

# INSTITUTE OF ACTUARIES OF INDIA

## EXAMINATIONS

**21<sup>st</sup> May 2009**

**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.*

### **AT THE END OF THE EXAMINATION**

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

- Q 1)** The pricing Actuary of a company had recently priced a non participating 10 year regular premium endowment product which is now open to sales. The economic scenario has changed significantly as a result of which the valuation actuary had to revise the valuation assumptions. The first few policies sold for this product produced negative reserves.
- i.** What do we mean by negative reserves? (2)
  - ii.** Why do most regulators ask the insurance companies to set the reserve to zero in case of negative reserves? (2)
  - iii.** Give one major change in the valuation assumptions which can result in negative reserves. Explain the impact as well. (4)
- [8]**
- Q 2)** Show that the prospective reserve is equal to the retrospective reserve for a non participating endowment policy with a policy term of  $n$  years, Premium of  $P$  and the sum assured of 1. (4)
- Q 3)** Explain the terms “Independent rates of decrement” and “Dependent rates of decrement” and give examples supporting your statements.
- It is given that there are two decrements  $\alpha$  and  $\mu$  operating in a population. If the independent rates of  $\alpha$  and  $\mu$  are 0.05 and 0.02 respectively for a life aged  $X$ , calculate the dependent rates of  $\alpha$  and  $\mu$ . State the assumptions you make in the calculations. (5)
- [5]**
- Q 4)**
- i.** What are the two main objectives a life insurance company must consider before declaring a bonus in participating policies? (2)
  - ii.** What are the three methods of adding bonuses and how do they fulfill the above objectives? (5)
- [7]**
- Q 5)** Explain how “Risk Discount Rate” is chosen in the context of profit testing a life insurance product and explain why this rate is usually higher than the yield on government bonds. (5)
- [5]**
- Q 6)** A unit linked endowment assurance contract has the following features:
- The benefit payable on death is the higher of the sum assured or the unit account value at bid price of units. Assume that the sum assured is two times of annual premium and it is paid at the end of the policy year in which the death occurs.

- The benefit payable on maturity is the unit account value at bid price of units plus the return of premium allocation charges of first two policy years.
- Following charges are payable under this contract:
  - Premium Allocation charge of 20% in first year and 10% in subsequent years
  - Bid offer spread of 5% i.e. bid price is 95% of the offer price
  - Fund management charge of 1.25% per annum which is deducted at the end of the year but before death or maturity benefit is paid.

Following profit test assumptions are given to you.

- Expenses: Rs.2,000 at the start of the first policy year and Rs.200 at the start of subsequent policy years;
- Commission: 5% of premium in first year and 2% in subsequent years
- Mortality Rate: 0.01 for all ages
- Unit Growth Rate: 8% per annum
- Interest rate on non unit fund: 4% per annum
- Non Unit Reserve basis: Mortality Rate: 0.01 for all ages; Interest rate: 4% per annum.
- Risk discount rate: 15% per annum
- The regulations requires that the unit reserve is the bid price of units and non unit reserves should be set up so as to zeroise any negative non-unit fund cashflows, other than those occurring in the first policy year.
- Ignore Tax.

- i. Calculate the unit account value at the end of each of the three years if the level annual premium is Rs.100, 000. (3)
- ii. Calculate the profit margin under this contract. (12)

[15]

Q 7)

i.

- a. Prove the following?

$$A_{x:t} + v^t {}^x p_t A_{x+t:n-t} = A_{x:n}^1 + \frac{D_{x+t}}{D_x} + \frac{D_{x+n}}{D_x} \quad (2)$$

- b. Explain each of the below given formula by general reasoning.

$$\text{i. } \overline{A}_x = \overline{A}_{x:n}^1 + \overline{{}_n A}_x$$

$$\text{ii. } \overline{{}_n A}_x = v^n {}^n p_x \overline{A}_{x+n} \quad (2)$$

- c. Explain why  $a_{x:n} \neq \ddot{a}_{x:n} - 1$  (2)

- ii. An insurance company sells a 5 year endowment assurance plan with a sum assured of Rs 100,000 to all 55 years old males only. The premium collected per policyholder is Rs.18, 000 and is payable annually in advance. The benefits are payable at the end of the year.

- a. Calculate the present value of profit or loss at the start of the contract where,

$$\text{PV of Profit (Loss)} = \text{EPV of Premiums} - \text{EPV of Benefits} - \text{EPV of Increase in reserve} + \text{EPV of interest earned on reserves}$$

$$\text{Reserve} = \text{EPV of Benefits} - \text{EPV of Premiums}$$

Mortality – AM92 Select

Interest – 4% per annum

Assume that the reserving basis is same as profit testing basis.

Ignore Expenses

Set Negative reserves to zero.

Make any other assumptions if necessary.

(6)

- b. Why does the Valuation Actuary generally allow for an element of caution in setting the reserving basis?

(2)

[14]

Q 8)

- i. Derive Thiele's differential equation for  ${}_t\bar{V}$ , the reserve for this policy at time  $t$  ( $0 < t < n$ ) for a pure endowment policy for a term of  $n$  years payable by a single premium issued to lives aged  $x$  at entry.
- ii. Derive a formula for the variance of the present value of a deferred annuity due of 1 per annum payable to a life aged  $x$ . Suppose that the deferment period is  $n$  years.

(8)

(6)

[14]

- Q 9) Explain how Climatic conditions and Geographical location can affect the mortality and morbidity rates. Give examples supporting your statements?

[5]

- Q 10) In the context of the valuation of the pension schemes, explain the following terms:

- Pensionable Salary
- Ill health Retirement
- Accrued Benefit
- Future Service Benefit

[8]

- Q 11) Calculate the expected present value of the pension payable to the spouse of a female member who is retiring now on her 60th birthday. The amount of pension payable to the spouse is Rs.10,000 per annum commencing following the death of the Member in retirement and ceases on earlier of death of the spouse or 15 years after death of the Member in retirement.

Assume that the spouse is older than the member by 5 years exact and the pension is payable on the anniversary of the member's retirement.

Use PMA92C20 and PFA92C20 mortality tables and interest rate of 4% per annum.

[7]

- Q 12)** The populations and claims data of the life insurance industry and the two life insurers A and B for the calendar year 2008 is given below:

Age Group	Industry Data		Life Insurer A		Life Insurer B	
	Population (in thousand)	No of deaths	Population (in thousand)	No of deaths	Population (in thousand)	No of deaths
18 to 30	2,000	800	200	100	100	36
31 to 40	4,500	3,600	400	400	200	88
41 to 50	1,500	4,500	150	750	50	150
51&above	1,000	6,000	100	800	40	200
Total	9,000	14,900	850	2,050	390	474

Calculate the Crude Mortality Rate, the Standardized Mortality Rate and the Standardized Mortality Ratio for Insurer A and Insurer B using the industry experience as standard.

[8]

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