INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

November 2026

CM1 - Actuarial Mathematics for Modelling

(Paper B)

Time allowed: 1 Hour 45 Minutes

Total Marks: 100

Q.1) Country X has recently adopted a new unisex life table given in the template from age 0 to 100.

i) Calculate the probability of dying within 1 year for all ages. **[2]**

ii) Calculate the probability of surviving a 30 year old male to age 65 year. **[2]**

In country X inheritance tax rate is 60% however to promote insurance in the country there is no tax on the insurance benefits. Company A has introduced a new whole life product in country X as a wealth transfer vehicle where premiums are payable annually in advance throughout life or till reaching age 100 and benefit is payable at the end of the year of death or reaching age 100. A male aged 65 has purchased this policy with Sum Assured of INR 20,00,000.

iii) Calculate the net premium reserve at all duration (including duration 0) with valuation mortality as 90% of the base mortality table and valuation interest rate of 6.5% per annum. **[11]**

[15 Marks]

Q.2) A father and daughter took higher education loan of INR 50,00,000 for 20 years and to cover the loan they purchased a joint life term assurance plan with Sum Assured of INR 50,00,000 from company B. The product is newly introduced in the country and only offer level sum assured option with following features:

- The policy term is 20 years and premium payment term is 12 years
- Upon at least one death during the policy term, death benefit equal to sum assured will be paid at the end of the year of death and policy terminates
- Upon survival of both the lives to the end of policy term 25% of the total premium paid will be refunded
- Upon surrender of the policy, a fixed percentage of total premium paid shall be refunded at the end of the year of surrender as given in the template

Best estimate assumption for profit testing:

- 75% of the mortality rate as given in the table A (operates independently)
- Surrender rate as given in the table B
- Interest rate is 6% per annum
- Risk discount rate is 11% per annum
- Fixed policy expense of INR 5,000 for first year and renewal expense during premium paying term is INR 800 and after premium payment term is INR 350. These are incurred at the start of the year.
- First year commission is 10% of annual premium and renewal commission is 2%
- Claim expenses are 0.20% of sum assured and incurred at the time of death claim payment only
- Reserve is 5% of total premium paid multiplied with remaining policy term

i) Calculate the policy profit margin given father age is 48 years and daughter age is 23 years and annual premium is INR 85,000. **[24]**

ii) In the recent study it is observed that female mortality is lighter than male lives by 3 years. Calculate the revised profit margin with no change in other assumptions. **[3]**

iii) Comment on the results of part (ii). **[2]**

iv) In the recent annual general meeting of the company, it is decided to target the higher return, hence risk discount rate increase from 11% to 13%. Calculate the revised annual premium to maintain same profit margin as calculated in part (i). **[4]**

v) Comment on result of part (iv). **[2]**

[35 Marks]

Q.3) Mr. A got a job offer from another city which requires Mr. A to relocate to this new city. Mr. A knew that property rent is very high in this new city, and he is wondering if it will be financially better off to rent or buy a house.

Mr. A is considering buying the house on housing loan where EMI (Equal Monthly Installment) are payable at the end of the month. Other details related to housing loan are as follows:

House Price: INR 1,50,00,000

Loan Available: 80% of house price

Tenure of the loan: 10 years

Interest rate on loan: 8% per annum effective

i) Prepare the monthly loan schedule and calculate the value of monthly installment amount payable for this loan. **[12]**

Mr. A has decided to spend only 10 years in this new city and considering the buying and selling efforts for the house, he thinks if instead of buying the house he can split the EMI in rent and investment. He studied the growth of the property price for past several years and is confident that the price of the house at the end of 10 years will be INR 2,50,00,000. He needed to pay 15% capital gain tax at the time of selling the house. Current rent for the same house is INR 50,000 and he can sign the 10-year lease with the owner with 7% increase in rent every year. Mr. A is also confident of earning a 10% per annum effective tax-free return on his investment including the down-payment which compounds monthly.

ii) Calculate which option is financially better off for Mr. A. **[11]**

iii) Calculate the effective duration and discounted mean term (Macaulay duration) of the loan at a yield of 6% per annum effective**.** **[6]**

iv) Comment on reasonableness of discounted mean term value as calculated in part (iii). **[2]**

[31 Marks]

Q.4) A foreign company, Hydra Limited wants to invest in beverage business in Sigma Land and assigned FCD 95,000 (Foreign Currency Dollar) capital to be invested for this project. Company has decided to move the funds to the new investment scheme introduced by Sigma Land for the time being and wants to continue with field research. Under this scheme, the investment can be kept in any bank in the foreign currency and maturity is fully tax free including on the foreign exchange fluctuation gains however the proceedings should be converted to local currency (which is Sigma Land Dollar- SLD) at maturity. The nominal annual interest rate is 6% convertible half yearly. Company plans to complete the research within 1 year so placed the investment for 1 year. The projected exchange rate from FCD to SLD is given in the input sheet.

i) Calculate the investment value at the end of year 1 in local currency. **[2]**

Hydra Limited has completed the research and found that initial investment for the factory is SLD 1 million and running cost is SLD 1,00,000 per month which is expected to increase once after every six months at 5% per annum effective rate. First month revenue is SLD 1,00,000 and same is expected to increase at the end of every month at the rate of 10% per annum effective. Running cost and revenue both are due at the end of the month.

Hydra Limited's shareholders have asked for 8% per annum effective return on this project given its riskiness. Hence, this rate should be used for accumulation or discounting purpose of the cashflows.

ii) Calculate the IRR, NPV, Payback period and Discounted payback period for this project by projecting the cashflow for 6 years. **[16]**

iii) Considering the IRR, comment if Hydra Limited should go ahead with this project or not given the shareholder's expectation from this project. **[1]**

[19 Marks]

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