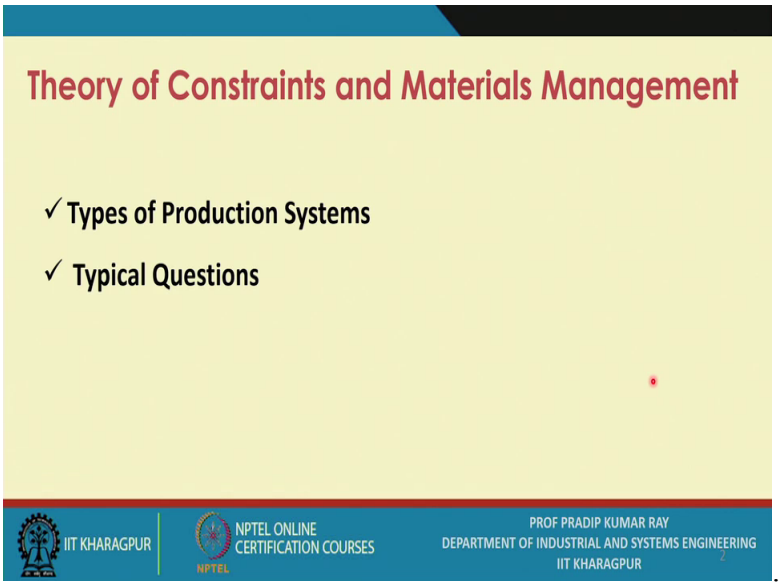
Management of Inventory Systems
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Lecture - 50
Theory of Constraints and Materials Management (Contd.)

So, this will be the fifth session, 5th lecture sessions on the TOC or Theory of Constraints.

(Refer Slide Time: 00:30)

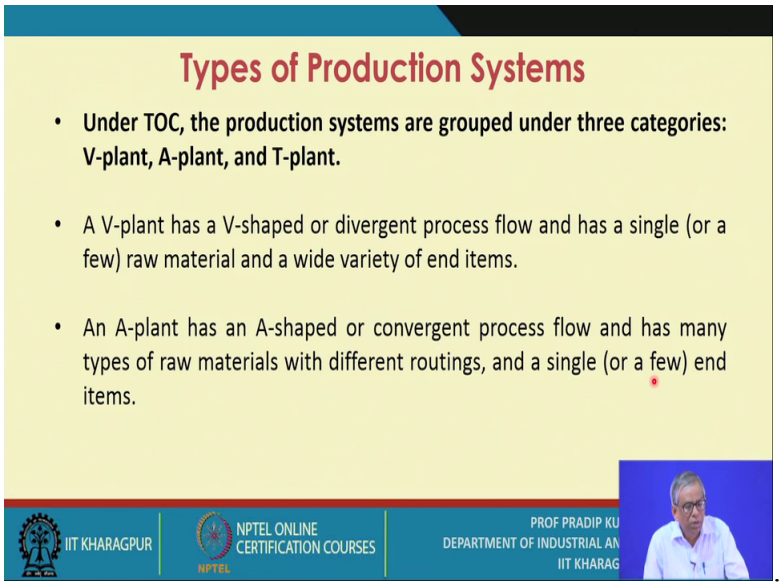


During these sessions I will discuss 2 specific aspects; one is the types of production systems. Already, we have referred to and in the last lecture sessions, in the previous lecture sessions and you know that there are 3 types of production systems. These are referred to as A-plant; that means, either there could be V-plant or A-plant or T-plant. Only in you know certain cases it may be a combination of all 3.

But, so, let us the first; so, what will try to do? That means, we will explain the what are the say the critical points you need to look into for implementation of TOC approach at a particular type of production system. And, then a few typical the questions related to the TOC, I am going to say discuss. And so that when you appear for the exam or you may have several queries on a particular topic.

So, if you go through this the numerical problems. So, your understanding will be better, understanding of the concept and whatever what we want actually. So, your learning should be based on say a knowledge development. And, if you have sufficient knowledge in that particular topic and we will be able to address those problems ok.

(Refer Slide Time: 02:18)



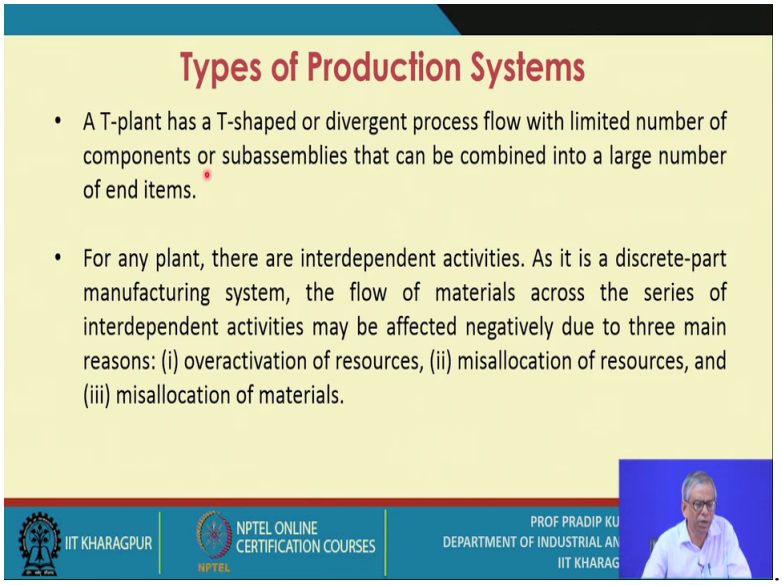
So, as already pointed out let me repeat it once again, under TOC the production systems have grouped under 3 categories ok; V-plant, A-plant, and T-plant. This term we have been using plant ok not explicitly we are saying the V-production system, we have been using V-plant because as we have already pointed out that say your the TOC approach is to be applied at the plant level. And so, that is why you know we have been using this term otherwise it does not have any other significance.

A, V-plant has a V-shaped or divergent process flow and has a single or few raw material and a wide variety of end items. Now, you just start thinking of is how many do you have any examples with you; that means, can you identify a product or end item production of which requires a V-plant ok. How many such products you are familiar with?

Similarly alternatively you can have a A-plant, it has an A-shaped or convergent process flow and has many types of raw materials with different routings and a single or a few end items.

Now, can you site few examples of such a production system or few examples of a products which must have this sort of plant for their production A-plant. So, you just had thinking of and you must be able to identify a few products which requires A-plant.

(Refer Slide Time: 04:14)



Similarly, you may have a T-plant and this plant has a T-shaped divergent process flow with limited number of components or subassemblies that can be combined into a large number of end items.

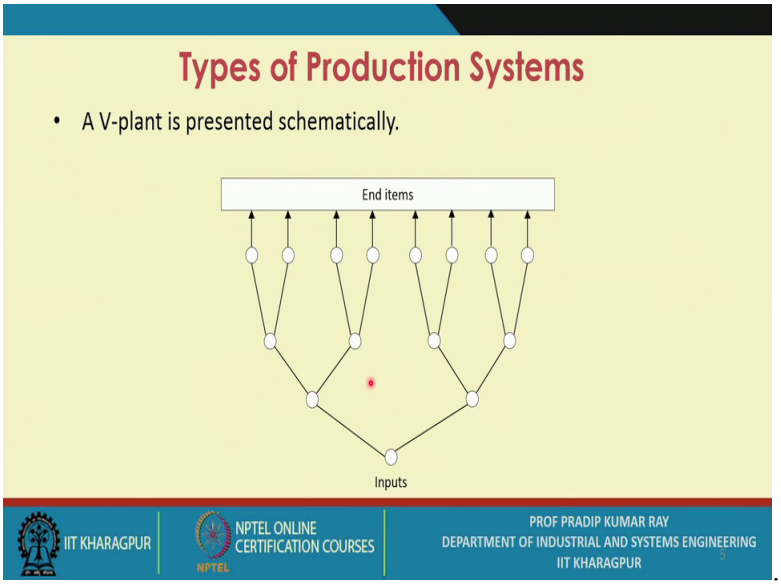
So, is essentially you know in a suppose assemble to all order situation assemble to order. So, up to so, what you try to do you produce the components and these components are; obviously, they are usually they are standard size components and, you can use them as per a particular the design. Now this components can be say the used in different combinations and each combination represent a particular product or the end item.

So, if you come across such a situation; obviously, you go for establishing a T-plant. For any plant there are interdependent activities these you cannot avoid, as it is a discrete part manufacturing system the flow of materials across the series of interdependent activities may be affected negatively. Due to 3 main reasons I have already mentioned overactivation of resources.

If you go for overactivation of resources it may so, happen that your utilization of the resource may be very poor and that is why you know you will be producing, but your as far as throughput generation is concerned your performance may not be up to the mark.

Misallocation of resources again it may lead to say the blocking, it may lead to say the starving. And, similarly if you have misallocation of materials you know at a particular stage there could be the blocking or there could be the starving. So, this 2 phenomenon you try to means there must not be at same point in time or you these 2 conditions you try to avoid.

(Refer Slide Time: 06:36)



And, if you apply the TOC approach you know there will not be there must not be any say the blocking conditions or there must not be any say the starving conditions.

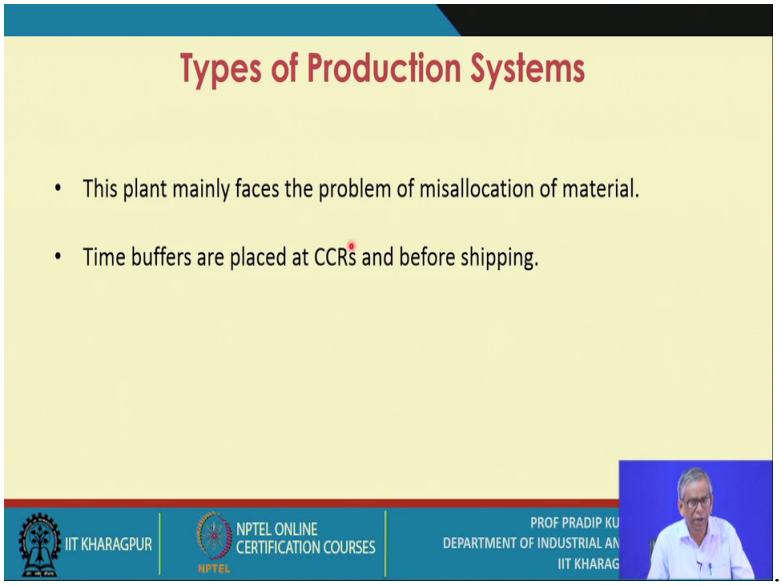
This is to be avoided that is why the allocation of the resource, at a particular say the point in the production system. Other they are basically you know the schedule release points is very is a very critical issue, otherwise there could be starving or there could be blocking. Now, the next important question is how do you represent V-plant? So, this is the V-plant can be presented schematically. So, this is a schematic representation so, what you have at the lowest level you have the inputs, say either one raw material or a few raw materials you use and then what you do you start processing them in different ways.

So, you create this divergent process flow; that means, from this point you go to the next point or you go to the next point from here again there will be branching and you move to the third stage like this and, again there will be further branching you will go to the next stage and ultimately you reach to the end items.

So, what you try to do you have a divergent series and with this divergent process flow; that means, from say one raw material or a few raw materials you can produce. Obviously, you have to follow all this the processes you have to use all these process at different stages in a systematic manner, but ultimately, you can produce a large number of end items.

So, there are many such say the production systems, which fit to this particular say schematic representations or say this particular say the divergent process flow. So, this is referred to as the V-plant.

(Refer Slide Time: 08:50)



Now, this plant mainly faces the problem of misallocation of material. So, this is very important in the sense that suppose certain say the material you require at this stage a particular type of material.

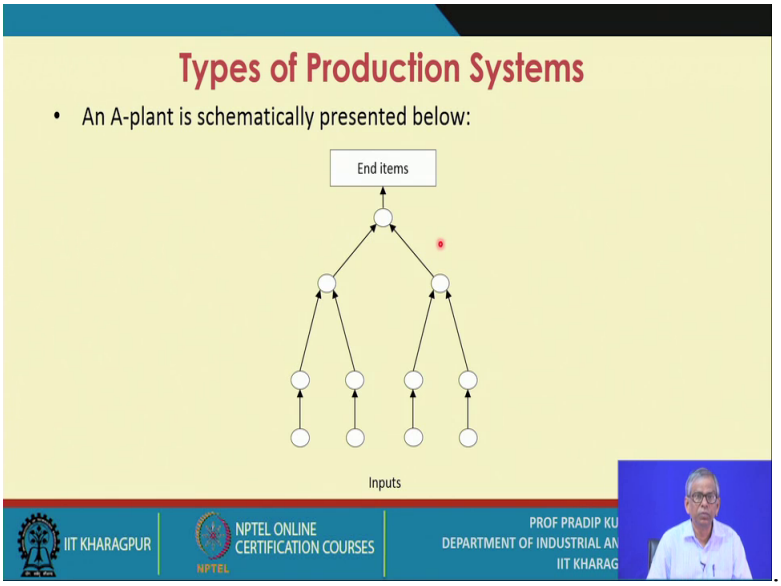
Now, it may so, happen that at this stage or at this stage or at any stage of the production systems, you are getting the material, but it is not the right kind of material. So, this is one aspect and the second aspect is as far as problem is concerned, you need certain

quantity of material at a particular stage of a given time. You are getting that definitely that type of material, but not in the required quantity. Either you are not getting sufficient quantity or you are getting you know say the excess quantity.

So, both are referred to as the misallocation of resources ok. So, this plant mainly faces the problem of misallocation of material and this problem you have to solve time buffers are placed at CCRs and before shipping. So, this is very important in order to maintain the flow of materials within the process, what you need to do? That means, the concept of say the time buffer you have to use; that means, the time buffers you have to create and these time buffers are to be placed at certain points only.

So, what are those the points where you should place the time buffers; one at definitely the CCRs and the second the time buffers you place before shipping the final say the end items.

(Refer Slide Time: 10:52)



Now, so, to some extent you have come to know what is the characteristics of a V-plant. And, similarly you also must know what are the; say the characteristics of A-plant?

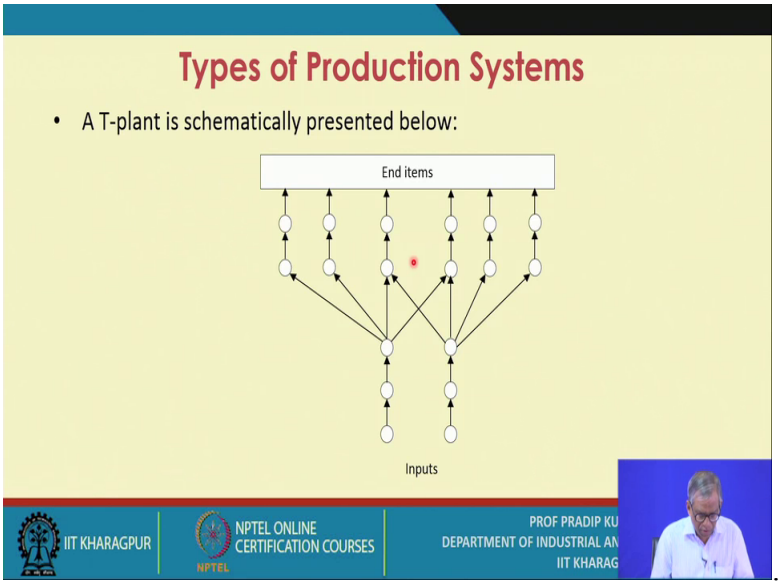
Now, how do you represent say the A-plant? Now, this is also presented schematically what you have over here you have the inputs. That means, there are a number of inputs the number of inputs or input raw materials, what you try to do as you proceed ok, from say the level or the stage 0 to stage one the next stage.

That means, you are diverging; that means, from one stage you go to the next stage and from this stage you go to the third stage and again you combine this the outputs of both the stages are combined, you get at the next stage a combined output and so, from a large number of inputs raw materials, you may get a one end item or few end items is it ok.

So, this is essentially a convergent say the process flow ok. So, this is your representation and you must site a few some few examples of products which requires this sort of the production system. This plant mainly faces the problem of misallocation of resources ok. So, this is to be properly understood misallocation of resources, not misallocation of say the materials primarily ok. So, that is a typical problem of V-plant, but for the A-plant the main the problem is the misallocation of resources and you know what is the definition of a resource.

Time buffers are placed at CCRs like you do in the previous case before assembly and before shipping is it ok, you if you refer to the previous plant that is V-plant, you will find the time buffers may not be needed before assembly. Whereas, here for this A-plant definitely the time buffer is required at the assembly is it ok so, this is your understanding of say the A-plant.

(Refer Slide Time: 13:38)



Next you go to the third variety the third type of production system this is referred to as the T-plant. So, a T-plant is schematically presented like this one; that means, you have few inputs you these inputs are further processed, you reach at this stage and then what

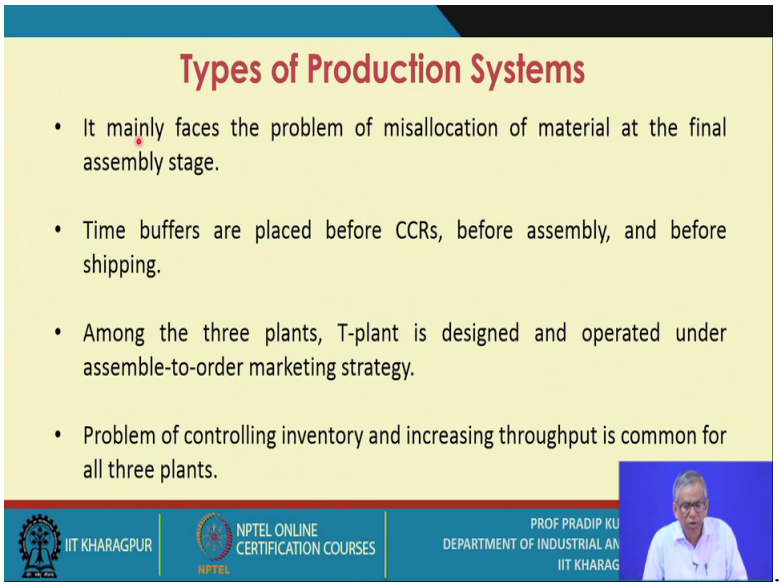
you do; that means, the multiple say the components of the subassembly you form or you produce multiple components only.

So, this is basically the final component level or the final subassemblies level. So, a group of or a set of components or the process parts along with a set of subassemblies you form at this stage you produce at this stage.

Next what do you do? You go for the different combinations of all these components different combinations and each combinations; so, how many such combinations you may have is it ok. So, with different combinations you can say have different types of end items or the final products is it ok. So, this is; that means, with few inputs you can have a large number of end items. So, this part is essentially this more or less for both the inputs for examples you follow the same process; that means, number of stages the processes number of processes almost remain same.

So, this is the vertical one and then you go for diversion, you go for diverging and that is why it is referred to as a T-structure, it is a T-structure that is why, this plant is referred to as a T-plant.

(Refer Slide Time: 15:32)



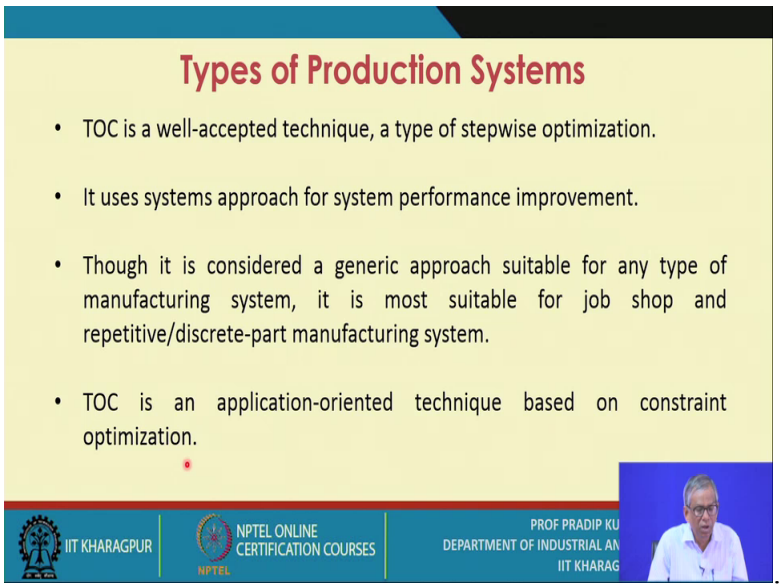
Now, what are the problems it may face? The main the problem it faces that is the misallocation of material at the final assembly stage is it ok; that means the you try to have one particular end item. And, it needs a set of particular parts and a set of particular

subassemblies it may so, happen that there could be misallocation of material at the final assembly stage ok.

So, this is so, this is one problem you have deal with time buffers are placed before CCRs like in previous cases, before assembly and before shipping; that means, the time buffers are placed before CCRs, before assembly and before shipping like you do for say you know like say the A-plant is it ok. Among the 3 plants T-plant is designed and operated under assemble to order marketing strategy. I have already mentioned that many such products you what you do; that means, you take this marketing strategy that is assemble to order. In the very the initial lectures we have mentioned, while we describing several aspects characteristic features of inventory control systems. That means, the inventory control systems which you propose has a got (Refer Time: 17:04) close relationship with the specific marketing strategies which you adopt.

And one such marketing strategies assembled to order and definitely based on the marketing strategy you propose a particular production system. So, if your marketing strategy is assembled to order; obviously, you refer to say the T-plant or this particular production system. Problem of controlling inventory and increasing throughput is common for all 3 plants and that is why the TOC approach is to be adopted.

(Refer Slide Time: 17:40)



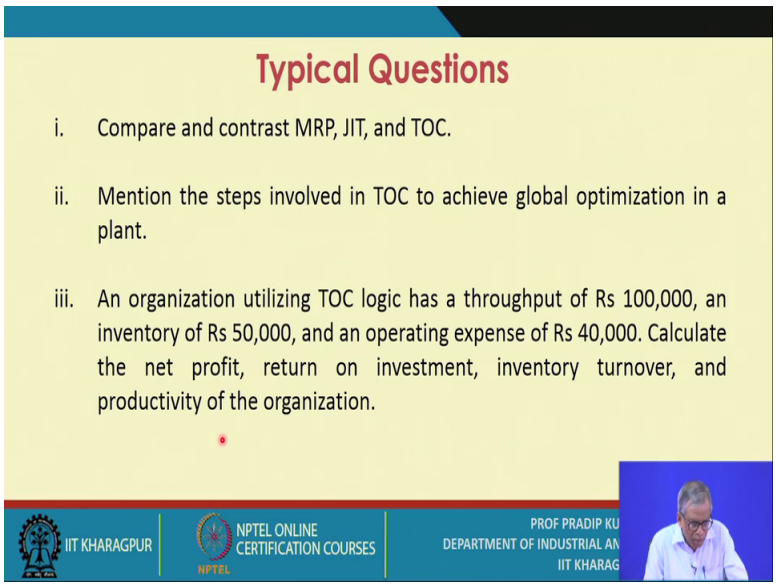
TOC is a well-accepted technique a type of stepwise optimization ok. So, just this is the remark and definitely you know by this time, you have come to know this is a stepwise,

optimization process. It uses systems approach for system performance improvement is it ok? We are not restricting ourselves to a subsystems performance or optimized subsystem performance. Though, it is considered a generic approach suitable for any type of manufacturing systems ok.

Mainly, the manufacturing the manufacturing systems are grouped under 3 categories. At one extreme you have the job shop and the other extremes you have continuous processing and in between you have the batch production. So, mainly you know this TOC approach is applicable for batch production, and it is most suitable for job shop also and repetitive or discrete part manufacturing systems ok. So, TOC is an application oriented technique based on constraint optimization; that means, unless you have the actual data, unless you the study a particular the manufacturing system it becomes impossible for you to develop the TOC approach.

Though there are the principles you have to follow all these terms and terminologies, you must be able to able to define and there are certain rules to be followed, there are certain the representation logic you must know. So, but otherwise it is an application oriented technique.

(Refer Slide Time: 19:40)



Now, what are the typical questions, now let me just tell you a few the typical questions related to say the TOC more or less we have covered all the important aspects of theory of constraints. And, when we are referring to say the several the types of problems or say

when you try to have say smooth flow of materials within your production system. And, as per the TOC logic what do you need to do; that means you need to propose a DBR scheduling. And, we have been using several terms and terminologies, which you find also in other techniques like in MRP, JIT and all.

So, so, by this time you have come to know what is an MRP system, we have already discussed the JIT based approaches to what extent you know the JIT based approaches are relevant for materials management, to what extent the MRP based approaches are relevant for materials management. And; obviously, when we discuss TOC? So, this TOC approach is also highly relevant for appropriate materials management. So, given the context of materials management how do you compare and contrast MRP, JIT and TOC is it ok.

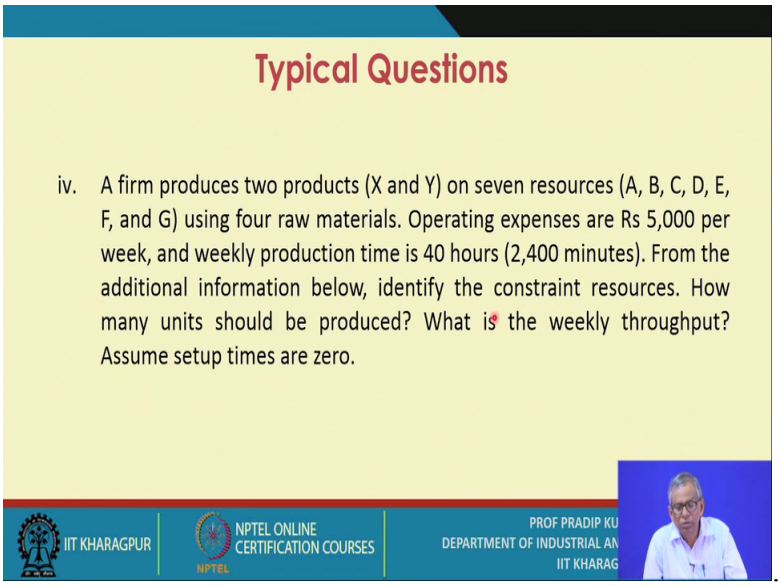
So, with respect to say materials management only the context of materials management only you need to compare, say among this 3 say approaches MRP, JIT and TOC. Mention the steps involved in TOC to achieve global optimization in A-plant, as we have been pointing out that it talks about the system performance.

That means, at all the steps involved in DBR scheduling or the TOC approach what you need to do you need to apply the systems approach. And so, we are interested in the systems throughput, we are interested in the systems inventory and we are interested in the systems operating expense. And; obviously, when you refer to the financial performance improvement in financial performance with the application of TOC approach, what we are trying to do; that means we are referring to the financial performance of the entire systems for the entire plant.

So, that is why the global say the optimization is the most critical issue. And, organization now here is one just simple examples, we are referring to. An organization utilizing TOC logic has a throughput of say rupees say 100000 and inventory of rupees 50000 and an operating expense of rupees 40000 ok. So, we know what are how do you what is throughput, what is inventory, what is operating expense? Is it ok.

Calculate the net profit return on investment, inventory turnover, and productivity of the organization ok.

(Refer Slide Time: 23:20)



So, can you calculate this, so, how do you define the net profit, how do you define say the return on investment, how do you define inventory turnover and, how do you define productivity? Is it ok. So, throughput divided by say operating expense and, the return on investment that also you know. So, you just please refer to our previous lecture sessions, I am sure you will be able to say the answer to this questions.

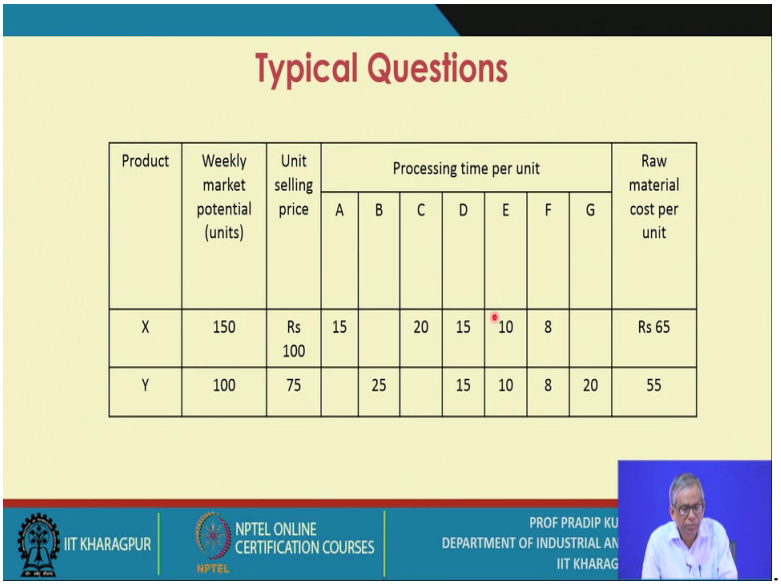
Now, the next important the typical questions, you may come across; one typical questions I am just elaborating, one is a firm produces 2 products X and Y on 7 resources, what is this resource, you know what is resource? We have given several examples of resource. So, 7 resources they are identified as A, B, C, D, E, F and G using 4 raw materials 4 types of raw materials. That means, you just refer to that schematic representation of a production systems either A-type, or V-type, or T-type.

Operating expenses are rupees 5000 per week operating expense, we know what is an operating expense; and weekly production time is 40 hours that is 2400 minutes. From the additional information below, identify the constraint resources; constraint resources, you know what is the CCR and what is non CCR, what is the bottleneck resource, what is non-bottleneck resource?

So, what is the relationship between the CCRs and non CCRs with the bottlenecks and non-bottlenecks? So, if it is a CCR and the bottleneck obviously, you know it constraint both say the quantity and timing. And, this is required and; obviously, need to consider

for the product flow planning is it ok. So, you are aware of all these terms and terminologies and to what extent they are all inter related? How many units should be produced? Ok. What is the weekly throughput? You know the definition of throughput assume set of times as 0 ok. So, that is our assumption many a time set of type may not be 0, it may be non-zero and this may be substantial.

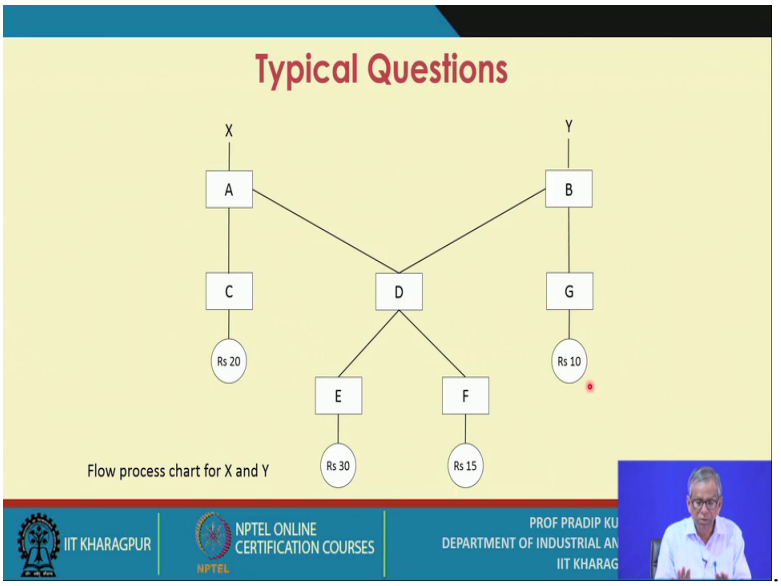
(Refer Slide Time: 26:27)



So, this way you represent the whole system; that means, there are 2 products X Y weekly market potential that means demand is 150 units and this is 100 units. Unit selling price rupees 100 and rupees 75 per unit, and these are the processing time per unit; that means, there are the 7 resources or say 7 say work centers or the facilities you have, each one is considered to be a resource. So, against A the processing time is given and this processing time for product A whereas, for product Y, you need resource B, but for product X, you do not need resource B.

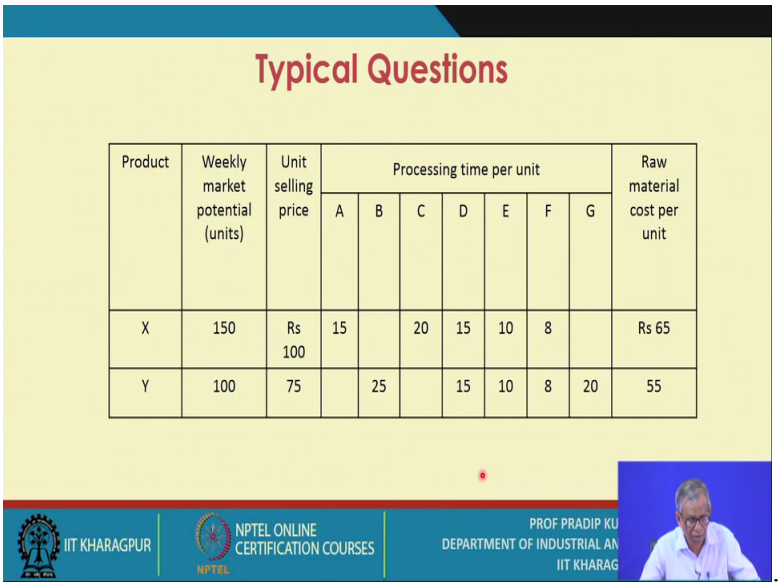
So, similarly resource C is required for product X, resource D is used for both X and Y, resource E is used for both product X and product Y, and similarly for resource F. Whereas resource G is used only for product say the Y ok. So, these information you must have and then the raw material cost per unit. This is also an important say the data, you must refer to that is this one is rupees 65 the other and this is raw materials the kinds of raw materials used for product X, and the kind of raw material is used for product Y. So your the raw material cost per unit for product Y is rupees 55.

(Refer Slide Time: 28:19)



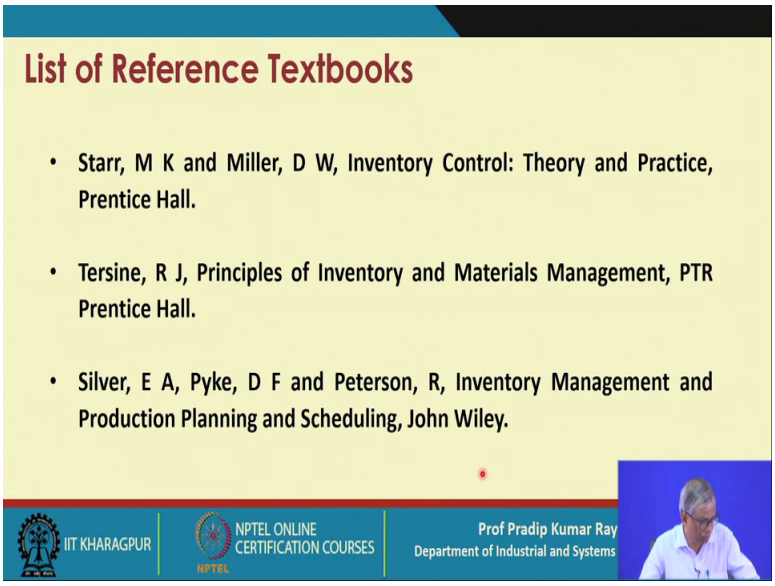
Now, this is the typical say the process flow. So, this diagram is given and this is X and this is Y; that means these are the 2 end items. And you have these are the resources A B C D E F G is it ok. All these values are given; that means, this is the flow process chart for X and Y, ultimately the 2 end items you get, that is X and Y is it ok. And, this is your rupees 30 and rupees 15 ok.

(Refer Slide Time: 28:58)



So, these values are given ok. So, nowyou have to answer to all these questions.

(Refer Slide Time: 29:06)



So, now, we have actually say the covered this particular topic in 5 session, that is the theory of constraints. And, what we have been pointing out that this theory of constraints or the logic is highly relevant for materials management purpose ok. And, what we need to have like say you know you have been developing the say the concept first and then what are the issues involved.

The main issue is actually to get a smooth flow of materials within the production systems, which any others systems or any other approaches also the talk about this, if you refer to say JIT based manufacturing systems. So, it is also the main objective for the JIT approach, how to get the smooth flow of say the materials within a production systems? So, primarily the JIT approach is applicable for repetitive manufacturing systems. So, similarly the TOC approach is also primarily applicable for repetitive manufacturing system, discrete part manufacturing systems is a complex the system dealing with, but TOC is many a time is referred to as DBR scheduling.

Now, the main advantage of say looking at the TOC approach as a scheduling approach is that you can concretize your the thinking, or the concept of TOC say in a specific manner and you will be dealing with all the important say the factors, and will be effecting the product flow, effecting the material flow in a system, and our main concern is that the entire scheduling of say that the production or the production scheduling

approaches, must be able to the produce throughput at a particular point in time with the minimum waste.

Now, when you talk about the TOC, what you can do? That means, your definitely the wastes you need to you will be producing and as far as possible ok. When you apply a systematic approach is the step by step approach, you must have a control on the waste. And, these waste when you talk about you refer to the JIT based systems. When you refer to the JIT based systems as far as production system is concerned, there are 7 types of wastes you just refer to our previous lecture sessions. And you just check that what extent these wastes can be defined as per those norms. And then you try to you know the find tune your DBR scheduling in such a way, that these wastes which you are going to generate this must be held at the minimum level.

So, with this I conclude the session and I hope that the critical issues, you should concentrate on what is the basic concept in TOC and what are the terms and terminologies and how do you the present say the DBR scheduling so.

Thank you.