Technical Arts 101
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Lecture - 1

Good after noon. In the academic roster of IIT Kanpur this course is named as T A 101, Technical Arts 101. I am Anupam Saxena, an Associate Prof with Mechanical Engineering at IIT Kanpur.

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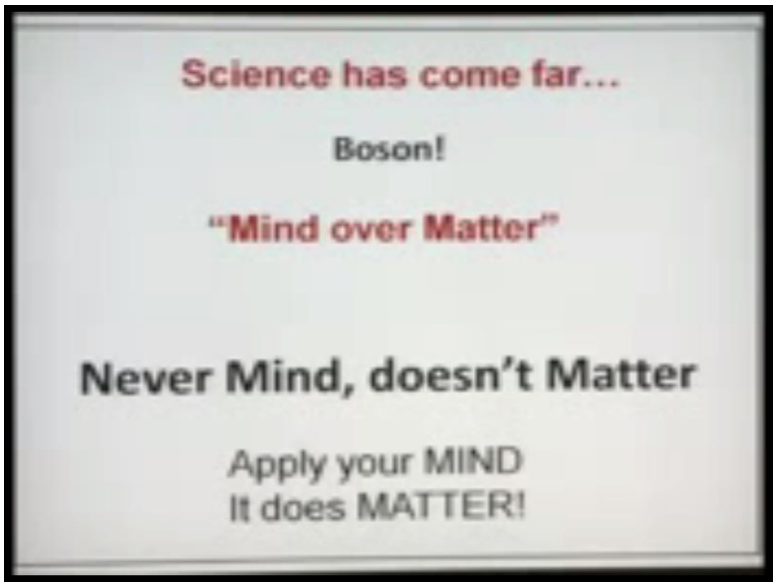

You know science has come quite far about couple of weeks ago a physicists were very excited scientists very, very excited that they are very close to discovering a particle called Boson. The name comes from 2 scientists Bos and Einstein and this is the particle that is responsible for matter. So, you have many intellectual minds many intelligent minds working over matter, but how is this fact related to the course? Well, if you are you are pondering never mind it does not matter really never mind does not matter not quite. In this course you will have to apply your mind it does not matter for anything that you would do engineering; you will have to apply your mind; you will have to apply your common sense, because that is what matters in the end.

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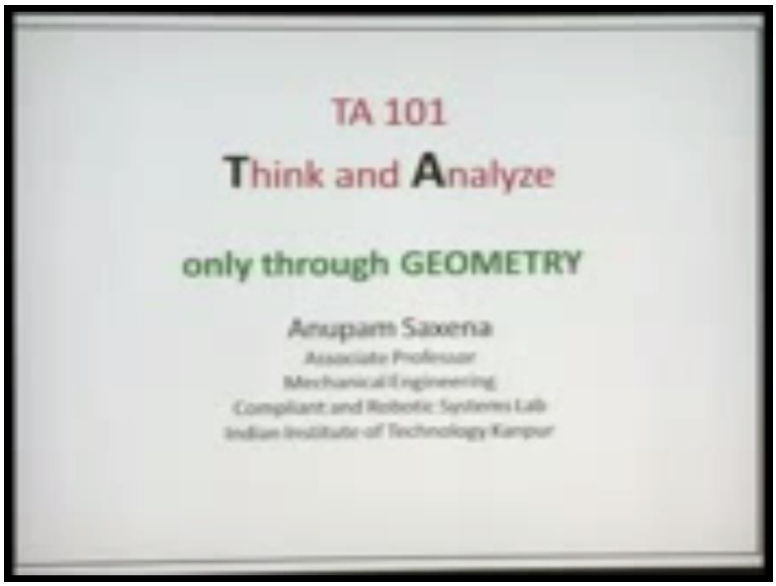

So, this course is called technical arts 101, but I will slightly I will give you a slightly different name. For me this course is about thinking and analyzing, think T and analyze A. But this is going to be slightly different in the sense that we are going to be thinking and analyzing only through geometry no equations, no analysis, no deduction, but only through geometry, through drawings.

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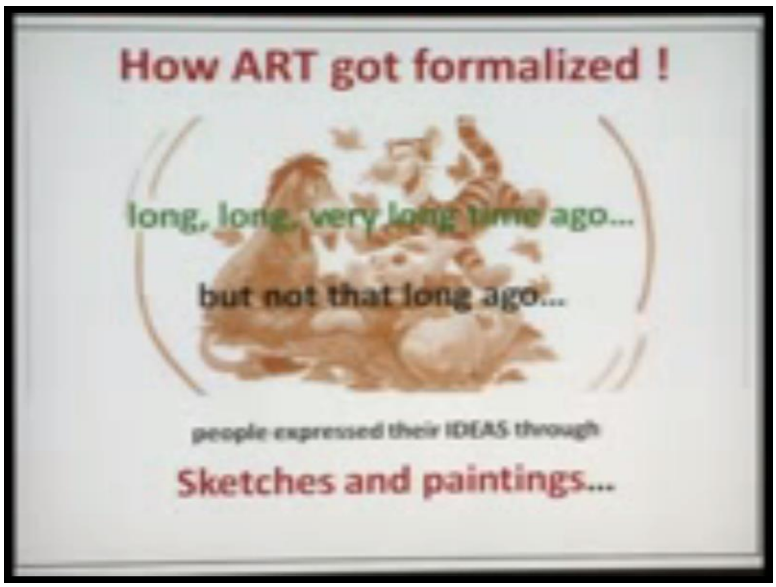

Anybody have an idea what this pictures about? Do you know who this character is? You are right he is poo, we knew poo. And he was conceived by 2 people a amilne and earnst

shepherd. That is what my 11 years would tells me these are his friends, the point behind the picture I will try to address this question as to how art got formalized over the years. You know long long very long time ago, but not so long ago, people expressed their ideas through sketches and paintings they probably did not have the grammar. They did not have the vocabulary they first of all started discussing or presenting or expressing the ideas using sketches and paintings.

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Look at these paintings for instance these are painting from a place called Bhim Betika which is about close to Bhopal about 40 45 kilometer 60 kilometer close to Bhopal. Bhopal is about eight and half hours away from Kanpur the city. You know this place Bhim Betika has lot of caves that were accessed by cave dwellers. And it seems to half paintings from all these ages upper, Paleolithic, Mesolithic, Chalcolithic early historic medieval. You know so, this stage here is about 50 to about 100 1000 years ago Mesolithic stage is about 10000 years ago. Chalcolithic is a stage where a barter system came in existence primarily with agricultural commodities early historic. So, if you look at these figures you would realize that people started sketching or painting schematic decorative in red white and yellow. And medieval stage was what is depicted by geometric linear manganese hematite red stone and use of wooden coal? You know so, these are paintings from long time ago and if you look at these paintings you would realize that this is not text. This is not grammar; this is not language just art and pure art nothing else.

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You know like this coat here by Reeva Kimble long before words were written thoughts were painted on the walls of caves you know. So, again I would I trade that there was no language there was no grammar all we could see were sketches that were painted in the wall of the caves some examples look at some paintings. So, this is from Srilanka from the fifth century so these are paintings from Ajanta caves are came from fifth century. These are paintings from ancient Egypt 5000 years ago some from Chauvet caves France 30000 years ago. And these are from Toquepala caves Peru about 6000 years from now you know once again coming back to this coat from Reeva Kimble long before words were written thoughts were painted on the walls of caves again. Look at these paintings no text; no grammar; no language just art; just colors. Of course, I mean the text is here; the grammar is here and these are paintings, keep on mind.

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All right, some more examples these are a couple of painting from Pompeii. But 2000 years Pompeii first century, even some examples from China the Tang dynasty 580 to 900 AD you know. So, this was a phenomenon that was an existing throughout the world.

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Well, ancient times the period of Sistine Chapel in Rome or in Vatican I guess.

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Look at this paintings absolutely fabulous, the main number over there look at the use of colors look at the details you know the features over here. So, people really master are when they were added and look at these paintings are here on the roof and on the walls. Look at the creature of the wall the way there were able to use the creature and represent paintings amazing.

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Well, how about sculptures people again were not behind again this are the examples from period runs on.

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Again sculptured from Rome over here for instance look at again the details You know the muscles the bones from here people became very, very good art defecting not only their ideas in 2 dimensions. But also in 3 dimensions the question is where able to do all this? Without expressing anything on paper in 2 dimensions they must be convince they must be conceiving you know these ideas somewhere.

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Well, let us look at some examples of ancient monuments.

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You have the Colosseum from Rome pyramid from Egypt Qutub Minar, from Delhi the in tower of Pisa, Tajmahal over here. This is something which is very very interesting this is picture of Buddha infect not a picture Buddha, but statue of Buddha. So, would not largest would not statue Buddha in the place called Nara Japan. You know a golden temple over here quite if u monuments from India, Asia and worldwide. Once again the question is, was it possible for us to have accomplished these monuments so nicely without using paper and pen. Or without conceding these ideas before at what would be your guess, my guess is definitely not. You must have work quite a bit to be able to concede these ideas.

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Well so this are or rather these are some examples from Gustave Eiffel, he was a French engineer. So, these are engineering examples.

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Garabit Viaduct railway; it is a bridge over here look at how efficiently he has been able to use frames. To be able to provide enough strength for the rail to cross this bridge railway station in Budapest Maria Pia bridge again. So, if you look at this example and this example very similar in construction. So, this arc over here that is over the, and this vertical columns keeping upwards. And there is a horizontal bridge supposed to be really

steps iron house in Peru Eiffel tower on of the famous examples of engineering by Gustave Eiffel. And his company rather his team again statue of liberty, one in France the other one in US close to New York.

You know he and his company were responsible to be building about 65 buildings and bridges in Europe and elsewhere throughout the world. Once again where they able concede these ideas and these are by the way engineering ideas. I mean a lot of these structure they happen to be quite for example, these 2 guys are to be quite they are able to enormous. You know vertical here the Eifel tower is able to bare enormous when load you know I was actually going through a few papers And I realized that rather people talk about this being conceived to expense or exponentials.

So, this is one exponential cover here and second exponential cover over here fantastic design, but again he and its team members they have to start with a paper and pen. So, they drew a lot of the preliminary sketches got the idea and that is true for both the Eifel tower as well as statue of liberty. So, these are the internal skeletons the sketches of internal skeletons of the statue of liberty. So, people did work with paper and pen before they conceived. All these you knew now very well known engineering marvelous bottom line designers may have been a single person or a team of few or many. I do not know design had to be communicated to those building it.

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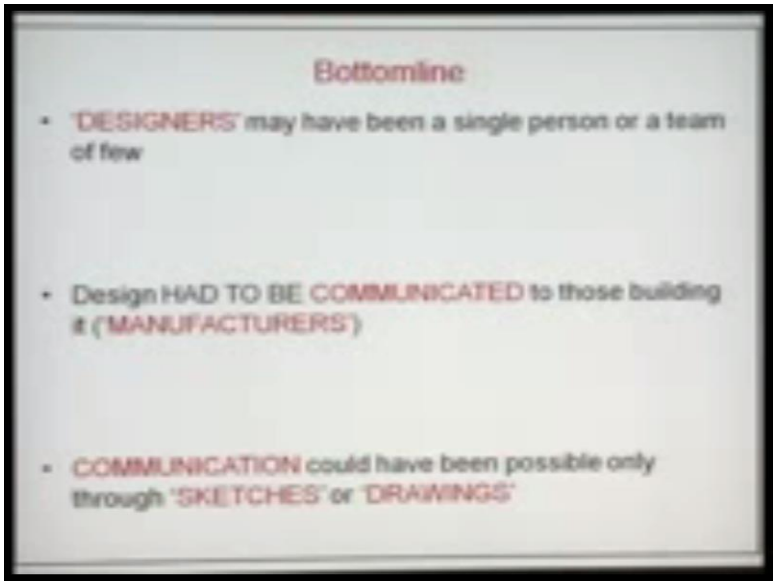

What we now know as manufactures, you know so designers they would be communicating their design or their ideas to what we call manufacturers these days. Without that it is impossible communication could have been possible only through sketches or drawings. You know that is the most efficient way in which I know I would be able to communicate my ideas to somebody else. And the question is you know I would draw sketch or I would draw a few sketches in different way or somebody else would draw these sketches in different way. A third person for example, if we looks at my sketch and if we looks at somebody else sketch is it possible for him to strike uniformity between these 2 ways of sketching. So, the idea is there a way we can draw sketches so that it is easier for manufacture to understand these sketches.

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I will ask that question in a little while later, but first some more examples. Do you know this guy's none other than a very famous artist and engineer from Italy? Leonardo da Vinci. He was very, very talented great artist and a great engineer more than that a wonderful visionary.

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You know what was something that I found surprising was his amazing way of describing human anatomy. Look at the details of sketches that he has over here you know I mean of course, he is writing some notes over here he is using some grammar some language. But look at the details human face typical human face look at the ratio he is try to work out skull human skull a baby in a womb I this pictures that represents or that depicts the golden ratio. Again pictures a babies features once again details over here the anatomy in bones and not only did he worked with an anatomy. I mean he also worked with the he also used sketches to describe lot of engineering components that he came up with the ideas that he came up with.

You know these are pictures from different machines one of the flying machine that he had concede around that time 1500 1600 may be. I do not know what is this, again a typical mechanical system I believe again a bunch of thinks over here typical mechanical system lot of and gears you know. So they are many, many plenty in number gear system. I guess of glitter that he considered around that time many these pictures that represents engineering anatomy medicine you know around the same time. And of course, he was an artist so not only the focus on anatomy and engineering aspects. But he was also interested in art in beauty and one of the final pictures that he that I would show you not from him. So, the single point perspective of a landscape probably inside of a hall if I am mistake you looks like it is.

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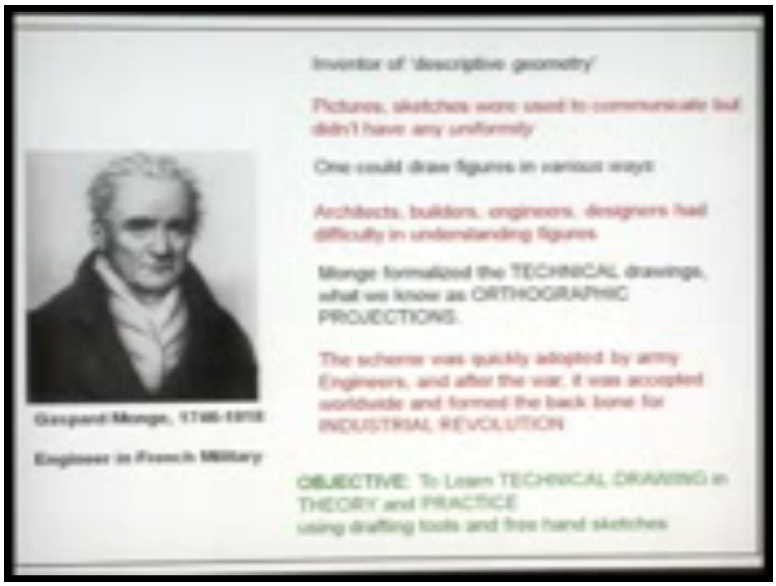

Alright to be able to answer that question there are little earlier was it possible for people to make the way we draw sketches more uniform. So, he was the person who made it possible his name is Gaspard Monge. He was a French, he was in French military, he was an engineer you know born in 1746, staid on this earth till 18 he is the person who is the inventor of descriptive geometry. You know pictures sketches were used around that time to communicate, but did not have any uniformity. So that what he start with one could draw figure in various ways one could draw paintings sketches in various space yes. You all know that architects builders, engineers, designers they had tremendous difficulty in understanding figures I am fine I am enough. Let us say I draw something over here its.

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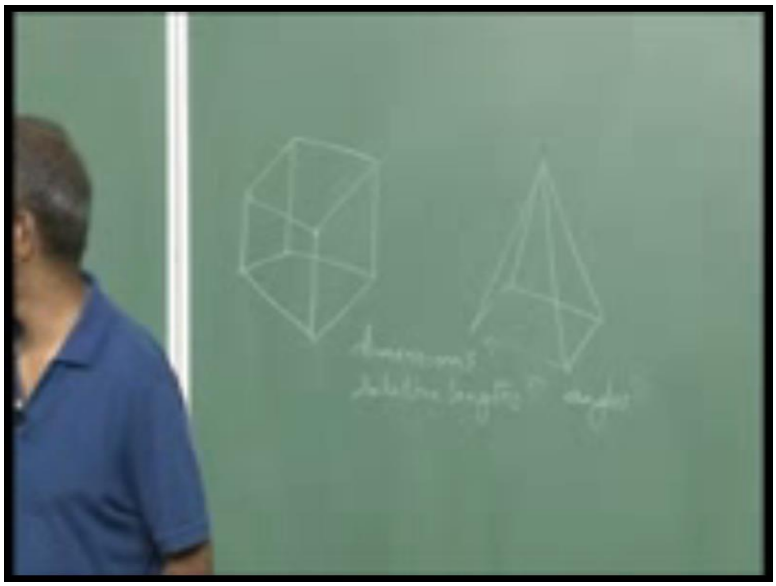

You know if I draw something like this perhaps it is not very difficult for you to identity what is this? Is it is a cube for instance or if I draw something for instance this would be a pyramid with a square based. So, these are sketches that you know people would understand, but how about the dimensions how about relative lengths or angles for that matter. So, these are thinks that you know manufacturers architects, builders, engineers designers they would use to be able to you know accomplish what this sketch would stand for or would this sketch it is stand for, right? So, these are details which were not present in those sketches. Monge formulized the technical drawings what we know as orthographic projections. The first few lectures will actually be dedicated to these projections and will learn more about them or other projections or other ways of representing different solids or different drawings.

Later in this course the scheme was quickly adopted by army engineers you know first in France and worldwide. And after the war it was accepted worldwide and formed the backbone for industrial revolution. You know look at the buildings we have around us look at the engineering marvels the cars; the trains; the bullet trains; the aircrafts. Existence of all of which probably would not have been possible unless we had a drawings or sketches being represented uniformly. So, the objective in this course is to learn technical drawing and theory as well as in practice using drafting tools and free hand sketches. Once again the objective is to learn the technical drawing or technical art

in theory and practice using drafting tools and free hand sketches. And we will do that you know in the next 40 hours that will devote to this course.

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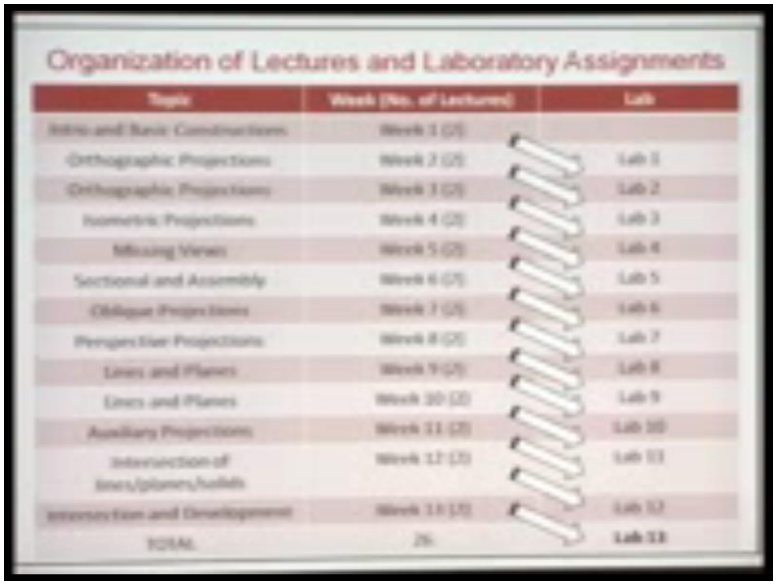

So, this is organization of lectures and laboratory assignments that we have planned week 1. Essentially we will have 2 lectures on introduction and basic construction on week 2. Again 2 lectures on orthographic projections, week 3, 2 lectures on orthographic projection, week 4 on isometric projections, week 5 on missing lines. And views week 6 on section and assembly, week 7 on oblique projection you know caviar and cabinet week 8 on perspective projections. Week 9 and 10 4 lectures over here on lines and planes week 11 will be on auxiliary projections week 12. And week 13 be devoted to the topics intersection of lines planes and solids and intersection and development. So, in all we will have about 26 lectures and will have about 13 labs so each lab will be of 3 hour each. So, lot of work that lies head of us.

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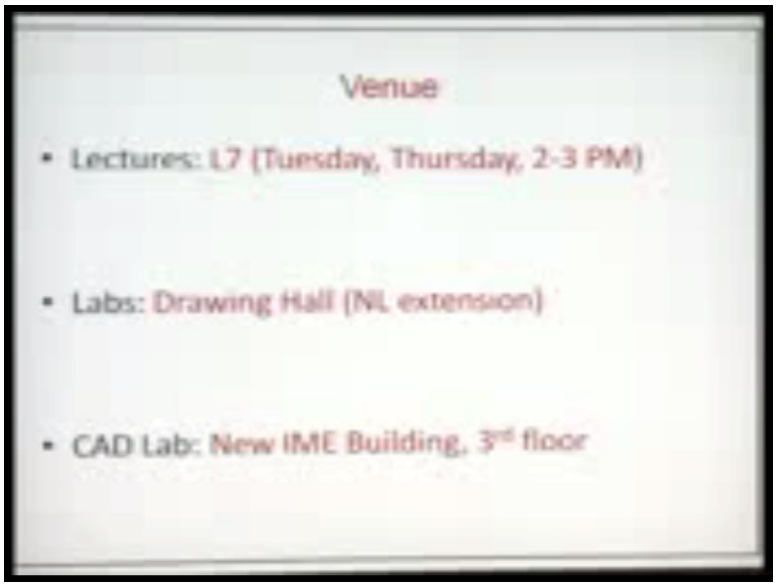

So the lectures will be held in L 7 today's Tuesday and Thursday from 2 to 3 PM. Labs will be held in drawing hall, which is the extension of the NL lab and will properly have 1 or 2 labs on auto cad which will be held in the new IME building on third floor.

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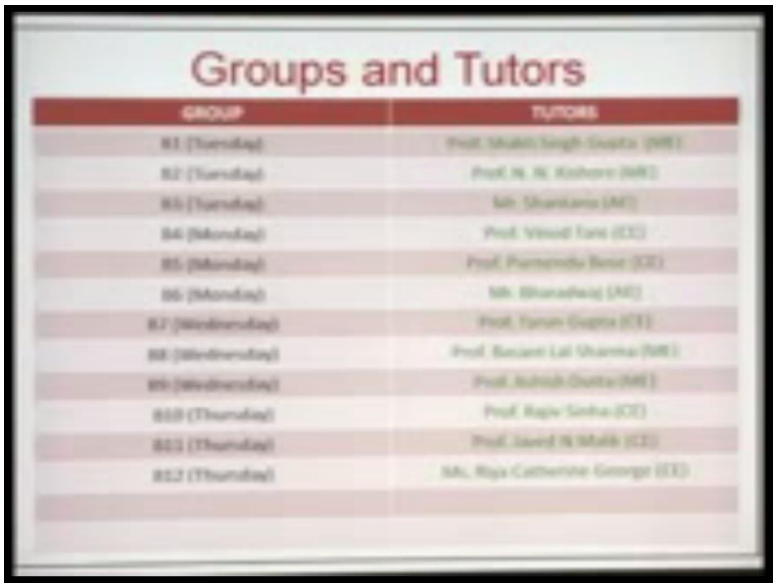

Alright so, your class is divided into 12 groups of I would say 40 student each on an average B 1 B 2 B 3. They will be doing labs on Tuesday tutors are Prof Shakti Singh Gupta, Prof N. N. Kishore and mister Shanthanu. The first two from mechanical engineer and second from or rather, third from aeronautical engineering B 4 B 5 B 6. They will do

the labs on Monday and you will have professors are Prof Bose and Prof or rather mister Bharadwaj as your respective tutors sections B 7 B 8 B 9 are planned for Wednesday with Tarun gupta, Basantlal Sharma And Ashish Dutta from civil and mechanical engineering and B 10 to B 12 they will be doing labs on Thursday with Rajiv Sinha, Javed Malik and Riya Caterine George. All from civil engineering the grading policy you know since they are going to be working a lot in your labs.

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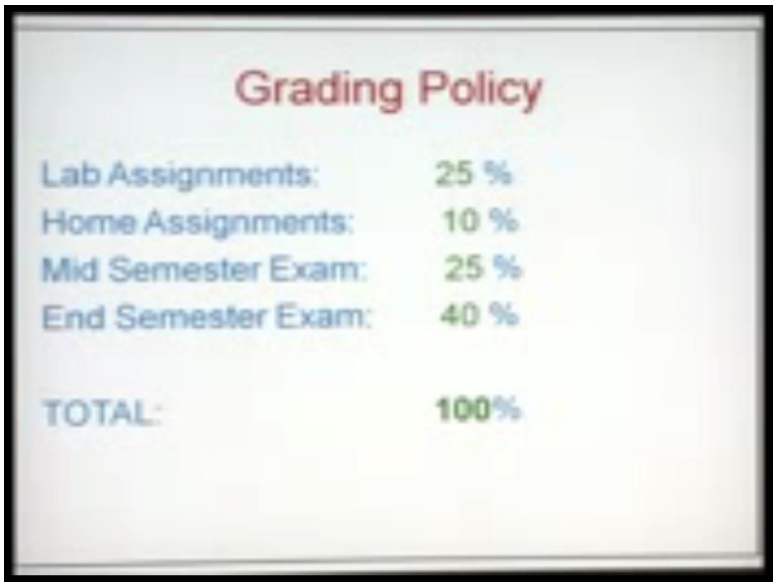

We have decided that will assign about 25 percent of a grade to your labs your lab work home assignments you will be doing them quite a bit. So, 10 percent for that mid semester examination 25 percent end semester examination 40 percent. So, 25 plus 25 50 10 plus 40 50 overall 100 percent and there would be a certain extra credit assignments that I may be giving that all add to it. So, just in case if you are doing better than what you are what rather what you are. Then of course, you will be expecting or you may expect you know more than 100 percent marks and there will be there will be pretty interesting there will be pretty nice.

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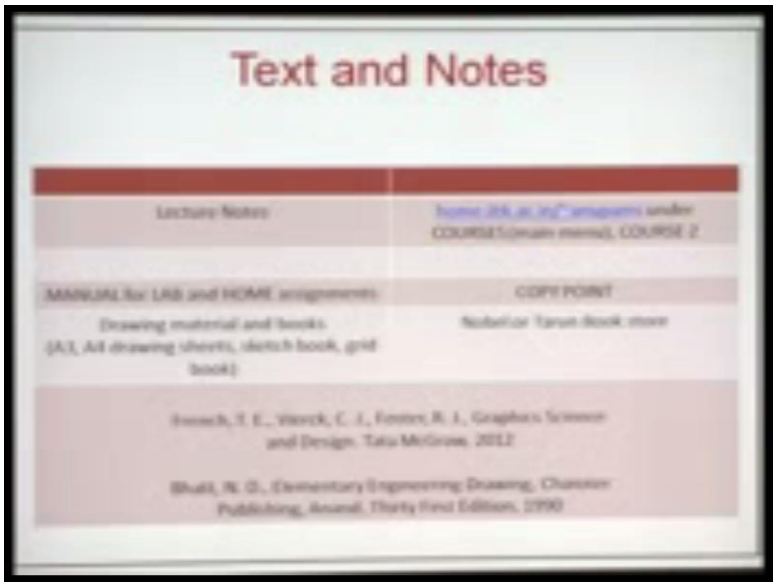

So, the lecture notes are going to be hosted on my web page home dot IIT k dot a c dot in slash till the Anupam s under courses in the main menu. And this is listed under course 2 T A 101 is listed under course 2. We will have a manual for lab and home assignments you know you can seek or you can buy drawing material and books. Essentially A 3 sheets A 4 sheets sketch book, grid book pretty much of that from Nobel book store or Tarun book store in the IIT campus. And we will be using primarily 2 books as a text French vie rick and foster graphic science and design published by Tata Mc Graw hills 2 1012. And another book by N. D. Bhatt on elementary engineering drawing charotar publishing Anand I think this is in Gujarat this it thirty first edition 1990, so 2 books that we will be using.

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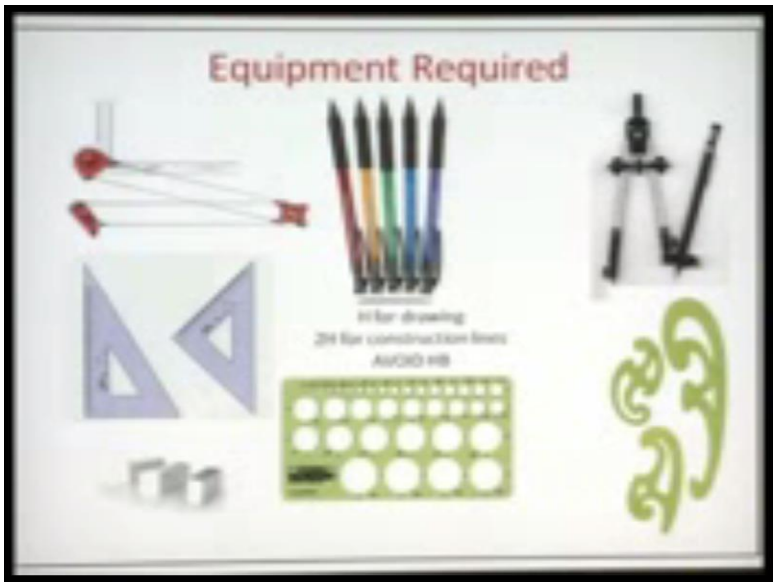

Equipment required; you will probably not able to do your drawings without these equipments. So, this is the many draft here a set of set squares this I think is a 45 45 90 and another one 60 30 90 you will have bunch of erasers what I recommend is a 0.5 led pencil. So, you will be doing some construction lines and you will be doing some main lines for the construction lines I usually use and recommend 2 H pencil or 2 H led. And for the drawing I recommend H led a pencil that heads avoid. You know spoiling of sheet just in case if I have to use the eraser one thing I also recommend is the use of this stencil full of circles. You know for smaller circle it is a lot easier and lot neater for all of us to draw circles using this stencil. Otherwise for largest circle we will have a compass and for veered looking curves you might funny use set of French curves you know to connect the dots and give them a smooth. So, all these should be available with or with Nobel book store or Tarun book store in the campus.

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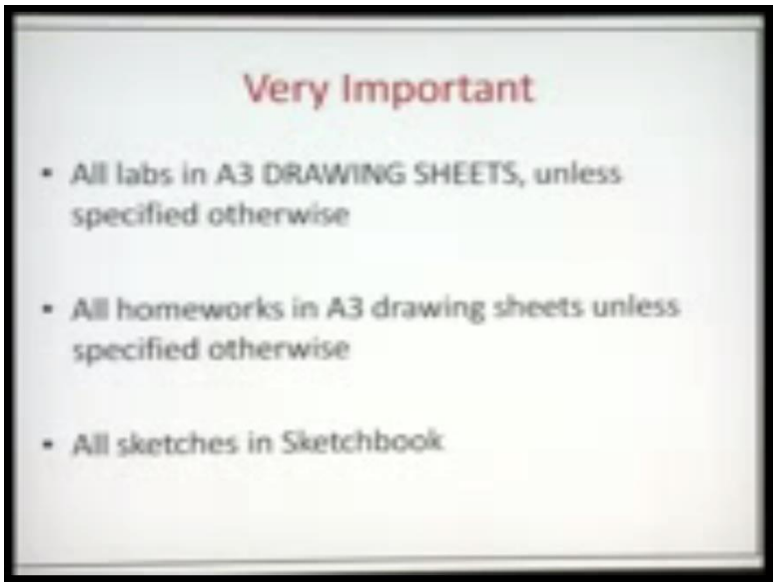

Now, few things which I would actually want you to note which are very important all labs are to be done in A 3 drawing sheets unless specified. Otherwise all home works again in A 3 drawing sheets unless specified otherwise and all sketches in sketch book. It is always a nice idea to come prepared for your sub sequent lab and you know working out your sketches in sketch book would be a nice idea. So, that way you will not be wasting lot of time you know scratching your head looking left right rather you would you know what you need to do in your lab if you at here to this third point. So, let us get started with some query.

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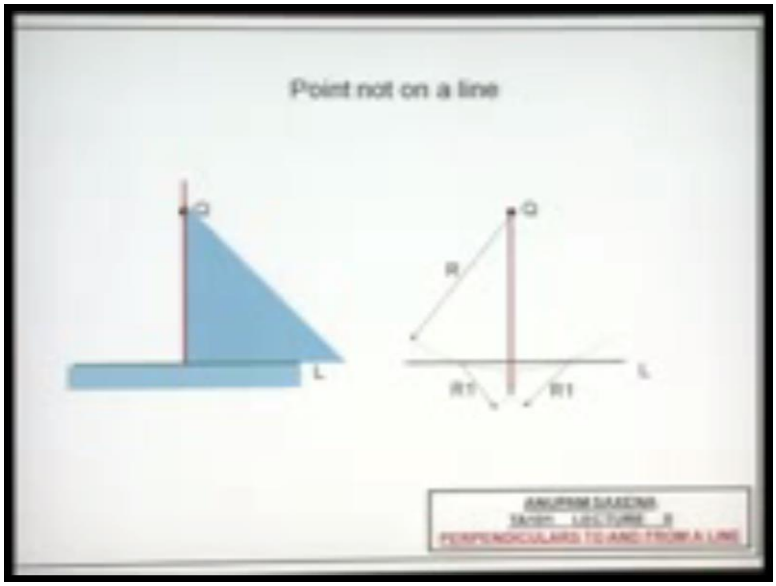

You will draw some perpendiculars to and from a line what kind of methods to be used for that. Well, so let us take a case where a point not on a line so you have a line L. You have point somewhere here not in line; you would like to draw perpendiculars from that point onto that line. So, let that point be Q you know the easiest thing that you would do is you would place a ruler with one of the edges on the line and the angle take a setsquare with one of the edges on the ruler. So, this would be I guess A 39 45 5 setsquare and you would place the other edge of the setsquare.

So, that it virtually passes to this point and then you would draw this line you know this is how not straight forward alright. So, another case we have a line here a point here rather it is a similar case. But in this case let us see if we do not use a ruler an d a setsquare. What do we or how do we draw a perpendicular perhaps? It is using a compass. Let us see so you know so we will take a compass will measure this distance and with radius larger than this distance will draw an arc which would be cutting this line in 2 points point here and point here. So, this the radius R which is greater than this distance.

And from this point over here we will draw another arc that is going to be cutting this arc. Let us say let us say this radius is arc 1 which I think it is slightly larger than the distance this distance over here. I am with the same radius R 1, we are going to be making another arc now what will be having is this point over here. And if you join this point with point Q this red line will be perpendicular to the line in question. So, this was the case where we had used a ruler and a setsquare this is an identical case where we did not use these geometrical entities rather we only use compass. These are you know things that you probably remember from the grade school.

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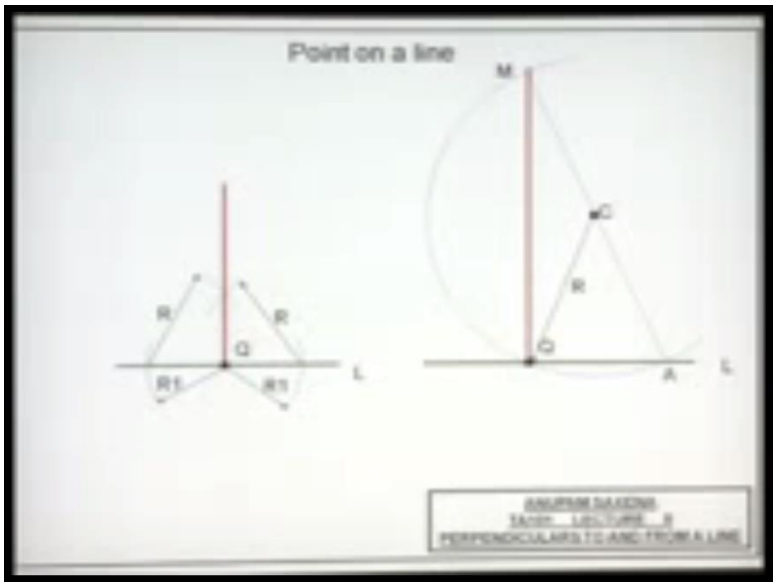

Point on a line; so, the previous case was when the point was not on the line what if the point is on the line, what you do in this case? So line L or point on line L Q. So, you are going to be drawing an arc with radius R again one. You will be drawing another arc on the other side of the line again with radius R 1 with radius R 2 or R and center. This point you going to be drawing in R Q and again the same thing so with this as center and radius as R. So, this R I think would be slightly larger than R 1 or maybe a little more larger than R 1 and the intersection point over here. If you join this point with point Q you are going to be having a line in red perpendicular to the line in green line L point on the line.

Let us say we have another point see which is not on the line we take this distance R distance C Q. And we draw a large arc you have c at center let that arc cut the line at point A. I would join point A and C and I would probably extended to insect with the arc over here. Let me call that intersection point as M and M is such that if I draw a line joining M in Q. This line is going to be perpendicular to the original line L try to prove this again. So, this course is about thinking an analyzing. So, whatever constructions we have discussed so far go back to your hostel rooms and try to work it out algebraically whether really all these red lines in different cases happened to be perpendicular to green lines. I am sure the poof is or proves rather are not very difficult arctangents to lines and arcs.

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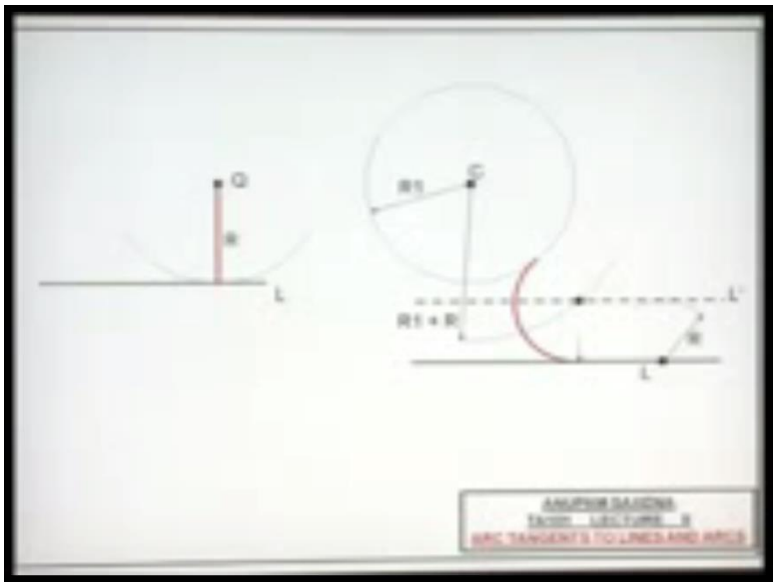

So, we have a line L we have a point Q or let us we draw perpendicular from Q to L. You know actually you have studied four cases just about how to draw perpendiculars line let this distance the R that is very straight forward you know. So, just take a compass take Q as center this as radius draw an arc straight forward about this one line L oh that is a big circle alright. So, we have a center for that circle let us call that center c so let us with this circle have radius R 1 alright. So, what are we doing here I guess we are looking for an arc one which is common to this circle and the line alright.

So, let us see how we do that let us take any point on the line and draw an arc you know of radius R. Let us draw line parallel to this line L you know tangent to this arc Let us call this line L prime now with c as center and the radius as R 1 plus R. Let us draw an arc that cuts this dashed line L prime here now with this as center. It is possible for us to draw an arc which is tangent to both the circle and the line and of course, this arc is of radius. So, I guess the problem was you know given a line and a circle and given a number R. How do we draw an arc of radius R that is tangent to both the circle and the line? So, this is how we draw that this is R.

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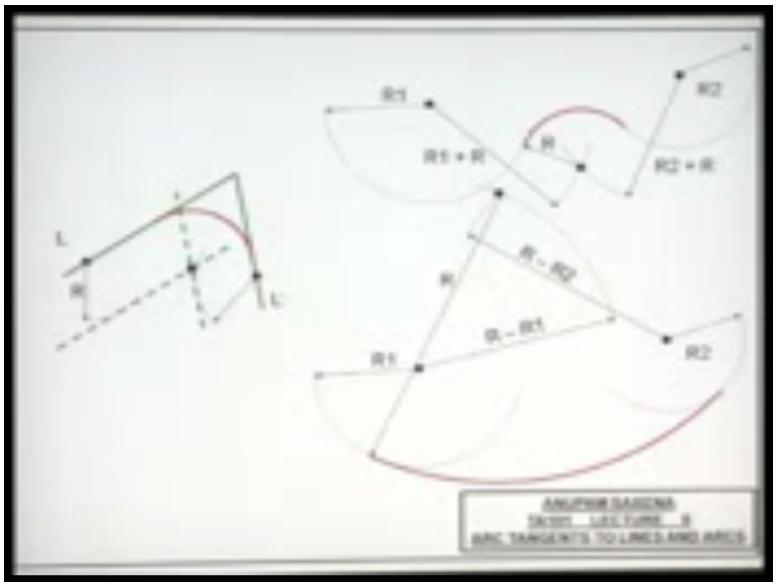

So, we have a point we have a circle let us say we have an arc we have another arc here. So, the first arc has a center and radius R 1 and the second arc has a center and radius R 2. So, this arc with this as center if we draw this arc of radius R 1 plus R and this as center if you draw another arc of radius R 2 plus R. Then we will get this center over here and with this center it will possible for us to draw an arc or radius R which is tangent to both the circles. The problem here was you know give in a circle with center here radius R 1 another circle or arc with center here radius R 2 and at number R. How do you draw an arc which is tangent to both the circles?

So, this is what the solution once again alright so this is the problem given draw an arc, with this a center and radius R 1 plus R to an arc with this as center and radius R 2 plus R. You know get the intersection points of these 2 arcs right over here with this as center and radius as R draw an arc that is tangent to both the circles. You know how about solving this problem in a slightly different manner again so, given 2 arcs with the respective centers and radius R 1 R 2. Now, draw an arc with this as center and radius R minus R 1. So, R is given to us let us say and draw another arc with this as center and radius R minus R 2. So, with this as intersection point the center and with radius R it is possible for you to draw an arc with this tangent to both this arcs, but you know this would actually be encompassing both the circles.

So, you know slightly different angle to the same prob of course,, this radius is R which larger than R 1 and larger than R 2. Alright, so given line L and L prime you know take any point on this line draw an arc of radius R. Draw a line which is parallel to this line you know with any point over here on line L prime to an arc of radius rand draw a line parallel to this line. So, you will actually be having these 2 dashed lines intersecting in some point and with this point is center and the radius R. It is possible for you to draw an arc which is tangent to both these lines; you know these are constructs or constructions that you are very well aware of from your grade school.

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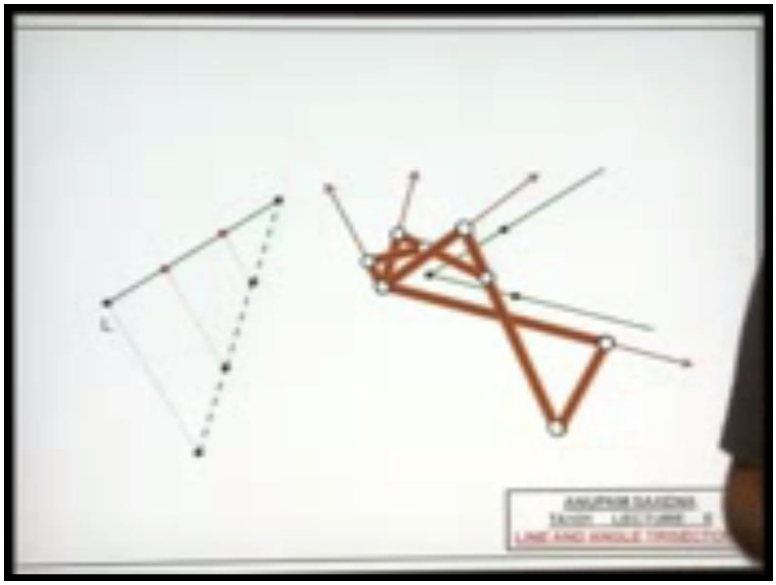

Line and angle by sectors again so the something that you probably have learnt in the eighth or ninth grade or even earlier. So, given a line so draw this arc with this as center and radius slightly larger than have the length of this line and vice versa. You know with this as center same radius draw this arc over here if you join these 2 points this essential or this line, but essentially be bisecting this line into 2 parts. So, it is actually going to be a perpendicular bisector it is probably not very clear. So, figure about that is how it is going be again so these 2 lines with this as center to an arc.

So, this arc is going to be intersecting this line and this line in these 2 points with the same radius or maybe a different radius I guess with this as center drawn an arc. With this as center draw an arc I guess it has to be the same center go back to your grades grown under figure. So, the intersection points between these 2 arcs would actually give

you point. So, if you join what am I saying so, the intersection of these 2 arcs will give your point. And if you join these points with this point the result essentially will be a that would be an angle or bisector defined by these 2 lines. So, essentially this angle will be the same as this angle how about bisection.

So, given a line you know draw another line over here could be of any angle do by this line into 3 parts 3 equal parts you know. So, this length; this length and this length they are the same. Join the end point of this segment with the original segment and you know draw these lines parallel to this line. And essentially these points will ensure that this line gets try sector divided into 3 equal parts, can we do the same thing for this angle? Let us say it is so, happens that using a ruler and a compass. It is impossible for you to trisect this angle what this something called a multiplicator or an angle trisector. It is a mechanical device that looks like this.

So, if you essentially have this link so such a link edge you know. So, if you have this link is placed on one of the edges of this angle. And this link placed on the other edge it is possible for you to trisect the angle I am sorry if you place this link on this edge and if you place this link on this edge. So, these 2 links will essentially be giving you the lines over here and over here in such a way that this angle is going to be divided into 3 equal parts. So, it is called an angle multiplicator, a mechanical link edge that was initially you can see it by A B campaign. Alright I will stop now, and I would request you to keep thinking and analyzing. So, I will come back in the next lecture.