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% C. Petersen, H. Werkle, Dynamik der Baukonstruktionen
% 2. Auflage, Springer Vieweg, Wiesbaden, 2018
%
% ML_21_2_Einfreiheitsgradschwinger_Stoss_plastisch_2: Plastischer Stoß bei
% einem Einfreiheitsgradschwinger - Beliebiger Kraftzeitverlauf
%
% 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: Zeitverläufe der Bewegungsgrößen

%---------------------------- EINGABEBLOCK ---------------------------------
% Eingaben im Quellcode

m=600;                          % Masse [kg]

d=0;                            % Dämpferkonstante [Ns/m]

k=8518500;                      % Federkonstante im elastischen Bereich
                                % [N/m]

y_ela=0.027;                    % elastische Verschiebungsgrenze [m]

dt=0.0005;                      % Berechnungszeitschritt [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 -------------------------------
% Eigenkreisfrequenz des Einfreiheitsgradschwingers im elastischen Bereich
omega=sqrt(k/m);

% Eigenschwingzeit
T=(2*pi)/omega;

% Dämpfungsmaß
xi=d/(2*m*omega);

% Interpolation des Kraftvektors mit Berücksichtigung des
% Berechnungszeitschrittes 'dt'
Zeit_Int=0:dt: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
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% Funktion "interp1" (Befehl 'help interp1' in Command Window)

% Berechnung des auf die Masse bezogene Stoßkraftverlaufs
a=Kraft_Int/m;

% Berechnung der Stoßreaktion
y_1=zeros(length(a),1);
y_p_1=zeros(length(a),1);
y_1(1)=0;
y_p_1(1)=0;
y_1(2)=1/2*((2-omega^2*dt^2)*y_1(1)+2*(1-xi*omega*dt)*dt*y_p_1(1)+...
    ((2/3)*a(1)+a(2)/3)*dt^2);
y_p_1(2)=(1/dt)*(y_1(2)-y_1(1));

for i=3:1:length(a)
    y_1(i)=(1/(1+xi*omega*dt))*((2-omega^2*dt^2)*y_1(i-1)-...
        (1-xi*omega*dt)*y_1(i-2)+((a(i-2)/6)+2*a(i-1)/3+a(i)/6)*dt^2);
    y_p_1(i)=(1/(2*dt))*(3*y_1(i)-4*y_1(i-1)+y_1(i-2));

    if y_1(i)>y_ela
        i_gr=i;
        for j=i_gr:1:length(a)
            y_1(j)=(1/(1+xi*omega*dt))*(2*y_1(j-1)-(1-xi*omega*dt)...
                *y_1(j-2)-(k/m)*y_ela*dt^2+((a(j-2)/6)+2*a(j-1)/3+...
                a(j)/6)*dt^2);
            y_p_1(j)=(1/(2*dt))*(3*y_1(j)-4*y_1(j-1)+y_1(j-2));
            if y_p_1(j)*y_p_1(j-1)<0
                y_1(j)=0;
                y_p_1(j)=0;
               break
            end
        end
    end

    if y_p_1(i)*y_p_1(i-1)<0
          y_1(i)=0;
          y_p_1(i)=0;
               break
    end
end

% Ermittlung der maximalen Verschiebung und des dazugehörigen Zeitpunkts
[pks,locs]=findpeaks(y_1);
ymax=y_1(locs(1));
t_max=Zeit_Int(locs(1));

% Erstellung der endgültigen Vektoren (Entfernen der anhängenden
% Nulleinträge von den Verschiebungs- und Geschwindigkeitsvektoren y_1 und
% y_p_1) beziehungsweise die entsprechende Anpassung des Zeitvektors
y=y_1(1:locs(1));
v=y_p_1(1:locs(1));
t=Zeit_Int(1:locs(1));

% Ermittlung der elastischen Verschiebung gemäß der numerischen Berechnung
% und des dazugehörigen Zeitpunkts
index_diff=find(y_1(1:locs(1))<y_ela);
index_ela=max(index_diff);
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y_e=y_1(index_ela);
t_e=Zeit_Int(index_ela);
%--------------------------------------------------------------------------

%------------------------ DARSTELLUNGSBLOCK ------------------------------
%Grafische Darstellung der Ergebnisse
name_fig1 = 'Zeitverläufe';
fig1=figure('Name',name_fig1,'NumberTitle','off');
set(fig1,'Position',[1000 50 700 900]);

subplot(3,1,1)
plot(Zeit_Int,Kraft_Int,'r','LineWidth', 1);
title('Kraftzeitverlauf');
xlabel('Zeit [s]');
ylabel('Kraft [N]');
grid on; zoom on;

subplot(3,1,2)
plot(t,y,'r','LineWidth', 1);
line([0 max(t)], [y_ela y_ela], 'Color','b','LineStyle','--',...
    'LineWidth',1);
title('Verschiebungszeitverlauf');
xlabel('Zeit [s]');
ylabel('Verschiebung [m]');
legend ('Verschiebungszeitverlauf','elastische Grenze y_e_l_a',...
    'Location', 'SouthEast');
grid on; zoom on;

subplot(3,1,3)
plot(t,v,'r','LineWidth', 1);
title('Geschwindigkeitszeitverlauf');
xlabel('Zeit [s]');
ylabel('Geschwindigkeit [m/s]');
legend ('Geschwindigkeitszeitverlauf')
grid on; zoom on;
%--------------------------------------------------------------------------

%---------------------------- AUSGABEBLOCK --------------------------------
% Ausgabe der Ergebnisse in eine Datei
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_21_2: Eingaben- und Ergebnisuebersicht');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','-------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','EINGABEDATEN:');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
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fprintf(fid,'%s\n','Masse des Einfreiheitsgradschwingers [kg]:');
fprintf(fid,'%d\n',m);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Federkonstante im elastischen Bereich [N/m]:');
fprintf(fid,'%d\n',k);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Dämpferkonstante [Ns/m]:');
fprintf(fid,'%d\n',d);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Elastische Grenze [m]:');
fprintf(fid,'%d\n',y_ela);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Berechnungszeitschritt [-]:');
fprintf(fid,'%d\n',dt);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Lastfunktion:');
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
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','ERGEBNISSE:');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n','Eigenkreisfrequenz des',...
    'Einfreiheitsgrandschwingers im elastischen Bereich');
fprintf(fid,'%d\n',omega);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Eigenschwingzeit [s]:');
fprintf(fid,'%d\n',T);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Daempfungsmass [-]:');
fprintf(fid,'%d\n',xi);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n%s\n','Zeitpunkt zur Erreichung der elastischen',...
    'Grenze gemaess der numerischen','Berechnung [s]:');
fprintf(fid,'%s \t %d\n','t_e=',t_e);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n','Elastische Grenze',...
    'gemaess der numerischen Berechnung [m]:');
fprintf(fid,'%s \t %d\n','y_e=',y_e);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
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fprintf(fid,'%s\n','Maximale Verschiebung [m]:');
fprintf(fid,'%d\n',ymax);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Zeitpunkt der maximalen Verschiebung [s]:');
fprintf(fid,'%d\n',t_max);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','-------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fclose(fid);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Ergebnis_Bewegungsgroessen=[t' y v];
fid = fopen('Outputdatei_2_Bewegungsgroessen.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 %s\n','Programm ML_21_2: Zeitverlaeufe der',...
    'Bewegungsgroessen');
fprintf(fid, '%s\n', ' ');
fprintf(fid,...
    '%s\n','-------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
fprintf(fid,'%s\n','Zeitverlaufe der Bewegungsgroessen');
fprintf(fid,'%s \t %s \t %s\n','Zeit [s]:', 'Verschiebung [m]',...
    'Geschwindigkeit [m/s]');
for ii=1:1:length(y)
    fprintf(fid,'%d \t %d \t %d\n',...
        Ergebnis_Bewegungsgroessen(ii,:));
end
fclose(fid);
%--------------------------------------------------------------------------
```