



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**SCHOOL OF MATHEMATICS AND ACTUARIAL SCIENCE**

**UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION  
AND ACTUARIAL SCIENCE**

**4<sup>th</sup> YEAR 1<sup>st</sup> SEMESTER 2022/2023 ACADEMIC YEAR**

**MAIN CAMPUS**

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**COURSE CODE: WAB 2403**

**COURSE TITLE: ACTUARIAL LIFE CONTINGENCIES II**

**EXAM VENUE:**

**STREAM: ACTUARIALSCIENCE**

**DATE: 13/12/2022**

**EXAM SESSION: 9.00-11.0AM**

**TIME: 2.00 HOURS**

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**Instructions:**

- 1. Answer question one (compulsory) and any other two questions.**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

**Question 1 [30marks]**

- a. A 25 year annual premium endowment assurance policy was sold to a life aged 40 exact at outset. Death benefits are payable at the end of the year of death. Calculate the Zillmerised net premium reserve at the end of the tenth year per unit sum assured.  
Basis: Mortality: A1967–70 Select  
Interest: 3% per annum  
Initial expense: 2.5% of the sum assured [5marks]
- b. Prove that:  
$$\bar{A}_{xy} = \bar{A}_x^1 + \bar{A}_y^1$$
 [5marks]
- c. Show that:
- i. 
$${}_tV_{x:\overline{m}} = 1 - \frac{\ddot{a}_{x+t:\overline{n-t}}}{\ddot{a}_{x:\overline{m}}}$$
 [3marks]
- ii. 
$${}_t\bar{V}(\bar{A}_{x:\overline{m}}) = 1 - \frac{\bar{a}_{x+t:\overline{n-t}}}{\bar{a}_{x:\overline{m}}}$$
 [3marks]
- d. Differentiate between:
- i. Defined benefit schemes and defined contribution schemes. [2marks]
- ii. Contingent assurances and reversionary annuities [2marks]
- e. A healthy life aged exactly 35 has a policy providing an income benefit of £50 per week payable during sickness. The benefit is not payable beyond age 60. There is no deferred or waiting period.  
Calculate the present value of this benefit. [5marks]  
Basis: Mortality: English Life Table No. 12-Males  
Sickness: Manchester Unity Sickness Experience 1893/97  
Occupation Group AHJ  
Interest: 4% per annum
- f. Contributions to a pension scheme by employees are made at a rate of 5% of salary when aged under 35, 6% between ages 35 and 45, and  $7\frac{1}{2}\%$  when aged 45 or over. Calculate the present value of the future contributions payable by a member aged exactly 30 who in the past year have received a total salary of £12,718. [5marks]

**Question 2[20marks]**

The premiums payable under a deferred annuity contract issued to women aged exactly 60 are limited to 5 years. The annuity commences at age 65, provided the policyholder is still alive at that age. The annuity provides payments of £3,500 payable annually in advance for 5 years certain (ie it continues to be paid for 5 years even if the annuitant dies before age 69) and for life thereafter. There is no benefit if the policyholder dies before age 65.

- (i) Calculate the annual premium. [6marks]
- (ii) (ii) Calculate the retrospective and prospective reserves after the policy has been in force for each of 5 and 10 years. [14marks]

Basis: PFA92C20 mortality, 4% pa interest

An endowment assurance policy, with sum assured £2000, term five years and level annual premiums, is issued to a life aged 55.

The annual premium is calculated on the following basis:

Mortality: A1967-70 ultimate

Interest: 6% per annum

Initial expenses: £250

### **Question 3[20marks]**

An endowment assurance policy, with sum assured £5000, term five years and level annual premiums, is issued to a life aged 55.

The annual premium is calculated on the following basis:

Mortality: A1967-70 ultimate

Interest: 6% per annum

Initial expenses: £250

Renewal expenses (associated with the payment of the second and each subsequent premium):£42 at the time of payment of the second premium, increasing thereafter by 5% per annum (compound).

The death benefit is payable immediately on death.

Assuming that the premium and experience basis are as described in that question and that the reserves held are as follows:

$${}_0V=0$$

$${}_1V=919$$

$${}_2V=1,876$$

$${}_3V=2,873$$

$${}_4V=3,914$$

$${}_5V=0$$

Calculate;

- a. Profit vector [10marks]
- b. Profit signature. [10marks]

### **Question 4[20marks]**

- a. A life insurance company issues 20-year temporary assurance policies to lives aged 45. The sum assured, which is payable immediately on death, is £400,000 for the first 10 years, and £100,000 thereafter. Level annual premiums are payable in advance for 20 years, or until earlier death. The premium basis is: Mortality: AM92 Ultimate Interest: 4% per annum Expenses: nil.
  - (i) Show that the premium payable is approximately £870.25 per annum. [5marks]
  - (ii) Find the net premium reserve ten years after the commencement of the policy, immediately before the payment of the eleventh premium, assuming the reserving basis is the same as the premium basis. [5marks]
- b. A whole life annuity is issued to a life aged  $x$ . The annuity is purchased by a single premium and a benefit of 1 is payable at the beginning of every year throughout life. Show that the net prospective and retrospective reserves are equal [10marks]

### **Question 5 [20marks]**

John, aged 60, wants to buy a reversionary annuity. If he dies before age 65 and before his wife Sarah, who is also now aged 60, she will receive an income of £10,000 pa. The income will be paid annually in arrears (from the end of the year of John's death) until Sarah's 75th birthday or until her earlier death. Calculate the single premium payable assuming PA92C20 mortality and 4% pa interest.

[20marks]