

**FELLOWSHIP EXAMINATION**  
**MATHEMATICAL BASIS OF LIFE ASSURANCE**

Reg. No.

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Time : 3 Hours ]

[ Total Marks : 100

Answer any **FIVE** questions only.  
All questions carry 20 marks each.

Q.1 Answer the following : 5 Marks Each

- a) Explain: Interim Bonus  
Tontine Bonus
- b) Give expression for the retrospective policy value and prospective policy value at the end of 35 years under a Whole Life Policy for a sum assured of Rupees 5,000/- effected on the life of a person at age 25 Annual premium under the policy were limited to 30 years. Show that two expressions are equal. Ignore expenses.
- c) Establish the relationship :  $A=1-d\ddot{a}$
- d) Calculate the net annual premium under a Children Deferred Whole Life Assurance for Rupees 5,000/- on the life of child aged 8, the assurance vesting at age 18 [Basis - LIC (1970) interest 6%  $\ddot{a}_{10}$ ]  $\} = 7.8017, \ddot{a}_{18} = 16.474, A_{18} = 0.06749$

Q.2 a) Given that  $A_x = 0.7115$  and  $a_x = 6.5$  calculate rate of interest. 5 Marks Each

- b) Calculate the true quarterly premium for a Whole Life Assurance of Rupees 75,000/- on the life of (30). Death benefit is payable immediately on death. Given: at 6%,  $P_{30} = 0.00742$
- c) Give an expression for bonus reserve policy value under on Endowment Assurance making provision for future expenses. Explain various symbols used in the expression.
- d) State the conditions necessary for Gross Premium Prospective Policy Values and Retrospective Policy Values to be equal.

Q.3 a) Calculate office annual premium for an Endowment Assurance for 10 Marks

- Rupees 25,000/- to a person aged 35 for 25 years. Provide for first year expenses at 40% of premiums and 10% sum Assured. Renewal expenses of 30% of premium and 5% Sum Assured. A Bonus Loading of 10% Sum Assured per annum.
- [Basis LIC (1970-73), 6% interest  $\ddot{a}_{35:25} = 13.086, A_{35:25} = 0.25931,$   
 $D_{35} = 12664.23, R_{35} = 516333.68, R_{60} = 132156.03, M_{60} = 10506.87, D_{60} = 24604.43]$

- b) On the basis of the LIC (1970-73) at 67, calculate the net annual premium for a sum assured of Rupees 50,000/- for the following Assurances on (40) 10 Marks
- i) Whole Life Assurance
  - ii) Whole Life Assurance, premiums limited to 20 years
  - iii) Endowment Assurance for 25 years
  - iv) Endowment Assurance for 25 years, premium limited to 15 years.
  - v) Deferred Temporary Assurance : commence at age 45 and then continue for 10 years.

Given:

$$\begin{array}{ll}
 M_{40} = 17625.63 & N_{40} = 1343014.73 \\
 M_{65} = 8119.74 & N_{60} = 249075.31 \\
 M_{45} = 16285.48 & N_{65} = 143668.44 \\
 M_{55} = 12716.28 & N_{55} = 403807.17 \\
 D_{65} = 16251.89 &
 \end{array}$$

- Q.4 a) The annual premium for a Whole Life Policy is 0.04 for five years, and 0.02 thereafter or 0.0475 for five years and 0.0175 thereafter find uniform annual whole life premium. 8 Marks
- b) The values of  $A_x$  on 6% basic is given below for a specified age range: 12 Marks

| $x$ | $A_x$   |
|-----|---------|
| 40  | 0.18822 |
| 41  | 0.19726 |
| 42  | 0.20655 |
| 43  | 0.21637 |
| 44  | 0.22641 |

Calculate in a tabular form the values of  $ax$  for all ages from 40 to 44.

- Q.5 An impaired life aged 35 wishes to effect an Endowment Assurance without profits for a Sum Assured of Rupees 10,000/- for a term of 20 years. A life office assumes that he is subject to mortality equivalent to that of a normal life aged 40. Calculate (a) the extra annual premium (b) the alternative debt that should be charged, reducing by a uniform amount every year so that the debt extinguishes at the end of 10 years. 20 Marks

Basis : LIC (1970-73) and 6% interest. Ignore expenses.

Given:

$$\begin{array}{ll}
 P_{35:\overline{20}|} = 0.02769 & P_{40:\overline{20}|} = 0.02900 \\
 \ddot{a}_{40:\overline{20}|} = 11.682 & A_{40:\overline{20}|} = 33876 \\
 M_{40} = 17625.63 & R_{41} = 407148.06 \\
 R_{41} = 246275.05 &
 \end{array}$$

Q.6 a) Express in the form of symbols, and also explain in words, the expressions : 6 Marks  
 “death strain at risk”, “expected death strain”, and “actual death strain”.

b) On 1 January 1996, an office issued a number of annual premium policies to a 14 Marks  
 group of lives, each of whom was then aged exactly 45. All policies were for  
 a term of 20 years and were of Endowment Assurance, Temporary Assurance,  
 and Pure Endowment types.

Assuming that there are no sources of decrement other than death, calculate  
 the profit/loss from mortality for the calendar year 2005, in respect of the  
 policies issued to this group of lives, given the following information:

| Type of policy      | Sum Assured in force at 1st January, 2005 | Sum Assured discontinued |
|---------------------|---|--------------------------|
| Endowment Assurance | Rupees 5,00,000/-                         | Rupees 8,000/-           |
| Temporary Assurance | Rupees 3,00,000/-                         | Rupees 4,000/-           |
| Pure Endowment      | Rupees 50,000/-                           | Rupees 1,000/-           |

Basis 4% p.a. interest. Ignore Expenses.

Given:

$$\begin{aligned} \ddot{a}_{45:\overline{20}|} &= 13.780 & \ddot{a}_{55:\overline{10}|} &= 8.219 \\ A_{45:\overline{20}|} &= 0.46998 & A_{45:\overline{20}|}^1 &= 0.05923 \\ A_{55:\overline{1}|} &= 0.68388 & A_{55:\overline{10}|}^1 &= 0.06037 \\ (D_{65}| \div D_{55}) &= 0.62351 & q_{54}| &= 0.003976 \end{aligned}$$

Q.7 Calculate the net annual premium for a life aged 25 in each of the under mentioned cases:

- a) Endowment Assurance for 20 years, premiums limited to 10 years. 6 Marks  
 b) A 20-years assurance under which the benefit on death during the term is twice 6 Marks  
 that payable on survival to the end of the term.  
 c) A deferred temporary assurance which is to commence at age 30 and then to 8 Marks  
 continue for 10 years.

$$\begin{aligned} N_{25} &= 1040000 & N_{35} &= 6370000 \\ N_{40} &= 482100 & N_{45} &= 353300 \\ D_{45} &= 22870 & M_{25} &= 16470 \\ M_{30} &= 15540 & M_{40} &= 13720 \\ M_{45} &= 12580 & & \end{aligned}$$

Q.8 A life office issued 750 identical 25-year Temporary Assurance Policies to lives aged  
 30 exact each with a Sum Assured of Rupees 75,000/- payable at the end of year of  
 death. Premiums are payable annually in advance for 20 years or until earlier death.

- a) Show that the annual net premium for each policy is approximately equal to 5 Marks  
 Rupees 104/- using the basis given below.

- b) Calculate the net premium reserve per policy at the start and at the end of the 20th year of the policy. 7 Marks
- c) Calculate the mortality profit or loss to the life office during the 20th year if twelve policyholders die during the first nineteen years of the policies and two policyholders die during the 20th year. 8 Marks

Basis: Interest: 4% per annum.

Given:

$$\ddot{a}_{30:\overline{20}|} = 14.0437 \quad A_{30:\overline{25}|}^1 = 0.01953$$

$$A_{50:\overline{5}|}^1 = 0.014014 \quad q_{49} = 0.002241$$

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