

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

07th November 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. 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)** In the context of a life assurance policy, define both overhead and direct expenses. Give an example of each. [4]
- Q. 2)** Describe three types of reversionary bonus that may be added to a with-profits contract. [4]
- Q. 3)** A life insurance company issues a 25-year endowment assurance policy to a life aged 40 exact. Level premiums are payable monthly in advance throughout the term of the policy provided the life survives. The sum assured of Rs. 100,000 is payable at maturity or at the end of year of death of the life insured, if earlier.
- i)** Prove that the monthly premium is approximately Rs. 240, given the following basis:
- Mortality: AM92 Select
 Interest: 6% per annum
 Initial fixed expenses: Rs. 1,000
 Initial variable expenses: 50% of the annual premium
 Renewal fixed expenses: Rs. 500 per annum, inflating at 1.92308% per annum, at the start of the second and subsequent policy years
 Renewal variable expenses: 5% of the second and subsequent monthly premiums.
 Claims expense: Rs. 2,000 inflating at 1.92308% per annum
- The amounts mentioned above for renewal and claim expenses are at outset and the increases due to inflation start immediately. (7)
- ii)** The insurance company calculates a surrender value, equal to the gross retrospective policy value, assuming the same basis as in (i) above. Calculate the surrender value at the end of the 20th policy year immediately before the premium then due. (7)
- Q. 4)** **i)** Calculate (to the nearest integer) the median of the complete future lifetime of a person aged 50 exact who is subject to mortality according to AM92 Ultimate. (3)
- ii)** A life insurance company is planning to issue a whole life policy to a life aged 0 whose curtate future lifetime, K has the following probability distribution:
- $P(K=k) = 0.01; k = 0,1,2,3,\dots,99$
- The policy will pay one unit at the end of the year of death in exchange for the payment of level premiums payable at the beginning of each year provided the life survives. Find the least annual premium such that the insurer has a probability of positive financial loss of at most 0.05, assuming an annual effective interest rate of 8%. (5)
- Q. 5)** **i)** Prove that: [8]
- $$P_{x:\overline{n}|} = {}_n P_x + P_{x:\overline{n}|}^1 (1 - A_{x+n}) \quad (4)$$
- ii)** Interpret the above formula. (2)

- Q. 6)** Calculate the annual benefit premium for a 30-year term insurance policy issued to a life aged 30 exact, providing the following death benefit at the end of the year of death:
- Rs. 10,000,000 plus return of premiums without interest (3)
 - Rs. 10,000,000 plus return of premiums accumulated at 4% interest rate per annum

Bases:

Mortality: AM92 Ultimate

Interest: 4% per annum

(5)
[8]

- Q. 7)** An endowment assurance on (x) provides, in case of death within n years, a payment of 1 plus the benefit reserve at the end of the year of death. Level benefit premiums are payable annually in advance. Given that the maturity benefit is 1, prove that the annual benefit premium is:

$$\frac{v^n + \ddot{a}_{\overline{n}|} v^{k+1} q_{x+k}}{\ddot{a}_{\overline{n}|}}$$

[6]

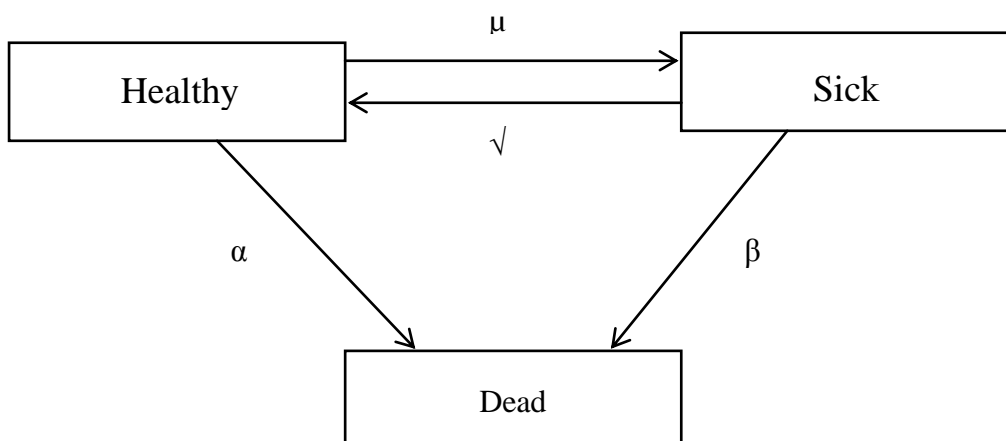
- Q. 8)** A member of a pension scheme is aged 55 exact, and joined the scheme at age 35 exact. He earned a salary of Rs 100,000 in the 12 months preceding the scheme valuation date. The scheme provides a pension on retirement for any reason of $1/80^{\text{th}}$ of final pensionable salary for each year of service, with incomplete years counting proportionately. Final pensionable salary is defined as the average salary over the three years prior to retirement.

Using the functions and symbols defined in, and assumptions underlying, the Example Pension Scheme Table in the Actuarial Tables:

- Calculate the expected present value of this member's total pension. (3)
- Calculate the contribution rate required, as a percentage of salary, to fund the future service element of the pension. (2)

[5]

- Q. 9)** A life insurance company prices its long-term sickness policies using the three-state continuous-time Markov model, with constant forces of transition between different states.



Under these policies, a lump sum benefit is payable on the occasion that a life becomes critically ill during a specified policy term. No other benefits are payable. A 20-year policy with sum assured Rs 200,000 is issued to a healthy life aged 40 exact.

Write down a formula, in integral terms, for the expected present value of benefits under this policy.

[5]

Q. 10) i) Derive the relationship between the probability density function and cumulative distribution functions of joint lifetime and last survivor random variables. (5)

ii) On 1st January 2014, a life insurance company issued joint life whole life assurance policies to couples. The policy benefit includes a payout of Rs 1,000,000 payable on the death of the second life, with premiums payable annually in advance while at least one of the lives is alive.

The life insurance company uses the following pricing basis:

- Mortality PMA92C20 for the male, PFA92C20 for the female
- Interest 4% per annum
- Expenses Initial Rs 5,000, renewal 5% of each premium

Calculate the premium payable on a policy sold to a couple both aged 60 exact? (5)

[10]

Q. 11) A life insurance company issues a 3-year unit-linked endowment assurance policy to a male life aged 45 exact.

Level premiums of Rs 20,000 per annum are payable yearly in advance throughout the term of the policy or until earlier death. 95% of the premium is allocated to units in the first policy year, 100% in the second and 105% in the third. A policy fee of Rs 50 is deducted from the bid value of units at the start of each year. The units are subject to a bid-offer spread of 5% on purchase. An annual management charge of 1.75% of the bid value of units is deducted at the end of each policy year. Management charges are deducted from the unit fund before death, surrender and maturity benefits are paid.

If the policyholder dies during the term of the policy, the death benefit of 125% of the bid value of the units is payable at the end of the policy year of death. On maturity, 100% of the bid value of the units is payable.

The policyholder may surrender the policy only at the end of the first and second policy years. On surrender, the bid value of the units less a surrender penalty is payable at the end of the policy year of exit. The surrender penalty is 20% of the fund value in the first policy year and 10% of the fund value at the end of the second policy year.

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 4% per annum
- Mortality AM92 Select
- Initial expenses Rs 200
- Renewal expenses Rs 50 per annum on the second and third premium dates
- Initial commission 15% of first premium
- Renewal commission 2% of the second and third years' premiums
- Rate of expense inflation 2% per annum
- Risk discount rate 7% per annum

For renewal expenses, the amount quoted is at outset. Assume that at the end of the first and second policy years, 12% and 6% respectively of all policies still in force then surrender immediately.

- i) Calculate the profit margin for the policy. (13)
 - ii) Suggest ways in which the profit margin on the policy be increased? Are there any practical challenges in implementing these measures? (3)
 - iii) What could be the considerations in setting a risk discount rate at 7%? (1)
 - iv) How would the profit margin change if the risk discount rate was increased? (1)
 - v) Explain why a life office might need to set up non-unit reserves in respect of a unit-linked life assurance policy. (2)
- [20]**

Q. 12) i) Define the following terms without giving detailed formulae:

- a) Crude Mortality Rate
- b) Directly Standardised Mortality Rate
- c) Indirectly Standardised Mortality Rate (3)

ii) The data below relates to a small country and one of its provinces:

Age group	Population - country	Deaths - country	Population – province A
0-19	3,000,000	580	800,000
20-39	3,500,000	2,450	1,000,000
40-69	2,500,000	20,300	700,000
70 and over	500,000	49,000	300,000
Total	9,500,000	72,330	2,800,000

The population figures are from a mid-year census along with the deaths that occurred in that year. There were 21,453 deaths in the province in total.

Calculate the Area Comparability Factor and a standardised mortality rate for Province A. (5)

[8]

Q. 13) What do you think would be the most dominant form of selection observed in the following and how:

- i) An insurance company offering higher smoker premium rates and lower non-smoker premium rates than its competitors.
- ii) Pension scheme for all employees of a company. (2)
