

INSTITUTE OF ACTUARIES OF INDIA
EXAMINATIONS

28th May 2024

CM1A - Actuarial Mathematics

Time allowed: 3 Hours 15 Minutes (09:30-12:45 Hours)

Total Marks: 100

- Q. 1)** In case of compound interest rates, investor can not earn more by withdrawing and reinvesting the same money at same rates, like he can earn in simple interest rate.
- A. True
 - B. False
 - C. True in some cases
 - D. None of the above
- [2]**
- Q. 2)** Manish wants to have a fund of INR 10,00,000 in three years' time from now to buy his dream car. How much approximate money should he Fix Deposit (FD) to get the required amount now if the FD rates are 6.5% per annum?
- A. 9,00,000
 - B. 8,27,850
 - C. 9,17,000
 - D. 9,27,000
- [2]**
- Q. 3)** Rohit invest INR 2500 at a discount rate of 18% per annum converted monthly for first three months followed by an interest rate of 20% per annum converted quarterly for next 9 months. Calculate the accumulated sum at the end of three months and at the end of one year.
- A. INR 2600 and 3000
 - B. INR 2605 and 2986
 - C. INR 2616 and 3028
 - D. None of the above
- [4]**
- Q. 4)** The real interest rate is equal to money interest rates in an economic situation when
- A. Inflation is positive and high
 - B. Inflation is positive but low
 - C. Real interest rate can never be equal to money interest rate
 - D. There is no inflation at all
- [2]**
- Q. 5)** A company expects to receive a continuous cash flow of INR 35 Lakh per annum for the next five years. It also expects to pay INR 60 Lakh at the end of first year and INR 40 Lakh at the end of third year.
- Calculate the NPV of these cash flows assuming $v(t)=1-0.01t$ for $0 \leq t \leq 5$
- A. INR 62,45,500
 - B. INR 72,55,000
 - C. INR 72,42,500
 - D. None of the above
- [4]**
- Q. 6)** In most of the capital projects, income occurs later in time than outgo. Therefore, as the risk discount rate increases, the present value of the project's income reduces by more than the present value of the project's outgo.

Due to this

- A. NPV of project increases
- B. NPV of project remains same
- C. NPV of project decreases
- D. None of the above

[2]

Q. 7) Using the values given in the table below, calculate the value of ${}_4q_1$.

x	lx	dx
0	100000	814
1	99186	62
2	99124	38
3	99086	30
4	99056	24
5	99032	22

- A. 0.001
- B. 0.002
- C. 0.00155
- D. 0.00255

[2]

Q. 8) A life insurance policy pays a benefit of INR 500,000 at the end of policy year of death of a life aged exactly 55 years provided that death occurs after exact age 60. The EPV of this benefit assuming that the effective annual rate of interest is 4% per annum and the mortality follows the AM92 ultimate table is

- A. Rs. 182479.21
- B. Rs. 173953.68
- C. Rs. 173738.46
- D. Rs. 182253.45

[4]

Q. 9) A man aged exactly 40 years buys a special 25 years endowment assurance policy that pays INR 300,000 on maturity. The man pays a premium of INR 6700 at the start of each year throughout the 25 years, or until death if it happens first. Should that happen, all premium paid so far are returned without interest at the end of year of death.

What will be the EPV of the benefits payable under this policy assuming AM92 select mortality and 4% per annum interest rate?

- A. INR 106608.47
- B. INR 100738.11
- C. INR 58700.30
- D. None of the above

[4]

Q. 10) A fund of Rs. 10,00,000 earns an interest of 5% effective per annum. The fund has to be divided into its 10000 members aged 40 now if they survive to age 60.

Assuming AM92 ultimate mortality calculate the expected pay out for each survivor.

- A. INR 232.53
- B. INR 281.59
- C. INR 232.48

[2]

D. INR 285.52

Q. 11) The value of $S_{55:10|}$ with mortality PFA92C20 and interest rate of 4% per annum is

- A. 11.923
- B. 12.166
- C. 12.660
- D. 11.900

[2]

Q. 12) A Husband and wife are both aged 65 exact. Upon wife's death, husband will receive Rs. 20000 per annum payable annually in advance for the rest of his life starting from the end of the year of wife's death, provided her death occurs in the next 10 years.

Husband's mortality follows PMA92C20 and wife's mortality follows PFA92C20. Interest rate is 4% for all future years. Calculate the EPV of benefit to husband.

- A. INR 15000
- B. INR 15200
- C. INR 15433
- D. INR 15223

[4]

Q. 13) At the beginning of a year, a life insurance company had a portfolio of 5000 female pensioners, all aged exactly 60 years. Each pensioner in the portfolio receives an annual income of INR 10,000, paid in arrears. The company maintains net premium reserves calculated based on PFA92C20 mortality table and a 4% per annum interest rate.

During that year 9 pensioners died. Will it be a mortality loss or profit and how much?

- A. Loss INR 210,000
- B. Profit INR 210,000
- C. Profit INR 210,412
- D. Loss INR 210,412

[4]

Q. 14) A Multiple decrement Model having multiple states Healthy, Sick and Dead provides sickness benefit during the period of sickness. Adding lapse state in the model would change the expected present value of sickness benefit by

- A. Increasing the EPV of the benefit payment
- B. Decreasing the EPV of the benefit payment
- C. No change in EPV of the benefit payment
- D. None of the above

[2]

Q. 15)

i)

- a) What do you understand by a multiple decrement table?
- b) What is meaning of independence of force of mortality?

(4)

ii) With information provided and assuming that all forces of decrement are constant over individual years of age, calculate the first line of double decrement table for mortality and sickness only.

The independent force of sickness for the year of age from 50 to 51 years is 0.075 and the independent force of mortality for the same year of age is 80% of the force of mortality according to the ELT15(males) mortality table. Radix $(al)_{50}=100,000$. (6)
[10]

Q. 16) Explain what is meant by the following theories of the shape of the yield curve.

- i) Market Segmentation theory
 - ii) Liquid preference theory
- [4]

Q. 17)

- i) Describe main features of a Unit-Linked Policy. (5)
 - ii) In respect of a unit linked life assurance product explain Unit fund and Non- Unit Fund and list all the components of non-unit fund. (5)
- [10]

Q. 18) A life insurance company sells decreasing term assurance policies with an initial sum assured of INR 150,000 to the lives aged exact 50 years. The term of the policy is 10 years, and the sum assured decreases by INR 10,000 at the start of each year from Year 2 onwards. The benefit is payable immediately on death. Premiums are payable annually in advance throughout the term of the policy. Following assumptions are used to calculate premium:

Mortality ---- AM92 Ultimate

Initial Expenses---INR 300

Renewal Expenses---INR 43 at the start of each except first

Claims expenses---INR 400

Interest rate---4% per annum

- i) Using P for the annual premium, write down the future loss random variable for the policy at the start of the term, and also just before the payment of the fifth premium, assuming that policy is still in force at that time. (4)
 - ii) Show that the premium for the policy is INR 491.31. (4)
 - iii) Calculate the gross premium prospective reserve for the policy just before the payment of the fifth premium. (4)
 - iv) Comment on your answer on part(iii). (2)
 - v) State the condition in one sentence under which the gross premium prospective reserve will be equal to the gross premium retrospective reserve. (1)
- [15]

- Q. 19)** A company is deciding to invest in a capital project where it has to invest INR 85 Crores at the start of first three years. Major refurbishment cost will be required after 10 year which is INR 125 Crores.

There will be no income from the project in first two years. An income received continuously of INR 30 Crores in third year and it will be increasing every year by INR 2 Crores till 6th year. Thereafter the income is expected to increase 2% per annum compounded at the start of each year.

The income is expected to cease at the end of 20th year from the start of the project.

The cash flow within each year is assumed to be received at a constant rate.

- i) Calculate the NPV of the project at a rate of interest 7% per annum effective. (6)
 - ii) Show that DPP does not fall within first 10 years assuming an effective interest rate of 7% per annum. (5)
 - iii) Calculate the DPP (discounted payback period) for the project assuming an effective rate of 7% per annum. (5)
 - iv) Explain why DPP is not a good criterion for project appraisal. (2)
- [18]**

- Q. 20)** A whole life assurance contract under which the sum assured is INR 50,000 is payable immediately on death, is issued to a life aged exactly 35 years.

Using AM92 select mortality and interest rate of 6% per annum effective, calculate

- i) EPV of the benefits (1)
 - ii) The variance of the present value of the benefits (2)
- [3]**
