Name: ________________________________

Please answer the following questions. Show all your work!

a. Three put options on Apple Inc. (AAPL) have the same expiration date (Friday, 21 June 2013) and exercise prices $450, $500, $550 respectively. The value of these three put options are $24, $68, $115. A butterfly spread can be created by buying one put with exercise price $450, buying one put with exercise price $550, and selling two puts each one with exercise price $500. Construct the table showing the payoff of all the positions and the total.

b. On the diagram below draw the profit for each position and the total (four graphs).

Butterfly spread using puts

![Butterfly spread diagram]
c. By increasing the following variables (one at a time, keeping all others fixed) indicate whether the corresponding European call or put will increase or decrease.

<table>
<thead>
<tr>
<th>Variable</th>
<th>European call</th>
<th>European put</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividends</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

d. Consider the multi-index model. The system that computes the $\Phi_i'$s can be written in vector and matrix form as $M \Phi = R$ and therefore, $\Phi = M^{-1}R$. Suppose you are working on a portfolio problem with five industries and 5 stocks in each industry. Write the elements of position (2,2) and position (3,1) of the matrix $M$.

e. Consider now the multi group model. Again we have five industries with five stocks in each industry. The solution requires first to find the $\Phi_i'$s using $\Phi = A^{-1}C$. Write the element of position (5,4) of the matrix $A$ and the element of position 5 of the vector $C$.

f. Consider the following data on two stocks and assume that $R_f = 0.01$:

```r
> ticker <- c("AAPL","IBM")
> gr <- getReturns(ticker, start="2009-03-31", end="2013-04-30")
> cov(gr$R)
   AAPL  IBM
AAPL 0.0058 0.0017
IBM  0.0017 0.0019
> cor(gr$R)
   AAPL  IBM
AAPL 1.0000 0.5034
IBM  0.5034 1.0000
> qqq <- as.data.frame(gr$R)
> mean(qqq)
   AAPL  IBM
0.03283572 0.01752981
```

Part (f) continues on the next page...
Use the constant correlation model: Rank the stocks based on the excess return to standard deviation ratio, complete the table, and find the composition of the optimal portfolio when short sales are not allowed.

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g. Refer to part (f). Without doing all the calculations briefly explain how to find the composition of the minimum risk portfolio using only the two stocks. You can simply write the formula and explain the inputs.

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h. Refer to part (f) and part (g). On the space (expected return against standard deviation), show approximately the portfolio possibilities curve, the two stocks and the portfolio of part (f).

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i. Consider the single index model. Five stocks have $\beta_1 = 0.9, \beta_2 = 1.1, \beta_3 = 1.2, \beta_4 = 0.8, \beta_5 = 0.7$. What is the beta of the equally allocated portfolio?

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j. Refer to part (i). If the variance of the error terms are all equal to 0.1, find the variance of the equally allocated portfolio.