Actuarial Society of India

EXAMINATIONS

17th May 2007

Subject CT5 – General Insurance, Life and Health Contingencies

Time allowed: Three Hours (10.00 – 13.00 Hrs)

Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

1) *Do not write your name anywhere on the answer sheets. You have only to write your Candidate's Number on each answer sheets.*

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) *Fasten your answer sheets together in numerical order of questions. This, you may complete immediately after expiry of the examination time.*

5) *In addition to this paper you should have available graph paper, Actuarial Tables and an electronic calculator.*

Professional Conduct:

"It is brought to your notice that in accordance with provisions contained in the Professional Conduct Standards, If any candidate is found copying or involved in any other form of malpractice, during or in connection with the examination, Disciplinary action will be taken against the candidate which may include expulsion or suspension from the membership of ASI."

Candidates are advised that a reasonable standard of handwriting legibility is expected by the examiners and that candidates may be penalized if undue effort is required by the examiners to interpret scripts.

AT THE END OF THE EXAMINATION

Please return your answer sheets and this question paper to the supervisor separately.

Q. 1) In a mortality table with a one year select period $q_{[x]} = a * q_x$ for all x ≥ 0 and for a certain constant 0<a<1. Calculate $\overline{A}_{[45]\overline{20|}}$ using the following assumptions:

- a= 0.9
- Interest   :   4% per annum
- Mortality   :   ELT 15 (Males)   **[8]**

Q. 2) A life insurance company issues a policy to male lives aged 45 exact, providing the following benefits:

- A decreasing term assurance with a death benefit, which is payable immediately on death, of Rs.200,000 in the first year, Rs.190,000 in the second year thereafter reducing by Rs.10,000 each year until the benefit is Rs.10,000 in the 20th year, with cover ceasing at age 65.

- An annuity of Rs.25,000 per annum, increasing by Rs.2,000 each year, where the first payment is made on the policyholders 65th birthday, and continues annually for life thereafter.

The policy is paid for by level quarterly premiums payable in advance for 20 years, ceasing on earlier death.

Calculate the premium, using the equivalence principle.

Basis:
Mortality : AM92 Select
Interest   : 4% per annum
Expenses : Initial: Rs.200 plus 35% of the premiums paid in the first year

Renewal: 5% of all subsequent premiums and Rs.40 per annum, increasing by 4% per annum compound, on each policy anniversary

Claim: Death: Rs.250*(1.04)^t where *t* is the exact duration of the policy at death, measured in years with fractions counting

Annuity: 2% of annuity payments

                                                                                                           [14]

Q. 3) A life office is investigating the initial expenses that can be supported by policies sold on its current premium rates. One of the policies being considered is a twenty-year endowment assurance policy for a 40-year old male with sum assured Rs.100,000 and annual premium of Rs.3,950. The basis is:

- Renewal expenses From year 2 onwards, 2.5% of premium, plus Rs.75 per annum (the latter increasing at 3% compound, starting from the first expense payment of Rs.75 in year 2)
- Mortality AM92 Select to age 55, with an additional force of mortality of 0.00956945 from age 55 onwards
- Interest 4% *pa*

The death benefit is payable at the end of the year of death. The premium is payable annually in advance.

(i) Given an annuity value of $\ddot{a}_{40:\overline{20}|}$ @ 1% = 17.598 which allows for the

additional mortality from age 55 onwards, show that the corresponding select
mortality annuity value is 17.601.   (4)

(ii) Given that $\ddot{a}_{55:\overline{5}|}$ @ 5% **=** 4.503, hence determine the initial expenses that can

be afforded by the above policy.   (6)

[10]

Q. 4)   For a continuous whole life annuity of 1 on (x) :
(i) $T(x)$ is the future lifetime random variable for (x) .
(ii) The force of interest and force of mortality are constant and equal.

(iii) $\overline{a}_x$ = 12.50

Calculate the standard deviation of $\overline{a}_{\overline{T(x)}|}$ **[4]**

Q. 5)   You are given:

(i) $A_x = 0.28$ (ii) $A_{x+20} = 0.40$ (iii) $A_{x:\frac{1}{20}|} = 0.25$

(iv) $i = 0.05$

Calculate $a_{x:\overline{20}|}$ **[4]**

Q. 6)   Under the rules of a pension scheme, a member may retire due to age at
any age from exact age 60 to exact age 65.

On age retirement, the scheme provides a pension of 1/60th of Final
Pensionable Salary for each year of scheme service, subject to a maximum
of 40/60ths of Final Pensionable Salary. Only complete years of service are
taken into account.

Final Pensionable Salary is defined as the average salary over the three-year
period before the date of retirement.

The pension scheme also provides a lump sum benefit of four times
Pensionable Salary on death before retirement. The benefit is payable
immediately on death and Pensionable Salary is defined as the annual rate
of salary at the date of death.
You are given the following data in respect of a member:
Date of birth 1 January 1979
Date of joining the scheme 1 January 2000
Annual rate of salary at 1 January 2005 Rs.50,000
Date of last salary increase 1 April 2004

(i)   Derive commutation functions to value the past service and future service pension liability on age retirement for this member as at 1 January 2005. State any assumptions that you make and define all the symbols that you use.

(12)

(ii) Derive commutation functions to value the liability in respect of the lump sum payable on death before retirement for this member as at 1 January 2005. State any assumptions that you make and define all the symbols that you use.

(6)

[18]

Q. 7)   A reversionary annuity issued to a male life (X), aged 60 years, and his wife (Y), offers the following benefits:

If X dies before age 65 years and before Y, who is now aged 60 years, Y will receive an income of Rs.10,000 p.a. The income will be paid annually in arrears (from the end of the year of X's death) until Y's 75th birthday or until her earlier death.

Calculate the Single Premium assuming PA92C20 mortality and 4% p.a. interest.

[7]

Q. 8)   For a double decrement model:

(i) In the single decrement table associated with cause (1), $(aq)^{1}_{40} = 0.1$

and decrements are uniformly distributed over the year.

(ii) In the single decrement table associated with cause (2), $(aq)^{2}_{40} = 0.125$

and all decrements occur at time 0.7.

Calculate q^{2}_{40}.

[4]

Q. 9)   A life insurance company sells 5-year-term, single-premium, unit-linked bonds each for a single premium of Rs.15,000. There is no bid/offer spread and the allocation percentage is 100%.

(i) Assuming that the only charge is a 3% annual management charge and assuming unit growth of 9% *pa*, calculate the unit provision at the start and end of each year and the management charge each year.

(3)

(ii) Calculate the net present value of the contract assuming:
- Commission of 5% of the premium
- Initial expenses of Rs.150
- Annual renewal expenses of Rs.50 in the 1st year, inflating at 5% pa.
- Independent rate of mortality is a constant 0.5%
- Independent rate of surrender is 5% *pa*
- Non unit fund interest rate is 9% *pa*
- Risk discount rate 12% *pa*

The company holds unit provisions equal to the full value of the units and zero non-unit provisions.

You may assume that expenses are incurred at the start of the year and that death and surrender payments are made at the end of the year.

(4)

[7]

Q.10) A unit-linked policy has the following profit vector:

Year	In force profit
1	−25
2	−12
3	−6
4	25
5	35

(i) Calculate the provisions required to zeroise losses at the end of years 2 and 3, assuming a rate of accumulation of 5% and that $qx = 0.02$ at each age.

(2)

(ii) If the risk discount rate used is 8%, determine the net present value of the profits before and after zeroisation and state with reasons which of these figures you would expect to be greater.

(5)

[7]

Q. 11) A special 3-year endowment assurance policy provides that the death benefit payable at the end of year of death is Rs.10,000 plus the endowment assurance net premium reserve for that year that would have been held had death not occurred. Rs.10,000 is payable on survival to the end of the 3 years.

On the basis set out below, use a discounted cash flow method to calculate the level annual premium payable in advance for a life aged 57 exact. The requirement is that at the discount rate defined below the value of the annual emerging surpluses should sum to zero.

Basis   :   Mortality: AM92 Select for experience and reserves
Expenses: 20% of the first annual premium
                    5% of subsequent premiums
Reserves: Value as a normal endowment assurance for a 3-year term on a net premium basis using a valuation rate of interest of 4% per annum. Ignore the effect on reserving of the extra death benefit defined above.
Interest earnings: 7% per annum on cash flow
Discount rate: 10% per annum
Ignore tax and any other items.

[12]

Q. 12) Explain how an insurance company uses risk classification to control the profitability of its life insurance business.

[5]

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