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% Kavya Manchanda
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% ECE 202: Project 1 - Power Expansion Series of function of the form
% Acos(wt)
% Phase 3 : Making the script more robust and general

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;          % array of nth term

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

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

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

%----- plotting the graph and its attributes -----
hold on

plot([tmin,tmax],[0,0], 'k', 'LineWidth', 1);
p1 = plot(tms,f1,tms,f2,tms,f3,tms,f4,tms,f5,'LineWidth',2.5);
p2 = plot(tms,f6,'LineWidth',5);
legend([p1;p2],"Up to n = " + n,"FontSize",18,"Location","bestoutside")

ax = gca;
ax.GridAlpha = 0.4;
ax.FontSize = 16;
xlabel('time t (ms)','FontSize',18);
ylabel('f(t)','FontSize',18)
ylim([-1.25*A,1.25*A])
str1 = sprintf("Power series expansion of f(t) = %gcos(%gt)",A,w);
str2 = sprintf("using truncated sums up to %g non-zero terms",nz);
title(["ECE 202, Project 1 Phase 3:",str1,str2],"FontSize",22)

grid on
hold off

% The output for Phase 3 is the same as the output for Phase 2.
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