Metrology
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Module-2
Lecture-4
Micrometers, Bore gauge

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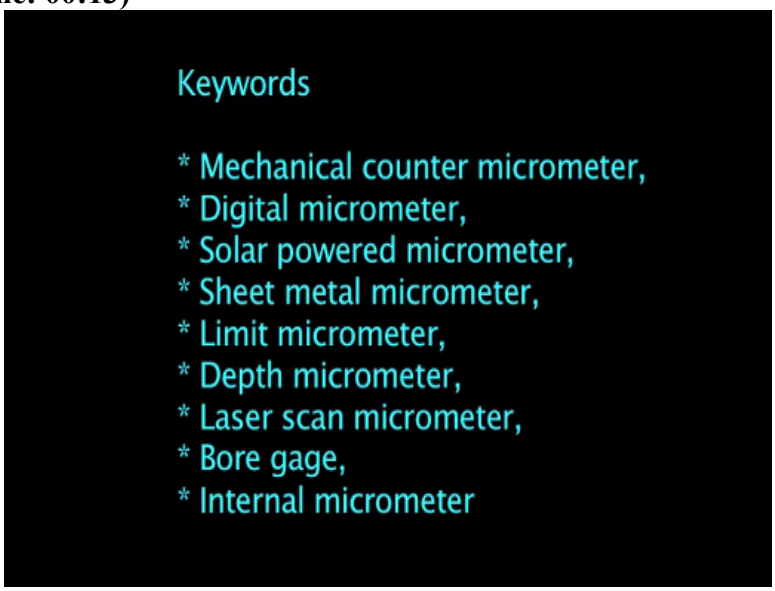

I welcome you all for this session, in the last session we discussed about the different types of micrometre. Now we shall continue with that. We will discuss some more types of micrometres available.

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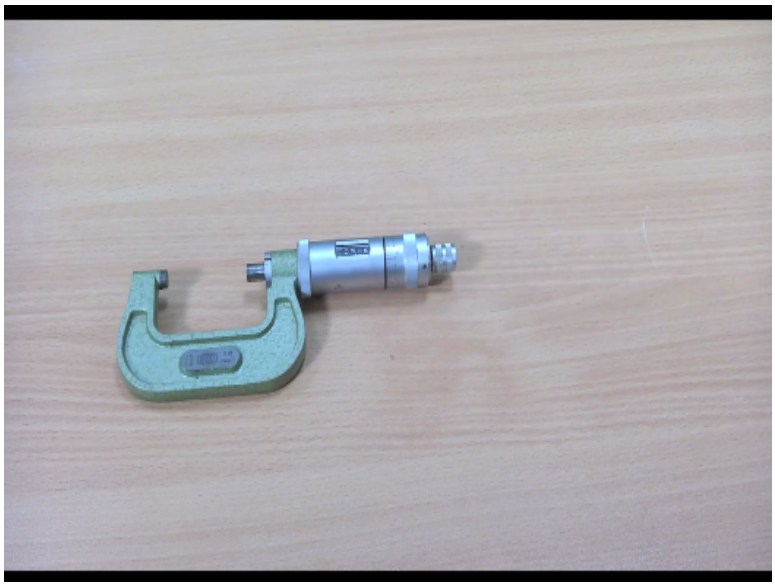

Now this is a micrometre of range 25 to 50 millimeter and now the speciality of this is we have a counter here mechanical counter. So we rotate the thimble, we can the counter will change and then we can directly take the reading from this.

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This figure shows a digital caliper wherein we can see there is a digital display. This is a dual type, we have the graduation sleeve and thimble, we can also read this mechanical system as well as the digital system. Now we can see the various buttons available, this is a button for switching from inches system to metric system and then we have on off button and this is 0 button, at any point of time or at any location of the spindle we can set 0.

And from that reference reading will be given, so like this can be used as comparator, we can set the distance between anvil and spindle using fitting master. For examples say 50 millimetre setting master will be used and a distance of 50 millimetre we can set to 0 and we can check the work piece and then the micrometre will indicate only the deviation from 15 millimetre setting. So this way we can use this as a comparator.

And I can see the using this hold the button you can hold the display and then we have direct data input to computer the pins from here RS332C data transmission is possible by connecting the suitable cable we can transfer the data to computer for statistical process control.

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This shows a close view of the display and see in this case we have to put the battery and whenever the battery goes down we have to recharge and we should use it now recently solar powered micrometre have been developed. So the light is converted into electricity and that is stored in a battery, so that way are solar powered micrometer also available.

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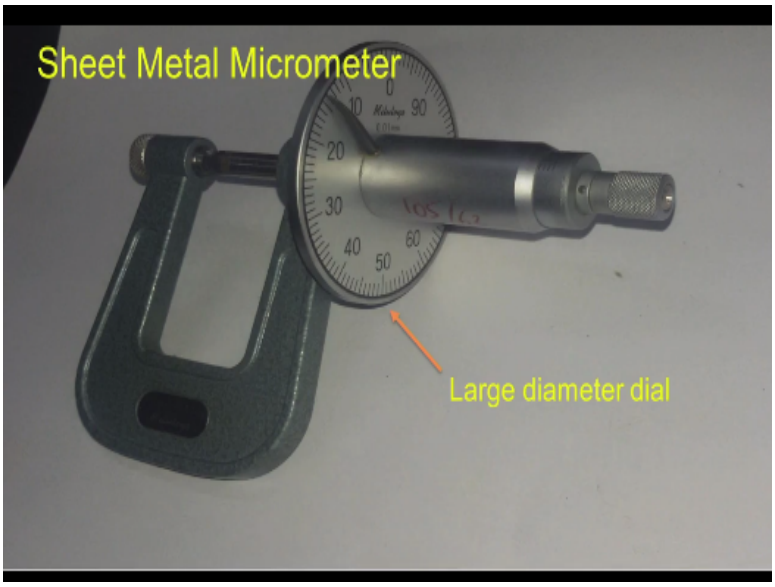

So this is a special type of micrometre sheet metal micrometre we can see the construction we have a u type body. The distance between you can see the in this distance is longer so that we can insert the sheet metal at the plates for measurement for thickness measurement purpose and then we have large diameter dial for easy reading and then again we have a ratchet mechanism.

So there is no vernier only one dial scale we have, so we can take this director reading and the resolution of this is 0.01 millimeter and in different ranges the sheet metal micrometer is available.

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This is range of 0 to 25 or range of 0 to 10 millimeter, so we have miniature thickness measuring micrometre also varying the range will be like 0 to 4 mm and 0 to 5 used for measurement of paper thickness of thin film thickness measurement of jewellery. So things are possible.

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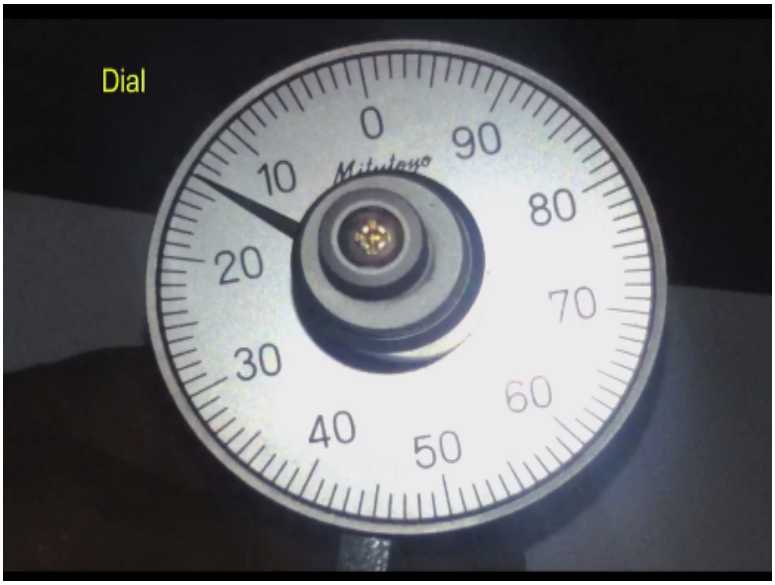

Now this is a close view of the dial, we can see the reading is very easy here, there the dial is very easy of the graduation we can see and all the numbers are printed and that are very

easily readable. Other interesting thing is we can observe the pointer is very close to the dial, so this is for elimination of the parallax error.

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And then we have another kind of micrometre which is the limit micrometre, you can see this has dual spindles , 2 spindles and 2 angles. So these 2 spindles can be used for setting the upper limit and lower limit, this is for tolerance setting up a limit can be set in this and lower limit dimension can be a certain days and then we can insert work piece of it goes and if it does not enter here the work piece is acceptable.

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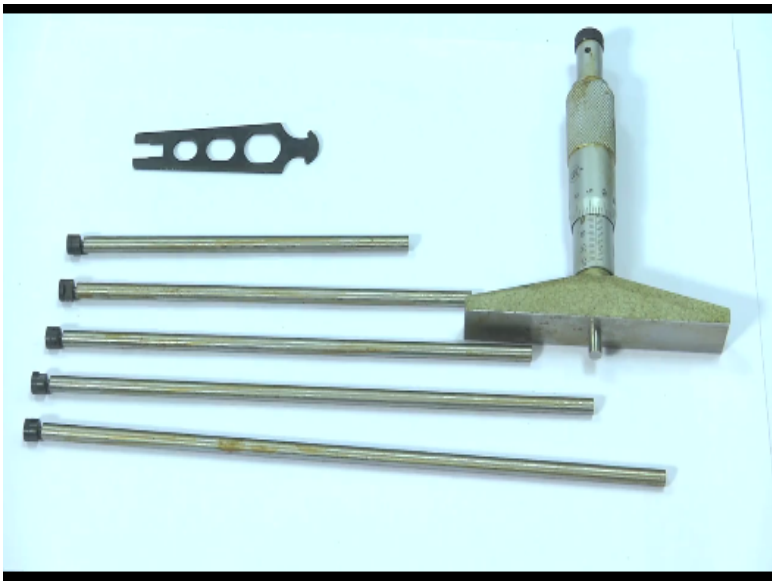

Now let me explain how to use the depth micrometre, first let us see what are the various parts of the depth micrometre, we can see the body of the micrometre, the spindle of the a micrometre and then we have this sleeve and main scale and now you can see the scale is

reversed, so 0 is from here and then 10, 15, 20, 25 like this and then this is a thimble and thimble scale. So the resolution of this instrument is 0.01 mm and range is 0 to 150 millimetre using these extension rods.

Depending upon the depth that is to be measured, we can select the appropriate extension rod and we can put the extension rod inside this and then we can use. If there is any 0 error we can rotate this sleeve by using the spanner and then we can make this error to 0, now how do we check the zero error of this instrument. So what we should do if we have to completely withdraw the spindle by rotating the thimble like this.

And then we have to keep in the after withdrawing this metal completely in we have to keep the instrument on the surface plate and then we have to rotate the thimble in the other direction. So that the spindle just touches the surface plate and then we should read the scale, now we can see that there is some zero error ok. So we have to rotate the sleeve for making zero adjustment.

Now we have to take the spanner we have to rotate this sleeve and then wait to make it zero. Now you can see the 0 on the thimble is coinciding with this reference line, now this is ready for use.

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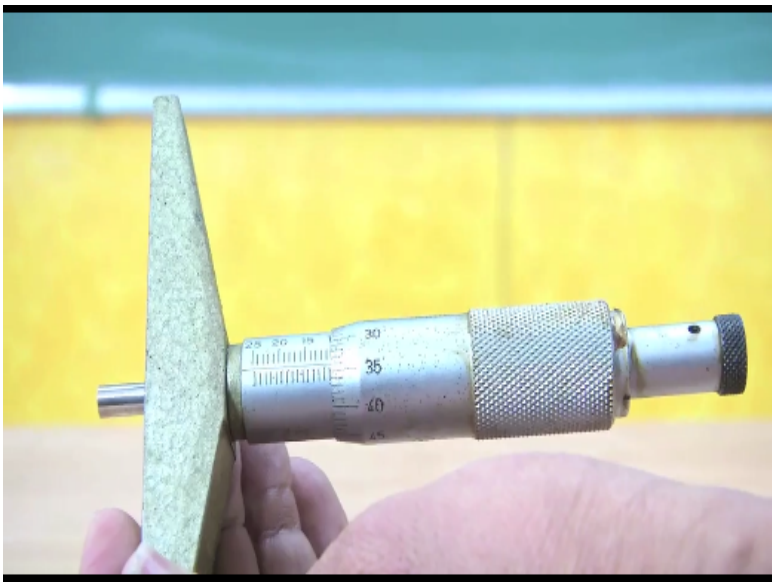

Now how do we use this for measurement of thickness of a work piece. So I have a work piece here I am keeping the work piece here and then I have to keep the instrument like this and then I have to press this body and then I have to rotate the thimble.

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So that the spindle just touches the surface, now it is moving towards work piece and surface and the now we should not work or operate this ratchet, now it is ready for reading, now you can see the thimble has just crossed 10 millimetre and it is near 10.5 ok and then after that we have 0,1,2, 2 revisions. That mean the thickness of a work piece is 10.5 millimeter and then where to add two divisions two divisions means 0.02.

So thickness of the work piece is 10.52 millimetre, so this is all we can use depth micrometre for measuring the thickness. Similarly we can measure the inside diameter and inside that folder. So in that case we have to keep the instrument like this and then we have to advance the spindle like this till the finger just touches the bottom surface datum and then we can lift and again we can take the reading.

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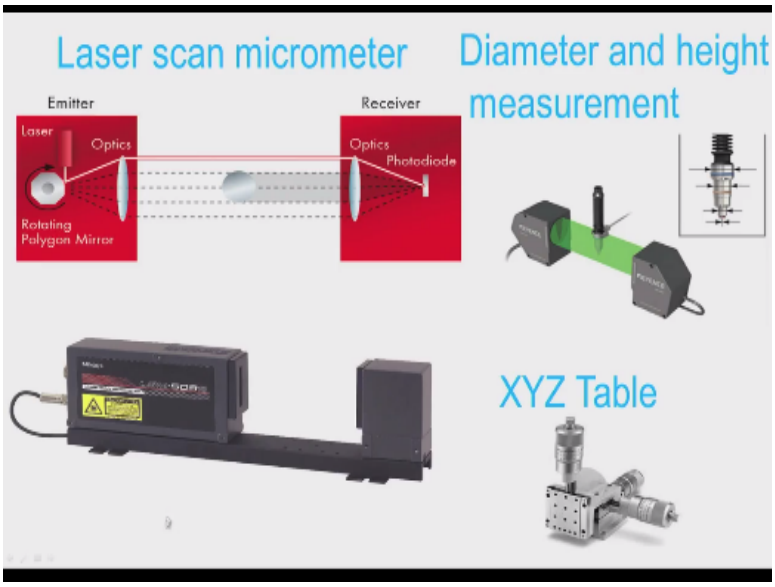

So next we have a special type of micrometre which is known as a laser scan micrometre, we can see the arrangement of the laser scanning one side we have a metre, we have laser source you have a rotating polygon mirror and an optical lenses are there and then we get the laser light it falls on a receiver side again we have lenses and photodiode. So from here we can take out the electrical signal and can be fixed to the distal display.

Now we have to keep the work pieces here for measurement purpose, now this shows a laser scan micrometre and there is the place where we have to keep the work pieces and there are some work pieces, work piece setting stages are available for depending upon the requirement and depending upon weather we are measuring the wires or sheets or plates or round bars, cylinder sector we have to choose appropriate stage.

And we have to fix the stage here and then the laser will fall on the work piece and then they receive a receive it and it is sent to the display unit. I can see one example here this is a diameter and measurement height measurement. So I can see the component here, so at a time I can measure all these sizes in diameters and other interesting thing is I can also measured a height, so at a time we can get diameter and height measurement.

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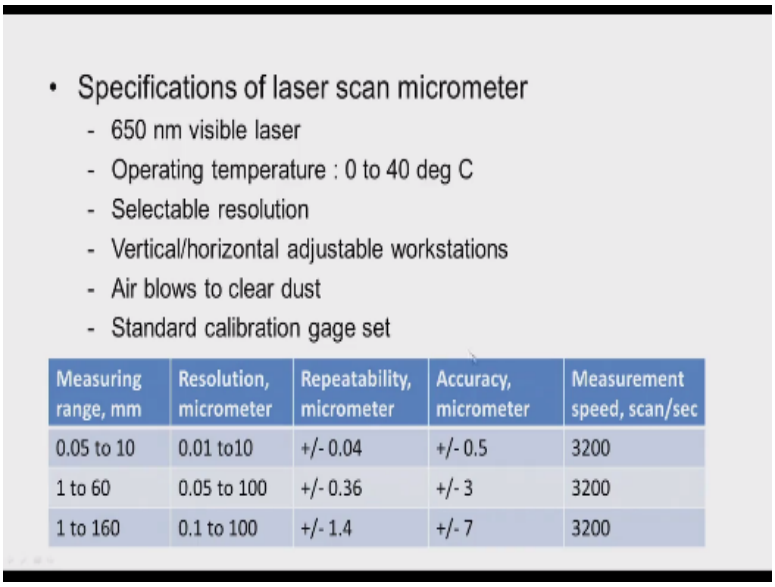

And this shows in XYZ table wherein they have micrometre heads we can create stages like X5 Teja or XYZ tables. We have some specifications of a laser scanner micrometre, 650 nanometer visible laser is used for the measurement purpose and operating temperature is 0 to 40 degree Celsius. Now we can see here the measuring rangers in different ranges micrometres available like 1, 0.05 to 10 mm and then 1 to 60 mm range, 1 to 160 millimeter range.

And resolution of we can see or it is 0.01 to 10 micrometre for this particular range and second range is 0.05 to 100 and for third range it is 0.1 to 100. So 0.01 to 10 micrometre resolution selectable depending upon the accuracy that is needed we can always required resolution. So very kind appreciation measurements required we can go for verifying resolution for medium profession.

But we can select the appropriate measurements. Now I told you about the state table adjustable workstation that means between the emitter and receiver we have to play some stages workstations and there are adjustable workstations, vertical/horizontal workstations and horizontal workstations are available we can select appropriate workstation and we can use them.

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- Specifications of laser scan micrometer
  - 650 nm visible laser
  - Operating temperature : 0 to 40 deg C
  - Selectable resolution
  - Vertical/horizontal adjustable workstations
  - Air blows to clear dust
  - Standard calibration gage set

Measuring range, mm	Resolution, micrometer	Repeatability, micrometer	Accuracy, micrometer	Measurement speed, scan/sec
0.05 to 10	0.01 to10	+/- 0.04	+/- 0.5	3200
1 to 60	0.05 to 100	+/- 0.36	+/- 3	3200
1 to 160	0.1 to 100	+/- 1.4	+/- 7	3200

For example if we have the laser scan micrometre like this and this is the place where we keep the adjustable workstation. So here this can be moved horizontally and there is arrangement to move this vertically and then say we have we can keep the work piece here and laser will fall here and then it receives and then and give the dimensions. So like this depends upon the work piece we have to select appropriate workstations and then the air blowing is possible to clear the dust.

For example the the window where we get the laser and where we receive laser we have windows, so that should not be any dust particle laying on window of lenses, so for cleaning purpose air goes possible before using the micrometre way to clean all surface and then we can use it and then for calibration purpose standard calibration gage set is available along with micrometer.

Before using it that gage that we can calibrate and then we can use the micro metre and I told you about the different ranges available and they selectable resolution are possible, see re solution here is 0.01 such find resolutions are possible and these micrometres they are capable of providing the ability of 0.04 micrometre and for this particular range +/-1.4 repeatability should and they also very good reputability is assure.

And at measuring measurement is possible for this 0.05 to 10 mm range I can see accuracy is +/- 0.5 micrometre that means see we get result we measure maybe the diameter of the spindle and may get some data. So that date the true value of a component will be within this

variation, for example if we get 8 millimetre as a diameter and then the true value of the work piece will be 8 millimetre +/-0.005 millimetre such a great accuracy we can get.

And then these instruments they have a very high measurement speed like 3200 scan per second, that means we can measure and work pieces are moving continuously, so I can measure the components of a mass production we can use instruments like this.

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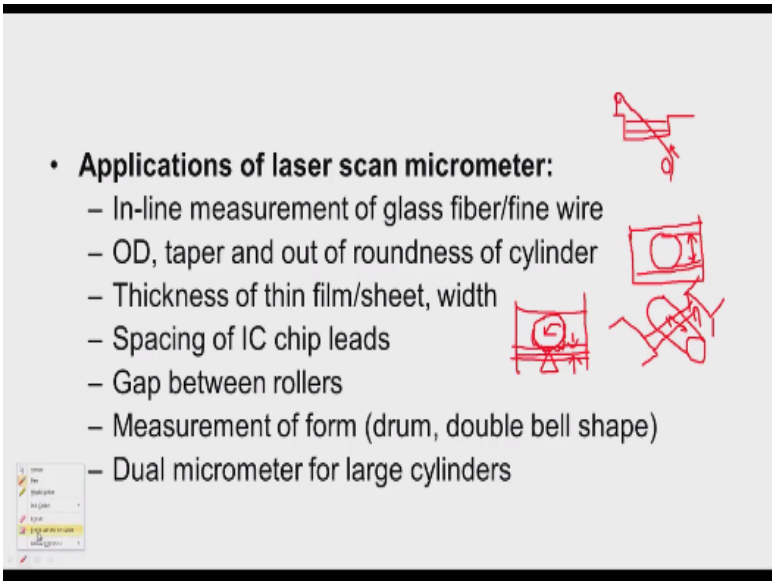

Now there are very interesting applications of these laser scan micrometre, now in line measurement of glass fibre or fined by responsible. For example say this is the laser scan micrometre, so and then we have the glass fibre or some other kind of fine wire. So the wire is moving in this direction and at the other end we have a receiver that means roller. So we continuously moving this glass fiber or fine wire we will continuously moving and the laser will be scanning.

What is the diameter of the and then that means continuous monitoring of the diameter of wire is possible that we can make some adjustments get the wire and giving the tolerance and then we have OD measurement, taper measurement and out of roundness measurement of cylinder is possible. For example say we have round work piece like this and we have kept it between the laser metre and receiving appropriate work stage.

So the laser will be falling like this ok laser is falling like this and here this work piece abstract laser. So we get like, so now this distance gives the diameter of the work piece, that this is OD measurement and then taper also we can measure for example we have a work

piece like this. So and we have the micrometre here and we have the window here to receive this is receiving side and here it is a laser is emitted, now either we can move the micrometre or we can move the work piece.

So it takes the diameter here and then when you move the work piece it takes the diameter of the other point, so like this multiple scanning for possible and then we can this will give by processing the data we can say whether it is a perfect cylinder or any taper that can be checked and then out of roundness is also can be checked for example we can keep the work piece and we can keep a reference here or reference gauge and then we have to rotate the work piece and laser will be falling like this ok laser will be falling like this ok.

Now if there is any variation in the work piece, so this gap will vary and that gives the out of roundness of the work piece. Similarly this can be used for measurement of thickness of sheets like this we have reference gauge and then we have a roller on which the sheet is moving, paper or something film is moving like this and then this laser is falling like this ok.

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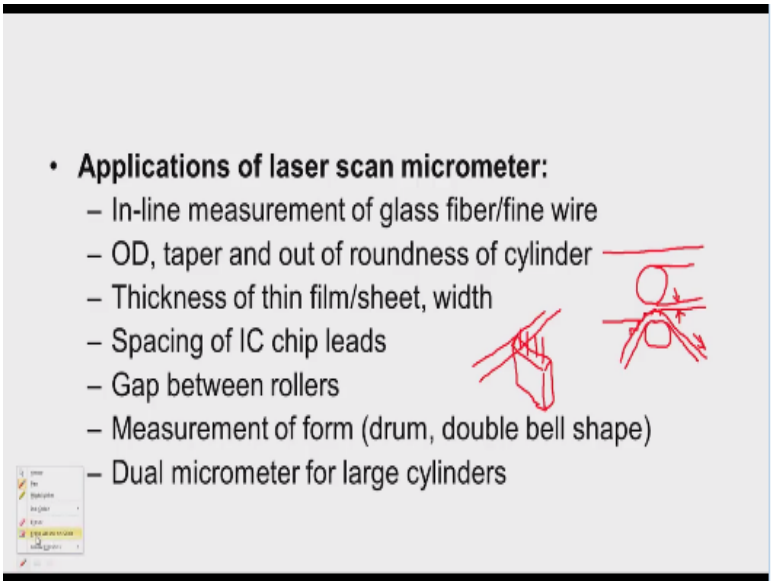

Now if there is any variation if there is any if there is any variation in the sheet thickness, so this will be and that gives the deviation from the required thickness of the sheet. So like this the thickness variation of the things can be measured and spacing of IC chip heads. For example we have an IC chip like this, and we have the lead like this, so this we can keep between micrometre.

And the laser will be falling like this, so it will measure the distance between 2 chip leads, so if there is any variation we get the measurement result and gap between rollers also we can also check. For example between roll mills we need to set the distance between rollers very precisely, so we have 2 rollers like this and we want very thin sheets wherein we have very tight tolerance.

So in that case for setting the a distance between rollers we can use this laser micrometre. So this will this distance will give the distance between rollers, so the precisely we can set the distance between 2 and we can whenever we have the distance to be checked we can use this lase scan micrometer and then measurement of form is also possible whether there is any variation the cylindricity is there whether it is dumb shape or double bell shaped like this, parallel shape.

So if the work piece is like this so by scanning multiple scanning will come to know what is the shape of the work piece and sometimes the work piece is very large cylinder is there and we want to measure the diameter of that. In that cases dual micrometer arrangement is possible, for example this is a diameter of the work piece is a large work piece and then we can have 2 micrometers like this and on the other side receiver.

So now laser will be falling like this ok may get one reading here and then find the reading here, so this will give the diameter to the work piece. So like this we can use X and Y direction XX direction, YY direction, depending upon the application we can use multiple laser micrometres and data can be required data can be taken.

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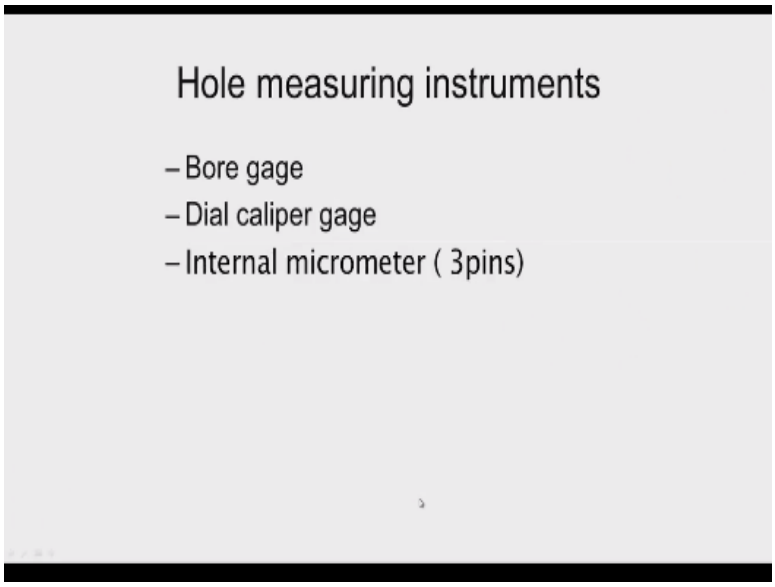

Now let us move to the whole measuring instruments are different kinds of instruments available bore gages 2 point contact bore gages 3 point contact bore gages, 4 point bore gauges and similarly dial caliper gauge is available for quick measurement of the inside dimension of a hole and then inside an internal micrometre for also available where in two point contact micrometres and 3 point contact micrometres available.,

So we will study some of these things. Now the let us move to the whole measuring instruments in the manufacturing plants we come across with many times measurement of hole inside dimensions of different sizes mat be very small hole like 1 millimetre diameter, 2 millimeter diameter or we can have very large hole like 100 millimeters, 200 millimeters, 300 millimeters and then different kinds of instruments available.

Now let us study some of the instruments bore gage, bore gages are available with different ranges and then we have dial caliper gauges for quick measurement of inside dimensions and then we have internal micrometre different types of internal micrometre. Now let her study these things one by one.

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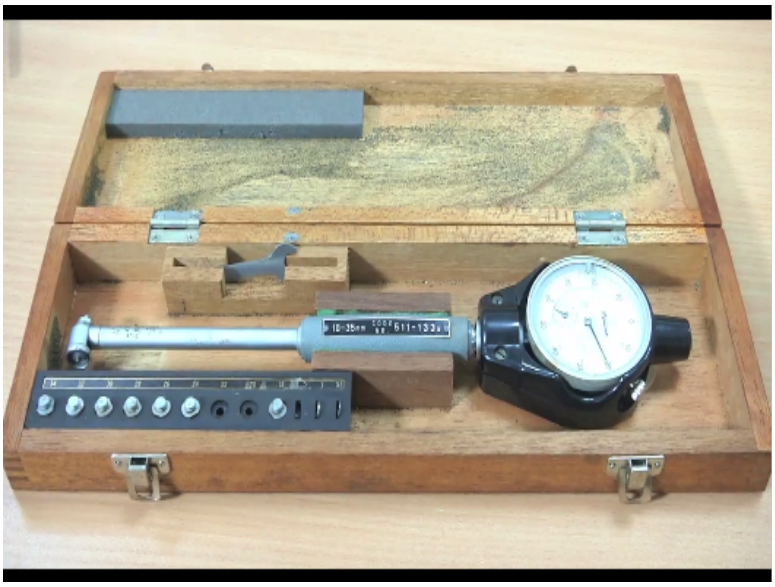

Let me explain the bore gage this is the bore gage, this is the part where we have to hold the bore gage, we can see an insulating material is provided here, so that they operate body heat will not flow into the instrument. Now this is the range of the instrument 18 to 35 mm and this is the dial ok and then we have the measuring portion here. So we have around guide here which will make contact with the bore of the work piece.

And this is a measuring the stylers which will move in and out this is carbide tipped to prevent to reduce the wear and then this is the fixed portion which will may contact with the wall of the hole and again this is the carbide tip is there, so these are interchangeable anvils depending up on the size of the hole we can remove these anvils and we can replace them, you can see a different anvils are available with different sizes 24 millimetre, 26 millimetre like this.

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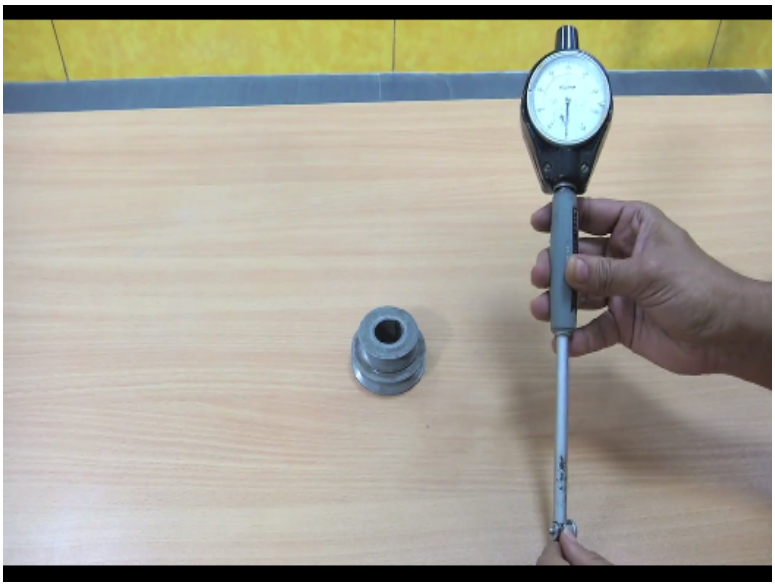

Also some washers are available, so if required we can use this washers to increase the length. Now I will explain how to use bore gauge for measuring the size of the whole I have taken an anvil of 22 millimetre and then I will just make sure what is the distance between the angle and spindle. So the distance between the stylus at this point he is As given by micro metre feet is 22.79 millimeter.

Now the dial is reading 0 and just inserted a measuring portion in the hole like this and we have to see the pointer is moving in the clockwise direction, now we have the 0 reference here and then in the clockwise direction it is moving we have to rock or better well the bore gauge like this so that it check the correct diameter for that we have to take what is the maximum reading that is given by the bore gage.

Now it is reading 74 divisions that means 0.74, so now slowly I am removing, now that 0.74 I have to deduct from the initial setting of 22.79, so that we will get 22.05 millimetre. That means the diameter of this whole is 22.05 millimetre.

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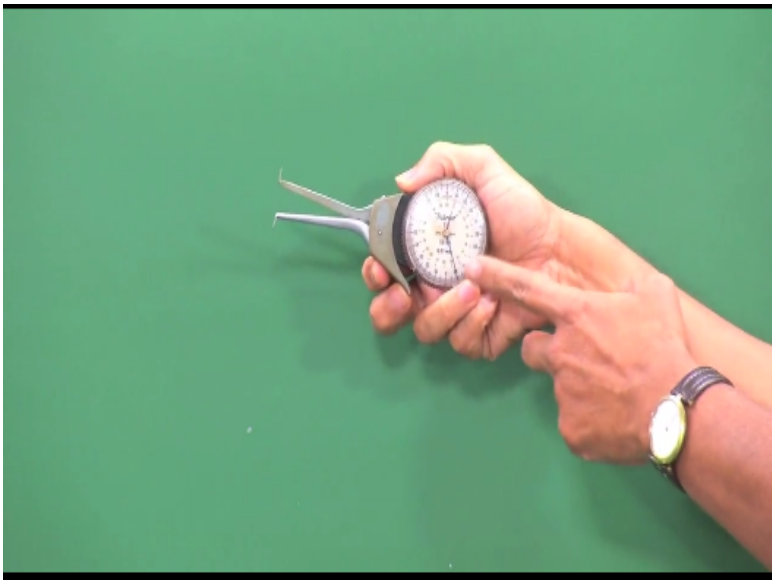

Now we have another kind of instrument known as dial caliper gage, you can see here I have a dial caliper and we have 2 legs of the dial caliper and we have lever here for moving the legs for 0 error checking we can use resetting master and we can check the 0 error and then we can use the instrument. The range of this particular instrument is the 10 to 30 mm and resolution of this instrument is 0.01 millimetre.

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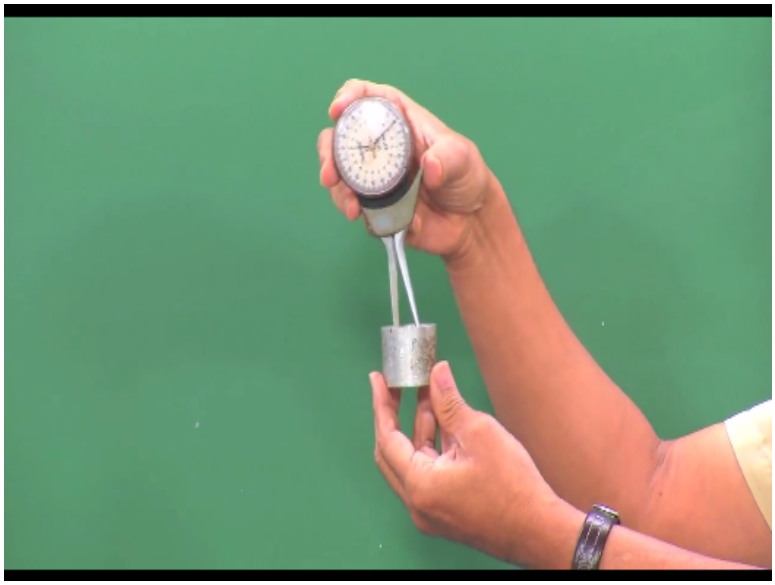

Now let me explain how we can use this dial caliper for measurement of internal diameter of a component here and I have to measure the internal diameter of this piece now I have to keep the work piece on the surface plate and then I have to operate the lever so that it to let come closer like this and then I have to insert the 2 legs into the bore of the work piece to the whole and then we have to swivel like this.

And then we should take the minimum reading, minimum reading will give the diameter of a work piece and when the caliper is like this we should not read because this will least to cosine error as shown on the blackboard.

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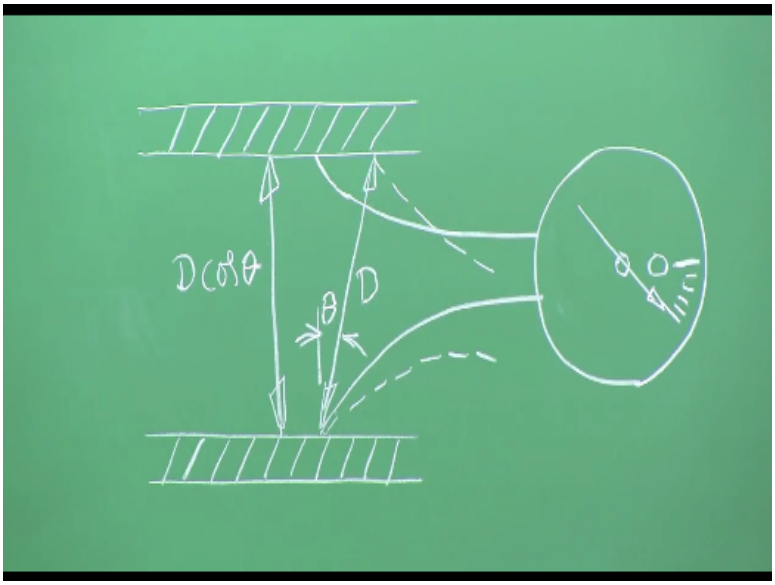

Now let us move to the internal micrometres.

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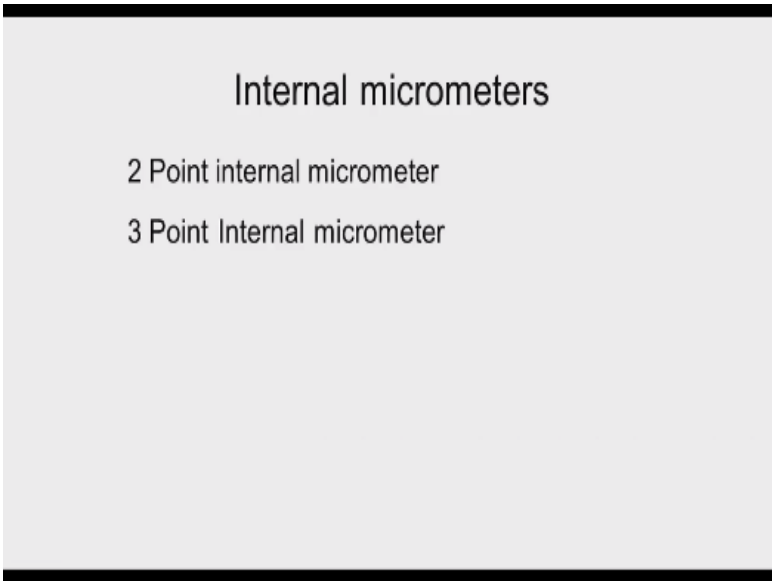

Now there are different kinds of internal micrometre like 2 point internal micrometre and 3 point internal micrometre. The problem with two 2 point internal micrometre is see we have a hole of the shape, if we use the 2 point internal micrometre what happened is they contact this is a micrometre, contact will be at only 2 points, and to get the mean value of the bore of the hole we have to take case 3-4 readings and then we have to get the mean.

And that will be the diameter of the whole, if it is only one reading you may get some wrong, for example say that is it like this and if it take only one reading it may give larger diameter, if it take the diameter at this place it is even smaller diameter so such, will be there in there 2 point internal micrometre, to avoid that 3 point internal micrometre have been developed will be contact at 3 points so automatic cousin will be there and we get there directly the mean diameter.

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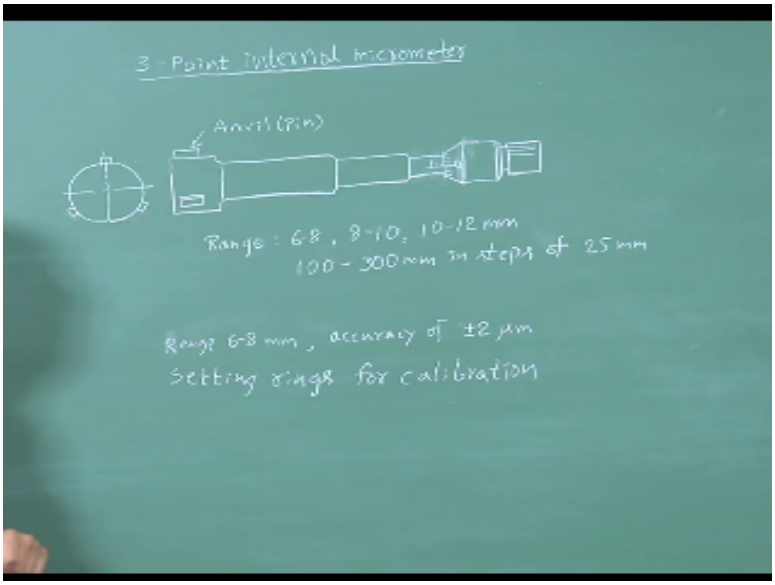

Now we can see the 3 point internal micrometre diagram is written here, so this is the front view and we can see these are the points are sometimes there are 3 anvils separated that angle of 120 degrees and we have a micrometre will be here and this is this sleeve with the main scale and thimble and we have the thimble scale. So when we operate this thimble these anvils they move in and out depending upon the direction in which we rotate the thimble.

So initially what we should do is we have to set this micrometer we have to see whether the setting is correct or not whether micrometre is giving the proper result and admit that are there is any 0 error, so setting the rings are available along with a micrometre using settings we have to check for zero error. If there is any 0 error we have to adjust it and then you can use a micrometre.

Now different ranges are available like 6-8 millimeter range, 8-10 millimeter range and 10 to 12 millimeter range, that also available from 100 to 300 ml of 25 millimeter. Now we have to insert this micrometre inside a hole and then we have to operate the thimble, so then pins will

move out and they will come in contact with the inner wall the bore and then you can directly take the reading.

So like this we can use 3 point internal micrometre and such instruments that capable of a very good accuracy of +/-2 micrometre the lower ranges.

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Now let us see the internal micrometres, now you can see the 3 internal micrometres are available here, the range is 6 to 8 millimeter, then 8 to 10 millimeter and then 10 to 12 millimeter. Now we can see the pins here anvils, so there will be 3 anvils, now 3 anvils are there at 120 degree apart and then this is the scale on the thimble, so 0 to 50 divisions are there and then this is a vernier 10 graduation of the vernier scale.

So the resolution of this instrument is 0.001 millimeter and main scale we can see here on the sleeve this is the main scale the range of this instrument is 6 to 8 millimeter, similarly we have another internal micrometre with this range and then the main scale on this sleeve and then vernier scale and then thimble scale similarly. We have one more internal micrometre 3 point internal micrometre, three anvils are there and then the range of this is 10 to 12 millimeter.

And then we have the main scale here on this sleeve and in vernier scale and scale on the symbol for again the day resolution of this instrument 1 division is equal to 0.001 millimeter. Sometimes a whole is very deep then we can use this extension rod, we can fix this extension

rod here and then deeper holes can be checked for fixing this extension rod we can see here both the ends we have a threaded end as well as we have threads here.

And then initially before using we should clean the anvils, so that the dust and all the layers are removed and then we have to check for 0 error, for that masters are given. So this is a 10 millimeter master and this is 7.996 millimeter and 8 millimeter master is given. Using these masters we have to check for 0 error and then we can use the instrument for full measurement.

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Now let me explain how to measure the diameter of this hole, I am taking this internal micrometre of 8 to 10 millimeter range and then I am rotating the thimble, so that the anvils are withdrawn. Now anvils are moving in, all the anvils now there they are moving in and now I have to insert the instrument inside and then where to rotate the thimble. Now anvils are coming out, they make contact with the internal wall of the hole.

And then we should put the ratchet, operate the ratchet, now this is ready for reading, now you can see the tenth graduation is just visible, that mean thimble has crossed 9.5 millimetre and now we have to take reading the 0 difference is here and the graduation on thimble 40, 41, 42, 43, 44, so 44th graduation of the thimble is coinciding here, that means the reading is 0.4 millimetre and then we have to look for which one is coinciding lesion.

So in this case the 44th reading itself is coinciding here 0,0 graduation is coinciding here , so if we add the0.44 with 9.5 the reading will be 9.94. So they diameter of this hole is 9.94

millimetre, like this we have to take the readings . Let us conclude this session. IN the session we discussed about different types of micrometres like digital micrometre and then sheet metal thickness micrometre and then depth micrometre.

And also the laser scan micrometres and what are the various applications of laser scan micrometre, what are the specifications of laser scan micrometres those things we studied also, we discussed about the different hole measurement devices like a bore gauges and dial caliper gauges and an internal micrometre. In the next session will continue with linear measuring instruments, thank you.