

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

15th September 2016

**Subject CT5 – General Insurance, Life and
Health Contingencies**

Time allowed: Three Hours (10.30 – 13.30 Hrs)

Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

- 1. Please read the instructions on the front 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.

Q. 1) i) List the 6 real factors apart from age, sex and smoker status which impact the mortality and morbidity rates. (3)

ii) Describe how genetics could be a source of difference in mortality and morbidity rates and how this could be used as a tool for better underwriting (3)
[6]

Q. 2) Calculate the expected present value and standard deviation of a whole Life assurance contract sold to male life aged 40 exact which has a death benefit of Rs 100,000 during first 20 years and Rs 200,000 thereafter.

The benefit is paid at the end of the year of death.

Mortality: AM92 Ultimate

Interest rate: 6% per annum

[8]

Q. 3) A life insurance company sells a 15 year money back assurance product to life aged 50 years exact. Monthly premiums are paid in advance for first 10 policy years. Benefits provided are:

- Death benefit of Rs 1,000,000 throughout the 15 year period, paid at the end of the year of death
- Monthly income of Rs 10,000 at the start of every month starting 11th year up till the end of policy term if the policyholder survives.
- At the end of 15th year a maturity benefit of Rs 500,000 is paid if the policyholder survives.

Calculate the monthly premium using the equivalence principle.

Mortality: AM92 Ultimate

Interest rate: 6% per annum

[8]

Q. 4) Two years ago, a life insurance company sold a regular premium twenty year endowment to a male life then aged 45 years exact. Under the contract annual premiums of Rs 6,300 were payable annually in advance. A death benefit of Rs 100,000 was payable at the end of year of death if the policyholder died during the policy term. A maturity benefit of Rs 250,000 was payable at the end of policy term.

The company uses the following assumptions for pricing and reserving calculations:

Mortality: AM92 Ultimate

Interest rate: 6% per annum

Nil Expense and commission

The interest earned on assets backing the reserves during the last two years was 7.5% per annum. Also the above policy is fully in-force as on the current valuation date.

- i) Calculate the Prospective and Retrospective reserves as at the valuation date. (4)
- ii) Explain why the two reserves calculated above are not equal (2)

The company pays a surrender value equal to 75% of the prospective reserves to surrendering policyholders starting from year third policy year.

- iii) Describe how the prospective reserves get impacted if the company starts allowing for surrenders in calculation of prospective reserves? (2)
- iv) Explain, what should be a prudent assumption for surrender rates if the best estimate (realistic) assumption suggests an annual surrender rate of 10%. (2)

[10]

- Q. 5)** Calculate the single premium required to buy a joint life annuity issued to a male life (A) aged 65 years exact and a female life (B) aged 60 years exact, where an annual payment of Rs 100,000 is made to B if A dies within next 5 years leaving behind B. The payment will be made to B at the end of every year starting from the end of year of A's death, and will continue till B's 75th birthday or her earlier death.

Mortality: PA92C20

Interest rate: 4% per annum

[6]

- Q. 6)** A life now aged 35 years of age exact is subject to a force of mortality $\mu_x = 0.0005 + 0.001 * x$. Calculate the probability that the life:

- i) Dies before the age of 70 (3)
- ii) Survives till age 70 but dies before age 75 (3)

[6]

- Q. 7)** A life aged 65 years exact buys a single premium whole life assurance policy, which pays a death benefit of Rs 100,000 at the end of year of death. Mortality follows a select table with a one-year select period and the following values are provided

$$q_{[65]} = 0.75 * q_{65}$$

Also:

$$A_{65} = 0.5412 \text{ and } A_{66} = 0.5591$$

Calculate the single premium to be paid.

Assume an interest rate of 8% per annum and zero expenses.

[5]

- Q. 8)**
- i) Define Area Compatibility Factor and give its formula. (2)
 - ii) Mortality levels for country A have been studied at both national as well as regional level. Explain the case where Area Compatibility Factor for a particular region can be 1/2. (2)
 - iii) Explain how nutrition affects mortality as well as morbidity. (3)
 - iv) The company has produced the following data in respect of two locations - A and B. Calculate the standardised mortality ratio for each location based on the standard mortality table ELT15 (Males). (5)

	Location A		Location B			
	Initial To Risk	Exposed	Number of Deaths	Initial To Risk		Exposed
60	100		1	200		3
61	175		3	150		3
62	190		2	170		3
63	210		3	100		2

[12]

- Q. 9)** The unit price for an insurer's unitised with-profits (UWP) contracts on 1st January of a particular year is Rs 10. There is a guaranteed bonus interest rate of 1% per annum, and for the coming year (which is not a leap year) the discretionary bonus interest is to be 6% per annum, so that the overall increase in value would be 1.01×1.06 for the whole year. The bonus interest payments are on compound basis and are credited daily to the policy by increasing the unit price at the equivalent daily interest rates. A regular charge of Rs 1,000 is deducted on the 30th of each month (except in February, it is last day of the month) throughout the contract, paid for by cancelling units.

All unit transactions (allocations or cancellations) that take place on any individual day are calculated on the same unit price. A particular policyholder is paying a regular premium of Rs 1,000 per month, paid on the first day of every month.

On 1st March of this same year this policyholder holds 500 units at the start of the day, immediately prior to the payment of the monthly premium.

- i) Calculate the value of this policyholder's fund as on the end of 15th April of the same year. (5)
- ii) Assuming that the policyholder's fund on 15th April does have the value you have calculated in part (i), give two possible reasons why the surrender benefit payable on this day might be different from this amount. (2)

[7]

- Q. 10)** A life insurance company issues a 3-year unit-linked endowment assurance policy to a male life aged 45 exact. Level premiums of Rs 10,000 per annum are payable yearly in advance throughout the term of the policy or until earlier death. 95% of the premium is allocated to units in the first policy year, 100% in the second and third. A policy fee of Rs 500 is deducted from the bid value of units at the start of 1st year which increases at the rate of 10% p.a. The units are subject to a bid-offer spread of 5% on purchase. An annual management charge of 1.35% of the bid value of units is deducted at the end of each policy year after addition of interest. 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 100% of the bid value of the units is payable at the end of the policy year of death. On maturity, 100% of the bid value of the units is payable.

The policyholder may surrender the policy only in the first and second policy years. On surrender, the bid value of the units less a surrender penalty is payable at the end of the policy year of exit. The surrender penalty is Rs 2,500 at the end of the first policy year and Rs 1,500 at the end of the second policy year.

The company uses the following assumptions in carrying out profit tests of this contract:

Rate of growth on assets in the unit fund is 9.0% per annum

Rate of interest on non-unit fund cash flows is 6.0% per annum

Mortality 0.1% per annum at age 45 and increasing each year by 10% post age 45.

Initial expenses Rs 1,000

Renewal expenses Rs 500 per annum (without inflation) on the second and third premium dates

Initial commission 15% of first premium

Renewal commission 2.0% of the second and third years' premiums

Rate of expense inflation 2.0% per annum

Risk discount rate 12.0% per annum

In addition, you should assume that for first and second policy years, 12% and 6% respectively of policies still in force after deaths for that year surrender immediately.

- i) Calculate the New Business Margin (Present Value of Profit as a percentage of Premium) for the policy showing one table each for decrements, Unit Fund and Non Unit Fund. (14)
- ii) Calculate the New Business Margin (Present Value of Profit as a percentage of Premium) assuming maturity value is 102% of value of units. (2)

- iii) Calculate the New Business Margin in (i) above assuming, the company provides waiver of all future premiums on disability of the policyholder. Rate of disability is 2% per annum in all 3 years. Disability happens after death and surrenders, if any, for the year. Charge for this benefit is 3% per annum for age 45 increasing by 5% per annum and is deducted along with policy administration charge. However, due to this benefit being offered company has introduced additional underwriting which costs Rs 500 per policy. For considering disability outgo, present value can be taken at 0%. (6)
- iv) Comment whether the new business margin in (iii) has increased or decreased vis-a-vis (i) and discuss the reasons why. (1)
- [23]

Q. 11) Explain, the following terms in the context of the lapse rates of life insurance policies giving an example in each case:

- i) Class selection (2)
- ii) Temporary initial selection (2)
- iii) Time selection (2)
- [6]

Q. 12) A three-state transition model is as below:

Healthy to ill = σ_x

Ill to Healthy = ρ_x

Healthy to Dead = μ_x

Ill to dead = γ_x

Assume that the transition probabilities are constant at all ages with $\sigma = 2\%$, $\rho = 6\%$, $\mu = 1\%$ and $\gamma = 3\%$.

An able life age 45 exact takes out a 20-year sickness contract that provides a “no claim” bonus of Rs.1,000 if the insured remains Healthy for the full duration of the contract.

Calculate the expected present value of the bonus at the beginning of the contract with a force of interest of 0.04. [3]
