

OCTOBER, 2010

FELLOWSHIP EXAMINATION
 MATHEMATICAL BASIS OF LIFE ASSURANCE

Time: 3 Hours]

[Total Marks : 100

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

1. i) A mortality table has a select period of three years. Calculate ${}_3p_{53}$ Marks
5
 given that :-

$${}_1q_{[50]} = 0.015 \quad {}_2p_{[50]} = 0.95$$

$${}_{21}q_{[50]} = 0.025 \quad {}_{2|3}q_{[50]+1} = 0.092$$

- ii) If $l_{40} = 1000$ and $l_{40+t} = l_{40} - 5t$ for $t = 1, 2, 3, \dots, 10$ 5

Calculate the value of $A_{40:\overline{10}|}$ at 6% p.a. interest.

Given: $a_{\overline{10}|} = 7.3601$, $v^{10} = 0.55839$

- iii) Of two persons 'A' aged 35 and 'B' aged 42 find the probability that : 10
- A and B both survive 10 years
 - A and B both die within 10 years
 - One of the two lives survives 10 years while the other dies within that period.
 - At least one survives 10 years.

Given: $l_{35} = 973550$ $l_{45} = 946656$

$l_{42} = 904837$ $l_{52} = 904837$

2. a) A sum of Rs.1000 is due at the end of 10 years 6 months. The present interest rates are 7% p.a. but it is expected that there will be a fall in interest rates after 6 years bringing down the rate to 6% p.a. Find the present value of the sum of money under these assumptions. 5

Given :- $v^{4.5}_{@6\%} = 0.7693$; $v^6_{@7\%} = 0.6663$

- b) Repeat the above calculations if in the above problem the rates of interests are 5% p.a. convertible half-yearly and 6% p.a. convertible quarterly in place of 7% p.a. and 6% p.a. respectively. 7

Given :- $V_{@ 5.0625\%}^{4.5} = 0.8007$ $V_{@ 6.1363\%}^6 = 0.6995$

- c) Find the gross and net rates of interest earned by a life insurance company in a certain financial year, given the following particular from the revenue account of the financial year. 8

| | Rs. |
|--|-----------|
| Fund at 1 st April 2009 | 50,00,000 |
| Premium income during financial year 2009-10 | 5,00,000 |
| Claim and Surrenders | 2,50,000 |
| Expenses of Management | 50,000 |
| Gross interest earned | 3,60,000 |
| Income tax | 80,000 |

3. A loan of Rs.10,000 is to be repaid over 20 years by equal yearly instalments. The instalments of repayment give the lender an effective rate of interest @ 15% per annum on his capital throughout and enable him to replace the Capital by a fund Sinking to accumulate at an effective rate of 10% per annum. 5 each

Find :-

- a) the yearly instalment,
- b) Capital Contained in 10th instalment,
- c) Interest Contained in 15th instalment,
- d) the principal repaid after 16 instalments have been paid.

Given : at 10% $a_{\overline{20}|} = 8.5136$, $v^{11} = .35049$, $v^6 = .56447$

$$a_{\overline{4}|} = 3.1699$$

4. i) Explain in words what is meant by ${}_5|_3 \overline{9} |_{[35]} + 1$ for a 2 year select mortality table calculate its value given that : 6

$$l_{41} = 28305 \quad l_{45} = 27005 \quad l_{[35]} + 1 = 29800$$

- ii) List the stages involved in construction of mortality table. 5

iii) A mortality is to be constructed by using census method.

The following data has been extracted :

| Age last Birthday on Census date | No. of in-force policies as at 01.04.2008 Curtate duration | | | No. of in-force policies as at 01.04.2009 Curtate duration | | | Deaths during 01.04.08 to 01.04.09 Curtate duration | | |
|-------------------------------------|---|------|-----------|---|------|-----------|--|---|-----------|
| | 0 | 1 | 2and more | 0 | 1 | 2and more | 0 | 1 | 2and more |
| 25 | 1510 | 1020 | 8050 | 1820 | 1670 | 8900 | 9 | 6 | 90 |
| 26 | 1620 | 1010 | 7510 | 1780 | 1650 | 8800 | 8 | 7 | 85 |

Find the values of :

- a) ${}_9p_{[25]}$
 b) ${}_9p_{[24]} + 1$
 c) ${}_9p_{25}$

5. Calculate for life aged 25 for 1000 Sum assured :-

4 each

- a) Net Single Premium for a 20 year Temporary Assurance.
 b) Net annual premium for 20 year Limited Payment Whole Life Assurance.
 c) Net annual premium for Double Endowment Assurance for 20 years
 d) Net annual premium for Endowment Assurance for 20 years, premium limited to 10 years.
 e) Net annual premium for a deferred Temporary Assurance which is to commence at age 30 and then to continue for 10 years and payable for 20 years.

| Given :- | x | D_x | M_x | N_x |
|----------|-----|-------|-------|---------|
| | 25 | 38080 | 16470 | 1040000 |
| | 30 | 34860 | 15540 | 832600 |
| | 35 | 30200 | 14630 | 637000 |
| | 40 | 25830 | 13720 | 482100 |
| | 45 | 22870 | 12580 | 353300 |

6. a) Prove that :

5 each

$$i) \quad {}_tV_{x:\overline{n}|} = \frac{P_{x+t:\overline{n-t}|} - P_{x:\overline{n}|}}{P_{x+t:\overline{n-t}|} + d}$$

$$\text{ii) } {}_tV_{x:\overline{n}|} = 1 - \frac{\ddot{a}_{x+t:\overline{n-t}|}}{\ddot{a}_{x:\overline{n}|}}$$

- b) i) Given that $A_x = .7115$ and $P_x = .0395$ 5 each

Find a_x and rate of interest.

- ii) Calculate the true quarterly premium for a Whole Life Assurance of Rs.40,000 on the life of (30). Death benefit is payable immediately on death.

Given : at 6% $P_{30} = .00742$

7. a) Describe the 'Selection against the Insurer'. 4
 b) Calculate office single premium under a 2 year Temporary Assurance for sum assured Rs.50,000/- on age 30 years. Provided for expenses at 8% of single premium and 3% sum assured. 6

Given : @6% $M_{30} = 19801.59$,
 $M_{32} = 19374.88$,
 $D_{30} = 170763.39$

- c) The net annual premium ceasing after 15 years or at previous death for a money back policy on (45) is to be Rs.700/-. 10

Calculate office annual premium by providing following expenses :-

| | First year expenses | Renewal expenses |
|----------------|---------------------|------------------|
| On Premium | 50% | 5% |
| On Sum Assured | 15% | 6% |

Bonus loading of 20% sum assured required. Sum assured is Rs.5000.

Given : @6% $N_{45} = 927313.11$ $N_{60} = 249057.31$
 $D_{45} = 68774.85$ $D_{60} = 24604.43$
 $R_{45} = 339218.67$ $R_{60} = 132156.08$
 $M_{60} = 10506.87$

8. a) i) If P_x is the annual premium under a whole life assurance family to a life aged x , then show that : 4
 $({}^tV_x + P_x) (1+i) = {}^{t+1}V_x + q_{x+t} (1 - {}^{t+1}V_x)$

- ii) Explain the above by general reasoning. 2
- iii) Explain what is meant by 'actual death strain' and 'expected death strain' 2
- b) A 20 year special endowment assurance policy is issued to a group of lives aged 45 exact. Each policy provides a sum assured of Rs. 10000 payable at the end of year of death or Rs. 20000 payable if the live survives until the maturity date. Premiums on the policy are payable annually in advance for 15 years or until earlier death. 12

Given that : i) Number of deaths during the 13th policy year = 4.
 ii) Number of policies in force at the end of 13th policy year = 195

Calculate the profit or loss arising from mortality in 13th policy year and comment on your results.

$$\ddot{a}_{45:\overline{15}|} = 11.386 ; \quad A_{45:\overline{20}|} = 0.46998 ; \quad V_{20}^{20} P_{45} = 0.41075;$$

$$\ddot{a}_{58:\overline{2}|} = 1.955 ; \quad A_{58:\overline{7}|} = 0.76516 ; \quad V_7^7 P_{58} = 0.71209;$$

$$q_{57} = 0.00565$$

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