INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

17th November 2011

Subject CT5 – General Insurance, Life and Health Contingencies

Time allowed: Three Hours (10.00 – 13.00 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. *In addition to this paper you will be provided with graph paper, if required.*

5. *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)   Define and calculate $_{5|10}\,q_{[40]+1}$ Basis: AM92   **[2]**

Q. 2)   For a double decrement table with independent decrements (1) and (2), you are given:

   i) $\mu_x^{(1)}(t) = 0.2\,\mu_x(t),\ t > 0$

   ii) $\mu_x(t) = k\,t^2,\ t > 0$

   iii) $q_x^{(1)} = 0.04$

Calculate $_2q_x^{(2)}$.

                                                                                                         [6]

Q. 3)   **i)**   Explain the terms "Overhead Expenses" and "Direct Expenses" in relation to allocation of
                        expenses in writing life insurance contracts and further explain as to how these expenses
                        are allocated while pricing the life insurance contracts.   (3)

   ii)   Classify the following expenses into Overhead or Direct Expense:

       a.   Underwriting costs

       b.   Salary of the Chief Marketing Officer

       c.   Salary costs of the New Business department

       d.   Salary of the Appointed Actuary   (2)

                                                                                                         [5]

Q. 4)   A group of lives all aged 45 years exact have bought a life insurance policy of 20 year policy
             term providing the following benefits:

   i)   Rs.100,000 is payable at the end of the year of death, if death occurs during the term of the
                        policy

   ii)   Rs.200,000 is payable on the maturity date of the policy in respect of those lives who
                        survive the policy term.

The premiums are payable annually in advance for 15 years.

Calculate the mortality profit during the 13th policy year if

   i)   the number of inforce policies at the end of 13th policy year is 195 and

   ii)   number of deaths during 13th policy year is 4.

Basis - Mortality AM92 Ultimate; Interest Rate 4% per annum

                                                                                                         [6]

Q. 5) A life insurance company has been selling regular premium unit-linked contracts for the past few years. The sum payable on the death or on the maturity is the unit fund value only where the death benefit is paid at the end of the year of death.

The Company charges a premium allocation charge of 10% of premium across all policy years levied at the time of premium payment and fund management charge (FMC) of 1.5% per annum levied at the end of each policy year.

The outstanding term and the unit fund value under one of the contracts is exactly 3 years and Rs.50,000 respectively as on 31 Dec 10. The annual premium under this contract is Rs.10,000 per annum payable at the beginning of each policy year.

The regulator has asked the life insurance companies to calculate the economic liability of the contracts. Economic liability is defined as unit fund value plus the non-unit reserves, where the non-unit reserves are allowed to be negative i.e. non-unit reserves are determined using the cash flow projections and are not zeroised at any point during the policy term.

Determine the economic liability of the contract as on 31 Dec 2010 using the following assumptions:

- Unit Fund growth rate   :   10% per annum

- Interest Rate   :   6% per annum
- Expense & Commission :   Rs.100 per annum and 5% of premium incurred at the beginning of each policy year.
- Withdrawal Rates   :   Nil
- Mortality rate assumption for the next 3 years is   :

Calendar Year	2011	2012	2013
Mortality Rate	0.0015	0.0020	0.0025

[7]

Q. 6) A continuous annuity of 1 per annum is payable while at least one of the lives, aged exactly 30 years and aged exactly 45 years is living, but not payable if the life aged exactly 30 years is alive and is under age 40 years exact. Derive the following expression for the actuarial present value (S) of the annuity.

$$S = \bar{a}_{45} + {}_{10|}\bar{a}_{30} - \bar{a}_{30:45}$$

[4]

Q. 7)   A life insurance company issues a 35-year non-profit endowment assurance policy to a life aged 30 years exact. Level premiums are payable monthly in advance throughout the term of the policy. The sum assured of Rs.75,000 is payable at maturity or at the end of the year of death of the life insured, if occurs earlier.

Calculate the monthly premium on the following basis:

Mortality	:	AM92 Select
Interest	:	6% per annum
Initial expenses	:	Rs.250 plus 50% of the gross annual premium
Renewal expenses	:	Rs. 75 per annum, inflating at 1.92308% per annum, at the start of the second and subsequent policy years and 2.5% of the second and subsequent monthly premiums
Claims expense	:	Rs.300 inflating at 1.92308% per annum
Inflation	:	For renewal and claim expenses, the amounts quoted are at outset, and the increase in expenses due to inflation starts immediately

[7]

Q. 8)   A life office issues identical deferred annuities to each of 100 women aged 63 years exact. The benefit is Rs.5000 per annum payable continuously from a woman's 65th birthday, if still alive at that time, and for life thereafter.

   i)   Write down an expression for the random variable for the present value of future benefits for one policy at outset.   (3)

   ii)   Calculate the total expected present value at outset of these annuities.

   Basis: Mortality: PFA92C20

   Interest: 4% per annum   (2)

   iii)   Calculate the total variance of the present value at outset of these annuities, using the same basis as in part (ii).   (8)

[13]

Q. 9)   **i)**   Explain the difference between a With Profit and a Without Profit contract.   (3)

   ii)   A life insurance company issues a 10-year with-profits endowment policy to a life aged 50 years exact. Under the policy, the basic sum assured of Rs.75,000 and attaching bonuses are payable at maturity or immediately on death, if earlier. The company declares compound reversionary bonuses vesting at the end of each policy year (i.e. the death benefit does not include any bonus relating to the policy year of death).

   Level premiums are payable annually in advance under the policy.

Calculate the annual premium, using the equivalence principle, on the following basis:

Mortality	:	AM92 Select
Interest Rate	:	6% per annum
Bonus loading	:	1.92308% of the sum assured compounded and vesting at the end of each policy year
Initial Expense	:	Rs.350 plus 50% of the annual premium
Renewal Expenses	:	5% of each premium payable in the second and subsequent years

(7)

[10]

Q. 10) **i)** Explain why the Risk Discount Rate used to be different from the risk free rate.   (2)

ii) A life insurance company issues a two-year without-profit policy to a life aged exactly 50 years. The policy provides the following benefits:

a) on death during the policy term, a sum of Rs. 100,000

b) on withdrawal from the policy before maturity, a return of 75% of premiums paid without interest

c) on surviving to the maturity, a sum of Rs. 10,000

Death and withdrawal benefits are payable at the end of the year of death or withdrawal respectively and the survival benefit is payable on the maturity date of the policy. There are no other decrements other than death and withdrawal.

A premium of Rs. 7,500 is payable annually in advance under the policy for 2 years or until death or withdrawal if occurs earlier.

The company would like to determine the risk discount rate (RDR). The RDR would be such that the net present value of cash flows after allowing for risks under the market-consistent valuation is equal to the net present value of cashflows without any risk allowance, discounted at RDR. Under market consistent valuation, profit cashflows are discounted at spot yields.

Prove that the RDR is equal to 15% per annum. Use the following basis and show all your working:

Mortality	:	the independent rate of mortality is that of AM92 Select
Interest Rate	:	7% per annum
Withdrawal	:	the independent rate of withdrawal is 5% per annum
Rate of decrements	:	Mortality and withdrawal occur uniformly throughout each policy year in the respective associated single decrement tables
Expenses	:	Rs.1,000 at start of Year 1 and Rs.300 at start of Year 2
Spot yield on Govt. Bonds :		7% per annum both for year 1 and year 2.
Risk margin	:	Expressed as 1% of Premium at the end of each policy year
Reserves	:	Ignore

(10)

[12]

Q. 11) You are a member of a committee responsible for monitoring the trend in assured lives mortality rates. You have been presented with the following ratios of actual to expected mortality rates on the basis of a standard table constructed twenty years ago ("Standard Table A") and the total expected deaths over the period 2007 – 2010 based on this table.

Age	Ratio of Actual to Expected Mortality Rates		Total Expected Deaths (000's)	
	2007-2008	**2009-2010**	**2007-2008**	**2009-2010**
15-44	1.80	2.00	10	10
45 & above	0.90	0.80	20	20

You have also been given details of the exposed to risk data in the two age groups 15-44 years and 45 years onwards corresponding to Standard Table A. The exposed to risk data are described as "Standard Population A".

i) Show how the Standardised Mortality Ratio may be expressed as a weighted average. Describe the function averaged and the weights.

(2)

ii) Calculate the Standardised Mortality Ratios for the periods 2007-2008 and 2009-2010 with reference to Standard Table A, using the data presented.

(2)

iii) The committee measured the change in mortality between the periods 2007-2008 and 2009-2010 by calculating a Comparative Mortality Factor (CMF) for each period. This factor was calculated as:

r_1/r_2, where

r_1 was the expected number of deaths for the period obtained by applying the observed mortality rates to Standard Population A

r_2 is the expected number of deaths in Standard Population A over a two-year period based on Standard Table A

The CMF was 0.95 for the period 2007-2008 and 0.99 for the period 2009-2010, which led the committee to conclude that mortality was deteriorating.

a) Explain the difference between the results of your calculation of the Standardised Mortality Ratios in part (ii) and these CMF figures.

b) State, giving a reason, which set of figures you think provides the better results.

c) Comment on the conclusion of the committee that mortality was deteriorating. (6)

[10]

Q. 12) A life insurance company uses the following multiple-state model for pricing and valuing annual premium long-term care contracts, which are sold to lives that are healthy at outset.
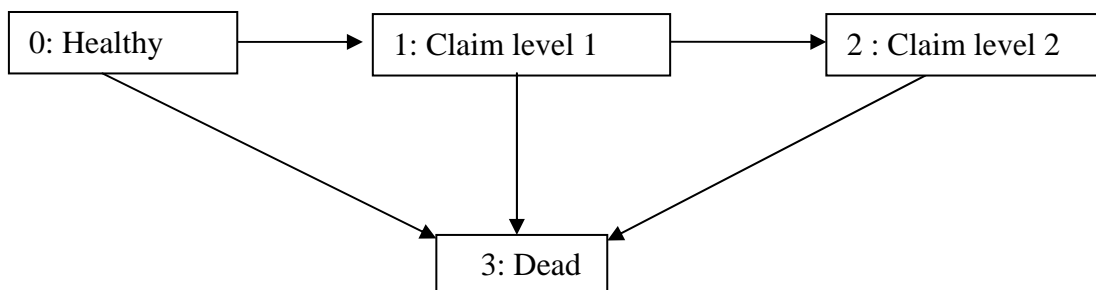
Under each contract, the life company will pay the costs of long-term care while the policyholder satisfies the conditions for payment. These conditions are assessed every year on the policy anniversary. If the policyholder satisfies the conditions, the annual amount of the benefit payable is paid immediately. A maximum of four benefit payments can be made under the policy. The policy expires on earlier of death or immediately after making the fourth benefit payment as mentioned above.

Premiums are payable annually at the beginning of each policy year and are waived if a benefit is being paid at a policy anniversary immediately before the premium is due.

For lives at claim level 1, benefits of 60% of the maximum benefit level are paid, while lives at claim level 2 receive 100% of the maximum benefit level. The current maximum benefit level is Rs. 50,000 per annum and increases by 6% per annum compounded.

p^{ij}_x is the probability that a life aged 'x' exact in state 'i' will be in state 'j' at age x+1 and the insurer uses the following probabilities for all values of x:

$p^{00}_x = 0.87$ $p^{01}_x = 0.1$ $p^{02}_x = 0.0$
$p^{11}_x = 0.6$ $p^{12}_x = 0.3$ $p^{22}_x = 0.6$

Calculate the annual premium under the contract. Assume an interest rate of 6% per annum and expenses as 7.5% of each premium incurred at the beginning of the policy year.

[10]

Q. 13) A small employer decides to set up a pension scheme for his 2 employees described by the following details:

Age (exact)	Past service (years)	Expected Annual Salary during next one year (Rs.)
30	5	25,000
35	6	20,000

The scheme will provide a pension of 1/60th of pensionable salary for each year of service (fractions of a year counting proportionally) on retirement for any reason. Pensionable salary is the average annual salary earned in the final 36 months of employment.

The employer meets the full cost of the scheme. The contribution rate is determined by equating the expected present value of the total scheme liabilities to the expected present value of annual salary. Contributions are calculated to be a constant percentage of the total salaries of the members at any time.

Using the symbols defined in, and assumptions underlying, the Formulae and Tables for Actuarial Examinations, calculate the contribution rate required for the scheme. Ignore the possibility of new members joining the scheme.

[8]

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