FELLOWSHIP EXAMINATION
MATHEMATICAL BASIS OF LIFE ASSURANCE

Answer ANY FIVE questions only.
All questions carries 20 marks each.

Q.1 a) Explain why provision is needed for the revival of lapsed Policies at the time of Valuation. Indicate the method of arriving at this provision.

b) On the basis of LIC (1970 - 73) Table and 6% interest calculate net annual premium for an Endowment Assurance for ₹ 10,000/- on the life of (30) for term of 30 Years. Death benefit is payable immediately on death.
[Given: M_{30} = 19801.59, M_{60} = 10506.87, D_{60} = 24604.43, N_{30} = 2666994.53, N_{60} = 249057.31]

c) Find the present value at the rate of 6% of 4 annual payments of ₹ 200/- p. a. followed by 7 annual payments of ₹ 350/- p. a., the first payment being made at the end of one year.

d) In lieu of a single payment of ₹ 1000 at the present moment a person agrees to receive three equal payments at the end of 3 years, 6 years and 10 years respectively. Assuming a rate of interest of 6 % p. a. what should be the value of each of the three payments?

Q.2 a) Find the office annual premium for a capital redemption assurance policy of ₹ 3000/- redeemable at the end of 20 years, assuming interest rate of 6% p. a. and a loading of 8% of office premium.

b) Define ‘Central Death Rate’ \( m_x \) and derive \( q_x = \frac{2 \cdot m_x}{2 + m_x} \)

c) Describe the various methods that can be used for comparing two mortality tables.

d) What is the benefit that is represented by \( a_{x:n} - a_{x:x} \) ?

Q.3 A policyholder of aged 30 yrs exact has taken a life insurance policy

i) A death benefit of ₹ 2 lacs through out the policy term.

ii) A survival benefit of ₹ 50,000 each on surviving to ‘n’, (n -1), (n-2) and (n-3) years, where ‘n’ is the policy term.

iii) A guaranteed addition of ₹ 2500 for each year’s premium paid. The policy term is 20 yrs. The premium paying term is 16 yrs. The expenses are:
First year: 20% of annual premium
2nd year onwards: 6% of annual premium
Fixed expenses:
First year: 2000
2nd year onwards: 500

a) Find the office premium.

b) Find the gross premium prospective value at the end of 11th year.
Given: \( M_{30} = 19801.59; M_{50} = 14654.66; D_{30} = 170763.39; D_{50} = 49929.83 \)
\( D_{60} = 53297.64; D_{80} = 56854.24; D_{97} = 60610.95; D_{46} = 64580.22 \)
\( R_{30} = 613219.70; R_{50} = 260929.71; N_{30} = 2666994.53 \)
\( N_{50} = 62395.21; M_{41} = 17378.26; D_{41} = 88097.22 \)
\( N_{41} = 1249369.50 \)

Q.4 a) Calculate office annual premium by providing for first year expenses at 55% of premium and 17 % Sum Assured and renewal expenses at 5% of premium and 6% Sum Assured. Consider the policy on with profit plan and
provide for bonus loading of ₹ 20% Sum Assured per year. Net premium is ₹ 349.04 and Sum Assured is ₹ 6,000/-
Basis : LIC (1970-73) table, 6% interest rate.
Given : āₜₚₚₚ = 9.862
(I)ₚₚₚₚ = 6.08545
b) A Person now aged 61 desires to purchase a deferred annuity vesting from age 71. The annuity will be payable yearly in arrear for 15 years certain and thereafter during his lifetime. Calculate the annual premium payable during the deferment period for annuity of ₹ 2000/- p.a. Basis : a (90) table with rating down of age by 3 years and 8% interest.
Given : D₉₃ = 541.97, D₉₈ = 4058.24
ā₈₃ = 3.989

Q.5 a) Derive the relationship between policy values in successive years \((V + P) (1 + i) = v_{t} V + q \cdot (S - v_{t} V)\)
where \(v_{t} V\) and \(v_{t+1} V\) are Policy value at time ‘t’ and ‘t + 1’ respectively, ‘P’ is office annual premium, ‘S’ is Sum Assured and ‘q’ is mortality rate. Ignore expenses.

b) Using the above relationship give the expression for Expected death strain and Actual death strain. You many make further assumptions if any.

c) Using the above, give the expression for mortality profit.

Q.6. a) Discuss the following methods of valuation:
- Net Premium method of valuation.
- Modified net premium method of valuation.
- Gross premium method of valuation.
- Gross premium Bonus reserve method of valuation

b) Explain the term new Business Strain.

Q.7 a) Give expressions for the prospective policy value and retrospective policy Value at the end of 3 years under an Endowment Assurance Policy for a Unit sum assured, effected on the life of a person at age x for term of n years. Annual Premiums under the policy are payable for a maximum of n years. Show that the two expressions are equal. Ignore expenses

b) What are the advantages and disadvantages of a gross premium valuation as compared to net premium valuation?

c) Explain Simple reversionary bonus system of distributing surplus and discuss its advantages over other systems in vogue.

Q.8 An Endowment Assurance for ₹ 1,00,000 effected on a life aged 40 years for a period of 20 years with the condition that in the event of death before maturity in addition the sum assured being payable all premiums paid are be returned without interest has been in force for 10 years.
a) Calculate the Premium Payable under the Policy ignoring expenses.
b) The premiums under the policy have not been paid after 10 years. Find the amount of the free policy, payable at age 60 or earlier death, which can be granted for the surrender of the assurance, if
i) The premiums paid are still to be returned in the event of death before age 60
ii) The premiums paid are not so returnable.

You are given the following :
\(M_{40} = 14913.53, M_{50} = 12866.40, M_{60} = 9977.36, N_{40} = 1388990, N_{50} = 666779.16, N_{60} = 282692.16, R_{40} = 400360.05, R_{50} = 259913.08, R_{60} = 143646.95 \text{ and } D_{60} = 25978.81\)

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