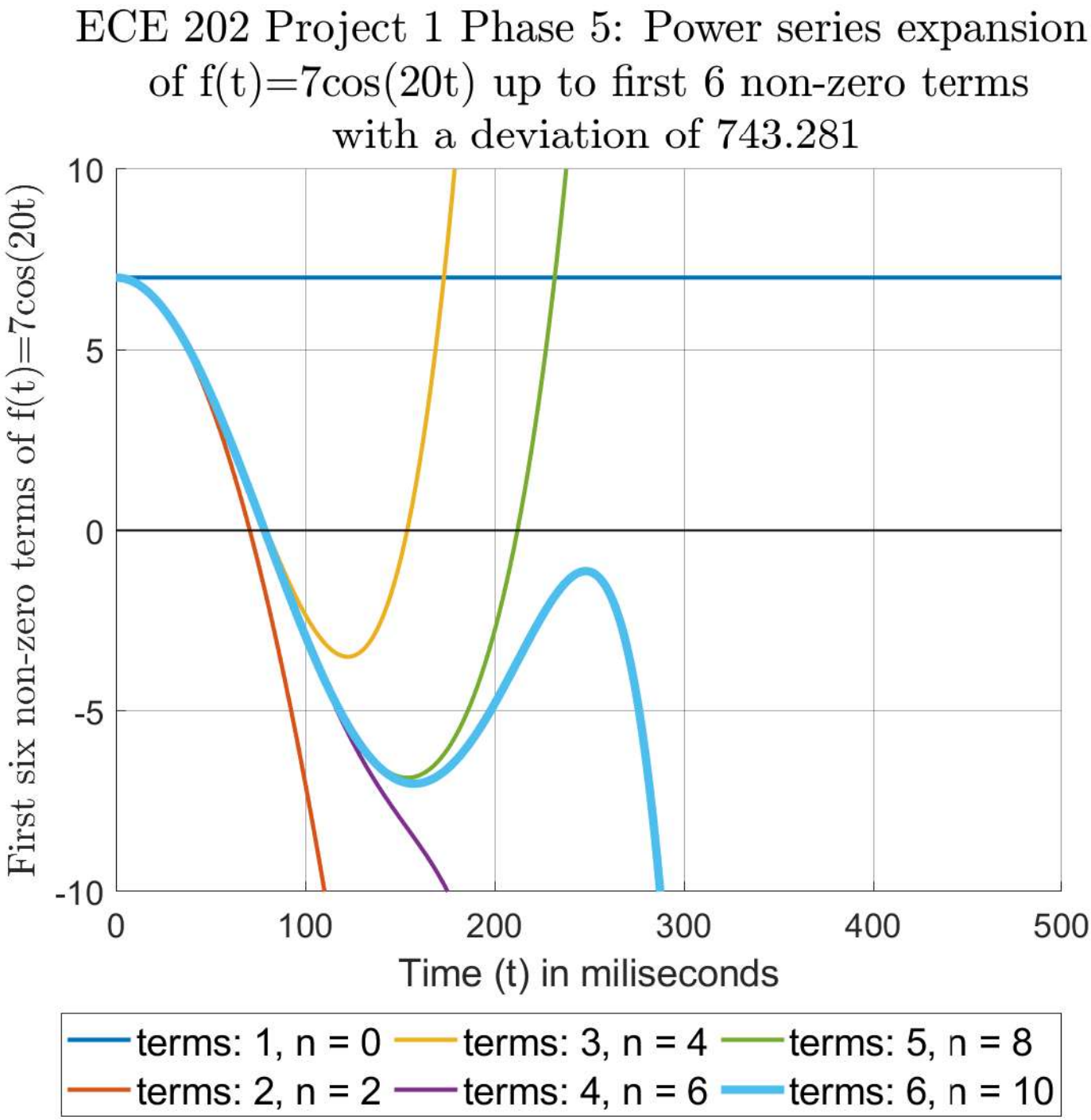
```
% Adi Nelson
% 11/10/23
% ECE 202: Project 1 phase 5

format shortG
clear
clc
clf

% ---- Setup ----

A = 7; % Amplitude of the sinusoid

w = 20; % Angular frequency of the sinusoid

num_terms = input("Enter the number of non-zero terms of the sinusoid: "); % Number of non-zero terms

tmin = input("Enter the minimum time in ms: "); % Minimum time in ms

tmax = input("Enter the maximum time in ms: "); % Max time in ms

intervals = input("Enter the number of intervals: "); % Number of points for plotting

t_ms = linspace(tmin,tmax,intervals); % Time t in seconds from 0ms to 500ms

t = t_ms/1000; % Time t in ms from 0s to 0.5s

n = [0:2:(2*num_terms)-2]; % n values of non-zero coefficients

a_n = (-1).^(n/2).*(w.^n)*A./factorial(n); % a_n values of non-zero coefficients

T = table(n',a_n','VariableNames', {'n values', ...
    'a_n values (Non-zero coefficients)'})

% ---- Old Calculations ----

f1 = a_n(1)*t.^n(1); % First term
f2 = f1 + a_n(2)*t.^n(2); % First and second term
f3 = f2 + a_n(3)*t.^n(3); % First through third terms
f4 = f3 + a_n(4)*t.^n(4); % First through fourth terms
f5 = f4 + a_n(5)*t.^n(5); % First through fifth terms
f6 = f5 + a_n(6)*t.^n(6); % First through sixth terms

% ---- New Calculations and Plotting ----

f = zeros([1 intervals]);

```

```
48 hold on
49 for k = 1:num_terms
50     f = f + a_n(k)*t.^n(k);
51     if k < num_terms
52         p(k)=plot(t_ms,f,'LineWidth', 2);
53     else
54         p(k)=plot(t_ms,f,'LineWidth', 4);
55         plot([tmin,tmax], [0,0], 'k', 'LineWidth', 1)
56     end
57 end
58
59 givenFunction = A*cos(w*t); % Given function 7*cos(20t)
60
61 avgDev = averageDeviation(givenFunction,f,intervals) % Uses function to calculate
62 % average devation between given function and final function
63
64 hold off
65 grid on
66 ax = gca;
67 ax.GridAlpha = 0.4;
68 ax.FontSize = 16;
69
70 title(sprintf("ECE 202 Project 1 Phase 5: Power series expansion \n of " + ...
71     "f(t)=%gcos(%gt) up to first %g non-zero " + ...
72     "terms \n with a deviation of %g",A,w,num_terms,avgDev),Interpreter='latex',↙
FontSize=21)
73 xlabel(sprintf("Time (t) in miliseconds"),Fontsize=18)
74 ylabel(sprintf("First six non-zero terms of " + ...
75     "f(t)=%gcos(%gt)",A,w),Interpreter='latex',FontSize=18)
76 ylim([-1*(A+3) A+3])
77
78 legend_terms = [1:num_terms];
79
80 legend(p,"terms: "+ legend_terms + ", " + ...
81     "n = " + n,Location="southoutside",FontSize=18,NumColumns=3)
82
83 if num_terms == 6
84     checkf = sum(f-f6) % Checks the difference between old and new final function
85 % Check should be equal to zero and is skipped when num_terms is not 6
86 end
87
88 function ave = averageDeviation(x,y,z)
89     ave = sum(abs(x-y))/z;
90 end
```

```
Enter the number of non-zero terms of the sinusoid: 6
Enter the minimum time in ms: 0
Enter the maximum time in ms: 500
Enter the number of intervals: 1000

T =

  6×2 table

    n values    a_n values (Non-zero coefficients)
    ________    __________________________________

        0                             7
        2                         -1400
        4                         46667
        6                    -6.2222e+05
        8                     4.4444e+06
       10                    -1.9753e+07


avgDev =

       743.28


checkf =

     0

>>
```


ECE 202 Project 1 Phase 5: Power series expansion of f(t)=7cos(20t) up to first 6 non-zero terms with a deviation of 743.281
First six non-zero terms of f(t)=7cos(20t)
10
5
0
-5
-10
0
100
200
300
400
500
Time (t) in miliseconds
terms: 1, n = 0
terms: 3, n = 4
terms: 5, n = 8
terms: 2, n = 2
terms: 4, n = 6
terms: 6, n = 10