Assume a continuously compounding dollar interest rate of 4% for all maturities, whenever applicable.

1. (28) Plot the payoff of the following (portfolio of) positions as a function of the underlying security price at expiry ($S_T$). All contracts have the same expiration date (say, one year later).
   
   (a) (7) Short 100 forward with a delivery price ($K$) of $120.
   
   (b) (7) Long 50 call at strike of $120, and short 50 put at strike $120.
   
   (c) (7) Long one put at strike $90, and long one call at strike 110.
   
   (d) (7) Short one call at strike $100, long 2 calls at strike $110.

   ($4 \times 3 = 12$) For each of the above four portfolios, what is the payoff if the underlying security price ($S_T$) is at exactly $100$ at expiry. [Four answers here]

2. (15) Consider the stock with a spot price ($S_t$) of $100$. The stock pays dividend of $3$ per share each half year.
   
   (a) (5) Compute the fair forward price on this stock with one year maturity.
   
   (b) (5) Suppose you are long 300 one-year forward contracts (one stock per contract) on the stock with a delivery price of $110, what is the value of your long forward position?
   
   (c) (5) Suppose a broker/dealer is willing to make market (buy/sell) at a one-year forward price of $100. What can you do to lock in a profit? (yes, there is an arbitrage. Just tell me what to do).

3. (25) Consider a European call option with two-year maturity and a strike price of $80$. The underlying security (which can be a stock, currency, commodity, etc) has a forward price of $100$. The call option value is $21.46$.
   
   (a) (5) Comparing the option strike with the forward price, is this option in the money or out of the money?
   
   (b) (5) What’s the intrinsic value of this call option? What’s the time value of this call option?
   
   (c) (5) Given the above information on the security, What’s the intrinsic value, time value, and total value for a two-year European put option at the same strike of $80$ on the same security?
   
   (d) (5) Suppose the underlying forward price jumps from $100$ to $110$ while nothing else changed, how do you expect the call and the put option prices to change? (Forward price increase also means spot price increase).
   
   (e) (5) Suppose the underlying volatility doubles while the forward price remains at $100$, how do you expect the call and the put option prices to change?

4. (10) A two-year European call option at $90$ strike is quoted at $5$, and a two-year European call option at $95$ strike is quoted at $5.1$. Design a trading strategy to lock in profits (yes, the two prices allow arbitrage).

5. (10) Use a portfolio of European call options, put options, forwards, and/or bonds to replicate the payoff in the following figure. You can, but you do not need to, use all of the above.
Payoff vs. Spot at expiry, $S_T$