	Measuring range	Capacity range	Depth of hole	Diameter of hole	Average
1						
2						
3						
4						
5						

PROCEDURE

- Put the workpiece on the surface plate.
- Find out the least count and capacity range of gauge.
- Now insert the gauge into the hole of workpiece.
- We can take the variation of diameter of hole on dial gauge.
- Therefore we take 4 observations and find out its average.



RESULT

Diameter with the help of bore gauge……

PRECAUTIONS

1. Least count of dial gauge should be correct.

VIVA-VOCE QUESTIONS

1. Segmental chips are formed during which machining process.
2. Cemented carbide tool tips are produced by powder metallurgy process.
3. Side rake angle of a single point cutting tool is the angle of which process?
4. In order to prevent tool from rubbing the work, which angle on tools are provided.
5. When the cutting edge of the tool is dull, then during machining which chips are formed?
6. The tool made of cemented carbide wear out faster at?
7. The rake angle required to machine brass by high speed steel tool is?
8. The average cutting speed for turning brass with a high speed steel tool is?
9. The maximum production of small and slender parts is done by which lathe?
10. What is thermocouple technique?