Mechanical Measurement Systems
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Lecture – 04
Methods of Correction for Interfering and Modifying Inputs

Hello, I welcome you all in this course on mechanical measurement systems. Today, we will discuss methods of correction for interfering and modifying inputs and we will take some examples also.

So, today we will discuss about the correction of interfering and modifying input, because in act of measurement the measurement has to be ideally the measurement has to be very accurate. And these interfering and modifying inputs they deviate the act of measurement from the accuracy. So, they erodes the accuracy of the measuring system. So, interfering system, interfering and modifying signals are not desired at all right. So, the issue is how to correct how to get rid of interfering and modifying signals?

So, first is in here not insensitivity.

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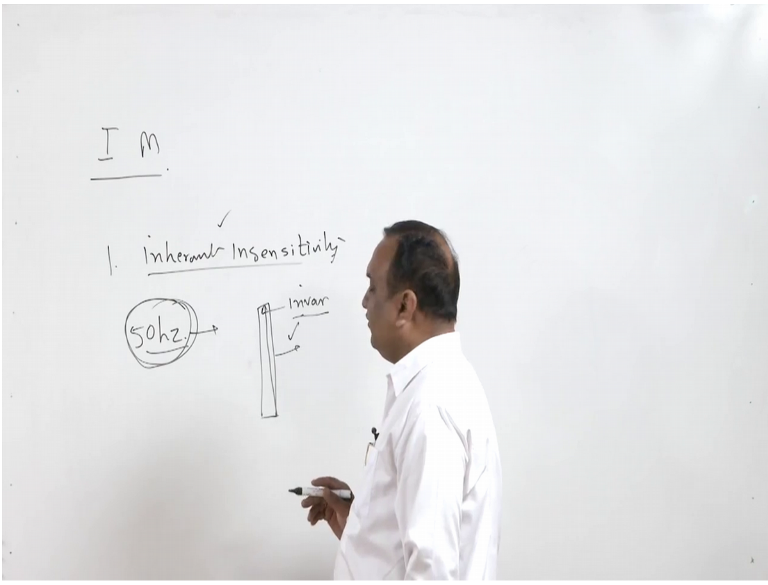

We can make the instrument inherently insensitive to these type of signals. Let us say for example, if there is a magnetic field, normally in the act of measurement, we get interference from the frequency of 50 hertz and multiple harmonics of 50 hertz because

50 hertz is of electrical supply. So, any cable passing nearby the measuring instrument, this will give this spurious input or this will get the instrument will get spurious input of 50 hertz and multiple of them in many of the cases not all cases.

So now, first method can be the instrument can be made inherently insensitive to the spurious input. That is interfering or modifying input.

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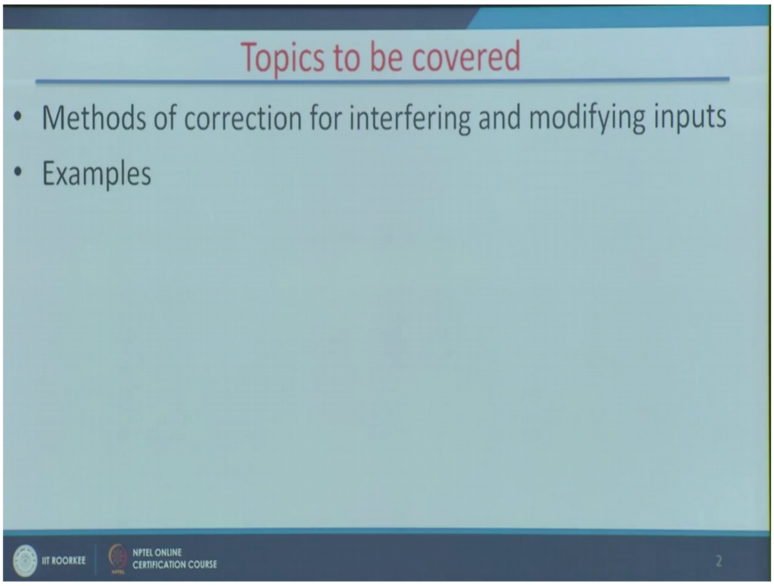

For example temperature, temperature modifies the input output relationship. So, what we can do the scale which are we are using we can use invar have has very low coefficient of expansion with temperature. So, the scale can be made insensitive to the variation in temperature, right. We can use ceramics also ceramics are also very low has they are also having very low coefficient of expansion, with respect to temperature. So, the first method is to make instrument inherently insensitive to the modifying or interfering input. Sometimes it is possible, sometimes it is not possible. Another method can be method of high gain feedback.

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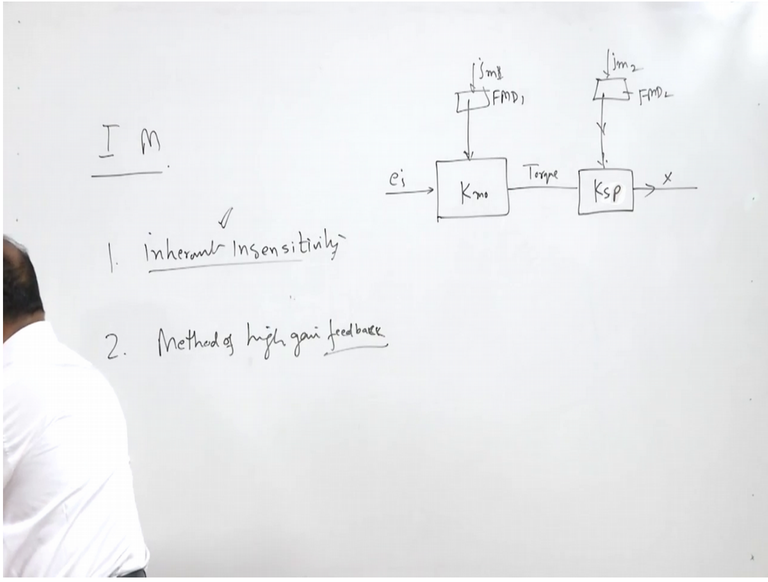

Using this method also we can get rid of interfering and modifying input suppose, we have to measure certain voltage. So, were voltage can be measured with the help of a motor voltmeter, but there are other method also for voltage measurements. For example, there is certain voltage which is applied to a motor. I will make it block diagram. So, there is motor. So, let us say their relationship is linear KMO right or f m o because linear relationship I am writing KMO and there is input to the motor the moment.

The this voltage is applied to the motor the motor will start rotating and it will start it will it will create torque not only start rotating it will create torque right. So, the input is given to the motor it will create torque and torque will tend to rotate the shaft, shaft is connected to a spring right. So, spring is there so, KSP spring will come into the picture and the spring will show the displacement. That is how the input signal will be converted the input signal will be converted into the torque and torque ultimately will be converted to the displacement and you can measure the displacement of the spring right. So, the motor can also be used for measurement of voltage. So, this is open loop.

Now, is in this open loop it will have so, this is desired input, but it will have interfering input also. And this will also have interfering input. So, I will write F M interfering I M interfering M I M to IM1 M F right. So, this interference from the spurious source this will change the output and input relationship, right. It can be modified interfering input it can be a modifying input, but it will change input output relationship.

Now, this problem can be solved either, we make them inherently insensitive to the spurious input. That is some time not possible right. So, other other method is to have high gain feedback what we can do? We can apply some amplifier before this, we can have one amplifier.

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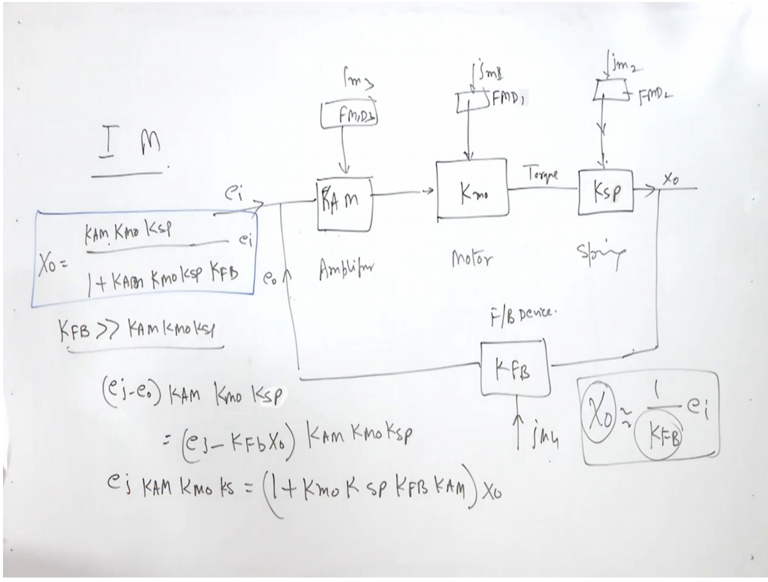

So amplifier right. So, amplifier will also have F or K and this is EI or this amplifier will also have some spurious input. So, this is also IM3 right. Amplifier this input signal will go to the amplifier then it will go to the motor then it will go to the spring. And part of this signal will be taken back and this is a feedback this is amplifier. This is motor and this is a spring.

Now, part of the signal will be taken and this is feedback device. Now, feedback device K feedback and it will give this to EO. Now, this feedback device will also have some spurious input IM4 having spurious input will come everywhere. I mean this modifying and interfering input will come everywhere all the devices. So, we have made some feedback system.

Now, EI minus EO is equal to and K AM K MO K SP they will be multiplied, right is equal to EI minus K FB KF feedback KFB KFB XO multiplied by K AM K MO K SP. Now, what we have done here? EI minus EO that is the actual input which is going because this input XOX, we are getting XO. This XO is again used to convert x into EO then that input is EI minus EO which is going in then it is multiplied by k m KMO k s right and then. So, here the input is going which is EI minus EO KM KMO KS and this EO is replaced by KFB. XO this is FAM or KM whatever you want to take you can take.

Now, further simplifying this equation we came right EI not here EI K AM K MO KS is equal to 1 plus K MO K SP K FB KAM into XO this is we can take XO right.

Now, if we further simplify this we will be getting XO is equal to K AM K MO K SP divided by 1 plus KAM KMO KSP or K FB into EI. If you rearrange this equation you will be getting this equation.

Now, here KFB this KFB feedback is much larger than K AM K MO K SP. So, we can always write that XO is equal to 1 by K FB EI. Now, what we have done here we have just simply provide feedback device and just providing feedback device. And this is high gain feedback by using this high gain feedback; we have reduced the significance of this interfering and modifying input. And our output or the output of the measuring instrument is dependent only on KFB, right. And this is how we can avoid the interference by spurious input to the instruments. So, this is another method of high gain feedback which can be used for, avoiding the interfering and modifying input.

Now, 3rd one is output connection.

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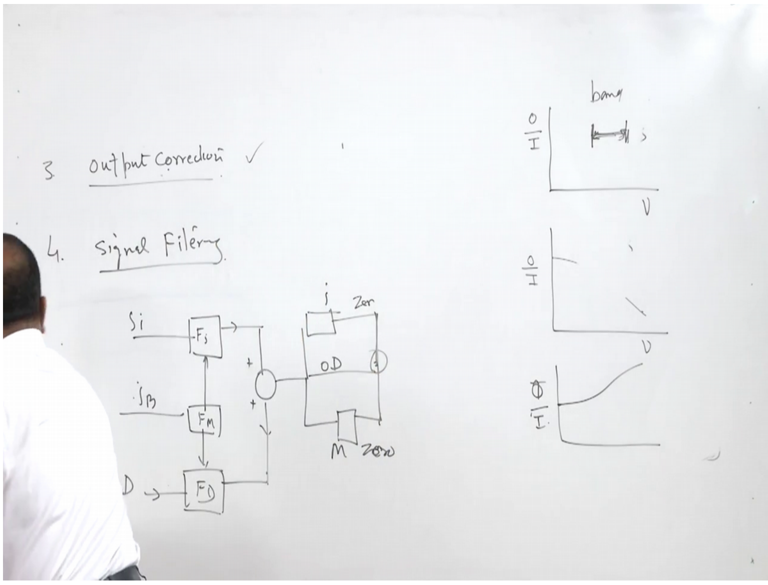

Another way of correcting the output is just calculate how much interference or how much modification of the signal has been done. Some calculation has calculations have to be done and by using those calculations we can correct the output, right and while sometimes when the programming of the instrument is done. So, these type of corrections are added into the programming, for example, if you are doing using virtual instrumentation, virtual instrumentation while programming in virtual instrumentation we can do that right. So, output connection is another method of avoiding interfering in or correcting the interfering and modifying input.

4th one is signal filtering we can provide filters, signal filters signal filters can be a physical entity or it can be a software also. Now, the different type of signal filters one is no pass this is output and this is frequency no pass signal. This filter will not allow any frequency to pass then another is no pass. So, you fix some frequency level and it will only allow the lower frequencies to be passed through the signal to the filter suppose there is an interference of 50 hertz cable. So, just provide a low pass filter of 10 hertz. So, the filter will allow only frequencies 10 hertz or less than 10 hertz to be passed.

So, this 50 hertz the interference from 50 hertz frequency because this is frequently observed that the passing by cables they interfere in the act of measurement. So, just we provide low pass filter of 10 hertz or 40 hertz frequency then 50 hertz will be filtered out and high pass once we have a low pass then we can have high pass also. So, there is a certain limit beyond that limit the filter will provide frequencies to pass you just set 100 hertz. So, any frequency above 100 hertz will be allowed to allowed and below that it will not be allowed. So, this is known as high pass filters then we have band filters the band filters are those filters which allow band filters which allow only certain range of frequency to pass suppose there is a interfering and modifying input at 50 hertz and 100 hertz right.

So, so, and so, you can say that you will allow frequency between 75 to 100 hertz. So, that you can avoid the interference from 50 hertz and 100 hertz, they are known as band filters which allow a certain band to pass through the filter and jet also is also there, the filter which will not allow certain band of frequency to pass through. So, there are different type of filters which can be put into the circuit in order to avoid interfering and modifying input. So, if we draw the block diagram for filters. So, this is interfering this is modifying input a modifying input gives input to both interfering and desired. So, modifying input and this is desired input desired input right. And interference and desired they will be summed here. This is the normal this is F interference F modifying and f desire this is the normal arrangement or configuration of a measuring instrument.

Now, after this output of desired will go to the filter they will go to the filter and after filtering they will combine again. So, these filters they will remove. So, this is desired input output desired or this is interfering and this is modifying this is 0. So, modifying is 0 and interfering is also 0 and they will sorry.

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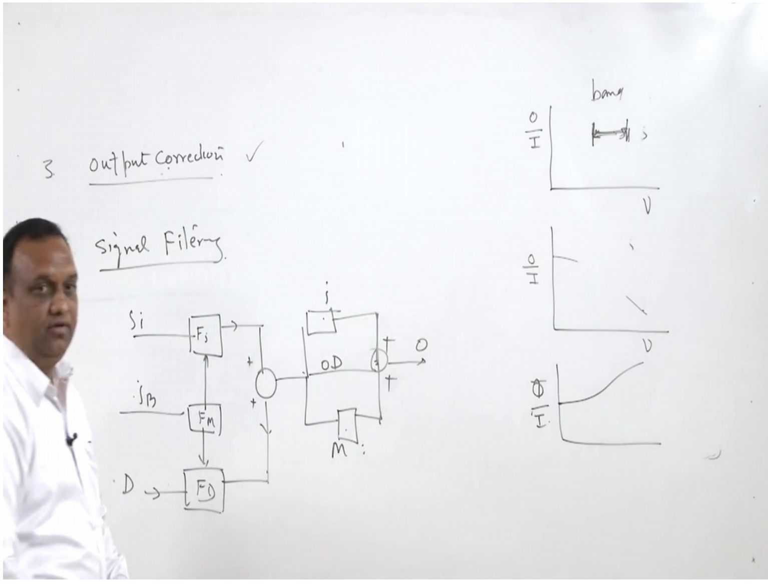

This is a plus and after putting the filters you will get the output with is which does not carry any impression of interfering and modifying input.

So, that is how we can use the signal filters for removing the interfering and modifying effect of spurious signals this is number 5.

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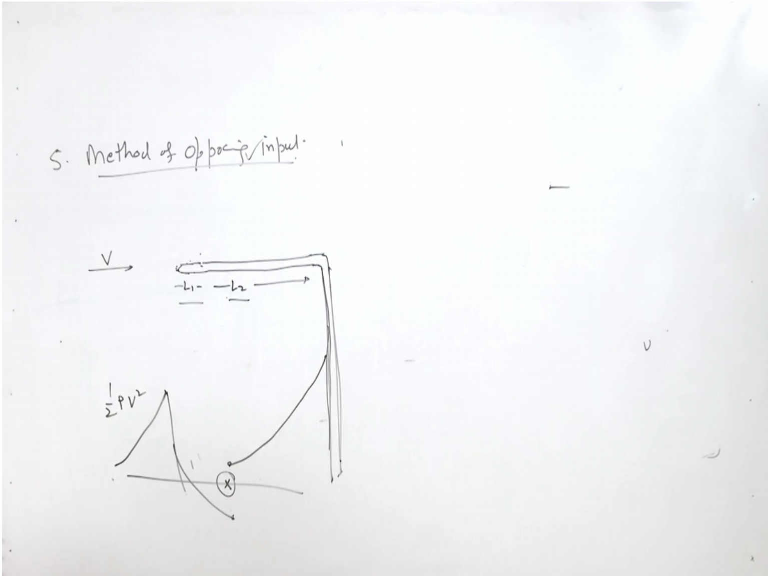

Method of opposing input now if we know the interfering and modifying input c magnitude and same nature of signals can be put in opposite direction. So, they neutralize each other now if we look at a mechanical device let us take a example of a static pressure prob a static pressure prob was proposed by a prantel and all of you must have used this probe in order in order to measure the static pressure. So, it is a right-angle pipe bent at the right angle right and the leading edge is this stagnation point leading edge is this stagnation point. And it is observed when the free flow when the free stream passes over this probe right.

The pressure the and static pressure has to measure from here there is a hole here we are from you can measure the static pressure and here will get the stagnation pressure.

So, when the stram flow stream passes over this probe the velocity here increases which reduces the static pressure they are 2 points one is the nose where we get stagnation pressure and another place is there where we these static pressure and there is error incurred because the velocity of the stream is higher than the normal due to intrusion of this tube static pressure measuring tube resulting in dip of pressure at this point right.

So, how to get the correct static pressure using this tube because this is a very simple tube and it is very reliable I mean this method of pressure measurement is very reliable, but there is an error and method of opposing input is very useful here right first of all if we draw a pressure diagram the fluid is coming with the certain velocity v when it is coming in contact with this tip, what is happening? The pressure of the fluid is rising.

So, it is half rho V square right this is stagnation pressure now, but if the fluid and now if you go in this direction the at this point the pressure is high, but just after this just after this point what happens just after this point because normally we confine to our self up to this point only, but beyond this point beyond this point in this plane what happens there is a sharp fall in pressure there is a sharp fall in pressure. This is a sharp fall in pressure due to high velocity of the fluid right and high velocity because this has this probe is placed here and which has increased the velocity of the fluid in the vicinity of the scheme of the probe.

Now, if further we move from this point further we move from this point the pressure will rise if you are closer to this point the pressure is high and when we are moving further from this point the pressure is reducing. So, we can we can manipulate the pressure at this opening by controlling length and l one by controlling length l one we can control the pressure at this point right now second thing second thing is this column this is also interrupting the flow and stagnation point is also generated close to this column. This column is vertical and fluid is coming on the vertical column it is also causing the stagnation tube and the pressure is highest at this point and it will keep on reducing when you are moving away from this point stagnation pressure or total pressure.

Now, this length l 1 and l 2 they have to be manipulated in such a way that, if you sum the pressure at these 2 points it becomes actual pressure at this point. So, I am explaining again this phenomenon the fluid is coming with a certain velocity here this stagnation point is there. So, pressure will rise, but just after this point the pressure will fall sharply.

Now, this is vertical I mean tube and here also stagnation point is formed. The pressure is high and this pressure will reduce when we move away from this column. So, this l 2 just by manipulating l 1 and l 2 we can have we can have a I mean this negative pressure will be neutralized by this positive pressure and we will be getting actual pressure or this has to be done by choosing suitable length l 1 and 2 for this tube. So, this is a very good example for method of opposing input for removing the interfering and modifying input to the measuring instrument.

Now, another example of this type of arrangement can be seen in orifice metre in orifice metre pipe.

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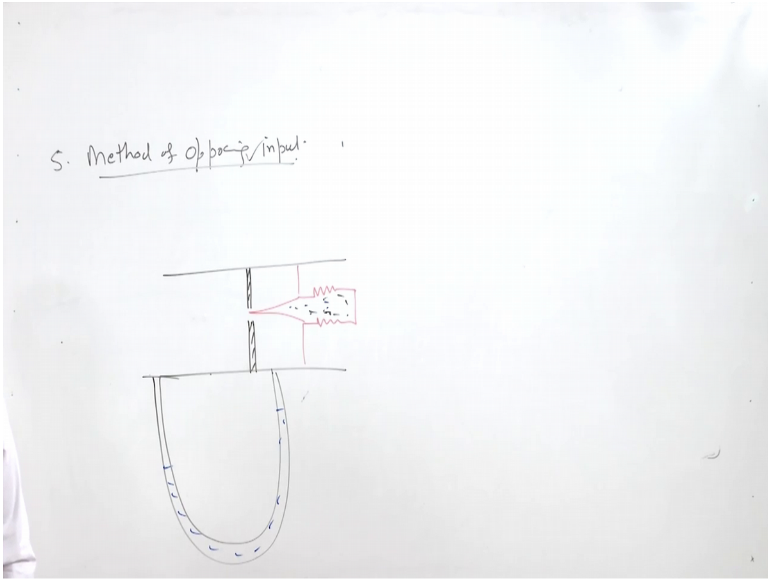

And pipe across the cross section of the pipe and orifice plate is fixed. And we put a manometer we put a manometer some somewhere starting from somewhere here and we simply take the difference in the column difference in the column right and this is how we get the pressure drop and through this pressure drop just using the Bernoulli’s equation, we get the output I mean mass flow rate. Suppose, there is a change in temperature, when there is a change in temperature or the suppose the temperature rises, when there is a rise in temperature the density of the fluid will increase sorry density of the fluid will reduce and that will change the mass flow rate through the orifice plate.

So, this instrument is sensitive to temperature if there is a variation in temperature the mass flow rate will also change right. So, in order to cope with this problem a needle is provided and. So, when there is a fall in pressure. So, this is a close entity and this is this is bellow type of system and this is also filled with some fluid this is also filled with some fluid right. So, when there is the fall in temperature when and this needle can move in this direction this needle can move in this direction.

So, when there is a fall in temperature when there is a fall in temperature then density of fluid will increase, right. The density of the and this bellow will push the needle in this opening and it will restrict the opening the moment it restricts the opening when there is a it can be either way when there is a change in temperature. I mean when the temperature is a temperature rise or temperature fall.

Accordingly, this bellow will move this needle in this opening and it will restrict the opening in order to maintain in order to in order to maintain, the mass flow rate because the density is high then velocity has to be low when density of fluid is high velocity has to be low and when the density is low when the temperature rises density is low then velocity has to be high right. So, accordingly, these needles move in this opening and restrict the opening in order to maintain the cost and mass flow rate. So, that is also a method of opposing input.

So, that different methods in addition to this there can be depends upon the designer. We can evolve some more methods to remove the interfering and modifying inputs to the system, but they have to be removed necessarily otherwise, our measurements will not be accurate. And the whole purpose of the or whole objective of the measurement will be lost that is all for today.

Thank you very much.