

TOM MBOYA UNIVERSITY

UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN ACTUARIAL SCIENCE
WITH I.T

**MAC 107 : INTRODUCTION TO ACTUARIAL
SCIENCE**

Instructions:

- Answer QUESTION ONE (compulsory) and any other TWO.
- Proofs should be written carefully.
- Cheating is NOT allowed and will be harshly punished.
- Observe further instructions on the answer booklet.

QUESTION ONE [30 Marks]

(a) Define the following concepts as used in Actuarial Science

(i) An equity. [2 marks]

(ii) A cash on deposit. [2 marks]

(iii) A zero coupon bond. [2 marks]

(b) Give THREE differences between short-term insurance and long-term insurance. [3 marks]

(c) Calculate $s_{\overline{10}|}$ and $\ddot{s}_{\overline{13}|}$ using an interest rate of $3\frac{1}{2}\%$ p.a effectively. [4 marks]

(d) An investor deposits £5000 into a savings account that pays 10% compound interest at the end of each year. Compare how much the investor would have after 6 years if the money is

(i) invested for 6 years

(ii) invested for 3 years, then immediately reinvested for a further 3 years

[4 marks]

(e) Calculate the effective annual rate of interest corresponding to;

(i) a nominal rate of interest of 11% p.a convertible half-yearly.

(ii) a nominal rate of interest of 12% p.a convertible monthly.

[4 marks]

(f) Outline the similarities and differences between an annuity certain and a contingent annuity . [3 marks]

(g) Given that $i = 0.07$, calculate, $i^{(6)}$, $d^{(6)}$, $i^{(4)}$, and $d^{(2)}$ [6 marks]

QUESTION TWO [20 Marks]

- (a) Explain the following methods of carrying out graduation.
- (i) Graduation by parametric formula
 - (ii) Graduation by reference to a standard table
 - (iii) Graduation using spline functions
- [6 marks]
- (b) Calculate $a_{\overline{20}|}$ and $\ddot{a}_{\overline{10}|}$ using an interest rate of $13\frac{1}{2}\%$ p.a effectively. [6 marks]
- (c) Vincent deposits C into a savings account at time 0, which pays interest at a nominal rate of i , compounded semi-annually. Daisy deposits $2C$ into a different savings account at time 0, which pays simple interest at an annual rate of i . Vincent and Daisy earn the same amount of interest during the last 6 months of the 8^{th} year. Calculate i . [8 marks]

QUESTION THREE [20 Marks]

- (a) Calculate the total present value as at 1 September 2022 of payments of £180 due on 1 September 2024 and £260 due on 1 March 2025 assuming that the interest rate is 15% p.a effective. [5 marks]
- (b) A payment of Ksh 3000 is due in 6 years' time. Calculate the present value using;
- (i) simple interest of 3% p.a
 - (ii) simple discount of 3% p.a
 - (iii) compound interest of 3% p.a
- [7 marks]
- (c) Distinguish between the following cash flow concepts.
- (i) A fixed interest security and an index-linked security
 - (ii) An annuity certain and an annuity due
- [8 marks]

QUESTION FOUR [20 Marks]

(a) Describe the characteristics of;

- (i) an interest-only loan, and
- (ii) a repayment loan

[4 marks]

(b) An inflation index $Q(t)$ is such that $Q(1/1/13) = 744$ and $Q(1/1/18) = 923$. Calculate the average annual rate of inflation over the period from 1 January 2013 to 1 January 2018. [4 marks]

(c) Given an investment of £1500, calculate the accumulation after 5 years using

- (i) Simple discount of 7.5% p.a
- (ii) Compound discount of 8% p.a
- (iii) Compound interest of 6.9% p.a

[6 marks]

(d) An investor purchased a three year index-linked security on 1.1.2015. In return, the investor received payments at the end of each year plus a final redemption payment, all of which were increased in line with the index given in the following table

Date	1.1.2015	1.1.2016	1.1.2017	1.1.2018
Index	101.00	105.5.00	108.00	113.00

The payments would have been £600 each year and £11000 on redemption if there had been no inflation. Calculate the payments actually received by the investor . [6 marks]

QUESTION FIVE [20 Marks]

(a) Calculate the present value of £1000 due at time 3 years using a simple discount and a compound discount rate of 6% p.a . [4 marks]

(b) Calculate the rate of interest convertible monthly corresponding to:

- (i) An effective rate of interest of 14.4% p.a

(ii) A nominal rate of interest of 11% p.a convertible three times a year.

[4 marks]

(c) Distinguish between the following assurance concepts.

(i) An endowment and a pure endowment assurance contracts

(ii) Whole life and term assurance contracts

[4 marks]

(d) Show that given an effective interest, a *pthly* nominal discount rate can be given by

$$d^{(p)} = p [1 - (1 - d)^{1/p}]$$

[8 marks]