



Department of Computer Science and Engineering (Data Science)

S.Y.B.Tech.

Sem: IV

Subject: Computational Methods and Pricing Models Laboratory

Experiment 2

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Date:	Experiment Title: Mortgage Payment Analysis with Extra Contributions and Investment Growth using Rule of 72
Aim	To analyze the impact of extra principal payments on mortgage tenure and interest savings, generate an amortization schedule, visualize loan balance reduction, and conduct a parametric study on different extra payment strategies. Additionally, apply the Rule of 72 to estimate the time required for an investment to double under different interest rate models (simple and compound interest) and compounding frequencies.
Software	Python on Google Colab



Theory	<p>A mortgage is a loan secured by real estate, where borrowers make regular payments comprising principal and interest. The key factors influencing mortgage repayment include:</p> <ul style="list-style-type: none">• Principal: The amount borrowed from the lender.• Interest Rate: The cost of borrowing money, expressed as an annual percentage.• Loan Tenure: The total repayment period, typically measured in months.• Monthly Payment (EMI): A fixed payment consisting of principal and interest, calculated using the mortgage payment formula: $EMI = \frac{P \times r \times (1 + r)^n}{(1 + r)^n - 1}$ <p>Where:</p> <ul style="list-style-type: none">• P = Loan Amount• r = Monthly Interest Rate (Annual Rate / 12 / 100)• n = Total Number of Payments (Term in Months) <p>The principal and interest components change over time, with a higher portion of the early payments going toward interest. The outstanding loan balance reduces over time as principal payments increase.</p> <p>Impact of Extra Principal Payments</p> <p>Borrowers can make additional payments towards the principal to reduce the loan tenure and total interest paid. The benefits include:</p> <ul style="list-style-type: none">• Shorter Loan Duration: Extra payments directly reduce the outstanding balance, leading to fewer months required to repay the loan.• Interest Savings: Since interest is calculated on the remaining balance, paying extra reduces the total interest expense.• Flexibility in Repayment: Borrowers can choose to make fixed extra payments every month or occasional lump-sum payments. <p>The formula for the updated balance after an extra payment is:</p> <p>Where:</p> <ul style="list-style-type: none">• B_m = Outstanding loan balance after month m• EMI = Regular monthly payment• Interest = Monthly interest charge• ExtraPayment = Additional amount paid towards principal <p>The Rule of 72: The Rule of 72 is a quick, useful formula that is popularly used to</p>
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estimate the number of years required to double the invested money at a given annual rate of return. Alternatively, it can compute the annual rate of compounded return from an investment, given how many years it will take to double the investment.

While calculators and spreadsheet programs like Microsoft Excel have functions to accurately calculate the precise time required to double the invested money, the Rule of 72 comes in handy for mental calculations to quickly gauge an approximate value.

Formula:

where T is the approximate doubling time in years and r is the annual interest rate (as a percentage).

To compare the results with the actual doubling time using the standard formulas for

- **Simple Interest:**

$$A = P(1 + rt)$$

- **Compound Interest:**

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

where n is the compounding frequency.



Implementation	<p>Part 1: Mortgage Payment Analysis with Extra Contributions</p> <p>Step 1: Calculate EMI for a given loan</p> <ul style="list-style-type: none">Define the following loan parameters:<ul style="list-style-type: none">Loan Amount = Rs. 50 lakhsInterest Rate = 8% annuallyTerm = 20 years (240 months)Compute EMI using the mortgage payment formula. <p>Step 2: Generate the amortization schedule with extra payments</p> <ul style="list-style-type: none">Compute interest and principal breakdown for each month.Deduct an additional principal payment of Rs. 5000 per month.Adjust the remaining loan balance iteratively.Display the first and last 10 rows of the amortization schedule. <p>Step 3: Visualize loan balance reduction</p> <ul style="list-style-type: none">Plot a line graph showing loan balance vs. months.Compare scenarios with and without extra payments. <p>Step 4: Conduct a parametric study</p> <ul style="list-style-type: none">Vary the extra payment amount (e.g., Rs. 3000, Rs. 5000, Rs. 10000 per month).Analyze and visualize the effects on:<ul style="list-style-type: none">Loan tenure reductionTotal interest savingsTotal amount paid <p>Step 5: Compare Lump-Sum vs. Regular Extra Payments</p> <ul style="list-style-type: none">Compare the effect of a one-time lump-sum payment (e.g., Rs. 2 lakhs) versus monthly extra payments.Determine which strategy provides greater interest savings and a faster loan payoff. <p>Use different graphs to illustrate the findings and discuss conclusions.</p> <p>Part 2: Investment Growth Analysis using the Rule of 72</p> <p>Step 6: Compute Doubling Time Using Simple and Compound Interest</p> <ul style="list-style-type: none">Implement the Rule of 72 formulaCompare the results with the actual doubling time using the standard formulas for: Simple Interest and Compound Interest <p>Step 7: Compute Doubling Period for Different Compounding Frequencies</p> <ul style="list-style-type: none">Calculate the actual time required for an investment to double when compounded:<ul style="list-style-type: none">Annually
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	<ul style="list-style-type: none">○ Semi-annually○ Quarterly○ Monthly• Compare theoretical Rule of 72 estimates with exact values. <p>Step 8: Visualize Investment Growth</p> <ul style="list-style-type: none">• Plot investment growth curves for different compounding frequencies.• Compare simple vs. compound interest using a line graph.
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Conclusion	Additional principal payments dramatically lower mortgage tenure and interest expense, as evident from the amortization schedule. Visualization of loan balance verifies the payoff acceleration effect. The Rule of 72 offers a rough estimate of investment doubling time in different interest models and compounding frequencies.
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