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% Kavya Manchanda
% 11/1/2022
% ECE 202: Project 1 - Power Expansion Series of function of the form
% Acos(wt)
% Phase 4 : Making the script more effecient and easier to scale to any
% number of terms

clear; clf;
format shortG;

A = 12;          % amplitude
w = 40;          % angular frequency in rad/s
nz = 6;     % Number of non-zero terms

tmin = 0;        % in ms
tmax = 200;      % in ms
N = 400;         % intervals

tms = linspace(tmin, tmax, N+1);  % time array in ms
t = tms/1000;                     % time array in s
n = 0:2:2*nz - 2;          % first "nz" number of non zero term
% indices in series (only even values)


% The angular frequency in rad/s
an = A*(-1).^(n./2).*w.^n./factorial(n);

coefTable = table(n.',an.','VariableNames',{'n', 'aₙ'})

%----Adding the for loop and plotting-----
f = zeros(1,N+1);
p = zeros(nz,1);
plot([tmin,tmax],[0,0],"k","LineWidth",1)
hold on
for i = 1:nz
    f = f + an(i)*t.^n(i);
    if i~= nz                          % if not the last sum
        p(i) = plot(tms,f,"LineWidth",2.5);
    else                       % if it is the last sum, make the graph thicker
        p(nz) = plot(tms,f,"LineWidth",5);
    end
end
hold off

%---- Check from the previous phase ----
f1 = an(1)*t.^n(1);      % first sum (ie. first term) in the power series
f2 = f1 + an(2)*t.^n(2); % sum of first two terms
f3 = f2 + an(3)*t.^n(3); % sum of first three terms
f4 = f3 + an(4)*t.^n(4); % sum of first four terms
f5 = f4 + an(5)*t.^n(5); % sum of first five terms
f6 = f5 + an(6)*t.^n(6); % sum of first six terms

check = sum(abs(f-f6))   % should be zero

%----- Attributes of the graph -----


ax = gca;
```

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59 ax.GridAlpha = 0.4;
60 ax.FontSize = 16;
61 xlabel('time t (ms)','FontSize',18);
62 ylabel('f(t)','FontSize',18)
63 ylim([-1.25*A,1.25*A])
64 str1 = sprintf("Power series expansion of f(t) = %gcos(%gt)",A,w);
65 str2 = sprintf("using truncated sums up to %g non-zero terms",nz);
66 title(["ECE 202, Project 1 Phase 4:",str1,str2],"FontSize",22)
67 legend(p,"Up to n = " + n,"FontSize",18,"Location","bestoutside")
68
69 grid on
70
```
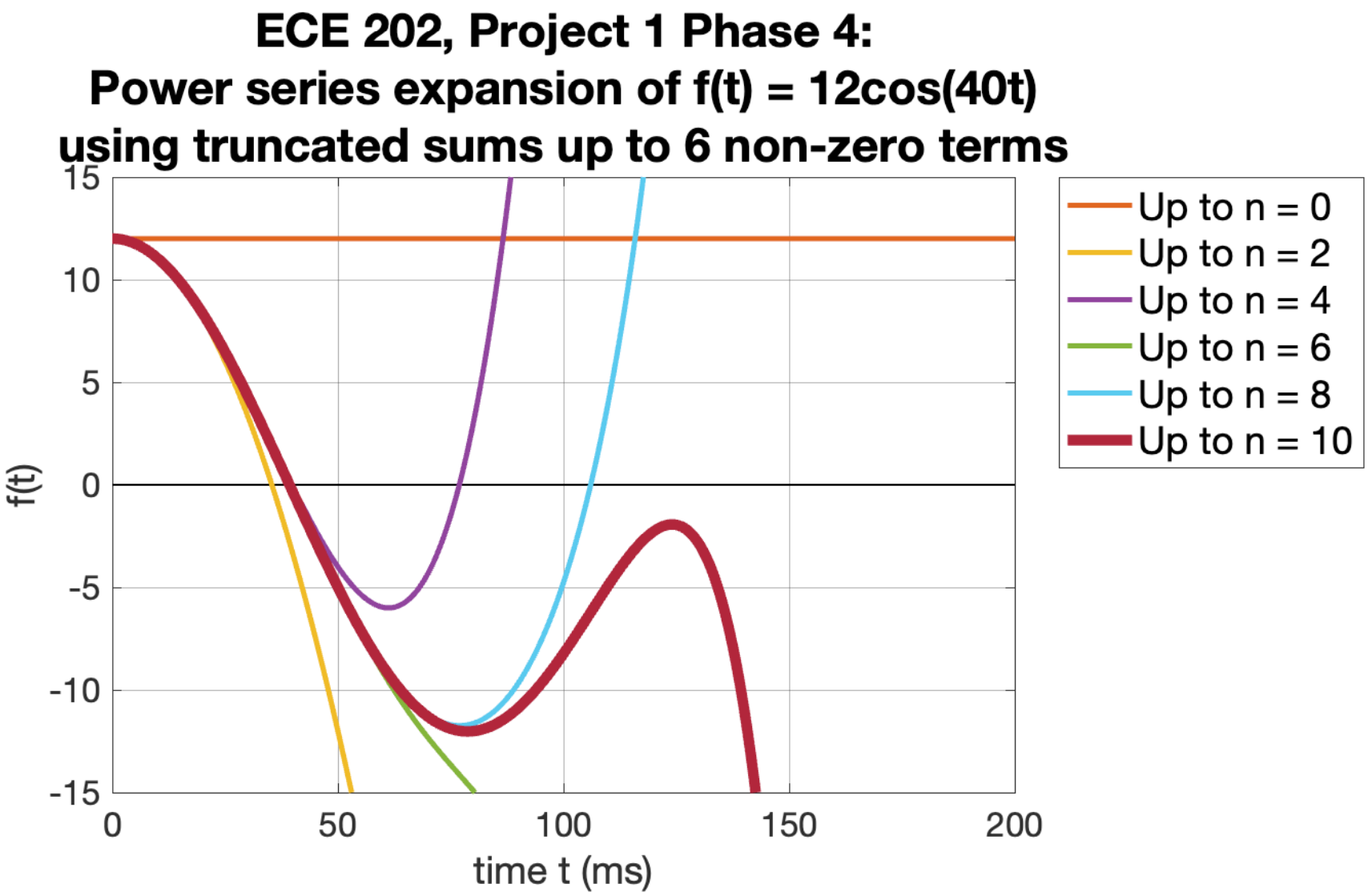

```
>> project1phase4

coefTable =

  6×2 table

    n          aₙ
    __    ___________

     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:
Power series expansion of f(t) = 12cos(40t)
using truncated sums up to 6 non-zero terms
15
10
5
0
-5
-10
-15
f(t)
0
50
100
150
200
time t (ms)
Up to n = 0
Up to n = 2
Up to n = 4
Up to n = 6
Up to n = 8
Up to n = 10