

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

31st May 2024

CP2A - Actuarial Modelling

Time allowed: 3 Hours 15 Minutes (09.30 – 12:45 Hours)

Total Marks: 100

Exam Requirements**Q. 1) Modelling steps and data checks**

Read the background document, which describes the scenarios that need to be modelled and documented for this project.

Construct a spreadsheet model that produces the following calculations. You should ensure that your spreadsheet contains appropriate self-checks and that you have performed (and documented in the audit trail) reasonableness checks at each stage of your calculations.

- i) Carry out checks on the data provided for revenue, making any adjustments wherever necessary to confirm that the data is complete, reasonable, and fit to use. (4)
- ii) Verify that the random numbers data provided for computing average values does follow a Normal (0,1) distribution by carrying out the following investigations.

- Graphical checks: Normal distribution appears as a 'bell curve'.
- Check the overall distribution by completing a chi-squared test.

Note:

1. You are not expected to make any changes to the data. You will also be able to continue to complete the model using the average values provided even if you have not completed the required verification.
2. The chi-squared test can be performed using *CHIINV* Excel function at 85% confidence interval and expected cumulative frequency can be determined using *NORM.DIST* Excel function. (6)

- iii) Calculate the inflation rate for 24 years from 2nd year onwards. (1)

- iv) To evaluate the Opportunity A, carry out the following projections:

- a) Revenue for 25 years. (2)
- b) Running Cost, Cost of Goods Sold and Royalty Amount for 25 years. (5)
- c) Net Cashflows for 25 years, including reimbursement, if any. (2)

- v) To evaluate the Opportunity B, carry out the following projections:

- a) Loan Schedule for 15 years which should include loan at the beginning and end of the year, interest amount during the year and repayment during the year.

Note: The level annual instalments on loan can be calculated using Goal seek Excel function. (4)

- b) Revenue, Total Cost and hence Net Cashflows for 25 years. (3)

- vi) The Government has decided to impose a tax on net cashflows of 10% on franchising business after 5 years of operation and tax on revenue of 1% on electrical wires industry after 5 years of operation. Compute the following for both the Opportunities:
- a) Net Cashflows after taxes for 25 years. (2)
 - b) Determine the Opportunity Mr. J should choose based on the criterion of Net Present Value assuming discount rate of 13%. (2)
 - c) Determine the Opportunity Mr. J should choose based on the criterion of Discounted Payback Period assuming discount rate of 13%. (2)

[Note: all scenarios outlined above should be modelled separately in your spreadsheet. The user should not need to change the parameters to see the results.] [33]

Q. 2) Modelling technique and practice

- i) Auto checks or reasonableness checks on the modelling completed in (Q.1). (3)
 - ii) Demonstration of good modelling techniques and practice. (7)
- [10]

Q. 3) Audit trail

Produce an audit trail for your spreadsheet model that includes the following aspects:
(Note: There is no need to use MS word for producing audit trail. It should be documented in a separate sheet in the same excel workbook as the model.)

- Purpose of the model.
- Data and assumptions used.
- Methodology, i.e., description of how each calculation stage in the model has been produced.
- Explanation of checks performed.

You should ensure that your audit trail is suitable for both a Senior Actuary, who has been asked to approve your work, and a fellow student, who has been asked to peer review and correct your model, to continue work on it or to use it again for a similar purpose in the future.

Marks available for audit trail:

Audit approach

- i) Communication skills (the audit trail provides enough detail to be read as a stand-alone document). (4)
- ii) Fellow students can review and check methods used in the model. (7)
- iii) Senior Actuary can scrutinize and understand what has been done. (7)

- iv) Written in clear English. (4)
 - v) Written in a logical order. (3)
- Audit content**
- vi) All steps clearly explained. (8)
 - vii) Clear signposting included throughout. (4)
 - viii) Statement of assumptions made. (5)
 - ix) All model steps accurately covered. (15)
- [57]**

Background:

Mr. J has accumulated surplus cash balance of INR 3 Crores and wants to commence business due to good prospects for the economy as predicted by the investors and economists. He has sought advice from management consultants to commence a new business and he has been presented with two interesting opportunities.

He has reached out to your actuarial firm, PQR Actuarial Services, to help him evaluate the opportunities independently. Mr. J has provided the following information to you to evaluate the opportunities.

Opportunity A:

A homegrown burger company is giving tough competition to foreign companies and is looking to aggressively expand within the country through franchise mode. The franchise stores of the company are expected to witness increasing revenue every year for the next 25 years. The initial investment in setting up a new store for this company is INR 3 Crores. The cost involved in running a store, like rent, electricity, salary etc., but excluding the cost of goods sold and franchise fees is INR 0.24 Crores for the first year and will increase by expected inflation rate plus 3% from the 2nd year onwards.

There are 100 similar franchise stores of this company in the city and their revenue projections for the next 25 years have been shared in the data template. The revenue of the new store is expected to be 10% higher than the average of the above franchise stores for the next 25 years.

The royalty for a new store will commence after 5 years and shall be equal to 3% of the revenue in the 6th year and will have an additive increase of 0.5% after every 2 years (i.e., 3% in years 6 & 7, 3.5% in years 8 & 9, and so on).

The cost of goods sold is expected to be as follows:

- 50% of the average revenue of new store in past 3 years when revenue of the new store for the year is less than INR 1.75 Crores
- 45% of the average revenue of new store in past 3 years when revenue of the new store for the year is more than or equal to INR 1.75 Crores but less than INR 3.75 Crores

- 40% of the average revenue of new store in past 3 years when revenue of the new store for the year is more than or equal to INR 3.75 Crores

Additionally, there is a guarantee provided by the company for a new store for an initial 10 years. If the excess revenue over expenses (running costs, cost of goods sold and royalty) is less than INR 0.45 Crores, then the shortfall will be reimbursed by the company to the store.

Opportunity B:

The electrical wires industry is witnessing tremendous growth in the economy on the back of increasing construction and industrial activities and modernization in agriculture. The manufacturing of electrical wires requires an initial setup investment of INR 4.5 Crores.

A loan of INR 1.5 Crores can be sanctioned from a reputed banking corporation. The loan will be available for a fixed tenure of 15 years at a fixed interest rate of 10%. The level annual instalments will commence from the 4th year and will be payable at the end of the year. No principal and interest repayment is expected in the first 3 years and the interest on the loan during this period will lead to an increase in outstanding loan balance.

The total cost of operations, excluding interest on the loan, is estimated to be fixed at INR 0.7 Crores for the first 3 years and will increase by expected inflation rate plus 5% from 4th year onwards.

NIL revenue is expected in the first 3 years of operations.

The revenue is expected to be 75% more than the total cost of operations, excluding interest on loan, from the 4th year onwards.

Note: All the cashflows for both the opportunities except initial investment and sanction of loan can be assumed to take place at the end of the year.

Additional Information: Projection of Inflation Rates

You have been provided the average values for 24 periods (consider year 2 to 25) in the data template. The average values have been calculated using 2,400 random numbers generated from Normal (0,1) distribution in format of 24 rows by 100 columns. The inflation rate for year 1 is 5% p.a. and the rates from year 2 onwards can be determined as follows;

Inflation rate at t + 1 = Inflation rate at t	- 0.10%	if	average value < - 0.1
	+ 0.20%	if	- 0.1 <= average value < 0.1
	+ 0.25%	if	0.1 <= average value
