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% Abhilash Gudgunti
% 1 November, 2024
% ECE 202 Project 1: Phase 3
% 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; % Intial 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 s to compute in functions

%Defining Functions
f1 = an(1) * t.^n(1); % The first non zero term
f2 = f1 + an(2) * t.^n(2); % The second non zero term
f3 = f2 + an(3) * t.^n(3); % The third non zero term
f4 = f3 + an(4) * t.^n(4); % The fourth non zero term
f5 = f4 + an(5) * t.^n(5); % The fifth non-zero term
f6 = f5 + an(6) * t.^n(6); % The sixth non zero term

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

%Plotting the first five funcitons
p1 = plot(tms, f1, tms, f2, tms, f3, tms, f4, tms, f5, ...
    'LineWidth', 1.5);
hold on
p2 = plot (tms, f6, 'LineWidth', 3); %plotting the last function (f6)

%Setting legends for the figure
legend([p1;p2], "n = " + n, Location='bestoutside')

% Figure components
ax = gca; ax.FontSize = 16;
title(sprintf(['ECE 202 Project 1 Phase 3:\nApproximation of ' ...
    'f(x) = %gcos(%gt) \nfor %g non-zero terms'],A, w, N) , "FontSize", 19)
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54 xlabel('Time t (in ms)', 'FontSize', 17)
55 ylabel('f(t)', 'FontSize', 17)
56 ylim([-1.2*A, 1.2*A])
57 xlim([ti, tf])
58 ax = gca; ax.GridAlpha = 0.4; % making the grid darker
59 grid on
60 hold off
61
62 %Yes, The graph continues to look the same visually from phase 2 and
63 %nothing has been changed
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>> ECE202_P1_Phase3

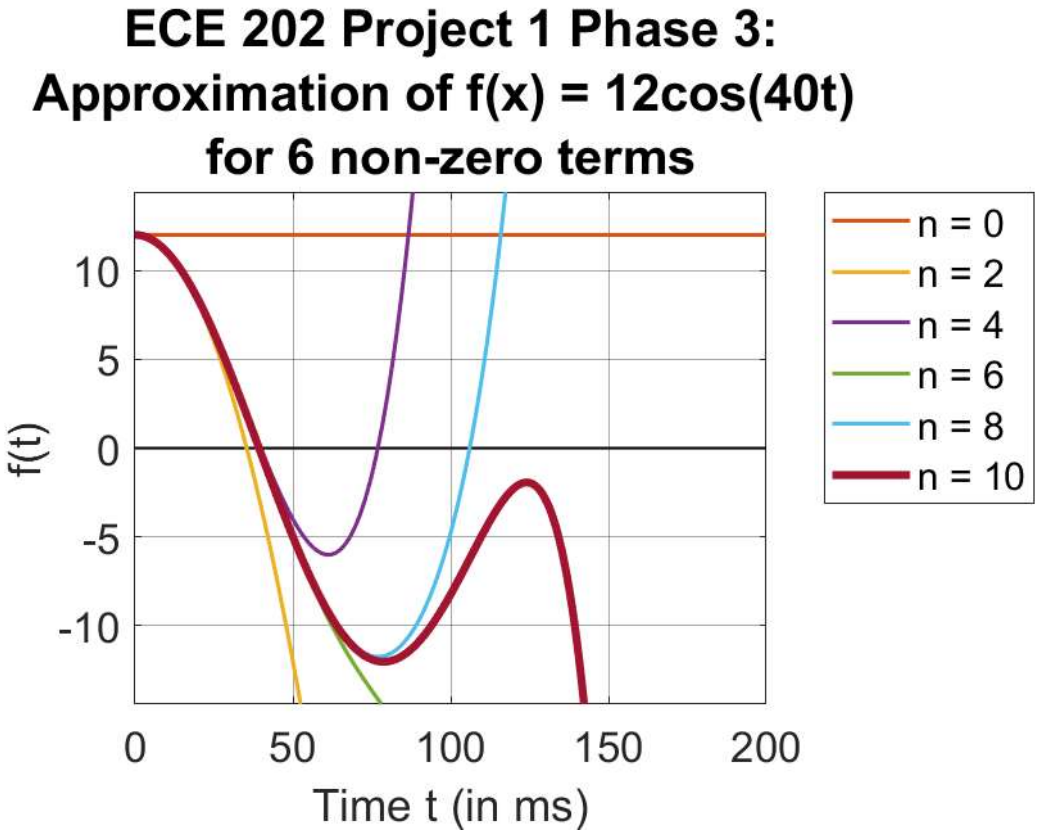
T =

  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

>>
```


ECE 202 Project 1 Phase 3:
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