INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

22nd March 2017

Subject CT5 – General Insurance, Life and Health Contingencies

Time allowed: Three Hours (10.30 – 13.30 Hours)

Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

1. *Please read the instructions inside the cover page of answer booklet and instructions to examinees sent along with hall ticket carefully and follow without exception*

2. *Mark allocations are shown in brackets.*

3. *Attempt all questions, beginning your answer to each question on a separate sheet. However, answers to objective type questions could be written on the same sheet.*

4. *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 your answer book and this question paper to the supervisor separately.

Q. 1)   Calculate

    i) $_{10|1}q_{[50]}$

    ii) $(IA)^1_{50:\overline{10|}}$

    iii) $\ddot{a}^{(12)}_{[45]:\overline{15|}}$

Basis:
Mortality AM92
Rate of interest 6% per annum   **[5]**

Q. 2)   **i)**   Outline the difference between the methods of Uniform Distribution of Deaths
        and Constant Force of Mortality.   (2)

     ii)   Calculate $_{1.75}q_{45.75}$ using Constant Force of Mortality and ELT15 Male.   (2)
                                                                                                  [4]

Q. 3)   A continuous whole life annuity is issued to a Life aged x.

    i)   Write down the notation for the annuity and that for the expected present value of
        this annuity.   (1)

    ii)   Calculate the Standard deviation of the present value of the benefits given the
        following
          • Constant force of interest of 4%.
          • Constant force of mortality.
          • Expected present value of the benefit is 16.   (5)
                                                                           [6]

Q. 4)   A pricing Actuary is designing a 20 year Endowment assurance product with regular
premiums for Male life aged 45 years exact. The sum assured on offer is Rs 1,000,000
payable at the end of year of death or end of policy term, whichever happens first. An
annual premium of Rs 30,000 is paid annually in advance.
Calculate the maximum initial commission that could be paid to the agent if the target
profit margin for the product is 10%, where the profit margin is defined as expected
present value of net future cash-flows divided by one annual premium.

Mortality: AM92 Select
Rate of interest: 6% per annum
Expenses:
Initial: Rs 5,000
Renewal (starting from start of year 2):
2.5% of premium
Rs 500 fixed (increasing at 1.9231% compounded per annum from third year)
Renewal commission:
2% of premium starting 2nd policy year
Tax: NIL   **[7]**

Q. 5)   X (Male 65 exact) and Y (Female 60 exact) jointly buy a single premium annuity. The following benefits are payable under the product:

- A guaranteed annuity of Rs. 1,000,000 for the first fifteen years payable annually in advance.
- Post 15 years, annual payments of Rs. 1,000,000 till survival of X.
- If X dies before Y then annual payments of Rs. 500,000 are made to Y whilst she survives, commencing from the end of year of X's death or start of 16th policy year, whichever comes later.

Calculate the Single premium using the following basis:

Mortality: PMA92C20 for X; PFA92C20 for Y
Interest: 4% per annum
Expenses: NIL   **[10]**

Q. 6)   A Life Insurance Company sells a 15 year guaranteed income endowment product to a Male life aged 50 years exact. Under this product premiums are paid for first 10 policy years, annually in advance. Starting from start of 11th year, an annual guaranteed benefit of Rs. 250,000 is paid on survival. However, if the policyholder dies within the first 10 policy years, he gets a benefit equal to the amount of premiums paid till date, whereas if the policyholder dies post completion of 10 policy years and before the end of policy term, he would get a sum of Rs. 1,000,000 along with sum of all the future remaining annual guaranteed benefits.

   i)   Calculate the annual premium, assuming:

   Mortality: AM92 Select
   Interest: 6% PA
   Expenses and commission: NIL   (10)

   ii)   If the Gross Premium Reserve at the end of 10th policy year is Rs. 1,200,000, calculate the Gross Premium Reserves at the end of 9th policy year, using the recursive relationship between reserves at successive intervals. We can assume following reserving basis for this purpose.
   Mortality: AM92 Ultimate
   Interest: 4% PA
   Expense and commission: NIL   (2)
                                                                                          [12]

Q. 7)   **i)**   Briefly describe the importance of Expense Investigations carried out by an Insurance company.   (2)

   ii)   Outline the key difference between direct and overhead expenses, giving suitable examples.   (4)
                                                                                          [6]

Q. 8)   **i)**   State and explain the assumption required in order to derive a single decrement table from a multiple decrement table.   (3)

   ii)   Give an example where the above assumption stated in i) might not hold true in practice.   (1)

iii) An insurance policy can take three states: Inforce (I), Paidup (P) and Claim (C). The policy is Inforce when issued but can subsequently be made Paidup by stopping the payment of premiums. The Paidup policy can also move back to Inforce state once it starts paying premiums. Claim can be made from both Inforce as well as Paidup states and it is an absorbing exit state. Let the force of transition be denoted from I → P as σ_x, from P → I as ρ_x, from I → C as μ_x and from P → C as ν_x. For a policyholder aged 45 years with five years remaining to maturity, write down an expression in integral form to calculate expected present value of:

    a) A Claim of Rs 1000, if the policy is currently in the Paidup state. (1)

    b) A Claim of Rs 250 from the Paidup state, if the policy is currently in the Inforce state. (1)

    c) Premiums of Rs 150 payable continuously if the policy is currently in Inforce state. Assume that no unpaid premiums of the Paidup state are payable while moving to Inforce state. (1)

    d) Same as b) but assume policy is currently in Paidup state. (1)

iv) Assume in the above sub question iii) that instead of Paidup state, the policy can be Surrendered (S) which is an absorbing exit state. The independent force of decrement from Claim and Surrender is 0.05 and 0.13 for age 45 and 0.06 and 0.10 for age 46 respectively. Calculate the probability of being in state Inforce at the beginning of age 47. (4)

[12]

Q. 9) A company has a flexible early retirement policy applicable from age 50 years but before age 65 years. It provides a pension on early retirement of 1/50th of Final Pensionable Salary (FPS) per year of service but capped at 30/50th of FPS, provided the employee has completed 10 years of service with the company at the date of such early retirement. Incomplete years are considered for the calculation. FPS is defined as salary earned over the five years period preceding retirement.

You are required to derive commutation functions to value pension payable on early retirement (denote the decrement as 'e') for a member who is aged exactly 52 with exactly 19 years of past service. All symbols used in the derivation need to be defined. **[8]**

Q. 10) **i)** Define a profit vector. (1)

    ii) Explain what is meant by a Profit Criterion. Give two examples of Profit criterion. (2)

iii) A regular premium endowment assurance has been issued to a life aged 42 exact for a term of 4 years. The regular premiums are not level; instead they increase at the rate of 4% per annum. The premiums are payable at the start of the year. The profit signature of the above contract is (-250, 150, 200, 225) and the profit margin is 5%. Assume that there are no lapses and the relevant mortality table is AM92 Ultimate. The cost of capital to the company is 10% and it would require a further premium of 3% to reflect the risks and uncertainties surrounding the cashflows.

Calculate the premium to be charged by the company in the first year of the contract. (5)

[8]

Q. 11) **i)** State the different basis that may be used in the financial management of life insurance business and what experience do these bases represent. (3)

ii) A student actuary has commented that since reserves are held such that there is an acceptably low probability of insolvency occurring in the future, we should assume that everyone dies on the next day of the valuation. You do not seem to agree with this statement. Give reasons to the student actuary for your views. (2)

iii) A company calculates non unit reserves on its unit linked products by zeroising future negative cashflows. It has issued a six year unit linked policy to a life aged 70 years exact. The profit signature from the policy is
(-20, -35.20, 50, -28.50, -20, 90.21)
Calculate the non unit reserves and the revised profit vector assuming the mortality rates to be AM92 Select and Interest rate of 6% per annum. (7)

[12]

Q. 12) **i)** The values of q_x, d_x, and l_x are plotted on a graph with age on X axis. Describe the shape of the resulting graphs. (3)

ii) Explain how each of the features below can have an effect on the mortality or morbidity rate:

a) Occupation
b) Nutrition
c) Climate and Geographical location
d) Education

(4)

[7]

Q. 13) Calculate the standardized mortality ratio for Mumbai assuming India as a Standard population based on below data:

Age	India		Mumbai	
	Exposed	Deaths	Exposed	Deaths
58	50,000	400	3,500	20
59	40,000	380	2,600	23
60	25,000	330	2,000	22

[3]

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