Chapter 7

Basics of Options

7.1   INTRODUCTION:

An option is an agreement between two parties, which gives the buyer of the option *the right, but not the obligation*, to buy or sell pre-decided quantity and quality of underlying asset (such as commodity, currency, stock, etc.) for delivery on specified future date at a pre-determined price, agreed upon on the date of entering contract.

In other words, an option confers on the buyer the eligibility to buy or sell a pre-decided quantum of underlying at a pre-determined price on a future date, without investing and with no obligation to do so. On the due date, the buyer of option may elect to buy/sell as per his entitlement or he may choose to let it go unused. Either of the decision of option buyer is binding on the option seller/writer. Thus, option writer/seller assume the obligation.

For assuming this obligation option writer charges a premium (called as option price), which is not a part of pre-decided price of underlying (which is called exercise price). Thus options contract has cost in the form of premium, whereas in case of forward or futures contract there is no such cost, except small transaction fees levied by exchanges.

There are two basic types of options viz. 'Call Option' and 'Put Option'. A Call option confers a right on the buyer of the call option to buy and Put option confers a right on the buyer of the Put option to sell, the underlying asset at a pre-decided price (called exercise price) up to a certain date (called expiry date).

First options were used in ancient Greece to speculate on olive. In USA in the early 1900s a group was set-up called Put and Call Brokers and Dealers Association with the aim of bringing buyers and sellers together. This association was the first to offer organized trading in Over-The-Counter options. With the formation of Chicago Board Option Exchange (CBOE) in 1973, the first exchange traded options came into existence. CBOE was followed by Philadelphia Stock Exchange, introducing options on common stocks in 1975 and Pacific Stock Exchange in 1976. Till 1980 options were available on common stocks on these

exchanges. In 1980s the options trading was expanded to other securities too. Options trading on Treasury Bills (Treasury Notes and Treasury Bonds) commenced in 1982 on the American Stock Exchange. Later options trading in Foreign Currencies began on Philadelphia Stock Exchange. Exchange Traded options now trade in more than 500 exchanges world-wide.

In India, traditionally options were traded on the OTC market popularly referred to as teji, mandi, teji-mandi, etc. Options trading in commodities were banned in India under the Forward Contracts Regulation Act, 1952 and till today no options trading in commodities is permitted. The Securities Contract Regulation Act, 1969, banned trading in options on common stock in 1977 under the administration of Morarji Desai's Government. Later, the Securities Laws (Amendment) Ordinance, 1995 was promulgated to withdraw the prohibition on options in securities. A new era of organized options trading began with the introduction of Index Options - BSE Sensex Options and S&P CNX Nifty Options, in June 2001 at BSE and NSE respectively, followed by introduction of individual stock options in July 2001 both at BSE and NSE. The Reserve Bank of India permitted Authorised Dealers to trade in Rupee Options from July 7th 2003. Authorised dealers were allowed by the RBI to enter into FC-INR option contracts with their clients.

NSE commenced trading in currency options on USD-INR from 29th Oct. 2010. Currently as of 1st July 2017 NSE and BSE offers currency options in 4 pair of currencies, vis US Dollar, Euro, British Pound and Japanese Yen. The pair of currencies on which options are available on NSE are USD-INR, EUR-INR, GBP-INR and JPY-INR.

7.2   OPTIONS TERMINOLOGY:

Knowledge of selected key terms that are often used in describing options is a prerequisite for better understanding of the working of options. Brief description of these terms is as under.

(1) **Option Buyer/Holder:** An option buyer/holder is a person who buys an option to either buy (call option) or sell (put option) underlying asset.
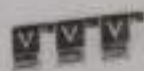
(2) **Put & Call Option:** 'Put option' is a contract in which option buyer has right to sell underlying asset at the exercise price (X). Whereas, 'Call Option' is a contract in which option buyer has right to buy underlying asset at the exercise price (X).

(3) **Option Seller / Writer:** An option seller/writer is a person who sells/writes, a call or a put option, to option buyer. Option writer has an obligation to buy (in case of put option wrote) or to sell (in case of call option wrote), if the holder of option decides to exercise his option.

(4) **Strike Price / Exercise Price (X):** It is the pre-decided price at which option buyer is eligible to buy or sell the underlying asset.

(5) **Expiration Date:** It is the last day on which option can be either exercised or lapsed.

(6) **Exercise Date:** The date on which the option is actually exercised by the option holder is known as exercise date.

(7) **Option Premium / Price:** It is a price (cost) paid by option buyer to the option seller to acquire the right to buy or sell the underlying at a specific exercise price. (It does not form a part of exercise price). Let's denote this as 'C_{pr}' = Premium on Call Option and 'P_{pr}' = Premium on Put Option.

(8) **In-the-Money (ITM):** An option is said to be In-the-Money when exercising of option is favourable. In case of Call option when ruling spot price (S) exceeds Exercise Price (X) then option is in-the-money i.e. $S > X$. Whereas, in case of Put option when ruling spot price (S) is less than Exercise Price (X) then the option is in-the-money i.e. $S < X$.

(9) **Out-of-the-Money (OTM):** An option is said to be Out-of-the-Money when exercising of option is not favourable. That is, in case of Call Option, $S < X$ and in case of Put Option, $S > X$.

(10) **At-the-Money (ATM):** An option is said to be At-the-Money when exercising of option is neither favourable nor

unfavourable. That is, $S = X$, both in Call as well as Put option.

(11) **Intrinsic Value (IV):** The amount by which an option is In-the-Money is called its intrinsic Value. Intrinsic Value of Call Option (IV_c) = Current Price of Underlying asset (S) minus Exercise Price (X), i.e. $IV_c = S - X$. Intrinsic Value of Put Option (IV_p) = Exercise Price (X) minus Current Price of Underlying asset (S), i.e. $(IV_p) = X - S$. The IV of OTM and ATM options shall be zero, since their exercisability is unfavourable and neutral respectively.

(12) **Extrinsic Value / Time Value (TV):** Time value is the amount an investor is willing to pay for an option above its intrinsic value as he expects that at some time before the expiration of the contract, the value of the underlying will generate positive cash flows. In other words, Time value is a difference between Option Premium and Intrinsic Value. Thus, the Time Value of Call Option $(TV_c) = C_{pr} - IV_c$ and Time Value of Put Option $(TV_p) = P_{pr} - IV_c$.

(13) **Option Class:** It refers to all listed options of a particular type (i.e. put or call) on a particular underlying asset. For Example, all put or call options on S&P CNX Index are referred to as option class.

(14) **Option Series:** An option series consists of all the options of a given class having same Expiration Date and Exercise Price. For Example 'OPTIDX NIFTY 27JUL 2017 PE 9500' is an option series which includes all S&P CNX Nifty Put Options that are traded with Exercise Price (X) of Rs. 9500 and Expiry 27 July 2017.

(15) **Open Interest:** Open Interest is the total number of options contracts outstanding in the market at any given point in time.

(16) **Futures Option:** It is option contract in which underlying asset is a futures contract.

(17) **Naked Call and Covered Call:** When an option writer writes a call option which is covered by a position in underlying asset it is referred to as covered call. For example, an option
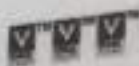
writer writes a call option on shares of ABS Ltd while holding the shares of ABS Ltd, so that if option buyer exercises the option then the option writer will be in a position to deliver the underlying. Naked call writing involves writing a call option without holding the underlying asset. Covered calls are far less risky than naked calls, since the underlying asset is already owned by the writer and he does not have to buy them from spot market at a steep price.

7.3 TYPES OF OPTIONS:

Options can be classified into three broad categories as under.

(1) **On the basis of timing of Exercisability:** The options based on time of exercisability can be of three types,

(a) **American Option:** These options can be exercised on any day between option purchase date and the expiration date. Thus, these options have as many exercise dates as there are in the days till expiration.

(b) **European Option:** These options can be exercised on the expiration date only. Thus, these options have single exercise date, which is same as expiration date.

(c) **Bermudan Option:** These types of options instead of having a single exercise date has set of predetermined discrete exercise dates and the option can be exercised on those dates only. They are commonly use in interest rate and foreign exchange markets.

(2) **On the basis of way they are traded:** They are of two types,

(a) **Over-The-Counter Options:** Market-place where in party-to-party negotiated option contracts are entered is known as OTC options. These are customized options contract. For Example, Foreign exchange options contract entered between bank and its clients.

(b) **Exchange Traded Options:** These are options contracts traded on derivatives exchanges where the buyer and the seller do not know each other. These are exchange standardized options contract. The exchange clearing house acts as a counter party for both the buyer and

seller. For Example, 'OPTIDX NIFTY' is an option on S&P CNX Nifty index traded on NSE.

(3) **On the basis of underlying:** Some of the popular genre of underlying assets on which options products available are,

    (a) Commodities – Agricultural, Metals, Energy, etc. (Not allowed in India)

    (b) Equities and Indices based on equities.

    (c) Foreign Exchange / Currency Derivatives.

    (d) Interest bearing debt instruments.

Note: *SEBI has disallowed American Options on Indian Derivatives exchanges.*

7.4 FUTURES/FORWARD V/S OPTIONS:

Though Futures/Forward and Options are derivatives products they are distinct in terms of risk and return. The distinct features of Futures and Options are tabulated in Table 7.4.1.

Table 7.4.1

Distinction between Futures and Options

	Futures	Options
Payoffs	Linear i.e. the losses as well as profits of the buyers and sellers of futures are unlimited.	Non-linear i.e. the loss of the option buyer is limited and profits potentially unlimited. Whereas, profits of option writer is limited and loss potentially unlimited.
Performance Obligation	Both on buyers and sellers.	Only on option writer, not on option buyer.
Trading	Usually, Exchange Traded.	Both Exchange Traded & OTC.
Premium	Not Required.	Buyer pays Premium to Writer.
Margin	Exchange specified margin is required to be deposited by both for buyer and seller.	Only writer has to deposit exchange specified margin.

Settlement	Daily on exchange.	American option daily basis. European & Bermudan option only on specified date/s.

7.5 OPTIONS CONTRACT SPECIFICATIONS OF NSE AND BSE:

Indian Index Options and Indian Equity stock options are available for trading on NSE and BSE. NSE also offers options on Global Indices. Brief options contract specifications of NSE and BSE is given in Table 7.5.1, 7.5.2 and 7.5.3 as under:

Table 7.5.1

Indian Indices and Equity Options Contract Specifications – NSE

Parameter	Index Options	Options on Individual Securities	Long Term Index Options
Underlying	7 indices	214 securities	Nifty 50
Underlying Symbol	Symbol of Underlying Index	Symbol of Underlying Security	NIFTY
Option Style	European	European	European
Option Type	Put and Call	Put and Call	Put and Call
Strike Prices	Minimum 3	Minimum 3	Minimum 3
Contract Period	3 month trading cycle - the near month (one), the next month (two) and the far month (three)		Three quarterly expiries (March, June, Sept and Dec cycle) and next 8 half yearly expiries (Jun, Dec cycle)
Expiry Day	Last Thursday of the expiry month. If the last Thursday is a trading holiday, then the expiry day is the previous trading day.		

Information Source: National Stock Exchange Ltd. (As on 30th June 2017)

Table 7.5.2

Global Indices Options Contract Specifications – NSE

Indices	S & P 500	DJIA	FTSE 100
Option Style	European	European	European
Option Type	Put and Call	Put and Call	Put and Call
Contract Size	250 Units	25 Units	50 Units
Tick Size	0.25	2.50	1.00

Contract Period	3 serial monthly contracts and 3 Quarterly expiry contracts in Mar-Jun-Sep-Dec cycle
Expiry Day	3rd Friday of the respective contract month.

Table 7.5.3

Indian Indices and Equity Options Contract Specifications – BSE

Parameter	Index Options	Options on Individual Securities	Long Term Index Options
Underlying	7 indices	214 Securities	S & P BSE SENSEX
Underlying Symbol	Symbol of Underlying Index	Symbol of Underlying Security	S & P BSE SENSEX
Option Style	European	European	European
Option Type	Put and Call	Put and Call	Put & Call
Strike Prices	Minimum 3	Minimum 3	Minimum 3
Contract Period	3 month trading cycle - the near month (one), the next month (two) and the far month (three)		Three quarterly expiries (March, June, Sept and Dec cycle) and next 8 half yearly expiries (Jun, Dec cycle)
Expiry Day	Last Thursday of the expiry month. If the last Thursday is a trading holiday, then the expiry day is the previous trading day.		

7.6 MONEYNESS OF OPTIONS:

Moneyness of an option illustrates the relationship between the spot price and the exercise price of the option. It basically explains how the option holder would benefit if the holder exercises the option. The moneyness of option is of three types, viz.

(a) **In-The-Money (ITM):** An option when exercised results in positive cash flow to the holder of option then the moneyness of option is said to be ITM. In case of call options when spot price at time 't' (S_t) is more than the exercise price (X), then the call option is said to be ITM and in case of put option when exercise price is more than spot price at time 't', then the put option is said to be ITM.

(b) **At-The-Money (ATM):** An option when exercised results in nil cash flow to the holder of the option then the moneyness of option is said to be ATM. When spot price is equal to exercise price then the option is said to be ATM, for both Call Option and Put Option.

(c) **Out-of-The Money (OTM):** An option if exercised results in negative cash flow, i.e. cash outflow, to the option holder (which no option holder would do) then the moneyness of option is said to be OTM. In case of call option when spot price is less than the exercise price then the call option is said to be OTM and in case of put option when exercise price is less than spot price then the put option is said to be OTM.

The Table 7.6.1 below summarizes the moneyness of options:

Table 7.6.1

Moneyness of Options

	Call Option	Put Option	Cash Flows if Exercised
In-The-Money	$S_t > X$	$S_t < X$	Positive
At-The-Money	$S_t = X$	$S_t = X$	Nil
Out-of-The-Money	$S_t < X$	$S_t > X$	Negative

An option holder will exercise option only when it finally results in positive cash flow for the holder. From above table it can be seen that ATM and OTM when exercised does not generate positive cash flow for the option holder, thus option holder will never exercise ATM and OTM options. Option holder would let the ATM and OTM options lapse.

Illustration 7.1:

In May 2010 Mr. Manibhai purchased a July Call Option on stock of Infotech Ltd at an exercise price of Rs. 1150 and a July Put Option on Biotech Ltd at an exercise price of Rs. 520. If the prices of shares of Infotech Ltd and Biotech Ltd in month of July 2010 are as under.

Possibilities	Infotech Ltd.	Biotech Ltd.
A	1170	510
B	1150	520
C	1130	530

What is the moneyness of options? Show cash flow computations and Suggest.

Solution:

Possibility	Infotech Ltd (Call)		Biotech Ltd (Put)	
	$S_t-X = CF$	Moneyness	$X-S_t = CF$	Moneyness
A	1170-1150 = 20	ITM	520-510 = 10	ITM
B	1150-1150 = 00	ATM	510-510 = 00	ATM
C	1130-1150 = -20	OTM	520-530 = -10	OTM

Suggestion:

Mr. Manibhai should exercise options under possibility A, since the options will be ITM, which would generate positive cash flow. In possibility B and C both call and put will generate nil and negative cash flows respectively. Thus, Mr. Manibhai should not exercise ATM and OTM options under possibilities B and C.

7.7 OPTION PREMIUM:

By definition, Option is a contract which confers right on the holder of contract and not obligation to buy or sell underlying asset at mutually agreed predetermined price for delivery at future date. So, options are uneven contracts that give right to one i.e. option buyer, while bind the other party i.e. option writer. The option writer gets bound to the contract for a consideration (price) called option price or option premium. In other words, the Option buyer / holder has to pay a price for acquiring this right to buy or sell the underlying assets on pre-agreed terms and the price of this right without obligation is known as 'Option Price' or 'Option Premium'. The option premium is paid by the Option Buyer for both Call as well as Put Option to the option writer. Thus, option premium is a cash outflow for option buyer and cash inflow for option writer. Therefore, option premium to the extent paid by

option buyer and received by option writer, will reduce the profit of option buyer and reduce the loss of option writer.

7.8 VALUATION OF OPTION – INTRINSIC VALUE AND TIME VALUE:

How much should be the Option Premium? Answer to this lies in the value of option. The value of option i.e. Option Premium payable is comprised of two components viz.

(1) Intrinsic Worth or Value (IV).

(2) Extrinsic or Time Value (TV).

(1) **Intrinsic Value (IV):** The amount by which an option is In-the-Money, either before the expiration date (denoted by t) or on expiration date (denoted by T), is called its intrinsic Value.

Intrinsic Value of Call Option is the maximum excess of current spot price of underlying over its exercise price, or zero (since option holder will never accept negative value). And Intrinsic Value of Put Option is the maximum excess of exercise price of option over the spot price of the underlying, or zero (since option holder will never accept negative value). Symbolically intrinsic value (IV) will be,

Option Type	Call Option	Put Option
American	$IV_c = Max\{0, S_t - X\}$	$IV_p = Max\{0, X - S_t\}$
European	$IV_c = Max\{0, S_T - X\}$	$IV_p = Max\{0, X - S_T\}$

Where,

Max $\{0, S_t - X\}$ or Max $\{0, S_T - X\}$, means that the intrinsic value of Call is either 0 or $S_t - X$, whichever is higher.

And

Max $\{0, X - S_t\}$ or Max $\{0, X - S_T\}$, means that the intrinsic value of Put is either 0 or $X - S_t$, whichever is higher.

(2) **Time Value (TV):** Time value is the amount option buyers are willing to pay for the possibility that the option may become profitable prior to expiration, due to favourable change in the price of the underlying. Thus, time value is the amount an option buyer is willing to pay for an option above its intrinsic value as he expects that at some time before the

expiration of the contract, the value of the underlying will generate positive cash flows. Because of principle of price convergence, an option loses its time value as its expiration date nears. At expiration an option is worth only its intrinsic value. Time value cannot be negative. At the most it can be Zero.

In other words, Time value is a difference between Option Premium and Intrinsic Value. Symbolically, time value (TV) will be,

Call Option: $(TV_c) = C_{pr} - IV_c$ Where, C_{pr} = Premium on Call Option,

Put Option: $(TV_p) = P_{pr} - IV_c$ and P_{pr} = Premium on Put Option

Illustration 7.2:

Today on 2nd July 2010 S&P CNX Nifty is trading at 4350. Mr. Bazarwala is contemplating buying option on September 2010 S&P CNX Nifty Index. From the below provided data compute moneyness, intrinsic value and time value of the S&P CNX Nifty Index option. Comment on your calculations.

	Sept. 2010 Strike Price (X_c)	Call Premium (C_{pr})	Sept. 2010 Strike Price (X_p)	Put Premium (P_{pr})
1	4200	175	4500	185
2	4350	150	4350	160
3	4500	20	4200	25

Solution:

Computation of Intrinsic Value

	Call Option				Put Option			
	X	S_t	IV_c = Max $(0, S_t - X)$	Moneyness	X	S_t	IV_p = Max $(0, X - S_t)$	Moneyness
1	4200	4350	150	ITM	4500	4350	150	ITM
2	4350	4350	0	ATM	4350	4350	*0	ATM
3	4500	4350	0	OTM	4200	4350	0	OTM

Computation of Time Value

	Call Option				Put Option			
	C_{pr}	IV_c	$TV_c =$ $C_{pr} - IV_c$	Moneyness	P_{pr}	IV_p	$TV_p =$ $P_{pr} - IV_p$	Moneyness
1	175	150	25	ITM	185	150	35	ITM
2	150	0	150	ATM	160	0	160	ATM
3	20	0	20	OTM	25	0	25	OTM

Comments:

Time value is Maximum when the option is ATM since it has the maximum potential to be ITM. OTM have lowest time value since it may be difficult for these options to become ITM.

7.9 FACTORS AFFECTING OPTION PREMIUM:

Factors affecting option premium can be broadly classified into two categories as under.

(A) Quantifiable Factors:

(1) Spot Price of Underlying.

(2) Exercise Price.

(3) Volatility of Underlying Assets.

(4) Time to Expiration.

(5) Risk-Free Interest Rate.

(B) Non-Quantifiable Factors:

(1) Market participants' perception about future volatility in prices of underlying assets.

(2) The effect of demand-supply situation of underlying both in derivatives and cash segment.

(3) Trading volume in the market.

Non-quantifiable factors are beyond the scope of this book. A brief discussion on quantifiable factors is as under.

(1) **Spot Price of Underlying:** In the preceding section we discussed about option valuation. We learnt that option premium has two elements i.e. Intrinsic Value (IV) and Time

Value (TV). The moneyness of option depends on the spot price of the underlying. Depending on the spot price the option is either ITM or ATM or OTM. Higher the spot price higher will be the call option value and lower the spot price higher will be the put option value. Spot prices are dynamic which keeps on changing, therefore, as and when spot price changes, option value will change.

(2) **Exercise Price:** Basically the option value is the difference between the spot price and strike price. Change in strike price will change the option value. Lower strike price indicates higher call option value and higher strike price indicates higher put option value.

(3) **Volatility of Underlying Assets:** The movement in asset prices is termed as volatility. Volatility is measured by considering historical price movements of underlying assets or the index, referred to as historical volatility. At times historical volatility may not truly reflect future volatility then implied volatility is estimated. (Historical volatility and implied volatility is discussed in chapters to follow).

The higher the expected movement in the price of d underlying asset i.e. higher the volatility, the higher is the chances of the spot price rising largely over the exercise price of call option on expiry or largely falling below the exercise price of put option at expiry. High volatility may also have opposite impact, resulting in the spot price largely falling below exercise price of call option on expiry or spot price largely rising above the exercise price of the put option on expiry. But, in such case the option holder need not worry, since the option will not be ITM and hence the option holder will not exercise the option.

Illustration 7.3:

Stock of ABS Ltd is currently quoted on BSE at Rs. 135 and a call option on ABS Ltd are available for exercise price of Rs. 135. From the following information on likely prices of ABS Ltd on expiry and respective conditional probabilities of volatilities calculate option price.

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Likely Prices Rs.	Probability of Low Volatility	Probability of High Volatility
115	0.10	0.30
125	0.20	0.20
135	0.30	0.10
145	0.20	0.20
155	0.10	0.30

Solution:

Computation of Option Premium

Exercise Price (X)	Likely Prices (S_t)	Payoffs = IV_c = Max (0, S_t-X)	Probability of Low Volatility	Probable Payoff of Low Volatility	Probability of High Volatility	Probable Payoff of High Volatility
(a)	(b)	(c) = Max{0,(b) − (a)}	(d) given	(e)=(c) × (d)	(f) given	(g)=(c) × (f)
135	115	0	0.1	0	0.3	0
135	125	0	0.2	0	0.2	0
135	135	0	0.3	0	0.1	0
135	145	10	0.2	2	0.2	2
135	155	20	0.1	2	0.3	6
Option Premium				4		8

The above computation clearly shows that the higher the volatility higher will be the option premium and vice versa.

(1) **Time to Expiration:** The length of time to expiry determines the option premium. Longer the time to expiry higher will be the option premium, since longer the period higher is the chances of the option to become ITM. Therefore options with same exercise price, but different expiry dates shall have different option premium. Thus, the far month option will have higher option premium than the near month option.

(2) **Risk-Free Interest Rate:** With the increase in increase rate the expected growth rate of the price of the underlying assets also increases, however, the present value of any future cash flows received by the option holder decreases. These two effects, affects the value of option. The value of a call option increases

with increase in interest rate and the value of put option decreases with the increase in interest rates.

There are two ways of calculating present value (PV) of exercise price viz. (a) Simple compounding / discounting method, and (b) Continuous compounding / discounting method.

(a) **Simple discounting method:** It is used when interest rates are fixed for the given period. The present value of exercise price is given by,

$$PV_X = X \times (1+rt)^{-t} = X/(1+rt)^t$$

(b) **Continuous discounting method:** It is used when interest rates are floating and accrues on continuous basis. The present value of exercise price is given by,

$$PV_X = X \times e^{-rt} = X/e^{rt}$$

Market participants will choose the method depending on the type of interest rate on their funding. Simple discounting method will be appropriate for fixed interest rate funding and continuous compounding will be more appropriate for floating interest rate funding. All our discussion will be based on floating interest rate funding.

Illustration 7.4:

In July SPS Ltd.'s September call option and put options are trading at following exercise prices Rs. 500 and Rs. 510 respectively. Risk free interest rate is 10% p.a. Calculate the present value of exercise price on simple discounting basis as well as continuous discounting basis.

Solution:

	Call Option	Put Option
Exercise Price (X)	Rs. 500	Rs. 550
Interest (r) p.a.	10%	10%
Period (t)	3 months	3 months
PV of X on simple basis	$= 500 / (1+.10 \times 3/12)^{3/12}$	$= 550 / (1+.10 \times 3/12)^{3/12}$
$PV_X = X / (1 + rt)^t$	$= 500 / (1.025)^{.25}$	$= 550 / (1.025)^{.25}$
	$= 500 / 1.0062 =$ Rs. 496.92	$= 550 / 1.0062 =$ Rs. 546.61

PV of X on continuous basis $PV_x = X/e^n$	$= 500 / 2.71828^{(0.10 \times 0.25)}$ $= 500 / 2.71828^{0.025}$ $= 500 / 1.02532 = $ Rs. 487.65	$= 550 / 2.71828^{(0.10 \times 0.25)}$ $= 550 / 2.71828^{0.025}$ $= 550 / 1.02532 = $ Rs. 536.42

The Table No 7.8.1 below summarizes the effect of increase in each factor on option premium, holding other factors unchanged.

Table 7.8.1

Effect of Increase in each factor on option premium, assuming other factors remaining unchanged.

	Increase in	Call Option Premium	Put Option Premium
1	Spot Price (S)	Increase	Decrease
2	Exercise Price (X)	Decrease	Increase
3	Volatility (σ)	Increase	Increase
4	Time to Expiration (t)	Increase	Increase
5	Interest Rate (r)	Increase	Decrease

Based on above discussion we infer the basic rules of option premium as under:

	Call Option Pricing Rules	Put Option Pricing Rules
1	The lower the exercise price, more valuable is call.	The higher the exercise price, more valuable is put.
2	The difference in call prices cannot exceed the difference in the exercise prices.	The difference in put prices cannot exceed the difference in the exercise prices.
3	Before expiration, a call must be worth at least the underlying price minus the present value of exercise price.	Before expiration, a put must be worth at least the difference between exercise price and the underlying price.
4	More the time till expiration, higher is the call option premium.	More the time till expiration, higher is the put option premium.
5	Higher the volatility, higher is the call option premium.	Higher the volatility, higher is the put option premium.
6	The more the interest rate, higher is the call option premium.	The more the interest rate, lower is the put option premium.

7.10 OPTION PAYOFFS:

The option has non-linear payoffs. The loss of the option buyer is limited to the extent of premium paid and the profit potential is unlimited. For the option writer the payoffs are exactly opposite

i.e. profit is limited to extent of premium received and loss potentially unlimited. The Call Option and Put Option payoffs of, Option Buyer and Writer are presented hereunder.

Illustration 7.5:

Ms. Tejal buys a European Call option on stock of ABC Ltd by paying Option Premium of Rs. 3 having Exercise Price of Rs. 50. Calculate Intrinsic Value and Profit or Loss of Mr. Tejal for spot prices at expiry of Rs. 46 to Rs. 55. Also present your calculations graphically.
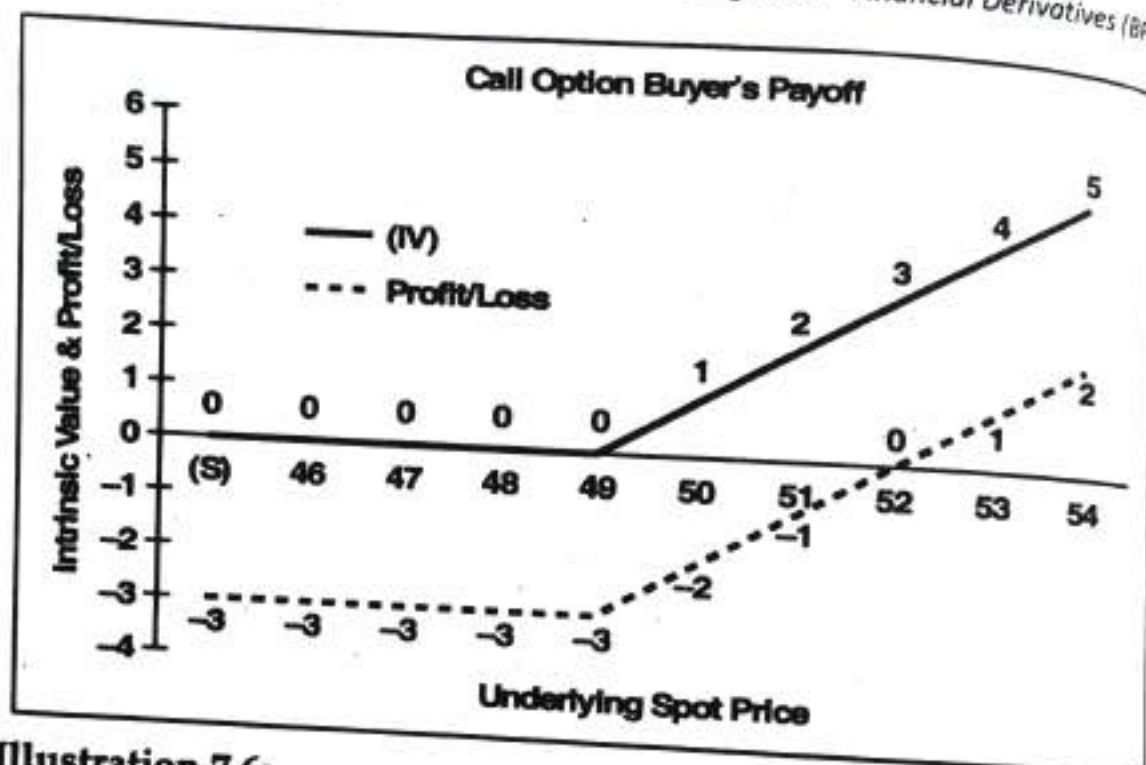
Solution:

A Call Option will have intrinsic value (IV) when Spot Price (S) exceeds Exercise Price (X). If S < X, then it will not be favourable for the Call option buyer to exercise the option and it will lapse. Thus, when S < X, then IV = 0. The payoffs of Ms. Tejal, the Call option buyer, will be as under.

Call Option Buyer's Payoff

Exercise Price	Spot Price	Intrinsic Value	Call Premium Paid	Profit/Loss	
(X)	(S)	(IV)	(C_{pr})		
50	46	0	-3	-3	
50	47	0	-3	-3	$IV_c = Max \{0, S-X\}$,
50	48	0	-3	-3	and
50	49	0	-3	-3	Profit / Loss = IV - C_{pr}
50	50	0	-3	-3	
50	51	1	-3	-2	
50	52	2	-3	-1	
50	53	3	-3	0	
50	54	4	-3	1	
50	55	5	-3	2	

Graphical Presentation of Call Option Buyer's Payoffs is as under.

Call Option Buyer's Payoff

Illustration 7.6:

Mr Mandu writes a European Call option on stock of RST Ltd having Exercise Price of Rs. 50 on which he receives Option Premium of Rs. 3. Calculate Intrinsic Value and Profit or Loss of Mr. Mandu for spot prices at expiry of Rs. 46 to Rs. 55. Also present your calculations graphically.

Solution:

A Call Option will have intrinsic value (IV) when Spot Price (S) exceeds Exercise Price (X). If $S < X$, then it will not be favourable for the Call option buyer to exercise the option and it will lapse. Thus, when $S < X$, then $IV = 0$. The payoffs of Mr. Mandu, the Call option writer, will be as under.

Call Option Writer's Payoff

Exercise Price (X)	Spot Price (S)	Intrinsic Value (IV)	Call Premium Received (C_{pr})	Profit/Loss
50	46	0	3	3
50	47	0	3	3
50	48	0	3	3
50	49	0	3	3
50	50	0	3	3

50	51	– 1	3	2
50	52	– 2	3	1
50	53	– 3	3	0
50	54	– 4	3	– 1
50	55	– 5	3	– 2

$$IV = Max \{0, X\text{-}S\} \text{ And Profit / Loss} = IV + Cpr$$

The Graphical Presentation of Call Option Writer's Payoff is as under:
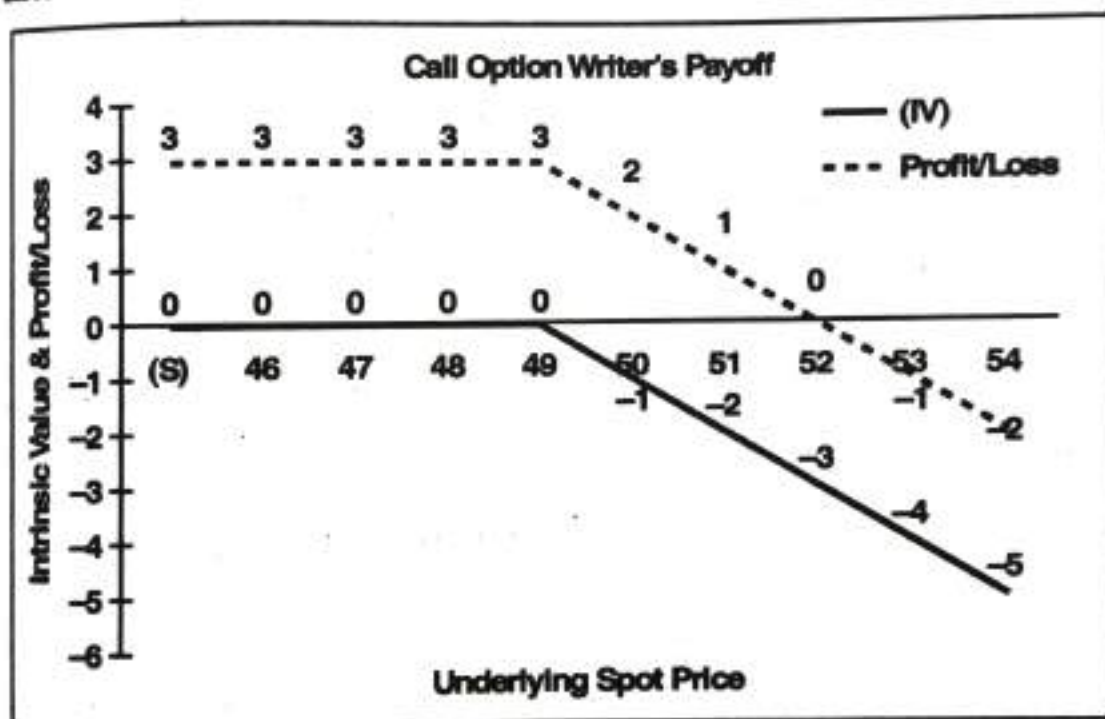

Call Option Writer's Payoff

Illustration 7.7:

Ms. Mandira buys European Put option on stock of MNP Ltd by paying Option Premium of Rs. 3 having Exercise Price of Rs. 50. Calculate Intrinsic Value and Profit or Loss of Ms. Mandira for spot prices at expiry of Rs. 46 to Rs. 55. Also present your calculations graphically.

Solution:

A Put Option will have intrinsic value (IV) when Exercise Price (X) exceeds Spot Price (S). If S > X, then it will not be favourable for the put option buyer to exercise the put option and it will lapse. Thus, when S > X, then IV = 0. The payoffs of Ms. Mandira, the Put option buyer, will be as under.

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Put Option Buyer's Payoff

Exercise Price	Spot Price	Intrinsic Value	Put Premium Paid	Profit/Loss
(X)	(S)	(IV)	(P_{pr})	
50	46	4	-3	1
50	47	3	-3	0
50	48	2	-3	-1
50	49	1	-3	-2
50	50	0	-3	-3
50	51	0	-3	-3
50	52	0	-3	-3
50	53	0	-3	-3
50	54	0	-3	-3
50	55	0	-3	-3

$IV = Max \{0, X\text{-}S\}$

And

$Profit/Loss = IV + P_{pr}$

Graphical Presentation of Put Option Buyer's Payoffs is as under.
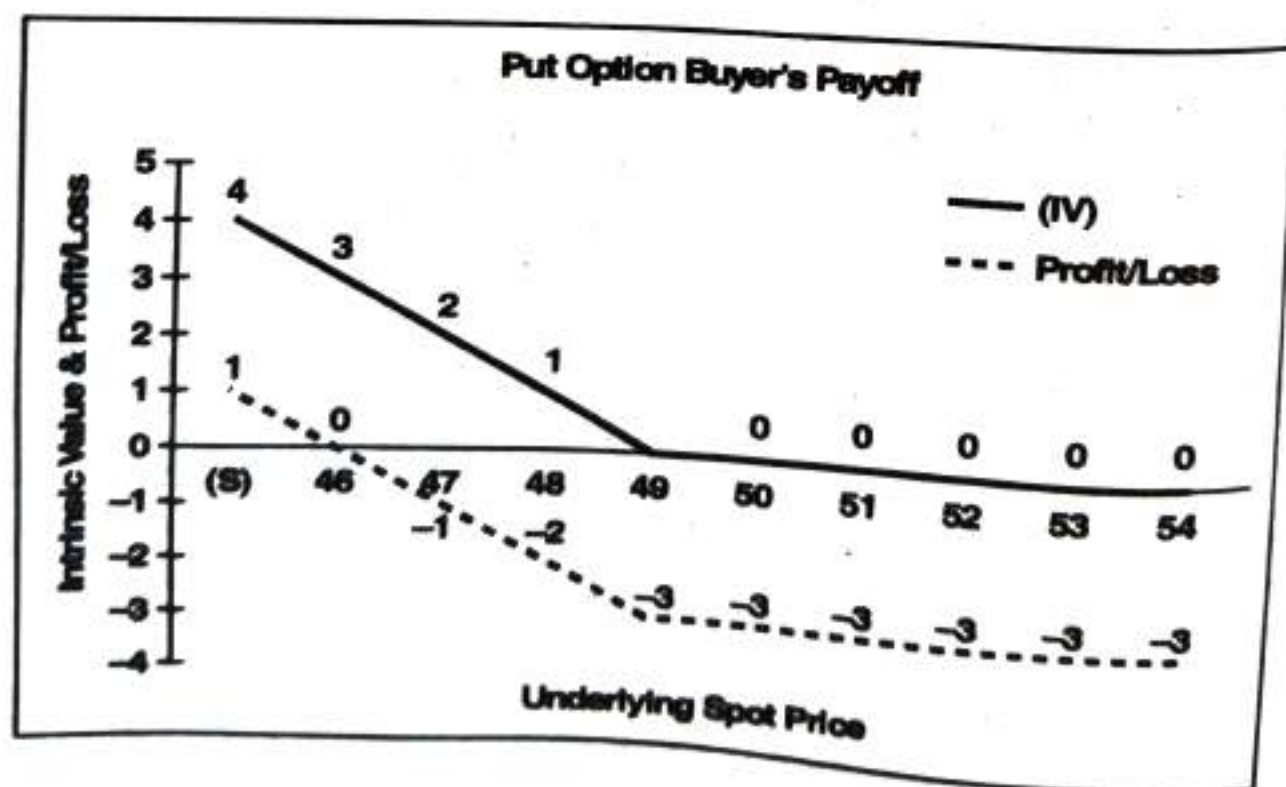

Put Option Buyer's Payoff

Illustration 7.8:

Mr. Teji writes European Put option on stock of LMN Ltd having Exercise Price of Rs. 50 and receives Option Premium of Rs. 3. Calculate Intrinsic Value and Profit or Loss of Mr. Teji for spot prices at expiry of Rs. 46 to Rs. 55. Also present your calculations graphically.

Solution:

A Put Option will have intrinsic value (IV) when Exercise Price (X) exceeds Spot Price (S). If $S > X$, then it will not be favourable for the put option buyer to exercise the put option and it will lapse. Thus, when $S > X$, then $IV = 0$. The payoffs of Mr. Teji, the Put option writer, will be as under.

Put Option Writer's Payoff

Exercise Price	Spot Price	Intrinsic Value	Put Premium	Profit/ Loss	
(X)	(S)	(IV)	(P_{pr})		
50	46	−4	3	−1	
50	47	−3	3	0	
50	48	−2	3	1	$IV = Max \{0, X-S\}$
50	49	−1	3	2	And
50	50	0	3	3	Profit/Loss = IV − Ppr
50	51	0	3	3	
50	52	0	3	3	
50	53	0	3	3	
50	54	0	3	3	
50	55	0	3	3	

Graphical Presentation of Put Option Writer's Payoffs is as under:

Put Option Writer's Payoff
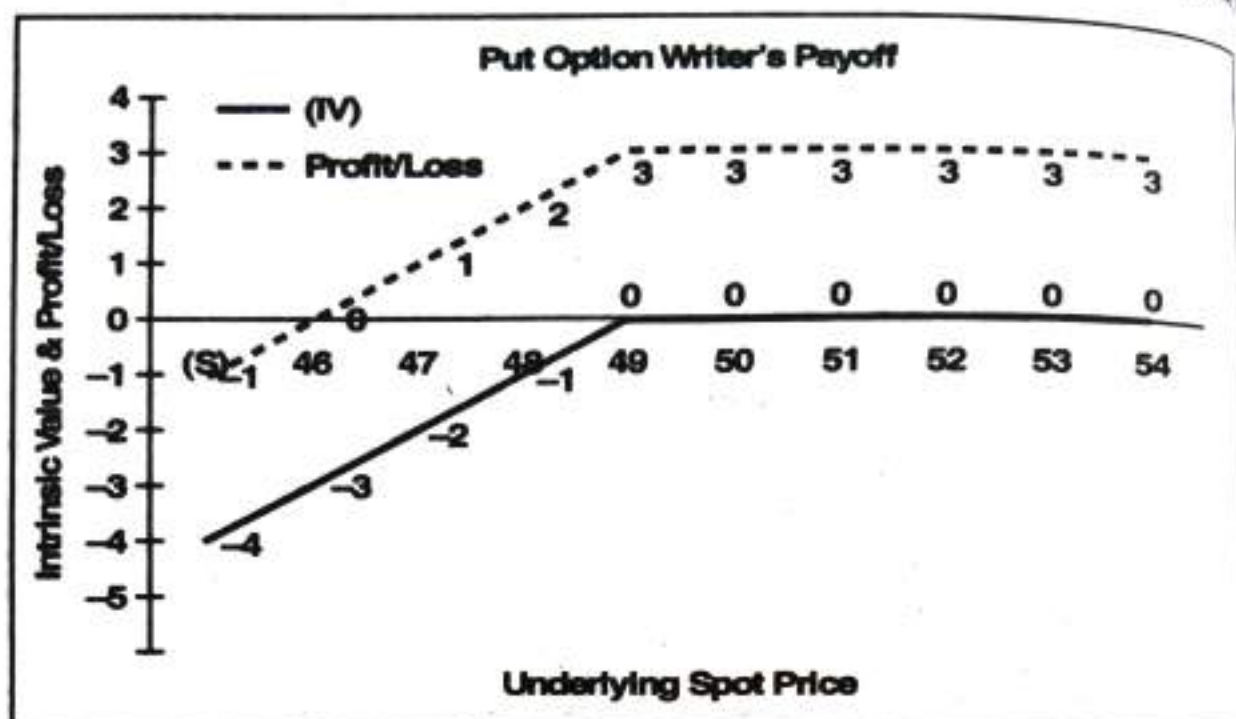
7.11　BOUNDARIES OF OPTION PREMIUM:

Option prices should be such that there is no arbitrage opportunity. Thus, the option prices shall have boundaries, beyond which there will be arbitrage opportunity. Further, option prices cannot be negative, as it would mean that the buyer of would receive price for buying option which is logically incorrect. The boundary conditions of options are discussed as under.

(A) Call Option:

(1) **Upper Bound:** The maximum value of call option cannot exceed the price of underlying itself, as no one would be willing to pay more money to buy a right to have the underlying asset than what is actually required to buy the asset itself. Symbolically,

$$C_{pr(Max)} = S \quad \text{or,} \quad C_{pr} \leq S$$

(2) **Lower Bound:** The minimum price at which call option will sell is its intrinsic value. The minimum value of option shall be the difference of spot price and the present value of exercise price, i.e.

$$C_{pr(Min)} = S - Xe^{-rt} \quad \text{or,} \quad C_{pr} \geq S - Xe^{-rt}, 0$$

Basics of Options

Illustration 7.9:

Shares of Nichani Ltd is currently selling at Rs. 700. The risk free interest rate is 9% p.a. continuously compounded. Call option on Nichani Ltd is available at following exercise prices. What should be the minimum price of option?

	Exercise Price (Rs.)	Time to Maturity (Months)
X_1	650	1
X_2	700	2
X_3	750	3

Solution:

The lower bound of call option is given by, $C_{pr} \geq S - Xe^{-rt}, 0$. Thus, the minimum value of calls will be as under.

C_{PrX1} (min)	$700 - 650 \times 2.71828^{-(0.09 \times 1/12)} = 700 - 650 \times 0.9942$
	$= 700 - 646.23 = $ **Rs. 53.77**
C_{PrX2} (min)	$700 - 700 \times 2.71828^{-(0.09 \times 2/12)} = 700 - 700 \times 0.9884$
	$= 700 - 691.88 = $ **Rs. 08.12**
C_{PrX3} (min)	$700 - 750 \times 2.71828^{-(0.09 \times 3/12)} = 700 - 750 \times 0.9826$
	$= 700 - 736.95 = $ **Rs. −36.95**[#] i.e. Zero.

[#] In case of X_3 the minimum option premium is negative, because the intrinsic value is negative. However, option premium cannot be negative. Option premium should be zero or positive. Thus, in case of X_3 the minimum option price will be zero. Further, negative option premium means the option buyer will receive option premium for buying the right from option writer, which is logically incorrect.

(B) Put Option:

(1) **Upper Bound:** Maximum value that one would be willing to pay for the right to sell underlying is its exercise price, if it could be sold immediately or the present value of exercise prise if can be sold at later date. Thus, price of put option cannot exceed the present value of its exercise price. Symbolically,

$$P_{pr(Max)} = Xe^{-rt} \qquad \text{or,} \qquad P_{pr} \leq Xe^{-rt}$$