**Problem 1)** In futures trading the buyer is obligated to buy the underlying and the seller is obligated to sell the underlying at the pre-determined price and date. In options, the buyer of the option has the right but not the obligation to buy/sell the underlying at the pre-determined price, on or before the expiry in case of American type option whereas only on the day of expiry in case of European type option. The buyer pays an extra premium to buy this right from the seller who has the obligation to buy/sell the underlying at the pre-determined price if the buyer decides to exercise his option.

There are 4 basic types of trading options:

1) Long Call (buying a call option)

2) Long Put (buying a put option)

3) Short Call (selling a call option)

4) Short Put (selling a put option)

1) Long Call: Someone goes long on a call option by buying a call option from an option writer. A call option gives the right to the buyer to buy the underlying from the writer at a pre-determined price called strike price. Let X be the market price of the underlying at the day of expiry, S be the strike price and P be the premium paid for the option. If X <= S, it wouldn't be profitable for the buyer to exercise his option, so he would leave it unexercised and lose the premium. If X > S, the buyer would exercise his option and make a net profit of X-S-P (it could be a loss if P > X-S) and the seller would make a loss of X-S-P (it could be a profit if P > X-S). Thus, the buyer is bullish on the underlying's market price.

2) Long Put: Someone goes long on a put option by buying a put option from an option writer. A put option gives the right to the buyer to sell the underlying from the writer at a pre-determined price called strike price. Let X be the market price of the underlying at the day of expiry, S be the strike price and P be the premium paid for the option. If X >= S, it wouldn't be profitable for the buyer to exercise his option, so he would leave it unexercised and lose the premium. If X < S, the buyer would exercise his option and make a net profit of S-X-P (it could be a loss if P > S-X) and the seller would make a loss of S-X-P (it could be a profit if P > S-X). Thus, the buyer is bearish on the underlying's market price.

3) Short Call: Someone goes short on a call option by selling a call option to the option buyer. A call option brings an obligation to the option writer to sell the underlying at a pre-determined price called strike price should the option buyer choose to exercise his option. Let X be the market price of the underlying at the day of expiry, S be the strike price and P be the premium paid for the option. If X <= S, it wouldn't be profitable for the buyer to exercise his option, so he would leave it unexercised and lose the premium. So, the option writer would make a profit P. If X > S, the buyer would exercise his option and make a net profit of X-S-P (it could be a loss if P > X-S) and the seller would make a loss of X-S-P (it could be a profit if P > X-S). Thus, the writer is bearish on the underlying's market price.

4) Short Put: Someone goes short on a put option by selling a put option to the option buyer. A put option brings an obligation to the option write to buy the underlying at a pre-determined price called strike price should the option buyer choose to exercise his option. Let X be the market price of the underlying at the day of expiry, S be the strike price and P be the premium paid for the option. If X >= S, it wouldn't be profitable for the buyer to exercise his option, so he would leave it unexercised and lose the premium. So, the option writer would make a profit P. If X < S, the buyer would exercise his option and make a net profit of S-X-P (it could be a loss if P > S-X) and the seller would make a loss of S-X-P (it could be a profit if P > S-X). Thus, the writer is bullish on the underlying's market price.

**Problem 2)** Factors affecting Premium of options:

1) Moneyness of the option

2) Time to expiry of the option

3) Volatility of the market

1) Moneyness of the option: If the current price of the underlying is much higher than the strike price, it is more probable than not that the price of the underlying at the expiry will remain higher than the strike price. Similarly, if the current price of the underlying is much lesser than the strike price, it is more probable than not that the price of the underlying at the expiry will remain lower than the strike price. Thus, for a call option, the Premium would increase as the value of strike price decreases since the option writer is at a greater risk of losing money and hence would demand a higher premium. Similarly, for a put option, the Premium would increase as the value of strike price increases since the option writer is at a greater risk of losing money and hence would demand a higher premium. This is why the premium for ITM options are always higher than the premium for OTM options.

2) Time to expiry of the option: More time to expiry of the option would mean a greater risk of the underlying's price to change greatly. Since, the option writer's profit is limited to the premium, but the loss is unlimited, this would increase the chance of the writer suffering a very high loss from the option and thus would demand a greater premium. For example, if the spot price of the underlying is $20000, there is a greater chance of the market price to increase to $25000 in 1 year than it would in 1 month. So, the option writer would be at a greater risk (in case of a call option) and would demand a greater premium. Also, in case of an American type option, more time to expiry would give the buyer a greater period of time to exercise the option and hence the option writer would demand a greater premium.

3) Volatility: The main reason options are used is for hedging, which means protecting the assets from the risk of sharp fall in the market prices. This can be done by buying a put option on their assets. So, if the market price of their assets increases, they would only lose the premium of the option and if the market price falls, the profit from the option contract could compensate the loss of their assets. Since the option writer's profit is limited to the premium but the loss is unlimited, higher volatility would mean a greater chance of the writer suffering a very high loss from the option and thus would demand a greater premium.

**Problem 3)** Let the stock price at expiration be I which tends to infinity. Since, all the options are call options, the buyers of each option would exercise their options. Hence, the trader would make a profit of I-13000-P1 by the 13000 ITM Call option, a profit of I-15000-P2 by the 15000 OTM Call option, a loss of I-14000-P3 on each of the two 14000 ATM Call options which the trader went short on. Hence, the net profit is 2\*P3 - P1 - P2 where P1, P2 and P3 are premiums of the 13000, 14000 and 15000 call options respectively.

**Problem 4)** Let P1 and P2 be the premiums of the call and put options respectively.

a) If the stock price at expiry is 700, the trader would exercise only the Put option. Profit from put option = 1000-700-P2 = 300-P2. Loss from the call option = P1. Hence, the net profit = 300-P1-P2.

b) If the stock price at expiry is 1100, the trader would exercise only the Call option. Profit from call option = 1100-1000-P1 = 100-P1. Loss from the put option = P2. Hence, the net profit = 100-P1-P2.

**Problem 5)** Without loss of generality, assume a<b<c. Let the stock price at the expiration be S > c. Similar to the third problem, let's take a trader who goes long on the options which strike price a and c, and goes short on 2 options with strike price b. Since all the options are call options and S > c (intrinsic value > 0 at expiry), each of the option buyers would exercise their options. The net profit made by the trader similar to problem 3, would be 2\*y - x - z. So, if y is greater than the average of x and z, the profit would always be greater than zero which would create an arbitrage. Since it is guaranteed that the net trade will always give a profit, any trader who spots the arbitrage would make use of it. Such arbitrages cause instability in the markets, so it is always ensured that the premium prices are such that there is no opportunity for an arbitrage. Hence, y must be less than the average of x and z.

**Problem 6)** Premium = $5, Strike price = $100.

a) Stock price = $90

Intrinsic value = max (0, stock price - strike price) = max (0, -10) = $0

Time value = Premium - Intrinsic value = $5 - $0 = $5

Moneyness: OTM (intrinsic value = 0)

b) Stock price = $105

Intrinsic value = max (0, stock price - strike price) = max (0, 5) = $5

Time value = Premium - Intrinsic value = $5 - $5 = $0

Moneyness: ITM (intrinsic value > 0)

For both a and b, since the trader is going short on the call options, the potential loss could be infinite since there is upper bound to the stock price at expiration. Since the margin deposit cannot be infinity, the brokerage firm mediating the trade would set a margin based on the risk associated. Hence, the margin deposit could be different for different brokerage firms.