

IC-104

Fellowship  
**EXAMINATION  
QUESTION  
PAPERS  
MAY 2008**



भारतीय बीमा संस्थान  
**INSURANCE INSTITUTE OF INDIA**  
Universal Insurance Building,  
Sir P. M. Road, Fort,  
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) Define $i$ , $v$ and $d$ , and prove by general reasoning that $iv = d$ .   | 5     |
|    | b) An investment fund has a value of Rs. 96,000 at the beginning of the year. A deposit of Rs. 19,200 was made at the end of 4 months. A withdrawal of Rs. 30,720 was made at the end of 7 months. The fund at the end of the year is Rs. 96,000. Find the rate of interest earned by the fund assuming simple interest during the year.   | 5     |
|    | c) At an effective annual rate of interest $i$ , each of the following two sets of payments have the present value of Rs. $k$ :  | 5     |
|    | i) An initial payment of Rs. 121 and another payment of Rs. 121 at the end of 1 year.  |       |
|    | ii) A payment of Rs. 144 at the end of 2 years and another payment of Rs. 144 at the end of 3 years.   |       |
|    | Calculate $i$ and $k$  |       |
|    | d) Ramesh puts Rs. 25,000 into a special bank account that pays an annual effective interest rate of 5% for 8 years. If a withdrawal from the account is made during the first $5\frac{1}{2}$ years, a penalty of 4% of the amount withdrawn is made. Ramesh withdraws Rs. $k$ at the end of each of the years 4, 5 and 6. The balance in the account at the end of 8 years is Rs. 15,000. Calculate $k$ . | 5     |
|    | Given at 5% : $(1+i)^2 = 1.1025$ , $(1+i)^3 = 1.1576$ ,<br>$(1+i)^4 = 1.2155$ and $(1+i)^5 = 1.4775$   |       |
| 2. | a) Prove both algebraically and by general reasoning that  | 8     |
|    | $a_x = vPx \times \ddot{a}_x + 1$  |       |
|    | b) Define and write expressions for $e_x$ and $e_x^o$ , and prove that $e_x^o = e_x + \frac{1}{2}$   | 8     |
|    | c) What conditions should be satisfied for a population to be stationary?  | 4     |

5. a) A Society consisting of 10000 members all aged 60 contribute Rs. 1,000 annually starting in one year's time for 10 years such that the accumulated amount in the fund is equally divided by the survivors at the end of 10 years. The contribution is made by members as long as they are alive. Assuming that the group experiences a(90) mortality and fund earns 8% p.a., find the expected amount each survivor is likely to get at the end of 10 years. 6

Given @ 8%  $D_{60} = 8786.01$   $D_{70} = 3275.49$

$a_{60} = 8.65$   $a_{70} = 6.708$

b) Show that 
$$\frac{(n+1) C_r \cdot n P_{r+1}}{n C_{r+1} \cdot (n+1) P_r} = r+1$$
 3

- c) How many 5 digit numbers can be formed using all the digits 1, 2, 3, 4 & 5 such that the resulting number is divisible by 3 3

- d) The probability that a person aged 40 dies within a year is 0.002 and the probability that a person aged 41 dies within a year is 0.003 8

In respect of 2 persons X & Y aged 40 & 41 respectively calculate :

- Atleast one die within one year
- Both survive one year
- X survives 2 years
- Both die before their 42<sup>nd</sup> birthday.

6. a) Three cards are drawn at random from a pack of playing cards. Find the probability that : 6

- All three are Black
- All three are Kings
- Atleast one is an Ace

- b) Show by general reasoning that 4

$${}_t|a_x:\overline{n} = a_x:\overline{n+t} - a_x:\overline{t}$$



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- c) An investor has the following **three (3)** options :
- Invest Rs. 1,000 at the beginning of every year for 5 years for a return of Rs. 5,600 at the end of 5 years.
  - Invest Rs. 2,000 now and Rs. 3,000 at the end of 3<sup>rd</sup> year to get Rs. 5,800 at the end of 5 years.
  - Invest Rs. 1,500 at the end of every year for 5 years for a return of Rs. 7,800 at the end of 6<sup>th</sup> year.

Which option should the investor choose and why, if the investor expects a minimum return of 6% on his investments?

Given : @6% :  $\ddot{a}_{\overline{5}|} = 4.465106$ ,  $v = 0.943396$ ,  $v^3 = 0.839619$   
 $v^5 = 0.747258$   $v^6 = 0.704961$

7. a) A life office issues a special Endowment Assurance policy in which the first year premium is twice the subsequent premiums. Calculate the first year and subsequent yearly premium for a life aged 40 on the following basis.

<b>Mortality</b>	: LIC (1970-73) ultimate
<b>Interest</b>	: 6%
<b>Expenses</b>	: 1% of the sum Assured every year
<b>Sum Assured</b>	: Rs. 1,00,000
<b>Term</b>	: 10 yrs.
<b>Simple reversionary bonus</b>	: Rs. 20 per thousand sum assured (Bonus vests at the end of the policy anniversary)

You may assume that expenses are incurred in the beginning of the policy year and claim on death is paid at the end of year of death.

Given at 6% :

$D_{40} = 93645.23$	$D_{50} = 49929.83$
$N_{40} = 1343014.73$	$N_{50} = 623195.21$
$M_{40} = 17625.63$	$M_{50} = 14654.66$
$R_{40} = 424773.69$	$R_{50} = 260929.71$

- b) A policyholder effected at age 40 an endowment assurance policy for sum assured Rs. 50,000 for a term of 15 years, 5 years back. Ignoring

expenses and bonus loading, find the value of retrospective reserve immediately before the payment of the 6<sup>th</sup> premium.

Mortality : LIC(1970-73) ultimate  
Interest : 6%

Instead of paying the 6th premium, the policyholder at that time desires to convert the policy into a paid up policy. Calculate the paid up Sum Assured.

Given at 6% :

$M_{40} = 17625.63$	$M_{45} = 16285.48$	$M_{55} = 12716.28$
$N_{40} = 1343014.73$	$N_{45} = 927313.11$	$N_{55} = 403807.17$
$D_{45} = 68774.85$	$D_{55} = 35573.26$	

- a) Write a short note on graduation.
- b) Explain briefly
  - i) Interest Surplus
  - ii) New Business Strain
  - iii) Reserve for Early Payment of Claims

5  
15

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