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MAIN EXAMINATION

SEPTEMBER- DECEMBER 2020 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

REGULAR PROGRAMME

ACS 304: LIFE CONTINGENCIES I

Date: DECEMBER 2020	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any other TWO Questions	

Q1. a) State the conditions that are required for the prospective reserves is equal to the prospective reserves **(4 marks)**

b.) Explain the reasons why insurance companies keep reserves **(4 marks)**

c.) An index-linked annuity payable annually in arrears is sold to a 60-year old male. The first payment is £8,160 and the annuity is assumed to increase at 2% *pa*. Calculate the net premium reserve at time 4 assuming PMA92C20 mortality and an interest rate of 6.1% *p.a*. **(6 marks)**

d.) Describe in your own words the difference between the functions;$(I\overline{A_{x:n\neg}})$ and $(\overline{IA}_{x:n\neg})$ **(4 marks)**

e.) Determine, showing all your working, $(I\overline{A_{x:15\neg}})$

Basis:
Force of mortality μ_x= 0.02 for all *x*
Force of interest 3% **(6 marks)**

f.) Explain the types of bonuses that are paid by the insurance companies

(6 marks)

Q2 a) Explain the differences between Actual death strain (ADS) and expected death strain (ADS) for a single life **(4 marks)**

a.) A life aged exactly 40 purchases a special single premium deferred annuity. The

annuity payments are to commence at age 60, and are payable monthly in advance for life. The amount of the first monthly payment is to be £1,000, but once in payment the amount is to increase in line with the rate of inflation. There are no death benefits payable in the event of death during the deferred period.

(i.) Show that the single premium is £54,543. **(10 marks)**

Basis:
Mortality: AM92 Select before age 60
PMA92C20 after age 60
interest: 6% *pa*
inflation: 1.9231% *pa*
expenses: initial: £500
claim: 1% of each annuity payment

(ii.) The life insurance company calculates prospective gross premium reserves on the same basis as above. Calculate the reserve held in respect of the policy at the end of the 10th policy year, assuming that the policyholder is still alive.

(6 marks)

Q3 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 **(5 marks)**

(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. **(5 marks)**

b.) A man aged 45 buys a 15-year with-profit endowment assurance with a basic sum assured of £25,000. Determine the single premium to be paid for this assurance, assuming that simple reversionary bonuses of 6% *pa* vest at the end of each policy year and that death benefits are payable at the end of the year of death. Assume AM92 Ultimate mortality and 4% *pa* interest. Initial expenses are £200 and renewal expenses are £30 at the start of each policy year, excluding the first. **(10 marks)**

Q4 a.) Sam, aged 40, buys a 20-year term assurance with a sum assured of £150,000 payable immediately on death. Calculate the quarterly premium payable by Sam for this policy. Assume that initial expenses are 60% of total annual premium plus £110, renewal expenses are £30 *pa* from year two onwards.

Basis: AM92 Select, 4% *pa* interest. **(10 marks)**

b.) At the start of a particular year a life insurance company had a portfolio of 5,000 female pensioners, all aged exactly 60, who each receive an income of £10,000 per annum, paid annually in arrears. The company holds net premium reserves, calculated using PFA92C20 mortality and 4% *pa* interest. During that year, 9 pensioners died. Calculate the mortality profit or loss. **(10 marks)**

Q5 a) State the equation of value used in calculating premiums when evaluating actuarial contracts **(4 marks)**

b.) Define the following terms as used in actuarial mathematics:

(i.) Equation of equilibrium **(2 marks)**

(ii.) Mortality profit **(2 marks)**

(iii.) Thieles differential equation **(2 marks)**

c.) Calculate the retrospective gross premium reserve at time $t = 2$ for a 5-year single premium endowment assurance with sum assured £30,000 payable on maturity or at the end of year of earlier death, issued to a 48-year old. Expenses were £360 (initial), £45 (renewal from Year 2 going onwards). Assume AM92 Select mortality and 4% *pa* interest for premiums and reserves. **(10 marks)**