INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

12th September 2018

Subject CT5 – General Insurance, Life and Health Contingencies

Time allowed: Three Hours (15.00 – 18.00 Hours)

Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

1. *Please read the instructions inside the cover page of answer booklet and instructions to examinees sent along with hall ticket carefully and follow without exception.*

2. *Mark allocations are shown in brackets.*

3. *Attempt all questions, beginning your answer to each question on a separate sheet. However, answers to objective type questions could be written on the same sheet.*

4. *Please check if you have received complete Question Paper and no page is missing. If so, kindly get new set of Question Paper from the Invigilator.*

AT THE END OF THE EXAMINATION

Please return your answer book and this question paper to the supervisor separately. You are not allowed to carry the question paper in any form with you.

Q. 1)   Calculate the probability of survival to age 55 exact using ELT15 (Males) for a life aged 35½ exact using two approximate methods stating any assumptions you make.   **[5]**

Q. 2)   A whole life contract for a life aged 47 exact provides a benefit of INR 1,000,000 payable at the end of the year of death. Calculate the expected present value and variance of benefits payable under this contract.
Basis:
Mortality: AM92 Ultimate
Interest: 4% per annum   **[4]**

Q. 3)   State & derive the relationship between $\ddot{a}_{x+1:\overline{n}|}$ and $a_{x:\overline{n}|}$ **[3]**

Q. 4)   Calculate the following –

   i) $A^1_{40:\overline{25}|}$ (2)

   ii) $\ddot{a}^{(4)}_{39:\overline{21}|}$ (2)

   iii) $(IA)_{30:\overline{15}|}$ (3)
Basis:
Mortality: AM92 Ultimate
Interest: 4% per annum   **[7]**

Q. 5)   Let K_{xy} be curate joint life expectation of x and y. Derive $P[K_{xy}=k] = {}_{k|}q_{xy}$ **[4]**

Q. 6)   **i)**   Why do insurance companies hold reserves?   (4)

   ii)   What are the conditions for equality of Gross Premium prospective and retrospective reserves?   (3)
   [7]

Q. 7)   A life insurance company sells a 20-year with-profits endowment assurance policy to a male life aged 30. The basic sum assured under this policy is INR 400,000.
The company expects to pay simple regular bonus at the rate of 40 per 1000 sum assured which would vest at the end of each policy year.
Calculate the net premium prospective reserve for this policy at time 7 assuming –
   • Premiums are payable annually in advance throughout the term of the policy
   • Bonuses declared till date have been in line with expectation
   • Death Benefit is payable at the end of policy year of death
   • Mortality is AM92 Ultimate and
   • Interest is 6% pa.   **[6]**

Q. 8)   A joint life whole life assurance with sum assured INR 100,000, payable at the end of the year of death of the first life to die, is sold to male lives aged 58 and female lives aged 56 both exact.

   i)   Calculate   the   annual   premium   payable   for   this   policy   assuming PMA92C20/PFA92C20 mortality rates, 4% per annum interest and zero expenses.   (3)

A number of such policies were sold on 1st April 2010. On 1st April 2017, 5000 such policies were still in-force. During the financial year 2017-18 ten claims were reported.

ii) Calculate the mortality surplus or deficit for the financial year 2017-18 assuming the reserving basis is the same as the pricing basis. (11)

[14]

Q. 9) **i)** Show the shape of the q_x and d_x curve. (2)

ii) Describe the use of risk classification by life insurance companies in underwriting life insurance policies and state two limitations to their use. (3)

[5]

Q. 10) **i)** An extract from a study undertaken by the United Nations to analyse the impact of climate on mortality is as below:

Age Group	Whole world		Temperate Zone		Mediterranean Zone	
	Population at risk (Lakhs)	Deaths (Thousand)	Population at risk (Lakhs)	Deaths (Thous and)	Population at risk (Lakhs)	Deaths (Thousa nd)
0-25	14400	1440	800	80	400	120
26-45	15600	3120	1600	320	1800	360
46-65	17200	10320	3800	1520	3600	1800
65-100	12800	30720	3000	7800	2800	5880

Assuming the Whole world as a standard population, calculate the crude death rates, standardized mortality rates and the standardized mortality ratio for the Temperate and Mediterranean zones. (5)

ii) It was suggested that another approach, to be called the standardized exposed to risk ratio (SERR), to measure the mortality experience in a particular climatic zone was to compute the ratio of the Population at risk estimated by a proxy method to the actual Population at risk for that climatic zone. The Population at risk would be estimated for a climatic zone by using the information on actual deaths within each age group and assuming they conform to the Whole world mortality rate for that age group.
Calculate the SERR for both climatic zones and comment on the results obtained in parts **(i)** and **(ii)**. (6)

[11]

Q. 11) **i)** A company operates a Pension Scheme to which members contribute at the rate of 5% of Salary per annum. Upon age retirement between ages 60 and 65, a member will receive a pension equal to one fiftieth of final salary for each year of service. Further, the company maintains a shadow account in respect of each member in which his contributions are credited. A notional interest rate of 2% per annum is credited to the shadow account. In case of a death in service, the balance as shown in the shadow account is paid to the legal heir of the member.

The company's performance appraisal cycle is for the twelve months ending 30th June. Final salary is defined as the average annual salary earned over the three years preceding retirement.

The Pension scheme is to be valued on 1st July 2018. At the valuation date, Sam was aged 40 exact having 20 years of past pensionable service. His earning was Rs. 55000 over the preceding 12 months. The balance in his shadow account is Rs. 15000 on the valuation date.

Using commutation functions calculate the expected present value of his pension benefits on the following basis:
Interest: - 4% per annum
Mortality; withdrawals; retirements; salary scale: as in the Pension Fund tables in Formula and Tables for Actuarial Examinations. (7)

ii) The actuary advising the trustees of the Pension Scheme is of the opinion that the decrements underlying the Pension Fund tables in Formula and Tables for Actuarial Examinations are not a good fit for this scheme. He has performed an analysis of the scheme's past experience and has come to the below conclusions:

The independent rate of mortality is 0.001 per year and the independent rate of withdrawal is 0.1 per year. Decrements due to death take place uniformly over the year in the associated single-decrement table. Due to spike in resignations post performance appraisal cycle, it can be seen that half of the decrements due to withdrawal occur uniformly over the year whereas the remaining occur at the end of the year.

Calculate the probability that Sam will die as an employee aged 41 last birthday. (Assume no decrements other than death and withdrawal). (4)

[11]

Q. 12) State three types of Health Insurance contracts and describe the features of any one in detail. **[4]**

Q. 13) A life insurance company issues a 3-year unit-linked endowment policy to a life aged 42 exact under which level premiums of Rs.10000 are payable at the start of policy year contingent upon survival. In the first policy year, 30% of the premium is allocated to units. In the second and third year, there is a premium allocation charge of 20% and 7.5% respectively. The units are subject to a bid-offer spread of 2.5% and an annual management charge of 1.25% of the bid value of units is deducted at the end of each policy year. Management charges are deducted from the unit fund before death, surrender and maturity benefits are paid. If the policyholder dies during the term of the policy, the death benefit of Rs. 20000 or the bid value of the units, whichever is higher, is payable at the end of the policy year of death. The policyholder may surrender the policy only at the end of each policy year. On surrender, the bid value of the units is payable at the end of the policy year of exit. On maturity, 115% of the bid value of the units is payable.

The company uses the following assumptions in carrying out profit tests of this contract:
Unit fund growth rate 9% per annum
Interest on non-unit fund cash flows 7% per annum
Mortality AM92 Select
Initial expenses Rs. 2000
Renewal expenses Rs. 750 per annum on the second and subsequent premium dates
Initial commission 10% of first premium
Renewal commission 3% of the second and subsequent years' premiums
Risk discount rate 13% per annum
Surrender rate in the first two years 10% of all policies still in force at the end of a year (prior to surrender).

i) Assuming that the company does not set up reserves, calculate the profit margin for the policy. (12)

ii) Assuming that the interest earned on reserves is equal to the risk discount rate, without doing any calculations state with reasons the impact on profit margin had the company set up reserves by zeroising future negative cashflows. (3)

iii) Calculate the expected reserve that must be set up at the end of each policy year, per policy in force at the start of each policy year assuming that the reserving basis is the same as the pricing basis, except for expenses and unit fund growth rate, which are prudent. The profit vector under the reserving basis is (3800.50, -760.10, -4532.25) (4)

[19]

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