INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

19th June 2019

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 named CM1B.***
5. ***Where possible, summarize your data used & assumptions made (if any) in a separate tab.***
6. ***Do save your work in Excel files on a regular basis.***
7. ***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.***
8. ***Ensure that you click the "Submit" button only when you have completed the question paper and final submission has to be made.***

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) A person takes a new home loan of INR 50,00,000 from a bank for a tenure of 20 years on 1st April 2010. Current floating rate of interest charged by the bank is 12% p.a. convertible monthly which is derived as 5% less than the PLR (Prime Lending Rate). The current PLR of the bank is 17% p.a. convertible monthly and the floating rate of interest is reviewable quarterly. The loan is repayable by equated monthly instalments.

i) Calculate the monthly instalment of the loan assuming that the current rate of interest is fixed for the tenure of the loan. (4)

ii) Prepare a loan schedule for the customer assuming that the current rate of interest is fixed for the tenure of the loan and state from which instalment the capital repayment will exceed the interest portion. (8)

The PLR varies with time and its details are provided in the spreadsheet. It can be assumed that PLR will remain equal to the latest value beyond the months provided in the data.

iii) Effective 1st October 2012, prepare a revised loan schedule with varying PLR and determine the outstanding tenure of the loan assuming that the instalment remains unchanged. (15)

The person wishes to repay the loan early and plans to increase the instalment each year with the increase in salary escalation rate. The instalment once increased remains fixed for 12 months till the next increment. The salary escalation rate is assumed to be 5% p.a. and the increment happens on 1st January each year.

iv) Effective 1st Apr 2010, prepare the loan schedule with increasing monthly instalment considering PLR varies as given in the data. Determine revised term of the loan based on the above arrangement. (15)

v) Calculate the amount of interest paid in **(ii), (iii) and (iv)** arrangements. (3)

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Q. 2) As at 31st December 2018, a company holds four kinds of assets:

- Asset A: A fixed interest security which pays coupon 8% p.a. payable semi-annually redeemable at par on 31st December 2031.
- Asset B: Zero coupon bonds of 100 nominal issued at 58 redeemable on 31st December 2024.
- Asset C: Index-linked bond which pays coupons of 6% p.a. annually in arrear and a nominal redemption price of 100%, maturing on 31st December 2026. The actual coupon payments and redemption payments are linked to the retail price index (provided in the Excel sheet).
- Asset D: Listed equities

i) An interest rate curve has been provided in the Excel worksheet. Calculate the below:

a) F(5,5) (3)
b) 3 year force of interest (2)

ii) Calculate the price of 100 nominal of each of assets A, B and C based on the interest rate curve provided in the Excel sheet. (10)

iii) Assuming that assets A, B, C and D represent 35%, 30%, 25% and 10% of the total investments of the company, verify that the overall yield on the interest bearing portfolio of the company is 7.8%. (7)

The company issued 100 identical contracts on 31st December 2016 to policyholders aged 45 exact on that date. The policy term for each contract is 15 years. Under this product, the premiums of INR 12,000 per annum are payable quarterly in advance with the premium paying term being 8 years. The Basic Sum Assured of policy is 100,000. In return, the policy pays the benefits below:

- On death of policyholder during the premium paying term a sum assured of INR 100,000 plus accrued reversionary bonuses plus a terminal bonus.
- On death of the policyholder after the completion of the premium paying term a sum assured of INR 200,000 plus accrued reversionary bonuses plus a terminal bonus.
- In the event of the policyholder surviving till the end of the policy term, a sum assured of INR 200,000 plus accrued reversionary bonuses plus a terminal bonus.
- In the event of a policyholder surrendering his / her policy, the policyholder receives a surrender value equal to t / n * death benefit, where t represents number of premiums paid and n represents total premiums payable under the policy.

Reversionary bonus is attached at each policy anniversary from the first policy anniversary onwards. A reversionary bonus amount once declared becomes guaranteed for the remainder of the policy term. Terminal bonus is payable at the time of death and maturity.

Before 31st December 2018, 10 of these policies do not pay all their premiums and choose to surrender their policy. The company declared simple reversionary bonus of 3% p.a. in 2017 and 2018 – this is applicable on the Basic Sum Assured of 100,000 at all times.

The company is required to set up a reserve for the policies which are in-force as at 31st December 2018. In order to determine the reserves, the company uses the basis below:

- Mortality table: 90% of mortality table provided in Excel.
- Renewal expenses: INR 200 per policy as at 31st December 2016 inflating at 5% per annum.
- Regular commissions of 5% p.a. payable with each premium installment.
- Interest rate: 7% p.a. effective.
- Reversionary bonus rate: simple interest rate of 3% p.a.
- Terminal bonus: 10% of guaranteed death benefit at the time of claim payment.
- Future assumption for surrenders: Nil.
- Assume that deaths are uniformly distributed, expenses and premiums are incurred at the start of each period.
- Assume that mortality rate corresponding to age last birthday can be used to project cash flows. For e.g. if age of policyholder is 35 year and 6 months, then mortality rate applicable to age 35 years can be used at this time point.

iv) Calculate the total reserves to be held by the company policies in-force as at 31st December 2018. (15)

v) The value of investments of the company as at 31st December 2018 equal the amount of reserves held. Determine the value of investments for each of the asset types held by the company. (2)

vi) Assess the change in market value of assets and reserves for a 1% drop in interest rates (1% drop in curve for assets and 1% drop in interest rate used to determine reserves). Briefly comment on the results. (8)

vii) If the company assumes surrenders of 10% p.a., how do you expect the duration of cash flows from insurance contracts and reserves to be affected and why? (2)

viii) Recalculate the reserves at 31st December 2018 assuming that reversionary bonus rate is 3% p.a. compounded annually; all else remaining unchanged and explain the change in the reserves. Without doing any further calculations, comment on how you would expect the DMT of the liabilities to change. (6)

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Link for Data Set:
https://actuariesindia.org/sites/default/files/2022-09/CM1_Paper_B_Supplement_Data.xlsx

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