Financial Mathematics
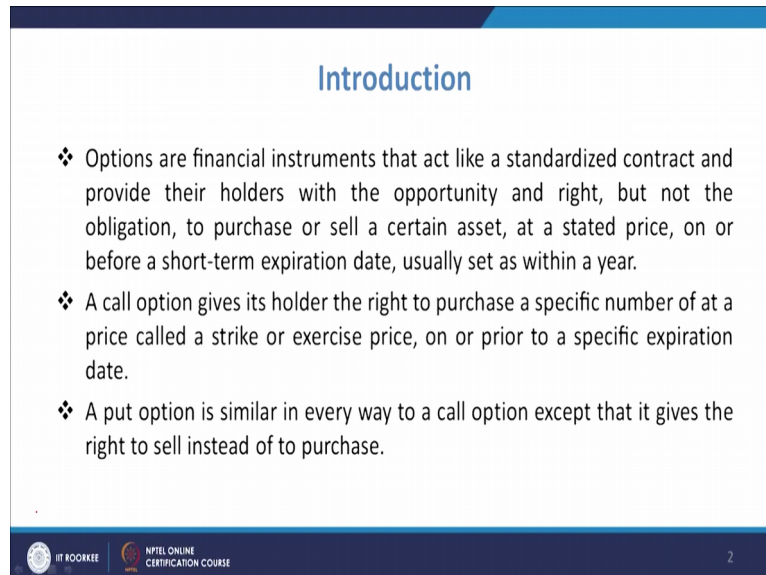**Prof. Pradeep K. Jha**
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Lecture – 48
Options
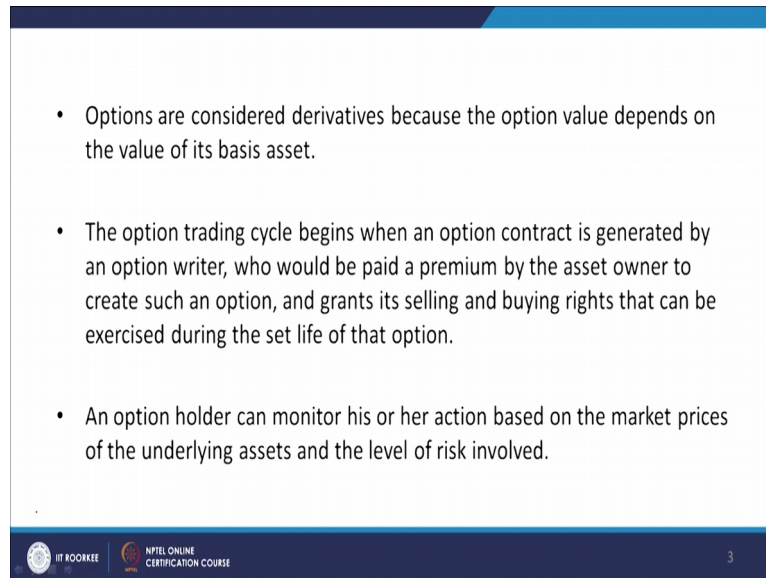
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Welcome to the lecture on, Options. So you will talk about options today. We discussed about mutual funds in the earlier classes. Now these options are the financial instruments that act like standardized contract and provide their holders with the opportunity and right, but not the obligation, to purchase or sell a certain asset, at a stated price, that is known as the market price or strike price pardon on or before a short term expiry date.

So that date normally is set as within a year. So basically, it will be, it gives the holder the right to purchase a specific number you know of shares at a price called the, you know, a strike price. So, so that way, you have they have the option you know and that too prior to a specific you know expiration date. So the date is there, so before that you have to do this, you know, work otherwise after that date the things will expire.

So that is a specific number of shares basically that is not written. So normally you have three types of options. These three types of options are rights, warrants, and then calls and puts. So, in most of the cases, we talk about the call and put option and in this lecture also we are going to talk about the put option and the call option. So you have you know something like buying or for sometimes you never have to do something like right to selling. So, based on that, you have either the call option or a put option.

So these are the, you know two types of options for which we have to talk call option will be giving the holder, the right to purchase specific number of shares at a price called the strike or exercise price, and then so that will be your call option and then if you talk about the put option, so it is similar to that you know call option but only difference is that it gives, you know, the right to sell. So when you have the right to buy that is your call option when you have the right to sell that is your put option.

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- Options are considered derivatives because the option value depends on the value of its basis asset.

- The option trading cycle begins when an option contract is generated by an option writer, who would be paid a premium by the asset owner to create such an option, and grants its selling and buying rights that can be exercised during the set life of that option.

- An option holder can monitor his or her action based on the market prices of the underlying assets and the level of risk involved.

So then options are also called as derivatives because their value will be depending upon the value of its basis assets. So because you have the market price which will be varying and based on that only its valuation is done. So that is why they are considered as the, you know, derivatives. Now the option trading cycle that will be beginning when option contract is generated by the option writer, who will be giving a premium by the asset owner to create some option, and then it will be granting its selling and buying rights.

So certainly that rights you know for I mean for the selling and buying had to be given and during the life of, you know, that option, that exercise is to be carried out. Now the, you know, option holder which will be monitoring, you know, he, he can monitor his or her action based on the market prices. So based on the you know value of the price, that is the market price, whether it is increasing or decreasing, you know, of the assets and also that depending upon the level of risk involved you know the option holy holder, will be monitoring his action.

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Option holder may follow one of the following actions:

❖ *To exercise the option:* When the market price of the underlying asset, such as a common stock, is higher than the strike price of the option, a holder of a call option would exercise his or her right to buy a call and make a profit. Similarly, when the market price is lower than the strike price of the put option, the put holder would exercise his or her right to sell and make a profit. This is the case called *in-the-money*.

❖ *Not to exercise the option:* when the investor does not see any opportunity to make a profit.

❖ *To let the option expire:* when investors keep waiting for the prices of the underlying assets to change in their favor so that they can exercise the option & take no action till the expiration date arrives, and their options are deemed worthless.

So this is about the options. Now the option holder will be following the actions which are like this. Now exercising the option, not to exercise the option, and let the option expire. So as we told that you have a call or a put option and either he can go for exercising the option he can think of not to exercise and and and then let the option expire.

Now in the case of the exercising the option, you know, when the market price of the underlying asset such as the common stock, it is higher than the strike price of the option. So that is the case, when you know the market price of the asset, it will be you know like stock now the strike price of them were you know option is there, and if it is more than that the the strike price of the option, then the holder of a call option, would exercise his or her right, to buy a call.

So certainly I mean since market price is larger and the strike price is smaller, so the this holder of the option, he they will exercise their right to buy the buy a call and make a profit. So in that time when the strike price is smaller and the market price has gone up in that case if he, you know, purchases at the strike price then, in that case, he will have the chance to earn a profit.

Similarly when the market price is lower than the strike price of the put option put option so the market price has gone down and a strike price is higher, so at that time it is it is beneficial to sell it, because you are selling at a larger price then the market price. So that way you are earning a profit. So when the market price is lower than the strike price of the put option, the put holder would exercise his or her right to sell and make a profit.

So depending upon the value of the strike price, whether it is more than the market price or whether it is less than the market price to buy or the sell option has to be in exercised and this case is known as the in the money so you are in the money that is how it is defined.

Now you know, this is not to exercise the option. Next option is that not to exercise the option, but then, when we talk about in the money. So you know in the money or in the case of you know when you are thinking of exercising the option. So the in the money condition will be that, when the market price, you know, for the call should be more than the you know strike price or the market price for the you know put option.

So, that will be less than the strike price, so that is MP C in the market price of a call. So this will be market price of a call. Similarly this will be market price, you know, of a put. So this will be market price of a put. So this situation is known as the in the money and these are the conditions which should be satisfied. Now then there is another you know action, that is not to exercise the option.

So when the investor does not see any opportunity to make a profit in that case he will think of not to exercise the option and this situation may come, you know, so that and this situation is also known as out of the money. So this is, in the money, and this is, out of the money, and this will be your, exercising the option, and when not to exercise, so in the case of not to exercise the option, so in this case what happens that the investor does not see any opportunity to make a profit.

So he will not try to exercise the option and in this case normally, the market price, so market price is either you know equal to or or lower than the strike price of call or same as as it is

equal or higher for put. So or you know equal or higher for a put so in that case you know so as you see that, in this case, this when you have such signs, so in that case, you have the opportunity to earning the profit, whereas if the market price is either equal to or lower if the signs becomes you know opposite.

So if you know market price for the call will be less than SP or market price for the put will be more than or equal to SP that is strike price. So in this case, investor does not you know want to exercise his option of either calling or you know either buying or selling. So this, you know, this situation, is known as the out of the money. So out of the money means you know in this case when it is less than equal to, so in the, so in that case, MPC will be less than SP or MPP will be more than SP so that will be your out of the money.

But when it is equal in that case it is known as, at the money. So in the case of, at the money you will have MPC will be same as SP and your MPP it will also be same as SP. So this is known as the, you know, not to exercise the option, or out of the money option. Then comes the; to let the option to expire. Now in this case the investor will be keep waiting for the prices of the underlying assets to change in their favour. So basically the investor will be waiting and waiting, so that, he will be anticipating, that there will be you know change in the prices in his favor, so that he can earn profits.

And you know we can take the option and and you know he does not take, he is not able to take the action, till the expiry date arrives and then that option becomes worthless, it is, you know, it is like a loss. So, so that is basically the, you know, known as the letting the option expire. So this is the three type of action which is being exercised in the case of options.

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Strategies used by financial institutions to protect investors against this loss and other types of loss in the investment market:
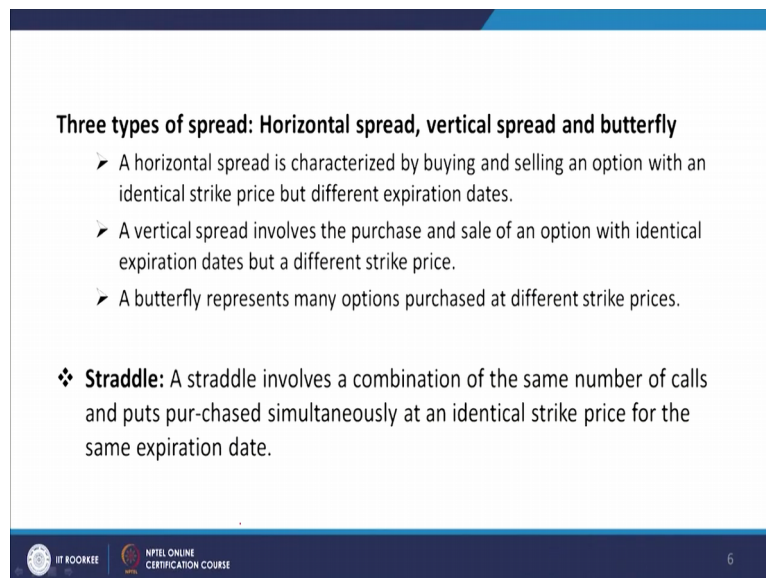
❖ Hedging: action taken with one security to protect another security against risks such as buying on one side and selling on the other. In option investment there are three common types of strategies: spreads, straddles, and a combination of both.

❖ Spread: It is a simultaneous purchase and sale of calls and puts on the same underlying asset, such as stock, which are written with either different strike prices, different expiration dates or both.

Now the strategies which are used by the financial institutions to protect against this loss and other type of lost in the investment market, so you have many kind of you know strategies and one of the strategy is that, is hedging. Now hedging is the action taken with one security to protect another security against risks such as buying on one side and selling, selling on the other. So this way, you are, you know having these steps, you know, so that you are you are protected against the risk.

So in the option investment, you have three common types of strategies, that is, you know spread, straddles, and a combination of both. Now what is spread? Now spread is basically it is a simultaneous purchase and sale of calls and puts on the same underlying assets. So it will be basically the simultaneous purchase and sale of the calls and puts like stock which are written with either different strike prices, different expiration dates or both.
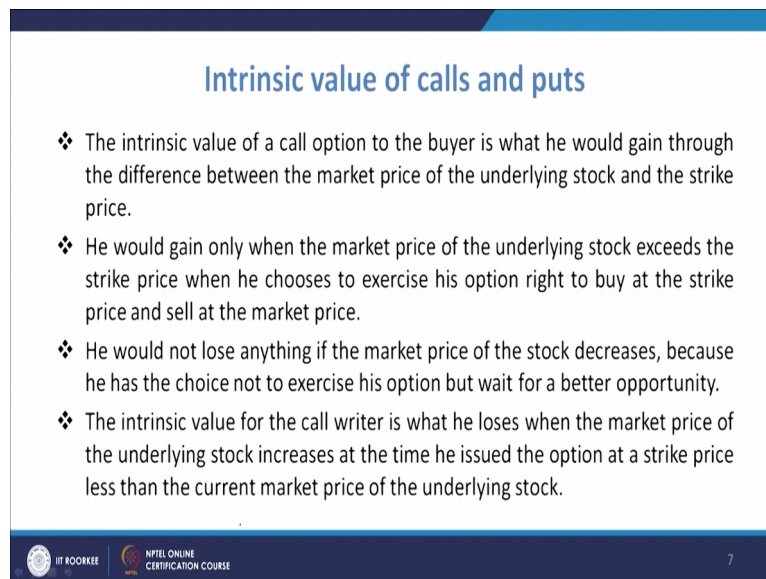
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So in that case you know we use this society's spread, you know, so in that case, you have 3 types of spreads, which are defined the horizontal spread, vertical spread, and butterfly. So the horizontal spread is characterized by buying and selling an option with an identical strike price but different expiration dates. So as we know that, in that case, you are simultaneously buying and selling. But here the strike price is identical but you have different expiration dates.

Similarly the vertical spread will be involving the purchase and sale of option with identical expiration dates, but the different strike price, you are taking, you know purchasing and selling the option, which have the; you know, similar, you know, same expiration date, but the

different strike price is there and then the butterfly is there which represents many options purchased at different strike prices. So that is known as the butterfly.

Apart from that, you have also the straddle now straddle is defined as the combination of the same number of calls and puts purchased simultaneously at identical strike price for the same expiration rate. So that is the example of this, that is the definition of a straddle, and that is how a straddle is defined.

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Now, we will discuss about the intrinsic value of calls and puts. So we will be talking about the valuation of the calls and puts options. Now intrinsic value of a call option to the buyer is, what he would gain through the difference between the market price of the underlying stock and the strike price. So we know that when you know the there will be difference in the market price.

And the stock price then there will be certainly in the profit or there or that will the value of the option, so he would gain only when the market price of the underlying stock exceeds the strike price. When he chooses to exercise his option right to buy at the strike price and sell at the market price. So suddenly, if he purchases or buys, at the strike price and then sells at the market price which is higher, in that case, he will be earning the profit.

He would not lose anything, if the market price of the stock decreases because he has the choice not to exercise his option but wait for a better opportunity. So certainly, you know, if it decreases, then he can wait for the better opportunity to come. Now intrinsic value of the call writer is, what he loses, when the market price of the underlying stock increases, you know,

at the time he sued the option at a strike price, you know, less than the current market price of the underlying stock.

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So basically what we say that you can calculate this intrinsic value of the you know the calls and puts. Now in both the cases, you know he has so depending upon the condition it is defined that the intrinsic you know value of a call so intrinsic value of a call to a call buyer. So that is normally represented by intrinsic value of the call, you know. So IVC that is for P. So this will be basically, this will be a maximum of, you know, MP minus SP and then zero.

So when the market price of the; you know call is higher in that case you have this is the MP - SP. So and the intrinsic value of the, you know, call to for a call writer. So, that will be W, so it will be a minimum of the SP minus MP, and this will be 0. So MP is the market price and SP is the strike price of the call option and you will have one for a buyer and one for a writer.

So, suppose if you try to understand by one example, like, if you have a call option is written and a call option is written for strike price. So suppose strike price is dollar 25 now per share, so that is for a common stock. So a common stock is there normally it is excited for common stocks. Now suppose after some time, so suppose after some time, market price has gone up, so market price will go in that case the chance of making profit so market price has gone up and you know to dollar 37.

Now what will be the intrinsic value of the buyer and the writer. So intrinsic value for buyer and writers will be what? So as you know, that the buyer, since it is the market price has gone up, so he will be getting some value. So, some profit, so if you take intrinsic value for the call

for a buyer. So in that case it will be maximum of, as MP - SP now SP was 25 and MP that is market price has gone to 37. So it will be 37 - 25, and then 0.

So it will be maximum of these 2 and this is 12 and 0. So it will be 12, so similarly if you talk about the writer, now it will be minimum of you know SP - MP so SP is 25 and this is 35 and then you have zeros out of the -12 and 0 your minimum value is -12. So this way, what you see that you are getting the, IVC, V that will be 12 and this will be and the 40 writer it will be minus 12. Now what you see, that whatever the buyer gains the writer will be losing.

So, so this is what is happening in the case of, you know, when you are, your price, has gone up or down, then how these values are changing. So this test can be computed and this can be also represented basically, graphically, also, like you have so that can be represented like it is going and then one side you have on the positive side you will have the IVC of the buyers, that will go up, so basically it goes to one side, it will go up and another side will be down.

So this will be IVC of buyer and this will be IVC of you know, the writer. So that way, your; this will be so this will be buyers call and this will be your; you know the writers call. So that way, you normally represent in terms of, this will be profit and this will be loss. So, so that way it is represented and the price you know price is the price is like this and when price has, the market price has gone up, so you will have this as the IVC of buyer and this will be the IVC for the writer.

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So that way these values are changing. Now so what we saw that, this is how these intrinsic value of the, you know, options are, you know, you know exercised in the similar case in the

case of you know put also. So that way you can calculate the values and find the intrinsic value of these calls and puts.
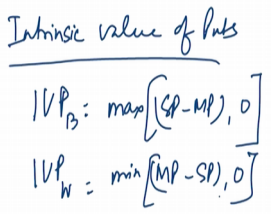
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Now coming to know, you know so puts are basically the opposite of calls and the intrinsic value in this case will be same as the call value equation except in switching the order of the prices. So basically in that case your; in case of puts IVC, you know IVP.

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So when we talk about the put case, so in the case of intrinsic value of puts, so in the case of put, it will be maximum of SP - MP and 0. So that is how IVP into the value of the put and that is for the buyer. So that will be basically maximum of SP minus the market price and 0 and similarly IVP, that in this value of the put for the writer, it will be minimum of you know MP - SP and then it is 0. So basically this is how you try to calculate the intrinsic values for the calls and puts.

Now the put buyer will seek a drop in the market price of the underlying stock, so that he can make a potential profit through buying cheap. So certainly, in that case, he will be thinking that the, you know, market value, should be dipping somewhat and the put writer on the other hand would make a loss by delivering an option at a strike price higher than what the market sells.

So both way, when such data is available to you, you can find these intrinsic values of the calls and puts, for the buyers or the writers, as the case may be. Now before that, before the end, we must also know something like the time value of the call and option. So something like time value of calls and puts.

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 So time value of calls and puts it is basically the difference between the option price and the intrinsic value of the option. So you know the time value for you know a call so that will be basically the difference between the option price. So that is OP and it will be the intrinsic value of the call option and you know and time value of the put, so this will be basically equal to the oprice you know option price and minus intrinsic value of the put option.

So that way it is defined, you know, as the portion of the premium above any, in the money premium. So that way it is known as the time value of the calls and puts, like you maybe understand through certain example like you know a call option. So that is, you know, is currently you know what 600 dollars and for this year and it is a strike price. So that is a dollar 40.

So you have to find the time value of the of; for its buyer, so to find time value for its buyer if you know market price of stock increases to dollar 45, let us say, you know, this is the situation where the option is currently worth dollar 600 and a strike price is 40 and your you have to find the time value for its buyer if market price of the stock is increasing to you know 45.

So in that case if you find the; you know IVC, so that will be IVC for the buyer, it will be basically the maximum of the you know the market price minus strike price. So market price is 45 and you know, you know the strike price is 40 and of 0. So it will be basically 5. So IVC B is basically you know 5, and this is for basically here the number of shares is 100. So number for, for 400 shares, so most shares are 100, so in that case, if you look at, so this is the dollar 5, you know, intrinsic value of the call for the buyer, it will be dollar 5.

And if you look at the option price, so option price basically is you know you have the you know what is 600 and then you have 100 shares. So it will be dollar 6. So if you look at the TVC, so it will be OP, that is option price, that is 6 and minus for the intrinsic value of the call for buyer that is 5. So it will be dollar 1. So that way, you can calculate the, the time value of the calls and puts. Similarly, similar case can be for the put also.

 In that case, you are going to have the OP minus IVP, so you have to find IVP and then you will subtract, you know, from there. So that way you can get these time values of the calls and puts. Thank you very much.