INSTITUTE OF ACTUARIES OF INDIA EXAMINATIONS

9th December 2022

Subject CM1B – Actuarial Mathematics (Paper B)

Time allowed: 1 Hour 45 Minutes (10.15 - 12.00 Hours)

Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

1. ***Mark allocations are shown in brackets.***
2. ***Attempt all questions beginning your answer to each question in the template provided.***
3. ***Attempt all sub-parts of the question in the template provided only, unless otherwise instructed to do so.***
4. ***The working of each part of the question should be on a separate tab (sheet). For example, question 1(i) should be worked out within the tab (sheet) with name 1(i) of worksheet.***
5. ***Where possible, summarize your data used & assumptions made (if any) in a separate tab.***
6. ***Do save your work in solution template on a regular basis.***
7. ***All the detailed guidelines are available on exam screen.***
8. ***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.

Q. 1) ABC Insurance company engages in life insurance business. It proposes to introduce a unit linked life insurance product that would offer low charge structure and attractive IRR to policyholder. Salient features of the proposed product are:

Premium paying term of 5 years with premiums payable annually in advance.
Policy term – 10 years.

Charges:

Fund management charge @ 0.6% p.a. deducted daily from unit fund before declaring NAV i.e. after application of mortality charge and investment returns.
Policy administration charge – Nil
Mortality charges – as per attained age, deducted with reference to sum at risk at each monthly anniversary by cancellation of units. Deducted at the start of the month.
Premium allocation charge – Nil

Benefits:

Policyholder shall be eligible for return of all mortality charges at the end of policy term, upon survival, provided all the premiums are paid.
Death Benefit: Higher of {10 times Annual Premium, 105% of Premiums paid till date, Unit Fund Value}.
Surrender Benefit: Policy acquires surrender value upon payment of second annual premium. Surrender value equal to available unit fund value after deducting applicable surrender penalty.
Maturity Benefit: Fund value at the end of policy term.

Assumptions:

Mortality: 80% of standard table is the mortality charge; and 50% of standard table is the expected mortality rate to determine death outgo. Standard mortality rate table has been provided in the solution template.

Investment return: 8% p.a. gross yield on unit fund and 7.5% p.a. on non-unit reserves.

Surrender rate:

Policy year	Surrender rates	Surrender penalty (% of Unit fund)
2	10%	10%
3	7.5%	7.5%
4	7.5%	7.5%
5	5%	5%
6	15%	5%
Thereafter	5%	Nil

Surrender can be assumed spread evenly during the year and take place at start of the month.

Initial Expense: Re. 0.2 per 1000 Sum Assured on death; 2% of Annual Premium.
Maintenance: Rs. 500 p.a. per policy incurred evenly during the year and inflating @ 6% p.a. at each policy anniversary.

Tax rate of 14.56% applicable on profits earned by the company.

For a policy issued to a life assured aged 35 years and 3 months at entry with Rs. 1,00,000 premium payable annually, you are required to:

i) Compute unit fund projection and also show the death benefit, surrender benefit and maturity benefit payable under the policy clearly. (20)

ii) Calculate policyholder internal rate of return on maturity from this policy that is fully paid. (4)

iii) Compute the non-unit fund cashflows and profit signature of the policy. (15)

iv) Calculate NPV of profit that would emerge at risk discount rate of 12% p.a. (3)

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Q. 2) You have been provided with mortality functions in the solution template. Use these to solve the question.

Calculate the expected present value of benefits under a 15-years term assurance, paying benefit at the end of year of death of a life currently aged 47 exact. This is a single premium product.

Basis: AM92 select life
Interest rate: 3% pa effective
Death benefit – as defined below part (i) and part (ii)

i) Death benefit Rs. 1,50,000 in the first year, increasing by 4% p.a. compound thereafter. (6)

ii) Death benefit is equal to the capital outstanding at the start of the year of death, on a 15-year mortgage of Rs.1,50,000 repayable by level annual payments in arrears where mortgage interest rate is 4% pa effective. (9)

iii) Calculate the reserve requirement for each year for part (ii) above. In addition to the basis provided above, you should assume that claim expenses amount to 1% of the settled claims. (5)

iv) Without performing further calculations, explain how the reserves will change if annual improvements to mortality are allowed for. (2)

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Q. 3) A leading pizza company is opening a new store in a metro town of a country. The company purchased the premises for Rs. 50,00,000 on 1st January 2022. The total cost of refurbishing the premises will be Rs. 1,50,00,000 which will be incurred in six equal instalments payable monthly in advance with the first payment made on 1st October 2022.

The store is expected to open on 1st May 2023 and is expected to sell 10,000 Pizza in the opening month increasing by the higher of 1% of previous month's sales or 200 in each month and becomes 15,000 thereafter sales of Pizza remain same for till December 2033. The price of each Pizza is assumed to be Rs. 300. All income from Pizza sales can be assumed to be received continuously during the month.

The costs of staffing and maintaining the new store will be Rs. 1,00,000 per month payable continuously from 1st May 2023 and it is assumed that these will increase on each 1st September by 2% per annum effective. It is also assumed that all costs and income will cease at the end of 2033.

The risk discount rate is 12% per annum effective.

i) Calculate the NPV of the store and determine whether this is profitable or not. (16)

ii) Calculate the discounted payback period and internal rate of return. (6)

iii) Assuming all cash flows occur at the beginning of each month, calculate the discounted mean term separately for income and costs related to this project. Present these to the nearest month and identify which is higher. (7)

iv) As continuation to part (iii) above, calculate the modified duration. (4)

v) Without performing further calculations, explain how the net present value will change as the risk discount rate increases? (3)

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