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% C. Petersen, H. Werkle, Dynamik der Baukonstruktionen
% 2. Auflage, Springer Vieweg, Wiesbaden, 2018
%
% ML_19_2_Einfreiheitsgradschwinger_personenerregt:
% Einfreiheitsgradschwinger mit Erregungsfunktion für Personenerregung
% (modale Masse)
%
% Version 1.0, April 2018
% Softwareentwicklung:
% Andrei Firus, M.Eng (andrei.firus@gmail.com)

% Aufbau Eingabedateien:
% Inputdatei_1: Lastdefinition durch Fourier-Reihe
%               - Spalte 1: Fourierkoeffizienten (Zeile "i" entspricht dem
%                 Koeffizenten "a(i)"). Der Koeffizient a(0) (konstanter
%                 Anteil der Fourierreihe) wird in dem Eingabeblock
%                 definiert
%               - Spalte 2: Phasenverschiebungen (Zeile "i" entspricht der
%                 Phase der "i"-ten Haromonischen gegenüber der ersten
%                 Harmonischen
% ANMERKUNG: Dezimaltrennzeichen '.'

% Ausgabedateien:
% Outputdatei_1: Eingaben- und Ergebnisübersicht
% Outputdatei_2: Zeitverläufe der Bewegungsgrößen: Verschiebung [m],
%                Geschwindigkeit [m/s] und Beschleunigung [m/s^2]

%---------------------------- EINGABEBLOCK --------------------------------
% Einlesen von Eingabedateien und Generierung der entsprechenden Vektoren
% und Matrizen
Kraftdefinition=dlmread('Inputdatei_1.txt');
% Fourierkoeffizienten
alpha_f=Kraftdefinition(:,1);
% Phasenwinkel
phi=Kraftdefinition(:,2);
%--------------------------------------------------------------------------
% Eingaben im Quellcode
m=44020;                          % Masse [kg]
k=10431384;                       % Federkonstante [N/m]
xi=0.01;                          % Dämpfungsmaß

fs=2.45;                          % Lastfrequenz [Hz]
G=700;                            % Kraft (Personengewicht) [N]
a0=1;                             % Koeffizient für den konstanten Anteil der
                                  % Fourierreihe
alpha_red=0.71;                   % Reduktionsfaktor

t_ber=10;                         % Dauer der Berechnung [s]
dt=0.005;                         % Zeitschritt für die Berechnung [s]
%--------------------------------------------------------------------------

%------------------------- 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
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omega_d=sqrt(1-xi^2)*omega;      % gedämpfte Eigenkreisfrequenz
nt=ceil(t_ber/dt)+1;             % Anzahl der Berechnungszeitschritte

% Erstellung des Zeitvektors
t=0:dt:dt*(nt-1);

% Erstellung des Kraftvektors
h=zeros(length(alpha_f),length(t));  % Matrix für alle Kraftharmonischen
kraft_harm=zeros(1,length(t));       % Überlagerung aller Kraftharmonischen
Kraft=zeros(1,length(t));            % Gesamtkraft nach dem Fourier-Ansatz
for i=1:1:length(alpha_f)
    for j=1:1:length(t)
           h(i,j)=alpha_f(i)*sin(2*pi*fs*i*t(j)-phi(i));
           kraft_harm(1,j)=kraft_harm(1,j)+h(i,j);
    end
end

for j=1:1:length(t)
    Kraft(j)=alpha_red*G*(a0+kraft_harm(j));
end

% Berechnung der Schwingungsantwort mittels Newmark-Verfahren

% Integrationsparameter
alpha=0.5;
beta=0.25;

% Definition der Ergebnisvektoren
y=zeros(1,length(t));
v=zeros(1,length(t));
a=zeros(1,length(t));
a(1)=(Kraft(1)-k*y(1)-d*v(1))/m;

% Berechnungsvorschrift
for i=2:1:nt
    a_h=((1/beta)*m)+(alpha/beta)*d*dt+k*dt^2;
    b_h=((1/beta)*m+(alpha/beta)*d*dt)*y(i-1)+((1/beta)*m+(alpha/beta-1)...
        *d*dt)*dt*v(i-1)+((1/(2*beta)-1)*m+(alpha/(2*beta)-1)*d*dt)*...
        dt^2*a(i-1)+Kraft(i)*dt^2;
    y(i)=a_h^-1*b_h;
    v(i)=(alpha/(beta*dt))*(y(i)-y(i-1))-((alpha/beta)-1)*v(i-1)-...
        (alpha/(2*beta)-1)*dt*a(i-1);
    a(i)=(1/(beta*dt^2))*(y(i)-y(i-1))-1/(beta*dt)*v(i-1)-...
        (1/(2*beta)-1)*a(i-1);
end

% Extremwerte
ymax=max(y);   ymin=min(y);
vmax=max(v);   vmin=min(v);
amax=max(a);   amin=min(a);
%--------------------------------------------------------------------------

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

subplot(4,1,1)
plot(t,Kraft,'r','LineWidth', 1);
title('Kraftzeitverlauf');
xlabel('Zeit [s]');
ylabel('Kraft [N]');
grid on;

subplot(4,1,2)
plot(t,y,'b','LineWidth', 1);
title('Verschiebungszeitverlauf');
xlabel('Zeit [s]');
ylabel('Verschiebung [m]');
grid on;

subplot(4,1,3)
plot(t,v,'b','LineWidth', 1);
title('Geschwindigkeitszeitverlauf');
xlabel('Zeit [s]');
ylabel('Geschwindigkeit [m/s]');
grid on;

subplot(4,1,4)
plot(t,a,'b','LineWidth', 1);
title('Beschleunigungszeitverlauf');
xlabel('Zeit [s]');
ylabel('Beschleunigung [m/s^2]');
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_19_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', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
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);
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```
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Daempfungsmass [-]:');
fprintf(fid,'%.3f\n',xi);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Lastfrequenz [Hz]:');
fprintf(fid,'%.3f\n',fs);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Kraft (Personengewicht) [N]:');
fprintf(fid,'%d\n',G);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Reduktionsfaktor [-]:');
fprintf(fid,'%d\n',alpha_red);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n','Koeffizient fuer den konstanten Anteil',...
    'der Fourierreihe [-]:');
fprintf(fid,'%d\n',a0);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Gesamtdauer der Berechnung [s]:');
fprintf(fid,'%d\n',t_ber);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Berechnungszeitschritt [s]:');
fprintf(fid,'%d\n',dt);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Kraftdefinition:');
fprintf(fid,'%s \t %s\n','Fourier-Koeff.','Phasenwinkel');
for jj=1:1:length(alpha_f)
    fprintf(fid,'%d \t %d\n',alpha_f(jj), phi(jj));
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\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', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
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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 Berechnungszeitschritte [-]:');
fprintf(fid,'%d\n',nt);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Integrationsparameter fuer das Newmark-Verfahren:');
fprintf(fid,'%s \t %.4f\n','alpha=',alpha);
fprintf(fid,'%s \t %.4f\n','beta=',beta);
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','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 Beschleunigung [m/s^2]:');
fprintf(fid,'%d\n',amax);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Minimale Beschleunigung [m/s^2]:');
fprintf(fid,'%d\n',amin);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fclose(fid);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Ergebnis_Bewegungsgroessen=[t' Kraft' y' v' a'];
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_19_2: Zeitverlaeufe der',...
    'Bewegungsgroessen');
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fprintf(fid, '%s\n', ' ');
fprintf(fid,...
    '%s\n','-----------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
fprintf(fid,'%s %s\n','Zeitverlaufe der Bewegungsgroessen und',...
    'der Erregerkraft:');
fprintf(fid,'%s \t %s \t %s \t %s \t %s\n','Zeit [s]:',...
    'Kraft [N]', 'Verschiebung [m]', 'Geschwindigkeit [m/s]',...
    'Beschleunigung [m/s^2]');
for ii=1:1:length(y)
    fprintf(fid,'%d \t %d \t %d \t %d \t %d\n',...
        Ergebnis_Bewegungsgroessen(ii,:));
end
fclose(fid);
%--------------------------------------------------------------------------
```