KARATINA UNIVERSITY

UNIVERSITY EXAMINATIONS

2024/2025 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF:

BACHELOR OF SCIENCE(P107)

COURSE CODE: ACS 212

COURSE TITLE: FUNDAMENTALS OF ACTUARIAL MATHEMATICS II

DATE: th DEC, 2024 TIME: AM-PM

Instructions: See Inside

Answer question **ONE** in section A and any other **Two** from section B.

SECTION A

Question ONE is compulsory

QUESTION ONE (30 marks)

(a) Differentiate between Select and Non-select life tables. **[2 marks]**

(b) A man purchases a 10-year annual annuity of 60000 pa for his son, aged 17. If the payments are to commence on his 25th birthday. Find the present value for this annuity using AM92 mortality at 4% interest. **[3 Marks]**

(c) An office issues a large number of 25-year without-profit endowment assurances on lives aged exactly 40. Level annual premiums are payable throughout the term, and the sum assured of each policy is \$10,000, payable at the end of the year of death or on survival to end of the term. The office's premium basis is:

A1967-1970 ultimate;

4% p.a. interest;

expenses are 5% of each annual premium including the first, with additional initial expenses of 1% of the sum assured.

Calculate the annual premium for each policy. **[4 Marks]**

(d) Define Reserves **[2 marks]**

(e) The life table function for a certain population is given by:

$$l(x) = \frac{l_0}{(1+x)^2}, \quad x \geq 0$$

where l_0 is the initial population at age 0, and x represents the age. Calculate the force of mortality at age 1 year. . **[3 marks]**

(f) Why do insurance companies set reserves when operating in the market? **[5 marks]**

(g) Prove that

$$A_x = \frac{M_x}{D_x}$$

[3 marks]

(h) Suppose that out of a typical group of 100 people age 70, 10 will die in the first year, 15 will die in the second year, and 20 will die in the third year. Calculate q_{70}, q_{71}, q_{72}, and ${}_3p_{70}$ **[4 Marks]**.

SECTION B

Answer **any Two** questions from this section

QUESTION TWO (20 marks)

(a) A whole life Assurance policy with the sum assured of 20M is sold to a life aged 25 with annual premiums payable throughout. Calculate the gross premium using the following basis: mortality AM92, interest 4% , expense loading 7% of each premium. [**4 marks**]

(b) A life aged 40 effects a 25-year without-profit endowment assurance policy with a sum assured of 50,000 payable at the end of the year of death or on survival to the end of the term. Level premiums are payable throughout the policy term or until the earlier death of the life assured. Calculate the level premiums,p, using the following premium basis. [**4 marks**]

Mortality: 1967-70 Ultimate,

Interest: 6% per annum,

Expenses: Ignored.

(c) Discuss the types of life insurance products that are sold in the Kenyan market. [**8 marks**]

(d) You are given the following mortality rates:

$$q_{60} = 0.20, \quad q_{61} = 0.25, \quad q_{62} = 0.25, \quad q_{63} = 0.30, \quad q_{64} = 0.40.$$

Find l_x for ages 60 to 65, starting with $l_{60} = 1000$. [**4 Marks**]

QUESTION THREE (20 marks)

(a) A 25-year term assurance with SA of ksh. 1M for a life aged 25 on the A1967-70 select table at 4 % interest has initial expenses of 2% of the SA and continuing administration cost of ksh. 1000 each year. Find the single premium payable given

that the premium paid is not to be returned with the SA in the event of a claim. [**5 marks**]

(b) A 25-year ordinary endowment assurance is sold to a life aged 37 with a sum assured of 7M. Annual premiums are payable up to the earlier death of age 50 years. Calculate the premium payable. The premium is to be calculated based on the following assumptions:

- Interest rate: 4%
- Mortality: AM92 Table
- Expenses:
  - Initial expense: 2.5% of the sum assured
  - Renewal expense: 4% of each premium excluding the first and administrative expenses of Ksh. 1,000 per year

[8 Marks]

(c) A life aged 40 purchases a whole life assurance cover with a sum assured of 6000000. Calculate the policy reserve after 15 years assuming regular premiums payable indefinitely using AM92 mortality at 4% interest rate. [**7 Marks**]

QUESTION FOUR (20 marks)

(a) State and explain the 2 main methods used in reserve calculation. [**4 marks**]

(b) A life Aged 27 buys a 20-year term assurance with level annual premiums payable throughout the term with a sum assured of 1.5M.

Basis:

- Mortality: AM92
- Interest: 4%
- Expenses:

- Initial: 2.5% of the sum assured
- Renewal expense: 3% of all the premiums

Calculate:

(a) The gross premiums payable. **[6 marks]**

(b) The reserves after the 13th year. **[4 marks]**

(c) The number of people aged x in a given population is found to obey the function; $l_x = 25000(90 - x)^2$.

Find:

i. P_{40} **[1 marks]**

ii. ${}_{15}|_{1}q_{10}$ **[2 marks]**

QUESTION FIVE (20 marks)

(a) A 10-year temporary annuity due of Ksh. 50,000 is issued to a life aged 50 exactly. calculate the present value of the annuity by first expressing it in terms of an Assurance function assuming mortality of m92 tables with 4% interest. **[5 marks]**

(b) A life office is issuing a policy to a life aged 40. The benefits under this contract are as follows:

1. On death before age 60, an immediate lump sum of 1,000 is payable.
2. On survival to age 60, an annuity of 500 per annum, payable continuously, is provided for the remaining lifetime of the policyholder.

Level premiums are payable continuously until age 60 or earlier. These premiums are calculated according to the following basis:

- Mortality: English Life Table No. 12 (males).
- Interest: 4%.

- Expenses: None

Calculate the annual premium. **[5 marks]**

(c) A 25-year regular premium Endowment Assurance is issued to a life aged 42 with a sum assured of Ksh. 2.2 million. The premiums are payable up to the policyholder's 60th birthday or earlier death. The office approximates expenses at a rate of 4% of the sum assured and administrative expenses of Ksh. 500 per annum throughout the policy term. The office also promises to return the premiums paid in case of death within the first 10 years. Calculate:

i. The annual premiums payable. **[7 marks]**.

ii. The reserve at the end of the 20th year. **[3 marks]**.