

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

01st November 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 sheet/s.*
- 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 sheet/s 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 sheet/s and this question paper to the supervisor separately.

- Q. 1)** An annual premium with profit 20-year endowment assurance policy, issued to a life aged exactly 40 has a basic sum assured of Rs.100,000 payable at the end of the year of death or at maturity. Premiums are calculated assuming AM92 Select mortality, 4% *pa* interest, initial expenses of Rs.500 and claim related expenses of 3% of the base sum assured (payable on death or maturity).

Calculate the premium if the policy is assumed to provide simple bonuses of 2% of the sum assured vesting at the end of each policy year (*ie* the basic benefit amount will be increased by Rs.2000 at the end of each policy year for future claims)

[7]

- Q. 2)** A special ten-year increasing endowment assurance policy provides a sum assured of Rs.20,000 during the first year, which increases by Rs.1,000 in each subsequent year. The sum payable on maturity at age 55 is Rs.35,000. Write down an expression for the prospective net reserve immediately before the 5th premium is paid.

[5]

- Q. 3)** A two-year term assurance policy is issued to a life aged x . The benefit amount is Rs.100,000 if the life dies in the first year, and Rs.200,000 if the life dies in the second year. Benefits are payable at the end of the year of death.

(i) Write down an expression for the present value random variable for this benefit.

(2)

(ii) Calculate the standard deviation of the present value random variable assuming that $q_x = 0.025$, $q_{x+1} = 0.030$ and $i = 0.06$.

(5)

[7]

- Q. 4)**

i) Discuss the uses and shortcomings of the crude death rate, the standardized mortality rate and the standardized mortality ratio for comparing the mortality at different times of the population of a given country

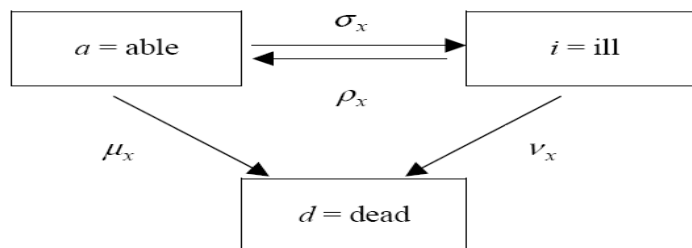
(5)

ii) Explain how a change in the stringency of underwriting may give rise to spurious selection.

(3)

[7]

- Q. 5)** Consider the following three-state illness-death model:



Let ${}_tP_x^{jk}$ denote the probability that a life in state j at age x will be in state k at age $x+t$, and let ${}_t\overline{P}_x^{jj}$ denote the probability that a life in state j at age x will remain in state j for at least t years. Given a constant force of interest of δ pa, write down integral expression for the expected present value of a benefit of Rs.50,000 payable immediately on the death of a life aged 50, currently in the able state, provided that death occurs within the next 10 years and the life has been sick for at least a year at the time of death. [5]

- Q. 6)** A pension scheme provides a pension of 1/60th of final pensionable salary for each year of service (with part years counting proportionately) payable on normal retirement at age 65 or on voluntary early retirement before age 65. Final pensionable salary is defined to be the average pensionable salary during the 36 months immediately prior to retirement. Pensionable salary is defined to be the annual rate of salary less a fixed deduction of Rs.2,000.

Members' contributions of 5% of pensionable salary are deducted from members' monthly pay. Pay levels are reviewed on 1 January each year.

A group of 5 men all aged 35 nearest birthday joined the scheme (as part of a transfer from another company) on 1 May 2003. The total salary these members would have received during the year ending on 30 April 2003, if they had been working for the company during that period, would have been Rs.75,000.

The trustees have asked the employer to meet the cost of future service benefits for these members by making monthly contributions proportional to the amounts contributed by the members throughout the remainder of their service with the company.

- i) Calculate the required employer's contribution rate for these members as a proportion of salary, assuming that the service table, salary scale, interest rate and other actuarial assumptions used in the Tables are appropriate in this case. (8)
- ii) Outline how you would modify your calculations if
 - (a) the Rs.75,000 referred to the members' starting salaries on 1 May 2003 (with subsequent pay reviews on 1 January each year)
 - (b) the period of service counting in the benefit formula was limited to a maximum of 20 years.
 (You are not required to give a full set of formulae.) (4)

[12]

- Q. 7)** You are given:

$$\begin{aligned} \mu(x) &= 0.05 & 50 \leq x \leq 60 \\ &= 0.04 & 60 \leq x < 70 \end{aligned}$$

Calculate $4 | 14q_{50}$

[5]

- Q. 8)** A whole life insurance of Rs.1000 is purchased on a life aged 80. The death benefits are payable at the end of the year of death. Mortality follows a select table with a one-year select period and the following values are provided

$$q[80] = 0.5 \cdot q_{80} \\ A_{80} = 0.67980 \text{ and } A_{81} = 0.68952$$

Calculate the value of $1000 \cdot A[80]$ for an interest rate of $i = 0.06$ [6]

- Q. 9)** Prove that the present value of an annuity of 1 per annum payable yearly in arrears so long as (x) and (y) both survive and for n years after the death of (y) if (x) is

still alive can be expressed as $a_{x:\overline{n}|} + v^n \cdot p_x \cdot a_{x+n:y}$ [7]

- Q. 10)** For a double – decrement table in which

$$(a\mu)_x^1 = 1/(1000 - x)$$

$$(a\mu)_x^2 = 1 \quad \text{and}$$

$$(al)_0 = 1000$$

Prove that

$$(al)_x = (1000 - x)e^{-x} \quad \text{and}$$

$$(ad)_x^1 = e^{-x} - e^{-x-1} \quad [7]$$

- Q. 11)** Prove Thiele's differential equation for a whole-life assurance issued to a life aged x to be as follows:

$$\frac{\partial}{\partial t} \overline{v}_x = -(1 - \overline{v}_x) \mu_{x+t} + \delta_t \overline{v}_x + \overline{P}_x \quad [6]$$

- Q. 12)** An individual aged 25 takes a pension policy with a term of 30 years. The policy requires payment of annual premiums in advance for two thirds of the policy term. On death, 10 times the annual premium is paid. On survival to the end of the term, a pension of Rs.12000 per quarter is paid in advance until the death of the policy holder. After vesting of pension no death benefit is paid.

Assumptions :

Mortality before age 55: AM92 ;

Mortality after age 55 : PMA92C20

Interest : 4% p.a Ignore expenses;

Calculate the annual premium under the policy [5]

- Q. 13)** A 4- year unit –linked endowment policy is bought by a male aged 50 with the following details:

Premiums: Rs.10,000 payable annually
 Investment in Units: 75% of 1st premium and 105% of each subsequent premium
 Bid – offer spread: 5%
 Unit growth rate: 5% p.a.
 Fund Management Charge: 0.75% of value of policyholders' fund is deducted at the end of each policy year
 Death Benefit: Rs. 30,000 or bid value of units, if greater
 Maturity value: Bid value of units
 Expenses: Rs.300 at the start of the 1st year
 Rs.75 at the start of the 2nd year
 Rs.25 at the start of 3rd and 4th years.
 Mortality: 0.015 at each age
 Withdrawals: ignored

Calculate the profit emerging each year for the above contract assuming that the office sets up non-unit reserves to ensure that the profit emerging in the 2nd and subsequent policy years is non-negative. Non- unit reserves are assumed to earn interest at 5% pa.

[16]

- Q. 14)** Explain each of the formulae given below by general reasoning:

$$\bar{A}_x = \bar{A}_{x:\overline{n}|}^1 + n|\bar{A}_x$$

$$\bar{A}_{x:\overline{n}|} = \bar{A}_{x:\overline{n}|}^1 + A_{x:\overline{n}|}^1$$

$$n|\bar{A}_x = v^n {}_n p_x \bar{A}_{x+n}$$

[5]
