DAV UNIVERSITY

(Empowering Students with 21st Century Skills)

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

FOR

Mechanical Measurement LAB
(MEC-265)

Vision of the Department

The Mechanical Engineering Department aims to be recognized as an outstanding educational centre to develop innovative engineers who are proficient in advanced fields of engineering and technology and can contribute effectively to the industry as well as for socio-economic upliftment of the society.

Mission of the Department

M1: To impart outcome-based education with a research orientation to the students to develop them as globally competitive engineers.

M2: To imbibe the students with academic, leadership and entrepreneurship skills needed by the industry in particular and society in general.

M3: To adopt flexibility and dynamism in designing the programme structures to cope up with emerging market needs.

M4: Establishment of liaison with top R & D organizations/Industries and leading educational institutions for practical exposure of the students and faculty as well as to the state of the art.

Programme Educational Outcomes (PEOs)

After the successful completion of undergraduate course, Mechanical Engineering, Graduates will be able to:

PEO1: Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable.

PEO2: Apply analytical, computational and experimental techniques to address the challenges faced in mechanical and allied engineering streams.

PEO3: Communicate effectively using conventional platforms as well as innovative / online tools and demonstrate collaboration, networking & entrepreneurial skills.

PEO4: Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career, organizational and societal goals.

Program Outcomes (POs) - B. Tech. Mechanical Engineering

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate

consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO) - B. Tech. Mechanical Engineering

PSO1: **Academic Competence:** Apply mechanical and interdisciplinary knowledge to analyze, design and manufacture products to address the needs of the society.

PSO2: Professional Competence: Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

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Department of Mechanical Engineering

L	T	P	Credits
0	0	2	1

Course Code	MEC 365							
Course Title	**Mechanical Measurement Laboratory**							
Course Outcomes	On the completion of the course the student will be able to: **CO1:** To understand the parts and working principle of vernier calliper, Micrometre, and height gauge. **CO2:** To understand the measuring of angle of specimens using sine bar and angle protector. **CO3:** To understand the working of surface tester and tool maker microscope. **CO4:** To know about the temperature measurement and strain.							
Examination Mode	Practical							
Assessment Tools	Continuous Assessment (CA)				MSE	MSP	ESE	ESP	Total
	Quiz	Assignment/ Project Work	Attendance	Lab Performance					
Weightage	-	-	-	20%	-	30%	-	50%	100

S. No.	LIST OF EXPERIEMENTS	CO Mapping
1.	Measurement of internal and external diameter or length of specimen with the help of vernier caliper.	CO1
2.	Measurement of internal and external diameter or length of specimen with the help of outside and inside micrometer.	CO1
3.	Measurement the height of specimen and marking the specimen to be worked with the help of height gauge.	CO1
4.	Measurement of an angle of specimen with the help of sine bar	CO2
5.	Measurement of an angle of specimen with the help of angle protector	CO2
6.	Measurement of surface roughness using surface roughness tester	CO3
7.	Measurement of gear elements using profile projector.	CO3
8.	Measurement of thread element by Tool maker's microscope	CO3
9.	Preparation of a thermocouple, its calibration and application for temperature measurement.	CO4
10.	Measurement of strain with the help of hole-drilling strain-gage method.	CO4

Mapping of COs with PO(s)

CO's / PO's	CO-1	CO-2	CO-3	CO-4
PO-1	3	3	3	3
PO-2	3	3	3	3
PO-3	2	2	2	2
PO-4	1	1	1	1
PO-5	1	1	1	1
PO-6	3	3	3	3
PO-7	3	3	3	3
PO-8	2	2	2	2
PO-9	1	1	1	1
PO-10	1	1	1	1
PO-11	1	1	1	1
PO-12	2	2	2	2

1- Slight (Low) 2- Moderate (Medium) 3- Substantiate (High)

Mapping of COs with PSO(s)

COs / PSOs	CO-1	CO-2	CO-3	CO-4
PSO-1	3	3	2	3
PSO-2	3	3	2	3

1- Slight (Low) 2- Moderate (Medium) 3- Substantiate (High)

EXPERIMENT NO: 1

AIM:- Measurement of internal and external diameter or length of specimen with the help of Vernier calliper.

Vernier Calliper: Vernier Calliper is a linear measurement device invented by Sir Pierre Vernier is 1631. It is a simple instrument used for the measurement of accuracy more than the engineer's scale. Vernier calliper widely used for precision measurement of thickness, length, depth, diameter etc.

Principle: The Principle of Vernier Calliper is based on the difference b/w two scales Or division, which are nearly but not exactly equal. The difference between them is utilized to determine the accuracy of measurement. It consist of two scale, Main and the Vernier scale. He main scales is fixed and the Vernier scale Slide over the main scale. The difference between the main scale and Vernier scale value division is called least count. If the valve of one "scale is 0.58 mm on main scale and the value of one small divisions on the Vernier scale is 0.48 mm. Then, the least count of instrument is given by the difference of these two values are 0.02 mm.

Construction Features: The main components of Vernier Calliper are beam, fixed jaw and sliding jaw. The Construction of Vernier calliper is shown in fig (A). The Vernier callipers consists of two scales and these can slide along each other. One of the scale is known as main scale is fixed and engraved an solid L shaped frame the movable scale is known as Vernier Scale. A sliding jaws moves along the guiding surface provided by main scale. The fixed jaws is an integral part of beam whereas the slide jaw makes a good sliding fit along the beam provides a seizure free movement along the bar, the finer adjustment of sliding jaw can be done by the adjusting screw. A locking arrangement is provided on the sliding jaw to clamp the sliding jaw on the beam. He graduations are engraved on main scale and Vernier scale. To value of division determines the extent of accuracy. Thus the value of these division are different depending upon accuracy Generally, the Vernier calliper is available in 0.1 mm, 0.05mm and 0.07 mm accuracy.

Calculation of least Count – The least count (LC) is the difference between the value of main scale division and Vernier scale division.

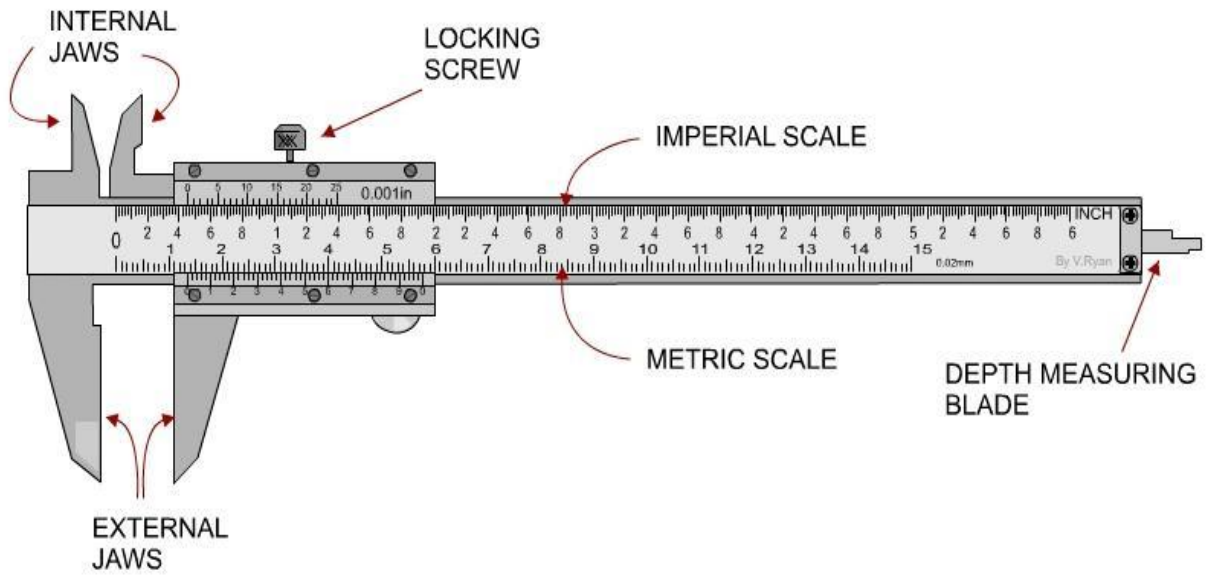
Least count of Vernier Calliper= Value of the smallest division on the beam – value of smallest division on Vernier Scale.

Procedure:

1. First of all, check the zero error of the Vernier calliper by closing the two jaws. In this position, the zero of Vernier Calliper scale should exactly match with zero of main scale.
2. The linear dimensions may be taken by placing the Work piece between fired and movable jaw.
3. The work piece must be exactly perpendicular to the measuring surface.
4. The internal dimension or Internal diameter may be taken by using upper measuring jaws
5. To obtain the reading, first count the number of Divisions on main scale. The Vernier scale is then examined to determine which of the division coincides with a division on main scale. Now Calculate the value as Total Reading = Main Scale Reading + (least Court X least Court X Vernier Scale Reading).

Repeat the produce three to four times, and then Calculate the average Valve.

Result:- The least count observed is 0.02 mm.



EXPERIMENT NO: 2

AIM:- Measurement of an internal and diameter or length with of specimen with the help of outside and inside Micrometer.

Micrometer. In 1848, first micrometer was design by Sir jean Palamer It is a linear measurement device which is used to measure diameter of wires, thickness of strip etc. This is used for precise measurement as the accuracy of micrometer to greater that that of Vernier calliper. Micrometer has accuracy of 0.01 mm as Working Principle – It works on the principle of screw and nut. If we rotate screw by one rotation, the screw will advance by a very Small distance axial direction by linear distance & equal to pitch of thread. If. The circumference of screw is divided into any no of equal division say 'n' then for one division or rotation, the screw will advance by a very small distance which will be equal to (pitch /n). This is the minimum amount of length that can be Measured. Hence it is also called least count The accuracy can be further increased by increasing number of divisions on circumference.

Construction Features: The micrometer consists of Frame, Anvil, Spindle, sleeve or barrel, Thimble, Ratchet and locknuts.

Procedure:

1. Before taking measurement, check the instrument for zero error. If it exists in instrument, remove it. Ensure that the measuring face should be free from dust and dirt. Adjust the fire error. By rotating barrel with the help of adjusting spanner.
2. Hold the workpiecce between the faces of anvil and Spindle, turn the thimble until the measuring faces touch the work surface and the ratchet slips.
3. Now observes the reading on the main scale. On the barrel a datum line is graduated with the two sets of division marks. The set below the datum line rod in millimetres and set above the datum live. Rods in half of millimetres. First of all note the whole number the major division on the barrel, now observe whether there is a half millimetre visible on the top of datum.
4. Take the thimble reading which coincides, with the reference line of the sleeve. The thimble scale is marked in 50 equal division In each revolution, the axial movement is ½ mm = 0.5 mm, which is screw pitch

So, Least Count (L.C)= Screw Pitch/no. of division of thimble

0.5/50 =0.01mm

5. Total reading is calculated as,

Total reading= main scale reading+ L. C × Reading in thimble

Sources of error:

1. The measuring faces (faces of anvil and spindle) may not be truly flat and parallel.
2. Zero error present in the micrometer.
3. Application of excessive pressure on thimble.
4. Wear of ratchet stop mechanism.
5. Inaccurate readings.

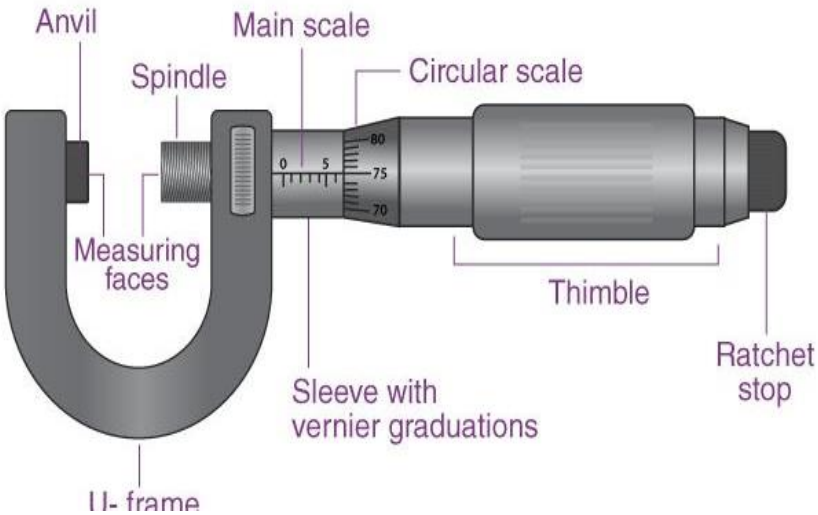
Parallelism is checked by measuring the diameter of a standard accurate ball across at least three different points on the anvil faces. Squareness of the anvil to the measuring axis is checked by using two standard balls having difference in diameter by an odd multiple of half a pitch. Flatness of the anvils is tested by interference method wing optical flats

Precautions

1. Always keeps the measuring faces of spindle and anvil free from dust and dirt.
2. There should not be zero in micrometer. If it exist, It must be removed before taking Measurement
3. Use the micrometer gently. Do not apply excessive Pressure.
4. While hold the workpiecce, turn the thimble with forefinger and thumb, till the measuring tip just the workpiecce. The fine adjustments should be made with help of ratchet.
5. Take observations carefully.
6. Clean, oil place the micrometres in frotective boxes when not in use.

Result: The least count observed is 0.01 mm.

DIAGRAM OF A MICROMETER



EXPERIMENT NO: 3

AIM: Measurement of an angle of specimen with the help of sine bar.

Instrument used :- Sine bar, work piece , dial gauge, slip gauge, height gauge.

Sine Bar – Centre distance of roller 200mm, Diameter of roller 20mm.

Theory:- Sine bar is precision instrument which is used to measure angles very accurately. It is used along with slip gauges. Sine bar consists of high carbon, high chromium corrosion resistance steel bar. The bar is hardened, grounded and stabilised. Two cylinder of equal diameter are attached at both ends the axis of two cylinder are mutually parallel to each other. These axis are at equal distance from the upper surface of sine bar. The distance b/w the axes of the roller is exactly 100 mm, 200mm, or 300 mm. the construction of sine bar is shown in figure. The sine bar works on the principle that in right angled triangle, if the length of hypotenuse is left constant, the sine of different angles can be obtained simply by changing the length of the perpendicular.

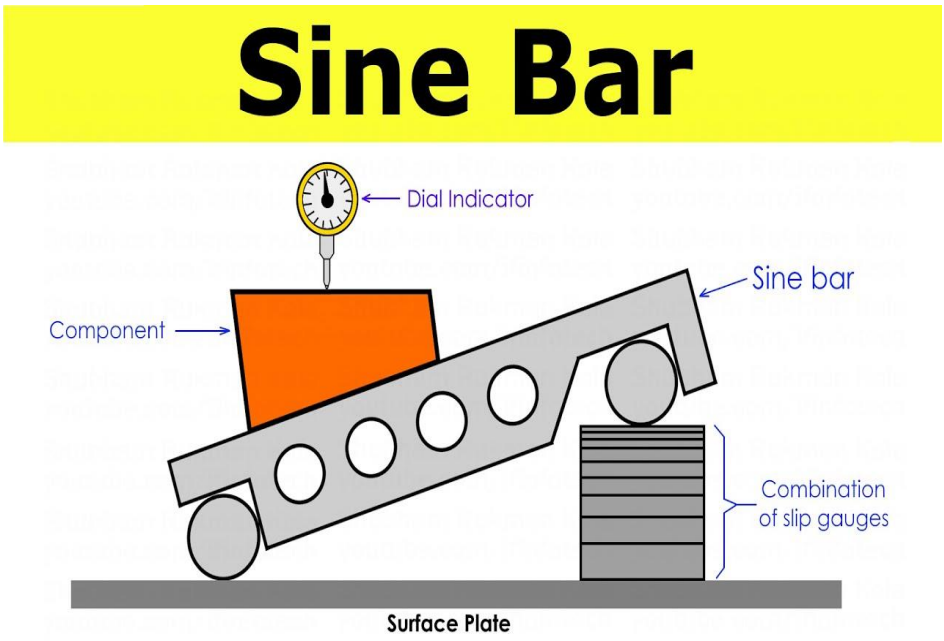
Procedure:

1. Place the work piece / wedge about the sine bar and make it horizontal with the base.
2. The dial work gauge is then set at one end of the work moved along the upper surface of the component and the surface plate.
3. If there is any variation in parallelism of the upper surface of the component and the surface plate, it is indicated by the dial gauge.
4. The combination of the slip gauges is so adjusted that the upper surface is truly farallel with the Surface plate.
5. Note down the values of slip gauges.
6. Calculate the angle using formula Sin α= H/L, $\alpha=S_1$ (H/L)
7. Repeat the procedure 3 or 4 times.

Precautions:-

1. The sine bar should not be used for angle greater than 45° because any possible errors in construction is a centred at this limit.
2. A compound angle should not be formed by mix aligning of work piece with the sine bar. This can be avoided by attaching the sine bar & weak against an angle plate.
3. As far as possible longer sine bar should be used since using longer sine bars reduces many errors.

Result: The angle of given specimen using sine Bar are 8.63°, 14.49°, 22.01°.



EXPERIMENT NO: 4

AIM:- Measurement of an angle of specimen with the help of Bevel protector.

Bevel Protector: A universal bevel protractor is used to measure angles between two planes. This consists of stem, which is rigidly attached to main scale and a blade, which is attached to Vernier scale and can be rotated to read angles to improve the accessibility, the blade can also slide. The least count is calculated by knowing the value of the smallest division on the main scale and no. of division on the Vernier scale. It should be noted that the division on the main scale is in degrees and minutes. To measure angles b/w two planes, rest stem on one of planes (Reference plane). Rotate the blade such that blade is flush with record plane. Readings are taken after ensuring that the stem and blades are in flush with the two planes. Lock the protector at this point & note down the reading.

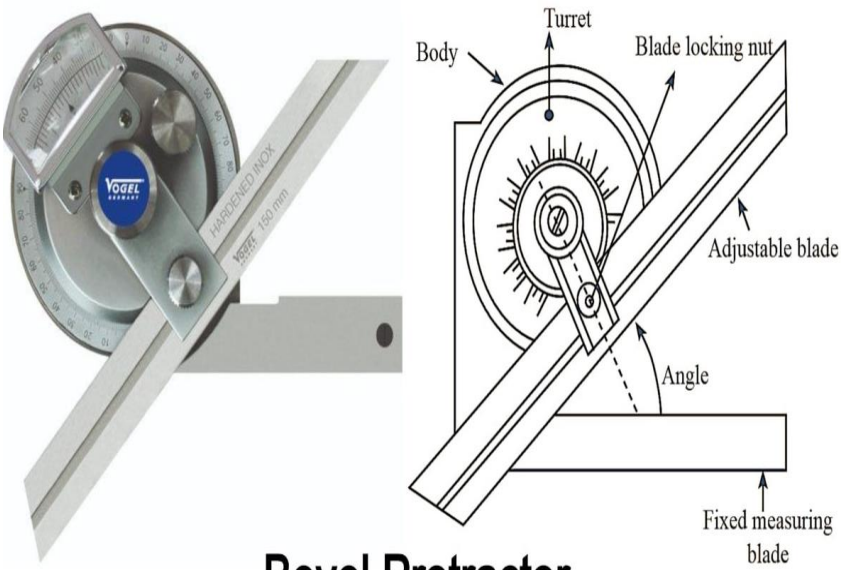
Least Count :- 0°-00'-30" (for Digital Bevel Protector)

Precautions:

1. The surface to be measured should be free for dust & dirt.
2. The parallax error must be avoided by proper positioning of the observer.
3. While holding the instrument on surface the blade & stock should be exactly parallel to the surface of sample job.
4. Zero error must be checked before starting the instrument.

Result:-The angle of the given specimen measured with the Bevel Protector is

1. 90° 45'
2. 87° 15'
3. 65° 10'
4. 116°



Bevel Protractor

EXPERIMENT NO: 5

AIM – Measurement the height of specimen and marking the specimen to be worked with the help of Vernier Height Gauge.

Vernier Height gauge

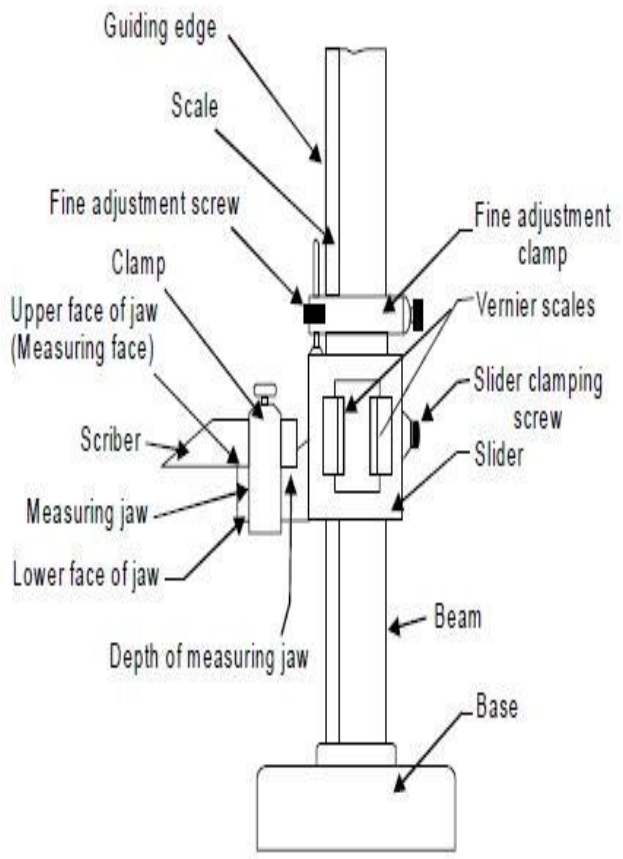
Vernier height gauge Is a sought of Vernier calliper with a special base and other attachments which make the instrument suitable for height measurement. Along with sliding jaw assembly arrangement is provided to carry removable champ. The upper and lower surfaces of the measuring jaws are parallel to base, so it can be used in the inspection of parts and be used to scribe lives at certain distance above surface With a scribing attachment in face of Measuring jaw. Dial indicators can be also be attached in the clamp and Many exactly gives the indication when the dial tip is touching the surface plates as datum surface are used for the above measurement.

Procedure :

1. Take the material (sample) for which the value must be measured.
2. Place the object and Vernier calliper height gauge on surface plates.
3. Note the value on scale when the making jaw is touching the bottom of the object.
4. Take the mating / sliding saw to the top of the object and note down the value on the scale.
5. The different b/w 3 & 4 will gives Light of the object.
6. " Hold bottom"
7. "mm/in" button Press it for metric and inch reading Conversion.
8. "ON /0FF" Zero button. Press it turn off display. Short press in to get the present value at absolute measuring mode.

Precautions :

1. Clean the bottom of base and the measuring tip put the height gauge on the surface plate and install the measuring tape.
2. Put battery into should gauge, the positive side should face out.
3. Check the height gauge measuring and marking Arm zero error.
4. The fine adjustment should be made with the help of fine adjustment clamp.
5. Measurement tip should be carefully protected from being damaged.



EXPERIMENT NO: 6

AIM : To study the surface roughness tester and the different terms used in it. Also calculate the surface roughness value on different surfaces.

Profile and fitness (DIN EN 1504287 1998 and DIN EN ISO 11562: 1998)

The actual surface profile results from the Intersection of the actual part surface, with a plane perpendicular to this surface. The plane should roughly be vertical to machining grooves. The measured Surface profile is the profile after tracing the actual surface profile using a probe. In doing so the measured valued are filtered through the effect of stylus tip radius of and where applicable through the sliding skid of the probe system. Imperfection of the surface, like cracks, scratches and dents do not count as Roughness and should not be measured. If necessary tolerances must be determined for this according to DIN ENTSO 8785. The primary profile is the profile after low-pass filtering is measured values using the cut-off wavelength As lambda s In doing so, the short-wave profile parts are cut off. The parameters are identified by P and evaluated within the sampling length.

Roughness profile :-

The roughness profile results from high pass filtering primary profile with the wavelength lambda . In doing so, the long-wave for profile parts are cut-off. The parameters are Identified by R and evaluated over a measured length. In which is usually composed of 5 single measured length I. The single measured length corresponds to the cut-off wavelength lambda c of the profile filter.

Waviness profile :-

results from low pass to profile with the cut off wavelength filtering high fall filtering with the cut off wavelength lambda. the parameter are identified by W and evaluated over a measured length. which is comfort of several sampling length w. single measured length/W. Corresponds to the cut-off wavelength λ. Be indicated on the drawing. It should range between 5 to 10. Profile filters lambda c and lambda are applied successfully. The waviness profile always results from application of both filters.

Roughness Parameter (DIN EN ISO 4287:1998)

Ra- Arithmetic mean surface roughness:

arithmetic mean of the sums of all profile value.

Rmr(c) Material proportions of the profile:

Quotient from the sum of all materials lengths of the profile elements at the specified sections height (in um) and the measured length I.

Rsm average grade width:

Mean value of the width of the profile element Xs for the evaluation, horizontal and vertical counting thresholds are determined.

Rt- Total height of the profile roughness.

Sum from the height Zp of the height profile Leak and the depth Zv of the lowest profile. Valley within the measuring Length In.

Rz - Maximum height of the roughness profile.

Sum from the height of the highest profile peak and the depth of the Lowest profile valley within sampling length Im.

Rz1 Maximum Surface roughness.

Largest of the five Rz1 - values from the five Sampling length Ir over the total measured Length In.

R_2- Surface roughness depth.

Mean value of the five R_2 values from the five sampling length. In over the total measured length Im.

Preferred Parameters: -

Maximum surfaces where roughness R_2, max:-

For surfaces where individual deviations heavily affect the function of the surface e.g. realing surface.

Material portion of the profile Rmr(c) :-

For guide surfaces and sealing surfaces moving against each other.

Surface roughness depth (R_2):-

As a rule, is used for other surfaces. The arithmetic average roughness value R_2- hardly reacts to peaks or the mean valve formation from all profile valleys due to values so that it's significance is rather low- Additionally the measuring point distance Delta x and the cut off wavelength of low pass filter. Lambda s are standardized . However, these value have already been set in the roughness measuring instruments.

EXPERIMENT NO: 7

AIM : measurements of gears elements using profile projector.

Operators Required: Profile projector, thread specimen, gear.

Theory: The optical comparator is a device that applies the principle of optics for the inspection of manufactured parts. The profile projector is basically an optical instrument which makes use of enlarged instruments. The purpose of the optical projector is to compare the shape or profile of relatively small engineering compound with an accurate standard or drawing. The projector magnifies the profile of specimen and shows this on the built in projection screen. From this screen there is usually grid that could be rotated 360 degrees. Therefore the XY axis of the screen could be aligned correctly using straight edge of machine part to analyse or measure. Dimension can be directly measured on the screen or compared to the standard reference.

Procedure:

1. Calculate the least count of micrometer of the projector.
2. Fix the given test specimen under the magnifying lens on the fixture Provided.
3. Select a suitable magnification.
4. Switch on the projector and focus to obtain the clear image of the object on screen.
5. Adjust the reference axis (core wire) to a point of element by adjusting the micrometer and angular disc.
6. Note down the initial reading of micrometer.

Thread parameters found using profile projector.

- Major diameter = 6.1025 mm
- Minor diameter = 5.69 mm
- Pitch of screw = 0.625mm
- Depth of thread = 0.65 mm
- Angle of thread = 7 degree

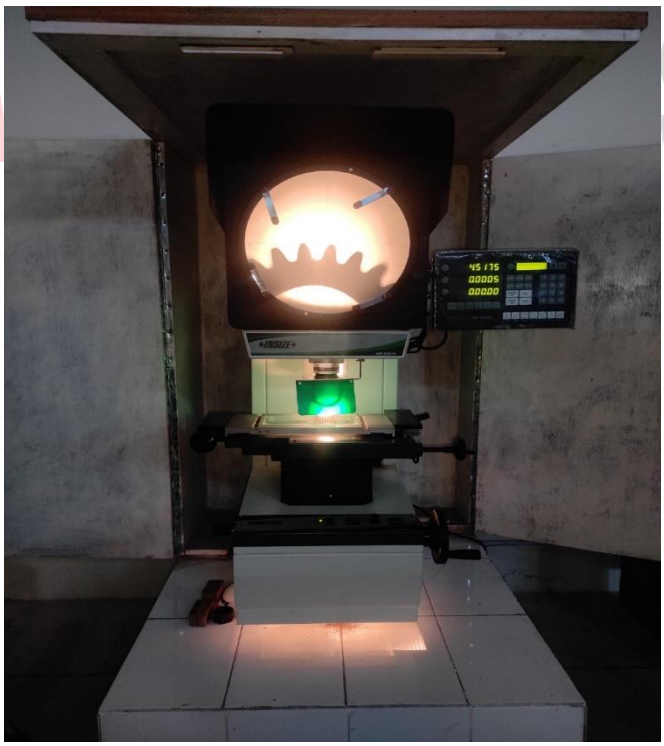
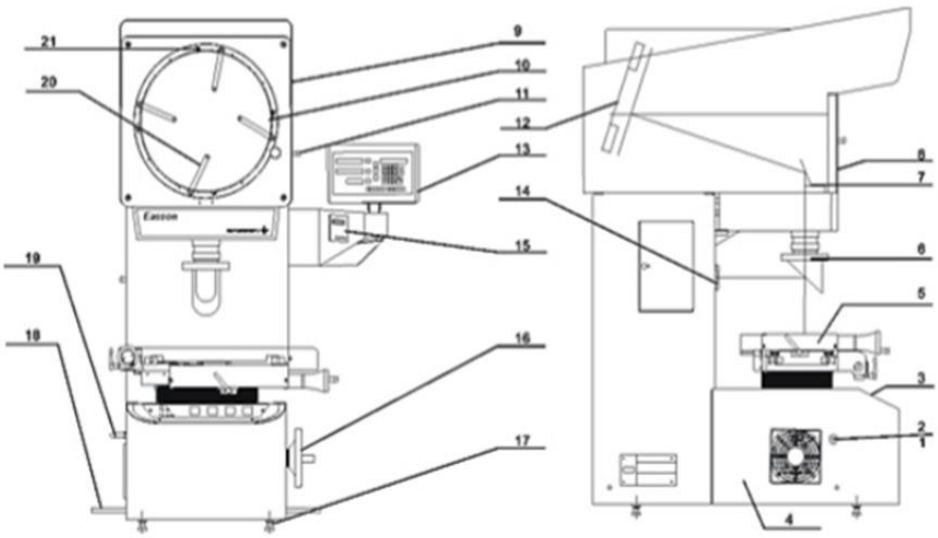


Fig: profile projector



tion system 2. parallel ray focalizing unit 3. control panel 4. body stand
5. XY table 6. lens 7. front reflective mirror 8. screen rotation knob 9. projector box
10. projector screen 11. screen knocking screw 12. rear reflective mirror 13. digital readout counter
14. reflective illumination system 15. line printer 16. Z axis handwheel 17. level adjusting screws
18. handles for transportation 19. high magnification focalizing select 20. comparison film holders