Hello students,

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Today, we will be discussing about the qualities of measurement. The module name is introduction, performance and static characteristics. Module number one.
The outline of my presentation is, we will be discussing about what exactly instrumentation is? The various performance characteristics. That is, among them is static characteristics. The learning outcomes will be, the students at the end of this presentation, will be able to define what is instrumentation? and list and define various static characteristics.

Now, instrumentation is a technology of measurement which serves not only for science, but for all branches of engineering, medicines etc. The knowledge of any parameter depends on the measurement, and, if one has the in-depth knowledge of any parameter, it becomes easy for measurement. Measuring is used to monitor a process or operation, or to control it. For example, when we talk about thermometer or barometer, it is used for the indication of various environmental parameters or environmental conditions.

So, intelligent selection and use of measuring equipment becomes very important. Intelligent selection and use of a measuring equipment depend on, 1. broad knowledge of what is available. and, 2. the performance of the equipment. For example, if you want to use or, if you want to measure the diameter of a wire, then, we will certainly try to use or will certainly use micrometer screw gauge. Because, that is the best tool, but, in order to measure that diameter we should also know that particular instrument well. What is the important parameter over there? The least count of the instrument.

The major problems which are encountered with any instrument is the error in that instrument. So, it is necessary to select the appropriate measuring instrument and the methods which can minimize these errors. To avoid errors in any experimental work, very careful planning, execution and evaluation is essential.

Suppose, if we are performing an experiment to measure the acceleration due to gravity using a bar pendulum. In that case, it is always advisable to take a maximum number of readings. Because, if we take one or two readings, it is quite possible that the student may make mistakes while measuring readings or while measuring number of oscillations. So that's why one should take more number of readings, thereby taking the average we can minimize the error. And in order to understand any instrument, the performance characteristics of that instrument plays a very important role. So, a knowledge of the performance characteristic of instrument is essential for selecting the most suitable instrument for specific measuring jobs.

There are two types of performance characteristics.
One is the static characteristics; another one is the dynamic characteristics.
Now, when we talk about static characteristics, there are various static characteristics. To least few, Precision or repeatability or reproducibility is one parameter. Sensitivity or responsibility is the second characteristic. Resolution or least count is the third. Linearity, Stability and drift, Threshold, Dead band and hysteresis, Input impedance, Output impedance. These are some of the static characteristics.

Now, what are static characteristics? The static characteristics are used to measure or process which is not variable. Anything which is static or anything which is not varying comes under static characteristics, and all static characteristics are obtained by one form or the other process called as calibration. So, what is calibration? Calibration is a process, where you are comparing the instrument with something called as standard. So, certainly now the question comes, what is an instrument? An instrument is a device or mechanism which is used to determine the present value of the quantity under measurement. So, whenever we are doing some measurement, whatever tool that is used for the measurement purpose is called as instrument.

So, now the next question comes is what is measurement? Measurement is nothing but the process of determining the amount, degree or capacity by comparison with the accepted standards of the system unit being used. Let us take one example. When we go to market, we want to purchase suppose say one kilogram of sugar. The shopkeeper puts it in the bag and gives it to us and we rely on it. Why?

Because, we see that shopkeeper measuring that sugar using some instrument. So, this is basically a process of comparison with some accepted standards, maybe suppose say weight in case of mechanical type of weighing machines, or in case of electronic weighing machines, the display.

The next static characteristic is accuracy. Accuracy is defined as the degree of exactness or closeness of a measurement, compared to the expected or the desired value. Here, I would like to give you one example. The acceleration due to gravity is 980 centimetres per second square. This is universally accepted. Whereas, practically if we get the acceleration due to gravity as suppose say, 970 centimetres per second square while performing an experiment. In that case, the difference is 10 centimetres per second square. So, the reading is quite accurate, when we talk about the experiment. of course, there is an error of 10 centimetres per second square.

The next static characteristic is Resolution. Resolution is defined as the smallest change in a major variable to which an instrument will respond. For example, if we take a scale, measuring scale or small scale, then the smallest reading that is noticeable or measurable is 1mm. So, the resolution of that scale which is used in compass box is 1mm. That is the smallest reading that is measurable.

Next static characteristic is Precision. Precision is defined as the major of the consistency or repeatability of measurements. i.e., successive readings do not differ. Let us take the same example. We are performing an experiment to measure the acceleration due to gravity. The same experiment is performed suppose say 10 times, and if a student gets suppose say 1500 centimetres per second square as the acceleration due to gravity, in all ten attempts. His measurement is precise. He is precise in the measurement. So, precision is nothing but the consistency of the instrument output for a given value of the input. The measurement need not be accurate here in this case, but it is precise, why? Because he is getting the same reading n number of times.

Let us take this example. One needs to hit the target. In the first case, if you see, the measurement is not or the hitting is not accurate, nor it is precise. But, in the second case, if you see, since that target is hit at a particular point, it is precise, but it is not accurate. In the third case, you will see that, it is accurate here, Why? Because it is hitting the centre of these target, but it is not precise. Why? because the readings are scattered or the hitting is scattered here. Whereas, in the last case, If you notice, the target is hit exactly at the centre, and all these six targets or all these six shots are targeted at the centre itself. That's why we can say that this particular hitting is accurate as well as precise. So, that is the difference between accuracy and precision.

Let us go to the next term. That is expected value. Expected value is defined as the most probable value that calculations indicate one should expect to measure. Again, I will take the same example: acceleration due to gravity is defined or it is given as 980 centimetres per second square or 9.8 meters per second square. In that particular case, this is the expected value of any measurement which is universally accepted. Whereas, when there is an error, there may be some deviation of the value from its expected value.

So, what is error? Error is defined as the deviation of true value from the desired value. So, in our case now, if we are performing an experiment for finding acceleration due to gravity. Then, 980 centimetres per second square is the expected value of the measurement. Whereas, if a student gets 970 centimetres per second square, in that case, that becomes a measured value. So, there is a deviation, that is 970 in one case 980 other case. So, this becomes an error.

The next static characteristic is sensitivity. It is defined as the ratio of the change in output of the instrument to a change of input or major variable. So, when we take the ratio of these change in output to a change of input, the ratio should be large. That means, the output change in the measured variable should be large compared to the change in the input. So, then in that case we can say that the instrument is sensitive.

Thank you.