

Actuarial Society of India

EXAMINATIONS

16th June 2005

Subject CT5 – General Insurance, Life and Health Contingencies

Time allowed: Three Hours (10.30 – 13.30 pm)

INSTRUCTIONS TO THE CANDIDATES

- 1. Do not write your name anywhere on the answer scripts. You have only to write your Candidate's Number on each answer script.*
- 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."

AT THE END OF THE EXAMINATION

Hand in both your answer scripts and this question paper to the supervisor.

Q.1) Explain what is meant by ${}_2 n q_{[x][y]}$ [2]

Q.2) Let K be a random variable representing the curtate future lifetime of a life aged 40, and let $g(k)$ be the function defined by:

$$g(k) = \begin{cases} 0 & \text{if } 0 \leq k < 10 \\ v^{10} \ddot{a}_{k-9} & \text{if } 10 \leq k < 35 \\ v^{10} \ddot{a}_{25} & \text{if } 35 \leq k \end{cases}$$

Calculate the value of $E[g(k)]$, assuming mortality follows AM92 ultimate and interest is 4% p.a. [4]

Q.3) A select mortality table with a select period of 5 years is to be prepared treating ELT 15 (Males) as the ultimate table.

$$\begin{aligned} \text{If } q_{[x]} &= 0.5 q_x \\ q_{[x]+1} &= 0.55 q_{x+1} \\ q_{[x]+2} &= 0.7 q_{x+2} \\ q_{[x]+3} &= 0.8 q_{x+3} \\ q_{[x]+4} &= 0.9 q_{x+4} \end{aligned} \quad \text{and}$$

Find the value of $l_{[40]}$. [4]

Q.4) The staff of a company is subject to two modes of decrement, death and withdrawal from employment. Decrements due to death take place uniformly over the year of age in the associated single-decrement table. 50% of the decrements due to withdrawal occur uniformly over the year of age and the balance occurs at the end of the year of age, in the associated single-decrement table. You are given that the independent rate of mortality is 0.002 per year of age and the independent rate of withdrawal is 0.2 per year of age. Calculate the probability that a new employee aged exactly 30 will die as an employee at age 31 last birthday. [5]

Q.5) A life insurance company issues an annuity policy to 2 lives aged 67 and 63 exact in return for a single premium. Under the policy an annuity of Rs.20,000 per annum is payable monthly in advance while at least one of the lives is alive.

Calculate the single premium. [5]

$$\begin{aligned} \text{Basis: Mortality:} & \quad \text{PMA92C20 in respect of the life aged 67 exact} \\ & \quad \text{PFA92C20 in respect of the life aged 63 exact} \\ \text{Interest:} & \quad 4\% \text{ p.a.} \\ \text{Expenses:} & \quad \text{None} \end{aligned}$$

- Q.6)** A life insurance company sold a number of 4-year single premium policies with a guaranteed amount payable at maturity. The closest matching investment available was a 5-year zero-coupon bond. Interest rates at the time of the insurance company selling the policies and investing the money in the bonds were 5.25% effective per annum. The office invested all the premiums received in these assets. The insurance company guaranteed a return of 5.0% per annum at maturity. On death, the return was not guaranteed but the company promised to pay out the full market value of the related asset immediately at the date of death.

If the distribution of $1 + i$ is lognormal with parameters $\mu = 0.05$ and $\sigma = 0.01$, and mortality follows English Life Table No. 15. Males, calculate the probability that the office makes a loss on a policy sold to someone aged exactly 50. You should assume that the company sells the matching asset at the time of any claim.

[6]

- Q.7)** (i) A pension fund offers the following benefits to its members:

- a) Upon age retirement between ages 60 and 65 a member will receive a pension equal to one sixtieth of final salary for each year of service.
- b) Upon death while being a member of the scheme the members contribution will be returned accumulated with interest of 3% per annum.

No other benefits are payable. The pension fund is due to be valued on 1 July. Salary is increased each year on 1 July. Final salary is defined as the average annual salary earned over the three years preceding retirement. Members' contributions are made at the rate of 5% of salary per annum.

At the valuation date one member is aged 40 exact, earned Rs. 32000 over the preceding 12 months, has accumulated contributions at 2% of Rs5000 (that is the current death benefit) and past pensionable service of 18years.

Using commutation functions calculate the expected present value of his pension benefits on the following basis:

Interest :- 4%

Mortality; withdrawals; retirements; salary scale: as in the Pension Fund tables in Formula and Tables for Actuarial Examinations.

[7]

- Q.8)** A life insurance company issues a 30-year without-profits endowment assurance contract to a life aged 30 exact under which annual premiums are payable for a maximum period of 15 years. The sum assured under the contract is as follows:

During the first 10 years:	Rs.1000
During the next 10 years:	Rs.2000
During the last 10 years:	Rs.3000
At maturity:	Rs.3000

In addition, at maturity, the premiums without interest are to be returned together with the sum assured. During the first 5 years the life is subject to the mortality of AM92 ultimate life 5 years younger. After this, he is subject to AM92 ultimate mortality. Rate of interest assumed is 4 % p.a. Ignoring expenses calculate the annual premium.

[10]

Q.9)

(i) Express in the form of symbols, and also explain in words, the expressions “death strain at risk”, “expected death strain” and “actual death strain”.

[3]

(ii) On 1 January 1996 an office issued a number of annual premium policies to a group of lives, each of whom was then aged exactly 45. All policies were for a term of 20 years and were of the following types:

- Endowment Assurances under which the sum assured was payable on survival to the end of the term or at the end of the year of earlier death
- Temporary Assurances under which the sum assured was payable only at the end of year of death within the policy term
- Pure endowments under which the only benefit payable is the sum assured on survival to the end of the policy term

Assuming that there are no sources of decrement other than death, calculate the profit/ loss from mortality for the calendar year 2005, in respect of the policies issued to this group of lives, given the following information:

Type of policy	Sum Assured in force at 1st January, 2005	Sum assured discontinued
Endowment Assurance	Rs.500,000	Rs.8,000
Temporary Assurance	Rs.300,000	Rs.4,000
Pure Endowment	Rs.50,000	Rs.1,000

Provisioning basis: AM92 ultimate mortality
4% p.a. interest

Ignore Expenses.

[12]

Total [15]

Q.10) A life insurance company sells with-profits whole life policies with the sum assured payable immediately on the death of the life assured and with premiums payable annually in advance ceasing with the policyholder’s death or on reaching age 65, if earlier.

The company markets 2 versions of this policy, one with simple reversionary bonuses and the other with compound reversionary bonuses. In both cases the bonuses are added at the end of the policy year.

The company prices the products using the following basis:

Mortality:	AM2 select	
Interest:	4% per annum	
Expenses:	Initial:	Rs.250
	Renewal:	2% of second and subsequent premiums
	Claim:	Rs.150 at termination of contract
Bonuses:	simple:	6% of basic sum assured per annum
	Compound:	4% of accumulated sum assured and bonus per annum

- (i) Write down an expression for the gross future loss at the point of sale for each of these policies, assuming they are sold to a life aged x exact ($x < 65$) at outset. Write the expression in terms of functions of the random variables T_x and K_x , which represent the exact future lifetime and the curtate future lifetime of (x) respectively. [4]
 - (ii) Calculate the gross premium required for each of the two policies for a sum assured of Rs.200,000 and a life aged 40 exact at outset, using the equivalence principle. [6]
 - (iii) After 10 years, bonuses totaling Rs.90,000 have been declared for the compound reversionary bonus contract. Calculate the net premium provision for that policy at that time, using AM92 ultimate mortality and interest of 4% per annum. [5]
- Total [15]**

Q.11) A life insurance company issues a 3-year unit-linked endowment assurance contract to a male life aged exactly 62 under which level annual premiums of Rs 4,000 are payable in advance throughout the term of the policy or until earlier death. 101% of each year’s premium is invested in units at the offer price.

The premium in the first year is used to buy capital units, with subsequent years’ premiums being used to buy accumulation units. There is a bid-offer spread in unit values, with the bid price being 95% of the offer price. The annual management charges are 5.25% on capital units and 1.25% on accumulation units. Management charges are deducted at the end of each year, before death, surrender or maturity benefits are paid.

On the death of the policyholder during the term of the policy, there is a benefit payable at the end of the year of death of Rs 10,000 or the bid value of the units allocated to the policy, if greater. On maturity, the full bid value of the units is payable.

A policyholder may surrender the policy only at the end of each year. On surrender, the bid value of the accumulation units plus a proportion of the capital units is payable. The proportion of the capital units payable on surrender is determined by the year of surrender, as follows:

Year of surrender	Proportion of capital units paid out
1	0.85
2	0.90
3	1

The life insurance company uses the following assumptions in carrying out profit tests of this contract:

Mortality: AM 92 Ultimate at all ages

Expenses:

Initial: Rs 500

Renewal: Rs 100 at the start of each of the second and third policy years

Unit fund growth rate: 9% per annum

Sterling fund interest rate: 4.5% per annum

Risk discount rate: 15% per annum

Surrender rates: 15% of all policies still in force at the end of each of the first and second years

- i) The company holds unit reserves equal to the full bid value of the accumulation units and full bid value of the capital units. The company holds no sterling reserves. Calculate the profit margin on the contract.

[20]

- ii) Assume instead that the company holds unit reserves equal to the full bid value of both the accumulation and capital units and that the company also holds sterling reserves, at the start of each policy year, equal to 10% of the annual premium. Calculate the revised profit margin on the contract.

[5]

- iii) What would be the effect on the answers in Part i) and part ii) if the mortality assumption was changed to mortality of AM92 select

[2]

Total [27]
