Project #5

Specify via UML diagrams an ADT Polynomial, (see: page 236, problem 12 for a start), and implement the ADT Polynomial which requires the input of at least two polynomials, e.g., p1 & p2 and allows the user to compute the sum of the polynomials, e.g., p1 + p2, and the difference between the two polynomials, e.g., p1 – p2. The system must provide at least twelve reference variables, e.g., p1, p2, p3, p4, p5, ..., p12 to be created to hold twelve input polynomials. Hint: use an array of head reference variables. When a polynomial is entered, e.g., the next available reference variable, e.g., p9, is assigned to hold that polynomial.

Maintain the results of the last add operation by using the reference variable p_add, and the results of the last subtract operation by using the reference variable p_diff. These variables will always hold the results of the last operation. However p_add and p_diff may be used in additional computations by simply invoking their name into the computation, e.g., compute p_add * (p_diff - p12); it may be necessary to maintain a few additional reference variables reserved for this task. Remember that p_add, p_diff will always hold the results of the last operation.

Thus, the following sequences of operations must be considered valid:

\[
\begin{align*}
&\begin{cases}
\ p1 - p2 \\
\ p3 - p_{\text{diff}}
\end{cases} \\
&\begin{cases}
\ p1 + p2 \\
\ p3 + p_{\text{add}}
\end{cases}
\]

The values of the input reference variables p1, p2, ..., p12 must always be maintained for future computations.

Assume that we are dealing only with polynomials of one variable; create a node for each term of the polynomial; require that the polynomial be entered in a descending order of the exponents. Create nodes for only those terms that are present in the given polynomial.

Before reporting results, collect and combine all like terms, i.e., the nodes

\[
\begin{align*}
73 & \quad 1 \\
-4 & \quad 1
\end{align*}
\]

must be combined into

\[
\begin{align*}
69 & \quad 1
\end{align*}
\]
i.e., store only the coefficients and exponents of the given non-zero terms of the resulting polynomial.

Input of the polynomial $5x^{15} + 7x^2 - 4x - 97$ should be implemented in some form acceptable to Java input such as

- Entering the string $5x^{15}+7x^2-4x^1-97x^0$ and then using string methods to extract the coefficients and exponents or

- entering the sequence of pairs $5 \quad 15$
  $\quad 7 \quad 2$
  $\quad -4 \quad 1$
  $\quad -97 \quad 0$

How to detect the entry of the last term of a polynomial

1. Limit the polynomial to positive exponents, e.g., $5x^{15} + 7x^2 - 4x - 97$ or $-3x^{15} + 7x^4 -5x^2 + 19x$
   - Use a sentinel such as a term with a zero exponent
   - If a term has a zero exponent and a non-zero coefficient then create a node to hold the data; the polynomial is then complete
2. If a term has a zero exponent and a zero coefficient enter 0 0 but do NOT create a node; the polynomial is complete, e.g., the polynomial $-3x^{15} + 7x^4 -5x^2 + 19x$ whose last term consists of a coefficient 19 and an exponent of one; during data entry, provide the polynomial with the additional term + 0x0, i.e., $-3x^{15} + 7x^4 -5x^2 + 19x + 0x^0$ but do NOT create that node

2. Allow the polynomial to have terms such as $8x^2 -9x^{-5}$
   - Enter the number of terms in the polynomial
   - Enter the terms; no need to use + 0x0

Do not create nodes for terms that are not exhibited in the original polynomial; $5x^{15} + 7x^2 - 4x - 97$ consists of four nodes and $-3x^{15} + 7x^4 -5x^2 + 19x$ consists of four nodes.

After the polynomials $p_1$ and $p_2$ have been entered and the sum $p_{\text{Sum}} = p_1 + p_2$ has been computed, the system should display the input polynomials $p_1$ and $p_2$ and the resulting polynomials $p_{\text{Sum}}$ as follows: assume that the polynomial to be displayed is $2x^{15} + 7x^4 + 2x^2 + 15x - 97$ then the actual output should be $2x^{15} + 7x^4 + 2x^2 + 15x1 - 97x0$

After the polynomials $p_1$ and $p_2$ have been entered and the difference $p_{\text{diff}} = p_1 - p_2$ or $p_{\text{diff}} = p_2 - p_1$ has been computed, the system should display the $p_{\text{diff}}$ polynomial as well as the input polynomials $p_1$ and $p_2$ described above.
For extra credit A (separate from B below)

Phase 1
- include the ability to multiply two polynomials, i.e., $p_1 \ast p_2$
- $p_{\text{mult}}$ is used, as described above, for the reference variables $p_{\text{add}}$ and $p_{\text{diff}}$
- $p_{\text{mult}}$ may be used in additional computations by simply invoking the name into the computation, e.g., compute $p_{\text{add}} \ast p_{\text{diff}} - p_{\text{mult}}$
- Remember that $p_{\text{mult}}$ will always hold the results of the last multiply operation

Phase 2
- maintain the results $p_{\text{add}}$, $p_{\text{diff}}$, $p_{\text{mult}}$ by assigning them to a list of additional reference variables

For extra credit B (separate from A above)
- Allow entry of the polynomial in an arbitrary order of exponents and provide a sorting method.

You may choose to both A and B for independent extra credit.