Actuarial Society of South Africa

WRITTEN EXAMINATION

25 MAY 2021

Subject A213 — Contingencies

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

INSTRUCTIONS TO THE CANDIDATE

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

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 2 hours 15 minutes examination**. Write your candidate number at the top of each page. (DO NOT WRITE YOUR NAME OR MEMBER NUMBER.)*

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

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 ASSA Exam Platform and may not be printed or copied outside of the ASSA Exam Platform.*

7. *You are required to write your answers on a clean A4 examination pad. Write only on 1 side of the paper 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) or files, nor open any other browser during the examination.*

12. *You may not make use of a Formulae and Tables book during the examination. Any such information that may be required will be provided to you within the examination.*

13. *Mark allocations are shown in brackets.*

14. *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.*

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

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

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

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

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

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

21. *Upload your answer file into the ASSA 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 have 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

Calculate the expected present value of the following benefit:

A lump sum benefit of R1 000 is payable to a male life currently aged 45 years exactly, if death occurs within 20 years of buying the policy. There is no survival benefit. Benefit payments are made at the end of year of death.

Basis:

Mortality such that: $\quad l_x = 115 - x \; for \; x \leq 115$

Interest: $\quad\quad\quad\quad$ 7.50% per annum

[Total 6]

QUESTION 2

i. Explain the terms 'unit fund' and 'non-unit fund' in the context of a unit-linked assurance contract.

[4]

ii. Explain the difference between a 'profit vector' and a 'profit signature'.

[2]

[Total 6]

QUESTION 3

An insurer issues a US Dollar denominated whole life assurance policy with a sum assured of $10 000, payable at the end of year of death, to a woman aged 35 exactly. Annual premiums of $92 are payable in advance for as long as the woman is alive.

i. Derive an expression for the future gross <u>profit</u> random variable at inception of this policy using the basis set out below. Simplify your expression as far as possible.

[3]

ii. Calculate the standard deviation of the insurer's profit on this contract using the basis below.

[6]

Basis:
Mortality: $\quad\quad\quad$ AM92 Select
Interest: $\quad\quad\quad\quad$ 4% per annum
Expenses: $\quad\quad\quad$ None

[Total 9]

PLEASE TURN OVER

QUESTION 4

A small insurer in South Africa sells 20-year temporary annuity policies. The annuity product makes annual payments of R180 000 payable in advance. Six hundred of these policies have just been sold to males currently aged 40 exactly.

A junior actuarial student has calculated the expected present value of the policies using an annuity factor based on the AM92 Ultimate mortality table and an interest rate of 1% per annum effective. However, a senior actuary has requested for the values to be calculated using AM92 Select mortality instead.

You are given that $\ddot{a}_{40:\overline{20|}} = 17.598$, at 1% per annum effective.

i.   Show that the corresponding Select mortality annuity factor value is approximately 17.601.

[7]

ii.   Hence, calculate the updated total expected present value of the 600 policies using the Select mortality basis.

[2]

[Total 9]

QUESTION 5

i.   Describe what is meant by a 'constant force of mortality' assumption.

[1]

Two independent lives, Jabu (aged 40 exactly) and Busi (aged 30 exactly), are subject to a constant force of mortality of 2% per annum.

ii.   Calculate the probability that Jabu dies first and then Busi dies within ten years after the death of Jabu.

[7]

[Total 8]

PLEASE TURN OVER

QUESTION 6

An insurer pays compound reversionary bonuses at a rate of 4% per annum on its book of with-profits whole of life policies. The sum assured is payable immediately on the death of the assured life. Premiums are payable monthly in advance ceasing when the policyholder dies or reaches age 65 if earlier.

i.   Show that the gross monthly premium for a sum assured of R1 200 000 for a life aged 45 exactly is approximately R7 400 using the basis below.

[8]

The marketing team has proposed that the bonus distribution methodology be changed to simple reversionary bonuses for new whole of life policies. Bonuses are declared at the end of each policy year. They have requested to keep the premium the same as before.

ii.   Calculate the revised simple bonus rates as a percentage of sum assured.

[6]

The product development actuary holds a different view and has suggested that a super compound method of distributing bonuses be adopted for new policies.

iii.   Suggest two reasons why an insurer might use the super compound distribution method as opposed to the compound distribution method.

[2]

Basis:
Mortality	AM92 Ultimate
Interest rate	4% per annum effective
Initial expenses	R1 500 and 2% of the first premium
Renewal expenses	1.5% of the second and subsequent premiums
Claim expenses	R250 incurred immediately on death

[Total 16]

PLEASE TURN OVER

QUESTION 7

A life insurer sells a policy with a term of ten years to a life aged 55 exactly. The policy provides a benefit of R100 000 payable immediately on death or on the earlier diagnosis of a critical illness.

If a policyholder had been paid the critical illness benefit, no further benefit is payable in the event of subsequent death within the term of the policy.

i. Draw a multi-state transition model for this policy, clearly labelling your diagram.

[3]

ii. Calculate the expected present value of the benefits under this policy, assuming that recovery from a critical illness event is not possible and using the following basis:

Basis:
Force of interest   10% per annum
Force of mortality from healthy   0.003 at all ages
Force of mortality from critical illness   0.009 at all ages
Force of critical illness   0.005 at all ages

[5]

[Total 8]

QUESTION 8

An insurer sells an annuity of R200 000 per annum payable annually in arrear in respect of two lives, a male and a female. Both lives are aged 50 exactly. The first payment is deferred until the end of the year in which the first of the two lives die. Following the death of the survivor, five additional annuity payments are made with the first payment at the end of the policy year in which the survivor has died.

Calculate the expected present value of this annuity, assuming that the mortality of the two lives is independent.

Basis:
Interest rate   4% per annum effective
Mortality (males)   PMA92C20
Mortality (females)   PFA92C20

[Total 12]

PLEASE TURN OVER

QUESTION 9

A small insurer issued 500, ten-year term assurance policies to lives aged 55 exactly on 1 January 2016. For each policy, the sum assured was R500 000 for the first five years and decreases to R250 000 thereafter. The sum assured is payable immediately on death and level annual premiums of R2 574.61 are payable in advance throughout the term of this policy until earlier death.

The company uses the following basis for calculating premiums and reserves:

Basis:
Mortality   AM92 Select
Interest   4% per annum
Expenses   Nil

i.   Calculate the retrospective reserve per policy as at 31 December 2020.

[5]

ii.   Describe the main risk of the above policy structure to the insurer.

[3]

There were in total 15 deaths during the years 2016 to 2019 inclusive. A further 13 deaths were experienced during 2020 following a global pandemic.

iii.   Calculate the total mortality profit or loss to the insurance company during 2020.

[4]

[Total 12]

PLEASE TURN OVER

QUESTION 10

i. Explain why an insurer would set up reserves for a single premium annuity policy.

[2]

On 1 March 2016, an insurer in a small country called Covivi sold a deferred annuity policy to a life aged 50 exactly. The policy pays annual benefits with the first payment being R10 000 and is payable from exact age 60 if the policyholder is alive at that time. The payments will continue annually thereafter during the policyholder's lifetime increasing by 1.923% per annum compound.

Level annual premiums of R11 818 are payable annually in advance for five years or until earlier death. If death occurs before age 60, the premiums paid prior to death are accumulated to the end of the year of death at a rate of interest of 1.923% per annum compound and paid to the policyholder's beneficiaries at the end of the year of death.

The actuarial team is currently calculating the reserves as at 1 March 2021 for this policy. The reserve is to be calculated in various parts as follows:

    A: Expected present value of future annuity payments plus
    B: Expected present value of death benefits plus
    C: Expected present value of future claim expenses less
    D: Expected present value of future premiums payable (if any)

ii. Calculate the expected present value of the future annuity payments as at 1 March 2021.

[4]

iii. Calculate the expected present value of the future death benefits payable as at 1 March 2021.

[7]

Due to the pandemic, the regulators in Covivi have updated the reserving methodology. The gross reserves to be held will no longer take account of future expenses.

iv. Hence calculate the reserve to be submitted to the regulator as at 1 March 2021.

[1]

Basis:

Mortality:	Before age 60	AM92 Ultimate
	After age 60	PMA92C20
Interest:	6% per annum	
Expenses:	Initial:	10% of the initial premium incurred at outset
	Renewal:	5% of each of the second and subsequent premiums payable at the time of the premium payment
	Claim:	R100 incurred at the time of payment of the death benefit

[Total 14]

[GRAND TOTAL 100]

END OF EXAMINATION