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% 11/1/2022
% ECE 202: Project 1 - Power Expansion Series of function of the form
% Acos(wt)
% Phase 5 : Letting the user define the parameters

clear; clf;
format shortG;

A = 12;          % amplitude
w = 40;          % angular frequency in rad/s
nz = input("Enter number of non zero terms: ");  % Number of non-zero terms

tmin = input("Enter starting time in ms: ");     % in ms
tmax = input("Enter ending time in ms: ");       % in ms
N = input("Enter number of intervals: ");        % 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 ----
if nz == 6  % checking only when non-zero terms are 6
    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
end

%----- Attributes of the graph -----
diff = abs(A*cos(w*t) - f);  % difference between the two functions
aveDeviation = sum(diff)/length(diff)  % average standard deviation
```

```
59 ax = gca;
60 ax.GridAlpha = 0.4;
61 ax.FontSize = 16;
62 xlabel('time t (ms)','FontSize',18);
63 ylabel('f(t)','FontSize',18)
64 ylim([-1.25*A,1.25*A])
65 str1 = sprintf("Power series expansion of f(t) = %gcos(%gt)",A,w);
66 str2 = sprintf("using truncated sums up to %g non-zero terms",nz);
67 str3 = sprintf("with an Average Deviation of %0.4g",aveDeviation);
68 title(["ECE 202, Project 1 Phase 5:",str1,str2,str3],"FontSize",22)
69 legend(p,"Up to n = " + n,"FontSize",18,"Location","bestoutside")
70
71 grid on
72
```

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>> project1phase5
Enter number of non zero terms: 6
Enter starting time in ms: 0
Enter ending time in ms: 200
Enter number of intervals: 400

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


aveDeviation =

       101.34

>>
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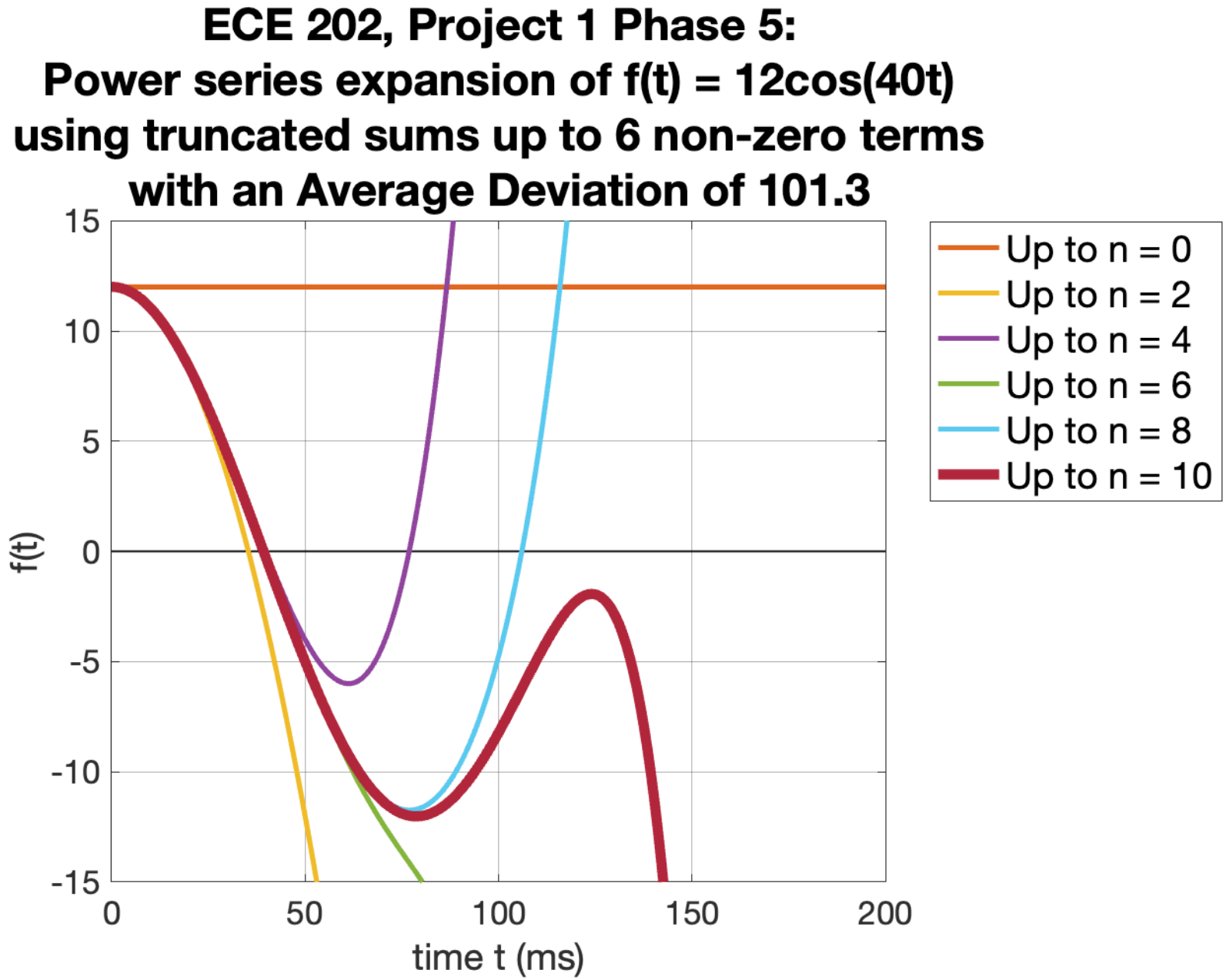
ECE 202, Project 1 Phase 5:
Power series expansion of f(t) = 12cos(40t)
using truncated sums up to 6 non-zero terms
with an Average Deviation of 101.3
15
10
5
0
-5
-10
-15
f(t)
0
50
100
150
200
time t (ms)
Up to n = 0
Up to n = 2
Up to n = 4
Up to n = 6
Up to n = 8
Up to n = 10