

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

28th May 2013

**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. *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) Prove the following and interpret the result in words:

$$\text{i) } A_x = A_{x:\overline{n}|}^1 + n|A_x \quad (3)$$

$$\text{ii) } a_x = \sum_{j=1}^{\infty} j p_x v^j \quad (3)$$

[6]

Q. 2) Let T_x and T_y be random variables which measure the complete lifetime of two lives aged x and y . A death benefit of INR 10,00,000 is payable immediately on death of (y) if this occurs after the death of (x) .

i) Write down an expression in terms of T_x and T_y (random variables denoting the complete future lifetimes of (x) and (y) respectively) for the present value of the benefit under this policy. (2)

ii) Write down an expression for the expected present value of the benefit in terms of an integral. Define all the terms used in the expression. (2)

[4]

Q. 3) **i)** Outline the benefits that are usually provided by a pension scheme on retirement due to ill health. (3)

ii) Write down the expression for valuing ill health retirement benefit of 1 per annum, payable continuously to a healthy life now aged x . (2)

[5]

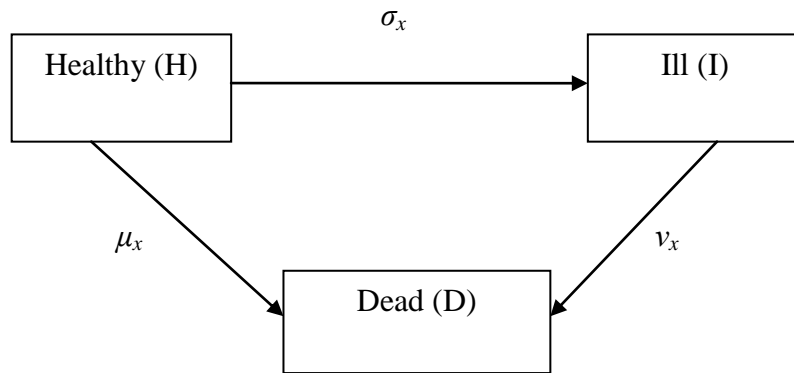
Q. 4) By considering the change in reserves over a short time period, construct Thiele's differential equation for a regular premium n -year term assurance for a life aged x using general reasoning. Assume that the sum assured of 1 is payable immediately on death, interest is earned continuously at force of interest δ and premiums are payable continuously.

[5]

Q. 5) A life insurance company sells a term assurance and critical illness policy with a 10 year term to a life aged 50 exact. The policy provides a benefit of INR 100,000 payable immediately on death or earlier diagnosis of critical illness.

In the event that the policyholder had earlier been paid the critical illness benefit, no further benefit is paid in the event of death within the term.

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



Assuming that recovery from ill to healthy is not possible, calculate the expected present value of the benefits under this policy using following basis:

Interest = 8% per annum

$\mu_x = 0.003$ at all ages

$\sigma_x = 0.005$ at all ages

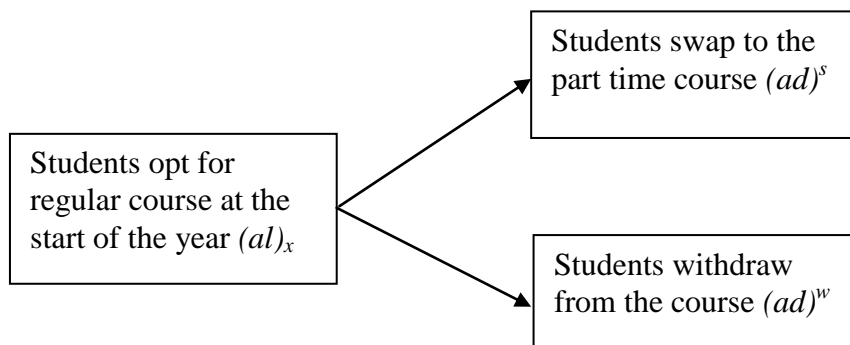
$\nu_x = 0.008$ at all ages

[5]

- Q. 6)** Assume that each of 10,000 independent lives aged x , subject to a constant annual force of mortality $\mu = 0.04$, is insured for a death benefit amount of 1 unit, payable at the moment of death. The benefit payments are to be withdrawn from an investment fund earning $\delta = 0.06$ per annum. Calculate the minimum amount at $t = 0$ so that the probability is approximately 0.95 that the fund will be sufficient to withdraw the benefit payment at the death of each individual.

[6]

- Q. 7)** In Actuarial city, a particular MBA college had experienced following pattern in their regular 2 years MBA course:



Age	$(al)_x$	$(ad)^s$	$(ad)^w$
21	1000	69	212
22	719	72	16
23	631		

A new Dean of the college has been appointed who has made strict rules on the withdrawals from the course. It is expected that the withdrawal rates will improve 40% in both the years.

Calculate a revised table assuming no changes to the course swap rates. Clearly state the assumptions made in your calculations

[7]

- Q. 8)** i) State the advantages and disadvantages of using crude mortality rates and standardised mortality rates. (4)
- ii) Calculate the standardised mortality ratio for the Madagascar City by using the following data:

Age	Standard Population		Madagascar city	
	Population	Deaths	Population	Deaths
50	3,500,000	56,675	15,000	130
55	3,200,000	93,006	12,000	322
60	2,200,000	116,090	9,500	564

(3)

[7]

- Q. 9)** i) State why an insurance company will set up reserves for a regular premium term assurance contract. (2)
- ii) A deferred whole life annuity-due issued to (x) for an annual income of 1 commencing at age $x+n$ is to be paid for by level annual premiums during the deferral period. The benefit for death prior to age $x+n$ is the net premium reserve. Assuming the death benefit is paid at the end of year of death, determine the annual net premium. (6)

[8]

- Q. 10)** A five-year unit-linked policy issued to a life aged 50 exact has the following pattern of in force per policy cash flows (before setting up required non unit reserves):

(-10, -20, -5, 15, 40)

- i) Explain why a life insurance company needs to set up non unit reserves with respect to a unit linked policy. (2)
- ii) Calculate the non-unit reserves that should be set up to zeroise the negative cash flows, assuming AM92 Ultimate mortality and interest rate of 5% per annum. (2)
- iii) Calculate the net present value of the profits before and after zeroisation. Assume RDR at 10% per annum. (4)
- iv) State with reasons which NPV (before or after zeroisation) is expected to be higher. (2)

[10]

- Q. 11)** i) Define death strain at risk and expected death strain. (3)
- ii) A group of 1,000 lives aged 45 exact set up a fund to pay 1,000,000 at the end of the year of death of each member. Their mutual agreement is to pay into the fund an amount equal to the expected present value of whole life insurance calculated on the basis of AM92 ultimate table at 6% interest. The actual experience of the fund is one death in each of the third and fourth years. The investment income is 6.5% per annum in the first three years and 7% per annum in the next two years. What is the difference at the end of the first 5 years, between the expected size of the fund as determined at the inception of the plan and the actual fund? (7)

[10]

- Q. 12)** A life company sells 20-year with-profit endowment assurances to lives aged 40 exact. The basic sum assured is 50,000, and compound bonuses of 1.923% are added to the sum assured at the end of each year. The death benefit is payable at the end of the year of death, after the bonus amount for the current year has been added. Level premiums are payable monthly, the first monthly premium being due immediately. The basis is as follows:

Mortality: AM92 Select

Interest: 6% per annum

Initial Expense: 50% of the first year's total premiums, payable at the start of the contract

Renewal Expense: 5% of all premiums, including the first year, payable at the start of each year.

- i) Calculate the monthly premium. (6)
- ii) Find the gross premium prospective reserve just before the start of the eleventh year of the policy, assuming that bonuses have been declared according to the initial assumptions. (6)

[12]

- Q. 13)** A life insurance company issues a three-year unit-linked endowment policy to a male life aged exactly 50. A premium of INR 4,500 is payable at the start of each year. The allocation proportion is 90% in year 1, 95% in year 2 and 100% in year 3. The units are subject to a bid-offer spread of 5% on purchase. An additional fee of INR 50 per annum is deductible from the unit fund at the start of each year. An annual fund management charge (FMC) of 1.5% per annum is deductible at the end of each year.

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 also has an option to surrender his policy at the end of year 1 and year 2. The surrender benefit to the policyholder is fund value of its units less a surrender penalty.

(Note: The surrender penalty is the charge taken by the insurance company from the policyholder in case he wants to exit the contract.)

The company uses the following assumptions to profit test the contract:

Mortality (q_x)	(0.001t) for year t
Initial Expenses	INR 500 at the start of the year 1
Renewal Expenses	INR 50 at the start of the year 2 and year 3
Expense Inflation	NIL
Initial Commission	15% of premium at start of year 1
Renewal Commission	2% of premium at start of year 2 and year 3
Surrender Penalty	INR 1,200 at the end of the year 1 INR 750 at the end of the year 2 INR 0 at the end of year 3
Interest On non-unit fund	5% per annum
Unit Fund Growth Rate	6% per annum in year1 5.25% per annum in year 2 5.00% per annum in year 3
Risk Discount Rate	8.00% per annum

In addition, you should assume that at the end of the first and second policy years, 10% and 5% respectively of all policies still in force then surrender immediately.

Create a table to show the following:

- i) The growth of Unit Fund (4)
- ii) The growth of Non-Unit Fund (4)
- iii) Calculate the profit margin of the contract. (5)
- iv) Due to a change in the regulations, surrenders are not allowed in first three years of the policy. Hence, the company is planning to launch the same product without surrender option and hence no surrender penalty will be earned by the company. Describe in your opinion the impact on profit margin due to this change. (2)

[15]
