3 FORM MEASUREMENTS

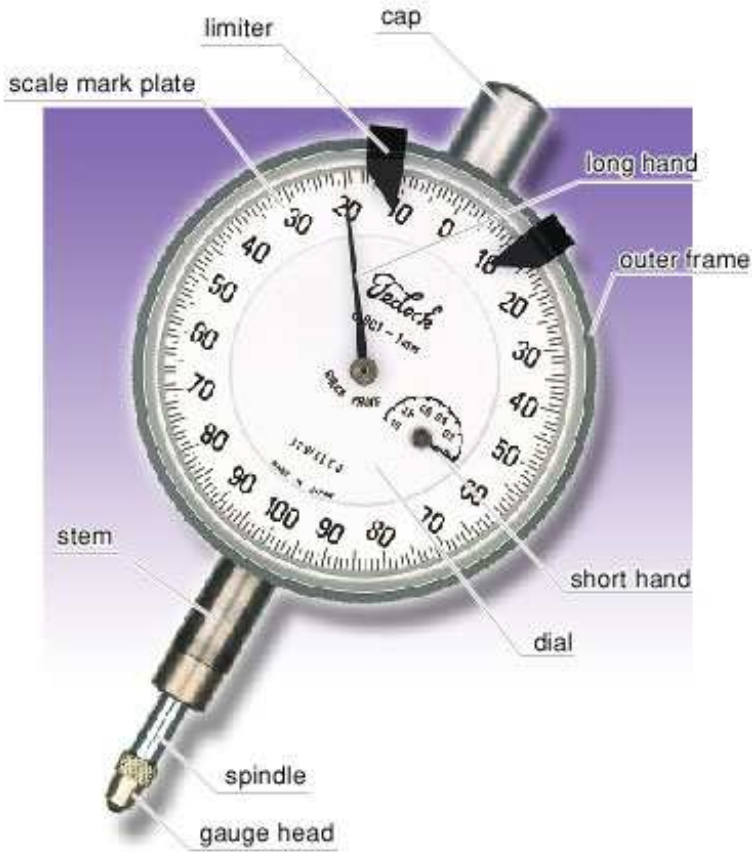
DIAL INDICATOR

LAB EXERCISE:

1. Differential Measurements
2. Parallelism test
3. Perpendicularity test
4. Flatness test
5. Circularity test

DIAL INDICATOR

Converts a linear displacement into a radial movement to measure over a small range of movement for the plunger.



The radial arm magnification principle is used here.
These indicators are prone to errors caused by errors that are magnified through the gear train. Springs can be used to take up any play/backlash in the rack and pinion to reduce these errors.
The gears are small, but friction can result in sticking, thus reducing accuracy.
A spring is used on the rack to return the plunger after depression.

Applications include,

1. Centering work pieces to machine tool spindles.
2. Offsetting lathe tail stocks.
3. Aligning a vise on a milling machine.
4. Checking dimensions.

These indicators can be somewhat crude for accurate measurements, comparator have a higher degree of sensitivity.

DIAL GAUGES

With their comparatively short plunger travel (3 or 10 mm), dial gauges (ISO/CD 463) are mostly used for difference measurements. Their applications are testing straightness, parallelism, or circularity. To determine an absolute dimension with a dial gauge and stand, it is first necessary to set the required specified dimension with a material measure, using for example, a gauge block and then adjust the pointer to a defined deflection calibration, Fig. 2.

The displacement of the measuring tip is transmitted to a gear wheel mechanism via a rack, converting the distance measured to a pointer deflection. The result is displayed on a circumferential scale with a scale interval of typically 0.01 mm. Since dial gauges include a significant element of backlash, measurements should be performed only touching the measuring object in the same direction as when the calibration set up was performed. Radial run-out measurements can therefore be afflicted with systematic errors. On dial gauges, the pointer can revolve around the scale several times over the entire plunger travel; a small pointer then counts the number of revolutions. Dial gauges are also available in digital versions. The probe tip diameter is usually 3 mm, but numerous other probe styluses are available, e.g. pointed, cutting edge, plane or ball measuring contacts, balls of other diameters or measuring rollers.

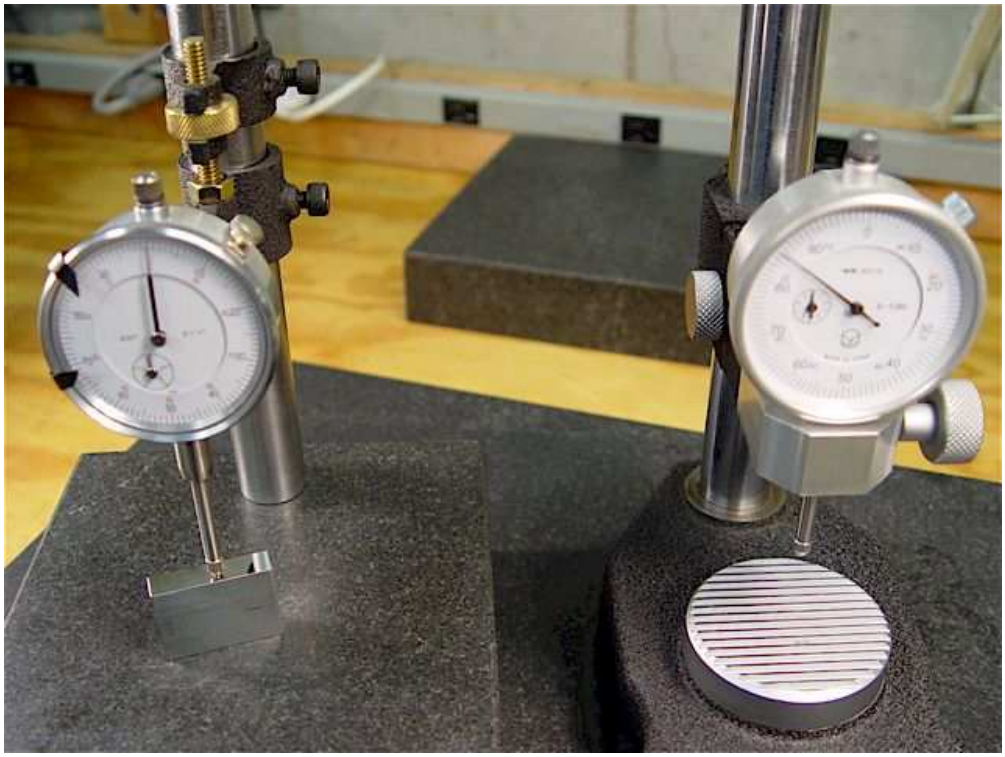


Fig. 2. Differential measurements with comparator dial and block gauges.

For the measurement tasks for which devices of this category are appropriate, the indirect measurement of linear dimensions can be counted where the value of the deviation of the work piece from a compared normal is measured. Therefore in the first measurement step device is adjusted with help of the normal. In the second step the normal is replaced by the work piece and the displayed value is taken. The measurement result is equal to the addition of the normal size and the displayed value with its sign to the normal for comparison can be either an exact manufactured work piece checked using a different metrology process (master piece) or a gauge block can be used, Fig. 2.

ANGLE AND ANGLE DIMENSION

Although the base SI unit for angle dimension is the radian (symbol rad) it is usual to specify angle dimensions on technical drawings in degrees and decimal portions of a degree or in degrees, minutes and seconds where symbols corresponding to units are specified after their numerical value.

A degree is equal to 60 minutes

$1^{o} = 60'$

and each minute is equal to 60 seconds

$1' = 60''$

A radian is equal to the angle subtended at the centre of a circle by an arc equal in length to the radius:

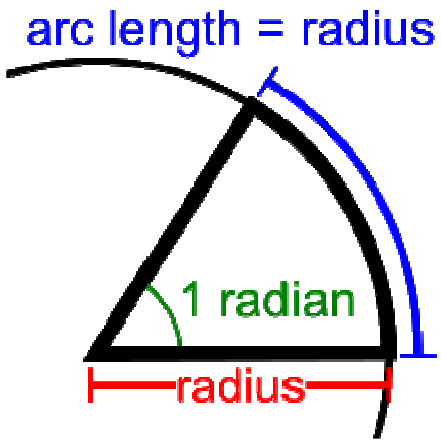
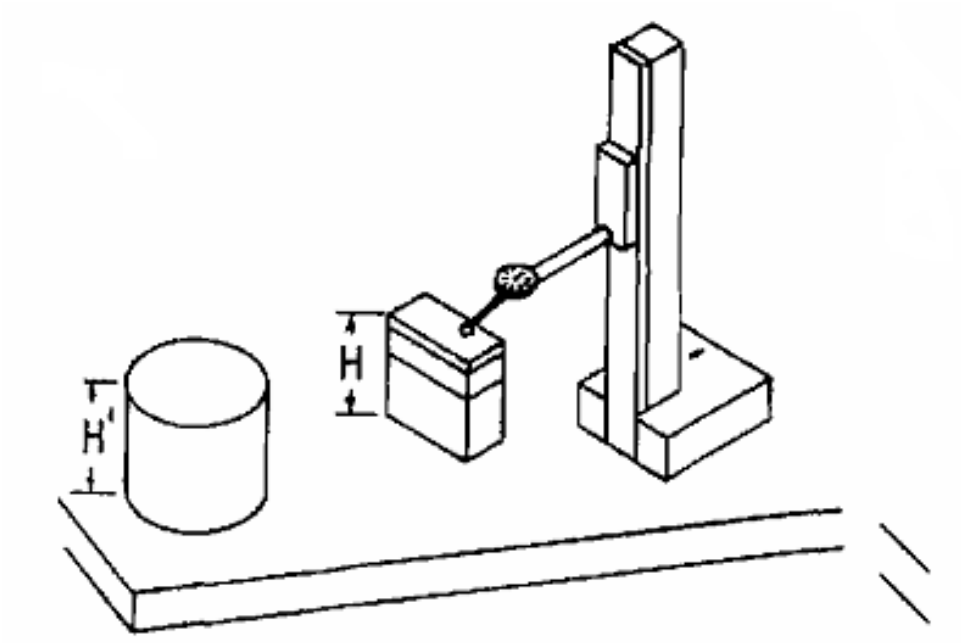


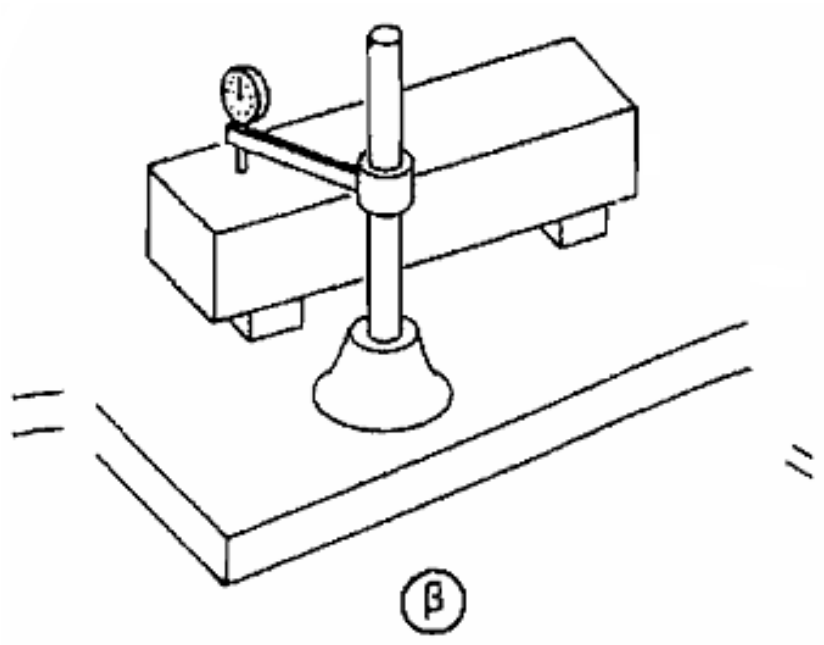
Fig. 3. Definition of Rad

$360° / 2\pi \rightarrow 1 \text{ rad} = 57{,}297°$

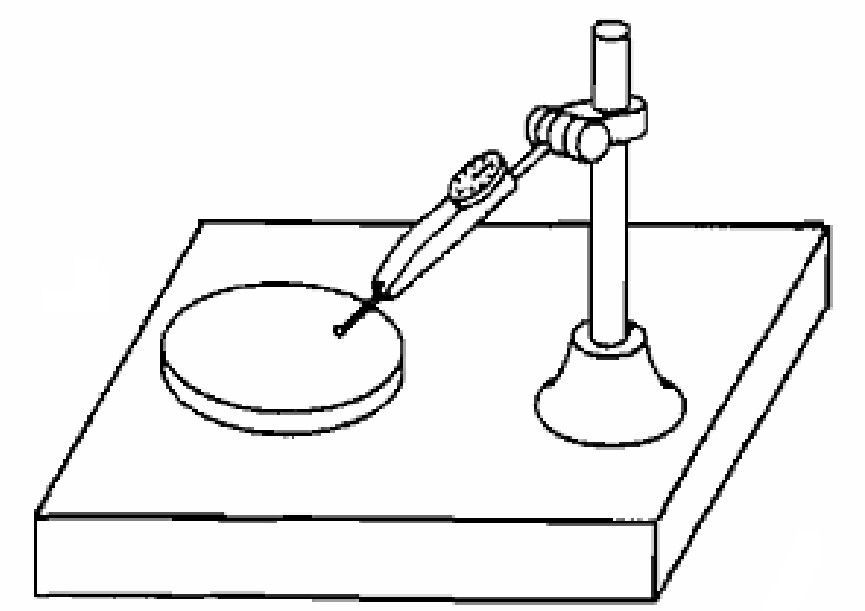
<u>Exercise 1:</u> Differential measurements with block gauges



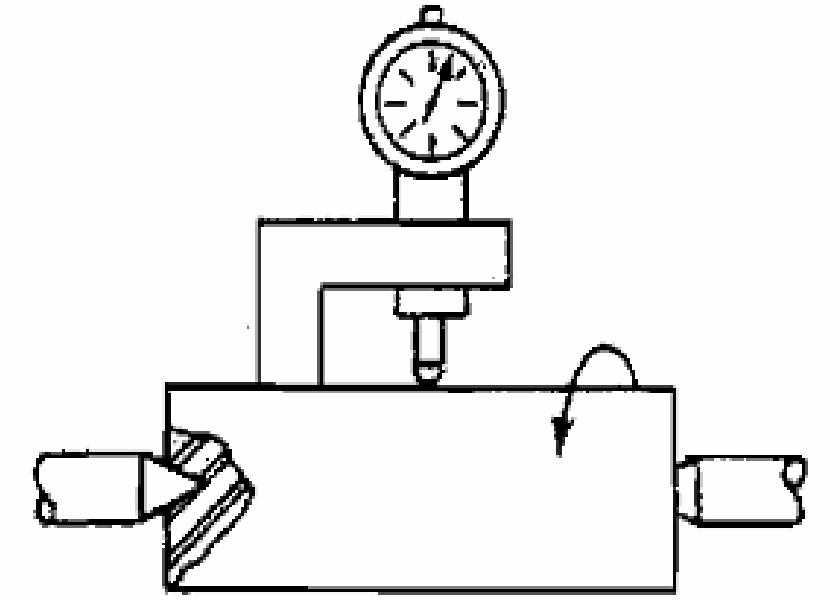
<u>Exercise 2:</u> Parallelism test



Exercise 3: **Flatness test**



Exercise 4: **Circularity test**



Definitions

Flatness is the condition of a surface having all elements in one plane.

Parallelism is the condition of a surface, center plane, equidistant at all points from a datum plane; or axis at equidistant along its length from one or more datum planes or a datum axis.

Perpendicularity is the condition of a surface, center plane, or axis at a right angle to a datum plane or axis.

Circularity is a condition of a surface where:

a. For a feature other than a sphere, all points of the surface intersected by any plane perpendicular to the axis are equidistant from that axis;

b. For a sphere, all points of the surface intersected by any plane passing through a common center are equidistant from that center.

Measurements

Exercise 1: Differential measurements

SET 1 Dimension measured with block gauges H =

Work piece number	Deviation	Work piece dimension
1		
2		
3		

SET 2 Dimension measured with block gauges H =

Work piece number	Deviation	Work piece dimension
1		
2		
3		

SET 3 Dimension measured with block gauges H =

Work piece number	Deviation	Work piece dimension
1		
2		
3		

Exercise 2: Parallelism test

Position	Dial Indicator Reading
1	
2	
3	
4	

Maximum deviation:

Exercise 3: Flatness test

Position	Dial Indicator Reading
1	
2	
3	
4	

Maximum deviation:

Exercise 4: Circularity test

Maximum deviation: **Minimum deviation:**