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**GARISSA UNIVERSITY**

**UNIVERSITY EXAMINATION 2019/2020 ACADEMIC YEAR THREE**

**SECOND SEMESTER EXAMINATION**

**SCHOOL OF PURE AND APPLIED SCIENCES**

 **FOR THE DEGREE OF BACHELOR OF INFORMATION SCIENCE**

**COURSE CODE: ACS 305**

**COURSE TITLE: LIFE CONTIGENCIES I**

**EXAMINATION DURATION: 2 HOURS**

**DATE: 19/11/2020 TIME: 12.00-2.00 PM**

**INSTRUCTION TO CANDIDATES**

* **The examination has FIVE (5) questions**
* **Question ONE (1) is COMPULSORY**
* **Choose any other TWO (2) questions from the remaining FOUR (4) questions**
* **Use sketch diagrams to illustrate your answer whenever necessary**
* **Do not carry mobile phones or any other written materials in examination room**
* **Do not write on this paper**

**This paper consists of FIVE (5) printed pages *please turn over***

**QUESTION ONE (COMPULSORY)**

1. Describe how education may affect mortality **[2 marks]**
2. Explain why lives are subdivided into separate groups for the analysis of mortality. **[3 marks]**
3. State three types of selection with an example for each. **[3 marks]**
4. Suppose and  are the only two independent modes of decrement and 

express  in terms of   **[5 marks]**

1. Draw a multiple state model diagram and label the diagram clearly **[6 marks]**
2. Derive (to the nearest integer) the median of the complete future lifetime of a person aged 30 exact who is subject to the force of mortality shown below:

$$μ\_{30+t}=\left\{\begin{array}{c}0.01, 0\leq t<10\\\\0.02, 10\leq t<20\\\\0.03, 20\leq t\end{array}\right.$$

 **[5 marks]**

1. Three employees of a manufacturing company are subject to two modes of decrement, mortality and withdrawal from employment.

The independent forces of mortality and withdrawal for employees aged 50 and 51 are given in the following table:

 Age  

 50 0.0010 0.15

 51 0.0015 0.10

Calculate, showing all your workings, the probability that new employee aged 50 exact will die as an employee at age 51 last birthday. State any assumptions that you make.  **[6 marks]**

**QUESTION TWO**

A life insurance company issues a three-year unit-linked endowment assurance policy to a life aged 58 exact under which level premiums of £3,000 are payable annually in advance throughout the term of the policy or until earlier death. The premium allocation rate (%) at time *t* is given by: [75 + 20*t*] where *t* = 0, 1 and 2. The units are subject to a bid-offer spread of 5%. An annual management charge of 0.75% of the bid value of units is deducted at the end of each policy year.

Management charges are deducted from the unit fund before any death, surrender or maturity benefits are paid.

If the policyholder dies during the term of the policy, the death benefit of £9,000 or the bid value of the units if 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 at the end of the policy year or on survival to the end of the term, the current bid value of the units is payable.

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

Rate of growth on assets in the unit fund 4% per annum

Rate of interest on non-unit fund cash flows 2% per annum

Mortality AM92 Select

Surrender 10% at the end of first, second and third

 policy years only

Initial expenses £275

Renewal expenses £70 per annum on the second and

 subsequent premium dates

Initial commission 5% of first premium

Renewal commission 2% of the second and subsequent years’

 premiums

Risk discount rate 6% per annum

1. Calculate the profit margin for the policy on the assumption that the company

does not zeroise future expected negative cash flows.  **[15 marks]**

1. Suppose the company sets up reserves in order to zeroise future negative expected cash flows, calculate the profit margin for the policy allowing for the cost of setting up these reserves.  **[5 marks]**

**QUESTION THREE**

1. A five-year unit-linked policy issued by an insurance company to a life aged 60 exact has the following profit vector:

(751.25, -321.06, -267.57, -192.05, 201.75)

1. Define the meaning of zeroisation in the context of this unit linked policy. **[2 marks]**
2. Explain why an insurance company might choose to zeroise the above profit vector.

 **[2 marks]**

1. Calculate, showing all your workings, the net present value of the profits of this policy after zeroisation.

Basis:

Mortality AM92 Ultimate

Rate of interest on non-unit fund cash flows 3.5% per annum

Risk discount rate 6.0% per annum **[6 marks]**

1. On 1 January 2012, a life insurance company issued joint life whole life assurance policies. Each policy was issued to a male life aged 65 exact and a female life aged 60 exact. A sum assured of 75,000 is payable immediately on the death of the second of the lives to die.

Premiums of 1,395.11 are payable annually in advance for each policy while at least one of the lives is alive.

At the beginning of 2014, there were 5997 policies in force. For all of these policies, both lives were still alive. During 2014, the following experience was observed:

1. for 2 policies, both lives died
2. for 12 policies, only the male life died
3. for 8 policies, only the female life died

Calculate, showing all your workings, the mortality profit or loss for the group of policies for the calendar year 2014.

Basis:

Mortality PMA92C20 for the male

PFA92C20 for the female

Rate of interest 4% per annum

Expenses Ignore **[10 marks]**

**QUESTION FOUR**

A life insurance company issues a 30-year with profits endowment assurance policy to a life aged 35 exact. The sum assured of £100,000 plus declared reversionary bonuses are payable on survival to the end of the term or immediately on death if earlier.

1. Show that the quarterly premium payable in advance throughout the term of the policy or until earlier death is approximately £616.

Pricing basis:

Mortality: AM92 Select

Interest: 6% per annum

Initial commission: 100% of the first quarterly premium

Initial expenses: £250 paid at policy commencement date

Renewal commission: 2.5% of each quarterly premium from the start of the second policy year

Renewal expenses: £45 at the start of the second and subsequent policy years

Claim expense: £500 on death; £250 on maturity

Future reversionary bonus: 1.92308% of the sum assured, compounded and vesting at the end of each policy year (i.e. the death benefit does not include any bonus relating to the policy year of death)  **[10 marks]**

1. At the end of the 25th policy year, the actual past bonus additions to the policy have been £145,000. Calculate the gross prospective policy reserve at the end of that policy year immediately before the premium then due.

Policy reserving basis:

Mortality: AM92 Ultimate

Interest: 4% per annum

Bonus loading: 4% of the sum assured and attaching bonuses, compounded and vesting at

 the end of each policy year

Renewal commission: 2.5% of each quarterly premium

Renewal expenses: £90 at the start of each policy year

Claim expense: £1,000 on death; £500 on maturity **[10 marks]**

**QUESTION FIVE**

On 1 January 2009, a life insurance company issued 10,000 joint life whole life assurance policies to couples. Each couple comprised one male life aged 60 exact and one female life aged 55 exact when the policy commenced. Under each policy, a sum assured of £100,000 is payable immediately on the death of the second of the lives to die.

Premiums under each policy are payable annually in advance while at least one of the lives is alive.

The life insurance company uses the following basis for calculating premiums and net premium reserves:

Mortality PMA92C20 for the male

PFA92C20 for the female

Interest 4% per annum

Expenses Nil

1. Calculate the annual premium payable under each policy **[7 marks]**
2. During the calendar year 2009, there was one claim for death benefit, in respect of a policy where both the male and the female life died during the year. In addition, there were 20 males and 10 females who died during the year.Calculate the mortality profit or loss for the group of 10,000 policies for the calendar year 2009. **[13 marks]**