

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

10th December 2022

Subject CP2A – Actuarial Modelling (Paper A)

Time allowed: 3 Hour 15 Minutes (10.15 – 13.30 Hours)

Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

- 1. Mark allocations are shown in brackets.*
- 2. Do save your work in solution template on a regular basis.*
- 3. All the detailed guidelines are available on exam screen.*
- 4. If Any, Data set file(s) accompanying the question paper is available for download on the exam screen.*
- 5. Please check if you have received complete Question Paper and no page is missing. If so, kindly get new set of Question Paper from the Invigilator.*

AT THE END OF THE EXAMINATION

Please return this question paper to the supervisor separately. You are not allowed to carry the question paper in any form with you. You are requested to save and submit the work before leaving the examination premises.

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 appropriate checks on the expected investment return data provided for debt mutual funds, making any adjustments wherever necessary. (2)
- ii) Verify that the data used for projecting equity returns does follow a Normal (10%, 20%) distribution by carrying out **both** statistical and graphical investigations.

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 projected returns provided by investment team even if you have not completed the required verification.

Note 2 - Hints for data checks:

- *Statistical investigation: Normal distribution has two parameters, the mean, and the standard deviation.*
- *In graphical form, normal distribution appears as a 'bell curve'.* (5)

- iii) Assuming Ms. A commences work with ABC Ltd. at the base location on expected joining date, carry out the following cash flow projections for Ms. A (projections to end on Ms. A's 50th birthday).

a) Salary income that Ms. A is expected to earn. (2)

b) Rental expenses that Ms. A is expected to pay. (1)

c) Personal expenses that Ms. A is likely to incur. These need to account the important life events that influence the amount of expenses. (3)

d) Investment income that Ms. A is expected to earn, considering she follows investment philosophy A.
(All cashflows - salary, rent and personal expenses can be assumed to be incurred at beginning of each year) (5)

e) Ms. A's accumulated wealth at end of each year. (2)

- iv) Repeat the calculations in Q1 (iii) assuming following scenario:

a) Ms. A opts to work from home location immediately.

b) Ms. A opts to work from base location immediately but switches to home location post marriage.

(5)

v) Assuming Ms. A continues to work from base location forever, re-compute Ms. A's accumulated wealth at age 50 if she were to follow investment philosophy B. (3)

vi) Produce a graph of Ms. A's wealth over the projection period comparing the outcomes of following investment philosophy A vs investment philosophy B. (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.]

[30]

Q. 2) Modelling technique and practice

i) Auto checks on the modelling completed in stages 1(ii) to 1(vi). (3)

ii) Demonstration of good modelling techniques and practice. (6)

[9]

Q. 3) Audit trail

Produce an audit trail for your spreadsheet model that includes the following aspects:

- 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

- Communication skills (the audit trail provides enough detail to be read as a stand-alone document). (4)
- Fellow student can review, and check methods used in the model. (7)
- Senior Actuary can scrutinize and understand what has been done. (7)
- Written in clear English. (4)
- Written in a logical order. (3)

Audit content

- All steps clearly explained. (8)

- Reasonableness checks. (4)
 - Clear signposting included throughout. (4)
 - Statement of assumptions made. (5)
 - All model steps accurately covered. (15)
- [61]**

Background

Ms. A has recently completed her education and is soon to begin her corporate journey. During her college, she was fascinated by topics related to finance and believes in taking planned financial decisions with a long-term view and keeping personal goals in mind.

The immediate decisions to be taken by her include:

- **Work Location:** Ms. A has landed a job with company ABC Ltd. on terms that the salary shall vary depending upon the work location chosen. She needs to decide between base location or home location.
- **Investment Allocation:** Ms. A has decided to keep her entire wealth in three asset classes, namely bank deposit, debt mutual fund and equity in a pre-defined proportion. She has two philosophies in mind and needs to decide which one to follow.

Ms. A is expected to start her job on her 25th birthday and plans to make the above decisions based on quantum of wealth she can generate till she turns 50.

(Ms. A intends to work for 25 years and retire subsequently)

While Ms. A understands the concept of financial planning, her understanding of cash flow projections is particularly limited and consequently, she intends to seek expert opinion to understand how her retirement corpus shall look like under various scenarios arising out of decision points she has in hand.

To carry out these projections, following information is provided by Ms. A:

Salary:

ABC Ltd. has offered an initial salary of ₹10,00,000 p.a. to Ms. A for base location. The salary is expected to increase at the rate of 10% annually.

The corresponding salary in Ms. A's home location is 20% lower.

Rental Expenses:

In the base location of her job, Ms. A is expecting rental expense of ₹25,000 per month.

On an average, rents in the location are expected to increase at the rate of 7% annually.

There shall be no rental expenses in the home location.

Important Life Events and Personal Expenses:

While currently unmarried, Ms. A expects to get married at the age of 30 and plans to have a child at the age of 35. Since these life events have a significant impact on personal expenses, Ms. A intends to consider these situations to project the wealth accumulation.

Asides rent, Ms. A currently anticipates monthly expenditure of ₹25,000. Based on discussions and inputs received from Ms. A on her lifestyle expectations, the amount is expected to be ₹40,000 if she were married and ₹50,000 if she had a kid.

These expenses are likely to increase at CPI inflation rate, which is usually 1% higher than rental inflation rate.

Investment Philosophy:

Based on academic knowledge and discussions in finance lectures, Ms. A believes in having a diversified portfolio of different asset classes. Her idea is to rebalance her portfolio at end of each year such that wealth distribution between different asset classes is as follows:

Bank Account – 20%

Debt Mutual Funds – 40%

Equity – 40%

(For projection purposes, this shall be referred to as Philosophy A)

However, she has an alternative philosophy in mind which she wants to evaluate. The details of same as are follows:

Proportion of wealth in bank account remains constant at 20% throughout

Proportion of wealth in equity to be 70% at the end of first year and it should reduce by 5% each year, subject to minimum of 20% during any year

(For projection purposes, this shall be referred to as Philosophy B)

Tax:

As per current tax regime Ms. A's country of residence, she is expected to pay 5% tax on her salary income.

Additional Guidance:

1. Returns on asset classes to be modelled as follows:

Bank Deposit – 4% p.a. throughout the projection period

Debt Mutual Funds –

Consider average of projected returns of 3 funds, namely, Fund X, Fund Y and Fund Z.

As a simple guidance followed at ABC Ltd., projected returns for a debt fund are estimated as 5 year-moving average return of the respective fund.

Returns for each of the three funds for last 5 years have been provided by investments team in excel format.

Equity –

Investments team at ABC Ltd. has provided projected annual equity investment returns for next 25 years in the attached excel. The returns have been calculated from 2,500 random numbers generated from Normal (10%, 20%) distribution in format of 25 rows by 100 columns.

2. Given the objective to see wealth accumulation, annual projection model is acceptable.
