Due Date

You must *submit* the source code for the solution to this lab exercise to *Moodle* by

Thursday, July 21, 2022

in order to receive full credit for this work. You must also *demonstrate* the solution to the instructor during class, at the earliest opportunity.

Background Information

The biggest purchase most people make in life is to buy their own home. This usually involves getting a "mortgage loan". There are also other types of loans, such as student loans and automobile loans. The calculations involved with all of these transactions are essentially the same.

In this lab exercise, you will calculate the monthly payment for a fixed-rate loan, using the formula given below. The monthly payment, with interest compounded monthly, can be calculated as follows:

$$\text{monthlyPayment} = \frac{\text{loanAmount} * \text{monthlyInterestRate} * \text{powerFactor}}{\text{powerFactor} - 1}$$

where $\text{powerFactor} = (1 + \text{monthlyInterestRate})^{\text{numberOfPayments}}$

and $\text{monthlyInterestRate} = \frac{\text{annualInterestRate}}{12}$

and $\text{numberOfPayments} = \text{numberOfYears} * 12$

For example, if you borrow **$250,000.00** in a **30-year fixed rate** mortgage, at **4.75 %** interest per year:

numberOfPayments = 30 * 12 = **360**
monthlyInterestRate = 0.0475 / 12 = **0.00395833**
$\text{powerFactor} = (1 + 0.00395833)^{360}$ = **4.14618**
Monthly payment = **$1304.12**.
Total Pay back = (Monthly payment) * (numberOfPayments) = **$469482.60**.

Programming Assignment

Design and code a **C++ class** called **Mortgage**, that will determine the monthly payment on a loan. The class must have member functions for setting the loan amount, interest rate, and number of years of the loan. It must also have member functions for returning the monthly payment amount and the total amount paid to the bank over the life of the loan.

Write an interactive "main program" that prompts the user to enter the parameters of a particular loan, creates a **Mortgage** object with those parameters and outputs the result. The "main program" must also ask the user if they wish to process another loan, and repeat until the user finally indicates that they wish to exit the program.

Organize your code according to the convention described in the lecture, and also in Section 13.5 (pages 745-751) of the textbook:

- A class specification file: **`Mortgage.h`**
- A class implementation file: **`Mortgage.cpp`**
- A "main program" file: **`Lab13a.cpp`**

Include a loop in your main program, which allows the user to repeat the mortgage calculations for different loan amounts, until the user finally indicates that they wish to quit the program. Each time the user chooses to enter data for a new loan, the program must create a new **`Mortgage`** object.

Designing the Mortgage Class

When designing the Mortgage class, you will probably want to have private member variables such as:

- **`loanAmount`**
- **`annualInterestRate`**
- **`monthlyInterestRate`**
- **`totalYearsToRepay`**
- **`numberOfPayments`**

You must create public "**getter**" and "**setter**" functions for the member variables *as needed*. These functions will allow the code outside the class to access the private member variables. (Depending on the details of your program, you may or may not need "**getter**" and "**setter**" functions for every member variable. Implement them as needed.)

Sample Output

Test your program with different loan amounts, interest rates and years to repay. The sample below shows correct output for several test cases. (In this example, the text that the user types is shown in **BOLD** font. The actual input / output will all be displayed in the same font.)

Sample Console Input / Output

```
Enter the amount of the loan: 250000
Enter the annual interest rate in decimal form (example .075): 0.0475
Enter the length of the loan in years: 30

Loan Amount: $250000.00
Annual Interest Rate: 0.04750
Years to repay: 30
Monthly Payment: $1304.12
Total Pay Back: $469482.60

Do you wish to process another loan? y
Enter the amount of the loan: 20000
Enter the annual interest rate in decimal form (example .075): 0.0500
Enter the length of the loan in years: 5

Loan Amount: $20000.00
Annual Interest Rate: 0.05000
Years to repay: 5
Monthly Payment: $377.42
Total Pay Back: $22645.48

Do you wish to process another loan? y
Enter the amount of the loan: 50000
Enter the annual interest rate in decimal form (example .075): 0.0625
Enter the length of the loan in years: 10

Loan Amount: $50000.00
Annual Interest Rate: 0.06250
Years to repay: 10
Monthly Payment: $561.40
Total Pay Back: $67368.06

Do you wish to process another loan? n
```

Enhanced Mortgage Class (extra credit)

Implement a new member function, as part of the **Mortgage** class. The function prototype must be part of the class specification, in **`Mortgage.h`**:

```
void outputPaymentSchedule();
```

The actual code for the **`outputPaymentSchedule`** function must be in the **`Mortgage.cpp`** source file.

The enhanced program must

- Ask the user to enter a name for the output file.
- Create the output (text format) file.
- Write the mortgage information to the output file in a format similar to the text found in **`sample_output.txt`**.
- The output file must include a "Payment Schedule": a month-by-month status of the mortgage, organized in the following columns:

Pmt#:	Sequential payment numbers, starting at 1.
Payment Amount:	The (fixed) monthly payment amount for the mortgage.
Interest:	Interest for the month.
Contrib to Principle:	Amount of payment used to diminish the remaining balance.
Remaining Balance:	New value for the remaining balance.

Calculations for the Mortgage Payment Schedule

When designing code for the **`outputPaymentSchedule()`** function, consider the following: For any given month, while the payment amount remains fixed, the amount paid to interest is given by the following:

interest = (monthly interest rate) * (current loan balance).

Therefore, the amount contributed to principle is:

contrib_to_principle = monthly_payment – interest.

When the *next* month's payment is made, the current loan balance has been reduced, so a smaller portion of the (fixed) monthly payment is needed to pay interest.

balance = (balance) – (contrib_to_principle).

Observe the Loan Payment Progress

Early in the life of a loan, the principle (remaining balance) is reduced by a small amount each month. However, over time, the amount paid each month to **interest** diminishes, so the **remaining balance** shrinks faster and faster, until the remaining balance finally reaches zero after the final payment.

A portion of the **sample_output.txt** file is shown below:

```
Loan Amount: $250000.00
Annual Interest Rate: 0.04750
Years to repay: 30
Monthly Payment: $1304.12
Total Pay Back: $469482.60

 Pmt#    Payment Amount          Interest  Contrib to principle Remaining balance
    1           1304.12            989.58                314.54         249685.46
    2           1304.12            988.34                315.78         249369.68
    3           1304.12            987.09                317.03         249052.65
    4           1304.12            985.83                318.28         248734.37
    5           1304.12            984.57                319.54         248414.83
    6           1304.12            983.31                320.81         248094.02
    7           1304.12            982.04                322.08         247771.94
    8           1304.12            980.76                323.35         247448.58
    9           1304.12            979.48                324.63         247123.95
   10           1304.12            978.20                325.92         246798.03
   11           1304.12            976.91                327.21         246470.82
   12           1304.12            975.61                328.50         246142.31
   13           1304.12            974.31                329.81         245812.51
   14           1304.12            973.01                331.11         245481.40
   15           1304.12            971.70                332.42         245148.98
         .   .   .
  356           1304.12             25.51               1278.61           5165.26
  357           1304.12             20.45               1283.67           3881.59
  358           1304.12             15.36               1288.75           2592.83
  359           1304.12             10.26               1293.86           1298.98
  360           1304.12              5.14               1298.98             -0.00
```

Sample Interactive Session

In this example, what the user types is shown in **bold**. In actuality, what the user types would appear as the same text format as the output.

Sample Console Input / Output -- EXTRA CREDIT Enhancement

```
Enter output file name: test01.txt
Enter the amount of the loan: 250000
Enter the annual interest rate in decimal form (example .075): 0.0475
Enter the length of the loan in years: 30

Loan Amount: $250000.00
Annual Interest Rate: 0.04750
Years to repay: 30
Monthly Payment: $1304.12
Total Pay Back: $469482.60
```

Sample Console Input / Output -- EXTRA CREDIT Enhancement

```
Do you wish to process another loan? y
Enter output file name:  test02.txt
Enter the amount of the loan: 20000
Enter the annual interest rate in decimal form (example .075): 0.0500
Enter the length of the loan in years: 5

Loan Amount: $20000.00
Annual Interest Rate: 0.05000
Years to repay: 5
Monthly Payment: $377.42
Total Pay Back: $22645.48

Do you wish to process another loan? y
Enter output file name:  test03.txt
Enter the amount of the loan: 50000
Enter the annual interest rate in decimal form (example .075): 0.0625
Enter the length of the loan in years: 10

Loan Amount: $50000.00
Annual Interest Rate: 0.06250
Years to repay: 10
Monthly Payment: $561.40
Total Pay Back: $67368.06

Do you wish to process another loan? n
```

Real-life advice: Future (First-Time) Homebuyers Beware!

The Monthly Payment calculated by this program is described in the Mortgage business as the "**Principle and Interest**" monthly payment. The "Principle and Interest" is only part of your actual monthly mortgage payment. You will also need to make contributions toward property taxes and insurance. Keep this in mind when deciding how much you can afford to pay for a house. (A good loan officer or real estate agent would be sure you understand this, but if they "forget to mention it", it is still the borrower's responsibility.)