Newton-Rhapson Method

Background: *Your coworker has taken several volume measurements of a gas at various temperatures. The measurements all correlate to odd order polynomials (i.e. 1st, 3rd, 5th…), and your coworker has already fit these polynomials to the data. She now needs your help creating a program to find the volume of the gas when the temperature is at 0℃. You will be provided with the coefficients for the polynomial fit, and need to solve for the volume at the correct temperature.*

Knowing that all odd order polynomials have at least 1 real root (roots are values where the equation is equal to zero), you have decided to use the Newton-Rhapson method to find the root. Your code should be flexible to work for any odd order polynomial. A simple tutorial of the Newton-Rhapson method can be found at: http://www.sosmath.com/calculus/diff/der07/der07.html#answer1.

Some examples of the polynomials your coworker has provided (you could be given higher order polynomials as well):

1st order polynomial	$T(V) = C_1 V + C_2$
3rd order polynomial	$T(V) = C_1 V^3 + C_2 V^2 + C_3 V + C_4$
5th order polynomial	$T(V) = C_1 V^5 + C_2 V^4 + C_3 V^3 + C_4 V^2 + C_5 V + C_6$

Newton-Rhapson Method:

$$V_n = V_{n-1} + \frac{T(V_{n-1})}{T'(V_{n-1})}$$

Assumptions:

- The user will always enter the coefficients as a vector ([C_1 C_2 … C_n])
- Each polynomial only has 1 real root.
- Helpful functions for working with coefficients of polynomials: polyval, polyder

Coding Requirements:

- Include required documentation and header for the problem and clearly label tasks with comments in your code.
- All output to the command window should be formatted (not unsuppressed output).
- Review the rubric for a description of test cases and a sample output.

TASK 1:

Ask the user to enter a vector of coefficients for the polynomial model. Verify that the entry has an even number of elements (an odd number of elements would mean an even order polynomial). If an incorrect vector is entered, ask the user to re-enter the vector until an appropriate vector is entered. If the user fails to enter an acceptable vector after 5 attempts, your code should display a warning and simply remove the last element of the last vector entered. (i.e. [1 2 3 4 5] becomes [1 2 3 4]).

TASK 2:

Ask the user to enter a starting value for the Newton-Rhapson method. The Newton-Rhapson method is an iterative method that gets increasingly accurate with each successive iteration. Repeat the method until the percent change between the last two iterations is less than 1%. The percent difference formula is:

$$Percent\ Difference = \left|\frac{V_n - V_{n-1}}{V_{n-1}}\right| * 100$$

TASK 3:
Output the final value of the root found by the Newton-Rhapson method and the number of iterations it took to converge to that value as shown in the sample output. Ask the user if they would like to find the roots for another polynomial. If yes, repeat the entire program; if no, the program should end (This is not shown in the sample output).

NOTE: After the output for the entered polynomial, the user should always be given the option to repeat the program. The program should only end once the user has stated that they do not want to enter another polynomial.

Sample Output to Command Window:

Given the 1st order polynomial: $T(V) = 5.4\,V - 37$

Command Window
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Enter a vector of coefficients for an odd order polynomial: [5.4 -37]
Enter a starting value: 19
The Volume at T=0 for the given equation is 6.85185 [m^3].
The solution converged in 3 iterations.
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Given the 3rd order polynomial: $T(V) = V^3 + 2.6\,V^2 - 17.8$

Command Window
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Enter a vector of coefficients for an odd order polynomial: [1, 2.6, 0, -17.8, 5]
Enter a vector of coefficients: [1, 2.6, 0, -17.8, 5]
Enter a vector of coefficients: [1, 2.6, 0, -17.8, 5]
Enter a vector of coefficients: [1, 2.6, 0, -17.8, 5]
Enter a vector of coefficients: [1, 2.6, 0, -17.8, 5]
Warning: Coefficients for odd degree polynomial not entered, dropping last coefficient.
Enter a starting value: 0.2
The Volume at T=0 for the given equation is 1.97301 [m^3].
The solution converged in 9 iterations.
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Given the 5th order polynomial: $T(V) = 0.2\,V^5 + 0.5\,V^4 + 3.1\,V^2 + 2.15\,V - 67.3$

Command Window
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Enter a vector of coefficients for an odd order polynomial: [0.2, 0.5, 0, 3.1, 2.15, -67.3]
Enter a starting value: 0.4
The Volume at T=0 for the given equation is 2.53873 [m^3].
The solution converged in 12 iterations.
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