Executive Summary

Part A:

1.
    a. 45%
    b. 5%
    c. 50%
2.
    a. EV=1100, SD=4048.46
    b. EV=1100, SD=382.54
3.
    a. 7.08%
    b. 1908.52
4.
    a. 17875000, 24,925000
    b. -124625, 108000

Part B:

1) **Regression, Assessing Risk**
    a)
        i) ABX: RABX,t=0.0038+0.4012×Rmt+0.6315×Rgt+.0085
        ii) HMY: RHMY,t=0.0042+0.3209×Rmt+1.1204×Rgt+.01187
    b)
        i) ABX: the model predicts that for a 1% increase in the price of gold, there will also be a .63% increase in the stock value of ABX.
            (1) This value is statistically significant as it's p value is .002 and .002<.1
        ii) ABX: the model predicts that for a 1% increase in the price of gold, there will also be a .40% increase in the monthly stock value of the S&P 500.
            (1) This value is statistically significant as it's p value is .02 and .02<.1
        iii) HMY: the model predicts that for a 1% increase in the price of gold, there will also be a 1.12% increase in the stock value of HMY.
            (1) This value is statistically significant as it's p value is .0001 and .0001<.1
        iv) HMY: the model predicts that for a 1% increase in the price of gold, there will also be a .32% increase in the monthly stock value of the S&P 500.
    c) The value of ABX stock is less reactive than HMY to changes in the price of gold. This is likely because American Barracks uses a lot of risk management techniques as we discussed in class, and thus their cash flows are not heavily dependent on gold prices. For example, if ABX makes a deal to sell gold in the following year for a set price, they will not be susceptible to a decrease in cash flows if the price of gold decreases in that period. In addition, ABX's stock value is more reactive to the market than HMY. This is because HMY's stock price is far more dependent on gold price risk and ABX's stock value is dependent on market risk.

2) **@RISK - Combining Distributions**

a) Based on the simulation, there is a 0% chance of losses exceeding 2 million.
b) Based on the simulation, 91.6% of losses are within 500000
c) 221763.2
d) 609482.4

3) **@RISK - Defining Output**
   a) There is a 3.6% chance revenue exceeds 150000
   b) There is a .8% chance costs exceed 150000
   c) 22829.2
   d) 52352.2
4) **@RISK - Claims/severity**
   a) =RiskNegbin(1,0.71609,RiskName("Number of Claims 2"))
   b) =RiskLevy(-234.2507,2301.4698,RiskName("Loss_Severity 2"))
   c)
      i) 5%
      ii) 1.9%
      iii) 16067.07
      iv) 2491936
5) **@RISK - VAR**
   a)
      i) Dollar threshold = 147,653
      ii) Losses relative to expected value = 333,900 - 147,653 = 186,247
   b)
      i) Dollar threshold = 160,683
      ii) Losses relative to expected value = 331,169 - 160,683 = 170,486
      iii) The relocation decreases your expected return but increases your value at risk. This makes sense intuitively as you are placing a higher weight in the assets with smaller standard deviations and smaller returns. So you have a smaller expected return but less volatility around that return.

Part B:

1) For this question, I used the monthly returns of the 4 assets. My input y-range was the individual stocks (ABX and HMY), and the independent variables I tested were gold price in the US and the S and P 500. Using this configuration I obtained these two regression outputs:

Regression Statistics	
Multiple R	0.29083459
R Square	0.08458476
Adjusted R Sq	0.07204482
Standard Erro	0.09914317
Observations	149

ABX

	df	SS	MS	F	Significance F
Regression	2	0.13260272	0.06630136	6.74523095	0.00157806
Residual	146	1.43508778	0.00982937		
Total	148	1.5676905			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.00382651	0.00849308	0.45054372	0.65298679	-0.0129588	0.02061178	-0.0129588	0.02061178
Gold, US$ per	0.63147424	0.20258756	3.11704353	0.00220043	0.2310912	1.03185727	0.2310912	1.03185727
S&P 500	0.40117288	0.17801244	2.25362264	0.02570944	0.04935875	0.752987	0.04935875	0.752987

Regression Statistics	
Multiple R	0.31821899
R Square	0.10126333
Adjusted R Sq	0.08895186
Standard Erro	0.13854805
Observations	149

HMY

	df	SS	MS	F	Significance F
Regression	2	0.31577186	0.15788593	8.22512646	0.00041226
Residual	146	2.80255215	0.01919556		
Total	148	3.11832401			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.00418315	0.0118687	0.35245266	0.72500709	-0.0192735	0.0276398	-0.0192735	0.0276398
Gold, US$ per	1.12044848	0.28310686	3.95768755	0.00011776	0.56093147	1.67996548	0.56093147	1.67996548
S&P 500	0.32094452	0.24876426	1.29015529	0.1990364	-0.1706996	0.81258869	-0.1706996	0.81258869

a)
   i) Rit=αi+βimRmt+βigRgt+εt
   ii) ABX: RABX,t=0.0038+0.4012×Rmt+0.6315×Rgt+.0085
   iii) HMY: RHMY,t=0.0042+0.3209×Rmt+1.1204×Rgt+.01187

b) To interpret the findings of this regression:
   i) The coefficient of how sensitive a gold mine's stock returns are relative to to a one percent change in gold prices (B(ig))
      (1) ABX: the model predicts that for a 1% increase in the price of gold, there will also be a .63% increase in the stock value of ABX.
         (a) This value is statistically significant as it's p value is .002 and .002<.1
      (2) HMY: the model predicts that for a 1% increase in the price of gold, there will also be a 1.12% increase in the stock value of HMY.
         (a) This value is statistically significant as it's p value is .0001 and .0001<.1
   ii) The coefficient representing the gold mines beta(B(im))
      (1) ABX: the model predicts that for a 1% increase in the price of gold, there will also be a .40% increase in the monthly stock value of the S&P 500.
         (a) This value is statistically significant as it's p value is .02 and .02<.1
      (2) HMY: the model predicts that for a 1% increase in the price of gold, there will also be a .32% increase in the monthly stock value of the S&P 500.

(a) This value is not statistically significant as it's p value is .19 and .19>.1

c) The value of ABX stock is less reactive than HMY to changes in the price of gold. This is likely because American Barracks uses a lot of risk management techniques as we discussed in class, and thus their cash flows are not heavily dependent on gold prices. For example, if ABX makes a deal to sell gold in the following year for a set price, they will not be susceptible to a decrease in cash flows if the price of gold decreases in that period. In addition, ABX's stock value is more reactive to the market than HMY. This is because HMY's stock price is far more dependent on gold price risk and ABX's stock value is dependent on market risk.

2) I set up a distribution for frequency and severity of fire risk. Frequency = riskpoisson(.5), Severity = risklognorm(300000,100000). I then set up a combined distribution =riskcompound(Frequency,severity)
   a) To find the probability that losses exceed 2 million, I ran a simulation with 1000 iterations and dragged the right hand slider to 2 million.
      i) Based on the simulation, there is a 0% chance of losses exceeding 2 million.
   b) To find the probability that losses are less than 500000, I dragged the right hand slider on the distribution to 500,000
      i) Based on the simulation, 91.6% of losses are within 500000
   c) To find the standard deviation, I went to function, simulation result, standard deviation and calculated the standard deviation of the compound distribution. I had to make sure to set this cell as an output.
      i) 221763.2
   d) To find the firm's process at the 95th percentile, I went to function again then risk percentile and set the percentile to .95.
      i) 609482.4
3) I set up a distribution for prices, (=risknormal(40,8)) and quantity (=risklognorm(2000,700)), I then multiplied these two values to find revenue and made it a risk output. I then set up a distribution for input costs (=risklogistic(30,10)) and # of inputs (=riskuniform(1500,2300)), and multiplied these two values together to find total costs. This also had to be a risk output. To find profit I created a risk output that subtracted total costs from revenue.
   a) When finding the probability that the firm's revenue exceeds 150000, I ran a simulation with a 1000 iterations on profit and dragged the left hand slider to 150000, and the right slider to infinity.
      i) There is a 3.6% chance revenue exceeds 150000
   b) When finding the probability that a firm's costs exceed 150000, I did the same process with the distribution of costs.
      i) There is a .8% chance costs exceed 150000
   c) When finding the firm's expected profits, I found the mean of the distribution of profits from the simulation
      i) 22829.2

d) When finding the firm's profit at the 75th percentile I used the riskpercentile function for the simulation of profits and plugged in the 75th percentile.
    i) 52352.2

4) I used the fit function to find the distribution that matches the data based for number of claims and severity.
    a) When using the chi-squared test on the # of claims data, I got the following output
        i) =RiskNegbin(1,0.71609,RiskName("Number of Claims 2"))
    b) When using the KS test on theLoss severity data, I got the following output
        i) =RiskLevy(-234.2507,2301.4698,RiskName("Loss_Severity 2"))
    c) I then created an aggregated loss distribution by multiplying the two distributions above and telling @risk it was an output cell.
        i) To find the probability that aggregate losses exceed 100,000, I moved the the right slider to 100000 and noticed the percentage on the right
            (1) 5%
        ii) I underwent the same process but set the slider to 500000
            (1) 1.9%
        iii) I used the riskpercentile function on the aggregated loss distribution cell
            (1) 16067.07
        iv) I used the same process but to the 99th percentile
            (1) 2491936

5) To answer this question I first used the correlation matrix to calculate the covariance matrix(below) .I used the covariance matrix to calculate the standard deviation of the portfolio (=SQRT(MMULT(MMULT(weights,covariance matrix),TRANSPOSE(weights))) I then used a sum product formula to calculate the expected return (multiplying weights by expected returns of the assets)

Total Portfolio	300000		
	Asset 1	Asset 2	Asset 3
expected return	0.11	0.05	0.17
Standard reviation	0.17	0.08	0.28
	Asset 1	Asset 2	Asset 3
Weights	0.25	0.35	0.4
Correlation matrix	Asset 1	Asset 2	Asset 3
Asset 1	1	0.6	0.2
Asset 2	0.6	1	0.35
Asset 3	0.2	0.35	1
Covariance Matrix	Asset 1	Asset 2	Asset 3
Asset 1	0.17	0.00816	0.00952
Asset 2	0.00816	0.08	0.00784
Asset 3	0.00952	0.00784	0.28

I then multiplied the standard deviation and expected return by the amount of wealth (300000). I then created a distribution using =risknormal to model the portfolio returns and standard deviation.
    a) Using the simulation of the risknormal distribution, I moved the left slider over to the left so 1% of the data was displayed. I then used that value as the VaR (1%)
        i) Dollar threshold = 147,653
        ii) Losses relative to expected value = 333,900 - 147,653 = 186,247

b) For part b, I simply copied and pasted the same setup I had in the last problem and changed the weights of the assets.
   i) Dollar threshold = 160,683
   ii) Losses relative to expected value = 331,169 - 160,683 = 170,486
   iii) The relocation decreases your expected return but increases your value at risk. This makes sense intuitively as you are placing a higher weight in the assets with smaller standard deviations and smaller returns. So you have a smaller expected return but less volatility around that return.

Part A:

1) a. $P(x) = \dfrac{\lambda^x e^{-\lambda}}{x!}$

$$P(x=0) = \frac{.8^0 e^{-.8}}{0!} = e^{-.8} = .45$$

b. $P(>2) = 1 - P(0) - P(1) - P(2)$

$$P(x=0) = .45$$

$$P(x=1) = \frac{.8^1 e^{-.8}}{1!} = .36$$

$$P(x=2) = \frac{.8^2 e^{-.8}}{2!} = .14$$

$$1 - .45 - .36 - .14 = .05$$

c.

$$P(x=1) = .36$$

$$P(x=2) = .14$$

$$.36 + .14 = .50$$

2) a

Loss	Prob	E(v)
0	.8	0
1000	.1	100
5000	.075	375
25000	.025	625

E(v) = 1100

$\sigma^2 = .8(0-1100)^2 + .1(1000-1100)^2$
$+ .075(5000-1100)^2 + .025(25000-1100)^2$

$\sigma^2 = 16390000$

$\sigma = 4048.46$

b.

$E(v) = 1100$

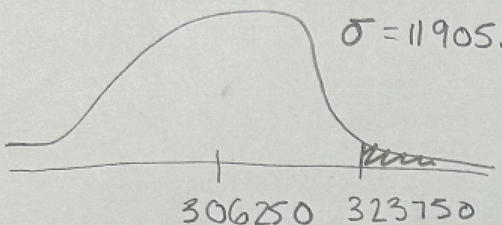
$\sigma_p = \sigma/\sqrt{n} = \frac{4048.46}{\sqrt{112}} = 382.54$

3) a. Total losses $= 175 \cdot 1750 = 306250$

Total premiums $= 175 \cdot 1850 = 323750$

Var of total losses $= 175 \cdot 810000 = 141750000$

$\sigma_{TL} = \sqrt{141750000} = 11905.88$



$\sigma = 11905.88$

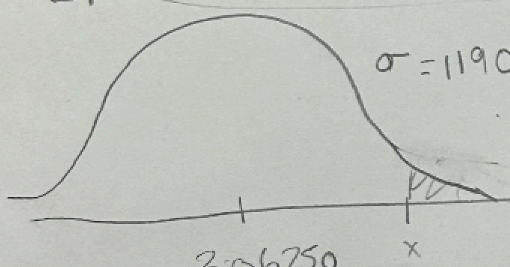
$Z = \frac{x - u}{\sigma}$

$Z = \frac{323750 - 306250}{11905.88}$

$Z = 1.47$

$\boxed{\text{Prob} = 7.08\%}$

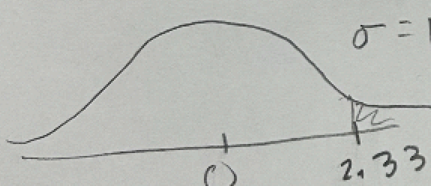
b.



$\sigma = 11905.88$

$2.33 = \frac{x - 306250}{11905.88}$

$x = 333990.7$



$\sigma = 1$

$= 333990.7 / 175$

$\boxed{= 1908.51829}$

4) a.

	$E(r)$	σ	w
Asset 1	.09	.17	$\frac{63}{90} = .7$
Asset 2	.19	.31	$\frac{27}{90} = .3$

$$E(r_p) = .7(.09) + .3(.19) = .12$$

$$\sigma_p^2 = w_1^2 \cdot \sigma_1^2 + w_2^2 \cdot \sigma_2^2 + 2 w_1 w_2 \sigma_1 \sigma_2 \rho_{1,2}$$

$$\sigma_p^2 = .7^2 \cdot .17^2 + .3^2 \cdot .31^2 + 2 \cdot .7 \cdot .3 \cdot .17 \cdot .31 \cdot .25$$

$$\sigma_p^2 = .0283435$$

$$\sigma_p = .17 \quad \times 90$$

$$VaR = (\text{Wealth} \cdot \overset{(1+E(rp))}{(E(r_p)} - \overset{(\$\,\sigma_p)}{(Z \cdot \sigma_p)}$$

$$VaR = (90{,}000{,}000 \cdot (1.12)) - (1.645 \cdot .1684 \cdot 90m)$$

$$VaR_{5\%} = 17{,}875{,}000$$

$$E(v) = 90m \cdot 1.12 = 100.8m$$

Loss relative to EV

$$VaR_{5\%} = 100{,}800{,}000 - 17{,}875{,}000$$

$$VaR_{5\%} = 24{,}925{,}000$$ ← Relative

b. $B_1 = \frac{w_1 \sigma_1^2 + w_1 \cdot w_2 \cdot \sigma_1 \cdot \sigma_2 \cdot \rho_{1,2}}{\sigma_p^2}$

$B_1 = \frac{.7 \cdot .17^2 + .7 \cdot .3 \cdot .17 \cdot .31 \cdot .25}{.17^2}$

$B_1 = .85$

$1 = B_1 (.7) + B_2 (.3)$

$1 = .85 (.7) + x (.3)$

$1.35 = B_2$

$\sigma = .168 \times 90m = 15.1520$

Risk

$((r_i - r_j) \cdot \Delta w \cdot W) = (B_2 - B_1) \cdot Z \cdot \sigma_p \cdot \Delta w \cdot W$

$= (1.35 - .85) \cdot -1.645 \cdot .01 \cdot 90m \cdot .168$

$= -124625$

Return

$= (r_i - r_f) \cdot \Delta w \cdot w$

$+108000 \quad = .12 \cdot .01 \cdot 90m$

Is the additional 108000 in return worth the -124625 VaR? Depends on the firm