

EXAMINATION

10 April 2026 (am)

Subject A211 — Financial Mathematics Intermediate Technical

Examination writing time: Two hours and fifteen minutes (includes reading time)

Total marks: 100

INSTRUCTIONS TO THE CANDIDATE

Failure to adhere to any of these instructions could incur examination sanctions including disqualification from the examination.

1. *The question paper is only available on the ASSA Exam Platform as a PDF download and may not be printed.*
2. *The invigilator will provide you with an answer booklet at the examination venue. You must not use your own examination pad.*
3. *Write your **Candidate Number**, which starts with “A211-exa-2026-...” at the top of each page **during the examination time only**. **Do not use your name and/or member number anywhere on your answer script**. Your candidate number is reflected on your exam permit.*
4. *You may not access any file from your computer, use any other computer software (e.g., Email or Excel), or open or use any other browser, collaboration tools or AI tools, including those embedded in MS Word and Adobe AI assistant (e.g. Copilot, ChatGPT etc.) during the examination. Nor may you use Grammarly, Grammarly Premium or similar built-in software tools including language and grammar tools which must be disabled.*
5. *You are not permitted to bring any other material into the examination (e.g. a Formulae and Tables book). Any such information/material that may be required will be provided to you in the examination.*
6. *You are strongly encouraged to use the first fifteen minutes as reading time only, however, you may start answering the paper whenever you are ready.*
7. *Attempt all questions, beginning your answer to each question on a new page.*
8. *Write in black or dark blue pen.*
9. *Show calculations where appropriate. You may use blank paper to carry out rough work calculations. You may use a calculator from the ASSA-approved list only.*

10. *Mark allocations are shown in brackets.*
11. *Assume that months are all equal length, unless otherwise stated.*
12. *At the end of the two hours and fifteen minutes examination time, you must stop writing and hand your answer booklet to the invigilator. (Follow invigilator instructions.) **You may NOT continue to write once your examination time has ended as this could lead to disqualification from the examination.***

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. The onus remains on you to read and implement all examination instructions.

END OF INSTRUCTIONS

QUESTION 1

If the annual nominal interest rate compounded half-yearly is 3.5%.

- i. Calculate, showing all workings, the following interest rates.
 - a. The annual force of interest.
 - b. The annual nominal discount rate compounded quarterly.
 - c. $\frac{i^{(12)}}{12}$

Express your answers as percentages, rounded to the nearest four decimals where appropriate.

[5]

It is known that $\frac{i^{(2)}}{2}$ is greater than $\frac{d^{(2)}}{2}$ when both rates are derived from the same positive annual effective interest rate.

- ii. Explain, with reason(s), why this is true.

[3]

[Total 8]

QUESTION 2

The force of interest at time t is $\delta(t) = 0.07 + 0.002t$ for $t \geq 0$, where t is measured in years.

A continuous cashflow stream is paid into an investment account at an annual rate of $\rho(t) = 140 + 4t$ for a period of four years, starting at time zero.

- i. Calculate the accumulated value of this investment after eight years.
- ii. Calculate the total interest earned on the investment over the eight-year period.

[9]

[2]

[Total 11]

PLEASE TURN OVER

QUESTION 3

The following expression is given, where n is a positive integer:

$$(I\bar{a})_{\overline{n}|} = \frac{\ddot{a}_{\overline{n}|} - nv^n}{\delta}$$

Derive this expression from first principles, starting with an integral expression.

[Total 6]

QUESTION 4

The current annual term structure of interest rates is:

$$\{y_1, y_2, y_3, y_4, y_5\} = \{5\%, 5.5\%, 5.75\%, 6\%, 6.25\%\}$$

- i. Calculate the three-year continuous-time forward rate applicable at time two.

[4]

- ii. Calculate the five-year par yield.

[4]

A five-year fixed interest bond is redeemable at par and is currently priced at R98 per R100 nominal. The bond pays coupons of 6.25% per annum, in arrears. The gross redemption yield on the bond is calculated and compared to the five-year par yield calculated in (ii).

- iii. Explain, with reason(s), whether the gross redemption yield is higher or lower than the five-year par yield.

No further calculations are required.

[3]

[Total 11]

PLEASE TURN OVER

QUESTION 5

An insurance company must make annual payments of R40,000 in arrears for a period of five years. The company's assets consist of two zero-coupon bonds. The first bond pays X in eight months' time and the second bond pays Y in nine years' time.

Assume that Redington's first two conditions for immunization are met at an annual effective interest rate of 7.3%.

Calculate the values of X and Y .

[Total 10]

QUESTION 6

A bank grants a business loan of R3m to a sole trader. The loan agreement is as follows:

- For the first three years of the loan term, no repayments will be made. During this time the loan will accrue interest at 4% per annum nominal compounded quarterly.
- The bank allows the trader to add this interest to the outstanding loan, increasing the outstanding loan.
- From the start of the fourth year, the loan is repayable by quarterly instalments in arrears for a period of 12 years.
- Loan repayments will remain level for five years at RX per quarter and the interest rate charged on the loan will be 8% per annum compounded quarterly.
- Thereafter, repayments will increase by R5,000 per quarter, and the interest rate charged on the loan will be 7% per annum compounded quarterly.

i. Calculate RX .

[10]

ii. Calculate the interest and capital portions of the 15th loan repayment using the retrospective method.

[4]

[Total 14]

PLEASE TURN OVER

QUESTION 7

A ten-year index-linked bond was issued on 1 January 2025. The bond pays annual coupons, in arrears, of 8% per annum and is redeemable at 103% of par. The coupon and redemption payments are linked to an inflation index with a time lag of three years.

The table below gives the retail price index (RPI) values as of 1 January of each year from 2022 to 2025.

Year	2022	2023	2024	2025
RPI values	115	113	111	109

The inflation rate is expected to remain constant at 2% per annum from 1 January 2025 onwards.

An investor purchased the index-linked bond at issue on 1 January 2025, and expects to earn a real rate of return of 5% per annum effective if the bond is held until redemption.

- i. Calculate the price paid by the investor.

[14]

Another investor purchases a ten-year fixed interest bond at issue, also on 1 January 2025. This bond also pays coupons of 8% per annum, in arrears, and is redeemable at 103% of par. This investor expects to earn a money rate of return of 5% per annum effective.

- ii. Explain, with reason(s), whether the price of this bond would be higher or lower than the index-linked bond.

No further calculations are required.

[3]

[Total 17]

PLEASE TURN OVER

QUESTION 8

An investor purchases a publicly traded share in a company that has historically paid annual dividends. The investor plans to sell the share several years after purchase, depending on market movements.

- i. Describe the cashflows of this transaction from the perspective of the investor, and for each cashflow, comment on the direction, uncertainty in timing and uncertainty in amount at the time of purchase.

[4]

Company Y pays dividends on shareholdings on 1 July and 1 January each year. The dividend declared on 1 January 2022 was R2.40 per share and subsequent dividends were expected to grow by 2.5% per annum compound over a period of four years, and then 5% per annum compound thereafter continuing indefinitely.

On 1 April 2022, an investor subject to 40% tax on dividend income and 25% tax on capital gains purchased a share in Company Y, ex-dividend. This investor must pay tax immediately on receipt of any cash inflows.

The investor assumed he will hold the share indefinitely and wishes to earn a net yield of 11% per annum effective.

- ii. Calculate the price of the share.

[10]

The investor sold the share on 1 February 2025 for R45.

- iii. Calculate, using linear interpolation, the net internal rate of return (IRR) earned by the investor.

[6]

The tax law changes on 1 June 2022 so that taxes on cash inflows, received during the preceding 12 month period, will now be payable annually on 30 March every year.

- iv. Explain, without further calculation, the effect of the change in tax law on the net internal rate of return (IRR) earned by the investor.

[3]

[Total 23]

[GRAND TOTAL 100]

END OF EXAMINATION