Actuarial Society of South Africa

WRITTEN EXAMINATION

2 OCTOBER 2020

Subject A213 — Contingencies

Time allowed:
Two hours and fifteen minutes – exam time
20 minutes (at the end of the exam) – scan and upload time

INSTRUCTIONS TO THE CANDIDATE

1. *Once you've entered the Exam Platform, ensure that you have accessed the **Video Room** Invigilation link with both your camera and microphone on, before you attempt the exam. .*

2. *Your PC must be placed, and camera angled so that your writing area on your desk is visible to the invigilator.*

3. *Ensure that you have your candidate number handy to input as part of the exam. Write your candidate number at the top of each page. (DO NOT WRITE YOUR NAME.)*

4. *Your cell phone that will be used to scan your final answer scrip must be switched **OFF** during the 2hours and 15 minutes exam time. <u>Place your cell phone at the top of your exam pad / writing pages in view of the invigilator.</u>*

5. *You are strongly encouraged to use the first 15 minutes as reading time only, however, you may commence answering the paper whenever you are ready. You then have two hours to complete the paper.*

6. *Questions are only available in the Exam platform and may not be printed or copied outside of the Exam platform.*

7. *You are required to write your answers on a clean A4 exam pad. Write only on 1 side of the paper. Write your candidate number at the top of each page and number your pages.*

8. *Attempt all questions, beginning your answer to each question on a new page and numbering your answers clearly.*

9. *Write in black or dark blue pen.*

10. *You should show calculations where this is appropriate.*

11. *You MAY NOT use any computer program (e.g. email, MS Word or Excel), files or open any other browsers or browser tabs during the examination time.*

12. *Mark allocations are shown in brackets.*

13. *You may use additional scrap paper to make notes where this is appropriate. This paper MUST NOT BE SCANNED as part of your answer script.*

14. *Assume that months are all of equal length, unless otherwise stated.*

15. *At the end of the 2 hours and 15 minutes exam time, you must stop writing and may start scanning and uploading your script. Do not continue writing into upload time.*

16. *Access to your PC will be opened-up after the exam time so you can access your scanned file. You may now also switch on your cell phone to scan.*

17. *Scan ALL your answer pages to .pdf so that your candidate number at the top of the page is clear.*

18. *Save your .pdf scanned file using your candidate number as file name. (DO NOT USE YOUR NAME AS FILE NAME)*

19. *Transfer your .pdf script to your PC and click on the UPLOAD ANSWERS link below the exam paper link.*

20. *Upload your answer file into the Exam Platform and ensure you click on FINISH below the upload box and again on FINISH all and SUBMIT, **before** the 20 minute upload time is up. (If the status on the summary page indicates "Answer saved" your file was uploaded. You can click on Review attempt to see the file you've uploaded.)*

Note: The Actuarial Society of South Africa will not be held responsible for any late submissions or loss of data where candidates have not followed instructions as set out above.

END OF INSTRUCTIONS

QUESTION 1

i. Show that

$$_{t-s}q_{x+s} = \frac{(t-s)q_x}{(1-sq_x)}, \quad 0 \le s \le t \le 1$$

assuming a uniform distribution of deaths between integer ages.

[4]

For a certain African turtle population, $q_6 = 0.07$ and $q_7 = 0.08$.

ii. Calculate the probability that a turtle aged 6 exactly will die between ages six and a half and seven and a half, assuming a uniform distribution of deaths between consecutive birthdays.

[4]

[Total: 8]

QUESTION 2

i. Show, from first principles, that $\bar{A}_{x:\overline{n}|} = 1 - \delta\bar{a}_{x:\overline{n}|}$.
Clearly define all random variables used.

[4]

ii. The daughter of a billionaire receives an annuity from her father of R365 000 per annum payable continuously to fund her expensive taste in fashion.

Her father has stated that he would like her to become more independent and that payments to her will cease in ten years' time. She is currently 25 years exactly.

The following basis is applicable.
Interest: 5% p.a. effective

Mortality: $\mu_x = \begin{cases} 0.005 & ; \quad 25 \le x < 30 \\ 0.006 & ; \quad x \ge 30 \end{cases}$

   a. Calculate the expected present value of the annuity payments.

[5]

   b. Calculate the standard deviation of the annuity payments.

[9]

[Total: 18]

PLEASE TURN OVER

QUESTION 3

One of the trustees of an independent wildlife sanctuary has recently passed away and has left a portfolio of assets in her will. The portfolio is guaranteed to pay R100 000 in five years' time.

The R100 000 will be shared equally between the director of the wildlife sanctuary, currently aged 35 exactly, if still alive, the game ranger of the wildlife sanctuary, currently aged 30 exactly, if still alive, and a wildlife trust set up for the conservation of rhinos in South Africa.

Calculate the expected present value of the share due to the wildlife trust.

     Basis:
     Mortality: AM92 Ultimate
     Interest: 5% p.a. effective

Assume that the trust will continue to exist in future.

[Total: 7]

QUESTION 4

A life insurance company specialising in life insurance for individuals with home loans sells 20-year decreasing term assurance policies. The death benefit is R500 000 in the first year, R490 000 in the second year, and continues to decrease by R10 000 each year until the end of the term. The death benefit is payable at the end of the year of death.

Level premiums are payable annually in advance for the term of the policy, ceasing on earlier death.

Calculate the annual premium for an individual aged 40 exactly.

Basis:
Interest:	6% per annum effective
Mortality:	AM92 Select
Initial Expense:	R500
Initial Commission:	20% of the first annual premium
Renewal Expenses:	R200 per annum, increasing by 6% per annum, payable at the start of second and subsequent policy years with the first increase due at the start of the second policy year
Renewal Commission:	1% of each premium payable from the start of the second and subsequent policy years
Claims expense:	R500, increasing by R25 per annum from the second year onwards

[Total: 15]

PLEASE TURN OVER

QUESTION 5

i.   Explain why a life insurance company will need to set up reserves for the single premium life annuity contracts it has sold.

[3]

Ubuntu Life, a large South African life insurer, sells the following policies:

- 10-year term assurance policies with a sum assured of R100 000 payable at the end of the policy year of death. Level premiums for this contract are paid annually in advance.

- 10-year single premium temporary immediate annuity policies with a monthly benefit of R10 000 payable monthly in advance.

The company sold 2 000 term assurances to lives aged 50 exactly and 1 000 annuities to lives aged 55 exactly.

ii.   Calculate the death strain at risk for each type of policy at the end of the second year of the policies.

Basis:
Mortality: AM92 Ultimate
Interest: 4% p.a. effective
Ignore all expenses.

[9]

iii.   During the first policy year, there were 30 deaths from the term assurance policies and 50 deaths from the annuity policies. During the second policy year, there were 35 deaths from term assurance policies and 60 deaths from the annuity policies.

Calculate the total mortality profit or loss to the company during the second year using the basis in (ii) above.

[8]

iv.   Explain whether the mortality profit or loss calculated for the term assurance policies would be higher, lower or unchanged to that calculated in (iii) above in the following scenarios:

a.   Initial expenses are considered.   [3]

b.   AM92 Select is used for the mortality basis.

[3]

[Total: 26]

PLEASE TURN OVER

QUESTION 6

An elderly couple, the female aged 70 exactly and the male aged 68 exactly, purchased an annuity at a well-known insurance company.

The annuity pays R120 000 per annum, payable in arrears for as long as either of the lives are still alive.

Basis:
Interest: 4% p.a. effective
Mortality: PFA92C20 (Female) and PMA92C20 (Male)

i.   Calculate the expected present value of this benefit.

[3]

iii.   Calculate the probability that the insurance company makes a profit if the single premium for this policy is R900 000.

[6]

[Total: 9]

PLEASE TURN OVER

QUESTION 7

i.   Show that:

$$\bar{A}_{xy} = \bar{A}^1_{xy} + \bar{A}_{xy}^{\ \ 1}.$$

[3]

ii. Two business partners, one a smoker and the other a non-smoker, purchase a single premium 15-year term assurance policy. The benefits payable under the contract are as follow:

- If either of the lives die within 15 years, a sum assured of R800 000 is payable immediately on the first death if it is the non-smoker or R400 000 if it is the smoker.

- If the second life dies within the remainder of the 15-year term, a further sum assured of 50% of the benefit amount previously paid is payable immediately on the second death.

Calculate the single premium.

Basis:

Mortality:
$$\begin{cases} \mu_{\text{non-smoker}} = 0.03 & ; \quad \text{for all ages} \\ \mu_{\text{smoker}} = 0.04 & ; \quad \text{for all ages} \end{cases}$$

Interest: 7.25% p.a. effective
Expenses: None

[14]

[Total: 17]

[GRAND TOTAL 100]

END OF EXAMINATION