NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE
(NAAC Accredited)
(Approved by AICTE, Affiliated to APJ Abdul Kalam Technological University, Kerala)

DEPARTMENT OF MECHANICAL ENGINEERING
LAB WORK BOOK

MEL 204 MACHINE TOOLS LAB-1

VISION OF THE INSTITUTION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION OF THE INSTITUTION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2002
- Course offered : B.Tech in Mechanical Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

Producing internationally competitive Mechanical Engineers with social responsibility & sustainable employability through viable strategies as well as competent exposure oriented quality education.

DEPARTMENT MISSION

1. Imparting high impact education by providing conductive teaching learning environment.
2. Fostering effective modes of continuous learning process with moral & ethical values.
3. Enhancing leadership qualities with social commitment, professional attitude, unity, team spirit & communication skill.
4. Introducing the present scenario in research & development through collaborative efforts blended with industry & institution.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates shall have strong practical & technical exposures in the field of Mechanical Engineering & will contribute to the society through innovation & enterprise.

PEO2: Graduates will have the demonstrated ability to analyze, formulate & solve design engineering / thermal engineering / materials & manufacturing / design issues & real life problems.

PEO3: Graduates will be capable of pursuing Mechanical Engineering profession with good communication skills, leadership qualities, team spirit & communication skills.

PEO4: Graduates will sustain an appetite for continuous learning by pursuing higher education & research in the allied areas of technology.

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 modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in 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 environment
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.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Students will be able to apply principles of engineering, basic sciences & analytics including multi variant calculus & higher order partial differential equations..

PSO2: Students will be able to perform modeling, analyzing, designing & simulating physical systems, components & processes.

PSO3: Students will be able to work professionally on mechanical systems, thermal systems & production systems.

MEL 204	MACHINE TOOLS LAB- I	CATEGORY	L	T	P	Credits	Year of Introduction
		PCC	0	0	3	2	2019

Preamble:

1. To understand the parts of various machine tools and impart hands on experience on lathe, drilling, shaping, milling, slotting, grinding, tool and cutter grinding machines.
2. To develop knowledge and importance of metal cutting parameters such as feed, velocity and depth of cut etc on cutting force and surface roughness obtainable.
3. To develop fundamental knowledge on tool materials, cutting fluids and tool wear Mechanisms.
4. To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.
5. To study process parameters and practice on arc and gas welding technologies.
6. To gain knowledge on the structure, properties, heat treatment, testing and applications of ferrous and non ferrous metals.

Prerequisite: MET 204 - Manufacturing Process

Course Outcomes - At the end of the course students will be able to

CO 1	The students can operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality.
CO 2	Apply cutting mechanics to metal machining based on cutting force and power consumption.
CO 3	Select appropriate machining processes and process parameters for different metals.
CO 4	Fabricate and assemble various metal components by welding and students will be able to visually examine their work and that of others for discontinuities and defects.
CO 5	Infer the changes in properties of steel on annealing, normalizing, hardening and tempering.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	3	-	-	-	-	-	-	-	-	-	1	-	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-	3
CO3	-	-	-	2	-	-	-	-	-	-	-	-	1	-	3
CO4	2	-	-	-	-	-	-	-	-	-	-	-	1	-	3
CO5	-	-	-	-	2	-	-	-	-	-	-	-	1	-	3

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

Assessment Pattern

Bloom's taxonomy	Continuous Assessment Tests	
	Test 1 (Marks)	Test 2 (Marks)
Remember	20	20
Understand	10	10
Apply	30	30
Analyse	20	20
Evaluate	10	10
Create	10	10

Mark distribution

Total Marks	CIE marks	ESE marks	ESE duration
150	75	75	2.5 Hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	15 marks
Regular class work/ /Laboratory Record and Class Performance	30 marks
Continuous Assessment Test/s	30 marks
The student's assessment, continuous evaluation, record bonafides, awarding of sessional marks, oral examination etc. should be carried out only by the assistant professor or above. Any two **e**xperiments mentioned in part - B, and any eight experiments in part A and total of minimum of ten experiments are to be performed.	

End semester examination pattern

The Practical Examination will comprise of three hours. Oral examination should be conducted and distribution of marks will be decided by the examiners.

Conduct of University Practical Examinations

The Principals of the concerned Engineering Colleges with the help of the Chairmen/Chairperson will conduct the practical examination with the approval from the University and bonafide work / laboratory record, hall ticket, identity card issued by college are mandatory for appearing practical University examinations. To conduct practical examination, an external examiner and an internal examiner should be appointed by the University.

SYLLABS

PART - A

Safety precautions in machine shop - Exercises on machine tools: turning, knurling, drilling, boring, reaming, trepanning, milling, hobbing, planning, shaping, slotting, broaching, grinding, lapping, honing etc. - Welding practice.

PART - B

Metallurgy, heat treatment and testing.

Text Books:

1. Acherkan N. S. "Machine Tool", Vol. I, II, III and IV, MIR Publications.
2. HMT, Production Technology, Tata McGraw Hill.
3. W. A. J. Chapman, Workshop Technology Part I, ELBS & Edward Arnold Publishers.

Course content and drawing schedules.

	List of Experiments **A minimum of ten experiments are to be carried out**	**Course outcomes**	**No. of hours**
Experiments	**PART -A** **(minimum eight experiments)**		
1	**Centre Lathe** Study of lathe tools: - tool materials - selection of tool for different operations - tool nomenclature and attributes of each tool angles on cutting processes – effect of nose radius, side cutting edge angle, end cutting edge angle and feed on surface roughness obtainable – tool grinding. • Study the different methods used to observe the work-piece is precisely fixed on lathe. • Study the optimum aspect ratio of work-piece to avoid vibration and wobbling during turning. • Machine tool alignment test on lathe. • Re-sharpening of turning tool to specific geometry	CO 1	3
2,3,4,5,6	**Exercises on centre lathe**:- Facing, plain turning, step turning and parting – groove cutting, knurling and chamfering - form turning and taper turning – eccentric turning, multi-start thread, square thread and internal thread etc.	CO 1 CO 2	3
	Exercises on lathe: - Measurement of cutting forces in turning process and correlate the surface roughness obtainable by varying feed, speed, feed, nose radius, side and end cutting edge angles.		6

7	Measurement of cutting temperature and tool life in turning and machine tool alignment test on lathe machine.	CO 2	3
86	**Exercises on Drilling machine** • **Exercises on drilling machine**: - drilling, boring, reaming, taping and counter sinking etc. • **Exercises on drilling machine: -** Measurement of cutting forces in drilling process and correlate with process parameters.	CO 1 CO 2	3
9	**Exercises on Shaping machine** • Exercises on shaping machine: - flat surfaces, grooves and key ways. **Exercises on Slotting machine** • Exercises on slotting machine: - flat surfaces, grooves and key ways.	CO 2	3
10	**Planing and Broaching machine** Study and demonstration of broaching and hobbing machine. • Exercises on planing machine	CO 1	3
11	**Exercises on Grinding machine** • Exercise on surface grinding, cylindrical grinding and tool grinding etc. • Measurement of cutting forces and roughness in grinding process and correlate with process parameters. • Study and demonstration of lapping and honing machines.	CO 1	3
12	**Exercises on Welding machine** • Exercises on arc and gas welding: - butt welding and lap welding of M.S. sheets.	CO 4	3
	PART - B - Metallurgy **(minimum two experiments)**	CO 5	6
13	• **Specimen preparation**, etching & microscopic study of Steel, Cast iron and Brass and grain size measurement.		
14	• **Heat treatment study**:–Effect on mechanical properties and microstructure of ferrous and non ferrous metals. • Studies of various quenching mediums, Carryout heat treatments on steel based on ASM handbook vol.4 and observe the hardness obtained.	CO 5	6

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FINAL VERIFICATION BY THE FACULTY
TOTAL MARKS:

INTERNAL EXAMINER **EXTERNAL EXAMINER**

1. MACHINE SHOP

1.1 SAFETYPRECAUTIONS

1) Be sure that all machines have effective and properly working guards that are always in place where machines are operating.
2) Do notattempt to oil, clean, adjust or repair any machine while it is running.
3) Do notoperate any machine unless authorized.
4) Do nottry to stop the machine with your hand or body whilerunning.
5) Always check whether the work and cutting tools properly clamped on the machine before starting.
6) Keep the floor clean of metal chips or curls and waste pieces.
7) When working with another, only one should operate machine or switches.
8) Concentrate on thework, avoid unnecessary talks while operating machine.
9) Get first aid immediatelyfor anyinjury.
10) Wear safety shoes, if heavywork has done.
11) Wear clothing suited for the job, wear shoes with thick soles.
12) Do notwear rings, watches, bracelets or other jewellerythat could get caught in movingmachinery.
13) Do notwear neckties or loose turn clothing of any kind.
14) Wear shirts or upperswith sleeves cut off or rolled above the elbows.
15) Always remove gloves before turning on or operating a machine.
16) Keep the floor alwaysclean.
17) Passage should be clear, at all time to avoid accident.
18) Do not leave tools or work on the table of a machine even ifthe machine in not turning. Tools or work may fall off and cause the fact of injury.
19) Switch off themachine immediately when supply fails.

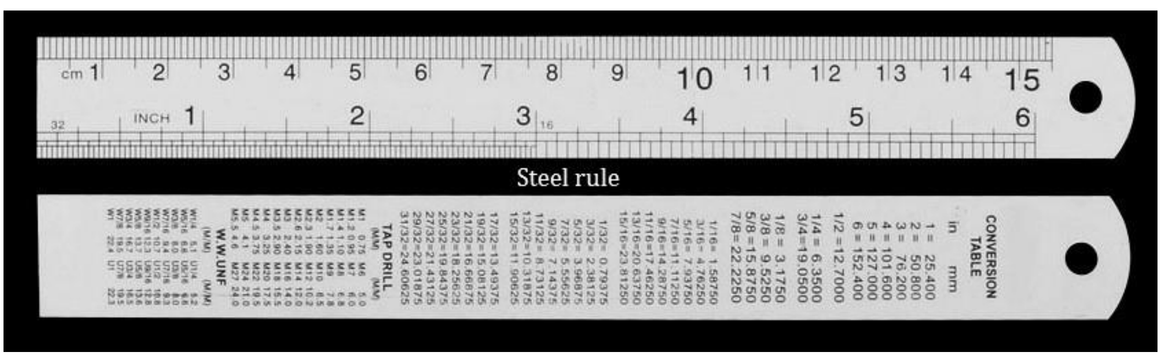
1.2 MEASURINGINSTRUMENTS

Measuring instruments have an important role ina mechanical workshop. The qualityof work is based on the accuracy and precision of the instruments used for inspection. There are different types of measuring instruments are used in a workshop; some of themare givenbelow.

1. Steelrule
2. Calipers
3. Verniercaliper
4. Micrometer
5. Vernier heightgauge
6. Dial testindicator
7. Screw thread pitch gauge
8. Screw cuttinggauge

1.2.1 1 Steelrule

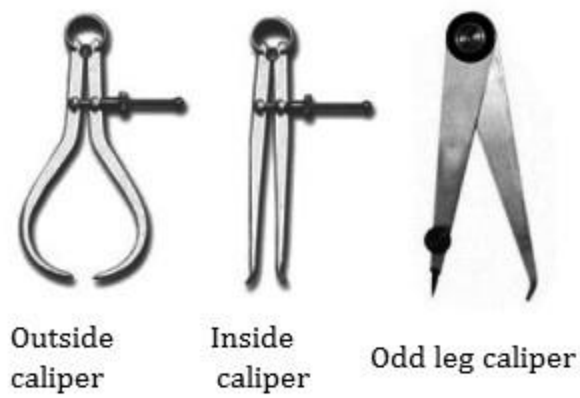
Steel rule is a measuring instrument having a long, thin stainless steel strip with a marked scale of unit division such as in centimetres or inches, used for drawing lines, measuring distances between two points, etc. These are available in different sizes, such as in 15cm, 30cm, 60cm, 1m, 1.5m, 2m, 3m, 4m, 5m & 6m. Generally, least count of a steel rule is 0.5mm.



1.2.2 2 Calipers

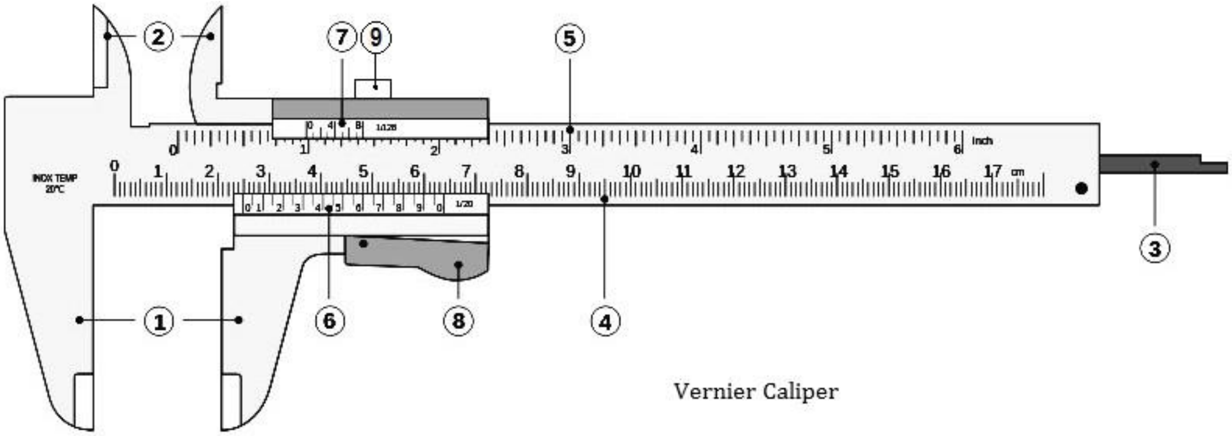
A caliper (British spelling also calliper) is a device used to measure the distance between two opposite sides of an object. An ordinary caliper may be classified as the following:

1. **Outside caliper**: Used to measure outside diameter of a round shaped objects or to measure distance between twopoints.
2. **Inside caliper:** Used for measuring inside diameter of a pipe or to measure inside dimensions of hollowsections.
3. **Jenny caliper:** It is also known as odd leg caliper or hermaphrodite caliper. It used for scribe a line at a distance from the edge of a workpiece.



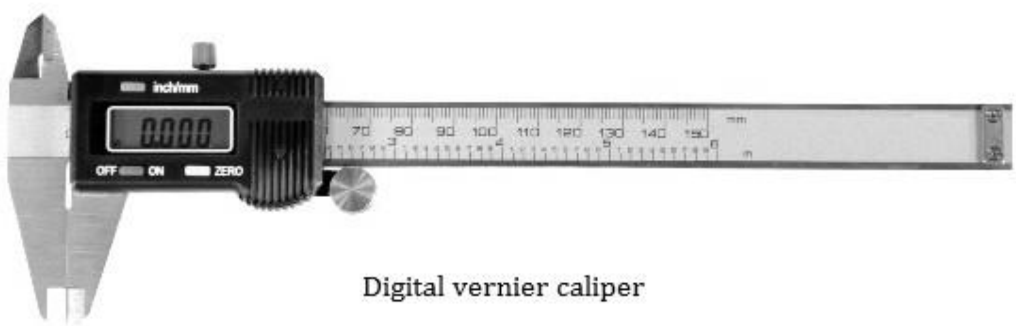
1.2.3 3 Verniercaliper

The Vernier calliperis a precision instrument used for measuring internal and external distances between two points extremely accurately. It has two versions, manual and digital. The manual version has both an imperial and metric scale. The digital version requires a small battery whereas the manual version does not needany power source. Vernier callipersare available in the range of 0 - 100mm, 0 - 150mm, 0 - 200mm, 0 -300mm, 0 - 600mm and 0 - 1000mm.Accuracy of metric scale vernier caliper is 0. 02 mm andimperial scale vernier caliper is 0. 002”.



Vernier Caliper

1. **Outside jaws**: Used to measure external diameter or width of anobject
2. **Inside jaws**: Used to measure internal diameter of anobject
3. **Depth probe**: Used to measure depths of an object or ahole
4. **Main scale**: Scale marked every mm (metricscale)
5. **Main scale**: Scale marked in inches and fractions (imperialscale)
6. **Vernier scale:** gives interpolated measurements to 0.1 mm orbetter
7. **Vernier scale:** gives interpolated measurements in fractions of aninch
8. **Retainer**: used to block movable part to allow the easy transferring of ameasurement
9. **Locking screw:** Used to lock movable jaw with mainscale.



Digital vernier caliper

Least count (LC): Least Count is the smallest value that can be read directly in thatscale.

Least Count (L. C) = 1 Main Scale Division (MSD) – 1 Vernier Scale Division(VSD)

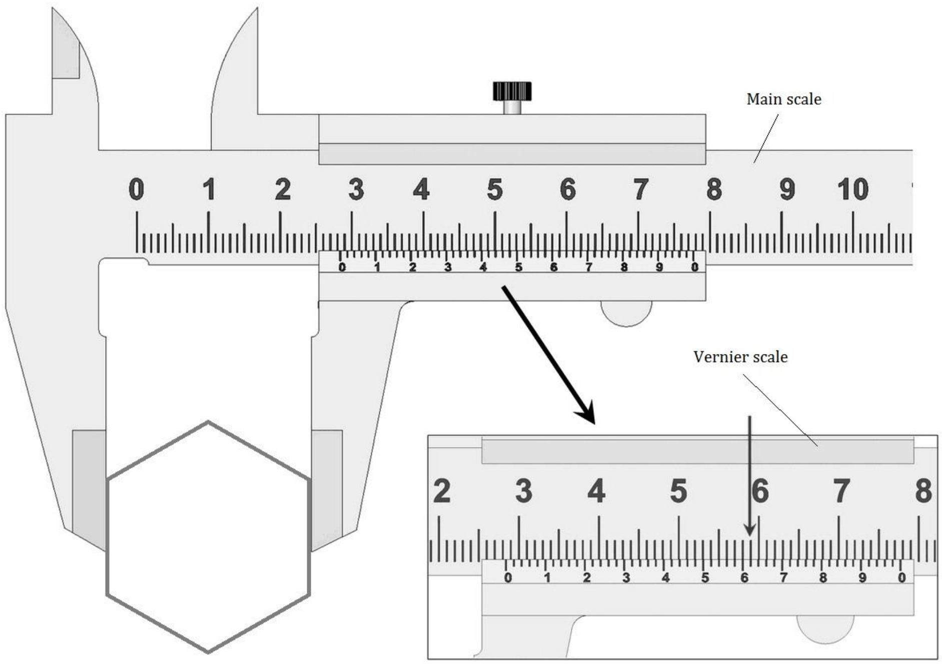
1MSD =1mm

1VSD = 49/50mm = 0.98mm

Therefore,**LC** = MSD – VSD =1 - 0. 98mm

= 0. 02mm

How to take measurements



Each division on the main scale is 1mm. The metric Vernier scale i s 49mm long and divided into 50 equal parts. Each division is 49/50, which is equal to 0. 98mm. The difference between one division on the main scale and one division on the metric vernier scale is 1 /50 or 0 . 02mm which is the Least Count.

Procedure:

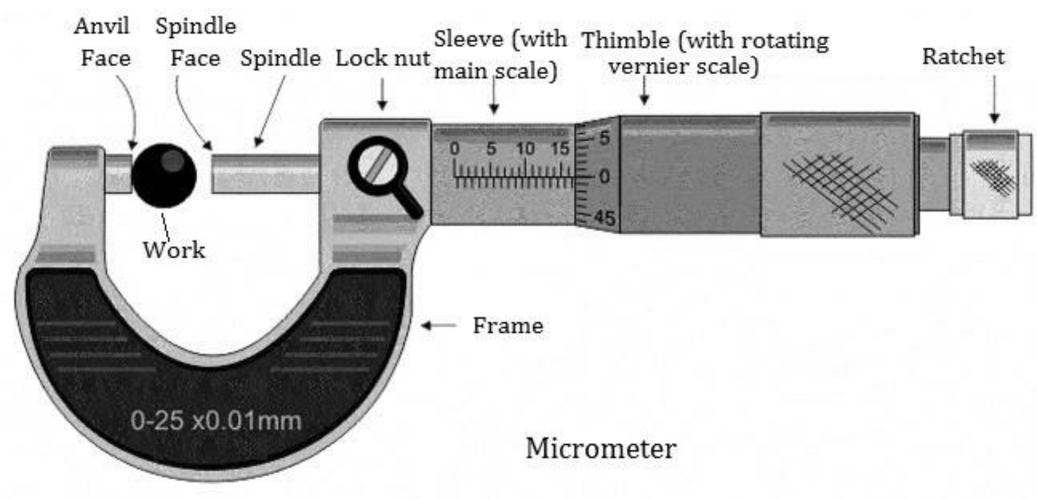
- Note the main scale reading, immediately precedingthe zero line on vernierscale.
- Here, zero of thevernierscale immediately preceding 28mm.
- This (28mm) must be added with decimal reading on the vernierscale.
- Note the line on the vernier scale, which is coinciding, with a line on the mainscale.
- 31th line coincides with a lineon the main scale.

So, the reading is 28 mm plus 31 divisions of 0. 02mm TOTAL:

28mm + 31 * 0. 02 = **28. 62mm**

1.2.4 4 Micrometer

A micrometer (also known as screw gauge) is used for measuring dimensions smaller than those measured by the Vernier caliper. A micrometer screw gauge is a small measuring device, which works on the “screw” principle. The accuracy of micrometers are varies between 0.01mm and 0.001 mm depending on the type of micrometer. Figure and detailed specifications of micrometers are given below.



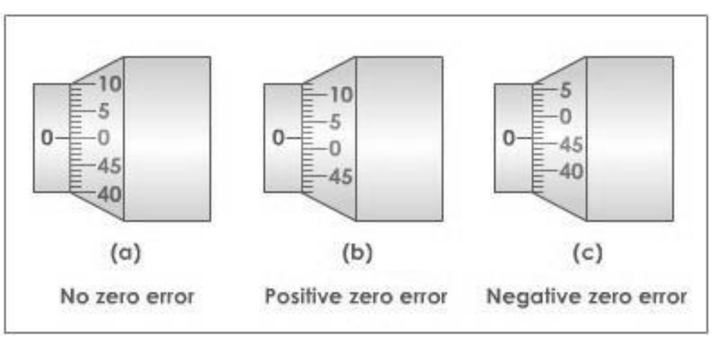
Micrometer

Metric digital micrometer

Various ranges of micrometers available

Metric Micrometer (mm)		Imperial Micrometer (inch)	
0 - 25mm	250 - 275mm	0 - 1"	10" - 11"
25 - 50mm	275 - 300mm	1" - 2"	11" - 12"
50 - 75mm	300 - 325mm	2" - 3"	12" - 13"
75 - 100mm	325 - 350mm	3" - 4"	13" - 14"
100 - 125mm	350 - 375mm	4" - 5"	14" - 15"
125 - 150mm	375 - 400mm	5" - 6"	15" - 16"
150 - 175mm	400 - 425mm	6" - 7"	16" - 17"
175 - 200mm	425 - 450mm	7" - 8"	17" - 18"
200 - 225mm	450 - 475mm	8" - 9"	18" - 19"
225 - 250mm	475 - 500mm	9" - 10"	19" - 20"

Zero error of micrometer



Leastcount(LC) = Pitch / Number of divisions on the main scale =0.50mm/50

= 0.01 mm

How to take measurements

Total observed reading = main scale reading + (circular scale division coinciding the base line of main scale) x least count

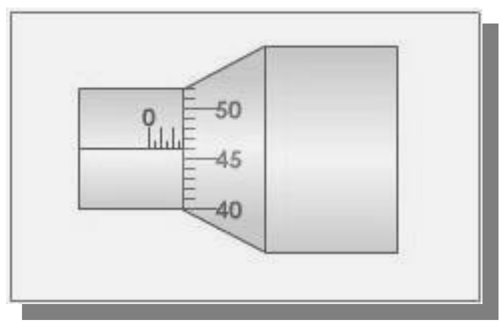
True diameter = observed diameter – zero error

Determination of the diameter of a wire rod

The wire whose diameter is to be determined is placed between the anvil and spindle end, the thimble is rotated till the wire is firmly held between the anvil and the spindle. The ratchet is provided to avoid excessive pressure on the wire. It prevents the spindle from further movement. The diameter of the wire could be determined from the reading as shown in figure below.

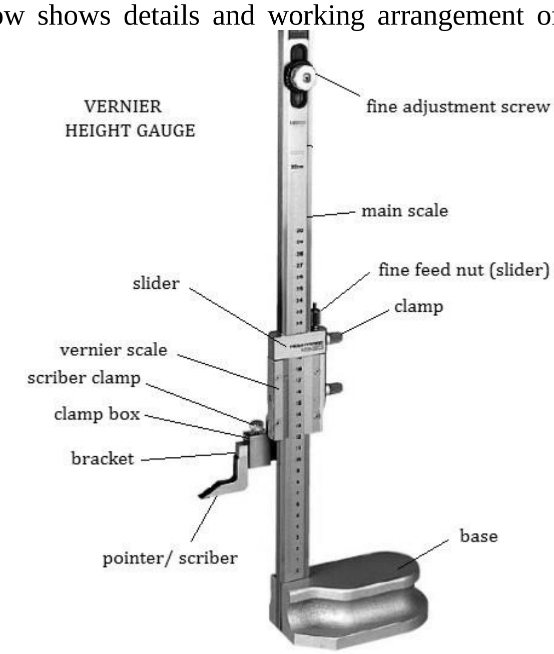
Reading = Linear scale reading + (coinciding circular scale x least count)

$$= 2.5\text{mm} + (46 \times 0.01) = (2.5 + 0.46)\ \text{mm}$$
$$= 2.96\ \text{mm}$$



125 5 Vernier height gauge

A Vernier height gauge is a measuring device used either for determining the height of something, or for repetitive marking of items to be worked on. The pointer is sharpened to allow it to act as a scriber and assist in marking on work pieces. Figure below shows details and working arrangement of a Vernier height gauge.

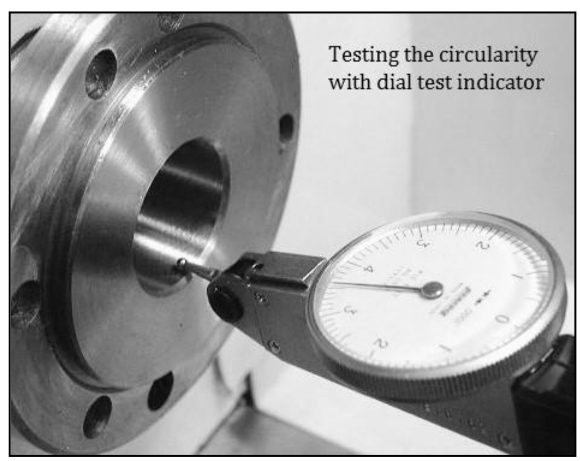


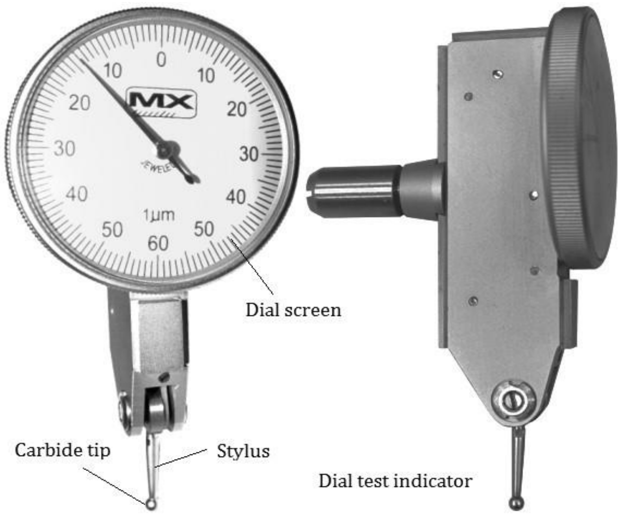
Various ranges of height gauges available

Metric height gauge (mm)	Imperial height gauge (inch)
0-150mm 0-200mm 0-250mm 0-300mm 0-450mm 0-600mm 0-1000mm 0-1500mm	0-6” 0-8” 0-10” 0-12” 0-18” 0-24” 0-40”

12.6 6 Dial test indicator

Dial test indicator have been used in the machine shop to test alignment and rotation measurement of machine parts. The dial indicator is a very precise instrument that measures distance between two parts and can be used to measure distances between two or more locations. Dial test indicators typically measure ranges from 0.25mm to 300mm (0.015 inch to 12 inch), with graduations of 0.001mm to 0.01mm (metric) or 0.00005 inch to 0.001 inch (imperial). Contact points of test indicators most often come with a standard spherical tip of 1, 2, or 3mm diameter. Many are of steel (alloy tool steel or HSS); higher-end models are of carbides (such as tungsten carbide) for greater wear resistance. Other materials are available for contact points depending on application, such as ruby (high wear resistance) or Teflon or PVC (to avoid scratching the work piece). These are more expensive and are not always available, but they are extremely useful in applications that demand them. Figure gives an idea about the dial test indicator gauges.





Dial test indicator

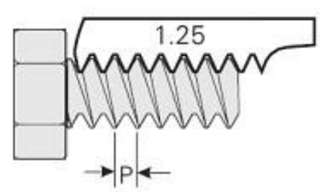
1.2.7 7 Screw thread pitch gauge

A screw thread pitch gauge is used to check or find the pitch of a thread. It is a series of thin marked blades which have different pitched teeth. Thread pitch gauges also come in the standard thread forms of metric, Whitworth, etc. which allows both the pitch of the thread to be gauged and the form or shape of the thread, to be checked. Each set of screw pitch gauges has the thread form stamped onit.

How to measure pitch of the thread with screw pitch gauge?

First, measure the approximate pitch of the thread with a steel rule. To do this for metric threads:

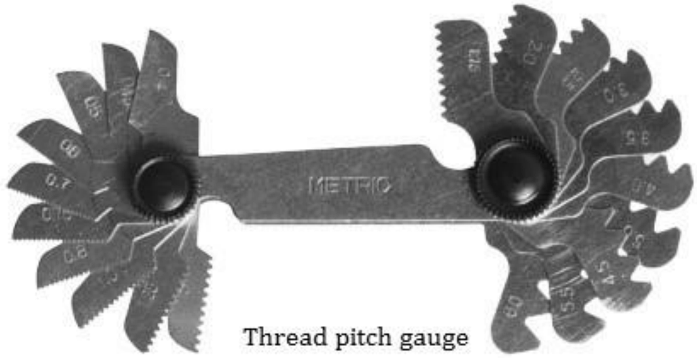
- Put the steel rule on the thread parallel to the threadaxis.
- Line up a major division on the rule with the top or crest of thethread.
- Count the number of crests to another major division, usually 20 - 30mm.
- Divide the length between the major divisions by the number of crestcounted.
- The answer is the pitch of thethread.
- Then choose the pitch gauge closest to this pitch for the firsttry.



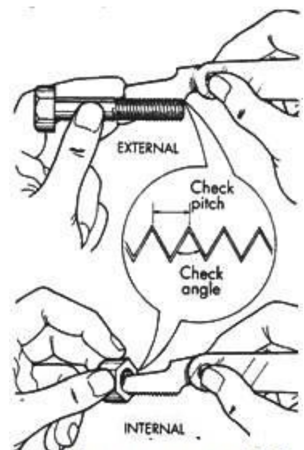
Checking the pitch of thread

For imperial threads, the method is similar, except that the pitch is given as threads per inch (TPI) and the numbers of crests in one inch are counted (TPI=25.4/P).

Example: If the major diameter is 10mm and pitch of the tread (P) is 1.25mm, then the thread is M10x1.25.



Thread pitch gauge



Inspecting the pitch of the thread

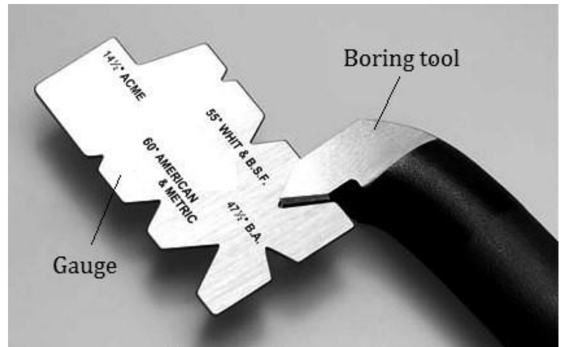
Available ranges of screw pitch gauges

Metric Screw Pitch Gauge **0.35-6mm** (22 leaves) 0.35, 0.4, 0.45, 0.5, 0.6, 0.7, 0.75, 0.8, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5 and 6mm, 60° angle. **0.4–7mm** (21 leaves) 0.4, 0.5, 0.7, 0.75, 0.8, 0.9, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5 and 7mm.
Unified Screw Pitch Gauge **4–42 TPI**(30leaves) 4, 41/2, 5, 51/2, 6, 7, 8, 9, 10, 11, 111/2, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, 30, 32, 34, 36, 38, 40 and 42 TPI
Whitworth Screw Pitch Gauge **4–42 TPI** (30 leaves) 4, 41/2, 5, 51/2, 6, 7, 8, 9, 10, 11, 111/2, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, 30, 32, 34, 36, 38, 40, 42 TPI **4– 60 TPI** (28 leaves) 4, 41/2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 22, 24, 25, 26, 28, 30, 32, 34, 36, 40, 48 and 60 TPI

12.8 8 Screw cutting gauge

Screw cutting gauge is an important tool used in a machine shop, made from hardened and polished stainless steel. It is also known as Center gauge or Fish tail gauge. It is used for checking tool angles while machining threads in metal turning lathes.

Metric, BSW, BSF, BA, American National and Acme thread angles are clearly etched on the plate for easy understanding. The angle on the thread cutting tool is checked on the V slots in the gauge as shown infigure.



Screw cutting gauge

1.3 CUTTINGTOOLS

Cutting tool is a device with one or more cutting edges used to create chips andremove metal from the work piece. Generally, cutting tools are classified as single point cutting tools andmulti point cutting tools. A single point cutting tool (such as lathe, shaper and planner and boring tool) has only one cutting edge, whereas a multi- point cutting tool (such as milling cutter, drill, reamer , broach, hack saw blade, etc.) has more than one teeth or cutting edge on itsperiphery.

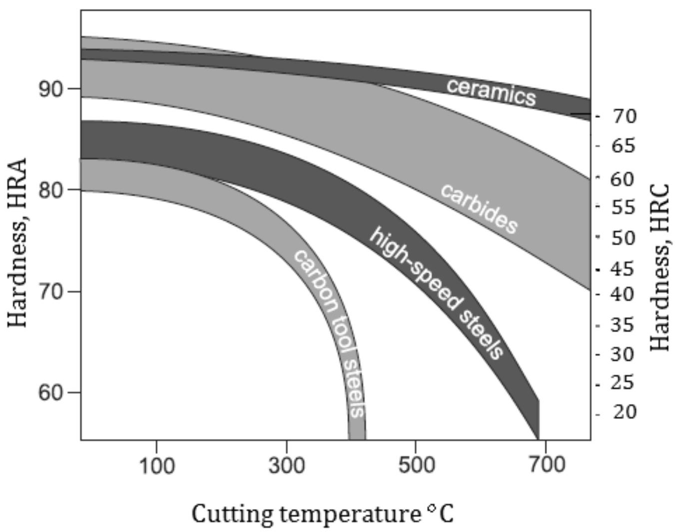
1.3.1 1 Cuttingtool materials and their uses

Tool material	Properties
Carbon Steels	Low cost. Used for low-grade drill bits, taps and dies, hacksaw blades, reamers.
High Speed Steel (HSS)	Low cost. Used for drill bits, taps, lathe cutting tools.
HSS Cobalt	Expensive. Excellent for machining abrasives, work hardening materials such as Titanium and Stainless steel. Used for milling cutters and drillbits.

Cemented Carbide	Expensive. Used for turning tool bits although it is very common in milling cutters and saw blades.
Ceramics	Fairly low cost. The most common ceramic materials are based on alumina (aluminium oxide), silicon nitride and silicon carbide. Used almost exclusively on turning toolbits.
Cermet	Expensive. Used primarily on turning tool bits although research is being carried on producing other cutting tools.
Cubic Boron Nitride (CBN)	Expensive. Being the second hardest substance in the world, it is also the second most fragile. Used almost exclusively on turning tool bits.
Diamond	Very Expensive. The hardest substance in the world. Used almost exclusively on turning tool bits although it can be used as a coating on many kinds of tools.

132 2 Characteristics of cutting toolmaterial

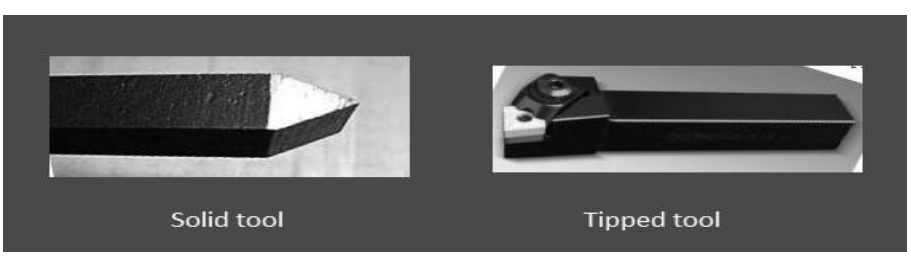
Property	High Speed Steel	Carbides		Ceramics	Cubic boron nitride	Diamond
		Tungsten Carbide	Titanium Carbide			
Hardness	83-86 HRA	90-95 HRA 1800-	91-93 HRA 1800-	91-95 HRA 2000-	4000-5000HK	7000-8000HK
Modulus of elasticity (GPa)	200	520-690	310-450	310-410	850	820-1050
Compressive Strength (MPa)	4100-4500	4100-5850	3100-3850	2750-4500	6900	6900
Impact Strength (J)	1.35-8	0.34-1.35	0.79-1.24	< 0.1	< 0.5	< 0.2
Density (Kg/M³)	8600	10000-15000	5500-5800	4000-4500	3500	3500
Melting Temperature (° C)	1300	1400	1400	2000	1300	700
Thermal conductivity (W/M k)	30-50	42-125	17	29	13	500-2000
Co-efficient of thermal expansion ($x10^{-6}$/° C)	12	4-6.5	7.5-9	6-8.5	4.8	1.5-4.8



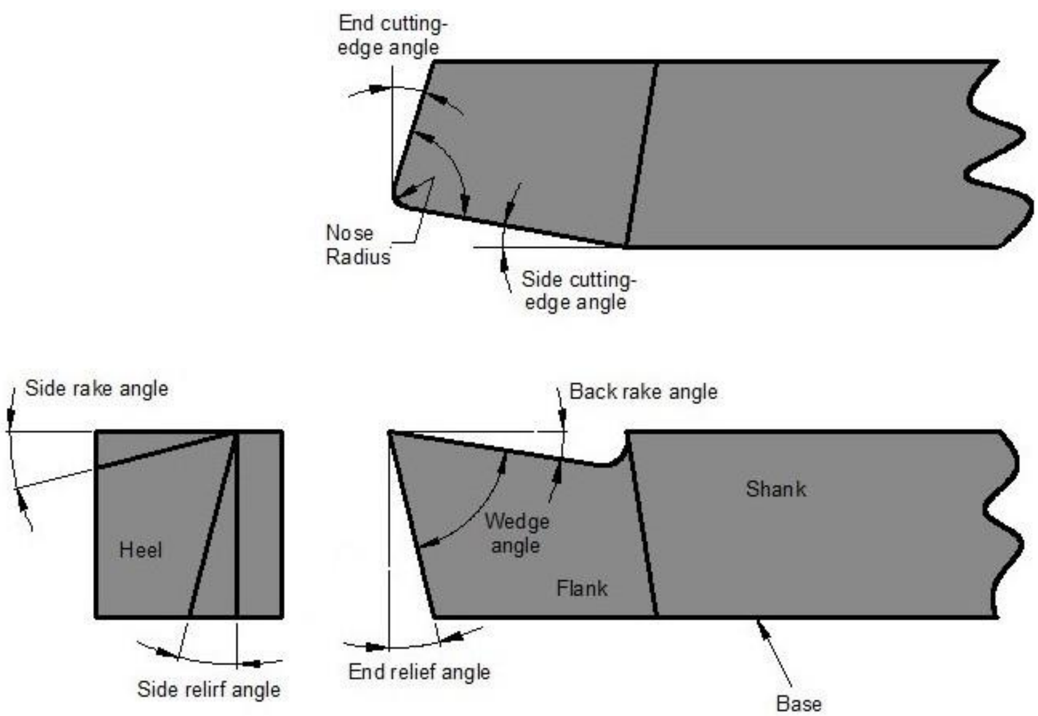
Hot hardness for different tool material

Single point cutting tools

Single point cutting tools can be dividedinto two, solid type and tipped tool type. The solid type cutting tool may be made from high- speed steel. Brazed tools are generally known as tool bits and areused with tool holders. Tool tip maybe made of cemented carbide. Figure below shows the details of solidand tipped tool.



Nomenclature of singlepoint cuttingtool



Single point cutting tool nomenclature

Definitions:

1. **Shank** – It is main body of tool. The shank used to grip in toolholder.
2. **Flank** – Flank is the surface or surface below the adjacent of the cuttingedge.
3. **Face** – It is top surface of the tool along which the chipsslides.
4. **Base** – It is actually a bearing surface of the tool, when it held in toolholder.
5. **Heel** – It is the intersection of the flank & base of the tool. It is curved portion at the bottom of thetool.
6. **Nose** – It is the point where side cutting edge and base cutting edgeintersect.
7. **Cutting edge** – It is the edge on face of the tool which removes the material from work piece. The cutting edges are side cutting edge and end cuttingedge.
8. **Tool angles -**Tool angles have great importance. The tool with proper angle, reduce breaking of tool, cut metal more efficiently, generate lessheat.
9. **Nose radius** – It provide long life and good surface finish. Sharp point on nose produces grooves in the path of cut and larger nose radius produceschatter.

1.3.2.1 3 ToolSignature

Convenient way to specify tool angles by use of standardized abbreviated system is known as tool signature. It specifies the active angles of the tool normal to the cutting edge. The seven elements that comprise the signature of a single point cutting tool can be stated in the following order:

Tool Signature	**10**	**20**	**7**	**6**	**8**	**15**	1/32 **(0.8)**
Back rake angle (°)							
Side rake angle (°)							
End relief angle (°)							
Side relief angle (°)							
End cutting edge angle (°)							
Side cutting edge angle (°)							
Nose radius (mm)							

EXPERIMENT NO-1

EXERCISES ON CENTRE LATHE

Aim

To make a model as per the given sketch and dimension by using plain, step, curve, taper, ball and thread cutting operations.

Material Required

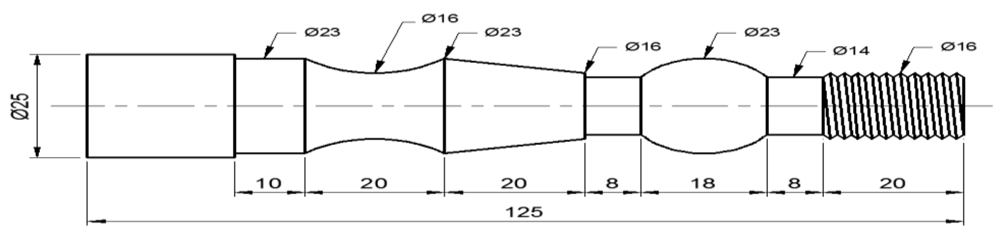
Mild steel rod of 25mm Ø and length125mm.

Tools Required

Steel rule, vernier caliper, jenny caliper (odd leg caliper), chuck key,surface gauge, centre bit, power hack saw, spanners, single point 'V' HSS cutting tool, parting tool, round nose tool, screw pitch gauge.

Lathe Operations

Facing, centering, work piece setting, tool setting, plain turning, step turning, curve & ball form turning, taper turning by swiveling the compound rest and thread cutting.



Procedure

- Cut mild steel rod of 25mm Ø in 125mm length from long bar by using power hack saw or ordinary hacksaw.
- Arrange the tools as specified above from the store before start the work.
- Fix the work piece in the lathe chuck properly.
- Remove the revolving centre from the tail stock and fix centre bit with holder and make a conical centering hole in right side face of the work piece called centering.
- After centering, remove the centering tool from the tail stock and fix revolving centre with holder.
- Fix the single point HSS cutting tool in the tool post considering the tool tip position in line with the axis passing through revolving centre tip in the tailstock and clamped

rigidly for normal lathe work.

- Make a fine face on right side of work piece calledfacing.
- By rotating the tailstock wheel, bring the revolving centre to the work piece and fix rigidly.
- Bring the tool post in normal position; i.e. the cutting tool must be perpendicular to the work piece axis and in line with the revolving centre and clamped rigidly.
- Start the machine by ‘ON’ the starter and local switch.
- Make the model as per the instructions given by the instructor in the order of operations; such as straight turning, step turning, curve turning, ball turning, taper turning and thread cutting.
- Check the dimensions when doing the work consecutively and complete the job.
- Clean the lathe machine and remove all chips from the tray.

Results:

Completed and make the model as per given drawing and dimensions.

EXPERIMENT NO-2

EXERCISES ON DRILLING MACHINE

Aim

To perform drilling, and tapping operations on the given M.S Flat work piece.

Apparatus

1 .Drilling Machine with standard accessories

2. Work piece

MATERIAL

Mild Steel flat plate 50 mm × 50 mm ×10 mm

PROCEDURE

•The given work piece is first filed to get required length, breadth and thickness wet chalk is applied on four sides and with the scriber lines are drawn to get center hole at required location.

•The centers are punched with a Punch and hammer.

•The work piece is fixed firmly in the vice of the Drilling Machine

•3/8” drill bit is fixed firmly in the chuck and drilling is performed giving uniform depths.

•The drill bit is removed from the drill chuck and is replaced by a reamer.

•The reaming operation is performed on the hole which has been previously drilled.

•The work is removed from the vice for performing tapping operation.

•The job is fixed firmly in a bench vice.

•Tap is fixed in the tap handle and pressure applied on the taps to obtain internal thread.

Result

- Completed the job key slot as per given drawing and dimensions.

EXPERIMENT NO-3

EXERCISES ON SHAPER

Aim

To make a key slots per the given sketch and dimension by Shaper operations.

Material Required

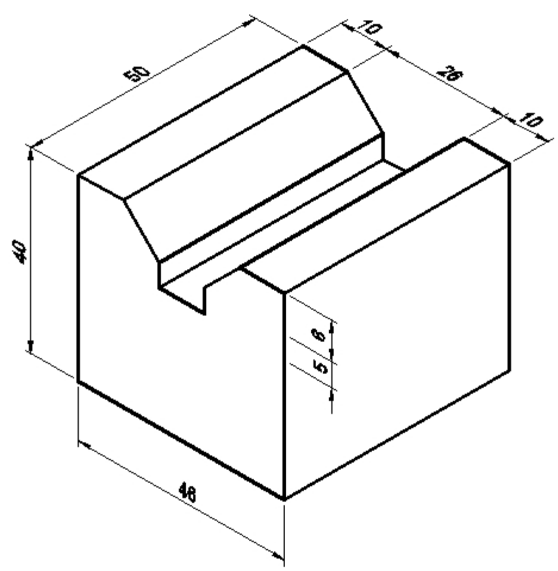
Cast Iron block of size50x60x60mm.

Tools Required

Steel rule, surface gauge, vernier caliper, vernier height gauge, try-square, single point HSS cutting tool with tool holder, etc.

Operations

Marking, Setting, Machining, Measuring and Finishing.



Procedure

- Held the work piece in the shaper machine table and rigidly clamped.

- Held the single point HSS cutting tool in the tool post.
- Check whether the work piece surface is perpendicular to the cutting tool.
- Arrange the ram in suitable position and adjust the stroke length.

- Start the shaper machine by turn the power switch and clutch lever.
- To be machined all six faces neatly, considering the faces are perpendicular to each other and check the dimensions.
- Rotate and fix the apron in suitable angle in both sides and machine the inclined surface.
- By using a form tool, make the two slots as per the drawing.
- Clean the machine and remove all scraps from the tray.

Result

- Completed the job key slot as per given drawing and dimensions.

EXPERIMENT NO-4

EXERCISES ON GRINDING MACHINE

AIM:

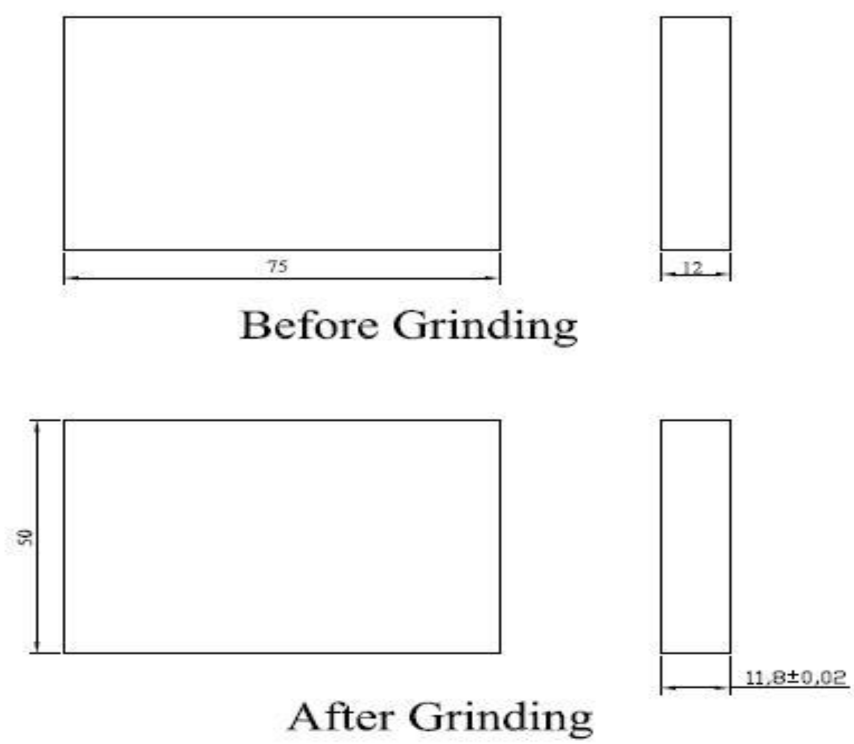
To perform a Plain surface grinding operation on the given work piece for the given dimensions

PRINCIPLE

The principle involved in this process is to make flat surface on the given work piece. The cutter is moved perpendicular to he work piece and the grinding is done.

REQUIREMENTS

1 Grinding Machine
2 Work Piece 100x50x6 mm MS Plate
3 Grinding Wheel



PROCEDURE
:

- At first work piece is placed in the magnetic chuck.

- The work piece should be light weight so that it cannot be removed from the magnetic chuck easily.
- Various arrangements regarding the positions of work piece is done.

- Grinding wheel and grinding spindle are kept in position with the work piece.
- Before switching on the motor, necessary steps should taken. For proper grinding process wheel speed, work speed, transverse speed of the wheel in feed, area of contact is to be noted.
- While running the area of contact is adjusted accordingly to the spindle in order to remove the surface.It is done slowly to remove the materials on the both sides.
- In surface grinding the stock removal rate is given by Q = bdy Where d =depth of cut (m) b=width of cut (m) y =work velocity (m/s)q =rate of stroke (m3/s)

Result

- Completed the job key slot as per given drawing and dimensions.

EXPERIMENT NO-5

EXERCISES ON SLOTTING MACHINE

AIM

To make a slot on the given work piece.

MATERIALS REQUIRED

M.S Round Block, Wooden Block

MACHINE REQUIRED

Slotting machine

MEASURING INSTRUMENTS

Vernier calipers slip gauges.

CUTTING TOOLS

H.S.S.Tool bit of the required slot size.

SEQUENCE OF OPERATIONS

•Fix the specimen in the three-jaw chuck of the slotting machine

•By giving the required feed and depth of cut, the required slot is being made progressively

PROCEDURE

- Fix the work piece in the head stock chuck firmly
- Turning tool is fixed in the tool post and centering is to be done
- Turn the job to get a diameter of required length
- Facing is to be done on one side of the job
- Drill bit of 8 mm diameter is fixed on tail stock and centering of workPiece is to be done by feeding through tail stock.
- Drill bit of 25 mm diameter is fixed in tail stock
- Drill through a hole of 25 mm diameter in the work piece feeding the tailstock.
- Boring tool is the fixed on tail stock to perform boring operation to get a hole of required diameter.

- Fit the job in reverse position in the chuck
- Facing of other side of the work piece is to be done to get the required length of the job
- Drilled work piece is fixed on slotting machine.
- A slot of required depth is made
- Slowly cross and longitudinal feed is given to obtain slots as per requirement.

Result

- Completed the job key slot as per given drawing and dimensions.

EXPERIMENT NO-6

EXERCISES ON WELDING

Aim: To make a Butt joint using the given two M.S pieces by arc welding.

Material Required:

Mild steel plate of size 100X50X5 mm – 2 No's

Welding Electrodes: M.S electrodes 3.1 mm X350 mm

Welding Equipment: Air cooled transformerVoltage-80 to 600 V 3 phase supply, amps up to 350

Tools and Accessories required:

1. Rough and smoothfiles.
2. Protractor
3. Arc welding machine (transformertype)
4. Mild steel electrode and electrodeholder
5. Groundclamp
6. Tongs
7. Faceshield
8. Apron
9. Chippinghammer.

Sequence of operations:

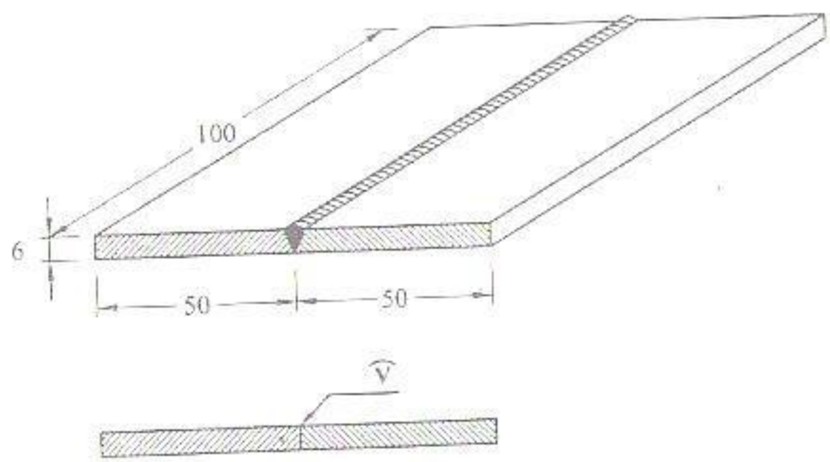
1. Marking
2. Cutting
3. Edge preparation (Removal of rust, scale etc.) byfilling
4. Try squareleveling
5. Tacking
6. Welding
7. Cooling
8. Chipping
9. Cleaning

Procedure:

1. The given M.S pieces are thoroughly cleaned of rust andscale.
2. One edge of each piece is believed, to an angle of 30^0, leaving nearly ¼ thof the flat thickness, at oneend.
3. The two pieces are positioned on the welding table such that, they are separated slightly for better penetration of theweld.
4. The electrode is fitted in the electrode holder and the welding current is ser to be a propervalue.

5. The ground clamp is fastened to the weldingtable.
6. Wearing the apron and using the face shield, the arc is struck and holding the two pieces together; first run of the weld is done to fill the rootgap.
7. Second run of the weld is done with proper weaving and with uniform movement. During the process of welding, the electrode is kept at 15^0 to 25^0 from vertical and in the direction of welding.
8. The scale formation on the welds is removed by using the chippinghammer.
9. Filling is done to remove any spanner around theweld.

DRAWING:



Welded Joint Representation

Result:

The single V-butt joint is thus made, using the tools and equipment as mentioned above.

EXPERIMENT NO-7

LATHE CUTTING FORCE MEASUREMENT

Aim:

To measure the principal forces in orthogonal machining by lathe tool dynamometer

Apparatus Requires:

Centre lathe
Cutting tool with carbide tip insert
Lathe tool Dynamometer
(i)Sensing Unit (ii) Force Indicator Unit (iii) Connecting wires

Material Required:

MS / CI work piece for which the principal cutting forces of machining are to be Measured

Principal Forces Measurement Tabulation:

S.No	Depth of cut (mm)	Speed (RPM)	F_C KgF	F_T KgF
1	0.2mm			
2	0.5mm			
3	0.8mm			

Procedure:

- The tool on which the dynamometer is to be mounted is first fixed on the tool post of the lathe
- Next the dynamometer is inserted via the cutting edge and is pushed and made square with the tool post, resting suspended on the tool itself through the slot on the dynamometer.

- Now the dynamometer setup is tightened so that any further movement / deflection of the tool body will activate the strain gauges and will give output

- Now the sensing unit of the dynamometer is connected to the force indicator unit with the help of the connecting wires

- First the lathe is switched on and the carbide tip of the tool is just made to touch the work piece surface very gently and the force indicator setup is calibrated to read zero

- Now the machining is carried out and the corresponding values of the principal forces cutting force (F_C) and Thrust force (F_T) are noted down

- The same experiment is repeated for various depth of cuts and cutting speeds and the values of the corresponding principal forces are tabulated

Result:

Thus the principal forces F_C and F_T turning in lathe are measured using a dynamometer and the results are tabulated

EXPERIMENT NO.8

STUDY OF PLANING MACHINE

INTRODUCTION

Planing is one of the basic operations performed in machining work and is primarily intended for machining large flat surfaces. These surfaces may be horizontal, vertical or inclined. In this way, the function of a planning machine is quite similar to that of a shaper except that the former is basically designed to undertake machining of such large and heavy jobs which are almost impractical to be machined on a shaper or milling, etc. It is an established fact that the planning machine proves to be most economical so far as the machining of large flat surfaces is concerned. However, a palning machine differs from a shaper in that for machining, the work, loaded on the table, reciprocates past the stationary tool in a planer, whereas in a shaper the tool reciprocates past the stationary work.

WORKING PRINCIPLE OF A PLANER:

The principle involved in machining a job on a planer is illustrated in fig. Here, it is almost a reverse case to that of a shaper. The work is rigidly held on the work table or a platen of the machine. The tool is held vertically in the tool- head mounted on the cross rail. The work table, together with the job, is made to reciprocate past the vertically held tool. The indexed feed after each cut is given to the tool during the idle stroke of the table.

SPECIFICATIONS:

Horizontal distance between two vertical housings:
Vertical distance between table top and the cross rail: 800mm
Maximum length of table travel: 1350mm
Length of bed: 2025mm Length
of table: 1425mm Method of
driving – Individual Method
driving table – Geared
H.P. of motor: 3 H.P. & 1 H.P.

STANDARD OR DOUBLE HOUSING PLANER:

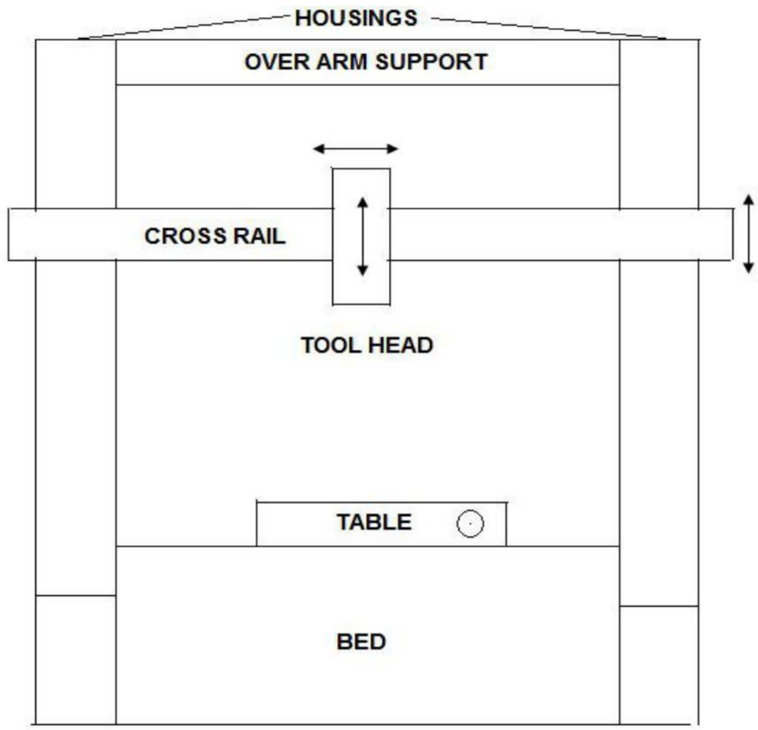
This is the most commonly used type of planer. It consists of two vertical housings or columns, one on each side of the bed. The housings carry vertical or scraped ways. The cross-rail is fitted between the two housings and carries one or two tool heads. The work table is mounted over the bed. Some planers may fit with side tool heads fitted on the vertical columns.

MAIN PARTS OF A PLANER

A planer consists of the following main parts as illustrated by means of a block diagram in fig.

- Bed
- Table
- Housings or columns
- Cross – rail
- Tool head
- Controls

These machines are heavy duty type and carry a very rigid construction. They employ high speeds for cutting but the size of work they can handle is limited to the width of their table i.e. the horizontal distance between the columns.



MAIN PARTS OF A PLANER

Extremely large and heavy castings, like machine beds, tables, plates, slides, columns, etc., which normally carry sliding surfaces like guide ways or dovetails on their longitudinal faces, are usually machined on these machines. Also because of long table and larger table travel, on either side of the columns, it is possible to hold a number of work pieces in a series over the bed length and machine them together. This will effect a substantial saving in machining time. Further because of no.of tool heads the surfaces can be machined simultaneously. This effects further reduction in machining time. Also because of high rigidity of high rigidity of the machine and robust design of the cutting tools heavier cuts can be easily employed, which leads to quicker metal removal and reduced machining time. Thus an overall picture emerges that the employment of this type of machine apart from its capacity to handle such heavy and large jobs which are difficult to be handled on other machines, leads to faster machining and reduced machining time and hence to economical machining. However considerable time is used in setting up a planer.

DRIVE MECHANISMS:

Four different methods are employed for driving the table of a planer. They are:

- Crank drive
- Belt drive
- Direct reversible drive
- Hydraulic drive

QUICK RETURN MECHANISM FOR PLANER TABLE:

Belt Drive:

Most of the common types of planers carry this system of drive for the quick return of their tables. The main features of this drive are shown in fig.

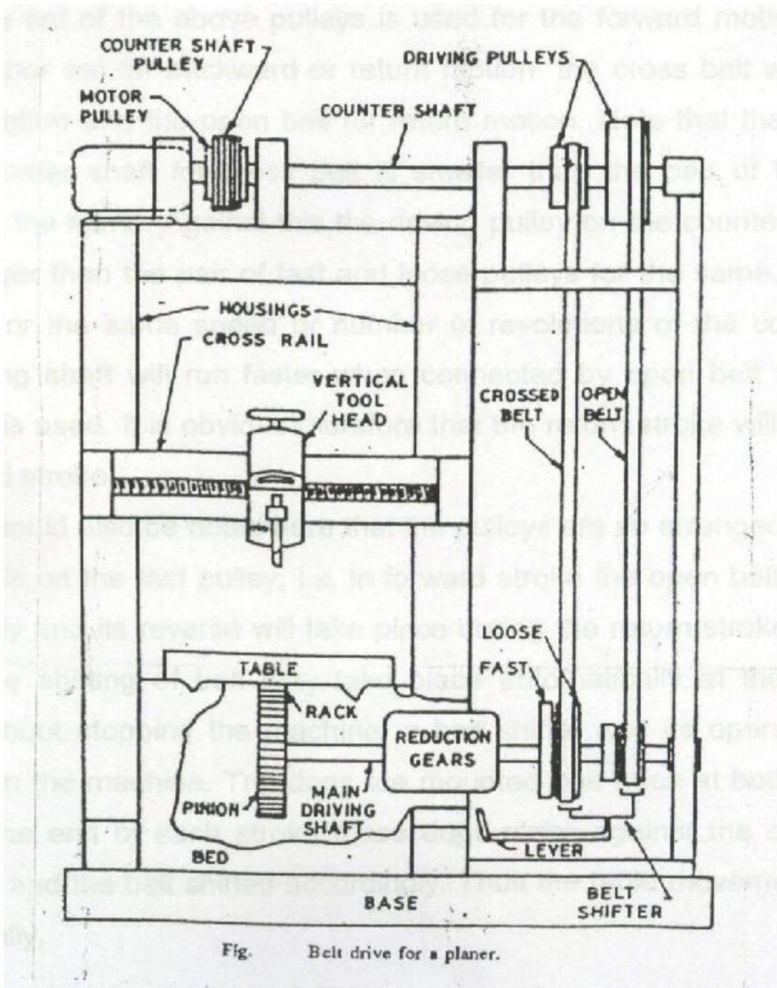


Fig. Belt drive for a planer.

It consists of the main driving motor situated over the housings. This motor drives the countershaft through an open V- belt. The countershaft, at its extreme carries two driving pulleys; one for open belt and the other for cross belt.

The main driving shaft is provided below the bed. One end of it passes through the housing and carries a pinion, which meshes with the rack provided under the table of the machine as shown. The other end of this shaft carries two pairs of pulleys – each pair consisting of a fast pulley and loose pulley. One of these pairs is connected to one of the driving pulleys by means of a open belt and the other to the second driving pulley by means of a cross belt. A speed reduction gear box is mounted on the main driving shaft and the same is incorporated between the pinion and the pairs of driven pulleys.

One set of the above pulleys is used for the forward motion of the table and the other set for backward or return motion. the cross belt will be used for forward motion and the open belt for return motion. Note that the driving pulley on the counter shaft for cross belt is smaller than the pair of fast and loose pulleys for the same. Against this the driving pulley on the countershaft for open belt is bigger than the pair of fast and loose pulleys for the same. Consequently therefore for the same speed or number of revolutions of the countershaft the main driving shaft will run faster when connected by open belt than when the cross belt is used. It is obvious therefore that the return stroke will be faster than the forward stroke.

It should also be noted here that the pulleys are so arranged that when the cross belt is on the fast pulley, i.e. in forward stroke the open belt will be on the loose pulley and its reverse will take place during the return stroke. In order that this relative shifting of belt may take place automatically at the end of each stroke, without stopping the machine, a belt shifter and its operating lever are provided on the machine. Trip dogs are mounted one each at both ends, on the table. At the end of each stroke these dogs strike against the operating lever alternately and the belt shifted accordingly. Thus the table movement is reversed automatically.

OPERATION DONE ON A PLANER:

The common operations performed on a planer include the following:

- Machining horizontal flat surfaces.
- Machining vertical flat surfaces.
- Machining angular surfaces, including dovetails.
- Machining different types of slots and grooves.
- Machining curved surfaces.
- Machining along premarked contours.

RESULT:

EXPERIMENT NO-9

SPECIMEN PREPARATION : FOR METALLOGRAPHIC EXAMINATION AND STUDY OF METALLURGICAL MICROSCOPE

AIM:

a) To prepare the given mild steel specimen for metallographic examination.
b) To study the constructional details of Metallurgical Microscope and observe the micro structure of the prepared specimen.

APPARATUS AND MATERIALS REQUIRED:

Metallurgical microscope, disc polishing machine, emery papers, lapping cloth, alumina powder, etchants, sample of metal.

THEORY:

The microstructure of metal decides its properties. An optical microscope is used to study the microstructure. A mirror polished surface of the metal is required for metallographic study.

PROCEDURE OF SPECIMEN PREPARATION:

a) Cut the specimen to the required size (small cylindrical pieces of 10 to 15mm diameter with 15mm height (Or) 10mm cubes.
b) The opposite surfaces (circular faces in case of cylindrical pieces) are made flat with grinding or filling. A Small chamfer should be ground on each edge for better handling. (If the sample is small it should be mounted)
c) Belt grinding: One of the faces of the specimen is pressed against the emery belt of the belt grinder so all the scratches on the specimen surface are unidirectional
d) Intermediate polishing: - The sample is to be polished on 1/0, 2/0, 3/0, 4/0 numbered emery papers with Increasing fineness of the paper. While changing the polish paper, the sample is to be turned by 900 so that new scratches shall be exactly perpendicular to previous scratches.
e) Disc polishing (fine polishing):- After polishing on 4/0 paper the specimen is to be polished on disc Polishing machine (Buffing machine). In the disc-polishing machine a disc is rotated by a vertical shaft. The disc is covered with velvet cloth.
f) Alumina solution is used as abrasive. Alumina solution is sprinkled continuously over the disc and the specimen is gently pressed against it. In case of Non-ferrous metals Such as Brass, Brass is used instead of Alumina and water. The polishing should be continued till a Mirror polished surface is obtained.

g) The sample is then washed with water and dried.

h) Etching:- The sample is then etched with a suitable etching reagent, detailed in article 5.

i) After etching the specimen should be washed in running water and then with alcohol and then finally dried. i) The sample is now ready for studying its microstructure under the microscope. ETCHING: Except for few cases a polished metallic surface can't reveal the various constituents (phases). Hence specimen should be etched to reveal the details of the microstructure i.e. a chemical reagent should be applied on the polished surface for a definite period of time. This reagent preferentially attacks the grain boundaries revealing them as thin lines. Thus under the microscope the grain structure of the metal becomes visible after etching i.e. grain boundary area appears dark and grains appear bright. The rate of etching not only depends on the solution employed and composition of the material but also on the uniformity of the material. A few etching reagents, their composition and their application are given below.

Sl.No	Name of Etchant	composition	Application
1	Nital a) 5% Nital b) 2% Nital	Nitric. acid (5ml) and Abs. Methyl alcohol (95ml) Nitric acid (2ml) and Abs. Methyl alcohol (98ml)	General structure of iron and steel
2	Picral	Picric acid (4gm) and Abs ethyl alcohol (96 ml)	General structure of iron and steel
3	Marbel's reagent	Copper sulphate (4 gm), Hydrochloric acid (20ml) and water (20ml)	General structure of iron and steel
4	Murakami's reagent	Potassium ferri cyanide, (10grms), KOH (10grms) and water (100ml).	Stainless steels
5	Sodium hydroxide	Sodium hydroxide (10gm) and water(90ml)	Stainless steels
6	Vilella's reagent	Hydro fluoric acid (20ml), Nitric acid (10ml) and Glycerene (30m*l*)	Aluminium alloys
7	Kellers reagent	Hydro fluoric acid (1 ml), Hydro chloric acid (1.5 ml), Nitric acid(2.5 ml) and Water (95 ml)	Aluminium & its alloys
8	Ammonium persulphate	Ammonium persulphate (10gm) And	Duralumin

METALLURGICAL MICROSCOPE:

Metallurgical microscope is used for micro and macro examination of metals. Micro examination of specimens yields valuable metallurgical information of the metal. The absolute necessity for examination arises from the fact that many microscopically observed structural characteristics of a metal such as grain size, segregation, distribution of different phases and mode of occurrence of component phases and non metallic inclusions such as slag, sulfides etc., and other heterogeneous condition (different phases) exert a powerful influence on mechanical properties of the metal. If the effect of such external characteristics on properties or the extent of their presence is known, it is possible to predict as to how metal will behave under gone by the metal. Study of structure of metals at magnifications ranging from 50X to 2000X is carried out with the aid of metallurgical microscope. A Metallurgical microscope (shown in fig) differs with a biological microscope in a manner by which specimen of interest is illuminated. As metals are opaque their structural constituents are studied under a reflected light. A horizontal beam of light from an appropriate source is directed by means of plane glass reflectors downwards and through the microscope objective on to the specimen surface. A certain amount of this light will be reflected from the specimen surface and that reflected light, which again passes through the objective, will form an enlarged image of the illuminated area. A microscope objective consists of a number of separate lens elements which are a compound group behave as positive and converging type lens system of an illuminated object. Specimen is placed just outside the equivalent front focus point of objective. A primary real image of greater dimension than those of object field will be formed at some distance beyond the real lens element.

Objective size of primary image w.r.t object field will depend on focal length of objective and front focus point of objective. By appropriately positioning primary image w.r.t a second optical system, primary image may be further enlarged by an amount related to magnifying power of eyepiece. As separation between objective and eyepiece is fixed at same distanceequivalent to mechanical tube length of microscope, primary image may be properly positioned

w.r.t eye piece. By merely focusing microscope i.e. increase or decrease the distance between object plane and front lens of objective the image is located at focal point. Such precise positioning of primary image is essential in order that final image can be formed and rendered visible to observer when looking into eyepiece. If now entrance pupil of eye is made to coincide with exit pupil of eyepiece, eyepiece lens is in conjunction with cornea lens in eye will form a second real image on retina. This retrieval image will be erect, un reversed owing to the manner of response of human brain to excitation of retina. The image since it has no real existence, known as virtual image and appears to be inverted and reversed with respect to object field6.1 Principle: . 6.1.1. MAGNIFICATION: The total magnification is the power of objective multiplied by power of eyepiece (Power of eye piece) (Distance from eye piece to object) / Focal length of object The magnification is marked on the side of objective.

CONSTRUCTION:

The microscope consists of a body tube (refer Fig 1.1), which carries an objective below, and an eyepiece above with plane glass vertical illuminator immediately above the objective. Incident light from a source strikes illuminator at 45 0 , part of which is reflected on to the specimen.

Rays after reflection pass through the eye again. Working table is secured on heavy base. The microscope has compound slide to give longitudinal and lateral movements by accurate screws having scale and venires. Vertical movement of specimen platform is made by a screw to proper focusing. For getting perfect focusing fine adjustment of focusing can be made use of.

1. Light filters: These are used in metallurgical microscope and are essentially of three types a. Gelatin sheets connected between two planes of clean glass b. Solid glass filters c. Liquid dye solution Solid glass filters are more preferable as they are more durable. Usually light filters are used principally to render a quality of illumination. Hence filters improve degree of resolution. A METZ - 57 model microscopes is used in the laboratory.

2 Optical compilations: Eye pieces and objectives of different magnifications are available. Huygens eyepieces: 5X, 10X Achromatic objectives: 5X, 10X, 45X

PRECAUTIONS:

a. Ensure mirror polished surface of specimen before etching.

b. Fine focusing should be done only after correct focusing has been done.

c. The glass lens should not be touched with fingers.

RESULT:

Hence prepared a mild steel specimen for metallographic examination.

EXPERIMENT NO-10

HARDNESS MEASUREMENT OF MILD STEEL SPECIMAN, APPLYING VARIOUS HEAT TREATMENT PROCESSES.

AIM:

To analyze the mechanical behavior and microstructure characteristic change of mild steel specimen, applying various heat treatments.

APPARATUS:

- Furnace
- Brinnell Hardness tester
- Mild steel Specimens (25 mm dia.& 20mm thick)
- Optical micro scope
- Disc polishing machine
- Emery papers (80,120,240,400 & 600)
- Etchants
- Alumina powder.

THEORY:

Heat treatment is a process of heating the metal below its melting point and holding it at that temperature for sufficient time and cooling at the desired rate to obtain the required Properties. The various heat treatment processes are annealing, normalizing, tempering, hardening, mar tempering, austempering.

Chemical composition of Mild Steel

Iron family	C%	Si%	Mn %	S%	P%	Cu%	Fe%
Mild steel	016 – 0.18	0.4	0.7 – 0.9	0.04	0.04	0.6	Remaininig

PROCEDURE:

The following steps were carried out;

1. Samples of Mild Steel were prepared for mechanical properties test.
2. After that the following heat treatment is to be carried out.

For annealing: In this case the specimen was put in the furnace for 910^{0}C and we kept it in this situation for approximately 70 minutes. After that it was cooled in the furnace so that it was cooled down at a very slow rate.For hardening**:** In this case the specimen was put in the furnace for 910^{0}C and we kept it in this situation for approximately 30 minutes. After that it was cooled in water so that it was cooled down very quickly.

For normalizing: In this case the specimen was put in the furnace for 910^{0}C and we kept it in this situation for approximately 70 minutes. After that it was cooled in room temperature (air).

3. Then the specific heat treatment operation like hardening ,annealing and normalizing had been done.
4. Take the given treated (annealed, normalized, hardened) specimens.
5. Polish the specimen by using (80,120.240, 400, 600) grade emery papers.Subject the given specimen to mirror like finish by using disc polishing machine and with suitable abrasives. Clean the specimen under the stream of flowing water.
6. After washing the specimen is dried. After drying supply the suitable etching agent for 30 to 50 seconds.
7. After etching wash the specimen under stream of flowing water.
8. Dry the specimen with the help of air drier.
9. Place the specimen for metallurgical studies.
10. Draw the micro structure and analyze the properties.
11. For specific heat treated specimen, the change of hardness was determined using Brinnell Hardness tester.

Summary of Heat treatment process.

Condition	Annealed	Normalised	Hardened
Temperature(^{0} C)	910	910	910
Holding time(Minutes)	70	70	30
Cooling Medium	Furnace	Air	Water

TABULATION

Heat treatment	Hardness (BHN)
Untreated	142
Annealed	96
Normalized	115
Hardened	945

RESULT

From the graph and micro structure of mild steel,it can be seen that mechanical properties depends largely upon the various form of heat treatment operations and cooling rates.

EXPERIMENT NO-11

EFFECT ON MECHANICAL PROPERTIES AND MICROSTRUCTURE OF MILD STEEL, APPLYING VARIOUS HEAT TREATMENT PROCESSES.

AIM:

To analyze the mechanical behavior and microstructure characteristic change of mild steel specimen, applying various heat treatments.

APPARATUS:

- Furnace
- Brinnell Hardness tester
- Mild steel Specimens (25 mm dia.& 20mm thick)
- Optical micro scope
- Disc polishing machine
- Emery papers (80,120,240,400 & 600)
- Etchants
- Alumina powder.

THEORY:

Heat treatment is a process of heating the metal below its melting point and holding it at that temperature for sufficient time and cooling at the desired rate to obtain the required Properties. The various heat treatment processes are annealing, normalizing, tempering, hardening, mar tempering, austempering.

Chemical composition of Mild Steel

Iron family	C%	Si%	Mn %	S%	P%	Cu%	Fe%
Mild steel	016 – 0.18	0.4	0.7 – 0.9	0.04	0.04	0.6	Remaininig

PROCEDURE:

The following steps were carried out;

1. Samples of Mild Steel were prepared for mechanical properties test.
2. After that the following heat treatment is to be carried out.

For annealing: In this case the specimen was put in the furnace for 910^{0}C and we kept it in this situation for approximately 70 minutes. After that it was cooled in the furnace so that it was cooled down at a very slow rate.For hardening**:** In this case the specimen was put in the furnace for 910^{0}C and we kept it in this situation for approximately 30 minutes. After that it was cooled in water so that it was cooled down very quickly.

For normalizing: In this case the specimen was put in the furnace for 910^{0}C and we kept it in this situation for approximately 70 minutes. After that it was cooled in room temperature (air).

3. Then the specific heat treatment operation like hardening ,annealing and normalizing had been done.
4. Take the given treated (annealed, normalized, hardened) specimens.
5. Polish the specimen by using (80,120.240, 400, 600) grade emery papers.Subject the given specimen to mirror like finish by using disc polishing machine and with suitable abrasives. Clean the specimen under the stream of flowing water.
6. After washing the specimen is dried. After drying supply the suitable etching agent for 30 to 50 seconds.
7. After etching wash the specimen under stream of flowing water.
8. Dry the specimen with the help of air drier.
9. Place the specimen for metallurgical studies.
10. Draw the micro structure and analyze the properties.
11. For specific heat treated specimen, the change of hardness was determined using Brinnell Hardness tester.

SUMMARY OF HEAT TREATMENT PROCESS.

Condition	Annealed	Normalised	Hardened
Temperature(^{0} C)	910	910	910
Holding time(Minutes)	70	70	30
Cooling Medium	Furnace	Air	Water

TABULATION

Heat treatment	Hardness (BHN)
Untreated	142
Annealed	96
Normalized	115
Hardened	945

RESULT

From the graph and micro structure of mild steel,it can be seen that mechanical properties depends largely upon the various form of heat treatment operations and cooling rates.