

# INSTITUTE OF ACTUARIES OF INDIA

## EXAMINATIONS

19<sup>th</sup> December 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) In addition to variation by age and sex, mortality and morbidity rates are observed to vary between geographical areas, by social class and over time. They are in fact proxies for the real factors that cause the observed difference. Explain four such real factors and possible confounding among these factors. (3)
- ii) Define the measure ‘Directly standardized mortality rate’ explaining all symbols used. (2)
- iii) Calculate the standardized mortality ratio for the population of City A using the following data

Age	Standard Population		City A	
	Population	Death	Population	Death
50	2,20,0000	22,532	10,500	128
51	2,40,0000	28,331	12,090	135
52	2,50,0000	25,742	10,012	180

(3)  
[8]

- Q. 2)** A company’s pension scheme provides a lump sum benefit to its employees on attaining age 65 (retirement age) equal to one and a half month’s pensionable salary for each complete year of service. Pensionable salary is defined as average annual salary in the last two years before the retirement.

Calculate the cost of this benefit as a percentage of salary for a new member of the scheme aged 35 exact, with salary in the next year of Rs 50,000.

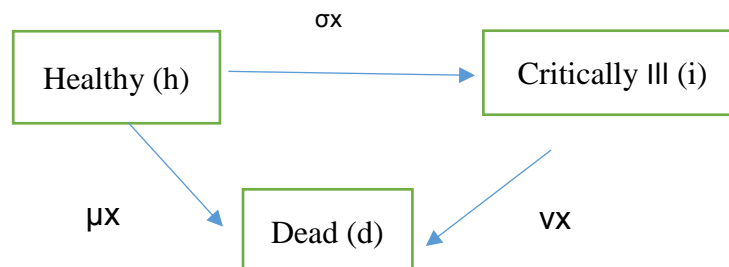
Basis:

- Pension Scheme tables in the Formulae and Tables for Examinations
- Interest 4% per annum

[4]

- Q. 3)** A life insurance company sells a term assurance and critical illness policy with a 20-year term to a life aged 40 exact. The policy provides a benefit of Rs 100,000 payable immediately on death or earlier diagnosis of critical illness. No further benefit is paid in the event of death within the term after a prior critical illness claim has been paid.

The company prices the policy using the following multiple state model:



Calculate the expected present value of the benefits under the policy.

Basis:  $i = 5\%$  per annum

$\mu_x = 0.004$  at all ages

$\nu_x = 0.005$  at all ages

$\sigma_x = 0.002$  at all ages

[7]

- Q. 4)** State what is meant by direct expenses incurred by a life insurance company in respect of a life insurance contract. Describe three different categories of direct expenses and give an example of each. [5]
- Q. 5)** A life insurance company issues a 35-year endowment assurance contract to a life aged 30 exact. The sum assured of Rs 500,000 is payable at maturity or at the end of the year of death if earlier. Level premiums are payable annually in advance for the duration of the contract.
- i)** Calculate the annual premium using the following basis:
- Interest: 6% per annum
  - Mortality: AM92 Ultimate
  - Expenses:
    - Initial: Rs 300 plus 50% of the annual premium
    - Renewal: 2% of the second and subsequent annual premiums
    - Claim: Rs 600 on death; Rs 200 on maturity
- (6)
- ii)** Calculate the retrospective policy reserve after 25 years, using the same basis as in (i), but with 4% per annum interest. (4)
- [10]
- Q. 6)** A life insurance company issues a 4-year non-par endowment insurance policy to a male life aged 61 exact for a sum assured of Rs 500,000 payable on survival to the end of the term or at the end of the year of death if earlier. Premiums are payable annually in advance throughout the term of the policy. Surrender benefit equal to a return of premiums paid, with no interest is payable at the end of year of the surrender.

The life insurance company uses the following assumptions to price this contract:

Mortality	AM92 Select
Surrenders	None
Interest	4% per annum
Initial expenses	Rs 800
Renewal expenses (on the second and subsequent premium dates)	Rs 100 per annum plus 2.5% of the premium
Surrender rates	5% of all policies in force at the end of year 1, 2 and 3

In addition, the company holds net premium reserves, calculated using AM92 Ultimate mortality and interest of 4% per annum. To profit test this contract, the life office assumes the same mortality and expense assumptions as per the pricing basis above. In addition, it assumes it earns 5% per annum on funds.

Calculate, using a risk discount rate of 8% per annum, the expected profit margin on this contract. [10]

- Q. 7)** Explain the terms “unit fund” and “non-unit fund” in the context of a unit-linked life assurance contract, listing the various items that make up the non-unit fund. [4]

- Q. 8)**
- i)** Define the constant force of mortality. (2)
  - ii)** Calculate the constant force of mortality applicable to a life aged between 55 and 56 exact. (Basis: AM92 Tables) (2)
- [4]**
- Q. 9)** A life insurance company is planning to launch the following product with the specifications as follows:
- The term of the policy is 20 years and the premium is payable monthly in advance for the duration of the policy.
  - The sum assured is Rs 50,00,000. It will be paid out in the following respects:
    - Section 1: Accidental Disability benefit – 100% of the sum assured will be paid out.
    - Section 2: Critical Illness – On occurrence of any of the listed Critical Illnesses 150% of the sum assured will be paid out.
    - Only one claim from each section is allowed so maximum two claims can be made in the policy.
  - The following are the details on expenses:
    - Commission of 35% of each monthly premium is payable for entire first policy year
    - 5% of the monthly premium is payable as commission from the second policy year onwards
    - Underwriting expense is Rs 500 paid out at the inception of the policy
    - Management expense is 10% of monthly premium amount payable at the end of each month
    - A claim investigation expense as 3% of the claimed amount
  - It is assumed that Accidental Disability claims and Critical Illness claims are independent
  - These policies will be sold to people aged 40 exact.
  - The following can be assumed as the basis for pricing and reserving:
    - Interest rate: 4% per annum
    - Rates for Accidental Disability claims: AM92 Select
    - Rates for Critical Illness claims: AM92 Ultimate
- i)** You are required to derive the monthly premium payable for this policy for the policyholder. (9)
- ii)** Calculate prospective reserve at the end of the 5<sup>th</sup> year. (4)
- [13]**
- Q. 10)**
- i)** On 1<sup>st</sup> April 2014, a life insurance company issued joint whole life assurance policies to couples. Each couple comprised one male and one female life and both were aged 50 exact on 1<sup>st</sup> April 2014. Under each policy, a sum assured of Rs 2,00,000 is payable immediately on the death of the second of the lives to die. Premiums under each policy are payable annually in advance while at least one of the lives is alive. You are required to calculate:

The annual premium payable under the policy.

Basis:

- Mortality: PMA92C20 for the male and PFA92C20 for the female
- Interest: 4% per annum
- Initial Expenses: Rs 1,000
- Expenses: 5% of each premium payment (7)

- ii) On 1<sup>st</sup> April 2018, 5,000 of these policies were still in force. Under 100 of these policies only the female life was alive. Both lives were alive under the other 4,900 policies. The company calculates provisions for the policies on a net premium basis, using PMA92C20 and PFA92C20 mortality for the male and female lives respectively and 4% per annum interest.

During the calendar year 2018, there was one claim for death benefit, in respect of a policy where the female life only was alive at the start of the year.

In addition, one male life died during the year under a policy where both lives were alive at the start of the year. 4,999 of the policies were in force at the end of the year. Calculate the mortality profit or loss for the group of 5,000 policies for the calendar year 2018. (13)

[20]

- Q. 11)** A life insurance company issues an annuity policy to two lives each aged 60 males and 55 females exact in return for a single premium. Under the policy, an annuity is payable annually in advance while at least one of the lives is alive. The premium is Rs 1,00,000.

- i) Write down an expression for the net future loss random variable at the outset for this policy. (3)
- ii) Derive the annuity in respect of the premium payable.  
Basis:
- Mortality: PMA92C20 for the first life, PFA92C20 for the second life
  - Interest: 4% per annum (6)
- iii) Calculate the standard deviation of the net future loss random variable at the outset for this policy, using the basis in part (ii) above.

You are given that  $\ddot{a}_{\overline{60m:60f}|} = 11.957$  at a rate of interest 8.16% pa. (6)

[15]

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