Network Analysis for Mines and Mineral Engineering

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Lecture - 19
Event oriented project management

Let me welcome you to the 19th lecture of NPTEL online certification course, Network Analysis for Mines and Mineral Engineering. In this class, our title is Event oriented project management.

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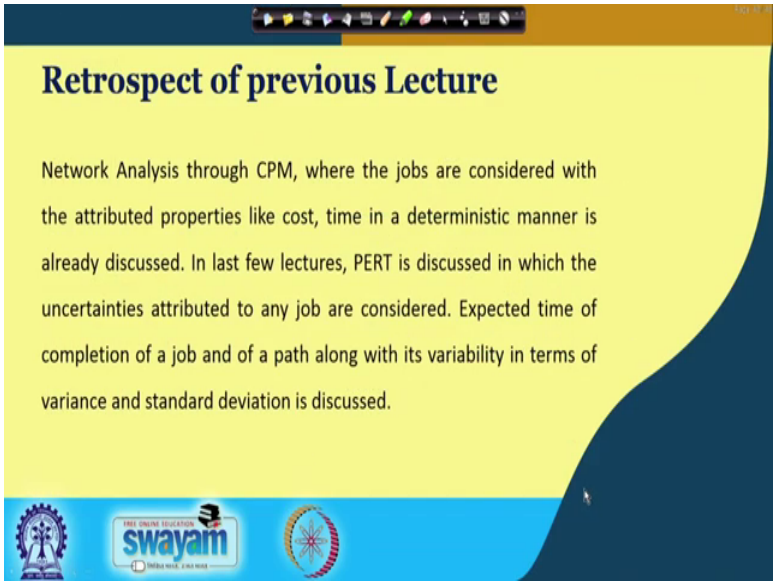

So, like every class let us retrospect, the what we have covered so far. So, network analysis through critical path method where the jobs are considered with attributed properties like cost, time in a deterministic manner is already discussed up to 15th lecture. After that, we have started program evaluation and review technique in which uncertainty attributed to any job are considered.

Expected time of completion of a job and a path along it is variability in terms of variance and standard deviation is also discussed. And we have also found what is the probability of completion of a job by a due date in consideration of the standard normal distribution table is also considered, also already covered in the previous lectures. And there are the considerations are that we only consider the critical path for that analysis.

Even last class, we have given one last slide to show the there are some effect on the near critical paths also on the project possible project completion date and we have will discuss that in detail in this class.

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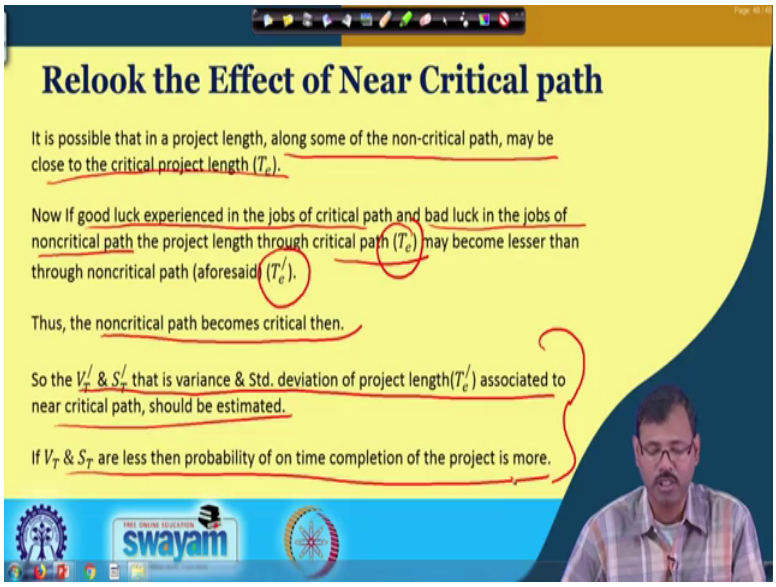

So, this slide was shown to you in the last class also. It is possible that in a project length, along some of the non critical path may be close to the critical project length and good luck may be experienced in the critical path and bad luck may be experienced in the non critical path and that may create such situation that critical path became less than the non critical path because of its bad luck condition and that became lingered to a longer duration.

So, non critical paths are becoming critical in this type of condition and we must take appropriate care on that. And the variance or standard deviation has very very important role. In this, the standard deviation takes a takes a good role, if the standard deviations are more in the non critical path, then it may effect very badly on to the project completion possibilities.

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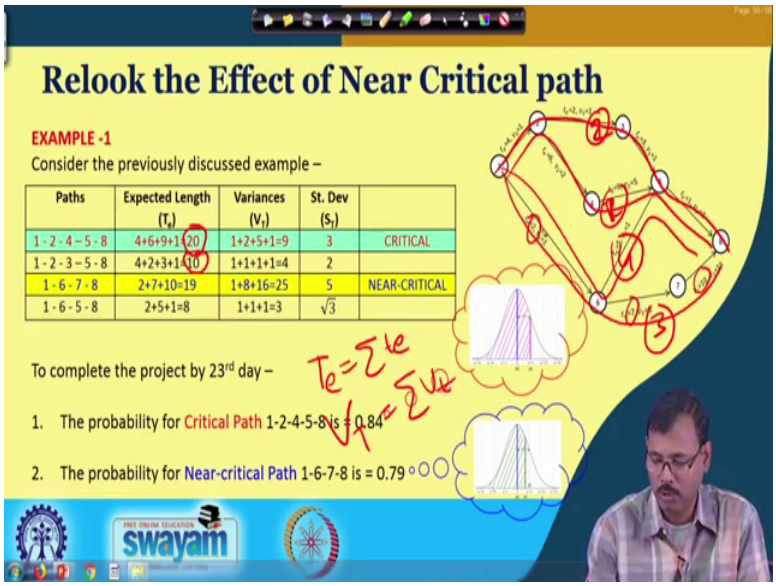

So, let us understand this principle with a one example. Last class, also we have discussed this example. And in this, already time values are given, expected time lengths and expected time of the each job and the variance time and variance are given in the network. And you can see, there are four path, this is path 1, this is path 2, this is path 3 and this is path 4.

So, 1, 2, 3, 4, 4 paths are there. And you know the path completion time T is equal to summation of te is of it is member job and variance is summation of the variances of its member job. So, by this way, we have determined the path length is 20 for path 1, 4 plus 2 plus 3 plus 1. So, 4 plus, sorry not this one, this one is sorry this one is path 4, path 1, this one is path 2.

So, 4 plus 6, 10; 10 plus 9, 19 plus 1, 20, this is path 1, path 2, this is 4 plus 2, 6 plus 3, 9 plus 1, 10, path 3, it is 2 plus 7, 9 plus 10, 19 and path 4, it is 2 plus 5 7 plus 1, 8. And if you see the variances for path 1, this is 1 plus 2, 3 plus 5, 8 plus 1, 9. So, variance is 9, standard deviation is square root of the variance 3. If you see that another path, a path 2, then it is 1 plus 1 plus 1 plus 1, it is 4.

So, square root of 4 is 2, if you see the path 3, then it is 1 plus 8 plus 16. So, 1 plus 8 plus 16 is 25 and variance is standard deviation is square root of 25, 5 and the fourth path is 1 plus 1 plus 1; so, it is 3, so, square root of 3 is the standard deviation. If you closely look into this table, you can see this is the critical path, this is the critical path whose expected

or mean value or the expected time length is 20 and this is very close to 20, it is giving us the 19. So, this path is also very very important which is we are terming as the near critical path.

So, these are all three are non-critical path. This is critical path and among these three non critical path, this one is very close to critical path. So, that is why we are considering it as a near critical, we newly term it as a near critical path in this case. So, if you look into this you will find out the critical path is having a mean value of 20 and standard deviation of 3. So, if you consider that what is the probability that this job will be completed by the 23rd day instead of critical path length given is 20 days.

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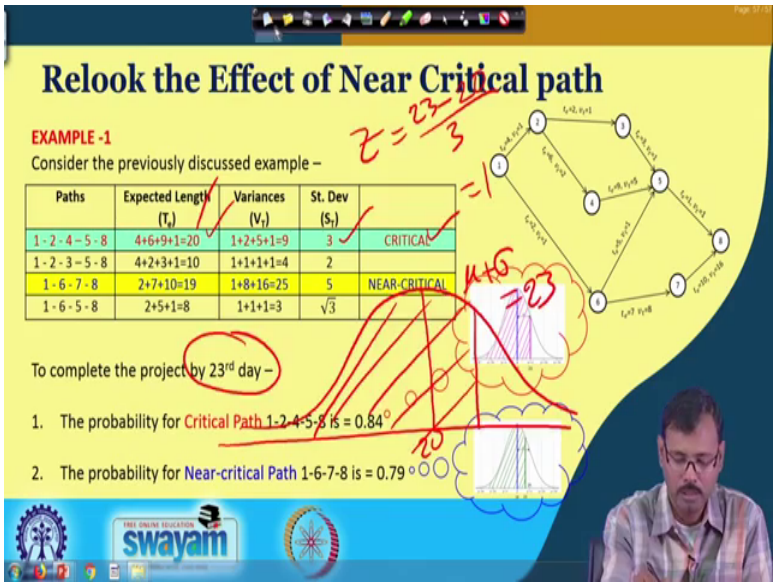

So, if we plot this on a normal distribution curve, you will find out mean value is 20 and 3 is the standard deviation. So, mu plus sigma is 23 and we are asking what is the probability of before this. So, the z value is coming basically 23 minus 20 by 3 that means, it is coming 1. So, z value of 1 plus 1 is representing the 84 percent. Probability is there that the critical path will be over by 23rd day where it is mean is 20 days.

Now, if you consider the same thing for the near critical path of this one where the mean value is 19, but the standard deviation is 5. So, what it is giving to us if you plot this normal distribution curve?

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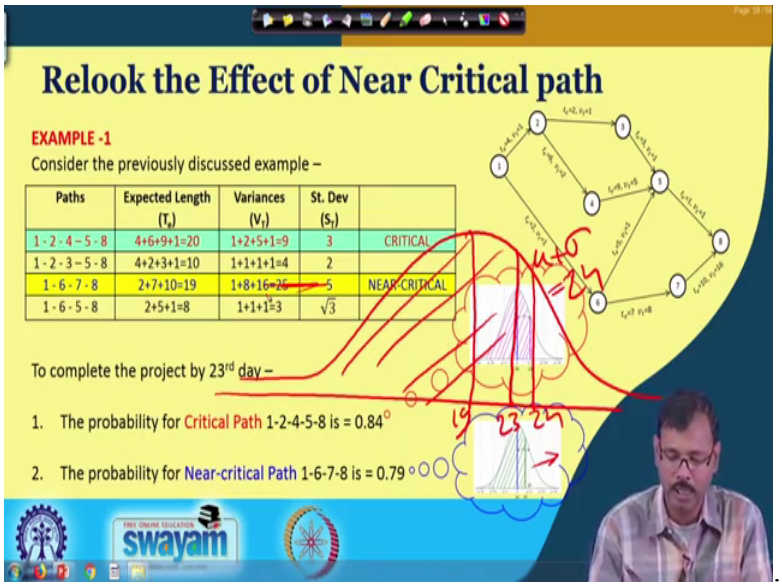

This is actually in a in state it is given here. This is the mean value of 19, it is standard deviation is 5, so, this is mu plus sigma is equal to 24. So, this is 24 and our given date due date is 23 which is lying here. So, the area under this curve which is giving us the probability of completion of the near critical path of this near critical path by 23rd day is by 23 minus 19 by 5.

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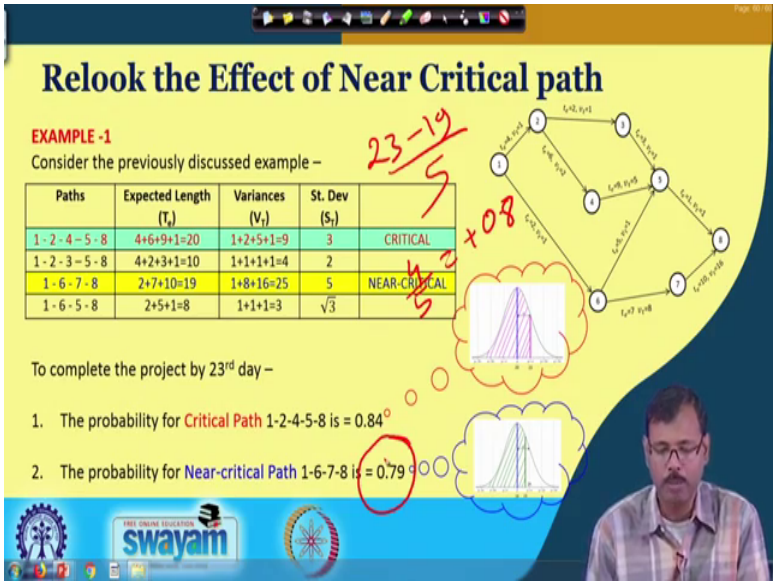

So, it is coming 4 by 5, that is equal to plus 0.8. So, this plus 0.8 gives us the probability from the normal distribution table of 0.79; that means, while we are considering this

particular condition, in that case the probability of completion of the jobs under critical path is much much higher than the near critical path which is lesser than this.

That means, because of the high standard deviation or high variance, the near critical path is becoming critical when we are considering the project length or project due date is 23 days; that means, a manager should have a significant concern about the jobs attributed in the near critical path of 3; that means, this job, this job and this job because the uncertainties are more associated with those jobs. So, that is why, this probability analysis is very very important. We have not considered for this and this.

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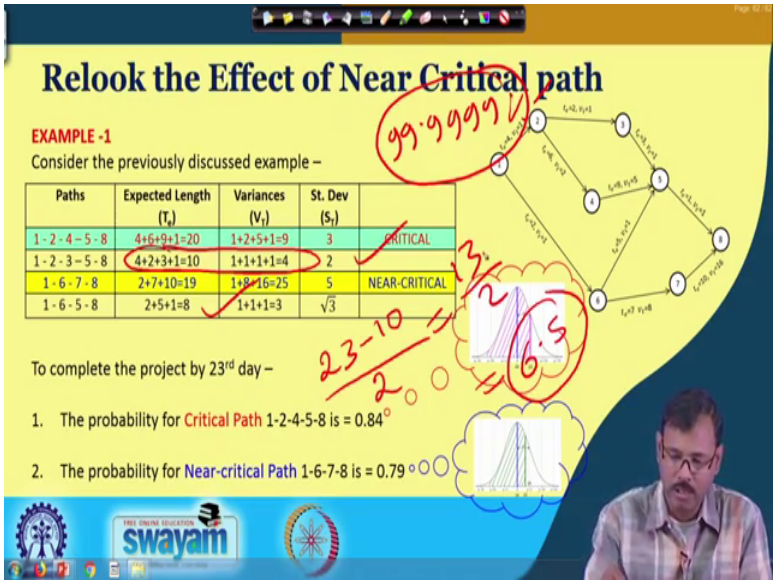

The reason is if you see, if you calculate the z value for path 2, it is 23 minus 10 divided by standard deviation 2; that means, it is giving us 13 by 2 which is almost 6.5. So, this 6.5 normal distribution value is very very high probably you can consider it is probability is 99.99999 percent or even more than that.

So, its attributes are to it is contributing much less on the and the probability of not satisfying this jobs under this case is not that much significant. If you consider for this, you will also find out the similar value. So, the chances of delaying of this path is less, but the near critical path of this one is becoming very very important for this particular condition.

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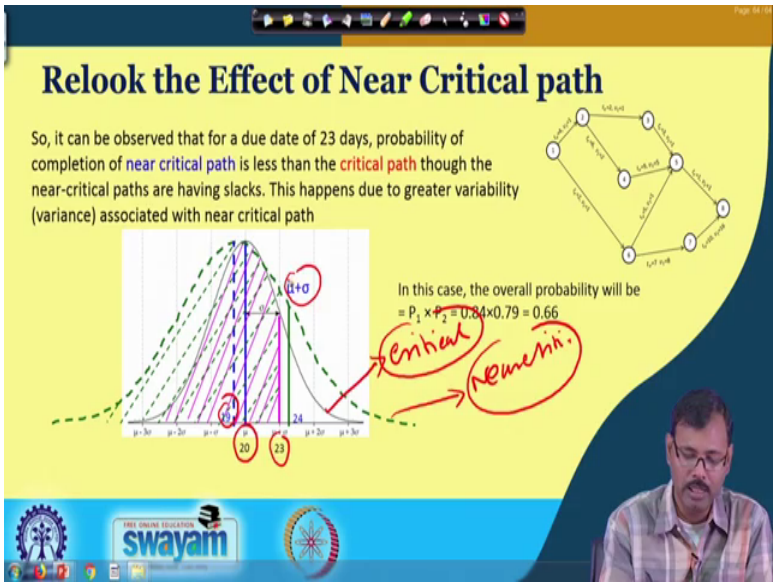

So, now let us plot both the curve on a single normal distribution table. In that case, the if you see this is the first one, first normal distribution curve plotted for the critical path, this is the second normal distribution plotted for the near critical. So, mean value is 19 here, mean value is 20 in this case, mu plus sigma is 24 for the near critical, 23 for the critical.

So, this path is basically showing this one and this path is showing basically the pink one. Near for the critical, it is the pink one, green for the near critical and you can see the probabilities are lesser in probabilities are lesser for the near critical than the critical. So, in this case an overall probability can be estimated by multiplying the both the probability and you can achieve that the over all probability of completion of the project is 0.66. But this is a very very crude assumption.

First is that if instead of this one, if your this one is the critical one and instead of say near critical this one, if you think this is becoming the near critical, then you can find out two jobs are the common jobs associated here. So, their contributions are taking twice while we are considering the over all probability.

So, basically this multiplication cannot be possible; however, this case it was possible because none of the jobs are common and that is why both the paths are basically independent path. Here, the paths are dependent to each other, but in this case the paths are basically independent and that is why multiplying this one may be gives us a good

idea about the overall probability of the completion of the project by 23rd days well the critical path length is expected as the 20 days. So, this is the probability we are observing, but in other case it may not be the issue.

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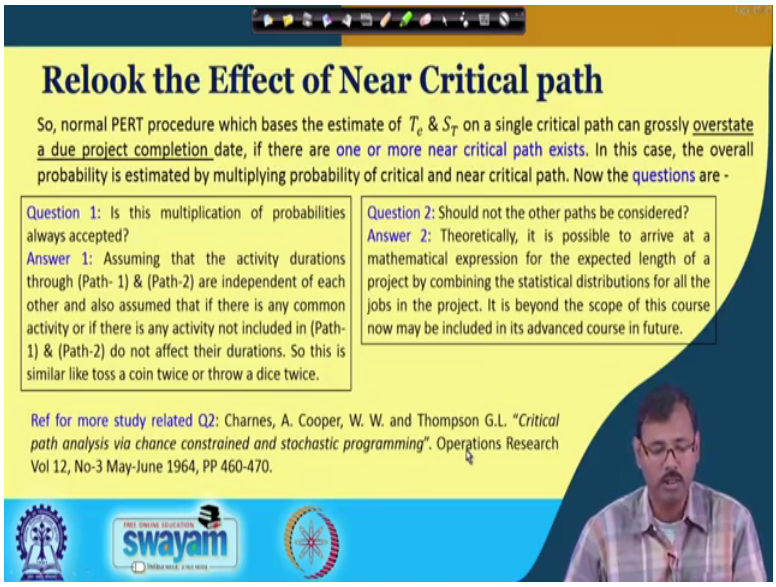

So, one must be very very careful while they are trying to determine the overall probability. So, that is why while we are relook into the effect of near critical path, the normal program evaluation review technique procedure which bases the estimate of path length and it is standard deviation on a single critical path can grossly overstate a due project completion date. That means, if we are considering only the critical path ignoring the non critical paths, then it is not gives us the complete probability or complete idea about the possible completion date or the probability of the completion of the project during the due dates.

If there are one or more near critical or non critical path exist close to the critical path length, in that case it is over estimation will be considered. In this case, the overall probability is estimated by multiplying probability of critical and near critical path, but in last slide also we have questioned, it is not always possible.

So, is this multiplication of probabilities always accepted? It is accepted only in consideration the activity duration through path 1, path 2 are independent of each other then only it is possible. And also assume that there is no any common activities or if there is any activity not included in the path 1, path 2 do not affect their durations. So,

both the paths are unbiased and both the paths are not inter dependent in any respect, in that case only this multiplication will work.

So, this is similar like situation while we are tossing a coin twice and both are the independent case. So, in that case, only we can go for the multiplication, but what about the other paths which are not non critical not near critical, but non critical of a significantly lower durations. Theoretically, we must consider to arrive at a mathematical expression for the expected length of a project by combining the statistical distribution for all the jobs in the project.

However, it is beyond the scope of this course and that is why it is not included in this course, but it may be a part of the advanced course in future when it will be given. Any one interested student may read this reference Charnes Cooper and where the critical path analysis by chance of constrained and stochastic programming which gives the idea of this one.

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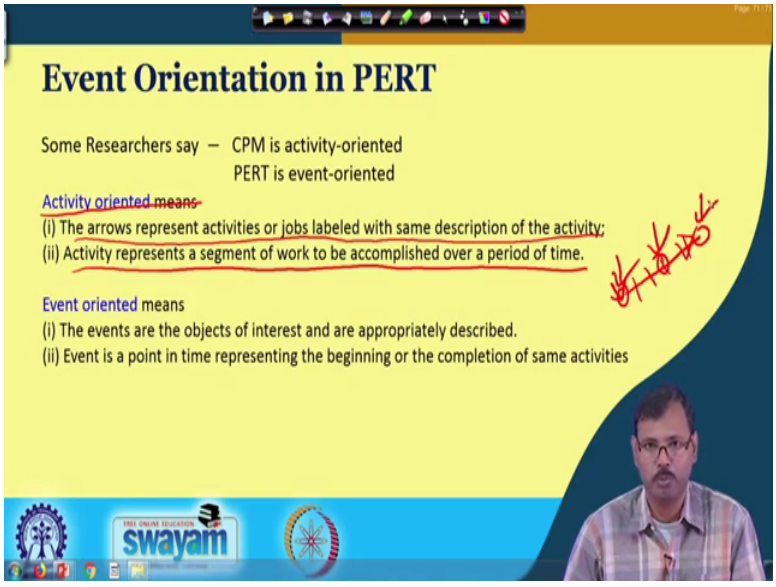

Now, let us discuss what is event oriented programming, now researchers says that critical path method is basically a activity oriented analysis and pert is basically or program evaluation review technique is basically a event oriented analysis. Now, let us understand what is the meaning of activity oriented activity oriented means the arrows represent activities or jobs labeled with same description of the activity. Activity

represents a segment of work to be accomplished over a period of time; that means, we are considering this is the job or activity.

Activity starts at this point, ends at this point, but our consideration may consider the at present the activity as a as in this position and this is the status of the activity. Basically, this is a part of engineers. Always engineers they consider the activity oriented considerations because they do not find out the mile stone. If their they have started the work they concentrated on the process of the work progress of the work not up to the end of the work, even if they are interested in between this also. However, planners for the planners they either consider whether it is started yes, it is started whether it is end, no it is not end, in between it is not considered.

So, either it is end or not they consider. So, they consider on the node to node that in a milestone achieving in the milestone approach. It is something like that the say suppose a train is moving from x place to y place and among in between that there are n number of stations. So, it is updated in consideration, it is it has left x, it has reached x one like that way it is considered. So, it is based on milestone basis.

So in fact, our updating on the time table etcetera is carried out based on these type of thing where it is described as the event oriented considerations. So, events are the objects of interest and are appropriately described; that means, object is that whether it has reached y or not yes or no. If it is reached, then object is achieved. If not reached object is not object is objective is not achieved.

So, that is why it is object oriented or event oriented and event is a point in time representing the beginning and the completion of the same activities. So, that means, if it is in the x node, it is considered as the beginning of the journey towards y node. If it is in the y node, then it is represents the completion of the journey at the y node. So, this is the way we consider the event oriented analysis and activity means it is the during the process also, we are considering how it is moving.

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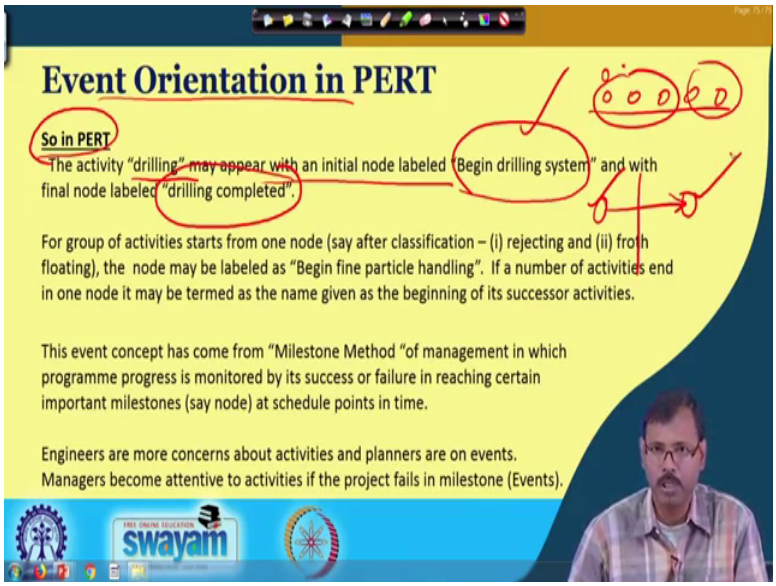

So, in program evaluation and review technique, we consider event oriented analysis. Say, let us give this more understanding on these event oriented orientation of the program evaluation review technique. Consider the activity we are considering drilling. So, the activity drilling may appear with an initial node that the begin the drilling system. Suppose, we are carrying out drilling in a phase were n number of holes has to be carried out.

So, the starting of that one starts with the begin the drilling system and it must end with the drilling system completed. It cannot say that we have drilled five holes, we have four holes are left; that means, in between in between these two, we are not considering say we have drilled 4 holes, 5 holes are left. Like this way, it is not considered. Drilling system started, drilling system completed. So, in between that nothing is there. So, that is why we are considering it is event oriented analyses and that is why this is one example.

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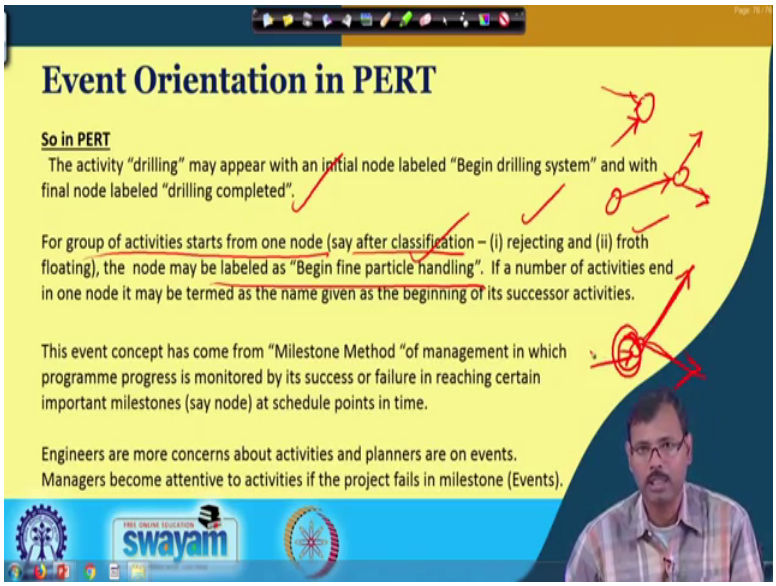

But in where, there may be some one job n number of jobs are moving or n number jobs are coming to one node, how that can be expressed for a group of activity starts from one node. Say, we are giving another example after classification either we are rejecting or we are sending the valuable material for the froth floatation. So, that node can be leveled begin the fine particle handling; that means, after this classification, this is the reject going, this is the valuable material going for froth floatation and this completion node are basically termed as the begin the fine particle handling; that means, fine particle handling at this point and this point will start. We are mentioning that as the end of the classification system.

So, by this way we can have different we can suggest different name for the different starting and ending of the jobs. And that is why our these are the basically achieve achievement of the milestone. So, these concept is basically milestone achievement method of management in which program progress is monitored by success or failure of reaching at a certain milestone.

If yes, in this case it is node at the scheduled time or in the delayed time or the earlier time; that means, we have to check whether this job is started this job is completed and this starting and completion whether it is completed on due time or not in due time. So, that is considered and the milestone is basically considered in this case.

We have already discussed this point. Engineers are more concerns about the activity oriented planning where whether we have drilled 3 holes, again we have go for 5 further 5 volt drilling or not engineers are concern on that. But the manager has to more concentrate concentrating on the achievements whether our drilling is complete, then I will ask my busting group to go into the face for the possible charging of this one. So, the management has to think on the event is achieved or not. So, event oriented monitoring has to be carried out by the management; however, engineers has to see the details of the activities how much it is it is progressed and how it can be performance will be increase or decreased.

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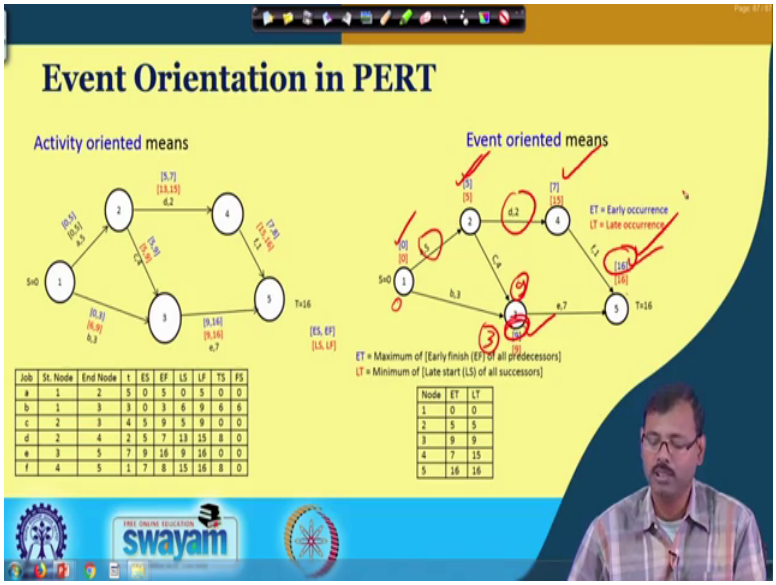

So, basically activity oriented means we are considering the jobs and event oriented means we are considering the nodes. So, this is expressed in terms of different way where we consider the jobs, we determine the early start time, early finish time, less start time, let finish time, total slag and free slag of the jobs.

In event oriented, we determine the maximum or early occurrence we consider the early occurrence time of the node late occurrence time of the node which we are considering in this case. So, event oriented programming in that event oriented analysis, manager has to think whether what is the earliest possible time to reach into that milestone, what is the latest possible time to reach into that milestone.

So, this early occurrence and late occurrence is important in the event oriented analysis. So, here early start, early finish is calculated. So, let us see this is simple calculation. These are the T e values are given and based on that we have calculated forward pass backward pass from forward pass we have achieved early start early finish. So, this is 0 5, this is 5 7, this is 7 8, this is 0 3, this is 5 9. So, this is 9 16 and we have got the 16 is the possible time. Considering this 16, we have gone for the backward. So, 16 minus 1, 15, 15, 13 and then it is 5 0, this is 69, this is 9 5. So, this is among this is the 5 is the minimum one. So, this is 5 0 and this is 9 6 is the late start late finish time.

So, from that, we have achieved the total slag also, free slag also and these are already discussed in your previous lectures. So, I am not going into the details of that. Similar way, we have gone for forward pass to see the earliest occurrence time here and late occurrence time in the backward pass let us see how we are calculating this one. So, from here, if we start at 0, the earliest possible time to occur here at 5 because this deviation is 5; as earliest time we have here 5.

So, 5 plus 2, it is 7 is the earliest occurrence time at this node, here it is 9 at earliest occurrence time at this node. In this case, it is for this if we are considering it is 0. So, it must be 3, but as this is coming at 9. So, maximum of these is the earliest possible time to reaching at this place. So, that is why earliest consider an 9 here and 9 plus 7 is giving 16, but 7 plus 1 though it is coming 8, but this is the maximum. So, that is why the earliest possible time to reach at this position completing all the jobs before that giving us the time is 16.

So, this consideration of 16 if you are going for the backward pass, we are getting this is 9, this is 16 minus 1, 15; 15 minus 2 though it is coming 7, but 9 minus 4 is giving 5. So, the minimum of that is expressed here before that this job has to be completed. So, that is why this is 5, again it is 0, it is 9 minus 3 it is coming 6 here for this job, but it is not considered here because this job has to be completed by 0.

So, the formula can be expressed as earliest occurrence time is the maximum of the early finish time of all it is predecessors. So, if you are considering, this is the early finish time of 8.

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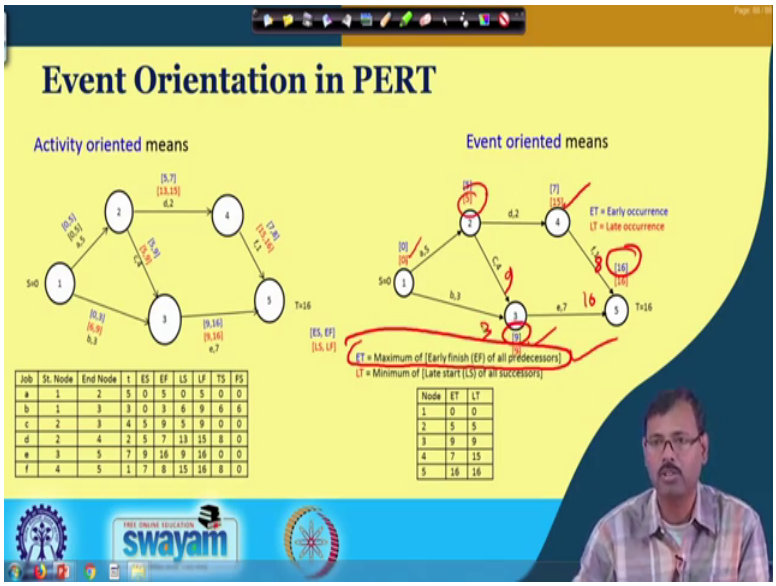

This is the early finish time of 16. So, maximum of the predecessors are called considered here as 16. Similarly, here it is 9, here it is 3. So, maximum of that is considered as the 9 here. If we are considering the latest occurrence time, the latest occurrence time is the minimum of the late start time of all it is successors.

So, let us see the formula, this is one successor. It is late start time of job d, late start time is 13 and job c, late start time is 5. So, the latest minimum of this is considered as the latest occurrence time, the minimum of the latest start time of the successors. So, minimum here it is 5, sorry here it is 5, here it is 13. So, the minimum of that is 5 which is coming here ok.

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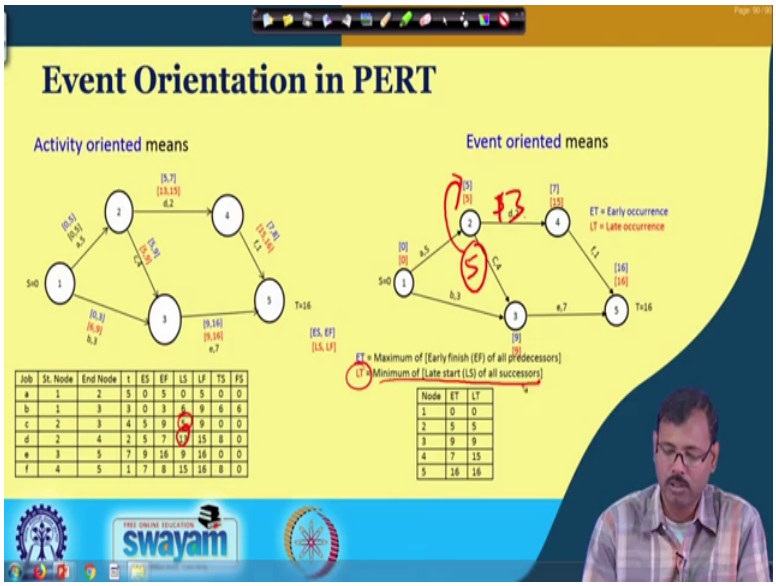

So, that is considered here and by that way, calculated and it is mentioned in this you can see the free slag's are available in this positions.

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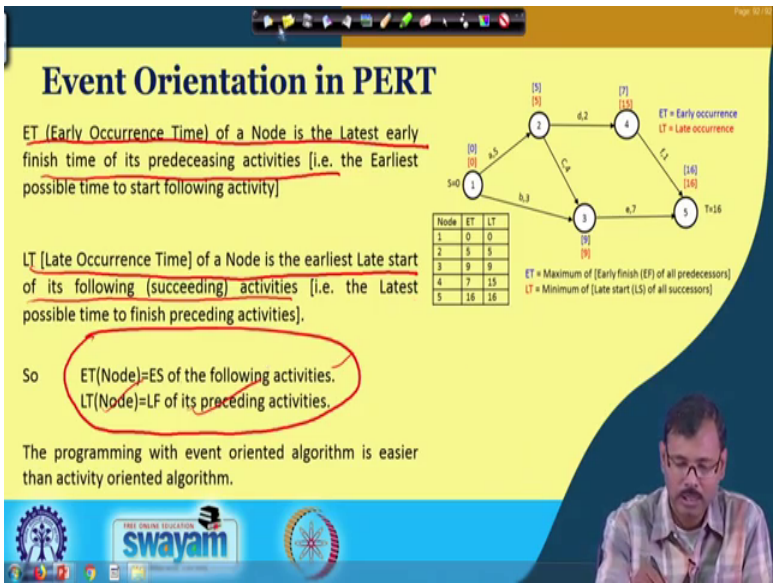

So, let us now describe this as a formula. Say early occurrence time of a node is the latest early finish time of it is predeceasing activities which we have already discussed and late occurrence time of a node is the earliest late start of it is following or succeeding activities that we have seen. And early occurrence time of the node is equal to the early

start of the following node following activities and late is the late finish of the preceding activities.

So, this is basically considered while we go for the computer programming for the analyzing of the critical, either in the c p m or in the programming evaluation review technique approach.

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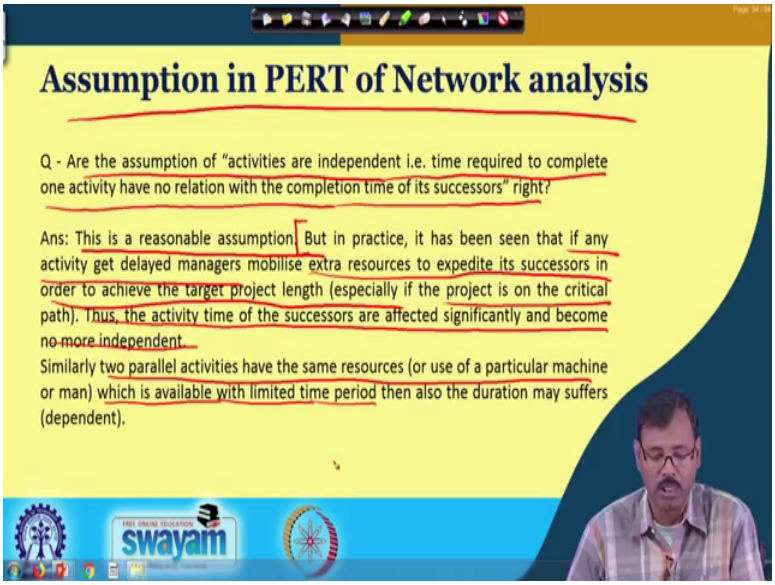

So, what are the assumptions we have considered in the pert network analysis. The assumptions of the activities are independent time required to complete one activity have no relation with the completion of time of it is successor whether it is right. So, this considerations of the program evaluation review technique that the jobs are independent and they are not affected by the others activity whether it is right or not and the answer is this is a reasonable assumption.

However, often it is observed that if any activity get delayed, manager mobilize extra resources to expedite that activity so that he cannot miss the time schedule, but how that extra resource will come, but to give this extra resource often the divert man power etcetera from one project to another project.

So, in order to achieve that target, often the activity time of the successors are affected significantly and that is why it is not becoming independent; so, this is one problem. For 2 parallel activities also, same resources has to be used and may be found that available

with the limited time period. So, the though we are considering it is independent, often it may not be independent.

But this is considered for the mathematical approach for analyzing this one this independency considerations are more or less accepted. Though often, the because of the shortage of the resources, we divert one from another site one site to another site though that is affected, but that is not truly accepted in a good practice. So, this assumption is more or less accepted.

So, that is all up to this network analysis using program evaluation and review technique. So, most we have learned that early occurrence time late occurrence time of the nodes which are used for the computer programming and the network analysis, solving the network analysis problem. So, that is all for this lecture.

Thank you.