

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

4th May 2016

**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)** What is select mortality? (1)
- ii)** Calculate ${}_{20}P_{[25]:[30]}$ using AM92. (2)
- [3]**
- Q. 2)** **i)** List the main forms of selection. (2)
- ii)** Explain how stringency of underwriting will result in spurious selection. (2)
- [4]**
- Q. 3)** Calculate ${}_{1.4}q_{54.5}$ using the method of Uniform Distribution of Deaths (UDD) and the ELT15 (males) mortality table. (3)
- [3]**
- Q. 4)** A life insurance company sells regular premium term insurance policies with return of premiums at maturity, wherein the policyholder (or his Estate) would get the Sum Assured payable at the end of the year of death, or the total premiums paid would be returned to the policy holder at time of maturity on survival. A policyholder aged 35 years exact buys one such policy with a sum assured of INR 5,000,000 and a term of 30 years. Calculate the annual premium for the policy assuming that premiums are paid yearly in advance for the full term and cease on earlier death.
- We can ignore any expenses, any lapses and surrenders.
- Basis:
- Interest rate: 6% per annum
- Mortality: AM92 Ultimate. (6)
- [6]**
- Q. 5)** **i)** Write down the notation for the present value of an immediate annuity of 1 per annum payable continuously during the lifetime of a life now aged x , in terms of expectation of life. (1)
- ii)** What is the notation for the expected present value of such an annuity? Also, derive the expression for the expected present value of such an annuity (in terms of integrals). (4)
- [5]**
- Q. 6)** A Life insurance company issues 20 year pure term single premium insurance policies. On 1 January 2015 it sells 10,000 such policies to females aged 45 years exact.
- The Sum Assured under the policy is INR 5,000,000 and the death benefit is paid at the end of year of death.
- As at Jan 2015 the company uses the following basis for calculating premium and net premium reserves:
- Interest rate: 4% per annum
Mortality: AM92 Ultimate
Expenses and commission: Nil

- i) Calculate the total single premium collected at start of January 2015. (2)

During the year the company experiences 10 deaths.

The Appointed Actuary at the end of the year revises the reserving basis and changes the interest rate to 6% per annum and the mortality rate for female policies equal to AM92 Ultimate with a two year set back.

- ii) Calculate the total mortality profit or loss arising during the year for the life insurance company. (5)
[7]

- Q. 7)** i) Why would a company distribute bonuses in with profit products? (1)
- ii) List the sources of surplus in a life fund, which could impact the bonuses for with profit policies. (2)
- iii) Describe how terminal bonus could be a useful tool in enhancing the overall returns for policyholders. (2)
[5]

- Q. 8)** A Life insurance company, specialising in with profit products, sells limited pay with-profit Endowment policies to male lives aged 50 years exact. The sum assured plus declared reversionary bonuses are payable on survival to the end of the term or on death if earlier.

Other details:

Premium payable term: 10 years

Policy term: 15 years

Sum Assured: INR 1,000,000

Initial Commission: 20 % of sum of monthly premiums of first year, payable at outset

Initial expenses: INR 2,500 + 35% of sum of monthly premiums of first year, incurred at start of policy

Renewal commission: 2% of renewal premium payable from second year

Renewal expenses: INR 400 at start of every year from second year to 15th year + 1.5% of renewal premium from second year

Mortality: AM92 Ultimate

Future reversionary bonus: 1.92308% of the sum assured, compounded and vesting at the end of each policy year

Interest rate: 6% per annum

Premiums are payable monthly in advance and benefits are paid at the end of year of death.

- i) Calculate the monthly premium. (6)
- ii) At the end of 10th year for a surviving policy the company has declared bonus at a constant rate of 2% over last 10 years. Calculate the Gross Premium Reserve at the end of 10th year basis following reserving assumptions.

Mortality: AM92 Ultimate

Interest rate: 5% per annum

Future bonuses: 4% of total of base sum assured and accrued bonuses

Expenses: same as pricing.

(4)
[10]

Q. 9) Mr. Sharma (exact age 65) purchases a Joint Life Annuity with his spouse Mrs. Sharma (exact age 64). The annuity provides following income benefits:

- Definite benefits of INR 50,000 per month payable for first 5 years, irrespective of survival status of any or both lives.
- Post completion of 5 years, if both lives are alive, the benefits increase to INR 75,000 per month until the death of the first life, post which it continues at INR 50,000 per month till the death of remaining life.
- However if at the end of 5th year If Mr. Sharma is alive and Mrs. Sharma is dead it will pay a lump sum benefit of INR 2,500,000 and the contract would cease. But, if Mr. Sharma is dead and Mrs. Sharma is alive, the benefit would continue at INR 50,000 per month till she dies.

All benefits are paid at the end of month.

Calculate the expected present value of such a contract.

Basis:

Mortality: PMA92C20 (male life), PFA92C20 (female life)

Rate of interest: 4% per annum

Expenses: Nil

[10]

Q. 10) i) Define the following terms:

- a) Crude Mortality Rate
- b) Directly Standardised Mortality Rate
- c) Indirectly Standardised Mortality Rate

(4)

- ii) The following data relate to Country Z and its biggest area 10. Calculate the Area Comparability Factor and a Standardised Mortality Rate:

Age Group	Country Z		Area 10
	Population	Deaths	Population
<20	3,200,000	522	800,000
21-40	4,000,000	2,522	1,200,000
41-60	4,200,000	20,234	1,000,000
60 and above	400,000	38,225	300,000
Total	11,800,000	61,503	3,300,000

The population figures are from a mid-year census along with deaths that occurred in that year. There were 32,356 deaths in Area 10 in total.

(6)
[10]

- Q. 11)** A life insurance company sells a term assurance and partial disability policy with a 20 year term to a life aged 42 exact. The policy provides a benefit of INR 50,000 payable immediately on death or earlier partial disability. Once the partial disability is claimed, no benefit is payable in the event of death after that. The company prices the policy using the following multiple state model:

Healthy (h) to partial disability (p) = σ_x

Healthy (h) to dead (d) = μ_x

Partial disability (p) to dead (d) = γ_x

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

Basis:

$i = 5\%$ per annum

$\mu_x = 0.005$ at all ages

$\sigma_x = 0.003$ at all ages

$\gamma_x = 0.006$ at all ages

[10]

- Q. 12)** The following table shows (in INR) a profit testing calculation with some of the entries missing for a three-year endowment assurance contract issued to a group of lives aged exactly 57 with a sum assured of INR 5,000 payable at the end of the year of death or on maturity.

Outgo terms are shown as negative entries.

Year	Premium	Expenses	Interest	Expected cost of claims	Expected cost of increasing reserves (Net of interest earned on reserves)	Profit vector
1	1,530	-50	?	?	?	-51
2	1,530	?	?	?	?	21
3	1,530	?	?	?	?	45

The mortality probability at each age is 1%. The rate of accumulation used is 6% per annum. Reserves are calculated using an interest rate of 4% per annum. The reserves are zero at the start and end of the contract. The interest earned on the reserve in the third year is INR 195.

- i) Complete the table showing all workings. (10)
 - ii) Calculate the internal rate of return. (2)
 - iii) Explain the effect that changing to a weaker reserving basis would have on the internal rate of return. (2)
 - iv) Calculate the net present value using a risk discount rate of 7% per annum. (2)
 - v) Explain the effect that changing to a stronger reserving basis would have on the net present value. (2)
- [18]**
- Q. 13)**
- i) Explain the terms unit fund and non-unit fund in the context of unit linked products listing various items that make up the non-unit fund. (6)
 - ii) Explain why a life company might need to set up non-unit reserves in respect of unit linked assurance contracts. (3)
- [9]**
