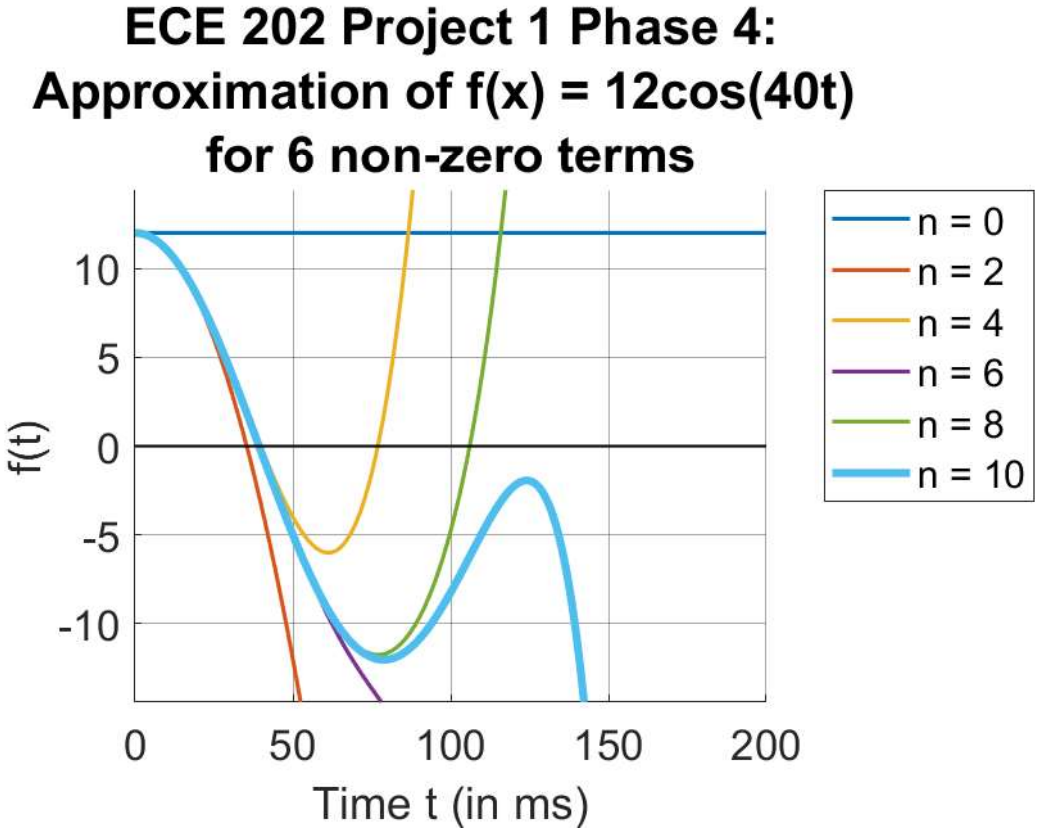
```m
% Abhilash Gudgunti
% 6th November, 2024
% ECE 202 Project 1: Phase 4
% Power series expansion of function of form Acos(wt)

clear % clear registers
clf % clear figures
format shortG

% Setting up Givens
A = 12; % Amplitude of the wave
w = 40; % Frequency of the wave
N = 6; % No. of non-zero terms in the truncated series
ti = 0; % Initial time (in ms)
tf = 200; % Final time (in ms)
int = 1000; % No. of Intervals between each time value

% Defining arrays
n = (0:2:2*(N-1))'; % values of n for the first N non-zero terms. (up by 2)
an = A*(-1).^(n./2) .* w.^n ./ factorial(n); % Array of values of a_n

% Outputting a table of n and a_n
T = table(n, an, 'VariableNames',{'n','Coefficients (a_n)'})

% Setting up array of time
tms = linspace(ti, tf, int); % time between 0 - 200 ms
t = tms/1000; % time in seconds to compute in functions

% Initialize the function array f as zeros
f = zeros(size(t)); % initialize f as an array of zeros
p = []; % initialize p as an array for plot objects

%FOR Loop to define funciton efficiently
hold on
for k = 1:N
    f = f + an(k) * t.^n(k); % adding each term to the series

    % Plotting each function
    if k == N
        % thicker line for the last function
        p(k) = plot(tms, f, 'LineWidth', 3);
    else
        p(k) = plot(tms, f, 'LineWidth', 1.5);
    end
end

plot([ti,tf], [0,0], 'k', 'LineWidth', 1) % x-axis (not shown in legend)

% Setting legends for the figure
legend(p, "n = " + n, 'Location', 'bestoutside');

% Figure components
ax = gca; ax.FontSize = 16;
```

```
54 title(sprintf(['ECE 202 Project 1 Phase 4:\nApproximation of ' ...
55     'f(x) = %gcos(%gt) \nfor %g non-zero terms'], A, w, N), ...
56     "FontSize", 19);
57 xlabel('Time t (in ms)', 'FontSize', 17);
58 ylabel('f(t)', 'FontSize', 17);
59 ylim([-1.2*A , 1.2*A]);
60 xlim([ti, tf]);
61 ax.GridAlpha = 0.4; % making the grid darker
62 grid on
63 hold off
64
65 %Inefficiently represented function
66 f1 = an(1) * t.^n(1); % The first non zero term
67 f2 = f1 + an(2) * t.^n(2); % The second non zero term
68 f3 = f2 + an(3) * t.^n(3); % The third non zero term
69 f4 = f3 + an(4) * t.^n(4); % The fourth non zero term
70 f5 = f4 + an(5) * t.^n(5); % The fifth non-zero term
71 f6 = f5 + an(6) * t.^n(6); % The sixth non zero term
72
73 % ====CHECK====
74
75 % Check difference between new and old approach for the final function
76 check = max(f - f6) % should be zero for the final function
77
78 %Yes, The graph continues to look the same visually from phase 2 and
79 %nothing has been changed (from  Phase 3)
```

```
>> ECE202_P1_Phase4

T =

  6×2 table

    n     Coefficients (a_n)
    __    __________________

     0                12
     2             -9600
     4           1.28e+06
     6       -6.8267e+07
     8        1.9505e+09
    10       -3.4675e+10


check =

     0

>>
```


ECE 202 Project 1 Phase 4:
Approximation of f(x) = 12cos(40t)
for 6 non-zero terms
f(t)
10
5
0
-5
-10
0
50
100
150
200
Time t (in ms)
n = 0
n = 2
n = 4
n = 6
n = 8
n = 10