Assume a continuously compounding dollar interest rate of 5% for all maturities, whenever applicable.

1. (30) If you long a 1-year forward contract on a security with a delivery price \( (K) \) of $55,
   
   (a) (10) What is your payoff at expiry if the security price at expiry \( (S_T) \) is $50? What is your payoff at expiry if the security price at expiry is $60?
   
   (b) (5) Plot your payoff at expiry as a function of the security price at expiry. Use the security price as the x-axis and the payoff as the y-axis.
   
   (c) (5) If the current spot price is $50, there is not other costs or benefits in carrying the security to the future (except interest cost). What should be the current forward price \( (F) \) on the security with 1-year maturity?
   
   (d) (5) Based on your calculated forward price, what is the current value of your long position in the 1-year forward with a delivery price of $55?
   
   (e) (5) If the market quote for the forward price is $50, is there an arbitrage opportunity (The answer is yes)? How can you set up trades to exploit the opportunity while assuming that there is no transaction cost?

2. (15) If you short a European call option on a security with a strike of $100,
   
   (a) (10) What is the option payoff at expiry if the security price at expiry is $90? What is the payoff if the security price at expiry is $110?
   
   (b) (5) Plot the call option payoff at expiry as a function of the security price level at expiry.

3. (15) If you long a European call at $120, and short a European put at $80.
   
   (a) (10) What is the portfolio payoff at expiry if the security price at expiry is $70? What is the payoff if the security price at expiry is $110?
   
   (b) (5) Plot the portfolio payoff at expiry as a function of the security price level at expiry.

4. (10) Consider a security with a forward price of $120 at 1 year maturity. The European call option price at the strike of $120 and 1-year maturity is quoted at $4. The European put option price at the same strike and maturity is quoted as $3. Is there an arbitrage? If so, how do you do the arbitrage trading to profit from it?

5. (15) An European call option with strike of $100 and maturity of 1 year has a value (price) of $5. The forward price of the security at the same maturity is at $90.
   
   (a) (5) Based on the forward price, is this call option in the money, out of the money or at the money?
   
   (b) (10) What is the intrinsic value of this call option? What is its time value?

6. (15) We intend to price options on a binomial tree. We assume that the current spot price of the security is $100. One year later, the security price can either go up to $120, or go down to $83.
   
   (a) (10) Based on the above assumption, price a one-year put option with a strike of $110.
   
   (b) (5) If the market quote for the put option is $12, is there an arbitrage based on your model assumption? How do you do the arbitrage trading to profit from it?