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% C. Petersen, H. Werkle, Dynamik der Baukonstruktionen
% 2. Auflage, Springer Vieweg, Wiesbaden, 2018
%
% ML_05_1_Duhamel_Integral: Duhamel-Integral
%
% Version 1.0, April 2018
% Softwareentwicklung:
% Andrei Firus, M.Eng (andrei.firus@gmail.com)

% Aufbau Eingabedatei:
%   - Spalte 1: Zeitvektor des Kraftverlaufs [s]
%   - Spalte 2: Kraftvektor [N]
% ANMERKUNG: Dezimaltrennzeichen '.'

% Ausgabedateien:
% Outputdatei_1: Eingaben- und Ergebnisübersicht
% Outputdatei_2: Verschiebungszeitverlauf [m]

%----- EINGABEBLOCK -----
% Eingaben im Quellcode
m=1000;           % Masse [kg]
k=25000;          % Federkonstante [N/m]
xi=0.02;          % Dämpfungsmaß

dt=0.01;          % Berechnungszeitschritt [s]

t_ber=14;         % Zeit der Berechnung [s]
%-----
% Einlesen des Kraftzeitverlaufs von der Eingabedatei und Generierung der
% entsprechenden Vektoren
Kraftverlauf=dlmread('Inputdatei_1.txt');
t_kraft=Kraftverlauf(:,1);
Kraft=Kraftverlauf(:,2);
%-----

%----- BERECHNUNGSBLOCK -----
% Berechnung weiterer System- und Berechnungsparameter
omega=sqrt(k/m);   % Eigenkreisfrequenz
f=omega/(2*pi);    % Eigenfrequenz
T=1/f;             % Eigenschwingzeit
d=xi*(2*omega*m);  % Dämpfungskoeffizient
omega_d=sqrt(1-xi^2)*omega; % gedämpfte Eigenkreisfrequenz
f_d=sqrt(1-xi^2)*f; % gedämpfte Eigenfrequenz
T_d=1/f_d;         % Eigenschwingzeit gedämpfter Schwingung
nt=ceil(t_ber/dt); % Anzahl der Berechnungszeitschritte

% Interpolation des Kraftvektors mit Berücksichtigung des
% Berechnungszeitschrittes 'dt'
Zeit_Int=0:dt/2:t_kraft(length(t_kraft));
Kraft_Int = interp1(t_kraft,Kraft,Zeit_Int,'linear');
% ANMERKUNG: Je nach Anwendungsziel kann die Interpolationsmethode geändert
% werden. Für weitere Interpolationsmethoden siehe Matlab-Hilfe zur
% Funktion "interp1" (Befehl 'help interp1' in Command Window)

% Erstellung eines Kraftvektors für die Berechnung der Impulse (die Kraft
% wird mittig in jedem Zeitintervall bestimmt). Sollte die Berechnungszeit
% größer als die Dauer des eingegebenen Zeitverlaufs sein, wird der

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% Kraftvektor mit Nulleinträgen ergänzt.
F=zeros(2*nt,1);
for i=1:1:2*nt
    if i<=length(Kraft_Int)
        F(i)=Kraft_Int(i);
    else
        F(i)=0;
    end
end
t_b=0:dt/2:(dt*((0.5*(length(F)-1))));

% Ermittlung des Impulses für jeden Zeitschritt mit der mittigen Kraft
I=zeros(nt,1);
for i=1:1:nt
    I(i)=F(2*i)*dt;
end
y=zeros(nt,1);

% Berechnung der Schwingungsantwort mittels Duhamel-Integral
for i=1:1:nt
    g=zeros(nt,1);
    for j=1:1:i
        g(j)=(I(j)/(omega_d*m)).*exp(-xi.*(dt*i-dt*j)*omega)...
            .*sin(omega_d*(dt*i-dt*j));
        y(i)=y(i)+g(j);
    end
end

% Maximale und minimale Verschiebung
ymax=max(y);
ymin=min(y);
%-----

%----- DARSTELLUNGSBLOCK -----
% Grafische Darstellung der Ergebnisse
name_fig1 = 'Kraft- und Verschiebungszeitverlauf';
fig1=figure('Name',name_fig1,'NumberTitle','off');
set(fig1,'Position',[1000 300 700 500]);
Zeit_y=0:dt:(nt-1)*dt;

subplot(2,1,1)
plot(t_b,F,'r','LineWidth', 1);
title('Kraftzeitverlauf');
xlabel('Zeit [s]');
ylabel('Kraft [N]');
grid on;

subplot(2,1,2)
plot(Zeit_y,y,'b','LineWidth', 1);
title('Verschiebungszeitverlauf');
xlabel('Zeit [s]');
ylabel('Verschiebung [m]');
grid on;
%-----

%----- AUSGABEBLOCK -----
% Ausgabe der Ergebnisse in eine Datei

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fid = fopen('Outputdatei_1_Allgemein.txt', 'w');
fprintf(fid,...
        '%s\n', 'C. Petersen, H. Werkle, Dynamik der Baukonstruktionen');
fprintf(fid,...
        '%s\n', '2. Auflage, Springer Vieweg, Wiesbaden, 2018');
fprintf(fid,...
        '%s\n', 'Softwareentwicklung: Andrei Firus (andrei.firus@gmail.com)');
fprintf(fid, '%s\n', 'Programm ML_05_1: Eingaben- und Ergebnisuebersicht');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
        '%s\n', '-----');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
        '%s\n', 'EINGABEDATEN:');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Masse des Einfreiheitsgradschwingers [kg]:');
fprintf(fid, '%d\n', m);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Federkonstante [N/m]:');
fprintf(fid, '%d\n', k);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Daempfungsmass [-]:');
fprintf(fid, '%.3f\n', xi);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Berechnungszeitschritt [s]:');
fprintf(fid, '%d\n', dt);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Gesamtzeit der Berechnung [s]:');
fprintf(fid, '%d\n', t_ber);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Kraftzeitverlauf: siehe Dateiende');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
        '%s\n', '-----');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
        '%s\n', 'ERGEBNISSE:');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Anzahl der Berechnungszeitschritte:');
fprintf(fid, '%d\n', nt);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Eigenkreisfrequenz [1/s]:');
fprintf(fid, '%d\n', omega);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Gedaempfte Eigenkreisfrequenz [1/s]:');

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fprintf(fid, '%d\n', omega_d);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Eigenfrequenz [Hz]:');
fprintf(fid, '%d\n', f);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Gedaempfte Eigenfrequenz [Hz]:');
fprintf(fid, '%d\n', f_d);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Eigenschwingzeit [s]:');
fprintf(fid, '%d\n', T);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Eigenschwingzeit der gedaempften Schwingung [s]:');
fprintf(fid, '%d\n', T_d);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Maximale Verschiebung [m]:');
fprintf(fid, '%d\n', ymax);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Minimale Verschiebung [m]:');
fprintf(fid, '%d\n', ymin);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, ...
        '%s\n', '-----');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Kraftzeitverlauf:');
fprintf(fid, '%s \t %s\n', 'Zeit [s]', 'Kraft [N]');
for ii=1:1:length(Kraft)
    fprintf(fid, '%d \t %d\n', t_kraft(ii), Kraft(ii));
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fclose(fid);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Ergebnis_Verschiebungen=[Zeit_y' y];
fid = fopen('Outputdatei_2_Verschiebungen.txt', 'w');
fprintf(fid, ...
        '%s\n', 'C. Petersen, H. Werkle, Dynamik der Baukonstruktionen');
fprintf(fid, ...
        '%s\n', '2. Auflage, Springer Vieweg, Wiesbaden, 2018');
fprintf(fid, ...
        '%s\n', 'Softwareentwicklung: Andrei Firus (andrei.firus@gmail.com)');
fprintf(fid, '%s\n', 'Programm ML_05_1: Verschiebungszeitverlauf');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, ...
        '%s\n', '-----');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid, '%s\n', 'Verschiebungszeitverlauf:');
fprintf(fid, '%s \t %s\n', 'Zeit [s]', 'Verschiebung [m]');
for ii=1:1:length(y)

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[illegible]