

## PIC 10B SPRING 2013 HOMEWORK 1

### Assignment

Make a `Polynomial` class with *integer* coefficients. This will store polynomials  $p$  of the form

$$P(x) = a_0 + a_1x + a_2x^2 + \dots a_kx^k,$$

where  $a = (a_0, a_1, \dots, a_k)$  is an *integer* vector. Please do NOT work with a double vector for this assignment. For each function *declared*, define the function below main.

In main, your program should ask the user to enter in the coefficients of two polynomials. You can separate the polynomials by testing for the input of -123456789. Your main should then add, subtract, and multiply these polynomials. Some sample output is displayed on page 3.

```
class Polynomial {
public:
    Polynomial();
    Polynomial(vector<int> coeffs);

    // Accessors
    int Degree() const;
    int Coefficient(int k) const;
    void print() const;

    // Mutator
    void constantMultiply(int x);
    void Transform();

private:
    vector<int> coefficient;
}

// poly1 + poly2
Polynomial Add(Polynomial poly1, Polynomial poly2);

// poly1 - poly2
Polynomial Subtract(Polynomial poly1, Polynomial poly2);

// poly1 * poly2
Polynomial Multiply(Polynomial poly1, Polynomial poly2);
```

Here is a brief description of what each function should do:

- `Polynomial()` is the default constructor, and should initialize the polynomial to 0 by default.
- `Polynomial(vector<int> coeffs)` is the constructor with parameters that sets the private variable coefficient to the input parameter coeffs.
- `Degree()` returns the degree of the polynomial.
- `Coefficient(int k)` returns the coefficient of  $x^k$ .
- `print()` prints out the polynomial.
- `constantMultiply(int x)` multiplies the polynomial by an integer constant,  $x$ .
- `Transform()` Transforms the polynomial, the exact description is given below.

**Notation and terms:** The *degree* of a polynomial is the largest power of  $x^k$  with a non-zero coefficient. For example, the degree of  $1 - x + x^2 + 3x^6$  is 6, and the degree of 34 is 0.

The  $k$ -th coefficient, or the coefficient of  $x^k$  is the numerical value multiplied by  $x^k$ . For example, the coefficient of  $x^2$  in  $1 - x + x^2 + 3x^6$  is 1, and the coefficient of  $x^5$  is 0.

I will define the Transform function as follows. For a polynomial

$$P(x) = a_0 + a_1x + a_2x^2 + \dots a_kx^k,$$

The Transform of  $P(x)$  is given by the formula

$$a_1 + 2a_2x + 3a_3x^2 + \dots ka_kx^{k-1}.$$

In the case when  $P(x) = a_0$ , the Transform is 0. This includes the case when  $a_0 = 0$ .

Here are some examples of the Transform function:

- $P(x) = 1 + x + x^2 + x^3 + x^4$ , then the transform is  $1 + 2x + 3x^2 + 4x^3$ .
- $P(x) = 1 - 2x + 34x^5 + x^{87}$ , then the transform is  $-2 + 170x^4 + 87x^{86}$
- $P(x) = 0$ , then the transform is 0.
- $P(x) = x^4$ , then the transform is  $4x^3$ .
- $P(x) = 5$ , then the transform is 0.
- $P(x) = -x^2 - x^3 + 5x^4$ , then the transform is  $-2x - 3x^2 + 20x^3$ .

NOTE: Once constantMultiply and Add are defined, the Subtract function is very easy.

Place your code in a source file labeled *hw1.cpp*. ***If your file is not named this exactly, your homework will not be collected.*** As with all programs in this course, your code should contain useful comments. In particular, your name, the date, and a brief description of what the program does should appear at the top of your source file.

### What to Turn in

Place in your Submit folder the source file *hw1.cpp* with exactly this name (all lowercase, no spaces). The files will be automatically collected on Friday 4/5/13 at 5:00pm.

Grading		
Correctness	No errors, input/output correct, output presented nicely	5 points
Arithmetic	Correctly performs polynomial arithmetic	5 points
Solution	Code is efficient but easy to follow	5 points
Style	Variable names, comments, indentation	5 points
	TOTAL	20 points

Note on grading: There is an automatic 5 point penalty for any homework that does not compile.

A *sample* of output is below. NOTE! The values input are just an example. When grading the homework the grader will select values to input for the coefficients, so do not just hard-code these coefficients. It is sufficient to use `cin` and `cout` for this assignment, there is no need to use `getline()`.

Welcome! Please input the coefficients of the first polynomial.  
When you are finished, enter -123456789.

1  
-2  
0  
4  
-123456789

Your first polynomial is  $1-2x+4x^3$ .

Please input the coefficients of the second polynomial.

0  
-1  
5  
0  
0  
0  
-3  
-123456789

Your second polynomial is  $-x+5x^2-3x^6$ .

The sum of these polynomials is

$1-3x+5x^2+4x^3-3x^6$

The first minus the second is

$1-x-5x^2+4x^3+3x^6$

The first multiplied by the second is

$-x+7x^2-10x^3-4x^4+20x^5-3x^6+6x^7-12x^9$

Thanks for using my program!

Press any key to continue...

Notes for the `print()` function. First, I suggest making a simple print function that is correct but not pretty before attempting to include these cases; this way in case you cannot get these cases to work you can still turn in a version that compiles.

- As a convention, print the polynomial from smallest degree to largest.
- Suppress terms which have a coefficient of 0 (the only exception is the 0 polynomial, which should print 0).
- Suppress the 1 and -1 coefficients, so  $-1x^4$  should print out as  $-x^4$ .
- Suppress the exponent of 1, so  $2x$  should print out as  $2x$  and NOT  $2x^1$
- For negative coefficients, do not print out the plus, as in  $1 - 3x$  should print as  $1-3x$  and NOT  $1+-3x$