LAMPIRAN

Lampiran 1 : Script Matlab Pengambilan Data Normal

```
%Script to run data acquisition using National Instrument NI 9234
%Created: Juli 2018, Rifasakin.

clear;
clc;
close all;


tic;

s = daq.createSession('ni');
s.DurationInSeconds = 5;
Dur = s.DurationInSeconds;
s.Rate = 25600;
s.addAnalogInputChannel('cDAQ1Mod1', 'ai0', 'Accelerometer');
%s.addAnalogInputChannel('cDAQ1Mod1', 'ai1', 'Accelerometer');
%s.addAnalogInputChannel('cDAQ1Mod1', 'ai2', 'Accelerometer');
s.addAnalogInputChannel('cDAQ1Mod1', 'ai3', 'Voltage'); % Tachometer
%s.addAnalogInputChannel('cDAQ1Mod2', 'ai0', 'Microphone');
%s.addAnalogInputChannel('cDAQ1Mod2', 'ai1', 'Microphone');

s.Channels(1).Sensitivity = 97.60E-3; %mV/g Type 4507B serial:11165
%s.Channels(2).Sensitivity = 95.83E-3; %mV/g Type 4507B serial:11026
%s.Channels(3).Sensitivity = 99.56E-3; %mV/g Type 4507B serial:10984
%s.Channels(4).Sensitivity = 94.50E-3;
%s.Channels(5).Sensitivity = 9.40E-3;  %mV/Pa Model 130B40 serial:41741
%s.Channels(6).Sensitivity = 8.60E-3;  %mV/Pa Model 130B40 serial:41842
 for i=1:50
```

```
data = s.startForeground();          % start recording vibration data
data_ch1 = data(:,1);
data_ch2 = data(:,2);
%data_ch3 = data(:,3);
%data_ch4 = data(:,4);
%data_ch5 = data(:,5);
%data_ch6 = data(:,6);

rootname = 'E:\Pengambilan_Data_TA';     % drive tujuan dan nama file
extension = '.mat';                      % ekstension utk nama file
namafile = [rootname,'SignalBearing',num2str(i),extension];
data_all = [data_ch1 data_ch2 ];
eval(['save ', namafile ,' data_all']);

pause(3)
pesan = ['Acquiring and saving data at loop number: ',num2str(i)];
disp(pesan)
end

toc
```

rootname : diganti tempat yang digunakan untuk menyimpan file.

Lampiran 2 : Script Matlab Pengambilan data cacat elemen bola

```
%Script to run data acquisition using National Instrument NI 9234
%Created: Juli 2018, Rifasakin.

clear;
clc;
close all;
```

```
tic;

s = daq.createSession('ni');
s.DurationInSeconds = 5;
Dur = s.DurationInSeconds;
s.Rate = 25600;
s.addAnalogInputChannel('cDAQ1Mod1', 'ai0', 'Accelerometer');
%s.addAnalogInputChannel('cDAQ1Mod1', 'ai1', 'Accelerometer');
%s.addAnalogInputChannel('cDAQ1Mod1', 'ai2', 'Accelerometer');
s.addAnalogInputChannel('cDAQ1Mod1', 'ai3', 'Voltage'); % Tachometer
%s.addAnalogInputChannel('cDAQ1Mod2', 'ai0', 'Microphone');
%s.addAnalogInputChannel('cDAQ1Mod2', 'ai1', 'Microphone');

s.Channels(1).Sensitivity = 97.60E-3; %mV/g Type 4507B serial:11165
%s.Channels(2).Sensitivity = 95.83E-3; %mV/g Type 4507B serial:11026
%s.Channels(3).Sensitivity = 99.56E-3; %mV/g Type 4507B serial:10984
%s.Channels(4).Sensitivity = 94.50E-3;
%s.Channels(5).Sensitivity = 9.40E-3;  %mV/Pa Model 130B40 serial:41741
%s.Channels(6).Sensitivity = 8.60E-3;  %mV/Pa Model 130B40 serial:41842

for i=1:50

data = s.startForeground();         % start recording vibration data
data_ch1 = data(:,1);
data_ch2 = data(:,2);
%data_ch3 = data(:,3);
%data_ch4 = data(:,4);
%data_ch5 = data(:,5);
%data_ch6 = data(:,6);
```

```
rootname = 'E:\Pengambilan_Data_TA';      % drive tujuan dan nama file
extension = '.mat';                               % ekstension utk nama file
namafile = [rootname,'CacatBola',num2str(i),extension];
data_all = [data_ch1 data_ch2 ];
eval(['save ', namafile ,' data_all']);

pause(3)
pesan = ['Acquiring and saving data at loop number: ',num2str(i)];
disp(pesan)
end

toc
```

Lampiran 3**:** Script Matlab Pengolahan Data Mentah Menjadi Plot Domain Waktu

```
clear
clc
%Direktori tempat data mentah getaran berada
load('E:\Data Tugas Akhir\2. Data Pakai\2. Testing Data\1.
Normal\Tugas_AkhirNormal1_15.mat')
y1=data_all(:,1); %diberi nama dengan variabel baru dan berbeda untuk masing-
masing variasi bukaan katup

load('E:\Data Tugas Akhir\2. Data Pakai\1. Training Data\2. Rusak
Bola\Tugas_AkhirRusakBola_15.mat')
y2=data_all(:,1);

% plot amplitude time domain
figure
subplot(5,1,1)
plot(y1(1:25600))
```

```
axis([0 5000 -5 5])
legend('Normal')
xlabel('Sampel')
ylabel('Amplitudo')


subplot(5,1,2)
plot(y2(1:25600),'r')
axis([0 5000 -5 5])
legend('rusak')
xlabel('Sampel')
ylabel('Amplitudo')
```

Lampiran 4**:** Script Matlab Ekstraksi Parameter Statistik

```
clc
close all
clear

%Normal
for d=(1:500)
signal_in=['E:\Data Tugas Akhir\2. Data Pakai\1. Training Data\1. Normal\Tugas_AkhirNormal1_',int2str(d),'.mat'];
load (signal_in)

a=data_all(:,1);
R(d)=rms(a);
S(d)=std(a);
P(d)=((max(abs(a))-min(abs(a)))/2);
```

```
K(d)=kurtosis(a);
V(d)=var(a);
C(d)=peak2rms(a);
M(d)=skewness(a);
x=1:500;

%rusak bola
for di=(1:500)
signal_in=['E:\Data Tugas Akhir\2. Data Pakai\1. Training Data\2. Rusak Bola\Tugas_AkhirRusakBola_',int2str(di),'.mat'];
load (signal_in)

b=data_all(:,1);
R1(di)=rms(b);
S1(di)=std(b);
P1(di)=((max(abs(b))-min(abs(b)))/2);
K1(di)=kurtosis(b);
V1(di)=var(b);
C1(di)=peak2rms(b);
M1(di)=skewness(b);
x1=1:500;


%R
figure
s=14;
c='r';
scatter(x,(R),s,c,'v');
```

```
hold on
s=14;
c='b';
scatter(x1,(R1),s,c,'x');
hold on

axis([0 500 0 1.5])
title('Grafik RMS')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')

%S
figure
s=14;
c='r';
scatter(x,(S),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(S1),s,c,'x');
hold on

axis([0 500 0 1.5])
title('Grafik Standar Deviasi')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')

%P
```

```
figure
s=14;
c='r';
scatter(x,(P),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(P1),s,c,'x');
hold on

axis([0 500 0 3.5])
title('Grafik Peak Value')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')

%K
figure
s=14;
c='r';
scatter(x,(K),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(K1),s,c,'x');
hold on

axis([0 500 2.5 4])
title('Grafik Kurtosis')
```

```
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')

%V
figure
s=14;
c='r';
scatter(x,(V),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(V1),s,c,'x');
hold on

axis([0 500 0 2])
title('Grafik Varians')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')

%C
figure
s=14;
c='r';
scatter(x,(C),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(C1),s,c,'x');
```

```
hold on

axis([0 500 4 6])
title('Grafik Crest Factor')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')


%M
figure
s=9;
c='r';
scatter(x,(M),s,c,'v');
hold on
s=9;
c='b';
scatter(x1,(M1),s,c,'x');
hold on

axis([0 500 -0.01 0.01])
title('Grafik Skewness')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Rusak')
```

Lampiran 1**:** Script Matlab Principal Component Analysis (PCA)

```
vector_ch1234(:,:,1)=Normaltrai;
```

```
vector_ch1234(:,:,2)=Rusaktrai;

for i=1:2

eval (
['[LOADING_ch',int2str(i),',SCORE_ch',int2str(i),',latent_ch',int2str(i),',T2_ch',int2str(i),'] =princomp(zscore(vector_ch12(:,:,',int2str(i),')));']);

eval ( [ '[norm_vector_ch12(:,:,',int2str(i),'),MU(i,:),SIGMA(i,:)]=
zscore(vector_ch12(:,:,',int2str(i),'));' ])

eval ( ['loading(:,:,',int2str(i),')=LOADING_ch',int2str(i),';'])

eval ( ['score(:,:,',int2str(i),')=SCORE_ch',int2str(i),';'])

eval ( ['latent(:,',int2str(i),')=latent_ch',int2str(i),';'])


end

 figure()

pareto(LATENT)

xlabel('Principal Component')

ylabel('Variance Explained (%)')
```

Lampiran 5 : Spesifikasi *Accelerometer*

Calibration Chart for DeltaTron® Accelerometer Type 4507 B

Brüel & Kjær

Serial No.: 30172

Reference Sensitivity [1] at 159.2 Hz (ω = 1000 s⁻¹), 20 ms⁻² RMS, 4 mA supply current and 24.0 °C: 9.953 mV/ms⁻² (97.60 mV/g)

Frequency Range:	Amplitude (±10%):	0.3 Hz to 6 kHz
	Phase (± 5°):	2 Hz to 5 kHz
Mounted Resonance Frequency:		18 kHz
Transverse Sensitivity [2]: Maximum (at 30 Hz, 100 ms⁻²):		< 5% re Reference Sensitivity
Transverse Resonance Frequency:		> 18 kHz
Calculated values for TEDS [3]:	Resonance frequency:	20.3 kHz
	Quality factor @ f_{res}:	88.7
	Amplitude slope:	-2.1 %/decade
	High pass cut-off frequency:	0.016 Hz
	Low pass cut-off frequency:	141 kHz
Measuring Range:		± 700 ms⁻² peak (± 71 g peak)

Polarity of the electrical signal is positive for an acceleration in the direction of the arrow on the drawing.

[1] This calibration is obtained on a modified Brüel & Kjær Calibration System Type 9610 System No.: 150157.3 and is traceable to the National Institute of Standards and Technology, USA and Physikalisch-Technische Bundesanstalt, Germany.
The expanded uncertainty is 1.0% determined in accordance with EAL-R2. A coverage factor k=2 is used. This corresponds to a coverage probability of 95% for a normal distribution.

[2] The uncertainty is 0.3% of Reference Sensitivity.

[3] Transducer Electronic Data Sheet according to IEEE P1451.4.

[4] Deviation from Reference Sensitivity.

Patents involved: US 08387851, JP 50952694 and DK 169653.

For further information, please see http://www.bk.dk and Product Data Sheet BP 1841.

Electrical:

Bias Voltage:	at full temperature and current range:	+ 13 V ± 1 V
Power Supply requirements:	Constant Current:	+ 2 to + 20 mA
	Unloaded Supply Voltage:	+ 24 V to + 30 V
Output Impedance:		< 30 Ω
Start-up time (to final bias ± 10%):		5 s
Inherent Noise (RMS): Broadband (1 Hz to 6 kHz):		< 35 µV corresponding to < 0.0035 ms⁻² (< 350 µg)
Spectral:	10 Hz:	1.5x10⁻⁴ ms⁻²/√Hz (15 µg/√Hz)
	100 Hz:	3.5x10⁻⁵ ms⁻²/√Hz (3.5 µg/√Hz)
	1000 Hz:	2x10⁻⁵ ms⁻²/√Hz (2 µg/√Hz)

Ground Loops can introduce error signals. These can be avoided by insulating the accelerometer from the mounting surface (see Mounting Technique).

Recommended cables: AO 1382, AO 0531, AO 0463 and other cables see Product Data Sheet

Built-in ID-information according to IEEE P1451.4

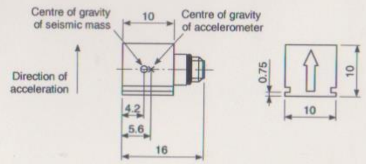
Mounting Technique:
The accelerometer can be fastened directly to the measuring object by glue e.g., hot glue. However, if a reduced frequency range can be accepted, it is recommended to use one of the special mounting clips (see below) which is glued to the measuring object. In any case the mounting surface must be clean and smooth.
Three types of mounting clips are available: UA 1407 (set of 100) is a low profile clip recommended for mounting on plane surfaces. UA 1475 (set of 100) is a clip with a thick base which can be filed to fit a curved mounting surface. UA 1478 (set of 100) is a swivel base clip for use where the accelerometer is to be aligned according to a given co-ordinate system (see Product Data Sheet BP 1841).
Applying a little grease to the mounting surface of the accelerometer as well as the clip will improve the frequency response.
See also ISO 5348.

Environmental:

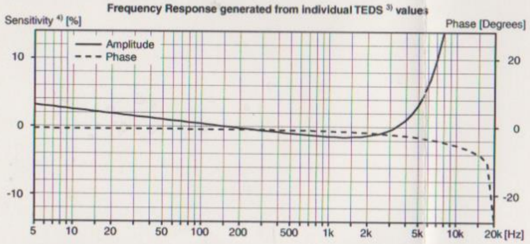
Temperature Range:	- 54 to + 121°C (- 65 to + 250°F)
Temperature Coefficient of Sensitivity:	+ 0.09%/°C
Temp. Transient Sensitivity (3 Hz Low. Lim. Frq. (-3 dB, 6 dB/oct)):	0.2 ms⁻²/°C
Magnetic Sensitivity (50 Hz, 0.038 T):	3 ms⁻²/T
Base Strain Sensitivity (at 250 µε in base plane): Mounted on adhesive tape 0.09 mm thick:	0.005 ms⁻²/µε
Max. Non-destructive Shock:	50 kms⁻² peak (5000 g peak)
Humidity:	90 % RH non-condensing

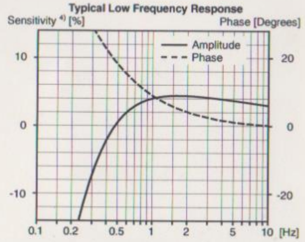
Mechanical:

Case Material:	Titanium ASTM Grade 2
Sensing Element:	Piezoelectric, Type PZ 23
Construction:	Theta Shear®
Sealing:	Welded
Weight:	4.8 gram (0.17 oz)
Electrical Connector:	10 - 32 UNF-2A
Mounting Surface Flatness:	< 3 µm



All dimensions in millimetres





Date 02 jun 2007, 13:24 Operator JHL

Specifications obtained in accordance with ANSI S2.11-1969 and parts of ISO 5347.

All values are typical at 25°C (77°F) unless measurement uncertainty is specified.

BC 0288-12

Serial No.: 30172