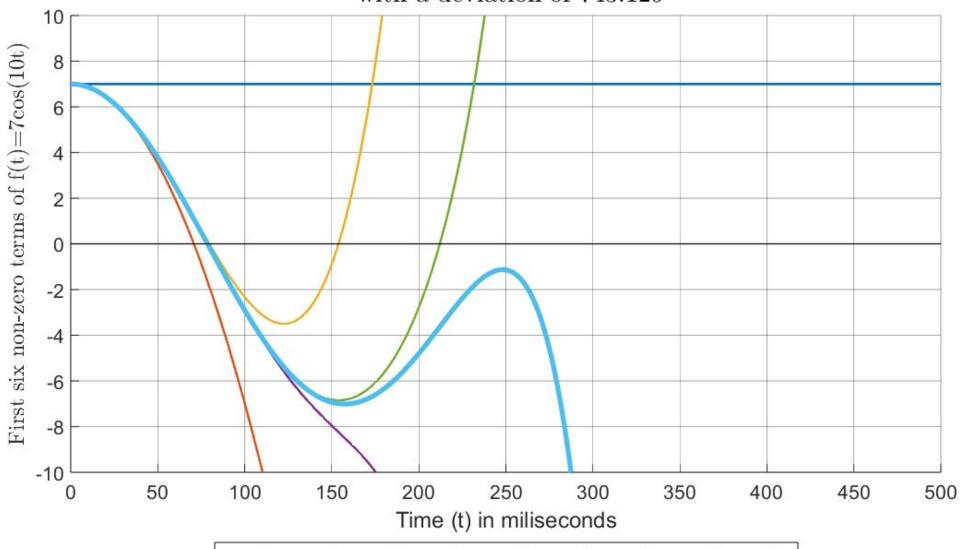```matlab
1 % Aidan Chin
2 % 12/10/23
3 % ECE 202: Project 1 phase 5
4
5 %---initialize---
6
7 format shortG
8 clear
9 clc
10
11
12 %---setup---
13
14 A = 7; %amplitude of sinusoid
15 w = 10; %angular frequency of sinusoid
16 num_terms = input("Enter number of non-zero terms of the sinusoid: ");
17 %number of non-zero terms
18 tmin = input("Enter minimum time in ms: "); %min time in ms
19 tmax = input("Enter maximum time in ms: "); %max time in ms
20 N = input("Enter number of intervals: "); %number of points for plotting
21
22 t_ms = linspace(tmin,tmax,N); % make time array t in seconds from 0s to 0.5s
23 t = t_ms/1000; % convert time t to ms from 0ms to 500ms
24
25 n = [0:2:(2*num_terms)-2]; % n values of non-zero coefficients
26 a_n = (-1).^(n/2).*(20.^n)*7./factorial(n); % a_n values of non-zero coefficients
27
28 %make a table
29 T = table(n',a_n','VariableNames', {'n values', ...
30   'a_n values (Non-zero coefficients)'})
31
32 % ---- old calculations ----
33
34 f1 = a_n(1)*t.^n(1); % First term
35 f2 = f1 + a_n(2)*t.^n(2); % 1-2 term
36 f3 = f2 + a_n(3)*t.^n(3); % 1-3 terms
37 f4 = f3 + a_n(4)*t.^n(4); % 1-4 terms
38 f5 = f4 + a_n(5)*t.^n(5); % 1-5 terms
39 f6 = f5 + a_n(6)*t.^n(6); % 1-6 terms
40
41 % ---- plotting with new calc----
42
43 f = zeros([1 N]);
44
45 hold on %keeps from making new plots
46
47 for i = 1:num_terms
48   f = f + a_n(i)*t.^n(i);
49   if i < 6
50   p(i)=plot(t_ms,f,'LineWidth', 2);
51   else
```

```matlab
52          p(i)=plot(t_ms,f,'LineWidth', 4);
53          plot([tmin,tmax], [0,0], 'k', 'LineWidth', 1)
54      end
55 end
56
57 givenFunction = A*cos(w*t); %the given function 7cos(20t)
58
59 avgDev = averageDeviation(givenFunction,f,N) % Uses function to
60 % calculate average devation between given function and final function
61
62
63 hold off
64 grid on %turn on gridlines
65 ax = gca; %initialize gca
66 ax.GridAlpha = 0.4; %change grid
67 ax.FontSize = 16; %change chart font size
68
69 title(sprintf("ECE 202 Project 1 Phase 5: Power series expansion \n of " + ...
70     "f(t)=%gcos(%gt) up to first %g non-zero " + ...
71     "terms \n with a deviation of %g",A,w,num_terms,avgDev), ...
72     Interpreter='latex', FontSize=21)
73 %make title
74 xlabel("Time (t) in miliseconds","FontSize",18)
75 %add title for x
76 ylabel(sprintf("First six non-zero terms of " + ...
77     "f(t)=%gcos(%gt)",A,w),Interpreter='latex',FontSize=18)
78 %add title for y
79 ylim([-1*(A+3) A+3])
80 %change bounds
81 terms = 1:num_terms;
82 legend(p,"terms: "+ terms + ", " + ...
83     "n = " + n,Location="southoutside",FontSize=18,NumColumns=3)
84 %create legend automatically
85 if num_terms == 6
86     checkf = sum(f-f6) %checks difference between old and new calculations
87 %should be 0
88 end
89
90 function ave = averageDeviation(x,y,z)
91     ave = sum(abs(x-y))/z;
92 end
93
```

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

      743.13

checkf =

      0

>>

ECE 202 Project 1 Phase 5: Power series expansion of f(t)=7cos(10t) up to first 6 non-zero terms with a deviation of 743.129