

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

29th May 2012

**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. *Please read the instructions on the front 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. *In addition to this paper you will be provided with graph paper, if required.*
5. *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

- a) $a_{[50]}^{(2)}$
- b) ${}_{10|10}q_{[60]+1}$
- c) ${}_5|a_{60}$

Basis

Mortality AM92

Interest rate 4% pa

[3]

Q. 2) For students entering a college, you are given the following from a multiple decrement model:

- 1000 students enter the college at $t = 0$.
- Students leave the college either because of failure (1) or all other reasons (2).
- $\mu_{x+t}^{(1)} = \mu \quad 0 \leq t \leq 4 \text{ years}$
- $\mu_{x+t}^{(2)} = 0.04 \quad 0 \leq t \leq 4 \text{ years}$
- 48 students are expected to leave the college during their first year due to all causes.

Calculate the expected number of students who will leave because of failure during their fourth year.

[5]

Q. 3) A fully continuous insurance policy is issued to (x) and (y). A death benefit of Rs. 10,000 is payable upon the second death. The premium is payable continuously until the last death. The annual premium is K while (x) is alive and reduces to 0.5K upon the death of (x) if (x) dies before (y). You are given:

$$(i) \delta = 0.05 \quad (ii) \bar{a}_x = 12 \quad (iii) \bar{a}_y = 15 \quad (iv) \bar{a}_{xy} = 10$$

Calculate K.

[4]

Q. 4) Explain the following terms with one suitable example of each.

- i) Class Selection (2)
- ii) Adverse Selection (3)

[5]

- Q. 5)** a) Rajesh, aged 30 years exact, opens a Provident Fund account and makes contribution of Rs 100,000 in the beginning of the every year. What will be expected accumulated value in his account when he is 60 years old exactly?

Basis:

Mortality: AM 92 Ultimate

Interest rate: 6% pa

Expenses: Nil

(3)

- b) At the age of 60 years exact, he purchases an annuity for a purchase price of Rs 5,000,000. The annuity is payable monthly in advance and is certain to be paid for first 5 years and guaranteed for life thereafter. Calculate the monthly annuity amount using the same basis as above.

(4)

[7]

- Q. 6)** A member of a pension scheme is aged exactly 40 years, having joined the scheme at age exactly 22 years. He earned Rs. 30,000 in the immediately preceding 12 months. Final pensionable salary is defined as the annual average earnings over the three years immediately prior to retirement. Normal Retirement Age is a member's 65th birthday.

Using the functions and symbols defined in, and assumptions underlying, the Example Pension Scheme Table in the Actuarial Tables, calculate the expected present value of each of the following:

- a) A pension on ill-health retirement of two-thirds of final pensionable salary.
- b) A pension on retirement at any stage on grounds other than ill-health of one-eightieth of final pensionable salary for each year of service (fractions of a year counting proportionately), subject to a maximum of 40 years.

(2)

(3)

[5]

- Q. 7)** A life insurance company uses the following three-state transition probability matrix for valuing its 3-year single premium illness-death contract for some parameter α :

$$P = \begin{matrix} & \begin{matrix} H & S & D \end{matrix} \\ \begin{matrix} H \\ S \\ D \end{matrix} & \begin{pmatrix} 1 - \alpha - \alpha^2 & \alpha & \alpha^2 \\ \alpha & 1 - 2\alpha & \alpha \\ 0 & 0 & 1 \end{pmatrix} \end{matrix}$$

Where, H represents Healthy, S represents Sick and D represents Dead.

- a) Draw the transition model based on the above probability matrix.
- b) Determine the range of values of α for which the matrix P is a valid transition probability matrix.

(2)

(2)

- c) Given that $\alpha = 0.2$, calculate the probability that a policyholder would be in state Sick (S) at the end of 2 years, given his current state is Healthy (H). (1)

If at the time of death the policyholder is Healthy, the company will pay Rs. 100,000 at the end of the year of death whereas if at the time of death the policyholder is Sick, the company will pay Rs. 50,000 at the end of the year of death. If the policyholder falls Sick (S), the company will pay Rs. 75,000 at the end of the year of falling sick.

- d) Calculate the reserve in respect of the benefits at the end of Year 2, given that the policyholder is in Healthy state at the end of Year 2. Assume an interest rate of 6% per annum for determining the benefit reserve and $\alpha = 0.2$. (2)

[7]

- Q. 8)** a) Explain the following terms:

i. Death Strain at Risk

ii. Expected Death Strain

iii. Actual Death Strain (6)

- b) A company issues whole life policies to a group of 700 lives aged 30 exact. The sum-assured for each policy is Rs 200,000. The death-benefit is payable at the end of year in which death happens. Level premiums are payable annually in advance throughout life of the life assured.

Basis:

Mortality: AM 92 Ultimate

Interest rate: 4% pa

Expenses Nil

- i. Calculate the net premium reserve per policy at the end of 10th year of the policy (4)

- ii. Calculate the profit or loss arising in 10th policy year given that the number of deaths during the year is 1 and the number of deaths before the 10th policy year is 11. (4)

[14]

- Q. 9)** A life company issues a 25 year with-profits endowment policy to a life aged 35 exact. The sum-assured of Rs 100,000 and declared reversionary bonuses are payable at maturity or at the end of year on death, if earlier. However, bonus does not vest in policy year of death. The company expects to pay compounding bonus of 1.92308% pa vesting at the end of every policy year. Level premiums are payable annually in advance under the policy.

- a) Calculate the annual premium using the following basis:
- Mortality AM92 Ultimate
 - Interest rate = 6% p.a.
 - Initial expenses = Rs 800 + 9% of the gross annual premium
 - Renewal expenses = 5% of the second and subsequent gross annual premiums
 - Claims expenses = Rs 400 on death; Rs 200 on maturity (6)
- b) Determine the gross prospective value at the end of 10th year assuming the same basis as above and given that the total reversionary bonus declared up to that time is Rs 30,000. (5)

[11]

Q. 10) A life insurance company has just priced a regular premium without-profit endowment product with policy term equal to 5 years, for policyholders all aged exactly 35 years. A premium of Rs. 25,000 is payable annually in advance under the product for 5 years or until earlier death. The product provides the following benefits:

- 1) On death during the policy term of 5 years, a Sum Assured (SA) of Rs. 100,000 will be payable
- 2) On survival till the end of policy term of 5 years, a Sum Assured (SA) of Rs. 100,000 will be payable

The death benefit is payable at the end of the year of death and the survival benefit is payable on the next day of the maturity date.

The Company now wants to determine the Surrender Value scale. The Surrender Value under the product will be determined prospectively i.e. the Surrender Value will be equal to the present value of all future expenses and future benefits less the present value of future premiums.

The Surrender Value scale will be equal to the ratio of the Surrender Value and the Paid-up Value

Where,

Paid-up Value at time t = (number of premiums paid till time t / total number of premiums payable under the product) * Sum Assured

As per the regulations, the first time Surrender Value becomes payable is at the end of the third policy year i.e. there is no Surrender Value before the end of the third policy year.

- a) Using the product details and the following assumptions, determine the Surrender Value scale at the end of each policy year for the product.

- Expense : Rs. 200 for all years, assuming to be incurred at start of year
- Discount rate of interest : 8.5% per annum
- Mortality Rates

Age (years)	35	36	37	38	39
Mortality Rate	0.0010	0.0012	0.0014	0.0016	0.0018

- There are no other decrements for the purpose of determining the Surrender Value. (8)

Use annual projections only.

- b) Without doing any further calculations, explain the impact on Surrender Value if:

- i. The discount rate is taken as 7% per annum for the first two years and 8.5% per annum for the remaining three years.
- ii. The expense assumption is increased to Rs. 300 and the discount rate is increased to 9% per annum.

(2)
[10]

Q. 11)

A person aged 40 is taking a cover of Rs 100,000 for a term of 5 years. The cover will reduce by Rs 5,000 every year. The death benefit is payable at the end of the year in which death occurs.

Basis:

Mortality: AM 92 Select

Interest rate: 4% pa

Expenses: Nil

- a) Calculate the single premium (4)
- b) Check your calculation using probabilities and discount factors directly. (5)
- c) Calculate the initial annual premium where the annual premium is reducing by Rs 10 every year. (4)

[13]

- Q. 12)** A life insurance company has been selling regular premium unit-linked contracts for the past few years. Only the unit fund is paid at the time of death or maturity. The only charges are allocation charge of 3% across all years levied at the time of premium payment and fund management charge (FMC) of 1.0% per annum levied at the end of each year.

The outstanding term under one of the contracts is exactly 3 years as on 31st December 2011. The unit fund for the contract as on 31st December 2011 is Rs. 100,000. The other details of the contract are as follows:

Regular Premium : Rs. 25,000 payable annually in advance

Calendar Year	2012	2013	2014
Mortality Rate for next 3 years	0.0015	0.0020	0.0025

The unit fund of the contract has 70% of equity proportion and 30% of debt proportion as on 31st December 2011. As per market expectations, the equity return expected is 10% per annum and the debt return expected is 6% per annum for the remaining 3 years.

The Company wants to perform a stress test to check the impact on the future profits of the contract. The stress test is a 20% fall in equity value i.e. equity value of the unit fund immediately falls by 20% as on 31st December 2011. Under this stress test, the market expectation of equity return changes to 8% per annum. There is no change in the market expectation of debt return.

- a) Determine the weighted unit growth rate which can be used for the contract, both before and after the stress.

The only expenses are Rs. 100 per annum for the remaining 3 years and a flat commission rate of 2%, both incurred at the start of each year.

(4)

- b) Determine the net present value of the contract, before and after the stress test. Assume an interest rate of 6.0% per annum and Risk Discount Rate of 12.5% per annum.

(9)

Show your calculations clearly.

- c) Without doing any further calculations, explain the impact on the net present value if instead of 70% equity and 30% debt proportion, the revised proportion is 60% equity, 30% debt and 10% money market. The return from money market is 4% per annum. Equity and debt returns remain the same. Assume no stress.

(1)

You are working on a new unit-linked product. The Company's risk officer proposes that the product's profitability should be insensitive to movements in equity market.

- d) Assuming you are considering the risk officer's proposal, discuss what type of charging structure or investments you may have under the product. You don't have to determine the charges.

(2)

[16]
