Optimization
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Lecture - 16
Project Management

Today, we are going to start the next topic that is project management. Basically, whenever you are having a project, a large project it may be related to construction, it may be related to R and D. A large project is there how to complete the project or how to handle the project that we want to discuss in today's class; different mechanisms are available methods are available for optimising the projects.

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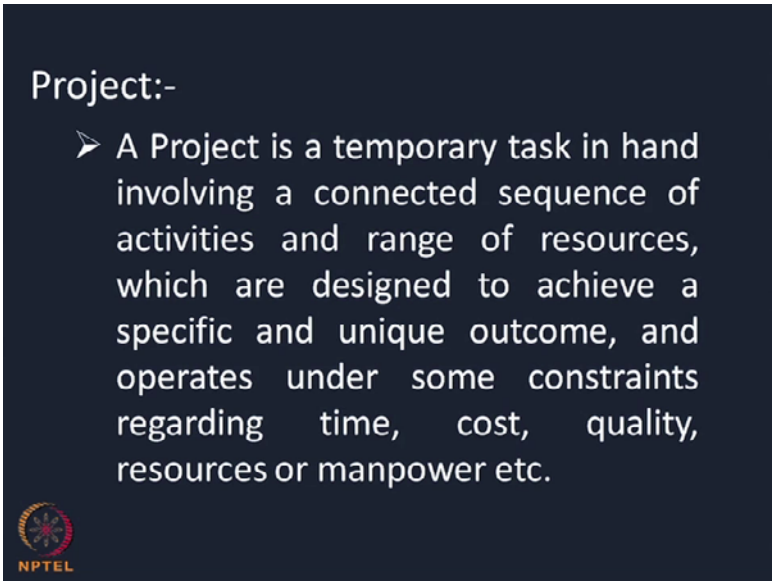

Let us see what is a project? A project is a temporary task in hand involving a connected sequence of activities and range of resources, which are designed to achieve a specific and unique outcome, and operates under some constraints regarding time, cost quality, resources or manpower etcetera; that is you have a sequence of connected activities are there. And, for that you are having a resources, a set of resources using the resources we have to design the task in such a way that we have to achieve a goal. And, for that we have certain constraints as we have told the constraints may be regarding time, it may be regarding cost, it may be regarding quality, or it may be regarding resource or manpower.

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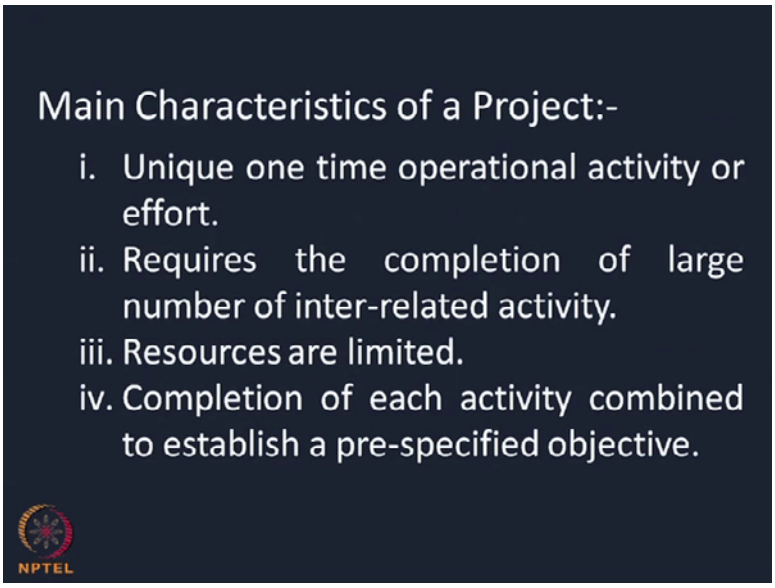

The next is; what are the characteristics of a project. So, basically when we are talking about the project that is you want to handle a situation where you have to solve or you have to perform a task for which you are having a particular goal. And, to achieve the goal; you have to perform either sequentially the activities or sometimes the activities may have to be performed parallely also, and the constraints are there.

Now, let us see their main characteristics of the projects. The number 1 is unique one time operational activity or effort; that means, the initially what you are telling operationally you have to do it the each activity or effort has to be performed only once and the activities are unique in nature. Please, note this one. The activities are unique in nature. Number 2 is requires the completion of large number of interrelated activities. That is you have some activities, the activities are interrelated, and you have to complete those interrelated activities. And so, interrelated activities means I want to say that; if you cannot complete one activity, you cannot proceed to the next activity. Just like whenever, you are constructing a material, may be first you will design it then, you will thing about the materials, then you may think about the manpower something like that way.

Number 3 is the resources are limited. It is not that you have unlimited resources, resources means; it may be in terms of manpower, it may be in terms of capital, it may be in terms of investment, anything. So, we have to understand that the resources are

limited. And, to complete one activity there are certain budgetary amount is available. The time; it may be in terms of time, it may be in terms of money. Number 4 is completion of each activity combined to establish a pre-specified objective. That is whenever, you are completing one activity then you are basically, you are getting some objective was there and that objective has to be fulfilled. So, we are having the predefined objectives and whenever, I am completing one activity the objective has to be performed, the objective has to be fulfilled.

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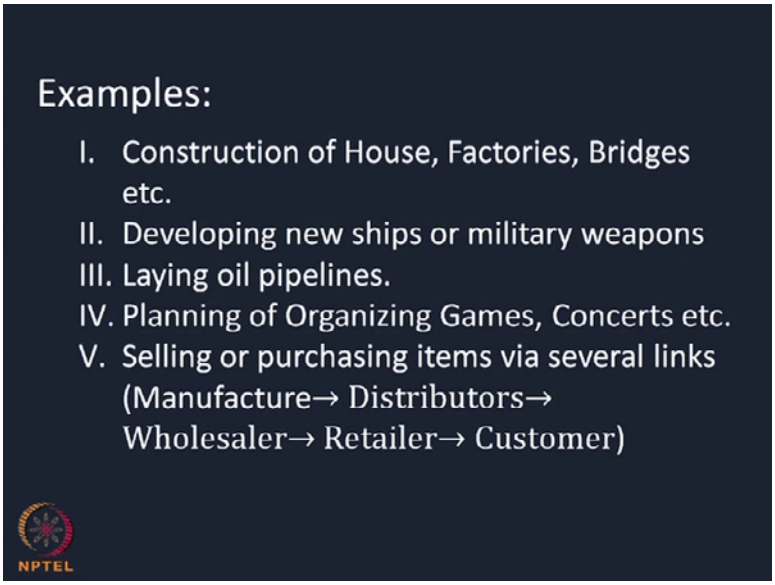

The examples of projects as I was telling, it may be construction of house, factories, bridge etcetera. Or, number 2 it may be you want to in terms of R and D developing new ships or the military weapons. Number 3 it may be laying the oil pipelines. Then, the planning of organising some games; just like your Olympic Games or world cup football, world cup cricket like this, similarly, the organization of the concerts. Selling or purchasing of items via several links, via several links means; manufacturer or purchasing or producing a particular item from the manufacturer. It is going to the distributor from distributor, it is coming to the wholesaler from wholesaler, it is going to the retailer from retailer again, it is coming back to the customer.

So, different forms are available and by this way I have to in the project, you are having different subsections. And, I have to complete this subsection. So, basically we want we

are interested whenever, a project is given to us, how to complete the different activities of the projects either sequentially or parallely to achieve the predefined goals.

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The next one is; what is project management? The project management we say that; it is the application of allocation of tools and techniques to direct use of diverse resources towards achieving a predefined goal within time cost quality constraint. So, please note this one that I have to, I have the tools, I have the techniques, I have different resources are available. So, I want to allocate the tools that I want to use the techniques and, I want to use the resources available. And, for these by these, what I want to achieve? I want to achieve some predefined goal.

Now, whenever you want to achieve some goal, some constraints are there. The constraints may be the time, it may be cost, it may be the quality. Time means; I have to build a bridge say within 6 months. So, my constraint is this one or sometimes it may happen that I have to complete a project within 1 crore rupees. So, that is my constraints or sometimes money does not matter, but; the quality matters. Just like for the R and D whenever, you are developing some weapon; what is the accuracy of the weapon it matters, not that how much money is required or how much time it takes, it matters. So, the objective I have to achieve some goal and for achieving the goal different kind of constraints are there depending upon what kind of projects you are handling.

Next is the task breakdown structure; whenever, you are having the project, I have to breakdown the task. So, number 1 we are telling that a method of breaking down a project into several parts in a hierarchical structure. Now, several parts means; I want to say, it may be component, it may be subcomponent, it may be activity, it may be task. Or, in other sense broadly if I say; I have to say that you have a large problem or the project you subdivide the problem that is you break the problem into some divisions. And, if required you again, break those subdivisions like this way you break into smaller problems.

That is you are having the large problem, and the large problem is being subdivided into very smaller problems. And, you can handle those smaller problems either sequentially or parallely and ultimately from hierarchically you have broken it. So, hierarchically from down, if you go up then, you will reach at the top that is you will achieve the goal. So, this we call as a task breakdown structure. The next point is; such tasks as I was telling can be completed independently with respect to other task, facilitating the resource allocation assignment of responsibilities and measurement and control of the projects. That is it may happen that some tasks can be completed independently without bothering, about whether other task has been completed or not.

And, sometimes you will find that there are some tasks which cannot be completed, unless you have done which cannot be taken up, unless you have taken or some other earlier tasks or predecessor tasks has been already completed. So, whenever you are breaking the project into some task or activities, there are 2 types of activities. Then, it may be there,1 is that you can parallely run some activities or perform some activities and there will be certain activities which cannot be performed until some earlier or previously defined activities has been completed. This is point number 2. And, point number 3 is there are certain constraints like due date, late penalties, early completion, incentive, budget etcetera.

Whenever, you are taking up a project always there must have a due date I have to complete it by this date. If I cannot complete it nowadays always there will be penalty clauses there, if you cannot complete it by 6 months if it is delayed by 1 month. Say there will be a penalty of one lakh rupees something like that. And, similarly; there may have early completion incentive, in place of 6 months if I can complete a job or project within say 5 and half months. I will get an extra amount of 2 percent or 3 percent. These

are early completion, incentives and similarly, we have the budgets, budgetary constraints are always available.

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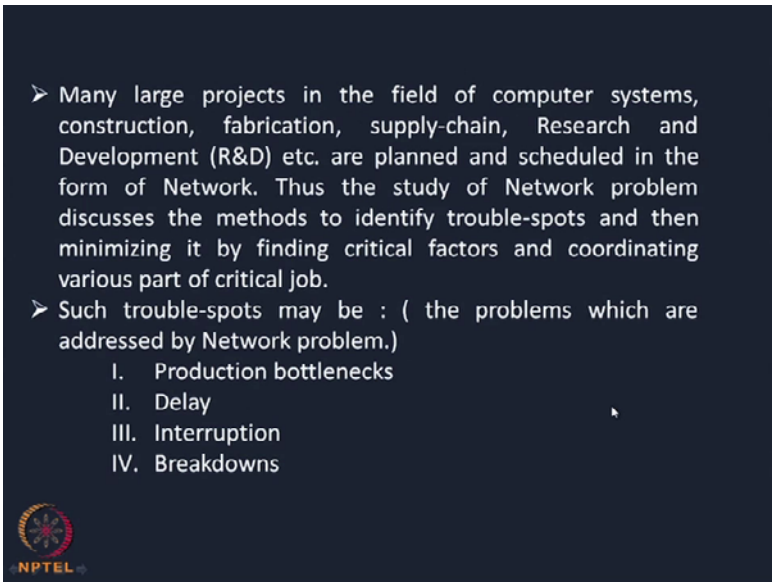

The many large projects in the field of computer system, construction, fabrication, supply-chain management, R and D that is research and that is Research and Development are planned and scheduled in the form of network. So, now we are using a new term that we are calling as network. As I have writ10 different fields I have writ10, in fields of computer science, or in the construction, or in the fabrication, supply chain, R and D. Wherever, you are having the project, the project basically; you are drawing.

You are drawing in some form, and that form you are telling as network that is different activities or task you are subdividing. As I was telling a project is there, the project has to be subdivided. So, once you are subdividing the project and you are getting different activities. Now, the activities paths can be shown through some diagram, through some graph, which we are calling as network or in other sense the project can be transformed in terms of retranslated in terms of some network.

The next is so, we have to basically, study the network problem, and here we want to discuss the methods to identify the trouble spots of the network problem. And, then we have to minimize it by finding the critical factor and coordinating the various parts of critical job. Basically, we are telling now, we are having some trouble spots in the network problem. What are the trouble spots? The trouble spots can be the production

bottleneck, it may be delay, it may be interruption, it may be breakdown, something like this.

So, I have told you production bottleneck; that is a want to produce something for this reason that reason, I cannot produce it. Similarly, I wanted to produce some item by 1 month, but; it got delayed, may be due to labour problem, due to shortage of labour, or due to unrest something like this. Similarly, different kind of interruptions can also occur. And, the last one is always machine can breakdown or the natural calamity may be there. So, for these reasons always, we have to take care of these problems, which we call as the trouble spot. And, from the trouble spot, we have to identify the trouble spot or take care of the trouble spot and then we have to minimise the critical factors and we have to find out the solution of the problem.

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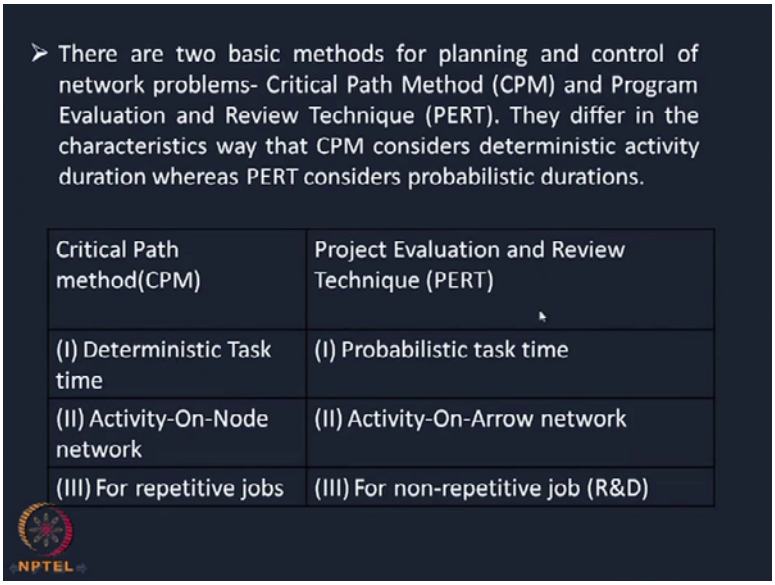

Now, as I was telling you that the problem can be or the project can be drawn in terms of sub network. And, from the network basically; we want to find out the solution. There are 2 basic methods for planning and control of network problems. As I was telling you, if you see one we call it as the critical path method or in short we call it C P M. Other one is the program evolution and review technique that is PERT. You see this one, 2 different techniques are there, 1 we are calling as critical path method in short afterwards I will call it as C P M. And, other one is P E R T that is program evaluation and review

technique. These are the 2 basic techniques which are used to solve the project management and all in other sense to solve the network problem.

Basically, that if you see they differ in one way that is C P M considers deterministic activity duration whereas, PERT considers the probabilistic activity duration. Now, you may ask what do you mean by probabilistic or what do you mean by deterministic and why we are differentiating? There may have some problems or some projects where I know to complete a project how much time is required or how much money is required, which is known to us, which is predefined. And, whose value is constant say, it will take 3 months, it will take 6 months something like that. So, the problems which are having the deterministic or known values those problems are solved by the C P M that is the critical path method.

Whereas, whenever you are trying to develop as a missile; when you are trying to develop a missile, you cannot tell the time range that I will complete it by say 1 year. It may take 1 year, it may take 8 months, it may take 1 year 2 months that is 14 months. So, by certainty you cannot say how much time it will take to complete one activity. To handle this type of situation by observing the previous data, we can say that my activity, or the activity time, or cost will follow some distribution. And, then we have to handle the activity as the, we have to take the activity as the probabilistic distribution.

So, whenever in a problem, network problem, or the project problem, project management problem, when your activities are taking the probabilistic values not the deterministic values. Then, we solve those types of problems using the PERT method that is program evaluation and review technique method. What are the basic differences between the PERT and C P M? Let us see this one, the basic differences as I number 1 is it takes deterministic task time, number 2, the PERT takes probabilistic task time. The activity on node network that is whatever activity you are doing that is a node network. Whereas, activity is performed on the arrow network, the difference will be clear whenever, we are handling the problems of C P M and PERT respectively.

Now, C P M is used for repetitive jobs whereas, for non-repetitive jobs we use usually PERT. That is for repetitive jobs means; I want to say that some problems which can be repeated, some activities which can be repeated, for those kind of problems we use C P M. Whereas, in R and D usually the problems are unique they cannot be clubbed with the

earlier defined problems. So, they are non-repetitive jobs therefore, those problems are solved by the PERT method.

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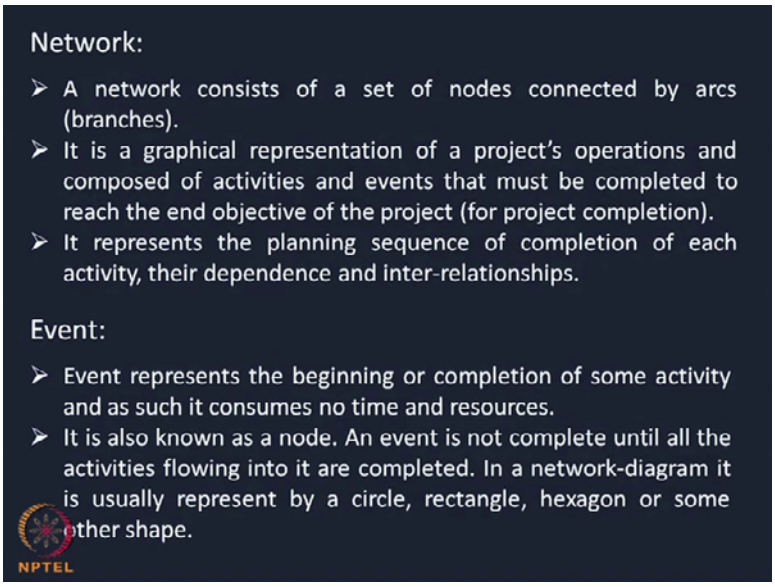

Now, come to the network; let us see first through the network, how to draw from a project, how to draw the corresponding network then, we will see how C P M works then, we will see how PERT works, this is our basic idea. So, what is a network? A network we say that it is a consist of a set of nodes connected by arcs or branches. That is if you tell if it is something like this.

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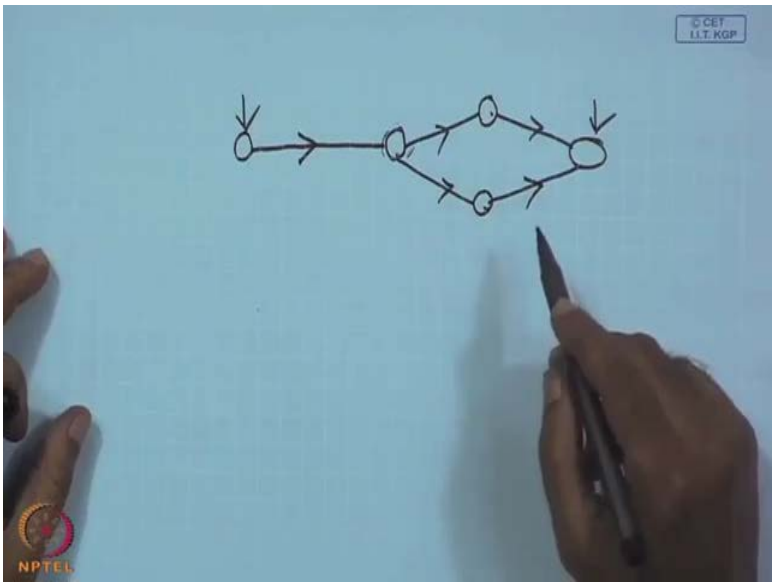

If I draw something like this, I may say this is a node, this is another node and you are drawing this it may be connected by some arc. So, as I was telling you the network is consisting of a set of nodes connected by some arcs or connected by some branches. The next one is we say, it is a graphical representation of projects operation. Graphical representation of projects operation; that is as the project flows graphically you are representing it. And, it is composed of activities and events that must be completed to reach the end of the end objective of the project. So, basically now we are telling that the in the graphical representation there will be activities, there will be events, and those activities and events has to be completed to achieve our desired goal.

So, if you can say something like this way, I have drawn this from here, I may go something like this, like this, and from here, I am achieving this one. So, it may be something like this. So, this is my starting position, this is my goal that is this is my ending position. So, different activities are there, you are drawing the flows. And, the activities have to be completed in time, just like if you see this activity. Unless this activity is completed I cannot start neither this activity nor this activity.

So, whenever you are graphically representing your problem that we are calling as network. So, basically what it happens, I can say that your network is nothing, but the, is a planning of sequence of completion of each activity. Planning of sequence of completion of each activity, and to get and, what is the relationship among them. That is if you see from here, these are the different activities. Once I am completing this activity, I am going over here. So, I am planning that the sequence in which different activities will be completed so, that I can achieve my goal.

So, my next point is now, what is an event? If you see event represents the beginning or completion of some activity and as such it consumes no time and resources. So, basically what I am telling beginning or completion, what is an event? I want to do something; I want to make a soil test. So, this is an event. So, for event this event has to start has to end for any event it does not associate any time or any cost. But for the activity that is for soil testing this is an activity. For this activity you require sometime, you require some money.

So, it is also known as; if you see is a, we also call it as a node. And, event is not complete until all activities following it following into it are completed. That is

whatever, activities before that is there if that in not completed we say that the activity will not be completed. Just like if you take this one, it will be completed only before this initial and this activity is being completed. And, so in a network diagram; as I am showing you usually the activity or the event is represented sometimes by circle. As I have shown here, it may be by a rectangle, it may be by a hexagon, or it may be by some other shape.

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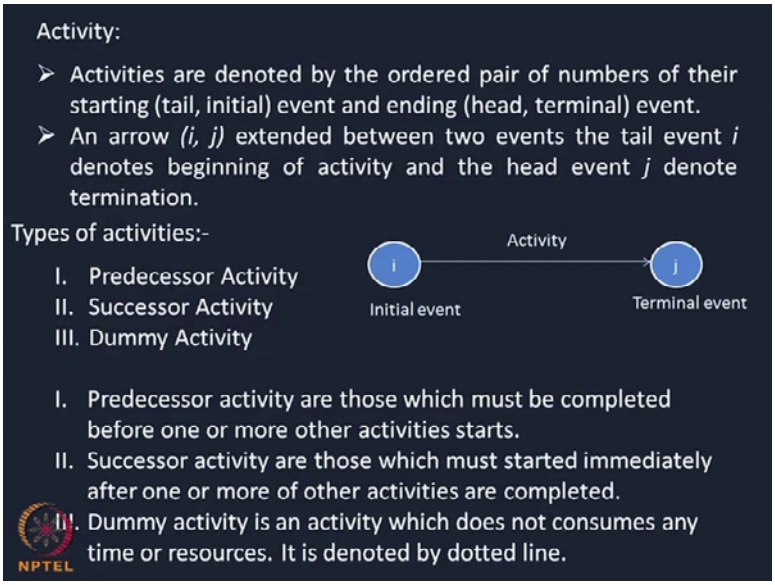

Let us see this one as I have writ10 at last; it is represented as in a network diagram, it is represented as by a circle, rectangle, hexagon, or by some other spaces. Now, the activity as I have showing you, I am formally now, we are defining. Activities are denoted by the ordered pair of numbers of the starting, it may be tail, it may be initial event, and there will be one ending event. So, basically there is one starting event, and there is one ending event. And, an arrow I to J if you see the figure, in the figure I to J extends between 2 events.

Where the, we tell that the initial event or the tail event is I, which marks the beginning of the activity and J is the head event. So, please and that is the terminating event. In our figure if you see; if you see this one, in this is the starting event, this is the ending event. Whereas, as this the initial event this we call as the tail, and this we call as the head. And, arrows are there depending upon the arrow you are deciding which one is the tail or

which one is the head. So, depending on this arrow, you are telling this is the tail, this is the head.

Now, different type of activities are available you see, in the p p t these are predecessor activity, successor activity, dummy activity. Now, what is predecessor activity? Predecessor activity, are those which must be completed before one or more other activities start or before whenever, you are staring one activity, if you see before you starting one activity, before that if some activities are there, those activities must be completed or in other sense in this figure here, if you see; if I think about this activity the predecessor activity of these are this one and this one.

So, these 2 are the predecessor activity of this that is which must be completed before one or this activity starts. So, before this starts these activities have to be completed and these activities are known as the predecessor activities. Similarly, your successor activities are those, which must start immediately after one or more of other activities are completed. That is in the figure, if you see the successor activity of this one will be this activity, because; this must start after this. So, once I am completing this after this activity whatever activities are there those are successor activities basically, and whatever activities are there before this activity this we are calling as the predecessor activities.

And, there is one more type of activity, which we call as the dummy activity. Dummy activity is an activity which does not consume any time or resource. It is denoted by dotted line. So, you may ask that once you are telling that the dummy activity is the activity, which does not consume any time or resource. So, why it is required, there must have some reason for which we it is dummy activity is required.

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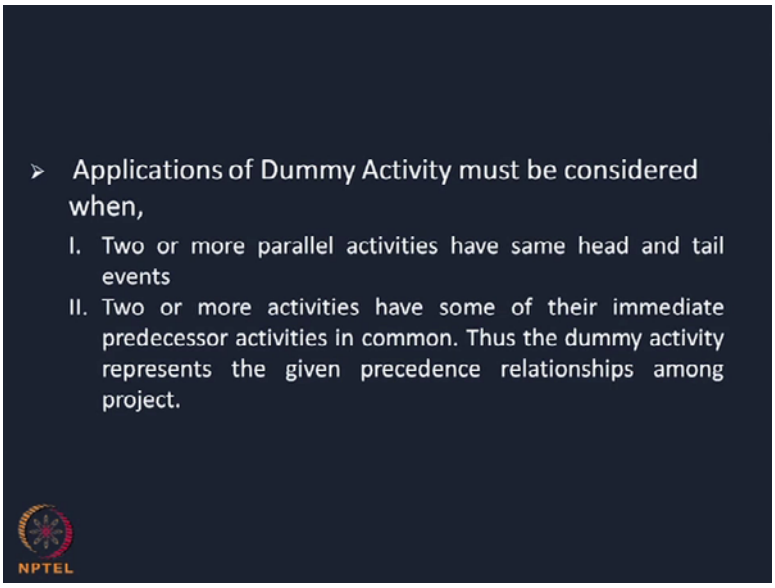

This we have writ10 here, application of dummy activity must be considered when; 2 or more parallel activities have same head and tail events. And, number 2 is 2 or more activities have some of their immediate predecessor activity in common. That is the dummy activity represents the given precedence relationship among the relations. It is something like this.

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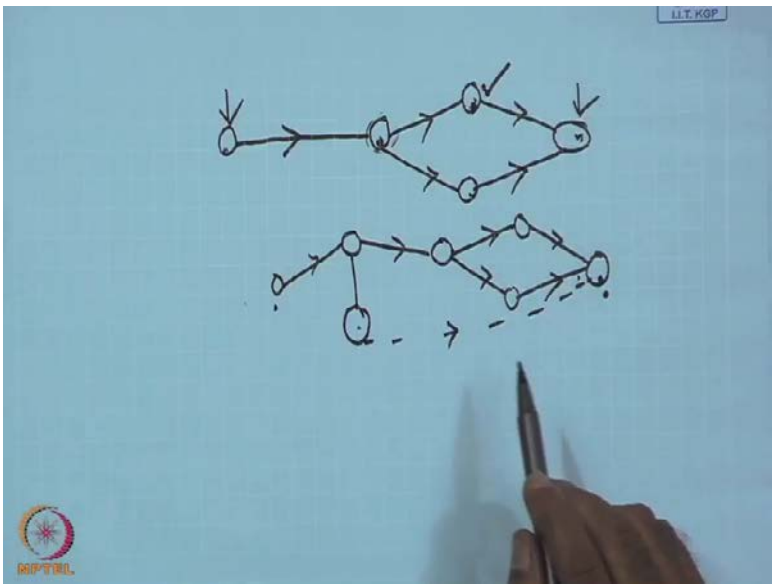

If you see, if you draw a figure, you have something like this from here, you have drawn this, you have drawn this one. From here, you are going to this say from here you are

coming to this side this side and from here you are coming to this. Usually, if you see the arrows are something like this. So, this is your starting activity and this is your ending activity. So, this is your goal, in general in a network problem what happens? Whenever, you are activity is there, it must have predecessor and it must have successor unless, it is the terminating node or terminating activity.

If you see this one, this is as predecessor, but it has no successor. So, basically after this it has nothing no activity has to be performed, in this case to complete the problem which I will discuss afterwards. Again, we draw some lines some activity like this, a dotted line is being writ10 drawn like this. So, that it can show that from here, it is basically going to the end node and this we call as the dummy activity just to complete the graph. That it has must a predecessor and it must have successor. And, for this reason we call it as the dummy activity, which does not require any cost or time.

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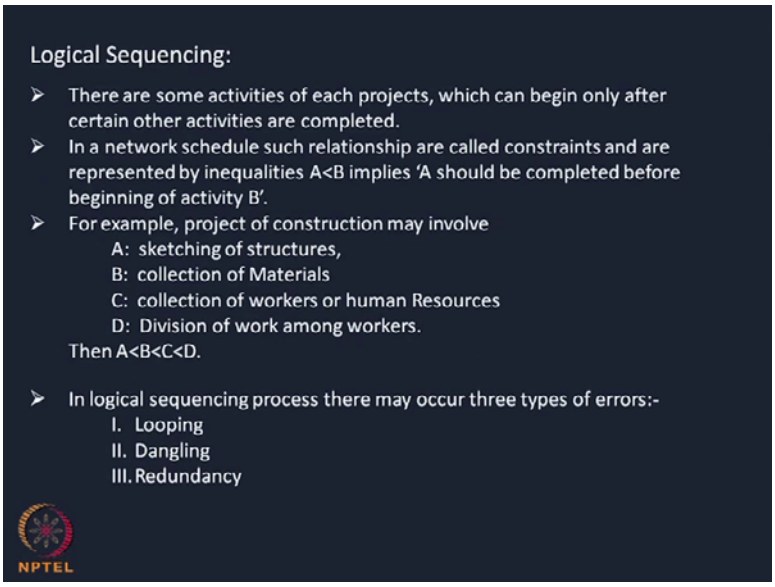

The next one is logical sequencing; there are some activities of each project, which can begin only after certain other activities has been completed. As I was telling the activities can start only when some other activities has been completed. In a network schedule such relationship are called constraints and we represent it by the inequality A less than B if you have writ10, I have writ10 here A is less than B, what is the meaning of A less than B? That means, A should be completed before B, before the beginning of the

activity B. That is A should be completed before the beginning of the activity B. So, please note this one.

So, if you see for an example we have 4 activities A B C and D. The project of construction A is sketching of the structure, B is collection of the material, C is collection of workers or human resource, D is the division of work among workers. Now, these are the different activities I have to perform A B C and D, A is the sketching of structure, B is the collection of materials, C is collection of workers or human resource, and D is the division of work among workers. So, if you see, unless I am completing the activities sketching of structure, I do not know how much material is required. Again, unless material is collected I cannot work with the, or I cannot find out the workers, or human resource who will work basically. And, then which people will work which kind of thing that I cannot divide.

So, that is the reason; the inequality can be here, A less than B less than C less than D. The meaning is that the first the sketching of structure has to be completed, and once the stretching of structure is completed than, only I can go for the activity collection of material. And, once the collection of material is completed then, only I can go for the next activity that is collection of workers or human resource. And, then I can go for division of work among workers. So, if you see; you have the project of construction of a say building, I divided into 4 activities, and here I have seen that the activities have to be performed sequentially. What is the sequence A B C and D? That is A less than B less than C less than D, you may find some activities which can be performed parallely. That is in one complete; in one housing project may be your building parallely 10 houses.

So, what you can do? You can draw the structure then, construction of material collection of material whenever, you are doing you can collect it at a time. And, when I am building the houses basically then, I can build it parallely. So, I want to say there will be some activities which has to be performed sequentially. There are some activities which can be performed the parallely. So, any project can be divided into several activities and the activities can be grouped whether they can be performed sequentially, whether they can be performed parallely, and what is the sequence? That is which activity has to be performed first or which activity should be performed. When this activity has been completed or like that. So, this we call as the logical sequencing. Now,

in logical sequencing process 3 types of errors may occur, what are the errors? If you see here one is looping, another one is dangling, another one is redundancy.

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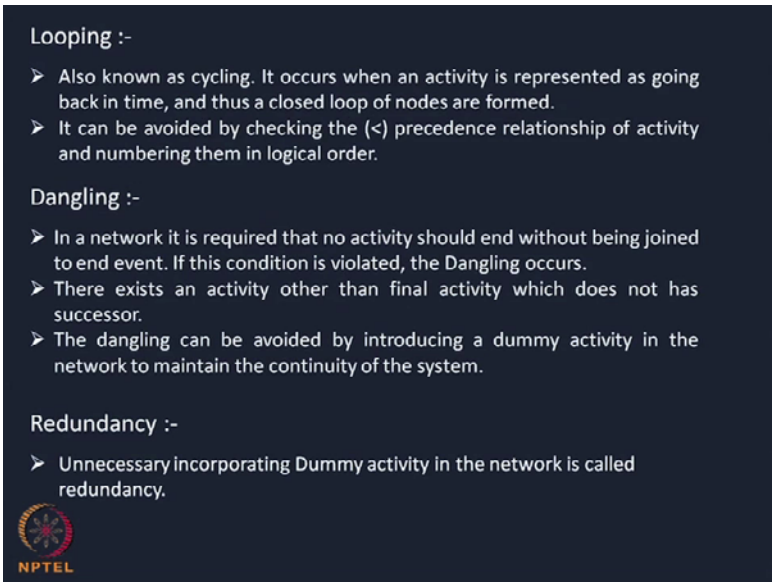

So, what is looping as you know, looping is your, it is also known as the cycling. That is looping we call it also as cycling. It occurs when an activity is represented as going back in time and thus a closed loop of nodes are formed.

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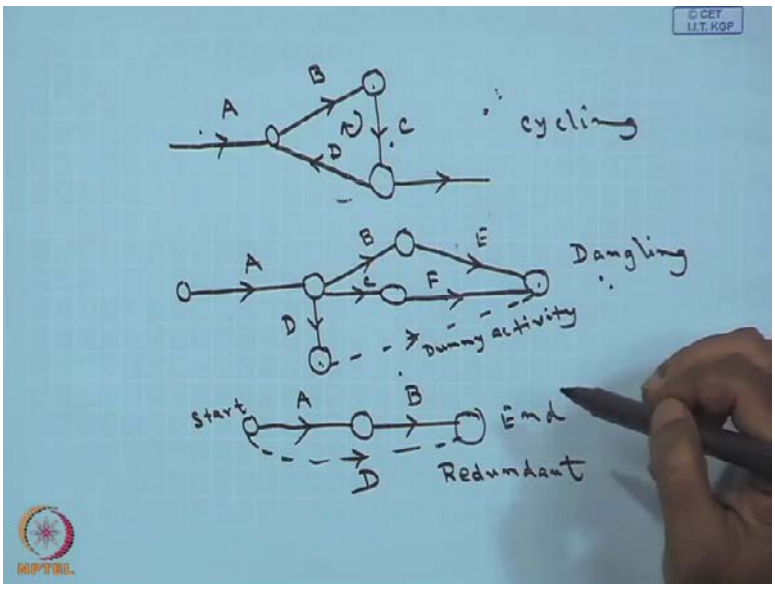

From the figure I think, it is not clear, but; you may see from here, from this one. You have an activity A say over here, from here you are going to the activity B. From B you

are performing another activity say C, from C it may be on this side and sorry not this C and from here you are performing another activity say D. So, basically if you see it is forming some cycle like this.

So, whenever you are having some approach something like this, then we call it as the looping. And so, whenever the what kind of errors I am telling that whenever, you are drawing the network then a looping can occur the looping looks like this. So, if you have the loop, then you cannot it you have to come out from the loop otherwise, you cannot complete the project. It is quite obvious; you cannot go to the other sides. So, how I can break the loop that we have written, it can be avoided by checking the precedence relationship. That is precedence relationship of activity and numbering them in logical order. That is depending on the precedence you can say from here, that this is completing this and, I can break anyone of them, this again we will see afterwards.

Then, the next one is if you see dangling. In a network, it is required that no activity should end without beginning being joined to end events, please note this one. In a network, if it is required that no activity should end without being joined to end events. I showed in basically in the last slide. If this condition is violated we say that the dangling occurs. And, number 2 is there exist an activity other than final activity which does not have any successor. So, basically there are 2 points; first point we are saying that there is no activity should end without being joined to the end event. There must have the starting and end event. So, it must join to the end event.

And, number 2 is each and every activity must have some successor. So, if you see you are having something like this, say this is activity A from here, you are doing something like B. And, from here you are going to say this is E, this is say C, this is from here to here say F and there is another one that is say D. You have a network like this. In this network this is the starting network, this is the ending network. If you see properly then, you will find that this particular D is not connected with the ending or in other sense, you can say it has no successor. So, this is a situation that this has no successor and this is not any way connected to the, this one.

So, how dangling can be avoided? Dangling can be avoided using the dummy activity. That is you can just add one dummy activity with this, and you can do something like this. So, this one we are calling as the basically dummy activity. So, whenever you have

something like this, there is one node which has no successor neither it is connected with the end node in that case using the dummy activity we can connect it. And, for this dummy activity means; effectively there is no activity between these 2 nodes, this node and this node. But to complete this one we are telling this. So, the time taken or the cost involved for the dummy activity will be 0. So, this is the second part which you are calling as. So, this was, this is cycling, this is your dangling.

And, the third one is redundancy; what is redundancy? Unnecessary incorporating dummy activity in the network is called redundancy. That is some dummy activity is not required at all, but; you have unnecessarily given that dummy activity that we call as the redundant activity. It is something like this, the redundancy can be shown like this, you have this one; 3 activities are there. So, basically this is your starting and this is your end. And, there is one dummy activity you have assigned here, from starting to end.

So, here we say that the D, this D is the dummy activity or the unnecessary activity. And, we call it as the redundant activity, because; for these 3 nodes always there is a predecessor and successor beyond the beyond this one, because; this is the ending node. So, this we call as redundant. So, whenever we are drawing the network I have to avoid these 3 types of errors one is cycling, another one is dangling, another one is redundancy.

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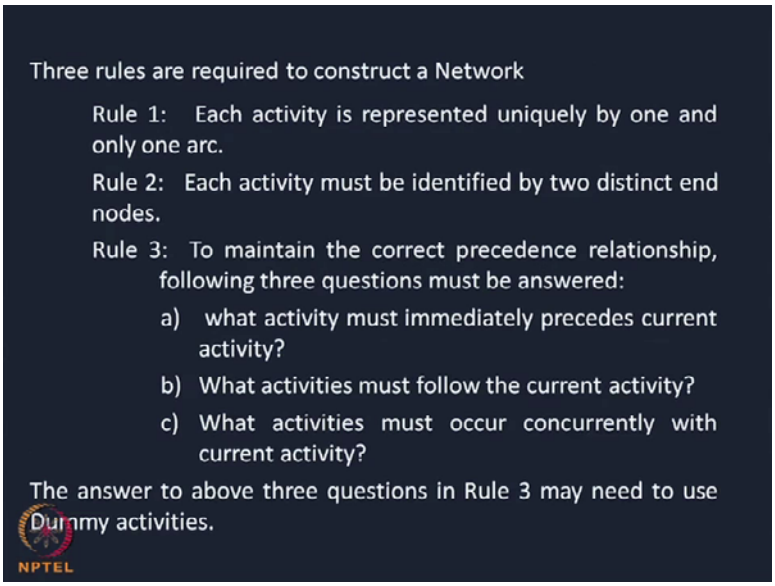

The next is; how to construct a network, some rules are there to construct a network. Basically, the rule one is each activity is represented uniquely by one and only one arc.

That is each activity whenever, you have the starting node and ending node in between them there will be only one arc; that is the flow only will be on one side, not more than one side. As I was drawing the flow cannot be on both directions and like this. So, each activity is represented uniquely by one and only one arc. Rule number 2 is; each activity must be identified 2 distinct end nodes. This again, you have already seen in the figure that there must have 2 distinct nodes from these 2 ends starting and ending. So, for each activity there must have distinct starting node, there must have distinct ending node.

Number 3; to maintain the correct precedence relationship basically, whenever we are drawing the following questions should be answered always. Number 1 what activity must immediately precede current activity? That is what are for the current activity before that what are the precedence or earlier activities are there that answer has to be there, before drawing the network. Number 2 is what activities must follow the current activity? So, the first one was what activity was there before the current activity, what activities are there just immediately after the current activity? And, number 3 what activities must occur concurrently with current activity? That is you are performing one activity concurrently can any other activity can be performed or not, this we call as the concurrently this one.

So, basically 3 things I have to think, one is what are the, for a current activity, before that what activities are there, after that what activities are there. And, number 3 is along with that, what other activities can be executed. So, this 3 if you can answer then, easily you can draw the network. The numbering of events or we call it as Fulkerson's rule, what is this? After the construction of each network, each event is assigned a unique number. Each event we are telling, we will see afterwards. Each event is being assigned by a unique number usually; the number may be 0, may be 1 or like this. We start with 0, 1, 2 something like this.

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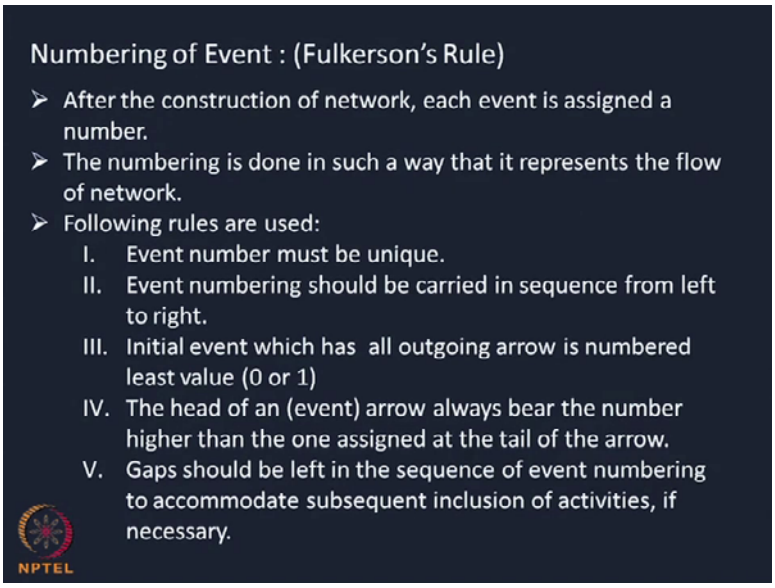

So, in each the numbering is done in such a way that; it represents the flow of the network. That is numbering means; I want to say 1 2 3 4 like this way. So, that from the number itself you can know, which work or which activity has to be completed first. And, then which activity should occur and like this way. After that the following rules should be used. Number 1; event number must be unique it has to be there, it should be unique, you cannot copy same number cannot be used in more than one place. Number 2; event numbering should be carried in sequence from left to right, please note this one. When, I was drawing, if you see.

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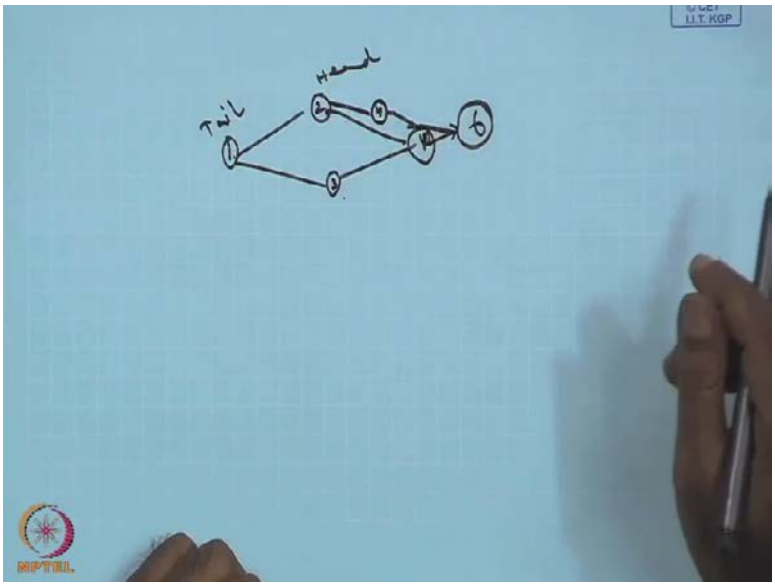

If you draw something like this, it has to be in the numbering should be from left to right this is your left. So, if I make one this may be 2, this may be 3 then, this may be 4 like this way. So, the numbering must be done from left to right on the increasing order 1 2 3 4 something like this way. The next is the event numbers initial event which has all outgoing arrows is numbered least value 0 or 1. Usually, we will start, we will see with 1. The initial event from where, we are going to the other events the number of that event has to be 1 or 0. The head of an event arrow always bear the number higher than the 1 assigned at the tail of the arrow. Again, it is obvious; the number of the tail should be lower than the number of the head. That is in the figure if you see from 1 to 2 this is your head this is your tail.

So, the numbering of the tail must be lower than the numbering of the head, this we want to say. And, the last point is the gaps should be left in the sequence of event numbering to accommodate subsequent inclusion of activities, if necessary. That means; we want to say, some numbers may be left in between. So, that some activities appearing afterwards we can readjust it. That is I want to say here, you have made a numbering 2 3 4 suppose, an activity has come over here. So, if I have given this number as say 6 then, very easily I can mark it as 4 and then I can go like this, this is something like this way.

So, some gaps whenever you are numbering usually, some gap should be even. Whenever, I am giving the gap it is for the betterment of us. So, that if some new activity is coming afterwards then, we can reallocate it. Otherwise I have to make some numbering as something like A B like this.

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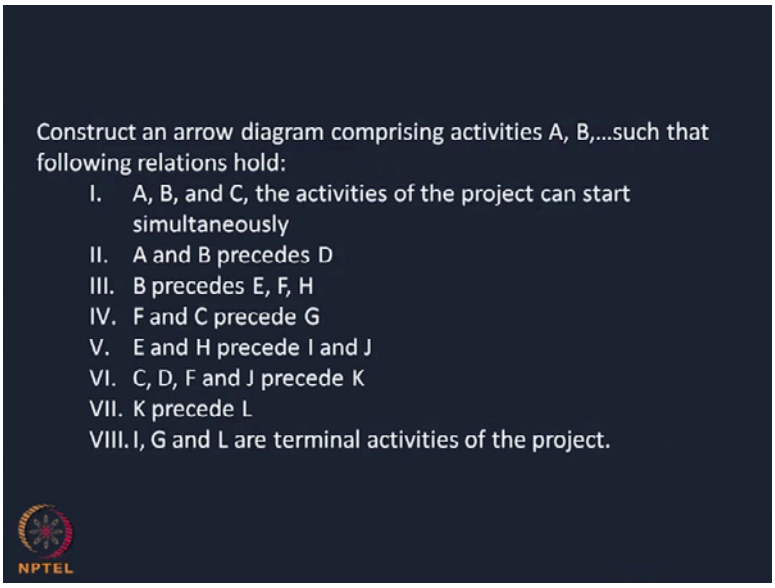

Now, let us see come to the next part; that is how to construct basically, one activity sorry, how to construct one network diagram. You just see the study the problem very carefully. Let me read the problem carefully and after that only I will go through the diagram. Construct an arrow diagram comprising activities A B something C D E F I J K L. Such that the following relation holds please, note. A B and C the activities of the project can start simultaneously. That is from the initial point 3 activities A B and C can be started simultaneously. Let me just read the problem first then, I am telling A and B precedes D. That is before D starts A and B must be completed. Similarly, B precedes E F and H that is before completion of starting of E F and H, B should complete. F and C precedes G then, next one is E and H precedes I and J. The sixth one is C D F and J precedes K and K precedes L, I J L are terminating activities.

So, we have told what are thus, which activities can be started simultaneously, and what are the terminating. So, now let us start how to draw this one. The first activity you see; A B and C the activities of the project can start simultaneously.

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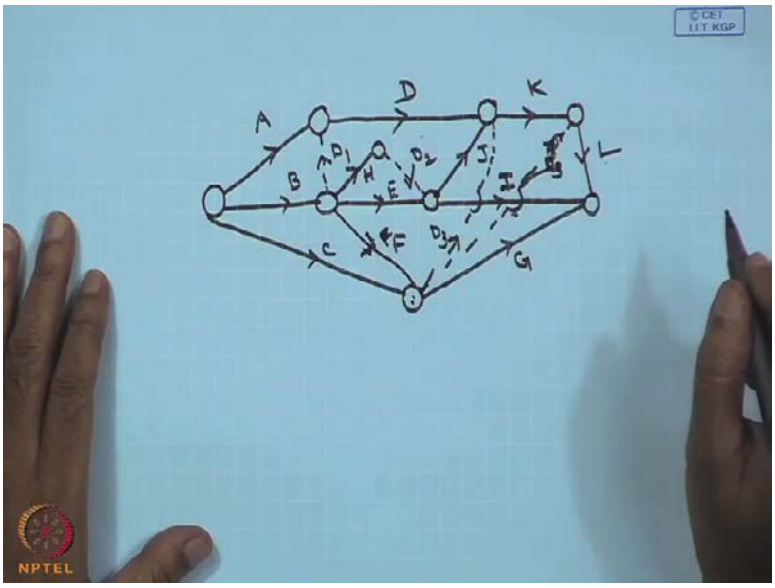

So, let us start this is your initial state; we have told A B and C the activities of the project can start simultaneously. So, this is your, we are just drawing, let me draw and then I will just. So, these are the 3 activities say, this is A this is B and this is C. So, to the project was given to me, if you see the problem A B and C the activities of the project can start simultaneously. So, we have drawn it A B and C can start, A B and C has started simultaneously they can work.

So, basically start simultaneously means; these 3 activities can be performed parallely not, sequentially please, make the difference. These activities can be performed parallely. The point number 2 is; A and B precedes D that is whenever, you are performing the activity D, before starting of the activity D, there A and B must be completed. So, I am writing say I am drawing here suppose this is D. So, what was the point number 2 A and B precedes D. That is before starting this D, this activity A and B should be completed. From here, it is quite obvious that A has been completed.

But from here I do not know whether B has been completed or not. And, unless B has been completed I cannot proceed to this, I cannot start this activity this one. So, what I have to do? Once B is completed here, from B to A I can use one dummy activity say D 1 please, note this thing. If I use a dummy activity D 1 then, when I will start this activity D, I am ensured that the activity A and the activity B has been completed already. But if you do not use this dummy activity D 1 you cannot say this thing. So, please again note

this thing. That here, I am using the dummy activity just to say that the activity B has been completed. Because once activity B has been completed, I am putting 1 dummy activity from B to A although, it is not there. This is the use of the dummy activity.

Let us see the point number 3; the point number 3 we are telling that B precedes E F and H; that is these 3 activities E F and H, these 3 activities must start only after completion of B. So, this is say, this one this is your E. So, I am drawing this is your H, what about F now. So, E and H both will start after completion of this B. Let us see this one; there is another one that is F. Now, F if you see, F and C precedes G we are telling, that is before stating another one that is G will come; obviously later, but; F also should be completed. And, for this reason; we are drawing from here to here and this we are denoting as F at present.

So, this is your F. So, once F is there this F. So, point number 2 3 has been completed that is B precedes E F and H. You see E F and H this 3 can be start only after B completes. That means, the B precedes this one. What is the next one? The next one is F and C precedes G, that is there will be a node, and from C the activity G can be completed, can be started only after both F and C has been completed. So, I have drawn this both F and C once they are being completed then, only we are starting the activity G. So, this goes to your number 4.

Number 5 is E and F, E and H precedes I and J. That is there will be 2 activities; one is I another one is J and they must precedes your E and H. So, therefore; from E we are saying that, one is J, another one is we are saying it as activity I. So, what we have told that E and H precede I and j, but; one problem is there, what is the problem? The problem is this E and H, but; H is here. So, therefore; again I have to use 1 dummy activity at this position that is this one. This I am telling denoting as D 2. So, once I am denoting this including 1 dummy activity D 2.

So, now you see E and H both precede I and J this is true now. So, this dummy activity is required now. So, using this dummy activity, I can tell that E and H precede I and J. The next one is C D F and J precedes K. So, this is your K, you see here, D is preceding your J is preceding your F where, is F is not preceding C is not proceeding. So, again what I have to do? To precede to say that before starting activity K, C and F has been completed again there must have 1 dummy activity between this node and this node. So, therefore; I

will draw it something like this. Usually, for cutting we use like this. So, say this is your node D 3.

So, once I am adding another node D 3 over I am sorry, this is wrong, this is absolutely wrong. This cannot be there, before this is your J. So, it must be something like this. It has to be dummy activity is connected should be there. So, this is your D 3. So, this connecting from this to this, because; this is not this, this is K before starting of this, K your say C and F should be completed. So, you are using 1 dummy activity J. And, the last one is K precedes L. That is from here if you do it. So, K precedes L this is not the last, and I G and L are the terminating activities. So, you see I G and L these are the terminating activities, I think it is clear now, to view that how we are completing the activities or how you are drawing the network over here.

So, here if you see depending upon the problem given to you whenever, the problem is given to you, you try to find out which precedes what, or which succeeding what, and what is the starting node, what is the ending node. And, from there you can draw like this way. We will see afterwards also, when we are solving the problem by critical path method.

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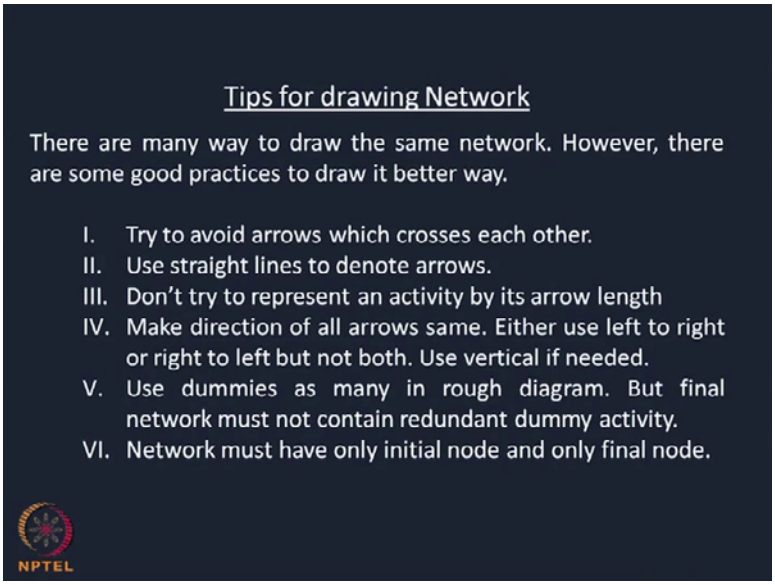

Just see quickly, tips for drawing the network. Number 1; try to avoid arrows which cross each other. If possible always try to follow it, try to avoid arrows which cross each other. Use straight lines to denote the arrows; do not try to represent an activity by its

arrow length please, note this one represent an activity by its arrow length. Number 4; make direction of all arrows same that is whether, it is left to right or right to left make only in one direction. Use dummies as many as you want in rough diagram please, note this, but; final network must not contain redundant dummy activity.

We list assured that you should not use any redundant dummy activity in your final network diagram, because; the costing will be much more. So, you have to note this one. And, the last point is network must have only one initial node and only one final node. That is there must have only one starting point, and there must have one ending point. So, if you follow the tips, I think you can draw the diagrams, network diagram very easily. In the next class we will see after drawing this network diagram, how to solve the find out the critical path of the project cost using the C P M method and then, the PERT method.

Thank you.