

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

21st March 2018

**Subject CT5 – General Insurance, Life and
Health Contingencies**

Time allowed: Three Hours (15.00 – 18.00 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. You are not allowed to carry the question paper in any form with you.

- Q. 1)**
- i) State the underlying assumption for the uniform distribution of deaths (UDD) and constant force of mortality (CFM) methods. (2)
 - ii) Calculate ${}_4p_{65.5}$ based on the PFA92C20 table using:
 - a) UDD assumption (2)
 - b) CFM assumption (2)
- Q. 2)**
- i) Define different categories of direct expenses and give one example of each category (3)
 - ii) List types of costs that are affected by inflation and comment on the allowance of inflation in the calculation of premiums. (4)
- Q. 3)** A ten-year term assurance policy is sold to a standard life aged 40 exact. The policy has a sum assured of Rs. 500,000 payable immediately on death.
- i) Calculate the expected present value of the benefits payable assuming that standard mortality is AM92 Ultimate and interest is 6% *pa*. (4)
 - ii) When an impaired life is applying for the same term assurance cover, both the sum assured and policy term are reduced by the ratio of the increase in the mortality rate. The company also undertakes additional investigations on a death claim and therefore the benefit is usually paid at the end of the year of the death. Calculate the expected present value of the benefits payable assuming an impaired life aged 40 exact experiences 5 times the force of mortality of a standard life. (3)
- Q. 4)**
- i) Explain the expression ‘death strain at risk’ for a term policy assuming the sum assured is payable at the end of the year of death. State any assumptions made. (2)
 - ii) A life insurance company issues the following policies:
 - 30-year term assurances with a death cover of Rs. 1,000,000
 - 20-year endowment assurances with a sum assured of Rs. 500,000

The death benefit under each type of policy is payable at the end of year of death.

On 1st January 2000, the company sold 10,000 term assurance policies to male lives then aged 30 exact and 20,000 endowment assurance policies to male lives then aged 40 exact.

The term assurance is payable by a single premium policy whereas the endowment assurance is a limited premium payment policy payable for 10 years annually in advance.

During the first ten years, there were 150 deaths reported from the term assurance policies sold. The company has generally observed actual deaths as 1.5 times the reported deaths for term assurance business due to delay in reporting.

During the first five years, there were 230 actual deaths from the endowment assurance policies sold.

- a) Calculate the death strain at risk (DSAR) for the term assurance during 2010 and endowment assurance during 2005. (9)

During 2010, there were 3 actual deaths from the term assurance policies and during 2005, there were 35 actual deaths from the endowment assurance policies.

Assume that there were no lapses/withdrawals on each type of policy during the first eleven years.

- b) Calculate the mortality profit or loss to the office from each policy type. (3)
- c) Comment on the results obtained in (b) above. (1)

Basis:
Mortality AM92 Ultimate
Rate of interest 4% per annum
Expenses Nil

[15]

- Q. 5)** A life insurance company plans to review the premium rates for with-profit whole life policies.

The company pays compound reversionary bonuses (4% of accumulated sum assured) on the currently sold whole life policies. Bonuses are added at the end of the policy year.

The sum assured is payable immediately on the death of the life assured and premiums are payable annually in advance ceasing with the policyholder's death or on reaching age 65 if earlier.

The current product was priced using the following basis:

Mortality AM92 Select
Interest 4% per annum
Initial expenses 1200 and Renewal expense 2% of second and subsequent premiums
Claim expense 500 at termination of contract

- i) Calculate the gross premium for a sum assured of Rs. 200,000 and a life aged 40 exact at outset, using the equivalence principle. (4)
- ii) The company plans to change the method of bonus declaration to simple reversionary for the new with-profit product being proposed. However, it still wants to charge the same premium from the policyholders. Calculate the revised bonus rates as a % of sum assured. (4)
- iii) After 10 years, bonuses totaling Rs. 100,000 have been declared for the compound reversionary bonus contract. Calculate the net premium reserve for that policy at that time, using AM92 ultimate mortality and interest of 4% per annum. (4)

[12]

- Q. 6)** A life insurance company issues a single premium insurance policy for a term of 20 years to lives aged 45 years exact, with the following benefits:

- A benefit of Rs 100,000 payable at end of year of death during the term of the policy.
- A benefit of Rs 100,000 payable at end of year on diagnosis of cancer during the term of the policy.

- If the life insured survives the period of 20 years and has also not been diagnosed with cancer during the term, then the premium paid is returned to the policyholder at the end of 20th year.
- No death benefit is payable in the event an earlier benefit has been paid on diagnosis of cancer.

Calculate the single premium payable assuming the following:

- Interest rate - 5% per annum
- Force of decrement due to death - 0.006 at all ages
- Force of decrement due to diagnosis – 0.002 at all ages
- Force of decrement due to death after diagnosis of cancer – 0.010 at all ages
- Initial commission of 2% paid at the start of the policy
- Initial expense of 2% of premium at start of policy
- Profit Margin of 10% of premium.

[8]

- Q. 7)** A life insurance company intends to launch 10-year unit-linked endowment contracts to lives aged 35 years exact under which level premiums of Rs. 50,000 p.a. is payable in advance for the first 3 years of the policy.

The premium allocation charge is 10% in the first year and 5% in the 2nd and 3rd year.

A policy administration charge of Rs. 600 per annum is deducted at the end of the policy year. Also, a fund management charge of 1% of the fund value is deducted at the end of the policy year. Both the policy administration charge and fund management charge are applicable only during the first three years of the policy.

If the policyholder dies during the term of the policy, the death benefit of Rs. 150,000 or the value of the units after the deduction of policy administration and the fund management charge, whichever is higher, is payable at the end of the year of death. At the end of the third policy year 5% of the value of units would be credited to the fund.

On surrender or on survival to the end of the term, the value of the units is payable at the end of the year of exit. The surrender charge is 10% of the fund value in the first policy year and nil thereafter.

The company is profit testing the above structure under the following assumptions

Decrements

Surrenders: 20% in the first policy year and 10% thereafter

Death: 90% of AM 92 Ultimate

Economic Assumptions

Interest rate: 6% p.a.

Expenses

Initial Expenses: 10% of premium

Initial Commission: 15% of first premium

Renewal Commission: 2% of renewal premium paid in years two and three

Risk discount rate: 8% p.a.

The company holds only unit reserves and no non-unit reserves.

- i) Calculate the profit margin (expected profit as a % of one premium) on the assumption that decrements are uniformly distributed over the year.

(9)

- ii) Explain the implications of the reserving method adopted by the company and suggest alternative reserving basis, if any. (2)
- iii) The company's internal target for profit margin is 15%. Without doing detailed calculations, suggest 3 changes to the product structure to achieve the target. (3)

[14]

Q. 8) An insurance company sells a 5-year endowment assurance contract wherein premiums are payable annually in advance. Bonuses are declared every year based on the surplus arising. On death during the 5-year period the sum assured with all accrued bonuses will be paid at the end of the year of death. On maturity at the end of 5th year the sum assured with all accrued bonuses will be paid. On surrender premiums paid are refunded with simple interest at 4% per annum.

A policyholder aged 45 years exact has taken a policy 3 years ago for a premium of Rs. 10,000 per year and Sum assured of Rs. 45,000.

He has expressed inability to pay future premiums under the policy (the 3 premiums due to date have been paid). Simple bonus at rate of 5% every year have been declared so far. The policyholder has asked for the policy to be converted to a lower Sum assured with no further bonus accrual in future.

The company calculates the reserve on an emerging cash-flow basis with no allowance for surrenders. Future bonuses are the same as those declared in the immediately preceding year.

Reserving basis

Interest rate: 4% per annum

Surrenders: Nil

Mortality: 0.2% per annum for ages 41 to 45 and 0.3% per annum for ages 46 to 50

Renewal Expenses: Rs. 100 per policy incurred at the start of the year

Renewal Commission: 5% of renewal premium paid

The Company calculates the revised sum assured such that there is no change in the reserve held at the valuation date.

Calculate the revised sum assured under the policy.

[5]

Q. 9) A pension fund pays a pension for life based on pensionable salary (PS) which is defined as $1/60^{\text{th}}$ of average of salary over the three years immediately preceding retirement. The death benefit is four times the pensionable salary. The pension is $m \cdot \text{PS}$ where 'm' is defined as the total number of years in service

For a member aged x at the valuation date and who was paid salary S in the year preceding the valuation date and who has m years of past service, assuming the member retires within one year from valuation date

- i) Derive the pensionable salary and hence the pension. (3)
- ii) Derive formulae for past service liability and future service liability. (3)

Extend this to retirements up to the normal retirement age of 65 and

- iii) Derive the formula for past service liability (2)
- Define all the terms used and state any assumptions made.

[8]

- Q. 10) i)** Explain what is meant by selection. Describe the following forms of selection and give examples of each as relevant to pension funds
- Class selection
 - Temporary initial selection
 - Time selection

(4)

- ii)** What is the need for summary measures of mortality? Explain each of the measures below with their relative merits and de-merits.

- Crude mortality rate
- Directly standardized mortality rate
- Indirectly standardized mortality rate

(5)

- iii)** The data on births from a particular state in India and the whole country is given below.

Age group	State		Country	
	Population	Number of births	Population	Number of births
<20	20,000	20	1,50,000	120
20-25	1,25,000	150	12,50,000	1650
25-30	1,50,000	200	12,00,000	2000
30-35	1,35,000	75	14,85,000	700
35+	1,00,000	50	9,00,000	350

Using the population of the country as the standard population calculate crude birth rates, the standardized birth rates and the standardized birth ratio for the state.

(3)

- iv)** The State Government has compared the crude birth rates of the state with that of the whole country and has observed that the state has a lower birth rate than that of the country. It has attributed the lower birth rates to an awareness program conducted by the Government on birth control measures 10 years ago to women in the age group 20-30 years. Comment on the Government's conclusion.

(2)

[14]

- Q. 11)** A pension fund scheme has the following benefits

- Death benefit of Rs. 10 lacs on death during employment
- Normal retirement if completed 20 years of service and aged 50 or more
- Ill-health retirement if completed 10 years of service and aged 45 or more
- Return of contributions on withdrawal other than death or retirement, provided the member has at least one year of service

The data extract for ages 50-52 from the last two years is given below.

	Age	Active	Withdraw	Ill-health	Age	Death
CY 2016	50	10000	2000	100	25	5
	51	10000	1500	150	30	5
	52	10000	1200	200	35	5
CY 2017	50	9000	2100	85	25	4
	51	8000	1200	120	25	5
	52	8500	1000	180	30	6

Calculate the following

- i)** Probability of a member aged 50 dying before reaching age 51 (1)
 - ii)** Probability of a member aged 50 retiring before age 53 (1.5)
 - iii)** Probability of a member aged 51 not receiving any benefit on leaving the scheme. (1.5)
- [4]**
