National University of Science and Technology
Think in Other Terms

FACULTY OF COMMERCE

DEPARTMENT OF FINANCE

BACHELOR OF COMMERCE HONOURS DEGREE IN FINANCE

RISK ANALYSIS [CFI 4104]

FINAL EXAMINATIONS DECEMBER 2014

TIME ALLOWED: 3 HOURS

Instructions to Candidates

1. Answer any **FOUR (4)** questions
2. Show **ALL** calculations

Information for candidates

1. The paper consists of **six (6)** printed pages
2. All **six (6)** questions carry **25 marks** each

QUESTION ONE

(a) Consider a $100 million portfolio with three bonds A, B and C. Assume that the exposures are constant, the recovery in case of default is zero, and that the default events are independent across the three issuers. The exposures and default probabilities of the three bonds are given below.

Issuer	Exposure ($m)	Default Probability
A	25	0.05
B	30	0.10
C	45	0.20

i. Calculate the portfolio's expected credit loss **(4 marks)**

ii. Calculate the standard deviation of credit losses. **(4 marks)**

(b) A portfolio consists of two bonds. The credit VaR is defined as the maximum loss due to defaults at a confidence level of 98% over a one-year horizon. The probability of joint default of the two bonds is 1.27%, and the default correlation is 30%. The bond value, default probability, and recovery rate are $1 000 000, 3% and 60% respectively for the first bond, and $600 000, 5% and 40% respectively for the other bond.

i. Calculate the expected credit loss of the portfolio. **(4 marks)**

ii. Estimate the unexpected credit loss of the portfolio. **(4 marks)**

(c) Given below are average bond cumulative default rates for different rating categories collected by a rating agency from 1980 to 1984.

Rating	Years 1	2	3	4	5
Aaa	0.000	0.000	0.000	0.026	0.099
Aa	0.008	0.019	0.042	0.106	0.177
A	0.021	0.095	0.220	0.344	0.472
Baa	0.181	0.506	0.930	1.434	1.938
Ba	1.205	3.219	5.568	7.958	10.215
B	5.236	11.296	17.043	22.054	26.794
Caa-C	19.476	30.494	39.717	46.904	52.622

Based on the above cumulative default rates, answer the following questions:

i. Calculate the probability of a bond rated ***Ba*** defaulting during the fourth year **(2 marks)**

ii. Calculate the probability that a ***Caa*** rated bond will survive until the end of year 3 **(2 marks)**

iii. Calculate the probability that a Baa rated bond will default in the fourth year conditional on no earlier default (hazard rate). **(3 marks)**

(d) The spread between the yield on a 3-year corporate bond and the yield on a similar risk-free bond is 50 basis points. The recovery rate is 30%. Estimate the average default intensity per year over the 3-year period. **(2 marks)**

Total = 25 marks

QUESTION TWO

(a) You observe the following two bonds:

Bond	Maturity	Coupon Rate	YTM
A	4 years	12%	7.5%
B	4 years	8%	7.0%

i. Which bond would you expect to have a higher sensitivity to changes in interest rates? Explain why. **(3 marks)**

ii. Confirm your intuition by calculating the Macaulay duration for the two bonds above. **(6 marks)**

(b) With supporting calculations or explanation, rank the following bonds from least to most risky: **(10 marks)**

	Maturity	Coupon	Payment	
Bond	(Years)	Rate	Frequency	Yield
1	10	6%	1	6%
2	10	6%	2	6%
3	10	0%	1	6%
4	10	6%	1	5%
5	9	6%	1	6%

(c) Macaulay duration is measured in years. Explain how then does it become a measure of a bond's risk, highlighting the link between the level of risk and a bond's duration. **(4; 2 marks)**

Total = 25 marks

QUESTION THREE

(a) An analyst would like to know the VaR for a portfolio consisting of long term government bonds issued in the US and long term government bonds issued in the UK. The expected monthly return on US bonds is 0.85% and the standard deviation is 3.20%. The expected monthly return on UK bonds, in US dollars, is 0.95%, and the standard deviation is 5.26%. The correlation between the US dollar returns of UK and US bonds is 0.35. The portfolio market value is $100 million and is equally weighted between the two asset classes. Using the variance-covariance method, calculate the following:

i. A 95% confidence level (CL) monthly VaR **(3 marks)**
ii. A 99% CL monthly VaR **(3 marks)**
iii. A 95% CL weekly VaR **(3 marks)**
iv. A 99% CL weekly VaR **(3 marks)**

(b) Suppose you invested $25 000 in Delta stock in early 2014. You have compiled the monthly percentage returns on Delta shares for the period 2009 to 2013 as given below.

2009	2010	2011	2012	2013
-0.0214	-0.0347	-0.1824	-0.0723	-0.1017
-0.0106	-0.0566	-0.0070	-0.1021	0.0264
0.0262	0.0158	0.0010	0.1114	0.1344
-0.1196	0.0862	-0.0648	0.2257	0.0786
-0.0313	0.0675	0.2378	-0.0043	-0.1772
-0.0362	0.0609	-0.0512	0.1867	-0.0953
-0.1137	-0.0203	0.1229	-0.0255	0.0978
0.0401	0.0100	-0.1156	0.1831	-0.1110
0.0129	-0.0230	-0.2416	-0.0360	0.1020
0.0652	0.1087	-0.2597	-0.0531	0.1099
0.1196	-0.1980	-0.0844	-0.0228	-0.0816
-0.0789	-0.0012	-0.0833	0.0170	0.0250

Using the historical method, calculate the following:

i. 95% confidence level monthly VaR **(3 marks)**
ii. 99% confidence level monthly VaR **(3 marks)**

(c) A firm runs an investment portfolio consisting of stocks as well as options on stocks. Management would like to determine the VaR for this portfolio and is undecided about which technique to use. Discuss the problems associated with using the analytical method for determining the VaR for this particular portfolio. **(7 marks)**

Total = 25 marks

QUESTION FOUR

(a) A company uses an exponentially weighted moving average (EWMA) model for forecasting volatility. It decides to change the parameter λ from 0.95 to 0.85. Explain the likely impact of this change on the forecasts. **(3 marks)**

(b) Suppose that λ=0.90, the volatility estimated for a market variable for day *n-1* is 1% per day, and during day *n-1* the market variable increased by 2%. Calculate the volatility per day for day *n* using the EWMA model. **(4 marks)**

(c) The most recent estimate of the daily volatility of an asset is 1.5% and the price of the asset at the close of trading yesterday was $30.00. The parameter λ in the EWMA model is 0.94. Suppose that the price of the asset at the close of trading today is $30.50. Update the asset's volatility using the EWMA model. **(4 marks)**

(d) Suppose that the daily volatilities for asset A and asset B, calculated at the close of trading yesterday, are 1.6% and 2.5% respectively. The prices of the assets at close of trading yesterday were $20 and $40 respectively and the estimate of the correlation coefficient between the returns of the two assets was 0.25. The parameter λ used in the EWMA model is 0.95.

Required

i. Calculate the current estimate of the covariance between the two assets. **(4 marks)**

ii. Based on the assumption that the prices of the assets at close of trading today were $20.50 and $40.50 respectively, update the correlation coefficient estimate. **(6 marks)**

(e) Discuss any two major shortcomings of using implied volatility to estimate an asset's volatility. **(4 marks)**

Total = 25 marks

QUESTION FIVE

(a) Show that the individual risk of securities does not matter as it can be diversified away while covariance risk cannot be diversified away, meaning that covariance risk is the important risk component. **(4 marks)**

(b) "Stress testing is not necessary because the same results are obtained by a VaR model with an increasing confidence level". Comment on this statement. **(4 marks)**

(c) A pension fund has a portfolio with $1 billion invested in US stocks and another $1 billion invested in Japanese stocks. The 99% 1-week VaR analysis reveals a VaR of $112 million. The risk manager, however, is concerned about extreme moves not reflected in VaR. Compute the stress loss for the following situations:

i. A univariate scenario where US stocks fall by 20% **(3 marks)**

ii. A univariate scenario where Japanese stocks fall by 25% **(3 marks)**

iii. A prospective scenario where US stocks fall by 20% and Japanese stocks fall by 15% **(3 marks)**

iv. A prospective scenario where US stocks fall by 5% and Japanese stocks by 25%. **(3 marks)**

(d) Whatever model of calculating VaR used, it is always necessary to have a reality check in the form of a back test. It is however worth probing further even if excession percentages are within levels prescribed by confidence level bands. Discuss the reasons for doing this. **(5 marks)**

Total = 25 marks

QUESTION SIX

(a) Explain why the delta normal approach is not suitable for measuring options portfolio risk. **(3 marks)**

(b) Suppose a financial institution in the US has the following three positions in options on the Australian dollar:

- ✓ A long position in 100 000 call options with a strike price of 0.55 and an expiration date in three months. The delta of each position is 0.533.
- ✓ A short position in 200 000 call options with a strike price of 0.56 and an expiration date in five months. The delta of each option is 0.468.
- ✓ A short position in 50 000 put options with a strike price of 0.56 and an expiration date in two months. The delta of each option is 0.508.

Calculate the portfolio's delta. **(4 marks)**

(c) A bank has sold $300 000 of call options on 100 000 equities. The equities trade at $50 and the strike price is $50, the maturity is in 3 months, volatility is 20% and the interest rate is 5%. Calculate the delta of this position. **(3 marks)**

(d) What does it mean to assert that the theta of an option position is -0.1 when time is measured in years? **(3 marks)**

(e) 'If a bond portfolio exhibits positive convexity, any surprises in the portfolio's change in value as interest rates change are good surprises whereas the surprises are not so pleasant with negative convexity'. Explain this statement with the aid of a diagram. **(12 marks)**

Total = 25 marks

END OF EXAMINATION PAPER