

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2024 – 2025

BR3212 Computing Solutions for Risk Management and Insurance

December 2024

Time Allowed: $2\frac{1}{2}$ hours

INSTRUCTIONS

1. This paper contains **FOUR(4)** questions and comprises **TEN(10)** pages. In addition, **ONE(1)** EXCEL template file (softcopy) is provided separately.
 2. Answer all **FOUR(4)** questions.
 3. You should follow the instruction given at the start of each question to save all your answers to each question in the **EXCEL** template file provided.
 4. At the end of the exam, you must save the template file onto the designated location.
 5. The number of marks allocated is shown at the end of each question.
 6. Answers will be graded for contents, correct formulas and figures, appropriate formats for presentation and good programming practices.
 7. This is a **Closed-Book** examination.
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Note: Exam Questions begin on Page 2

Question 1

Remark 1: Please use **Excel** to perform the calculations.

Remark 2: Please save your answers in worksheet “Q1” in the template provided.

AI Health is a start-up company offering private health insurance plans. Currently, it is retaining all the claims arising from medical treatments provided to its policyholders. Based on research conducted by a team of industry experts, the average claims amount for medical treatments in private healthcare facilities is \$12,345. The team has also provided the claim incidence rate based on different age group.

- (a) Determine the total expected claims per annum for *AI Health*.

(Hint: Expected claims = Incidence rate × Average amount per claim)

(5 marks)

The team suggested that the company should cede its health insurance portfolio to a large health reinsurer, *Berlin Re*, to protect itself from large claim amounts, especially those involving critical illnesses. As *Berlin Re* also operates an arm of medical providers, it is able to provide lower cost of good quality medical treatments. With that, it is expected to reduce average claims amount by 15%.

- (b) Determine the total expected claims per annum if the portfolio is under Berlin Re.

(1 mark)

- (c) Suggest possible reasons for the premium rates charged by *Berlin Re* onto *AI Health* to be different from the amount calculated in part (b) above.

(3 marks)

As part of an industry-wide initiative to promote preventive healthcare, a group of policyholders were invited to a free wellness program. The program participants were:

- Individuals with BMI 30 and above; or
- Individuals over 55 years old;

Note: Question No.1 continues on page 3

Question 1 (continued)

As a result, the claim incidence rate for this group of policyholders (Group A) improved significantly by dropping 25%. On the other hand, the claim incidence rate for those who did not attend the wellness program (Group B) increased by 10%.

- (d) Determine the total expected claims per annum if (i) the scheme is retained by *AI Health* and (ii) the scheme is ceded to *Berlin Re*.
(6 marks)
- (e) Summarise the information for the two groups *i.e.*, (i) number of policyholders, (ii) average age, and (iii) average claim amount per policyholder.
(3 marks)
- (f) Plot a chart to illustrate the proportion of the number of policyholders for the two groups.
(2 marks)

(TOTAL: 20 marks)

Question 2

Remark 1: Please use **Excel** to perform the calculations.

Remark 2: Please save your answers in worksheet “Q2” in the template provided.

SecureEdu is an educational group focused on tuition and student housing. The company is considering an investment of S\$8 million in an online platform, *LearnUp*, which provides digital tutoring services for university students. The Board of Directors of *SecureEdu* has approved a risk appetite of a maximum loss of S\$3 million over 1 year with a probability of 99%.

You are the financial risk analyst for *SecureEdu* and have been tasked with evaluating the risk of this investment using Monte Carlo Value-at-Risk (VaR). Your analysis will help determine if the investment aligns with the company's risk tolerance.

As part of your analysis, you will:

- (a) Define Value-at-Risk and explain how Monte Carlo simulation can be used to estimate VaR in the context of investing in an online educational platform like *LearnUp*.
(3 marks)

A dataset of historical monthly revenue for *LearnUp* is provided in worksheet “Q2”.

- (b) Review and clean the data (if necessary). Explain the reason for any adjustments made. Compute the monthly revenue growth rates based on the historical revenue.
(4 marks)
- (c) Construct the empirical probability distribution of the monthly revenue growth rates.
(4 marks)
- (d) Perform a Monte-Carlo simulation ($n = 2,000$) to estimate the distribution of potential monthly growth rate from the *LearnUp* investment. Assume that the monthly growth rates follow a normal distribution. Use the historical data to estimate the necessary parameters μ and σ . Compare the simulated probability distribution with the empirical probability distribution from part (c) above, using a chart.
(7 marks)
- (e) Assess the goodness-of-fit of the Monte-Carlo simulation that was performed in part (d) above. You should:
(i) Compare the mean and standard deviation of simulated revenue growth rates against those of actual revenue growth rates.
(1 mark)

Note: Question No.2 continues on page 5

Question 2 (continued)

- (ii) Perform chi-square test with $\alpha = 0.05$. Please define the null and alternative hypotheses, followed by a conclusion based on the p-value.
(Hint: $df = \text{number of categories} - \text{number of estimated parameters} - 1$) (5 marks)
- (iii) Comment on the goodness-of-fit at the left-tail of the distribution by applying a visual assessment of the chart plotted in part (d) above. (1 mark)
- (f) Determine the 1% VaR over 1 year and recommend whether the *SecureEdu* should go ahead with the proposal to invest in *LearnUp*. The fixed expense is \$30mil per annum, while variable expense is 15% of revenue.
(Hint: Profit = Revenue – Fixed Expense – Variable Expense) (5 marks)

(TOTAL: 30 marks)

Question 3

Remark 1: Please use **Excel VBA** to perform the calculations.

Remark 2: Please save your answers in worksheet “Q3” in the template provided.

You are a financial advisor specialising in providing insurance solutions for university students. To better serve your young, tech-savvy clientele, you are developing a simple budgeting calculator using **VBA Program** to help students manage their student loans, tuition fees, and living expenses. The calculator is designed to project the student's loan balance, interest charges and other cashflows over different periods, helping them understand their financial obligations post-graduation.

The calculator has the following features:

(a) User Interaction

Ask user whether to proceed with the calculation or exit the calculation.

(2 marks)

(b) Input Handling

Obtain the necessary inputs from cells highlighted in blue (*i.e.* tuition fees, living expenses, interest rate, inflation rate, study duration, repayment duration) and the repayment instalment.

(2 marks)

(c) Input Validation

Alert the user with a message if the input(s) is(are) missing or invalid. The macro should check that:

- Input cells should not be blank.
- Input cells should only contain numeric entries.
- The annual tuition fees should be from \$0 to \$30,000.
- The annual living expenses should be from \$6,000 to \$20,000.
- The annual interest rate should be from 0% to 6%.
- The annual inflation rate should be from 0% to 3%.
- The study duration should be from 3 to 5 years.
- The repayment duration should be from 1 to 10 years.

After alerting the user of inappropriate inputs, the program will quit to allow the user to re-enter the correct input(s).

(10 marks)

Note: Question No.3 continues on page 7

Question 3 (continued)**(d) Financial Projection**

Project the tuition fees, living expenses, interest, repayment instalment and outstanding student's loan balance from the current year until the loan is fully repaid.

In particular,

- Tuition fees are constant during study duration.
- Living expenses increase at the annual inflation rate.
- Student's loan only covers the tuition fees.
- Loan interest only begins after graduation. The interest is compounded at the end of each year.
- Repayment of student's loan only begins after graduation. Equal amount of instalment is paid at the end of each year (after interest accumulation).

Ensure that previous results in cells highlighted in green are cleared before the projection starts.

(6 marks)

(e) Display Results

Display the results of part (d) in cells highlighted in green and inform the user when the projection is completed.

The results of a sample client profile and economic assumptions are as follows:

- Tuition fees: \$18,000 p.a.
- Living expenses: \$15,000 p.a.
- Interest rate: 2.0% p.a.
- Inflation rate: 1.5% p.a.
- Study duration: 3 years
- Repayment duration: 3 years

Year	Outstanding Loan (BOY)	Tuition Fees	Living Expenses	Loan Interest (EOY)	Repayment Instalment (EOY)	Outstanding Loan (EOY)
1	0	18,000	15,000	0	0	18,000
2	18,000	18,000	15,225	0	0	36,000
3	36,000	18,000	15,453	0	0	54,000
4	54,000	0	15,685	1,080	18,725	36,355
5	36,355	0	15,920	727	18,725	18,358
6	18,358	0	16,159	367	18,725	0

(2 marks)

Note: Question No.3 continues on page 8

Question 3 (continued)

(f) Documentation

Have proper documentation of the macro program.

(8 marks)

(g) Scenario Analysis

Run a projection for the following client profile and economic assumptions.

- Tuition fees: \$20,000 p.a.
- Living expenses: \$16,000 p.a.
- Interest rate: 3.0% p.a.
- Inflation rate: 2.0% p.a.
- Study duration: 5 years
- Repayment duration: 10 years

Plot a chart to show the minimum income required after graduation to cover the repayment instalment and living expenses, while maintaining a savings goal of 30% of income. The chart should show the income, repayment instalment, living expenses and savings over time.

(5 marks)

(TOTAL: 35 marks)

Question 4

Remark 1: Please use **SQL program** to perform the calculations.

Remark 2: The datasets are stored in the database, *EduProtect*, in the SQL server.

Remark 3: Please save your **SQL commands** in worksheet “Q4” of the template provided.

You are working as an actuarial analyst for *EduProtect*, a company that provides insurance products tailored to university students. These products include health insurance and student loan protection policies. The company maintains a comprehensive SQL database that tracks policies, claims, and movements in its insurance portfolio.

The management team is reviewing the performance of *EduProtect*’s insurance portfolio for the year 2024. They want to assess changes in policy distribution across different universities and identify any significant shifts in policyholder behaviour. You are tasked with performing an analysis using SQL to provide insights into these changes. In particular, you will:

- (a) Determine (i) the total number of policies, and (ii) the mix of policy type by respective universities, as of 31 December 2023 and 31 December 2024. Arrange the results in descending order based on the mix of policy types for each university.

(4 marks)

- (b) Using the *Policy_202312* and *Policy_202412* tables, identify the policies that were (i) newly added in 2024, and (ii) terminated in 2024. For policies newly added in 2024, store the information into a temporary table, *#NEW_POLICIES_2024*. For policies terminated in 2024, store the asset portfolio information into a temporary table, *#TERMINATED_POLICIES_2024*.

(Hint: use `DROP TABLE` to reset the temporary table if necessary)

(4 marks)

The company’s Claims Operations department has provided a separate dataset, *Claims_2024*, which tracks all claims filed during 2024. This table includes information on the university, policy type, and the claim amount.

- (c) Compare the results in part (b) against the movement data *Claims_2024* provided by Claims Operations department. You should determine (i) average claim amount per policy for new policies in 2024 according to respective universities and policy types, and (ii) universities and policy types where policies terminated in 2024 had no claims filed.

(4 marks)

Note: Question No.4 continues on page 10

Question 4 (continued)

- (d) It was noted that (i) the average claim amount per policy for new policies in 2024 is higher than the portfolio average, and (ii) some policies terminated in 2024 had zero claims in 2024. Suggest possible reasons for these observations.

(3 marks)

(TOTAL: 15 marks)

- END OF PAPER -