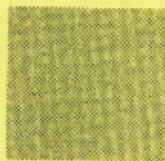


IC-104

Fellowship

**EXAMINATION
QUESTION
PAPERS
NOV. 2005**



भारतीय बीमा संस्थान
INSURANCE INSTITUTE OF INDIA
Universal Insurance Building,
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Mumbai - 400 001.

FELLOWSHIP EXAMINATION

MATHEMATICAL BASIS OF LIFE ASSURANCE

Time: 3 Hours]

[Total Marks : 100

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

Marks

1. a) If :-

6

$$\frac{\sqrt{1+2x} + \sqrt{4+6+3x}}{\sqrt{4-2x}}$$

is nearly equal to $a + bx$ find a and b .

b) Write short note on equation of value.

c) Value of an annuity of 1 p.a. for n years at any intermediate time ' t ' can be expressed in three different ways as shown below :-4
10

$$(i) (1+i)^t a_{\overline{n}|} \quad (ii) v^{n-t} S_{\overline{n}|} \quad (iii) S_t + \frac{a}{n-t}$$

explain it. Further verify it algebraically.

2. a) Fill in the blanks in the following portion of Life Table :

4

Age x	l_x	dx	qx	P_x
10	100,000		0.00409	
11			0.00370	0.99630
12		346		
13		337		
14			0.00342	0.99658

- b) Find the Probability that of two persons M and N aged 35 and 40 respectively.

- i) Both die after attaining age 60 2
 ii) M dies before age 70 while N dies after age 65 2
 iii) Both die before attaining age 65 2
 iv) Atleast one of them survives to age 70 2

c) Given that :-

X	35	40	60	65	70
l_x	973550	963206	811640	717436	591286

- c) Write down expressions for Probability in Terms of l_x in the under mentioned cases :-

- i) Life aged 55 survives for 15 years and dies in 16th or 17th year. 2
 ii) Of the three lives aged 60, 65, and 60 exactly two lives survive 10 years. 2
 iii) Of the two lives aged 70 and 75 at least one life dies before attaining age 80. 2
 iv) Life aged 50 dies between 65 and 70 2

3. a) Define commutation functions:

- i) D_x ii) C_x iii) M_x iv) R_x 4
 and get the expression for the present value of -

- a) Endowment Assurance b) Deffered Temporary Assurance in Terms of Commutation Functions. 4

- b) A person aged 34 years has taken a Fixed term (Marriage) Endowment Assurance of Rs. 100,000 for the marriage of his daughter (aged 9 years) for 13 years, hence find the value of the benefit at 7% p.a. interest given that $(1+i)^{13} = 2.40984$. 6

- c) From the table given below evaluate 6

- i) $2^P(21) + 1$ ii) ${}^1_2q(21) + 1$ iii) ${}^1q(22)$

Age of entry (x)	$L_{[x]}$	$L_{[x]+1}$	L_{x+2}	Attained age (x+2)
20	495396	494534	493633	22
21	494480	493620	492716	23
22	493566	492702	491797	24

4. a) Calculate the net annual premium for Double Endowment Assurance for basic Sum assured of Rs. 10,000 on the life aged 40 for a term of 10 years. Assume that the death benefit is payable immediately on death. 6
- Basic LIC (1970-73) table and 6% interest given :-

x	M_x	D_x	N_x
40	17625.63	93645.23	1343014.73
50	14654.66	49929.83	623195.21

- b) Establish algebraically 4
- $$a_x : \overline{n} | - a_x : \overline{n-1} | = Ax : \frac{1}{\overline{n} |}$$
- c) Obtain the expression for the present value of a life annuity of 1 p.a. payable to a person aged x and deferred for 't' years 10
5. a) Calculate the net annual premium for a life aged 30 years in each of the under mentioned cases :-

- i) Endowment Assurance for 25 years 4
 Premium limited to 15 years
- ii) A 20 years Assurance under which the benefit on death during the term is twice that payable on survival to the end of the term. The following commutation functions are given :- 4

$$M_{30} = 19800, M_{45} = 16285, M_{55} = 12715, M_{50} = 14655$$

$$D_{30} = 170760, D_{55} = 35570, D_{50} = 49930,$$

$$N_{30} = 2667000, N_{55} = 927300, N_{50} = 623200,$$

- b) A loan of Rs. 7,500 is to be repaid with interest at 8% p.a. by means of an immediate annuity for 10 years.
- Find the level payment
 - What will be the interest and principal contained in the 5th instalment?
 - What will be the principal outstanding immediately after the 8th payment is made?

Given at 8% :-

$$v^2 = 0.85734, \quad v^6 = 0.63017, \quad \frac{1}{a_{\overline{10}|}} = 0.14902$$

$$a_{\overline{6}|} = 4.6229, \quad a_{\overline{2}|} = 1.7833$$

- c) Enumerate various stages involved in the process of constructing a mortality Table.

6. a) Define the following Symbols :

$$n p_x, \quad l m q_x, \quad m l q_x, \quad \text{and} \quad m l n q_x$$

- b) The population of a city is 80 lakhs assuming that it is a stationary population experiencing H^m Mortality table, find the number of Schools and colleges the city needs on the basis of one School for every 1000 students. You may assume that 82% of the residents in the city who are aged 5 years or more but less than 15 years qualify for school and 61% of the residents who are aged 15 years or more but less than 20 years qualify for study at college.
7. a) Calculate office annual premium for an Endowment Assurance of Rs. 8,000 to a person aged 35 for 25 years. Provide for first year expenses at 60% of the premium and 16‰ (per thousand) sum assured renewal expenses of 6% of premiums and 5‰ (per thousand) sum assured.

- b) From the above data also calculate the office annual premium for a with profit Endowment Assurance by providing a bonus loading of 25% sum assured per annum. 6

Given :-

$$\ddot{a}_{35 : 25} = 13.086, \quad R_{35} = 51633.68$$

$$A_{35 : 25} = 0.25931, \quad R_{25} = 715813.78$$

$$M_{60} = 10506.87, \quad R_{60} = 132156.08$$

$$D_{25} = 229992.17, \quad D_{60} = 24604.43$$

$$D_{35} = 126664.93,$$

- c) Give expression for the prospective policy value and retrospective policy value at the end of t years under an Endowment Assurance Policy for term of n years. Annual premium under the policy are payable for a maximum of n years. Show that the two expressions are equal. Ignore expenses. 8
8. a) Briefly describe Gross premium method of valuation. 5
- b) Explain the concept of Estate in valuation? 5
- c) What is meant by Profit and Surplus in Life Insurance business? Explain whether they are affected due to changes in the valuation bases. 10

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