

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

28th May 2014

**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.*
- 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)** State the principle of equivalence in the context of life insurance. [1]
- Q. 2)**
- i)** Explain why a life insurer should hold reserves. (2)
 - ii)** List four typical basis items used in setting life insurance reserves. (2)
- [4]
- Q. 3)** Calculate ${}_3p_{80.5}$
- i)** Using PFA92C20 and assuming Uniform Distribution of Deaths (3)
 - ii)** Using PMA92C20 and assuming Constant Force of Mortality (3)
- [6]
- Q. 4)** A company has sold a lifetime annuity (payable monthly in advance) with a purchase price of INR 2,000,000 to a life aged 60 exact. The policy provides guaranteed payments of INR 5,000 per month for 5 years followed by INR 10,000 for another 5 years. After this 10 year period the annuity provides a fixed monthly income for the remainder of life.
- i)** Calculate the expected monthly payouts thereafter under the basis AM92 Ultimate, 4% per annum interest. (4)
 - ii)** If a higher valuation interest rate was used, would the annuity payments after 10 years be higher or lower? Explain why. (1)
- [5]
- Q. 5)**
- i)** Explain and write in actuarial notation:
 - a)** Death strain at risk (1)
 - b)** Expected death strain (1)
 - c)** Actual death strain (1)
 - ii)** On 1st January 1998 a life insurance company issued a number of 20-year endowment and pure endowment policies to a group of lives aged 40 exact. In each case, the sum assured was INR 1,000,000 and premiums were payable annually in advance. For endowment contracts, death benefit was payable at the end of year of death.

On 1st January 2013, 100 policies were in force in each category. During 2013, 2 policyholders died among the pure endowment policies and 2 among the endowment policies.

The office calculates net premiums on AM92 Select mortality @ 4% per annum interest.

 - a)** Should reserves be calculated using select or ultimate mortality? (1)
 - b)** Calculate the profit or loss from mortality for this group for calendar year 2013 assuming no lapses during the year. (8)

- c) Explain why mortality profit or loss has arisen for pure endowment contracts, endowment contracts and on the aggregate portfolio level. (4)
- d) In the case of annuity contracts, when would we expect a mortality profit? (1)

[17]

- Q. 6)** i) Express $\ddot{a}_{x:\overline{n}|}$ in the form of an assurance function. (1)
- ii) Hence, find the value of $\ddot{a}_{50:\overline{30}|}$ using AM92 mortality and 4% per annum interest. (3)

[4]

- Q. 7)** A life insurance company sells an annual premium whole life assurance policy where the sum assured is payable at the end of the year of death. Expenses are incurred at the start of each policy year, and claim expenses are nil.

Write down a recursive relationship between the gross premium provisions at successive durations, with provisions calculated on the premium basis. Define all the symbols that you use. [2]

- Q. 8)** A company has sold a whole life assurance to a life aged 30 exact with premiums payable until the age of 60 exact. The sum assured is INR 3,000,000 (payable at the end of year of death) and simple bonus vests at 4% per annum at the end of each policy year. Premiums are payable monthly in advance.

- i) Calculate the monthly gross premium on the following basis:
- Interest – 4% per annum.
- Mortality – AM92 Select
- Expenses – Initial INR 3000, renewal 5% of premiums from second year inclusive
- Commission – Initial 50% of annual premium, subsequent 5% of all monthly premiums
- Claim expenses – INR 500 on death or maturity (4)
- ii) How would the premium change if compound bonus at 4% was payable? (2)
- iii) What is the key advantage of compound bonus over simple bonus from the company's perspective? Why might a company still decide to use simple bonus? (2)

[8]

- Q. 9)** i) Explain what this notation stands for - $\ddot{a}_{x:\overline{n}|}^{(m)}$ (1)
- ii) Given that $a_{50:\overline{5}|} = 4.18$ using AM92 mortality at 6% per annum interest calculate $\ddot{a}_{50:\overline{5}|}^{(12)}$ (2)

[3]

- Q. 10)** Define the term 'spurious selection' and give an example. [2]

Q. 11) An employer provides a lump-sum retirement benefit payable immediately on retirement at age 60 exact or earlier other than on the grounds of ill-health. The amount of the benefit is INR 100,000 for each year of an employee's service, with proportionate parts of a year counting. Write a formula for the expected present value of this benefit for an employee currently aged x with n years of past service, defining all terms used. [5]

Q. 12) Describe the causal factors that explain the observed differences in mortality and morbidity. [6]

Q. 13) A life insurance company issues an annuity contract to a man aged 60 exact and his wife aged 55 exact. Under the contract, an annuity of INR 100,000 per month is payable during the lifetime of the man. On the man's death, an annuity of INR 50,000 per month is payable to his wife, if she is then alive, for her lifetime. Annuities are payable monthly in advance. In addition to the annuity benefits, the contract also provides a death benefit equal to the single premium. The death benefit is payable immediately on the second death of the couple.

Calculate the single premium required for the contract given the following basis.

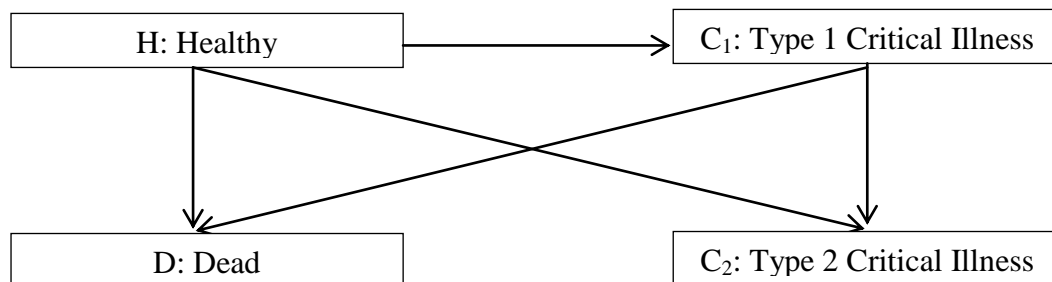
Mortality: PMA92C20 for the male and PFA92C20 for the female

Interest: 4% per annum

Initial expense: 2% of single premium and INR 1,000

Renewal expenses: INR 1,000 per annuity payment. [7]

Q. 14) A life insurance company uses the following model for a 2-year stand-alone critical illness policy issued to healthy policyholders aged 58 exact at entry.



In return for a single premium payable at the outset of the policy, the life insurance company will pay the following benefits:

- If a healthy policyholder is diagnosed to have a Type 1 critical illness, then 50% of the sum assured is payable and the contract continues with the balance sum assured. If this policyholder is then further diagnosed to have a Type 2 critical illness, the balance sum assured (i.e. 50% of the sum assured) is payable and the contract terminates.
- If a healthy policyholder is diagnosed to have a Type 2 critical illness, then 100% of the sum assured is payable and the contract terminates

No benefits are payable on death. All benefits are payable at the end of the relevant policy year.

Let S_t represent the state of the policyholder at age $58 + t$, so that $S_0 = H$ and for $t = 1, 2$, $S_t = H, C_1, C_2$ or D . The transition probabilities are defined as follows:

$$p_{58+t}^{ij} = P(S_{t+1} = j | S_t = i)$$

The values of the transition probabilities are as follows:

t	$p_{58+t}^{HC_1}$	$p_{58+t}^{HC_2}$	p_{58+t}^{HD}	$p_{58+t}^{C_1C_2}$	$p_{58+t}^{C_1D}$
0	0.06	0.03	0.02	0.10	0.20
1	0.09	0.06	0.03	0.15	0.30

Calculate the expected present value of the benefits payable for a contract with a sum assured of INR 1,000,000 assuming a rate of interest of 7% per annum. [10]

- Q. 15)** A life insurance company is developing a new product that will be exclusively distributed through its banc-assurance channel. The product is a 4-year unit-linked endowment assurance contract that will be sold to male lives aged 56 exact. Level annual premiums of INR 100,000 are payable in advance. 70% of the premium is allocated to units in the first year and 100% in the subsequent years. An annual management charge of 1% of the bid value of the units is deducted at the end of each year. There is no bid-offer spread. If the policyholder dies during the term of the policy, a death benefit of INR 400,000 or the bid value of the units after the deduction of the management charge, whichever is higher, is payable at the end of the year of death. On surrender or on survival to the end of the term, the bid value of the units is payable at the end of the year of exit.

The company uses the following assumptions in the profit testing of this product:

Rate of growth on assets in the unit fund:	6% per annum
Rate of interest on non-unit fund cash flows:	4% per annum
Independent rates of mortality:	120% of AM92 Select
Independent rate of withdrawal:	10% per annum in the first policy year; 5% per annum in the subsequent policy years.
Initial non-commission expenses:	INR 500 plus 10% of the annual premium
Renewal expenses:	INR 200 per annum on the second and subsequent premium dates
Renewal commission:	2% of the second and subsequent years premiums
Risk discount rate:	8.5% per annum

- i) The company wishes to set the initial commission such that the net present value of the profit for the product is 10% of the annual premium. Calculate the initial commission, given that the company zeroises future expected negative cash flows and decrements are uniformly distributed over the year. (18)
- ii) State with reasons, what the impact on the first year profit would be, if the withdrawal rate in the first policy year is higher than that assumed. (2)
- [20]**
