```
% C. Petersen, H. Werkle, Dynamik der Baukonstruktionen
% 2. Auflage, Springer Vieweg, Wiesbaden, 2018
%
% ML_21_1_Einfreiheitsgradschwinger_Stoss_plastisch_1: Plastischer Stoß bei
% einem Einfreiheitsgradschwinger - Plötzliches Aufbringen einer konstanten
% Kraft
%
% Version 1.0, April 2018
% Softwareentwicklung:
% Andrei Firus, M.Eng (andrei.firus@gmail.com)

% Aufbau Eingabedatei: Eingabedatei nicht notwendig

% Ausgabedateien:
% Outputdatei_1: Eingaben- und Ergebnisübersicht
% Outputdatei_2: Zeitverläufe der Bewegungsgrößen

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

m=600;                          % Masse des Einfreiheitsgradschwingers [kg]

k1=8518500;                     % Federkonstante der ersten Bewegungsphase
                                % [N/m]

k2=851850;                      % Federkonstante der zweiten Bewegungsphase
                                % [N/m]

y_ela=0.027;                    % elastische Grenze [m]

Kraft=150000;                   % Kraft des Lastsprunges in [N] (plötzlich
                                % aufgebrachte Last). Die Kraft muss größer
                                % als (0.5*k1*y_ela) sein! Sonst kommt es zu
                                % keiner plastischen Reaktion.

n1=10;                          % Anzahl der Zeitpunkte, für welche die
                                % Bewegung zwischen 0 und der elastischen
                                % Verschiebungsgrenze y_ela berechnet werden
                                % soll.

n2=20;                          % Anzahl der Zeitpunkte, für welche die
                                % Bewegung zwischen der elastischen
                                % Verschiebungsgrenze y_ela und der maximal
                                % erreichten Verschiebung y_max berechnet
                                % werden soll
%--------------------------------------------------------------------------

%-------------------------- BERECHNUNGSBLOCK ------------------------------
% Eigenkreisfrequenzen des EMS in der jeweiligen Bewegungsphase
omega1=sqrt(k1/m);
omega2=sqrt(k2/m);

% Zeitpunkt der Erreichung der elastischen Grenze y_ela
t_ela=(1/omega1)*acos(((Kraft/k1)-y_ela)/(Kraft/k1));

% Berechnungszeitschritt für die erste Bewegungsphase
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dt1=t_ela/n1;

% Definition des Berechnungszeitvektors für die erste Bewegungsphase
t1=zeros(n1,1);
for i=1:1:n1+1
    t1(i)=(i-1)*dt1;
end

% Ermittlung der Verschiebung und Geschwindigkeit in der ersten
% Bewegungsphase
y1=zeros(length(t1),1);
y1_p=zeros(length(t1),1);
for i=1:1:length(t1)
    y1(i)=Kraft/k1*(1-cos(omega1*t1(i)));
    y1_p(i)=(Kraft/k1)*omega1*sin(omega1*t1(i));
end

% Zeitpunkt maximaler Verschiebung (bezogen nur auf die zweite
% Bewegungsphase)
if ((1+k1/k2)*y_ela-Kraft/k2)>=0
    t2_max=(1/omega2)*atan(((Kraft/k1*sin(omega1*t_ela))/((1+k1/k2)*...
        y_ela-Kraft/k2))*omega1/omega2);
else
    t2_max=(1/omega2)*(atan(((Kraft/k1*sin(omega1*t_ela))/((1+k1/k2)*...
        y_ela-Kraft/k2))*omega1/omega2)+pi);
end

% Zeitpunkt maximaler Verschiebung (Gesamt)
t_max=t_ela+t2_max;

% Berechnungszeitschritt für die zweite Bewegungsphase
dt2=t2_max/n2;

% Definition des Berechnungszeitvektors für die zweite Bewegungsphase
t2=zeros(n2,1);
for i=1:1:n2+1
    t2(i)=(i-1)*dt2;
end

% Ermittlung der Verschiebung und Geschwindigkeit in der zweiten
% Bewegungsphase
y2=zeros(length(t2),1);
y2_p=zeros(length(t2),1);
for i=1:1:length(t2)
    y2(i)=(Kraft/k1)*(omega1/omega2)*sin(omega1*t_ela)*...
        sin(omega2*t2(i))+((1+k1/k2)*y_ela-Kraft/k2)*cos(omega2*t2(i))...
        +Kraft/k2-(k1/k2)*y_ela;
    y2_p(i)=(Kraft/k1)*omega1*sin(omega1*t_ela)*cos(omega2*t2(i))-...
        ((1+k1/k2)*y_ela-Kraft/k2)*omega2*sin(omega2*t2(i));
end

% Zusammenfügung der Vektoren der zwei Bewegungsphasen
y=[y1;y2(2:end)];
v=[y1_p;y2_p(2:end)];
t=[t1;(t2(2:end)+t_ela)];
```

```
% Maximale Verschiebung
ymax=max(y2);
%-------------------------------------------------------------------------

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

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

subplot(2,1,2)
plot(t,v,'r','LineWidth', 1);
title('Geschwindigkeitszeitverlauf');
xlabel('Zeit [s]');
ylabel('Geschwindigkeit [m/s]');
grid 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_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 in der ersten Bewegungsphase [N/m]:');
fprintf(fid,'%d\n',k1);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Federkonstante in der zweiten Bewegungsphase [N/m]:');
```

```
fprintf(fid,'%d\n',k2);
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','Kraft des Lastsprunges [N]:');
fprintf(fid,'%d\n',Kraft);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Anzahl der Zeitschritte in der ersten Phase [-]:');
fprintf(fid,'%d\n',n1);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Anzahl der Zeitschritte in der zweiten Phase [-]:');
fprintf(fid,'%d\n',n2);
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%s\n','Eigenkreisfrequenzen des',...
    'Einfreiheitsgrandschwingers in den zwei','Bewegungsphasen [1/s]:');
fprintf(fid,'%s \t %d\n','Phase 1:',omega1);
fprintf(fid,'%s \t %d\n','Phase 2:',omega2);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Zeitpunkt zur Erreichung der elastischen Grenze [s]:');
fprintf(fid,'%s \t %d\n','t_ela=',t_ela);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Berechnungszeitschritt in der ersten Phase [s]:');
fprintf(fid,'%d\n',dt1);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Berechnungszeitschritt in der zweiten Phase [s]:');
fprintf(fid,'%d\n',dt2);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n%s\n','Zeitpunkt zur Erreichung der maximaler',...
    'Verschiebung (bezogen auf den','Anfang der zweiten Phase) [s]:');
fprintf(fid,'%s \t %d\n','t2_max=',t2_max);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n%s\n','Zeitpunkt zur Erreichung der maximaler',...
    'Verschiebung (bezogen auf den','Anfang der ersten Phase) [s]:');
fprintf(fid,'%s \t %d\n','t_max=',t_max);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Maximale Verschiebung [m]:');
fprintf(fid,'%d\n',ymax);
fprintf(fid, '%s\n', ' ');
```

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
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_1: 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);
%-------------------------------------------------------------------------
```