Experimental Physics I
Prof. Amal Kumar Das
Department of Physics
Indian Institute of Technology, Kharagpur

Lecture – 12
Basic analysis (Contd.)

So, today we will discuss about Basic Analysis in laboratory. So, I have discussed about the about the data collection procedure in the laboratory.

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So, today I will discuss out the graph plotting. So, after that taking data, we have to extract information from that data. So, this it is easy way to interpret or to extract information from those data is basically plotting graph ok. So, I will discuss about the plotting graph using the data obtained in laboratory.

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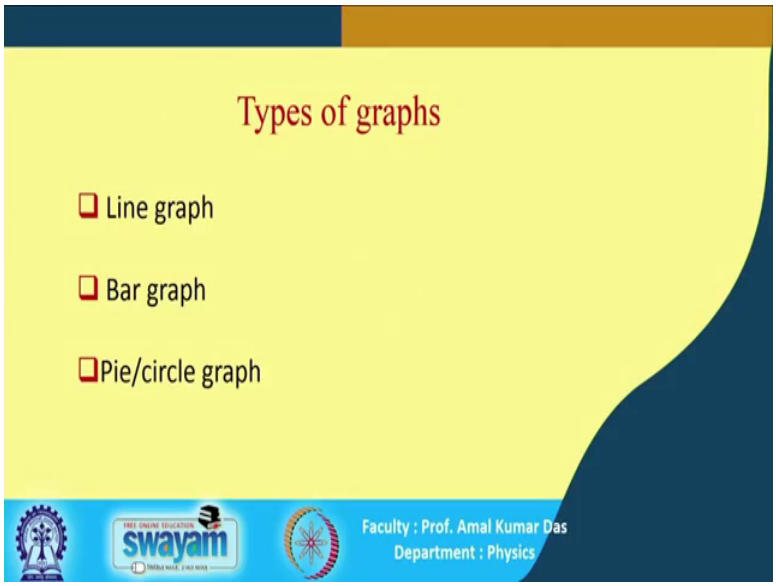

So, what are the types of graphs? When we plot graph which types of graphs we have plotting that we should know.

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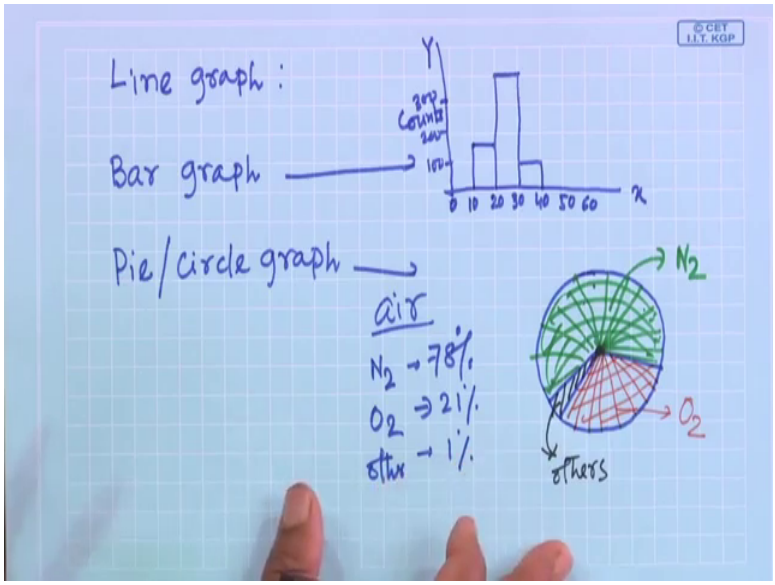

So, basically there are three types of graph; one is line graph one is line graph, another is I think bar graph and third type is pie graph or circle graph also you tell circle graph. So, line graph basically its mainly we will use line graph, I will discuss about the line graph. So, here basically we represent the variation of an variable with respect to other variable. So, in that case this we use line graphs and bar graph its a use for comparison ok.

So, I will discuss about the line graph in details. So, just let me briefly tell about the bar graph and this pie graph. So, this bar graph is a use for comparison. So, if you have data. So, you can say size of the particles you have a material, which you are having a different size of particle ok. So, here is the number of particles; now what is the size variation if you want to study? So, generally we make it group that 0 to 10 say nanometer sized particles 10 to 20; 20 to 30 nanometer 30 to 40 nanometer ok. So, this way we group this particle size instead of instead of a considering each size of the particle. So, you consider the size of the particle in group. So, this is one example second eh example in a class, what is the there are many students. So, how many numbers of students are there? So, basically we plot count verses the sum parameter, it can be age and it can be particle size.

So, how many particles are there in this group? 0 to 10 or 10 to 20 nanometer or how many students are there who are having age between say 10 to 15 or 15 to 20. So, this for comparison, we make groups this group of particle size group. Now then we count and that that we plot as you in around the y axis, this count. So, this basically bar diagram this represents with the bar diagram X axis and Y axis x and y; so in along the x axis. So, you have grouped it 0 to 10, it can be age or particle size as I told 10 20 30 40 50 60 like this. So, then we are putting here count it may be number of particles or it may be number of students. So, then we count it and then what is the number? Now this you have to make scale say this is 100 this is 200.

So, you have to scale it this 300 like this ok. Now if you if you see this within this 0 to 10, there is no there is no particles within the size span, 10 to 20 there are say 150 particle. So, this is 150 particle. So, nearly we represent with this bar and then between 20 to 30 you see that say 400 particle. So, then we represent like this 30 to 40 say 100 number of particles. So, this way you represent. So, it is easy to compare this way. So, between 20 to 30 this graph is showing that it is the maximum number of particles within this 20 to 30 nanometer or number of students are there or peoples are there within this age 2 into 2 30.

So, for this comparison, its very easy to represent. So, other there are many examples. So, what is your income or your family income in different years? So, this X axis you will scale it, level it as a year and Y axis you will represent with is your income that rupees per year in rupees per year.

So, then we can plot we can then you can see the variation of the income in different years ok. So, this is basically bar graph, this is basically bar graph and pie chart or pie graph, it is a basically if you want to this is used for representing a portion of a quantity. So, as per example say what is the in atmosphere in year what are the elements are there and how much there. So, in years this composition is basically nitrogen gas you know this around 78 percent, oxygen gas it is around say 21 percent and this other gas argon and this other gas it is around 1 percent ok. So, you want.

So, you are representing the different components in year; so different composition portion. So, these are the parts portion component. So, how much it is? See if you want to represent that one this type of things, it is easy to represent with this pie graph. So, that is basically circle we take a circle this represent the whole year ok. Now you are just total area you are dividing with this with this percentage. So, 78 percent area we will use for representing nitrogen, 21 percent area will represent used to represent oxygen and others will use the area 1 percent area will use. So, the total its the 100. So, then I think you can just divide the area. So, this portion of area is, this portion of area is an we can mark. So, basically this is just mark it generally we use colours different colour ok.

So, this is portion is representing nitrogen, nitrogen and say this portion this portion is used for is a 21 percent area of the ok. This portion is for oxygen and this other part other part basically this part. So, this part is a 1 percent. So, this is the pie chart. So, now I will discuss out the line graph this mainly in our laboratory we use line graph although this other things we use, but mostly we use this line graph. So, I will discuss some of the line graph in details.

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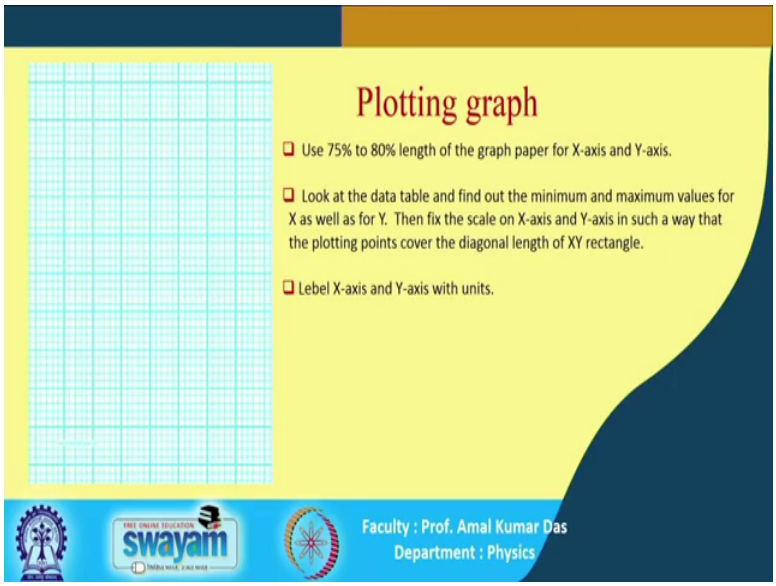

So, line graphs. So, how to plot line graph on graph paper? So, I have shown one graph paper here, one graph paper here. So, you are quite familiar, but now a days you are using computer this graph error where we good graphics to plot graphs, but this manual plotting is important to learn what I am doing. So, to learn that one is very important to learn manually. And after learning you use graphics computer graphics for plotting graph that is fine, but manually you should learn how we are plotting graph how computer is plotting graph; so, that we will understand.

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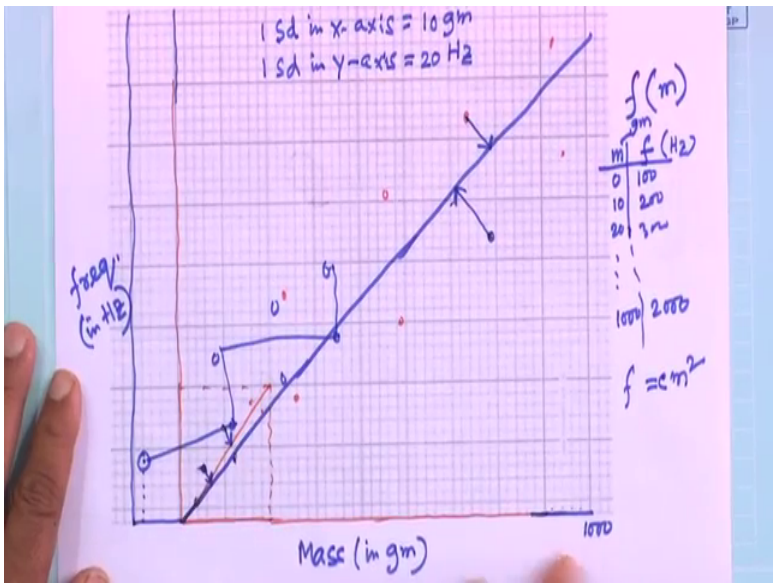

So, this is a graph paper this is a graph paper standard graph paper. So, graph paper generally the small box square box. So, it has each box has length and its width right.

So, this we take this length here its a. So, this box say here this one is a bigger box right this one is the bigger box, inside again the small small box are there. So, we have to consider this each box we have to scale this each box with your data, with your data it is in different units ok. So, this is each length. So, we have to define we have to calibrate basically with your data, if your data is in mass is in gram. So, data is there from 0 gram to say 1000 gram ok; so here on the graph paper.

So, you have to consider one line. So, this we tell axis. So, this horizontal line one line will take as a axis that is X axis and to representing the dependent variable. So, X axis along the X axis then we plot in dependent variable in, and along the vertical axis that is called y axis. So, we will take a line. So, that is Y axis now that axis will scaled with some dependent variable ok. So, that that dependent variable it depends on the x if x varies; so x and y have relation. So, y we will from the relation, we will get the value of y. So, that is dependent variable in it depends on x. So, that x we will plot along the horizontal line that is x axis, and the dependent variable that we plot along the particle axis.

So, that is basically Y axis right. So, rule is that rule is that that you have to choose the length of X axis and Y axis in such a way that it should be 75 to 80 percent of the total area of length and width of the graph. So, reason is that that you can show your data clearly, your data should be distributed over the over the 75 to 80 percent of the area of the graph.

So, basically main reason for the that yours you are enhancing the representation or you are magnifying the representation of your data, if you choose very small area X axis length and Y axis length is small and then you are plotting your graph then what will happen? So, that scale say as per example I told that 0 to 1000 gram. So, this if you scale with the length of here with two box bigger box two bigger box one 0 to 1000.

So, your data in between 100 200 500 700 say these al plotted. So, that within this the (Refer Time: 17:33). Now if you choose 10 boxes box for 0 to 1000 gram so; that means, you are basically magnifying your plot. So, same data you are plotting in magnified way. So, you can represent you can represent well and that will be interpolation, extrapolation

that will be easy what is interpolation what is extrapolation that I will discuss. So, you can. So, visibility will be enhanced. So, that is the reason why we tell that at least you should use 75 to 80 percent area of the graph waveform for your data plotting ok.

So,. So, as I told that you put just two box two box for it is not necessary it will be rectangular. So, you may choose this here two box here one box. So, here you have representing your; so this basically one. See this is the total area you are using for your plotting of. So, plotting graph you have this way ok. So, you are using this portion of the graph only for representing your data instead of that if you use this larger area. So, larger area for plotting graph the same data yours you are plotting. So, this your data is say like this. So, if its data you are taking average plot you are taking drawing line that is line you are drawing.

So, for same data, now here with the smaller graph what is the deviation of your of your data point, but whatever the visibility here deviation from this line then what is line here drawn what is the deviation here whatever you have seen. Here this same deviation, here you can see this deviation this it looks very prominent. So, it will help you if you use bigger area, it will help you to find out that deviation from the average curve of your data points more accurately. Because here, you have to count basically here you have to count this what is the deviation right.

So, from scale you have to find out this is the deviation. So, here this you will get more accurately because more number of this small square box you can count here. And that value it will be more accurate then this one, because here scale this its again is like least count ok. So, here least count is higher; for least count in this case will consider as a and this smaller box, what is the smaller box that is X axis scale and Y axis scale if it is 1000; so within this two. So, basically if you use two box.

So, your each box value 0 to 1000 means, you have 10 boxes are there 10 boxes are there so; that means, each box value will be a 100 gram whereas, here if you take 10 each box value will be 10 gram. So, here this least count will be 10 gram whereas, in this case least count will be 100 gram. So, you know this if least count is smaller so, that is better.

So, your error will be lower. So, this is the region we tell that you should use higher area larger area of the graph paper to represent your data. So, this is the reason why you should use 75 to 80 percent area of the graph paper for plotting your data. Second now

how you will scale how you will scale your X axis and Y axis right? So, you have to look your data. So, because you have you have two column two column data say. So, one is dependent variable and another is independent variable. So, in dependent variable what is the range of the data? Say if told that as for example, that you are you are measuring weight and for that weight; what is the say some parameter frequency, frequency depends on this mass ok. So, frequency is a function of mass frequency is a function of mass. So, basically you have two column data, then you have two column data you are changing mass and measuring the frequency.

So, mass it is in gram, frequency it is in hertz. So, you have data 0 say 10, 20 etcetera etcetera and corresponding frequency say 100 200 300 etcetera ok. So, it is you have to as I told when you will collect data say you should mention the unit in the table, and this also you should use the unit that is a gram ok. Now here I have to say up to 1000 gram it is there and this frequency it is up to up to 2000 hertz is there.

So, you range is for mass 0 to 1000; so your X axis that you have to scale. So, this starting from 0 and ending will be 1000. So, how many boxes are there? First you consider the bigger boxes now in each bigger boxes you have the five division. So, smallest division is here is the basically smaller smallest box. So, here 1, 2, 3, 4, 5, 6, 7, 8, 9 up to it is 9 is there up to it is 9 is there; so up to 9. So, you have to consider this up to 9 say this 1000.

So, that is a slightly inconvenient. So, I could shift the zone here, what is the (Refer Time: 25:45) shift here. So, then I will have 10 boxes say 10 boxes corresponding 1000 gram ok. So, each box is basically 100 gram and now in 100 gram in each box there are five division 1, 2, 3, 4, 5. So, each smallest box will be then 10 gram. So, that you have to define one smallest division, one smallest division in X axis equal to 10 gram ok. Similarly one smallest division in Y axis equal to you have to define. So, this is a 2000. So, if it is 10, if it is also 10. So, then basically it will be 20 hertz it will be 20 hertz now from your data if it is 10 gram. So, it will be just one box it will be just. So, I have to shift this like this.

So, this is 10 and hertz is 100; that means, I have to go five division 1, 2, 3, 4, 5. So, make it circle same way you just plot other data, you just plot other data. And then after plotting you have to draw an average curve average curve. So, here I have drawn just one

line. So, it can be curve also it may not be linear curve, it may be non-linear curve depending your data depending your theoretical knowledge whatever the dependence of y and x, what is the relation between y and x in this case frequency is related with the mass m with some constant or it is a square of mass it depends on square of mass.

So, depending on that this curve; so if you have this knowledge, it easy to easy to draw graph. So, basically we do not draw the graph this just connecting the point just connecting the point, this is a zig zag this we do not plot we plot this average curve. So, and then consider the points are deviated from this from this average curve, and that deviation of upper side and the lower side lower side this is the its a minus and upper side is the plus. So, it should be this here plus minus, it should be more or less total plus and total minus that is a deviation it should be 0 also; that means, plus deviation and minus deviation should be same. So, that way one has to draw this curve. And there were some list (Refer Time: 29:08). So, this is basically line graph ok. So, line graph bar graph and pie graph. So, these three types; so among them this line graph is very frequently we use in lab. So, will discuss about this about this line graph more and how after plotting graph how we can extract information from that graph.

So, that I will discuss and if you can as I told how to choose the scale; that means, X axis and Y axis and then you have to level the X axis. So, in this case we have to write mass right you have to mass in bracket in gram, Y axis you have to write frequency you have to write frequency in bracket you have to write in hertz ok. So, without seeing these table one should understand everything from your graph.

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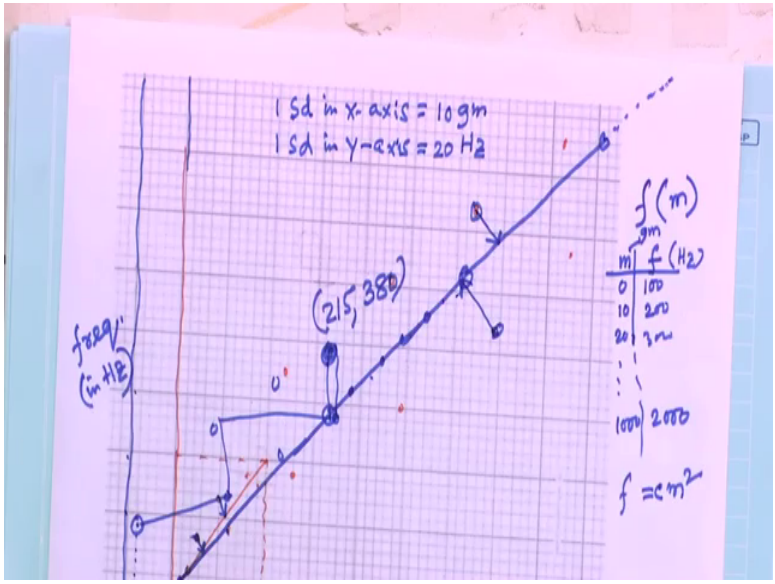

So, if you plot this way. So, this people will know that along the X axis what is the value of this of this point. So, one can find out. So, from here you just each small devia smallest deviation is 10 gram. So, how many of this points along are there how many boxes are there?. So, bigger boxes 1, 2, 3, this 4 4 means 4 into 5 this 20 box smallest box and then I think this 1 and then 21, 22 it is 21.5; so this 21.5 into 10 gram. So, 21 means 210. So, it will be 200. So, multiply with 10 21 point 210. So, this value X axis it will be 215 gram this point is 215 x along the x this x value and y value you have to count here.

So, here smallest deviation is 20 hertz how many are there 1 2 3 and this is three means 15 and this is 4; so 19. So, 19 into 20 its a 380, say it will be 380: so 380. So, the value of this one is 215 gram and 380 hertz. So, all information should be on this graph and any one can see and find out the value of this any points on this graph ok. Now after plotting the points; so why we need to draw a average line average graph. So, this is basically you have taken the data is a discrete data is not continuous data.

So, what will be the value between two this two points, whatever you have taken data this two points it is giving two points in between what will be the value of. So, what will be the other value? So, for other masses what will be the. So, that experimentally you have not find out so, but from graph if you just draw a average curve, now from that curve now that that will give you in between this value. So, this basically its a this a and

its not exactly extrapolation that is a basically this point is no more this experimental value, now average value average curve this is the value. On average curve this one actually this is the value. So, if you connect this point.

So, in between other points will get it is not found experimentally, but from the graph other points you can find out. So, this curve interpolation this called interpolation and if you want to find out the beyond this whatever experimental maximum this one, beyond this what is the value. So, these are called the extrapolation; extrapolation this side it can be it can be this other side also ok. So, this is called the extrapolation, interpolation between two points what are the other points. So, if you connect them you will get the other points if you.

So, interpolation and when this is a data if you want to know the values; so then you have to extrapolate. So, that is the curve extrapolation this can be this side or it can be this other side ok. Interpolation and extrapolation; so it is because in your instrument it is beyond you cannot measure beyond this point so, but if you plot graph then from that graph, you can find out the other higher side and lower side other points, which you are not able to measure using your instrument, because that is the limitation of this instruments ok. So, graph will help you to get this other points ok, which experimentally was not (Refer Time: 35:02).

So, I think I will stop it and continue in next class.

Thank you.