Financial Mathematics
Prof. Pradeep K. Jha
Department of Mechanical and Industrial Engineering
Indian Institute of Technology – Roorkee

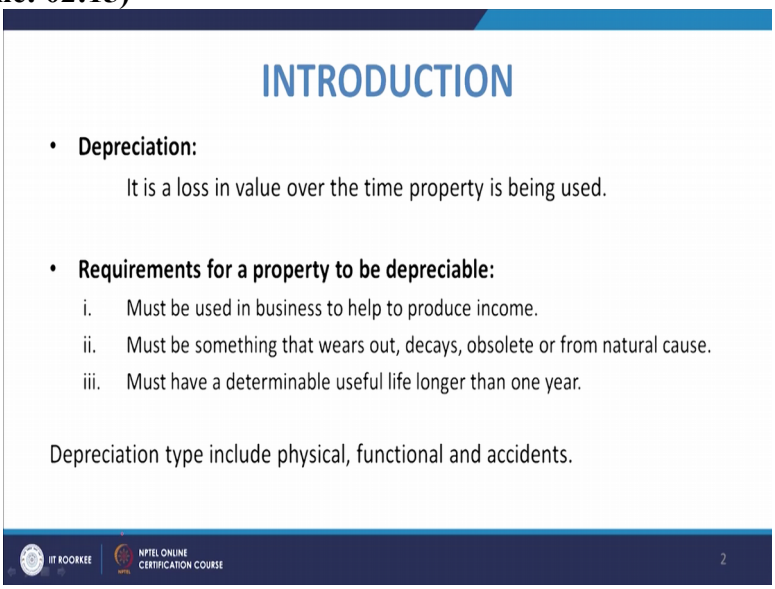
Lecture – 31
Introduction to Depreciation and Depletion

Welcome to the lecture on Introduction to Depreciation and Depletion. So, now in this lecture we are going to have the overview about depreciation which is a very important aspect when we study the economy especially about the assets which are used its values are basically assessed. So, in that process we need to understand the depreciation its meaning its types then that is also required for many times the tax calculation purposes many times we take the tax rebate.

So, for these things this depreciation is very important you know a topic to be studied. Now let us start with the introduction of depreciation. So, any physical object you know with the passes of time it will lose its value and that is what is known as the depreciation. So, anything we use as the time progresses its value will certainly be less and the amount by which you know or any parameter by which we measure the change in its value so that quantity is known as depreciation.

Now for depreciation to you know be defined we must have certain requirements and the requirement is that the product which we are talking about for which for which we are talking about.

(Refer Slide Time: 02:15)



The depreciation that must be used in business to help you to produce income so then it must be something that wears out decays obsolete or from natural causes. So, basically the object

which we are using if it is a physical object which is you know in in function by by used by being in meeting with the parts or by being used in machines then certainly it will wear out because of the contact or even if it is not used it is kept in the open then it will be certainly rusted or you know its function will be certainly functionally it will not be that much effective for that much you know productive as it is when it is purchased.

So, certainly that there may be something that wearing out then it may decay over the period of time or many times the you know material may be obsolete you know at the period you know because of the technological advances because of the change in the required type of demand or requirements many times the product does not have the same demand and it has to be so it is because of many times because of the type of needs or maybe most of the requirements or the technological upgradation at the same time in other assets or so.

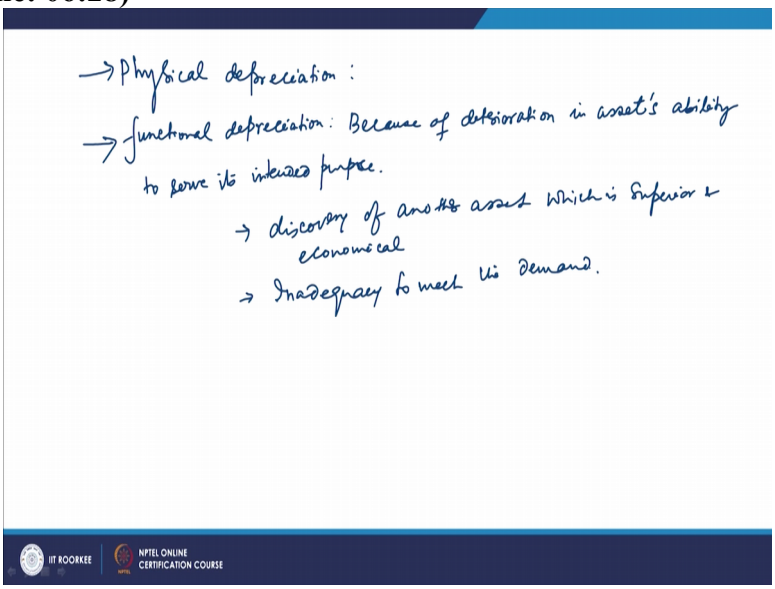
So, the requirement is that for the property to be depreciable that it must be something which should be wearing out if so decay should be obsolete or may be from natural causes. Then it is must have a determinable useful life longer than one year's which must have certain terms of that you have to compute what is the you know depreciation so for that it must have a determinable useful life and that must be longer than one year.

Now the depreciation types that that could include physical functional and accidents. So, when we talk about the physical depreciation then we talk about different cases like we talked about the pipes which are you know which are corroded you know then the timber which is there, which will be rotten. As you keep it in the; you know atmosphere then it will be rotten then there may be chemical decomposition. Then you may have the bacterial action on the material. So, all these things they are basically bringing that physical you know wear and tear and damage.

And also if the material is subjected to sock vibration then you have abrasion impact all these things you know they induce the kind of depreciation that is known as physical depreciation. So, basically in that it is visible that physically there is loss to the material so material you know it may be you know eroded it may lose certain of its weight or it may lose its appearance you know or the mating parts because of the frictional friction and so it may lose its property for which it is intended to be. So, these are the types of depreciation which is known as the physical depreciation.

Then you come to the functional depreciation now functional depreciation means you know its ability to solve the intended purpose so you know when we talk about the you know functional depreciation.

(Refer Slide Time: 06:28)



So, now if you talk about you know so we talk about physical depreciation and so in that you have wear and tear and sock vibration and all that so because of that you will have all of the mating parts it will not serve the purpose as it should be. Then you have functional depreciation and functional depreciation is because of the assets ability to serve its intended purpose.

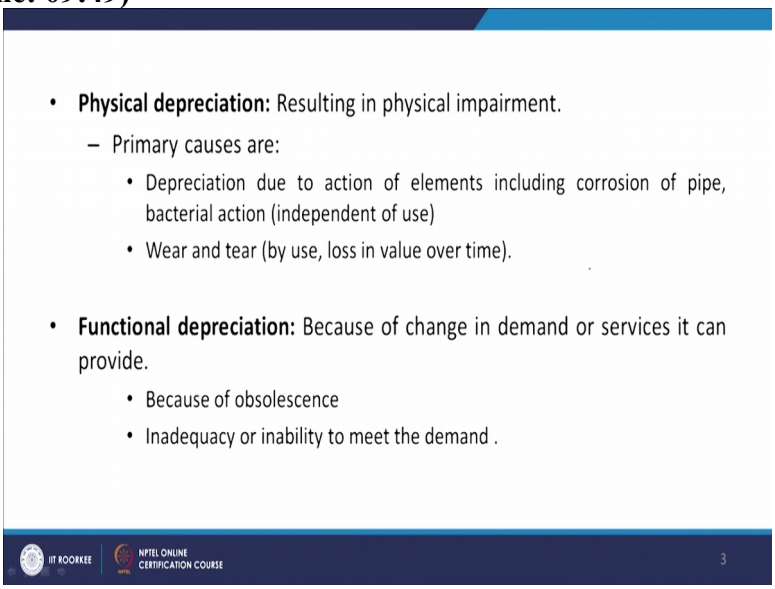
So, because of deterioration in assets ability to serve its intended purpose so now you know many a times because of the change in demand you know or the service which it can render many times the things become of solid like you purchase the lathe and then that lathe had the capacity to do the turning of 100 pieces you know per hour but you require 1000 pieces per hour. So, now that lathe of no use for you so its value is decreased.

So all these things because of the application in technologically or so, so because of that or because of the presence of more efficient machines you know the asset is said to be depreciated. So, it may be because of reasons like may you know because of discovery of another asset which is superior and economical. So, because of you know the; so that will make the existing asset obsolete.

So, that may be the reason or it may be also because of the inadequacy to meet the demand. So, know that as we discuss that there are two reasons basically one is that at the same time you have another asset which has come into the market which is technologically superior and also economical so that makes this present asset devalued. Second thing is that you are not

able to meet the demand so you have another asset which is there by which you can meet the demand so that way also you know there may be the depreciation being arised.

(Refer Slide Time: 09:49)

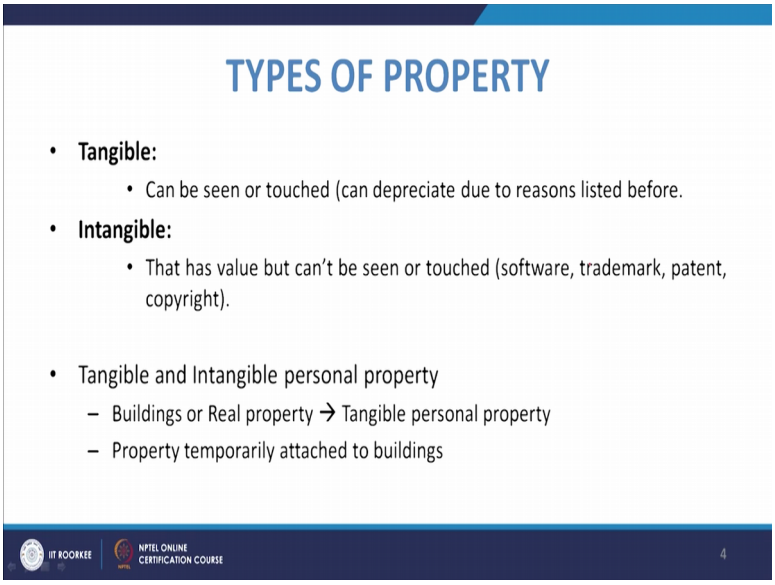


So, these are the different types of depreciation you know this is the; you know depreciation type. Now so as we discuss that physical depreciation will be resulting in physical impairment and we already discussed that is due to action of elements including corrosion of pipe by bacterial actions and wheel and tear. So, many things you know there are two things one is that one will be independent of use whether you use or not certain things will depreciate because like pipes if you are using or not using.

If you are not even using and you are keeping it in the open it may corrode so even if you are not using it is depreciating and some of the things which is constantly in use. So, because of the wear and tear or because of its constant use that will depreciate. So, these are the physical depreciation and functional depreciation as we discussed is because of obsolescence or it is because of inadequacy or ability to meet the demand.

Now when we talk about the depreciation then we must know that what are the properties? Which are going to be depreciated and before that we must be defining the property what are the properties. So, basically properties are of normally two types what is tangible and another is intangible.

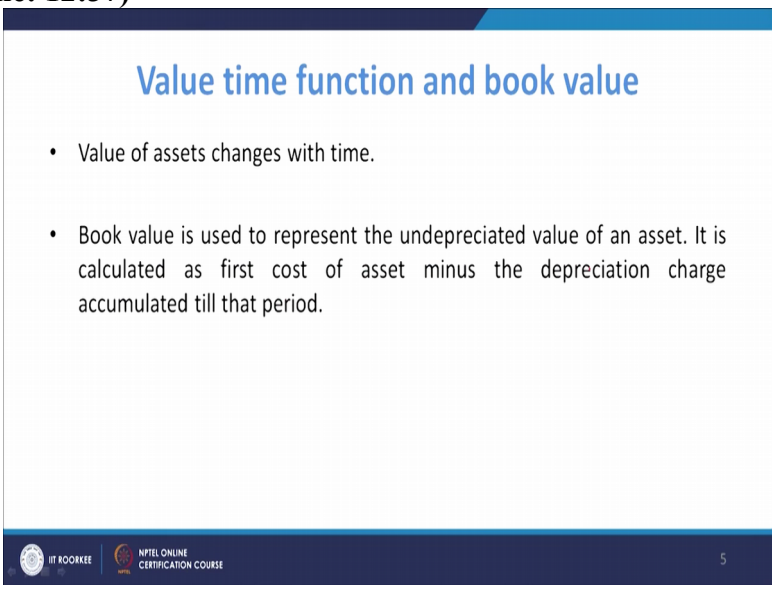
(Refer Slide Time: 11:15)



So, tangible means you it can be seen or touched, so it can be depreciated two regions which have been listed so whichever whatever machines are there you know because of the physical depreciation they can be you know they can be depreciated. Intangible means something which has value but which we cannot touch it which cannot be seen like software, trademark, patent, copyright.

So, these are the; this is how the properties are differentiated or classified and there is depreciation to both tangible as well as intangible property. There may be personal property there may be buildings or real property. Then property is temporarily attached to buildings you have I mean things like that so this way you have different types of properties and land also is there but land is not said to be appreciable because its value is not decreasing with time.

(Refer Slide Time: 12:37)



Now we will talk about certain terminologies and you know one of the terminology is you know value time function and Book value. Now when we talk about depreciation basically this depreciation is also used in accounting purposes while we claim depreciation we get the income tax benefit on depreciation that is why the depreciation is important when we calculate the tax amount to be paid when we purchase an instrument for any investment company will purchase instruments.

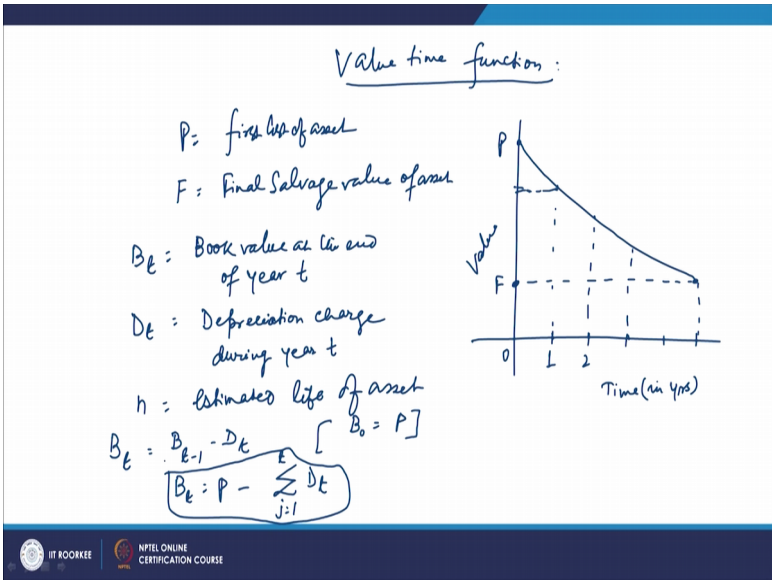
And then there are certain rebate which is given to them the depreciated amount basically certainly the provisions for getting the rebate on that. So, that is how this depreciation is basically useful for the financial institutions. Now once the material will depreciate in that case the there has to be change in this value. So as the time progresses and if there is depreciation then the value will be decreasing and this will be represented by a function and that function is known as the; you know value time function.

So, value of assets as it will be changing with time and then Book value is used to represent the un-depreciated value of an asset. So, when the asset is purchased it will be purchased at certain cost and that cost is known as the first cost of the asset. Then as the time progresses there will be depreciation and that depreciation is to be quantified and there are many methods that we will discuss in our coming lectures.

So, so once there will be depreciation means the present cost of the asset or original value of the; you know asset it is going on decreasing. So, at any time when the depreciation amount is to be subtracted from the you know original value suppose in the we are calculating yearly so in at the end of first year you your value which is now off the object will be the original value minus depreciation in the first year and that basically is known as the Book value.

So, we talk about this term we stand early in a standard manner we talk about the book value and book value indicates, so it will be representing the un-depreciated value of the asset is calculated as first cost of asset minus the depreciation charge accumulated till that period so that way Book value is normally used. And if you try to refer to the standard book values you know which is used then there is a book value function and that is a value time function and how this value time function is basically presented.

(Refer Slide Time: 15:46)



So, this is known as value time function so suppose any asset is there which has certain first cost so if P is the first cost of the asset and then if your F is basically the salvage value final salvage value so that is your of asset, now so P so total depreciation will be P - F now what happens that normally your you know asset has certain present cost so you purchase in some amount P so that is your first cost and then it may depreciate slowly with time so your time will be, so this will be your time in years.

And this is your value so what will happen that as the time progresses 1, 2, 3, 4 and 5 as the time progresses its value will be changing. So, initially its value is here and at the end of 5 years its value will be here and this value will be basically F. now P - F is basically that change in its value and this is the total depreciated you know amount which is for this asset. So, what happens that during that year if this is a; you know defined graph so you can go and just see that this value this value will be;

So at this point this is the value of the asset so this is known as the book value at the end of first year and similarly a book value at the end of second year will be you know this much like that so the your this you know this function which is which talks about the value and time that is known as the value time function. So, here in the standard manner we talk about the book value and this B t is known as book value at the end of year t.

So, this is your B t and similarly D t, D t will be called as the depreciation value so this is you know what is happening during that what amount of depreciation is there during that year. So, this is known as depreciation charge during year t so this is your depreciation charge D t and in this case we talk also about the estimated life of the asset.

So, what happens that if you know the estimated life of the asset then the book value at the end of estimated life of the asset is known as the F that is your final salvage value of the asset and basically this graph will be behaving in a different manner it may be you know going in linearly may go in a different way. The depreciation which is occurring during the different years may be different.

So, so that way the depreciation amount is calculated and for that there is a standard formula so what happens that if you take in the standard way the book value at the end of year t will be nothing but book value at the end of year t - 1 – D t. So, this is how the book value is defined at the end of any year t and if you say then in that case B 1 will be B 0 - D 1 so similarly B 2 will be B 1 - D 1 like that D 2 something like so depending upon as you go on changing this value so you can get these values.

Now the B t - 1 will be written as so this is your t now B t - 1 can be written as B t - 2 – D t - 1 so like that this will be accumulated curve. Now if you take so as now in this case you have B 0 will be equal to P because Book value at the end of year 0, it will be P your first cost of the asset so that is your B 0. So, in that case if you see the formula this B t will be P minus and then ultimately your B 0 will coming and all that D terminologies D 1 all that will be basically accumulated.

So, it will be summation of j = 1 to t + D t so this is how your depreciation amount is calculated this is Book value and in the; during the year t at the end of year t is being calculated. So, this is the value time function and also the book value calculation. Now for different you know our purpose is to find this book value at the end of any year or during any year you our aim is to find the depreciation.

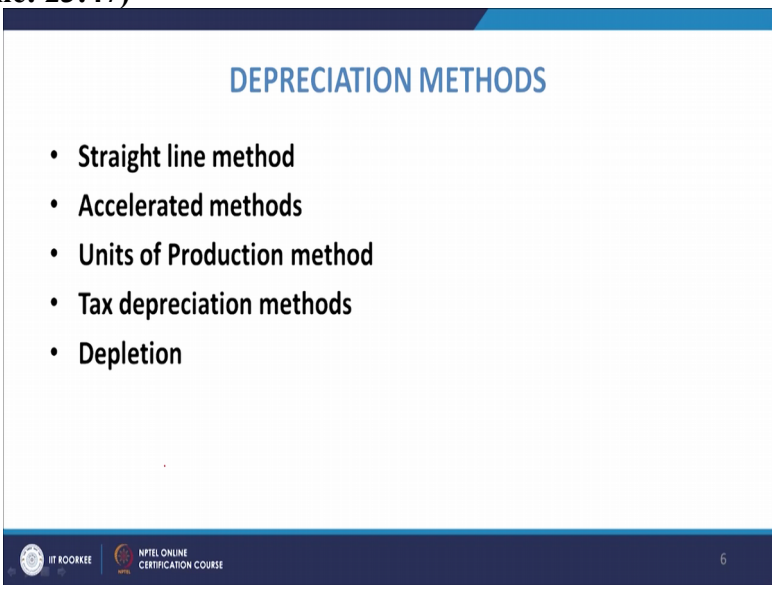
So, that the associated you know requirements of finding you know the change in value or the tax benefit or so can be calculated and depending upon the function this book value function you will have depreciation amount deferring. You may have the depreciation amount every year being same that will be in the case of straight line function then you may have something by which it will be more in the initial periods and less in the final years or there may be you know different cases that there may be rules for the n also.

And there may be you know other rules so that we will see and that is how this value time functions and Book value is defined. So, now we have to know about the different type of depreciation methods now as we discussed that since there is a value time function and

depending upon the nature of this curve you will have the different you know amount of depreciation during certain year.

Now there are if the slope is you know same slope is constant of that line then it is known as straight-line method which has particular slope and in that case slope being the same in that case the depreciation amount will be same so that will be straight line method.

(Refer Slide Time: 23:47)



Then apart from straight-line method you have accelerated methods certain methods means the depreciation amount will be more during the early periods and then it will be decreasing as the you know time progresses and that is basically very you know practically you know you might can be thought of in reality that when we take any material its value is you know decreasing at a more pace initially and then later on at lesser paced.

So, that is known as accelerated method in that basically the amount of depreciation is normally a function of its Book value. So, Book value since it is decreasing so it will be certain percentage of the book value. So, actually depending upon that these accelerated methods are there are many accelerated methods. Basically we have declining balance method and then we have the units of production you have we have basically the you know sum of digits methods there are many methods which talk about this that the depreciation amount will be more in the early stages and it will be decreasing as the time progresses.

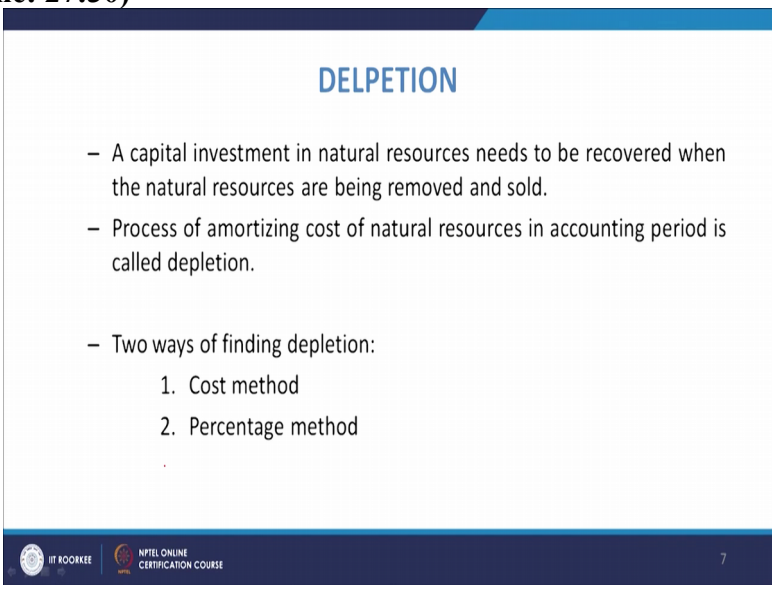
Then you have units of production methods so that it also is about how much is the production? Depending upon that you have depreciation. So, that even you can be used for the depreciation calculations. And we will talk about the depletion later. Then you have a tax depreciation methods where we talked about you know you have many methods by which the tax calculation is you know done.

And in that you have you know what we do is that we divide the assets into different categories and basically you have a recovery period and based on the discovery period the depreciation amount is calculated and in that basically we have this is you know modified form of the accelerated method. So, that is why we also call it as modified accelerated cost recovery method. So, that is they are used in many countries for calculating this depreciation.

And in that basically there are certain rules there are certain conventions which are followed like the convention is of half year convention then you have a recovery period so depending upon the class of the material the material has a certain you know recovery period in which the it is cost is to be recovered. So, it will come in some like 5 year property or 3year property or so or 7 year property or so. So, in that 7 year property it is all cost is to be recovered.

So, in that case after 7 year it is you know the salvage value is 0. So, like that there are methods by which we calculate these you know depreciation by using those methods you know for such assets for tax you know calculation. Then the next is the depletion now depletion is also a kind of depth but we talk about depletion and when we deal with the depreciation of natural assets.

(Refer Slide Time: 27:30)



So, the depletion is the capital investment in Natural Resources needs to be recovered when the natural resources are being removed and sold. So, normally when we deal with the use of natural resources in that case when you are doing the capital investment. Now in that case because you know once these natural resources are there it will be over so they are not going to be further you know the presence of these resources.

So, the process of amortizing this cost of Natural Resources in accounting period it is known as the depletion. So, this is also a type of depreciation and here also you have two methods of finding the depletion one is cost method and that is the percentage method and in that normally the cost method is similar to the element of production method where depending upon how much you have taken out what percentage of resources are being taken out? Based on that you calculate these depreciation charges suppose it has 35 million tons of certain you know resource is there and you have taken 5 million tons.

So, certainly you have taken 1/7th of it so certainly depreciation will be accordingly calculated. So, so that way this depletion is calculated then you have percentage method also and percentage method will be depending upon you know on every asset type of asset you have certain percentage to be depreciated and then it is also seen depending upon the income tax you know whatever you are having the you know net income which you are putting or income tax which you are giving depending upon that there are certain rules like should not be more than 50% of taxable income.

So, on all these rules and also the percentage is defined for different types of materials we calculate these you know the precision amount in the case of depletion. So, this is how the depletion is calculated for the when we deal with the natural resources. So, this is what we know about this is what we need to know about the depreciation and depletion and we will talk about the different types of depreciation how we calculate the book value.

How we calculate the amount of depreciation in during particular year or book value at the end of particular year all that needs to be known or what will be the total amount of depreciation or how much will be the depreciation schedule all that is required to be known and that we will understand in the subsequent lectures where we will talk about different types of depreciation methods like straight-line method, declining balance method then you have the sum of digits method.

You have other methods also sinking fund methods you have the depletion methods and all that so that we will discuss in our subsequent you know lectures, thank you very much.