**Problem 1 [Wall street]**

The stock of Douglas and Sheen Inc. can take values in the set {$1,$2,…,$100}. Its current price is $50. There is a zero-coupon bond for the price of $0.9 maturing in one year, a European call option with strike price $50 (current price $10), a European put option with strike price $50 (price not known to us) – both options maturing in one year. The butterfly spread is a financial contract giving you the payoff of max(K-|L-S|,0), if stock price is S in a given time T in the future (K,L and T are parameters of the contract). Consider T=1 year and K=$10, L=$50.

1. What is a reasonable arbitrage-free price of a European put option described above?
2. What are the payoff vectors for the available financial instruments?
3. What is the payoff vector for the butterfly spread specified above?
4. Formulate a linear program to find the cheapest super-replicating portfolio and solve it using Solver.
5. Consider the following modification: everything stays the same except that now there are transaction costs: you have to pay $0.5 transaction fee for 1 stock, $0.1 for one bond, $0.2 for the call option, and $0.15 for the put option (both at selling and buying). Solve the problem now.

