

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

13th May 2015

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

Time allowed: Three Hours (10.30 – 13.30 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. 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)**
- i)** Define gross premium prospective reserve and gross premium retrospective reserve. (2)
 - ii)** State the conditions under which, in general, the prospective reserve is equal to the retrospective reserve, allowing for expenses. (2)
 - iii)** Prove that, under the above conditions, the prospective reserve is equal to the retrospective reserve at time t for an immediate annuity contract with annual annuity amount of B payable in arrears, initial expenses of I at the outset of the contract and renewal expenses of R at the start of every year from the second year onwards. (4)
- [8]**

- Q. 2)** **i)** Prove that:

$$P_x = \frac{dA_x}{1 - A_x} \quad (3)$$

- ii)** Interpret the above formula considering an insured (x) who borrows the single premium for the purchase of a single premium whole life assurance for a unit sum assured. (3)
- [6]**

- Q. 3)** Calculate the annual premium for a 20-year endowment policy issued to a life aged 40 exact, providing a maturity benefit of Rs. 1,000,000 and a death benefit of return of premiums accumulated at 1.923% interest rate per annum at the end of the year of death.

Bases:

Mortality: AM92 Select

Interest: 6% per annum

[6]

- Q. 4)** At the beginning of 2005, a life insurance company issued a number of immediate annuity policies to male lives then aged 50 exact. Each policy provides an annual annuity amount of Rs. 1,000 in advance and a death benefit of the single premium amount payable at the end of year of death.

- i)** Calculate the single premium for each policy using the following premium basis:

Mortality: AM92 Ultimate

Interest: 4% per annum

Commission: 2% of the single premium

Initial expenses: Rs. 100

Renewal expenses: Rs. 10 per annum at the start of the second and subsequent policy years

(2)

- ii)** Calculate the gross premium reserve for each policy in force at the end of the tenth policy year using the same basis as above. (2)
- iii)** Using the recursive relationship between reserves at successive intervals, calculate the gross premium reserve for each policy in force at the end of the ninth policy year. (2)

- iv) At the beginning of 2014, there were 500 policies in force. The actual experience for this portfolio of business during 2014 was as follows:

Number of deaths: 1
Interest earned: 4%

Expense incurred per policy in force at beginning of policy year: Rs. 9

Calculate the profit or loss from this portfolio of business in 2014 separately from mortality, interest and expenses.

(6)
[12]

- Q. 5) A life insurance company is planning to issue an immediate annuity of Rs. 120,000 payable annually in arrears to a life aged 70 exact.

- i) Calculate the single premium such that the expected present value of loss is 0 (2)
- ii) Given the premium calculated in (i) above, calculate the probability that the present value of loss is positive. (3)
- iii) Calculate the least premium such that the probability that the present value of loss is positive does not exceed 5%. (5)

Bases:
Mortality: PMA92C20
Interest: 4% per annum

[10]

- Q. 6) A whole life assurance issued to a life aged 30 exact with death benefit of Rs. 100,000, payable at the end of the year of death, is paid for by annual premiums escalating at 4% p.a. Calculate the prospective reserve per policy in force at the end of 20 years from issuance of the contract.

Bases for both premium and reserving:
Mortality: AM92 Select
Interest: 4% per annum

[8]

- Q. 7) Using the PMA92C20 and PFA92C20 tables and 4% pa interest, calculate $\ddot{a}_{\overline{50:50:20}|}$, assuming that one life is male and the other is female. (6)

- Q. 8) i) What is Standardized Mortality ratio? (1)
- ii) Calculate the standardised mortality ratio for the population of Actuarial using the following data: (3)

Age	Standard Population		Actuarial	
65	2,500,000	22,462	12,700	159
66	2,200,000	23,000	11,000	165
67	2,000,000	23,791	10,876	171

- iii) What does the Standardised Mortality Ratio signify about the mortality trends of Actuarial? (1)
- iv) List the various factors that could be leading to such mortality trends. (3)

[8]

Q. 9) A life insurance company issues a four-year unit-linked policy to a male life aged 30. The non-unit cash flows (NUCF_t, t = 1,2,3,4) obtained at the end of each year t per policy in force at the start of the year t are:

Year t	1	2	3	4
NUCF(t)	-250	-400	-600	1500

Assume that the annual mortality rate for the male life follows AM92 ultimate.

- i) Calculate the net present value of profits using a risk discount rate of 6%. (3)
- ii) The company sets up reserves in order to zeroise future negative cash flows. The rate of interest earned on non-unit reserves is 3% per annum. Calculate the net present value of the profits after zeroisation. (3)
- iii) Comment on the results obtained in (i) and (ii) above. (1)

[7]

Q. 10) A life insurance company issues a 4 - year unit-linked endowment policy to a life aged 61 exact under which level premiums of Rs 30,000 are payable yearly in advance throughout the term of the policy or until earlier death. In the first policy year 40% of the premium is allocated to units, in the second year 90%, in the third year 100% and the fourth year 110% of the premium is allocated to units. The unit prices are subject to a bid-offer spread of 5%.

If the policyholder dies during the term of the policy, the death benefit of Rs 100,000 or the bid value of the units, whichever is higher, is payable at the end of the policy year of death. On maturity, 105% of the bid value of units is payable.

An annual management charge of 1.5% of the bid value of units is deducted at the end of each policy year before death and maturity benefits are paid.

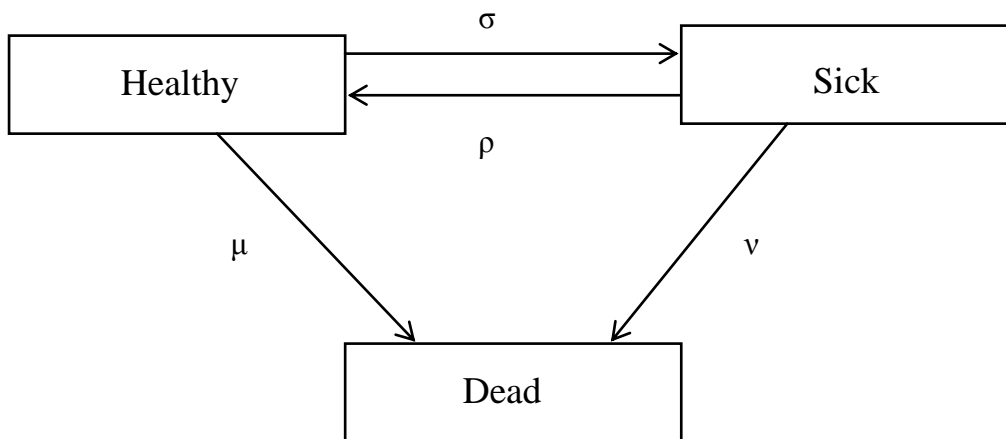
The company uses the following assumptions in carrying out profit tests of this contract:

• Rate of growth on assets in the unit fund	5% per annum
• Rate of interest on non-unit fund cash-flows	3.5% per annum
• Independent rate of mortality	AM92 Select
• Independent rate of surrender	6% per annum
• Initial expenses	Rs 5000
• Renewal expenses (second and subsequent premium dates)	Rs 2000
• Initial commission	20% of first premium
• Renewal commission (of second and subsequent years' premiums)	2%
• Risk discount rate	7% per annum

- i) Calculate the profit margin for this policy, assuming no zeroisation of negative cashflows. (15)
- ii) How would profit margins be impacted if surrender benefits are payable (at the end of the year) and why? (2)
- iii) Why would you expect the first year allocation rate to be low? (1)
- [18]

Q. 11) What is mortality selection? Explain the various types of selection effects that can occur. [6]

Q. 12) A three-state transition model is shown in the following diagram:



Assume that the transition probabilities are constant at all ages with $\mu = 2\%$, $\nu = 4\%$, $\rho = 1\%$ and $\sigma = 5\%$.

Calculate the expected present value of a sickness benefit of Rs 20,000 pa paid continuously to a life now aged 40 exact and sick, for this period of sickness only, discounted at 4% pa and payable to a maximum age of 60 exact. [5]
