IC-104

Fellowship

EXAMINATION QUESTION PAPERS NOV.2007

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FL-81

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) Prove by general reasoning and algebraically that : 6
$id = i - d$

b) Write short note on equation of value . 4

c) Mr. B has taken loan of Rs. 10,000 at a rate of interest 6% p.a. payable half yearly . He repaid Rs. 2,000 after 3 years, a certain sum after 6 years and cleared all remaining dues of Rs. 8,857.22 at the end of 8 years from the commencement of the transaction . What is the certain sum paid by him at the end of 6 years ? 6

Given : $(1.03)^{16} = 1.60471$, $(1.03)^{10} = 1.34392$,
$(1.03)^{6} = 1.19405$, $(1.03)^{4} = 1.12551$

d) Prove that $S_{\overline{t}|} + a_{\overline{n-t}|} = (1+i)^t a_{\overline{n}|}$ 4

2. a) A borrower agrees to repay a loan of Rs. 6,000 by 15 annual repayments of Rs. 1,000, the first repayment instalment being due after 5 years . Find the annual yield for this transaction. 6

Given that :- $a_{\overline{19}|} = 8.9501$ @ 9% $a_{\overline{19}|} = 9.6036$ @ 8%

$a_{\overline{4}|} = 3.2397$ @ 9% $a_{\overline{4}|} = 3.3121$ @ 8%

b) Prove that :- $\frac{1}{a_{\overline{n}|}} = \frac{1}{s_{\overline{n}|}} + i$ 6

algebraically and also by general reasoning

c) A loan of Rs. 12,000 repayable by level yearly instalments of principal and interest in arrear over 10 years, was granted 4 years ago. Interest on the loan was @ 8% p.a. effective. Immediately after payment of the fourth instalment, the borrower requests that the principal then outstanding shall be repaid by level instalments of principal and interest payable yearly in arrear over the next 8 years . The lender agrees to this proposal on the condition that the revised instalment shall be such as to give him a return on the whole transaction, from the time when the original loan was granted until it is finally repaid, of 9% p.a. effective. Calculate the revised instalment. 8

Given that :- @ 8% $a_{\overline{10}|} = 6.7101$, $(1.09)^4 = 1.41158$ and

@ 9% $a_{\overline{8}|} = 5.5348$

3. a) The probability that a person aged 35 years dies in 5 years is 0.05, that a person aged 40 dies in 5 years is 0.06 and that a person aged 45 years dies in 5 years is 0.08 . Find the probability that of the three person aged 35, 40 and 45 years respectively. 10

i) exactly one survives 5 years
ii) the person aged 35 dies between ages 45 and 50
iii) at least one survives 5 years
iv) at least one dies in 5 years.

b) Write down expression in terms of l_x function for the probability that out of the three lives aged 50 years and four lives aged 60 years, only two lives aged 50 and one life aged 60 survive 15 years. 6

c) The total population of city is 70 lakhs . Assuming that it is a stationary population experiencing H^m mortality, find 4

i) The number of persons who are aged 35 years or more but less than 55 years .
ii) The number of persons who have not attained the majority i.e. who are less than 21 years of age .

Given :-

$T_0 = 6082031$, $T_{35} = 2674686$, $T_{55} = 1126680$,

$T_{21} = 3948451$.

4. a) An employee of an institution has to retire at age 60. A gratuity benefit of one month's salary for each year of service subject to a maximum of benefit of 20 months' salary is payable to an employee on retirement or death, as the case may be . 12

Find the probability that :

i) full gratuity benefit will be payable to a person aged 30, who has just now completed 10 years of service .

ii) the gratuity benefit will not exceed 15 months' salary .

iii) the gratuity benefit payable will be at least 17 months' salary.

iv) the employee earns at least 17 months' salary as gratuity benefit payable at death .

Given that :-

$l_{30} = 980776$, $l_{35} = 973550$,

$l_{37} = 969941$, $l_{40} = 963206$

$l_{60} = 811640$

b) Fill up the blanks in the following portion of a life table . 8

Age X	l_x	d_x	q_x	P_x
15	999999	.....	0.00132	.....
16	.....	.....	0.00131	.....
17	.....	1306	.....	.....
18	.....	.....	.....	0.99870
19	.....	.....	0.00130	.....

5. a) Explain the 'calender year method' of mortality investigation and enumerate its advantages and disadvantages . 10

b) A person aged 45 had taken a 20 year 'educational annuity' when he was 25 years old . The annuity of Rs. 1,000 per half-year for five years commencing after six months is due to him now. He desires to have lumpsum payment in lieu of ten half-yearly payments. Find the present value of the benefits at 6% p. a. interest . 8

Given that : $a_{\overline{5}|} = 4.2124$ @ 6%

$(1.06)^{1/2} = 1.029563$

c) Show that : $a_{x:\overline{n}|} - a_{x:\overline{n-1}|} = \frac{Dx + n}{Dx}$ 2

6. a) Calculate for a life aged 35, the net annual premium in each of undermentioned cases . 10

i) A Double Endowment Assurance for 20 years for basic sum assured of Rs. 1,00,000.

ii) A 15 year assurance under which the benefit on death during the term is twice that payable on survival to the end of the term.

iii) Endowment Assurance for 20 years premium limited to 15 years.

iv) Deferred Temporary Assurance - the assurance to commence at age 50 and then to continue for next 5 years .

Given :

$M_{35} = 18747$ $N_{35} = 1906522$ $D_{35} = 126664$

$M_{50} = 14654$ $N_{50} = 623195$ $D_{50} = 49929$

$M_{55} = 12716$ $N_{55} = 403807$ $D_{55} = 35573$

b) Calculate the single premium under a two year temporary Assurance for sum assured of Rs. 1,00,000 on a person aged 45 . Provide for expenses of 9% of single premium and 2‰ sum assured . 4

Given :

$M_{45} = 16285$ $M_{47} = 15669$ $D_{45} = 68774$

c) Write down the expression for office premium for a without profit endowment assurance for sum assured of Rs. 25,000 to a person aged 30 years and for term of 20 years. First year expenses are I_1 per unit of premium and I_2 per unit of sum assured and renewal expenses relating to subsequent years are k_1 per unit of premium and k_2 per unit of sum assured. Also Q per unit sum assured as constant addition for contingencies purpose . 6

7. a) A Life office issues a special Marriage Endowment (with profit) policy under which the sum assured with bonus (at the rate of 'b' per annum per unit sum assured) is payable on completion of the term 'n' years, irrespective of the survival or death of the life assured till the end of the term. In case of death before the expiry of the term, an additional amount equivalent to the sum assured is payable and the subsequent

premiums are waived; however, the policy will continue to earn bonus. The benefit are secured by the annual premiums payable in advance during the term of the policy.

i) Write an expression for the annual premium. 2

ii) Derive expressions for retrospective reserves at the end of 1st year, 2nd year and t^{th} year ($t < n$). 6

iii) Write an expression for prospective reserves at the end of t^{th} year and show that this equals retrospective reserves derived under (ii) above. Ignore Expenses. 6

b) Calculate the net annual premium for an Endowment Assurance of Rs. 25,000 for a period of 25 years for a person aged 30, on LIC (1970-73) ultimate mortality basis @6% 6

Given that : $a_{30:\overline{24}|} = 12.253$

8. a) Calculate the net annual premium ceasing after 15 years or at previous death for a Money Back Policy on a life aged 40 years, to secure the following benefits. 8

i) Rs. 5,000 on survivance to the end of 10 years.

ii) Rs. 10,000 on survivance to the end of 15 years.

iii) Rs. 15,000 on death any time within 15 years.

Given at 6%: $N_{40} = 1343014$ $N_{55} = 403807$
$D_{40} = 93645$ $D_{50} = 49929$
$D_{55} = 35573$ $M_{40} = 17625$
$M_{55} = 12716$

b) Given that the rate of interest is 4.5638% and $a_x = 8.0142$, Find the value of A_x and P_x 8

c) Prove that $A_{x+t} = \frac{Dx}{D_{x+t}} \left| P - A \frac{1}{x:\overline{t}|} \right|$ 4

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