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% C. Petersen, H. Werkle, Dynamik der Baukonstruktionen
% 2. Auflage, Springer Vieweg, Wiesbaden, 2018
%
% ML_05_3_Uebertragungsverfahren: Übertragungsverfahren
%
% 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
% Outputdatei_3: Geschwindigkeitszeitverlauf
% Outputdatei_4: Verlauf der am Fußpunkt abgesetzten Kraft

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

na=200;                          % Anzahl der Intervalle für den
                                 % Ausschwingvorgang (ganze Zahl)

Ta=0.1;                          % Breite der Zeitintervalle im
                                 % Ausschwingvorgang [s]

y_0=0;                           % Anfangswert der Verschiebung zum
                                 % Zeitpunkt 0 [m]

v_0=0;                           % Anfangswert der Geschwindigkeit zum
                                 % Zeitpunkt 0 [m/s]
%-------------------------------------------------------------------------
% Einlesen des Kraftzeitverlaufs von der Eingabedatei und Generierung der
% entsprechenden Vektoren
Zeitverlauf=dlmread('Inputdatei_1.txt');
t_kraft=Zeitverlauf(:,1);
Kraft=Zeitverlauf(:,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

n=length(Kraft)-1;               % Anzahl der Zeitintervalle innerhalb derer
                                 % die Last einwirkt

Tf=zeros(n,1);                   % Breite des Zeitintervalle: Einwirkung
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for i=1:1:n
    Tf(i)=t_kraft(i+1)-t_kraft(i);
end

nn=n+na;                          % Gesamtanzahl der Intervalle, für die die
                                  % Schwingreaktion berechnet werden soll

% Steigung der Geraden in jedem Intervall
p=zeros(n,1);
for i=1:1:n
    p(i)=(Kraft(i+1)-Kraft(i))/(Tf(i));
end

% Berechnung der Schwingungsantwort mit dem Übertragungsverfahren
ts=zeros(nn,1);
y=zeros(nn,1);
v=zeros(nn,1);
fb=zeros(nn,1);

% Definition der endgültigen Ergebnisvektoren
y_f=zeros(nn+1,1);
y_f(1)=y_0;
v_f=zeros(nn+1,1);
v_f(1)=v_0;
fb_f=zeros(nn+1,1);
fb_f(1)=v_0*d+y_0*k;

% Anfangswerte für die Berechnung
y0=y_0;
v0=v_0;

% Zeitvektoren für die Berechnung
ts(1)=Tf(1);
for i=1:1:n-1
    ts(i+1)=ts(i)+Tf(i+1);
end
for i=n:1:nn-1
    ts(i+1)=ts(i)+Ta;
end

% Berechnungsvorschrift für die Lasteinwirkungszeit
for i=1:1:n
   t=Tf(i);

   % Hilfswerte
   z1=exp(-xi*omega*t);
   z2=sin(omega_d*t);
   z3=cos(omega_d*t);
   z4=p(i);
   z5=Kraft(i);
   z6=z5-(d*z4/k);
   z7=z4+xi*omega*z6;

   a=xi*omega*y0/omega_d+(v0/omega_d)-(z7/(k*omega_d));
   b=y0-(z6/k);
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   y(i)=(z1*(a*z2+b*z3))+((z6+z4*t)/k);
   v(i)=z1*(omega_d*(a*z3-b*z2)-xi*omega*(a*z2+b*z3))+z4/k;
   fb(i)=d*v(i)+k*y(i);

   y0=y(i);
   v0=v(i);
end
% Berechnungsvorschrift für den Ausschwingvorgang
for i=n+1:1:nn
   t=Ta;

   z1=exp(-xi*omega*t);
   z2=sin(omega_d*t);
   z3=cos(omega_d*t);

   a=xi*omega*y0/omega_d+v0/omega_d;
   b=y0;

   y(i)=z1*(a*z2+b*z3);
   v(i)=z1*(omega_d*(a*z3-b*z2)-xi*omega*(a*z2+b*z3));
   fb(i)=d*v(i)+k*y(i);

   y0=y(i);
   v0=v(i);
end
for i=1:1:nn
    y_f(i+1)=y(i);
    v_f(i+1)=v(i);
    fb_f(i+1)=fb(i);
end

% Extremwerte
ymax=max(y_f);   ymin=min(y_f);
vmax=max(v_f);   vmin=min(v_f);
fbmax=max(fb_f); fbmin=min(fb_f);
%-------------------------------------------------------------------------

%------------------------ DARSTELLUNGSBLOCK -----------------------------
%Grafische Darstellung der Ergebnisse
name_fig1 = 'Zeitverläufe';
fig1=figure('Name',name_fig1,'NumberTitle','off');
set(fig1,'Position',[1000 50 700 900]);
Zeit_plot=zeros(length(y_f),1);
Zeit_plot(1)=0;
for i=2:1:length(y_f)
    Zeit_plot(i)=ts(i-1);
end
Kraft_plot=zeros(length(y_f),1);
for i=1:1:length(y_f)
    if i<=length(Kraft)
        Kraft_plot(i)=Kraft(i);
    else
        Kraft_plot(i)=0;
    end
end

subplot(4,1,1)
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plot(Zeit_plot,Kraft_plot,'r','LineWidth', 1);
title('Kraftzeitverlauf');
xlabel('Zeit [s]');
ylabel('Kraft [N]');
grid on;

subplot(4,1,2)
plot(Zeit_plot,y_f,'b','LineWidth', 1);
title('Verschiebungszeitverlauf');
xlabel('Zeit [s]');
ylabel('Verschiebung [m]');
grid on;

subplot(4,1,3)
plot(Zeit_plot,v_f,'b','LineWidth', 1);
title('Geschwindigkeitszeitverlauf');
xlabel('Zeit [s]');
ylabel('Geschwindigkeit [m/s]');
grid on;

subplot(4,1,4)
plot(Zeit_plot,fb_f,'b','LineWidth', 1);
title('Kraft am Fußpunkt');
xlabel('Zeit [s]');
ylabel('Kraft [N]');
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_05_3: 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 [-]:');
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fprintf(fid,'%.3f\n',xi);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Anzahl der Intervalle im Ausschwingvorgang:');
fprintf(fid,'%d\n',na);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Breite der Intervalle im Ausschwingvorgang [s]:');
fprintf(fid,'%d\n',Ta);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Anfangsauslenkung (Zeitpunkt 0) [m]:');
fprintf(fid,'%d\n',y_0);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Anfangsgeschwindigkeit (Zeitpunkt 0) [m/s]:');
fprintf(fid,'%d\n',v_0);
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','Eigenkreisfrequenz [1/s]:');
fprintf(fid,'%d\n',omega);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Gedaempfte Eigenkreisfrequenz [1/s]:');
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','Eigenschwingzeit [s]:');
fprintf(fid,'%d\n',T);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Daempfungskoeffizient [Ns/m]:');
fprintf(fid,'%d\n',d);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Anzahl der Intervalle der Lasteinwirkung:');
fprintf(fid,'%d\n',n);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Gesamtanzahl der Intervalle bei der Berechnung:');
fprintf(fid,'%d\n',nn);
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','Minimale Verschiebung [m]:');
fprintf(fid,'%d\n',ymin);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Maximale Geschwindigkeit [m/s]:');
fprintf(fid,'%d\n',vmax);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Minimale Geschwindigkeit [m/s]:');
fprintf(fid,'%d\n',vmin);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Maximale Kraft am Fusspunkt [N]:');
fprintf(fid,'%d\n',fbmax);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Minimale Kraft am Fusspunkt [N]:');
fprintf(fid,'%d\n',fbmin);
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_plot y_f];
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_3: 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_f)
    fprintf(fid,'%d \t %d\n',Ergebnis_Verschiebungen(ii,:));
end
fclose(fid);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
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Ergebnis_Geschwindigkeiten=[Zeit_plot v_f];
fid = fopen('Outputdatei_3_Geschwindigkeiten.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_3: Geschwindigkeitszeitverlauf');
fprintf(fid, '%s\n', ' ');
fprintf(fid,...
    '%s\n','------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
fprintf(fid,'%s\n','Geschwindigkeitszeitverlauf:');
fprintf(fid,'%s \t %s\n','Zeit [s]', 'Geschwindigkeit [m/s]');
for ii=1:1:length(v_f)
    fprintf(fid,'%d \t %d\n',Ergebnis_Geschwindigkeiten(ii,:));
end
fclose(fid);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

Ergebnis_Kraft_Fusspunkt=[Zeit_plot fb_f];
fid = fopen('Outputdatei_4_Kraft_Fusspunkt.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_3: Fusspunktkraftzeitverlauf');
fprintf(fid, '%s\n', ' ');
fprintf(fid,...
    '%s\n','------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
fprintf(fid,'%s\n','Fusspunktkraftzeitverlauf:');
fprintf(fid,'%s \t %s\n','Zeit [s]', 'Kraft [N]');
for ii=1:1:length(fb_f)
    fprintf(fid,'%d \t %d\n',Ergebnis_Kraft_Fusspunkt(ii,:));
end
fclose(fid);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%-------------------------------------------------------------------------
```