



QP CODE: 26019275



26019275

Reg No :

Name :

M.Sc DEGREE (CSS) EXAMINATION, MARCH 2026

Fourth Semester

M Sc ACTUARIAL SCIENCE

Core Courses - AS010401 - PRICING & RESERVING OF LIFE ASSURANCES & ANNUITIES

2019 Admission Onwards

566557C4

Time: 3 Hours

Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

Weight 1 each.

1. Why we need a Health insurance contracts.?
2. Using the three-state healthy-sick-dead model and the notation defined in , write down an expression for the expected present value of each of the following sickness benefits for a healthy life aged 40. (i) £3,000 pa payable continuously while sick, but ceasing at age 60. (ii) £3,000 pa payable continuously throughout the first period of sickness only, but ceasing at age 60.
3. What are the approach Using multiple decrement tables to evaluate expected present values of cashflows ?
4. What are guaranteed benefits the Unit-linked policies may offer?
5. What is Unitised (accumulating) with-profits contracts?
6. Describe Conventional endowment assurance.
7. Write a short note about Unit-linked endowment assurance.
8. Briefly explain about Profit vector and Profit signature.
9. Short note about the aspects of life insurance company management.
10. Covid-19 and insurance world .

(8×1=8 weightage)





Part B (Short Essay/Problems)

Answer any **six** questions.

Weight 2 each.

11. A population of healthy people over the year of age 60 to 61 is subject to a constant force of decrement due to sickness of 0.08 per annum, and a constant force of mortality of 0.002 per annum. Assuming that a double decrement model is used, calculate:
1. the probability that a healthy person aged exactly 60 will still be healthy at exact age 61
 2. the probability that a healthy person aged exactly 60 will leave the healthy population through death before exact age 61
 3. the independent probability of a life aged exactly 60 dying before exact age 61.
12. (i) Explain what is meant by a dependent probability of decrement and by an independent probability of decrement.
- (ii) The following is an extract from a multiple decrement table subject to 3 modes of decrement, a , b and g :

Age, x	$(al)_x$	$(ad)_x^a$	$(ad)_x^b$	$(ad)_x^g$
50	5,000	86	52	14
51	4,848	80	56	20

Calculate the probability that a 50-year-old leaves the population through decrement g between the ages of 51 and 52.

13. For the unit-linked endowment assurance shown on page 6 (details repeated below), calculate the unit fund value at the end of the first month of the policy (deducting all charges at the end of the month) for a 40-year-old policyholder, and calculate the total charges arising for the same period. Assume the unit fund has been growing at an annual rate of 12.3% over the first month (before the charges are deducted).
- Policy details: · Premiums of £1,500 are paid annually in advance. · 97% of every premium paid is used to buy units. · There is a 5% bid/offer spread. · There is a minimum guaranteed sum assured on death of £40,000 but no guaranteed minimum benefit on maturity. · A fund management charge payable at the rate of 1% pa is deducted at the end of each month from the bid value of the units. · A policy fee payable at the rate of £50 pa is deducted at the end of each month by cancellation of units.
14. Study about the Comparison between UWP and the simple AWP designs.
15. What are The balancing items in the projected revenue account ?
16. A policy with a 3-year term has a profit vector of (-428, 72, 560). The policyholder is aged 55 exact at entry. Calculate the internal rate of return for this policy, assuming AM92 Select mortality.





17. Under a five-year unit-linked policy, and assuming no non-unit reserves are held, the expected non-unit cashflows emerging at the end of each year, per policy in force at the start of that year, are: (- 10, - 20, 5, -15, 40) Calculate the non-unit reserves that should be set up to zeroise the negative cashflows, and give the profit vector. Assume 5% pa interest, and ignore mortality.
18. The in-force expected non-unit cashflows for a five-year unit-linked contract taken out by a person aged exactly 60 are (- 10, -20, 5, -15, 40) . Calculate the non-unit reserves required to zeroise any negative cashflows other than those occurring in the first policy year. Assume AM92 Ultimate mortality and 6% pa interest.

(6×2=12 weightage)

Part C (Essay Type Questions)

Answer any **two** questions.

Weight 5 each.

19. A company provides the following benefits for its employees:
- immediately on death in service, a lump sum of £20,000
 - immediately on withdrawal from service (other than on death or in ill-health), a lump sum equal to £1,000 for each completed year of service
 - immediately on leaving due to ill-health, a benefit of £5,000 pa payable monthly in advance for 5 years certain and then ceasing, and
 - on survival in service to age 65, a pension of £2,000 pa for each complete year of service, payable monthly in advance from age 65 for 5 years certain and life thereafter. The forces of decrement for the employees at each age, assumed to be constant over each year of age, are as follows:

Age x	μ_x^d	μ_x^i	μ_x^w
62	0.018	0.10	0.020
63	0.020	0.15	0.015
64	0.023	0.20	0.010

where μ_x^j is the (assumed constant) force of decrement by cause j over $(x, x+1)$ d represents death, i represents ill-health retirement and w represents withdrawal.

(i) Construct a multiple decrement table with radix $(al)_{62} = 100,000$ to show the numbers of deaths, ill-health retirements and withdrawals at ages 62, 63 and 64, and the number remaining in employment until age 65.

(ii) Calculate the expected present value of each of the above benefits for a new entrant aged exactly 62. Assume that interest is 6% pa effective before retirement and 4% pa effective thereafter, and that mortality after retirement follows the PMA92C20 table.

20. Demonstrate Unit-linked contracts with your own example with support of flow chart.





21. A life insurance company sells five-year-term, single-premium, unit-linked policies each for a premium of £10,000. There is no bid/offer spread and the allocation percentage is 100%. The only charge is a 2% annual management charge. The maturity, death and surrender benefits are equal to the value of the units at maturity, or at the end of the year of death or surrender, as appropriate, after deduction of the annual management charge in each case.

(i) Assuming unit growth of 9% pa, calculate the value of the units at the start and end of each year after deduction of the management charge, and the amount of management charge each year.

(ii) Calculate the net present value of the contract assuming:

- Commission of 5% of the premium
- Initial expenses of £50
- Annual renewal expenses of £20 in the 1st year, inflating at 5% pa
- Independent probability of mortality is 0.5% at each age
- Independent probability of surrender is 5% at each age
- Non-unit fund interest rate is 9% pa

Risk discount rate 12% pa The company holds unit reserves equal to the full value of the units (after deduction of annual management charge) and zero non-unit reserves. You may assume that expenses are incurred at the start of the year and that death and surrender payments are made at the end of the year.

22. A conventional 3-year endowment assurance is issued to a life aged exactly 56. The details are:

- sum assured 10,000 payable after 3 years or at the end of the year of death, if earlier
- surrender value equal to the return of premiums without interest, less 400, at the end of the year of surrender
- annual premium 3,250 paid at the start of each year.

The company calculates its reserves for this contract on the following basis: Expenses: 30 at the start of Year 2, 32 at the start of Year 3 Surrender probabilities: 4% of policies in force at the end of Year 2 only Mortality: AM92 Ultimate Interest: 2% pa

(i) Calculate the prospective gross premium reserves required per policy in force at the start of Years 2 and 3, according to the above basis, using a cashflow projection approach.

(ii) Calculate the expected profit arising in the second year per policy in force at the start of Year 2, assuming the following profit test experience basis:

Expenses: as reserving basis

Surrenders: as reserving basis

Reserves: as calculated in part (i)

Mortality: 75% of AM92 Select from policy outset

Interest: 4% pa

(2×5=10 weightage)

