LABORATORY MANUAL

Production Process

(ME 507)

Department of Mechanical Engineering

Jorhat Engineering College
Jorhat – 785007 (Assam)

COLLEGE VISION AND MISSION

Vision:

To develop human resources for sustainable industrial and societal growth through excellence in technical education and research.

Mission:

1. To impart quality technical education at UG, PG and PhD levels through good academic support facilities.

2. To provide an environment conducive to innovation and creativity, group work and entrepreneurial leadership.

3. To develop a system for effective interactions among industries, academia, alumni and other stakeholders.

4. To provide a platform for need-based research with special focus on regional development.

DEPARTMENT VISION AND MISSION

Vision:

To emerge as a centre of excellence in mechanical engineering and maintain it through continuous effective teaching-learning process and need-based research.

Mission:

M1: To adopt effective teaching-learning processes to build students capacity and enhance their skills.

M2: To nurture the students to adapt to the changing needs in academic and industrial aspirations.

M3: To develop professionals to meet industrial and societal challenges.

M4: To motivate students for entrepreneurial ventures for nation-building.

Program Outcomes (POs):

Engineering graduates will be able to:

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

Programme Educational Objectives (PEOs):

The Programme Educational Objectives of Department of Mechanical Engineering are given below:

PEO1: Gain basic domain knowledge, expertise and self-confidence for employment, advanced studies, R&D, entrepreneurial ventures activities, and facing challenges in professional life.

PEO2: Develop, improve and maintain effective domain based systems, tools and techniques that socioeconomically feasible and acceptable and transfer those technologies/developments for improving quality of life.

PEO3: Demonstrate professionalism through effective communication skill, ethical and societal commitment, team spirit, leadership quality and get involved in life-long learning to realize career and organisational goal and participate in nation building.

Program Specific Outcomes (PSOs)

The programme specific outcomes of Department of Mechanical Engineering are given below:

PSO1: Capable to establish a career in Mechanical and interdisciplinary areas with the commitment to the society and the nation.

PSO2: Graduates will be armed with engineering principles, analysing tools and techniques and creative ideas to analyse, interpret and improve mechanical engineering systems.

Course Outcomes (COs)

At the end of the course, the student will be able to:

CO1	Construct a single point tool and use it to construct a job on the turret lathe.
CO2	Make use of tool-makers microscope for precise measurements of single point cutting tools.
CO3	Use Slip Gauges to calibrate Micrometer and Vernier Calliper.
CO4	Use the surface roughness tester and measure the surface roughness of a given specimen.

Mapping of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1					1	1					1
CO2	2	1		1				1	1					1
CO3	2	2						1	1			1	1	1
CO4	2	2						1	1			1	1	1

STUDENT PROFILE	
NAME :	
ROLL NUMBER :	
SECTION :	
SEMESTER :	5th Semester
YEAR :	

PERFORMANCE RECORD		
EXP. NO.	**TITLE OF EXPERIMENT**	**REMARKS / GRADE**
1	Sharpening of a single point cutting tool.	
2	Machining of a Hexagonal Bolt on a turret lathe.	
3	Study of CZ Tool Maker’s Microscope.	
4	Tool Wear Measurement.	
5	Study of Slip Gauges.	
6	Calibration of Micrometer using Slip Gauges.	
7	Calibration of Vernier Calliper using Slip Gauges.	
8	Surface Roughness Measurement.	

OFFICE USE	
Checked By :	
Overall Grade / Marks :	
Signature of Teacher :	

Experiment No. 1

TITLE: Sharpening a Single Point Cutting Tool.

OBJECTIVE:

To sharpen a single point cutting tool to a given signature (ASA System) on a tool and cutter grinder

MATERIAL USED:

1. HSS or MS tool bit, 12×12×100.

EQUIPMENT:

1. ADDISON make tool and cutter grinder fitted with the cup shaped grinding wheel.
2. Universal vice.

PROCEDURE:

1. Hold the cutting tool in the universal vice and set the vice to suitable angles for each of the face.
2. Sharpen the face one at a time. Repeat the process for other faces.
3. Measure the angles.
4. Take at least three readings and record the Proforma.
5. Compare the angles set and angles measured.

PROFORMA:

TOOL AND CUTTER GRINDER	UNIVERSAL VICE
Make = ADDISON	Make = ADDISON
Grinding tool speed = 2820	Least count = 2°

Sl. No.	Basic Angle	Angle Set	Angle Measured	Error
1. BR (Back Rake)				
2. SR (Side Rack)				
3. ER (End Relief)				
4. SR (Side Relief)				
5. ECEA (End cutting edge angle)				
6. SCEA (Side cutting edge angle)				

Exp. No. 1	**Title:** Sharpening of a single point cutting tool.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check **SEAL**

Experiment No. 2

TITLE: Machining of a Hexagonal Bolt on a turret lathe.

OBJECTIVE:

1. To prepare an operation sheet, and
2. To sketch the following layout compatible to the operation sheet.

OPERATION SHEET:

Machine: HMT TURRET LATHE, MODEL - L22TP.

Material used: 25.4 mm diameter aluminum bar.

Operation	Description of operation	Tool position	Tool used

CUTTING CONDITIONS:

(1) Cutting speed:

(2) Feed:

(3) Depth of cut:

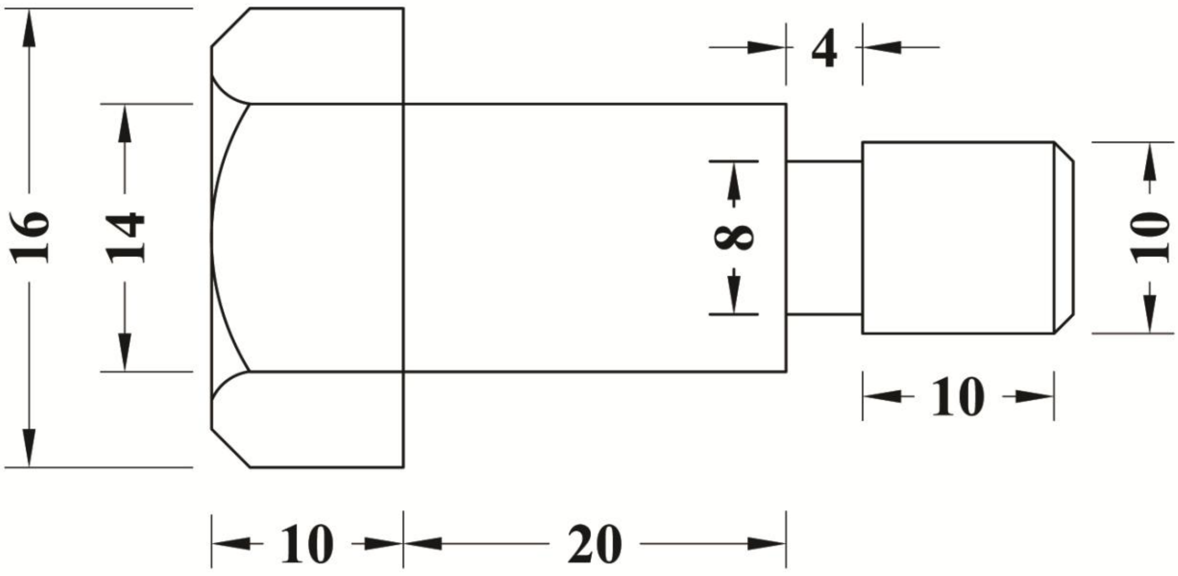


Figure 2.1: Sketch for Job No. 1

Exp. No. 2	**Title:** Machining of a Hexagonal Bolt on a turret lathe.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check **SEAL**

Experiment No. 3

TITLE: Study of CZ Tool Maker's Microscope.

OBJECTIVE:

To study the tool maker's microscope and hence to measure the following tool angles of a Single-point HSS tool:

(1) Back Rake angle

(2) End Clearance angle

(3) SCE angle

(4) ECE angle

(5) Side Rake angle

(6) Side clearance angle

APPARATUS:

1. CZ Tool Maker's Microscope
2. Single – point HSS tool
3. Auxiliary light source (Preferably monochromatic source)

THEORY:

Describe the optical principle of tool maker's microscope with a neat sketch. Refer Fig. 3.1.

PROCEDURE:

1. Draw the three views of the single point cutting tool.

2. Tabulate the measure values of the angles for the given tool.

3. Write the complete tool signature in ASA system. (Table overleaf)

TABLE OF OBSERVATION:

Tool angle	Initial (Degree)	Final (Degree)	Difference (Degree)	Known angle (Degree)	Error (Degree)	Remarks
1.						
2.						
3.						
4.						

ANSWER THE FOLLOWING:

1. What are the various uses of a tool maker's microscope?
2. Why monochromatic light source is preferred?
3. What is the linear as well as angular resolution of the microscope?

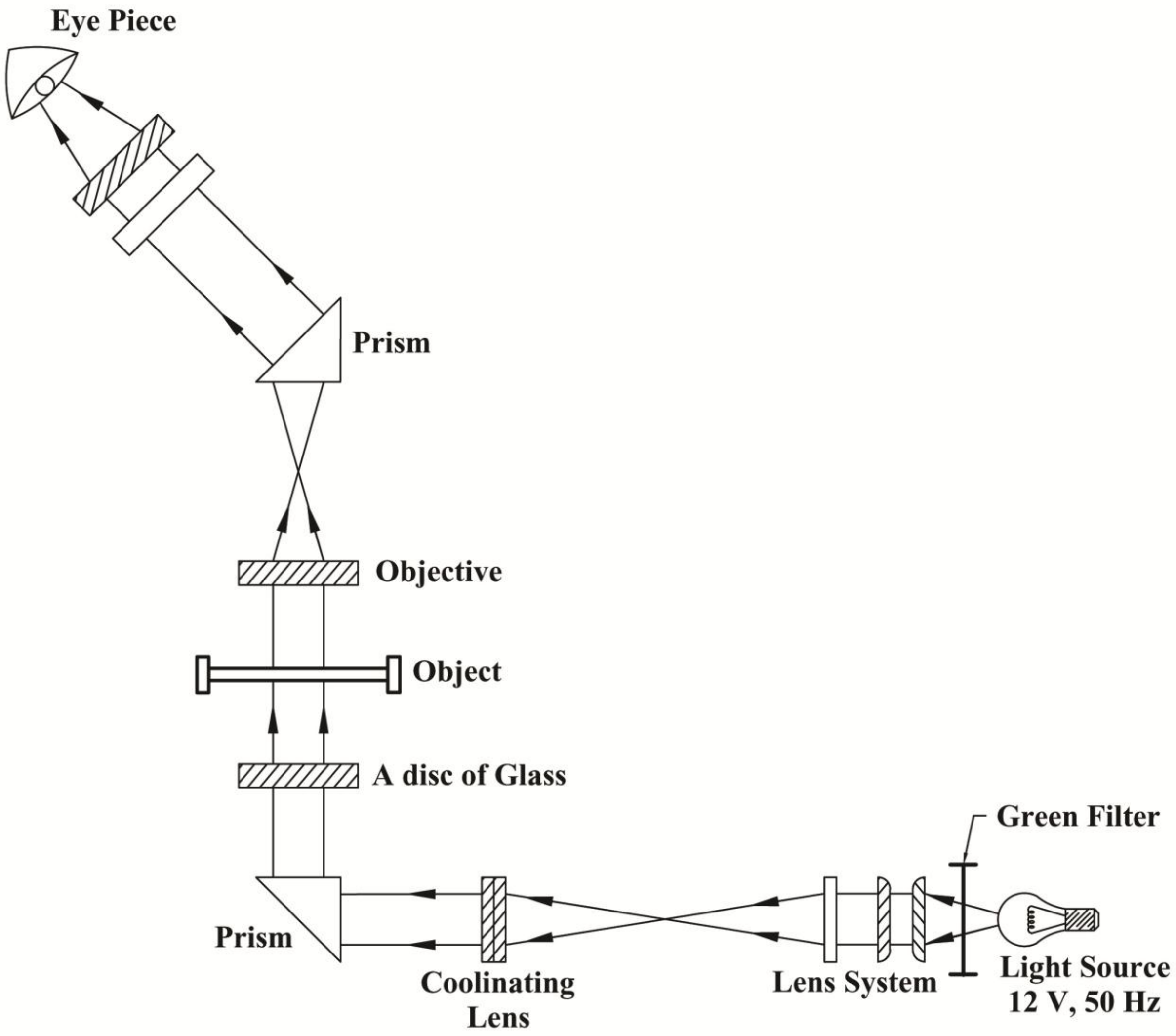


Figure 3.1: Schematic diagram of CZ Tool Maker's Microscope showing Optical Principle

Exp. No. 3	**Title:** Study of CZ Tool Maker’s Microscope.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check **SEAL**

Experiment No. 4

TITLE: Tool Wear Measurement.

OBJECTIVE:

To Measure the Tool Wear of a Cutting Tool.

THEORY:

Cutting tool life is one of the most important economic considerations in the metal cutting and much effort has been put in investigating the factors that limit the life of a cutting tool. The life of a cutting tool can be ended in various ways and these may be separated into two main groups:

1. The gradual or progressive wearing of certain regions of the face or flank of the cutting tool
2. Failure of breakage bringing the life of a tool to a premature end.

In the metal cutting three main forms of progressive wears have been suggested, namely, adhesion, abrasion and diffusion wear. The progressive wear of a cutting tool occurs in two distinct ways.

1. Wear on the tool face that is characterized by the formation of a crater and is a result of action of chip flowing over the face
2. Wear on the tool flank, where a flat wear land is formed because of the friction between the tool and the newly generated work piece surface.

At very high cutting speeds, crater wear is believed to be the factor that controls the life of a cutting tool, while at normal cutting speed life of cutting tool is generally controlled by the wear on its flank. The amount of wear on the tool flank may be conveniently determined from a measurement of the average wear-land width. The objective of the present experiment is to observe the development of the flank wear on a cutting tool during a turning test.

EQUIPMENT:

(1) HMT precision lathe type NH 26/1000.
(2) Lathe tool with disposal carbide (steel-cutting grade) P30, SNUN 120408.
(3) Cylindrical work-piece 60 mm long and 70 mm diameter.
(4) CZ Toolmaker's microscope.
(5) Stop watch.

CHOICE OF CONDITIONS:

To demonstrate clearly the various stages in the flank wear of a cutting tool, it is necessary that the cutting condition be adjusted so that the life of the cutting tool is approximately 1 hour. End machining of the tube under these conditions is impracticable since large quantities of the work material will be consumed. It is therefore more practical to machine a cylindrical work piece that can be successively turned down.

Cutting condition to be applied:

- Cutting speed $V =$
- Feed $s = 0.02\, mm/rev$
- Depth of cut $a = 1.50\, mm$
- Tool geometry : $-6°$, $-6°$, $4°$, $4°$, $15°$, $75°$ and 0.8 mm

PROCEDURE:

After about 60 sec of machining, the machine is stopped and the carbide insert removed to permit measurement of the width of the flank wear-land the insert is carefully replaced and the procedure repeated until the tool shows signs of complete failure. The measurements of the flank wear-band width are plotted against type.

DISCUSSION:

The progress of flank wear during, machining is characterized by three stages:

1. The initial breakdown stage, where the sharp cutting edge is rapidly broken down and a tool wear-land of finite dimensions established.

2. The middle stage where wear occur at uniform rate.

3. The final breakdown stage, where it is thought, the tool wears at an increasing rate due to the rapidly increase in temperatures generated by friction between the flank wear land and the transient surface on the work piece

OBSERVATION TABLE:

Observation Number	Cutting Conditions			Duration of machining (min)	Measured value of flank wear (mm)	Remarks if any
	V m/min	**S** mm/rev	**a** mm			
1				1.0		
2				2.0		
3				3.0		
4				4.0		

Exp. No. 4	**Title:** Tool Wear Measurement.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check **SEAL**

Experiment No. 5

TITLE: Study of Slip Gauges.

OBJECTIVE:

Students will be able to know the use and working of slip gauges.

THEORY:

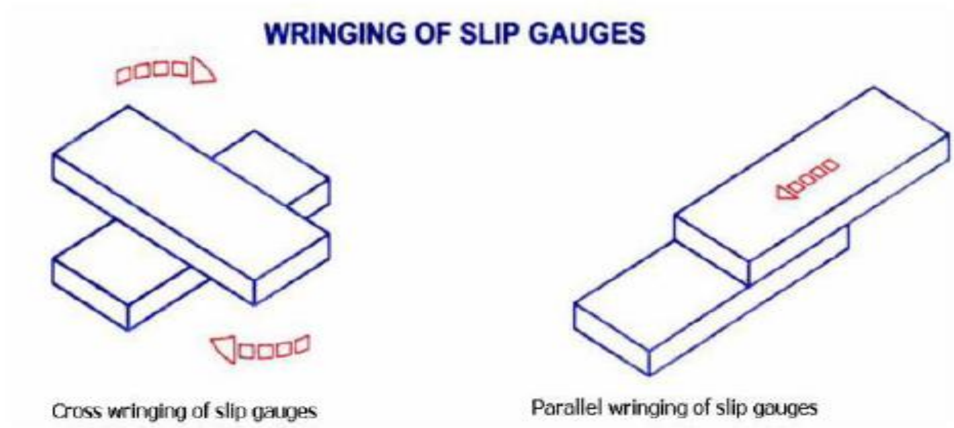
Slip gauges are end standards used in linear measurements. They are used in workshop for work where a tolerance as low as 0.001mm is needed. Slip gauges were invented by Swedish engineer, C.E. Johnson, so they are also called Johnson gauges. Slip gauges are rectangular blocks, made of high grade steel, having cross section about 30 mm x 10mm. These blocks are made into required sizes and hardened to resist wear and allowed to stabilize so as to relieve internal stresses. This prevents occurrence of size and shape variations. After hardening the blocks, measuring faces are carefully finished to fine degree of surface finish, flatness and accuracy. This high grade surface finish is obtained by super finishing process known as lapping.

Wringing of Slip Gauge:

The measuring face of the gauges is flat and it possesses high surface finish. If two slip gauges are forced against each other on measuring faces, because of contact pressure, gauges stick together and considerable force is required to separate these blocks. This is known as wringing of slip gauges. Thus, wringing refers to condition of intimate and complete contact and of permanent adhesion between measuring faces. Slip gauges are wrung to build desired dimension. Slip gauges are wrung together by hand and no other external means.

- Fig. 5.1 (a) shows **Parallel wringing of slip gauges**, and
- Fig. 5.1 (b) shows **Cross wringing of slip gauges**.

In **cross wringing**, the two slip gauges are first cleaned to remove dirt and then they are placed together at right angles in the form of cross and then rotated through 90°, while being pressed together. This method causes less rubbing of surfaces. Almost any dimension may be built by suitable combination of gauges. Wringing phenomenon is purely due to surface contact and molecular adhesion of metal of blocks. Hence, **wringing** is defined as the property of measuring faces of gauge blocks of adhering, by sliding or pressing the gauge against measuring faces of other gauge blocks or reference faces or datum surfaces without the use of external means.



(a) **(b)**

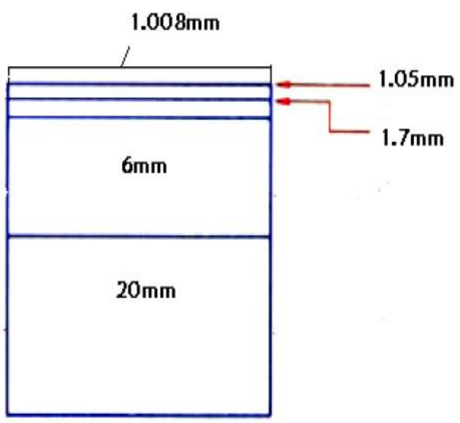
Figure 5.1: Wringing of Slip Gauges

USES/APPLICATIONS OF SLIP GAUGES:

1. As a reference standard.
2. For verification and calibration of measuring apparatus.
3. For adjustment of indicating devices.
4. For direct measurement.
5. For setting of various types of comparators.
6. Micrometers are used to measure the small or fine measurements of length, width, thickness and diameter of the job.

DESCRIPTION OF THE APPAPATUS:

(1) Slip gauge:



PROCEDURE:

Example: Determine the dimension 18.356 by using slip gauge set:

Rule 1: Minimum number of slip gauges should be used to build dimension.

Rule 2: Always start with the last decimal place**.**

Procedure	Least decimal	Calculation
1) Write the required dimension		18.356
2) Starting with least decimal place i.e. 0.006. But we can use 1.006 as to follow rule 1.	0.006	$18.356 - 1.006 = 17.35$
3) After subtraction the value remaining is 18.35. Here the least decimal is 0.05. But we can use 1.05 as to follow rule 1.	0.05	$17.35 - 1.05 = 16.3$
4) Now value remaining is 18.3. Here the least decimal is 0.3. But we can use 1.3 as to follow rule 1.	0.3	$15.3 - 1.3 = 14$
5) Now value remaining is 17. But we have 4 mm gauge block.	4.0	$14 - 4 = 10$
6) Final value is 10 mm and this gauge is available. Reminder should always be zero.		$10 - 10 = 0$
7) Revised the above procedure for three different dimensions. 8) After cleaning place the gauge blocks should be placed in their respective places.		

OBSERVATION TABLE:

Sl. No.	Dimensions	Least decimal	Calculation
1			
2			
3			

Exp. No. 5	**Title:** Study of Slip Gauges.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check

SEAL

Experiment No. 6

TITLE: Calibration of Micrometer Using Slip Gauges.

OBJECTIVE:

To calibrate the micrometer using slip gauges.

THEORY:

Micrometers are designated according to screw and nut principle where a calibrated screw thread and a circular scale division are used to indicate the principle practical part of main scale divisions.

The semi circular frame caries a fixed anvil at one extremely and cylindrical barrel at the other end. A fine accurately cut screw of uniform pitch is machined on a spindle. The spindle passes through the barrel and its left hand side constitutes the movable anvil. A sleeve fits on the screw and caries on its inner edge a circular scale divided into desired no. of divisions. The spindle with its screw and thimble are in one piece and sleeve forms the nut. The thimble scale serves to measure the friction of its circular rotations. The number of complete rotations is read from main scale, which is graduated in ‘mm’ on nut parallel to axis of screw.

DESCRIPTION OF THE APPAPATUS:

(1) Micrometer, (2) Slip gauges

Figure 6.1

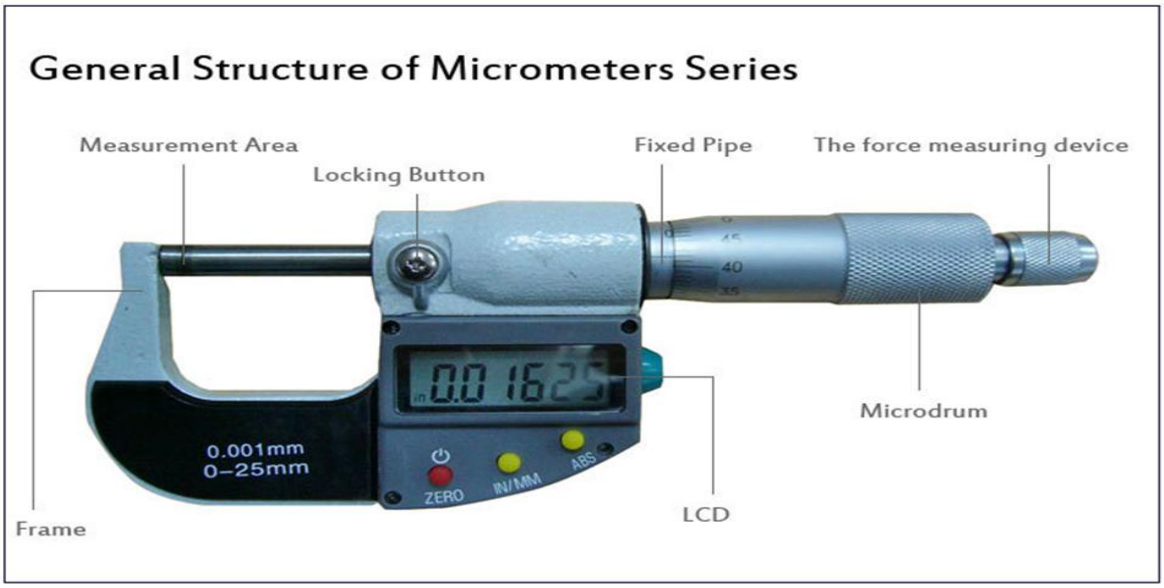


Figure 6.2

PROCEDURE:

1. Clean the fixed vice and micrometer
2. Clamp the micrometer in vice putting cushioning material between micrometer and jaw of vice to protect the micrometer from probable damage due to clamping force.
3. Make pile of gauge blocks and insert between two anvils of the micrometer and take reading.
4. Increase the value of gauge blocks pile and take next few readings.
5. Then decrease the value of gauge blocks pile and take same readings in decreasing order.
6. Tabulate the readings.
7. After cleaning place the gauge blocks should be placed in their respective places.

OBSERVATION TABLE:

Sl. No.	Slip gauge combination	Slip gauge dimensions D_a (mm)	Micrometer Reading D_m (mm)	Correction $(D_a - D_m)$	Error $\lvert D_m - D_a \rvert$	Percentage error $\frac{\lvert D_m - D_a \rvert}{D_m} \times 100$
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

PLOT THE GRAPHS:

1. Micrometer Readings (D_m) vs. Slip Gauges combination (D_a)
2. Error vs. Micrometer Readings (D_m)

Graph 6.1: Micrometer Readings (D_m) vs. Slip Gauges combination (D_a)

Graph 6.2: Error vs. Micrometer Readings (D_m)

Exp. No. 6	**Title:** Calibration of Micrometer Using Slip Gauges.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check **SEAL**

Experiment No. 7

TITLE: Calibration of Vernier Caliper using Slip Gauges.

OBJECTIVE:

To Calibrate and measure the given component by using Vernier Caliper.

THEORY:

The Vernier Caliper is a precision instrument that can be used to measure internal and external distances extremely accurately. Measurements are interpreted from the LCD digital display by the user. These sensors detect changes in electrical charge that occur when the distance between the jaws changes. Manual Vernier Caliper is more difficult than using a digital vernier. Manually operated vernier calipers can 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 **main use of the vernier caliper** is to measure the internal and the external diameters of an object.

DESCRIPTION OF THE APPAPATUS:

(1) Micrometer, (2) Slip gauges

Figure 7.1

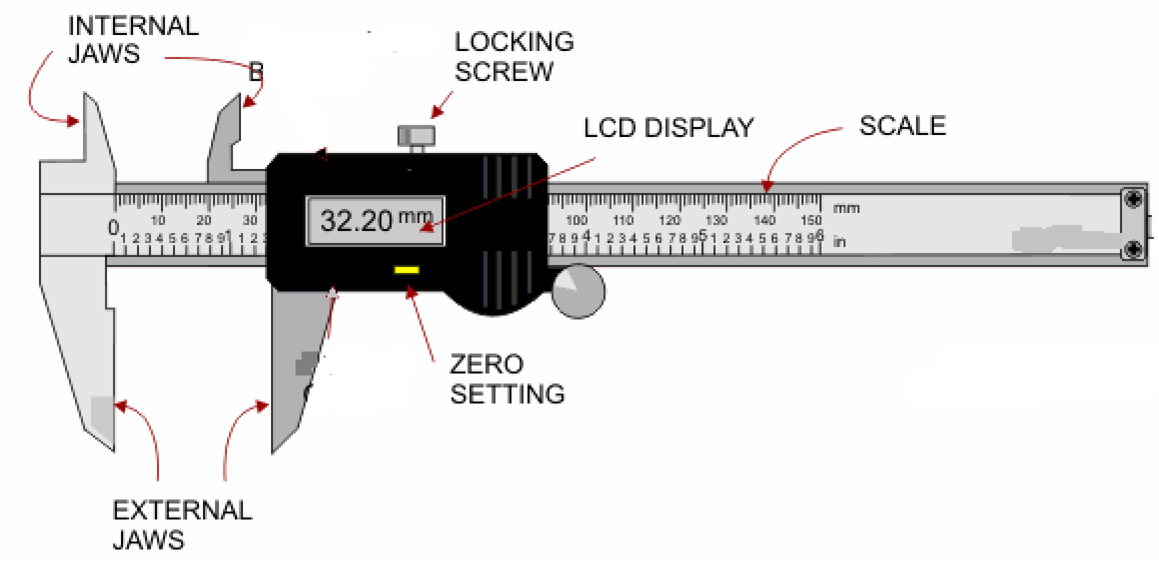


Figure 7.2

PROCEDURE:

1. Clean the Vernier Caliper's measuring surfaces and the work piece/gauge blocks surface to be used.

2. Before using the instrument should be checked by zero error on LCD display.

3. Place the gauge block/work piece appropriately.

4. After closing the jaws on the work surface, take the readings from LCD display.

5. Revised the above procedure for different gauge blocks/work pieces.

6. Tabulate the readings.

7. After cleaning the place the gauge blocks should be placed in their respective places.

OBSERVATION TABLE:

Sl. No.	Slip gauge combination	Slip gauge dimensions D_a (mm)	Vernier Reading T_y (mm)	Correction $(D_a - T_y)$	Error $\lvert T_y - D_a \rvert$	Percentage error $\frac{\lvert T_y - D_a \rvert}{T_y} \times 100$
1						
2						
3						
4						
5						
6						
7						
8						

PLOT THE GRAPHS:

1. Vernier Readings (T_y) vs. Slip Gauges combination (D_a)
2. Error vs. Vernier Readings (T_y)

Graph 7.1: Vernier Readings (T_y) vs. Slip Gauges combination (D_a)

Graph 7.2: Error vs. Vernier Readings (T_y)

Exp. No. 7	**Title:** Calibration of Vernier Caliper using Slip Gauges.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	

Signature of Teacher with Date of Check **SEAL**

Experiment No. 8

Title: Surface Roughness Measurement.

OBJECTIVE:

To measure the surface roughness of the given specimens using surface roughness tester.

THEORY:

Surface texture is deemed to include all those irregularities which, recurring many times across the surface, tend to form on it a pattern or texture. The irregularities in the surface texture which result from the inherent action of the production process is called roughness or primary texture. That component of surface texture upon which roughness is super imposed is called waviness or secondary texture. This may result from such factors as machine or work deflections, vibrations, chatter, heat treatment or warping strains. The direction of the predominant surface pattern, ordinarily determined by the production method used is called lay. The parameters of the surface are conveniently defined with respect to a straight reference line. The most widely used parameter is the arithmetic average departure of the filtered profile from the mean line. This is known as the CLA (Centre Line Average) or Ra (roughness average).

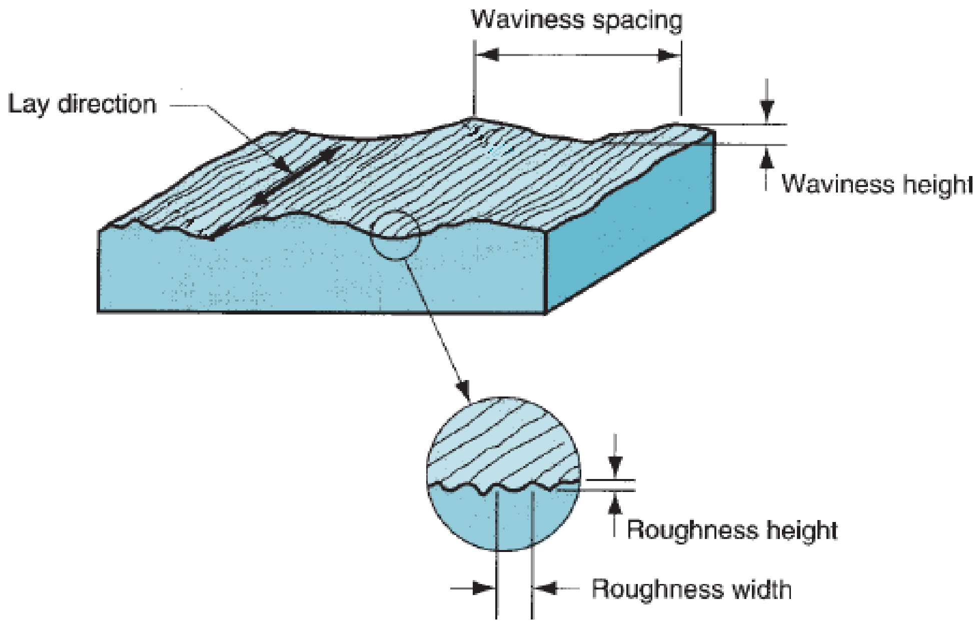


Figure 8.1

Elements of Surface Texture:

- **Actual Surface:** It refers to the surface of apart which is actually obtained after manufacturing process.

- **Nominal surface:** A nominal surface is theoretical, geometrically perfect surface which does not exist in practice, but it is an average of the irregularities that are superimposed on it.

- **Profile**: It defined as contour of any section through a surface.

- **Lay:** It is the direction of predominant surface pattern produced by the tool marks or scratches, generally surface roughness is measured perpendicular to the lay.

- **Sampling Length:** It is the length of the profile necessary for the evaluation of the irregularities to be taken in to account.

- **Roughness Height:** This is rated as the arithmetical average deviation expressed in micro-meters normal to an imaginary center line, running through the profile.

- **Roughness Width**: Roughness width is the distance parallel to the normal surface between successive peaks or ridges that constitute the predominant pattern of the roughness.

DESCRIPTION OF THE APPAPATUS:

(1) Surface roughness tester (SJ - 410), (2) Test specimens.

Figure 8.2

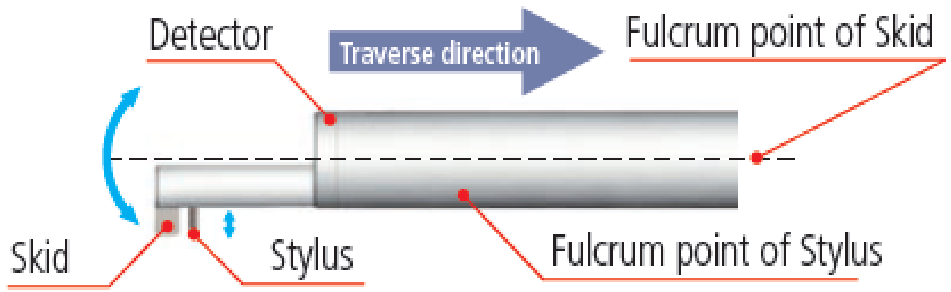


Figure 8.3

The surface tester SJ-410 is a stylus type surface roughness measuring instrument developed for shop floor use. The SJ-410 is capable of evaluating surface texture with variety of parameters according to various national standards and international standard. The measurement results are displayed digitally/graphically on the touch panel, and output to the built-in printer. The stylus of the SJ-410 detector unit traces the minute irregularities of the work piece surface. Surface roughness is determined from the vertical stylus displacement produced during traversing over the surface irregularities. The measurement results are displayed digitally/graphically on the touch panel.

PROCEDURE:

1. Connect the surface tester SJ-401 to the power supply.
2. Place the work piece over the foundation.
3. Adjust the detector over the work piece by adjustment knob.
4. Start the machine by pressing start button on LED display.
5. Print the results by pressing print button and Tabulate the all results.
6. Remove the work piece by adjusting the detector.
7. Follow the above procedure for different surface.

Note:

- R_a is the arithmetic average of the absolute values of the profile heights over the evaluation length.
- R_q is the root mean square average of the profile heights over the evaluation length.
- R_t is the vertical distance between the highest and lowest points of the profile within the evaluation length.

OBSERVATION TABLE:

Specimen No.	R_a micron	R_q micron	R_t micron

Exp. No. 8	**Title:** Surface Roughness Measurement.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**