Department of Computer Science and Engineering (Data Science)

S.Y.B.Tech. **Sem: IV**

Subject: Computational Methods and Pricing Models Laboratory

Experiment 1

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Date:	**Experiment Title:** Loan Payment Calculator and Amortization Schedule
Aim	To calculate the EMI for a given loan using the standard mortgage payment formula, generate an amortization schedule, visualize the breakdown of payments, and perform a parametric study on the effects of tenure and interest rate.
Software	Python on Google Colab
Theory	A **loan amortization schedule** is a structured table that details the periodic payments made on a loan. Each instalment consists of two components: 1. **Principal Repayment** – The portion of the payment that reduces the outstanding loan balance. 2. **Interest Payment** – The cost paid to the lender for borrowing money, which is based on the remaining principal. The loan payments remain **constant** (EMI stays the same), but the composition changes over time: • Initially, a larger portion of the EMI goes toward interest, while a smaller portion contributes to the principal. • Gradually, as the outstanding loan balance decreases, the interest portion reduces, and the principal portion increases. The EMI (Equated Monthly Installment) is calculated using the formula: $$EMI = \frac{P \times r \times (1+r)^n}{(1+r)^n - 1}$$ Where: • P = Loan Amount • r = Monthly Interest Rate (Annual Rate / 12 / 100) • n = Total Number of Payments (Term in Months) 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. A parametric study helps understand how changes in tenure and interest rate affect the total amount paid and interest paid.

	The Impact of Loan Parameters **Interest Rate Effect** • A higher interest rate increases the EMI and the total amount paid over the loan term. • A lower interest rate reduces the EMI and the total cost of the loan. **Loan Tenure Effect** • A longer tenure reduces the EMI but increases the total interest paid. • A shorter tenure increases the EMI but decreases the overall interest paid, making the loan more economical. **Total Interest Paid** • The total interest paid over the loan duration can be computed as: Total Interest = (EMI × n) − P • Loans with longer tenures tend to result in much higher interest payments due to the extended period of borrowing. **Outstanding Loan Balance** • The outstanding balance reduces over time as principal payments accumulate. • The formula to calculate the outstanding balance after a given month mmm is: $$B_m = P \times \frac{(1+r)^n - (1+r)^m}{(1+r)^n - 1}$$ • This helps in understanding how much of the loan is still unpaid at any given time.

Implementation	**Step 1: Calculate EMI for the given loan details**
	
	• Define the given loan parameters:
	  ○ Loan Amount = Rs. 1 Cr
	  ○ Interest Rate = 9% annually
	  ○ Term = 20 years (240 months)
	• Use the mortgage payment formula to compute EMI.

```
[1]  p = 10000000
     r = 9/(12*100)
     n = 20*12
```

```
[2]  def emi(p, r, n):
         num = p * r * ((1+r)**n)
         den = ((1+r)**n)-1
         return int(num/den)

     e = emi(p, r, n)
     print(e)
```

```
89972
```

Step 2: Generate and display the amortization schedule

- Calculate the monthly interest and principal paid for each month.
- Update the remaining loan balance iteratively.
- Display the first 10 and last 10 rows of the amortization schedule.

```
[3]  def mi(p, r):
       mi = p * r
       return int(mi)
```

```
[4]  def pp(p, r, n):
       pp = emi(p, r, n) - mi(p, r)
       return int(pp)
```

```
[5]  balance = p
     data = []
     for i in range(1, n+1):
       interest= mi(balance, r)
       principal = pp(balance, r, n - i + 1)
       balance -= principal
       data.append([i, e, interest, principal, int(balance)])
```

```
[6]  import pandas as pd
```

```
[7]  df = pd.DataFrame(data, columns = ['Month', 'EMI', 'Interest', 'Principal', 'Balance'])
     df.reset_index(drop=True, inplace=True)
```

```
df.head(10)
```

	Month	EMI	Interest	Principal	Balance
0	1	89972	75000	14972	9985028
1	2	89972	74887	15085	9969943
2	3	89972	74774	15198	9954745
3	4	89972	74660	15312	9939433
4	5	89972	74545	15427	9924006
5	6	89972	74430	15542	9908464
6	7	89972	74313	15659	9892805
7	8	89972	74196	15776	9877029
8	9	89972	74077	15895	9861134
9	10	89972	73958	16014	9845120

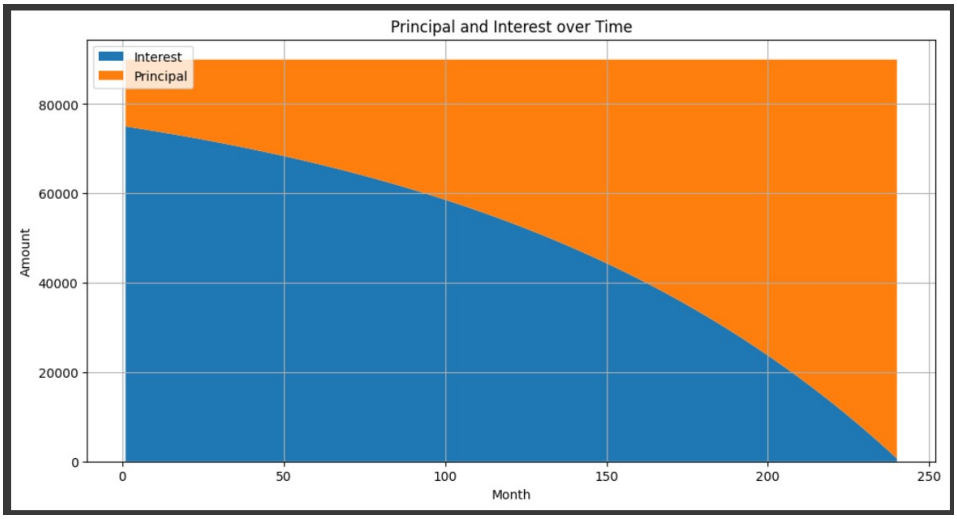
```
[9] df.tail(10)
```

	Month	EMI	Interest	Principal	Balance
230	231	89972	6477	83496	780207
231	232	89972	5851	84121	696086
232	233	89972	5220	84752	611334
233	234	89972	4585	85388	525946
234	235	89972	3944	86029	439917
235	236	89972	3299	86673	353244
236	237	89972	2649	87324	265920
237	238	89972	1994	87978	177942
238	239	89972	1334	88639	89303
239	240	89972	669	89303	0

Step 3: Visualize monthly breakdown of principal and interest

- Use a bar chart or stacked area plot to show how the principal and interest components change over time.

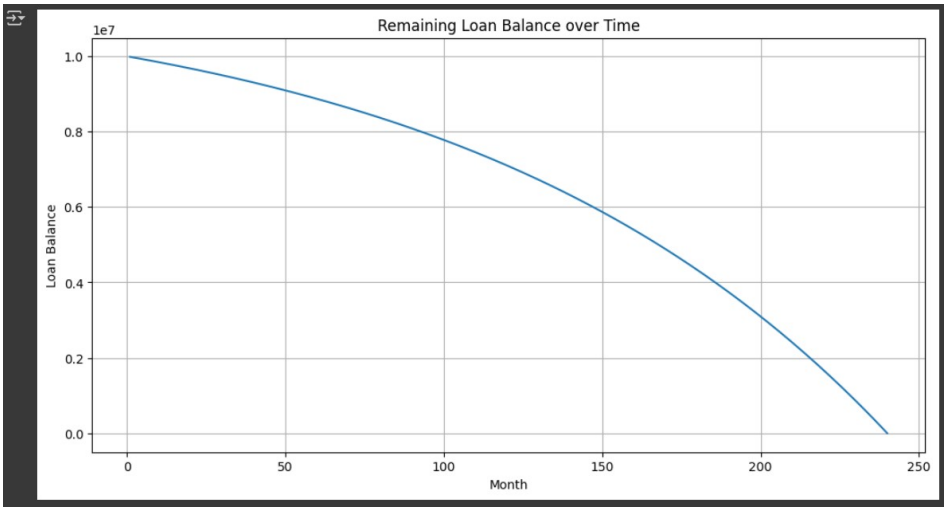
```
[10] import matplotlib.pyplot as plt
     plt.figure(figsize=(12, 6))
     plt.stackplot(df['Month'], df['Interest'], df['Principal'], labels=['Interest', 'Principal'])
     plt.xlabel('Month')
     plt.ylabel('Amount')
     plt.title('Principal and Interest over Time')
     plt.legend(loc='upper left')
     plt.grid(True)
     plt.show()
```



Step 4: Visualize loan balance over time

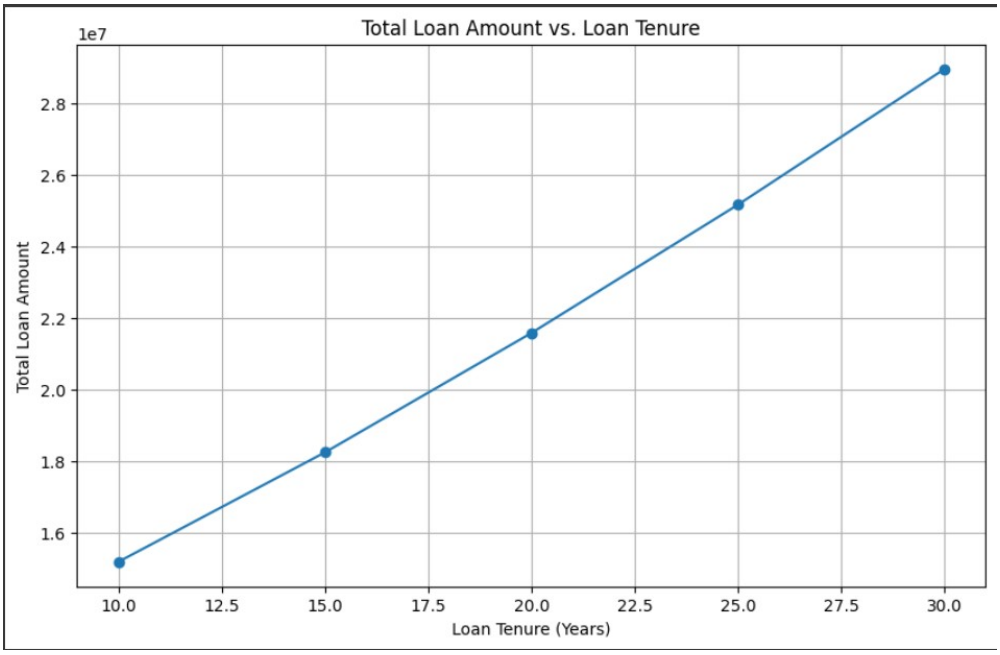
- Plot the declining loan balance over the repayment period.

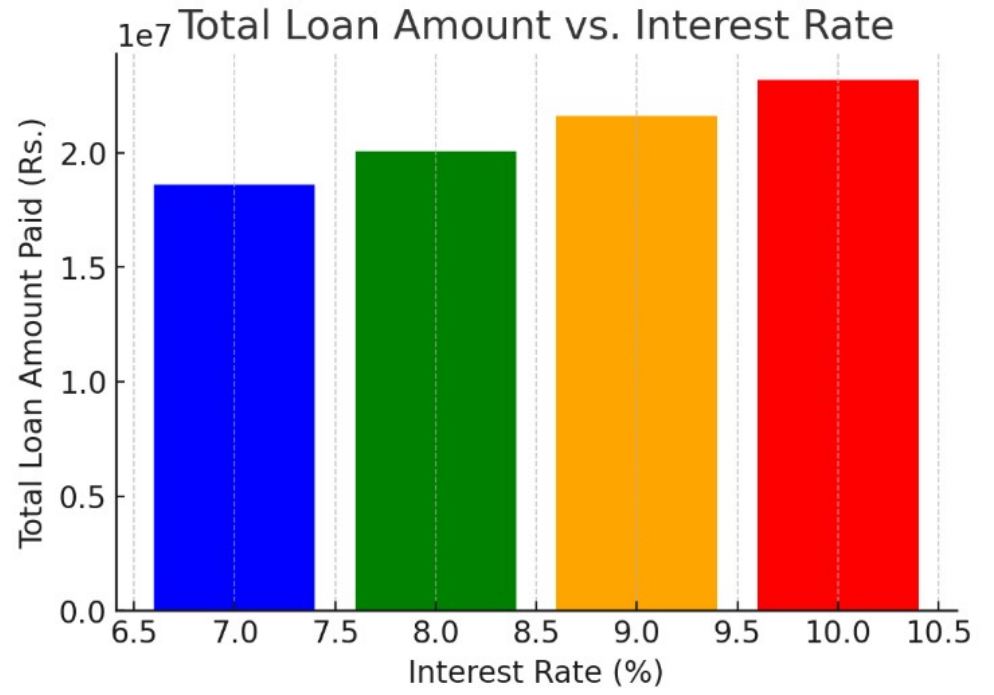
```
[11] plt.figure(figsize=(12, 6))
     plt.plot(df['Month'], df['Balance'])
     plt.xlabel('Month')
     plt.ylabel('Loan Balance')
     plt.title('Remaining Loan Balance over Time')
     plt.grid(True)
     plt.show()
```



Step 5: Conduct a parametric study

- Vary the loan tenure (e.g., 10, 15, 25, and 30 years).
- Vary the interest rate (e.g., 7%, 8%, 9%, 10%).
- Analyze and visualize the effects on:
  - EMI
  - Total Interest Paid
  - Total Amount Paid
- Use different graphs to illustrate the findings and discuss conclusions.



	
Conclusion	A longer tenure lowers the EMI but significantly increases total interest paid. A shorter tenure increases the EMI but reduces overall interest, making the loan more economical. A higher interest rate increases both the EMI and total repayment amount. A lower interest rate reduces the EMI and total loan cost. The total amount is adjusted and kept the same as EMI and interest paid differ as loan tenure and interest rates differ. As in the first graph above, as the tenure increases, the total loan amount also increases.
Colab Link	https://colab.research.google.com/github/SmayanKulkarni/AI-and-ML-Course/blob/master/D100%20CMPM/cmpm_exp1.ipynb