

PPSAS102

Financial Mathematics

Time: 2 hours
Total Marks: 60 marks

Note:

- 1) The candidate has option to either attempt question 4A or question 4B. Rest all questions are mandatory.
- 2) Numbers to the right indicate full marks.
- 3) The candidates will be provided with the formula sheet and graph papers (if required) for the examination.
- 4) Use of approved scientific calculator is allowed.

Q1A. [5 Marks]

- I. Write down the formula for n-year accumulation factor of an investment in terms of (i) Simple Interest and (ii) Compound interest and explain the terms [3 Marks]
- II. An investment of amount P accumulates to amount A after n years. Calculate the annual compound interest rate that would give the accumulation factor equal to that of the simple interest for the above investment. [2 Marks]

Q1B. [5 Marks]

- I. Describe the operation of a traditional repayment loan in terms of a cash flow model. [3 Marks]
- II. How do you differentiate between the cash flows of the repayment loan and interest only loan [2 Marks]

Q1C. [5 Marks]

An annuity of INR10,000 pa is paid half-yearly in advance for five years, followed by INR 20,000 pa paid quarterly in arrears for a further ten years. The rate of interest is 8% pa convertible monthly. Determine the accumulated amount at the end of fifteen years.

Q2A

[5 Marks]

The force of interest at time t is given by $\delta(t) = \begin{cases} 0.06, & 0 \leq t \leq 5 \\ 0.03 + 0.01t, & 5 < t \leq 8 \\ 0.004 + 0.04t - 0.003t^2, & 8 < t \leq 12 \end{cases}$

Calculate the accumulated value at time 10 of an investment of INR 10,000 at time 2

Q2B

[5 Marks]

- What do you mean by $\ddot{s}_{n|}$ and $s_{n|}$ **[2 Marks]**
- Calculate $\ddot{s}_{16|}$ and $s_{15|}$ by taking 7.5% per annum as the effective interest rate **[2 Marks]**
- What is the relationship between the two values i.e. state the reason for difference in the above two values ? **[1 Mark]**

Q2C

[5 Marks]

An investor deposits INR 10,000 into an investing account at time 5, INR 9,500 at time 6, \$INR 9,000 at time 7, and so on. The last deposit he made is INR 3,000 Calculate:

- Present value of the payments at time 4 **[2.5 Marks]**
- Accumulated value of the payments at time 15 **[2.5 Marks]**

Consider an effective interest rate of 8% per annum for both the parts.

Q3A

[5 Marks]

XYZ Ltd is a very big Pharmaceutical company in India. It invested INR 50 crores and procured an equipment to execute a research project to produce vaccine for a dreadful disease in the country. The chances of success producing the vaccine are 10%, 20% and 30% in the first, second and third years of research. These probabilities are independent of each other. At the end of third year, the company plans to sell off the equipment for 10% of its procured price. The maintenance cost of the equipment is 2.5 crores in the first year and is expected to grow by 10% compound every year in the second and third years. The maintenance cost is paid at the end of the year. In case the research is successful, the company will be getting a cash inflow in the form of royalty of INR 20 crore continuously per year starting from the end of the year in which the project is successful for the next 15 years. For this research project, find the effective annual rate of interest at which the present value of the company's outlays equals the expected present value of its income from the project. Your answer can be rounded off to the third significant digit after the decimal point.

Q3B.

[5 Marks]

A student has approached a bank for a loan of INR 80 Lakhs to fund for his higher education. The bank agreed to disburse the amount in 4 equal annual installments at the beginning of each year over the course of his four year study. The loan needs to be repaid in equal quarterly payments over a seven year period. The first payback instalment will be made at the end of 17th quarter after the loan disbursement date.

- i. Calculate the installment amount that the student needs to pay every quarter, assuming an effective interest rate of 12% per year (Interest is applicable from the date of disbursement of the loan) **[3 Marks]**
- ii. Calculate the interest and principal components of the first quarterly payment. **[2 Marks]**

Q3C.

[5 Marks]

An investor, invests INR 25 Lakhs, to purchase an annuity certain which makes payments over a fifteen-year period. Calculate the amount of the payments that can be provided if the annuity takes each of the following forms (assuming interest of 10% pa effective):

- I. a level annuity payable quarterly in arrears **[2 Marks]**
- II. a level annuity due payable half-yearly, commencing in 3 years' time **[3 Marks]**

Q4A.

[15 Marks]

Ms. Supraja Subhash has approached a bank for a housing loan for her new villa costing INR 4 crores. The loan period is 20 years and the repayment needs to be done monthly in arrears. The possession of the house will take three years, during which period only interest will be paid to the bank. After the possession, the initial two years will have a flat monthly installment of INR 4,00,000 per month, after which level monthly installments need to be made till the loan repayment gets completed. The bank proposed to give 60% of the loan now and the remaining 40% at the time of possession of the villa. The proposed interest rates are 9%p.a for the first 5 years, 10% p.a. from then onwards for the remaining period.

- I. What is the equal monthly installment (EMI) that needs to be paid on this loan **[3 Marks]**

II. Prepare a loan schedule that includes EMI, interest and principal repayment components and loan outstanding for Ms. Supraja for the last installment of the 3rd, 8th and 13th and 18th years. [8 Marks]

III. Ms. Supraja thinks of repaying 25% of the loan amount outstanding at the end of 8th year. Assuming the monthly installment remains the same, find the principal outstanding at the end of 13th year [2.5 Marks]

IV. Supraja proposes to the bank that she can pay INR 2,00,000 as the first installment after the possession and after that increase the installments by 1% every month. Explain with reasoning whether the proposal will be acceptable to the bank or not. What is the major risk to the bank in this proposal [1.5 Marks]

OR

Q4B.

[15 Marks]

Rajasthan Kings Ltd. is exploring two mutually exclusive investments. The expected cash flows in Lakhs for the investments are as follows:

Year	Project A	Project B
0	-50	-60
1	-65	25
2	-20	25
3	-15	25
4	125	25
5	200	25
6	-25	25

I. Construct the NPV profiles for both the projects at required rate of returns of 10% and 15% and 25%. [6 Marks]

II. What is the IRR of each of the projects [4 Marks]

III. Which project needs to be explored by the company based on (i) NPV and (ii) IRR [2 Marks]

IV. Provide your interpretations on the risk associated with the investments. [3 Marks]