

**M.Sc. ACTUARIAL SCIENCE  
(MSCAS)**

Term-End Examination

June, 2013

**MIA-009 (F2F) : GENERAL INSURANCE, LIFE AND  
HEALTH CONTINGENCIES**

Time : 3 hours

Maximum Marks : 100

*Note : In addition to this paper you should have Actuarial table and your own electronic calculator.*

**SECTION-A**

(Answer *any five* questions)

1. Evaluate the following functions, assuming the given basis :

(a)  $\frac{D_{50}}{D_{40}} a_{50}$  AM92 ultimate mortality and 2

6% pa interest.

(b)  $\ddot{a}_{23:\overline{18}|}$  AM92 Ultimate mortality and 2

6% pa interest.

(c)  $\bar{A}_{30:\overline{25}|}$  AM92 Ultimate mortality and 2

6% pa interest.

(d)  $\ddot{a}_{68:160}^{(12)}$  Mortality 2

First life : PMA92C20

Second life : PFA92C20

Interest : 4% pa

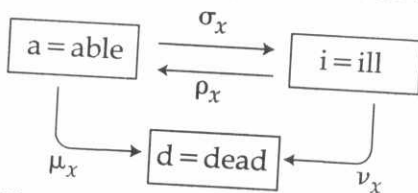
2. Define, stating any assumption that you make, the present value random variable of an endowment assurance contract where the death benefit is payable immediately on death and derive its mean and variance. 8
3. (a) A population is subject to a constant force of mortality of 0.015. Calculate.
- (i) The probability that a life aged 20 exact will die before age 21.25 exact. 2
- (ii) The curtate expectation of a life aged 20 exact. 2
- (b) The mortality of a group of independent lives follows the ELT15 (Females) table. If  $k$  is the largest integer such that
- $P(k_{50} \geq k) \geq 0.9$  Calculate the value of  $k$ . 4
4. A pure endowment policy for a term of a  $n$  years payable by single premium is issued to life aged  $x$  at entry. 8

Thiele's equation for this benefit is

$$\frac{\partial}{\partial t} t\bar{V} = (\mu_x + t + \delta) t\bar{V}$$

Derive this result algebraically, showing all the steps in your argument.

5. Defining all the symbols that you use, write down formula to value the past and future service ill-health retirement benefits of a scheme with an ill health retirement pension of  $\frac{1}{100}$ th of final pensionable salary for each past year of service. Salaries are known for all members for the year preceding the valuation date. Final pensionable salary is defined to be average earnings over the previous three years.
6. You are using the following three-state illness-death model to price various sickness policies.



Using the notation, write down an expression for the expected present value of each of the following sickness benefits for a healthy life aged 30.

- (a) Rs. 3000 pa payable continuously throughout the first period of illness only, but ceasing at age 60. 3
- (b) Rs. 3000 pa payable continuously while ill, but ceasing at age 60. 2
- (c) Rs. 3000 pa payable continuously while ill provided that the life has been ill for at least one year. Again any benefit ceases to be paid at age 60. 3

7. A multiple decrement table is subject to two forces of decrement,  $\alpha$  and  $\beta$ . Under the assumption of a uniform distribution of the independent decrements over each year of age,  $(a^q)_x^\alpha = 0.15$  and

$(a^q)_x^\beta = 0.07$ . Calculate  $q_x^\alpha$  and  $q_x^\beta$

## SECTION-B

(Answer **any four** questions)

8. (a) (i) What are the conditions for equality of prospective and retrospective gross premium reserve ? 3
- (ii) Prove algebraically stating all the assumption that you make the equality of prospective and retrospective gross premium reserve for an endowment assurance contract. 5
- (b) (i) State why mortality profit or loss arises. 2
- (ii) At a start of a particular year a life insurance company had a portfolio of 5000 female pensioners, all aged exactly 60, who each receive an income of Rs. 10000 pa paid annually in arrears. 5

The company hold net premium reserves, calculated using PFA92C20 mortality and 4% pa interest.

During that year, 9 pensioners died, calculate the mortality profit or loss.

9. A life company sells 25-years with profit endowment assurance to lives aged 30 exact. The basic sum assured is Rs. 50000, 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 basis is as follows :
- Mortality : AM92 select
- Interest : 6% pa
- Expenses : Initial, 30% of the first year's premiums, payable at the start of the contract. Renewal, 5% of all premiums, including the first year, payable at the start of each year.
- (a) Show that the monthly premium is Rs. 130.91 8
- (b) Find the gross premium prospective reserve just before the start of the tenth year of the policy, assuming that bonuses have been declared according to the initial assumptions. 7
10. A life insurance company issues a three years unit-linked endowment assurance contract to a male life aged 62 exact under which level annual premiums of Rs. 10000 are payable in advance throughout the term of the policy or until earlier death. 85% of each year's premium is invested in units at the offer price. 15

There is a bid-offer spread in unit values, with the bid price being 95% of the offer price.

There is an annual management charges of 1.25% of the bid value of units. Management charges are deducted at the end of each year, before death or maturity benefits are paid.

On the death of the policyholder during the term of the policy, there is a benefit payable at the end of the year of death of Rs. 20000, or the bid value of the units allocated to the policy, if greater. On maturity, 115% of the full bid value of the units is payable.

The company hold unit reserves equal to the full bid value of the units. It sets up non-unit reserves to zeroise any negative non-unit fund cashflows, other than those occurring in the first year.

The life insurance company uses the following assumptions in carrying out profit tests of this contract.

Mortality : AM92 Ultimate  
Expenses : Initial Rs. 600  
Renewal Rs. 100 at the start of  
the second and third policy  
years.

Unit fund growth rate : 8% pa  
Non-unit fund interest rate : 4% pa  
Non-unit fund reserve basis : AM92 Ultimate  
mortality, interest  
4% pa  
Risk discount rate : 15% pa  
Calculate the profit margin on the contract.

11. (a) A life insurance company issues a joint-life annuity to a male, aged 68, and a female, aged 65. The annuity of Rs. 10000 pa is payable annually in arrears and continues until both lives have died.  
The insurance company values this benefit using PA92C20 mortality and 4% pa interest.
- (i) Calculate the expected present value of this annuity. 2
- (ii) Derive an expression for the variance of the present value of this annuity. 3
- (iii) If the insurance company charges a premium of Rs. 150000 for this policy, calculate the probability that it makes a profit on the contract. 5
- (b) Given that  $\mu_x = \frac{1}{100-x}$  for  $0 \leq x < 100$ , 5
- Calculate the value of  ${}_{30}q_{50} : {}_{60}q_{50}$
12. Derive a formula for the mean and variance of the present value of a deferred annuity due of 1 pa payable to a life aged  $x$ . Suppose that the deferment period is  $n$  years. 15
13. Define each of the following terms and give an example of each : 15
- (a) class selection
- (b) selective decrement
- (c) spurious selection
- (d) adverse selection
- (e) temporary initial selection