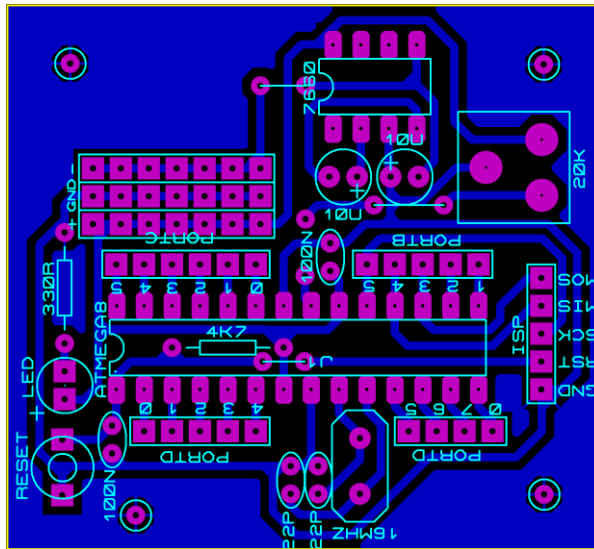
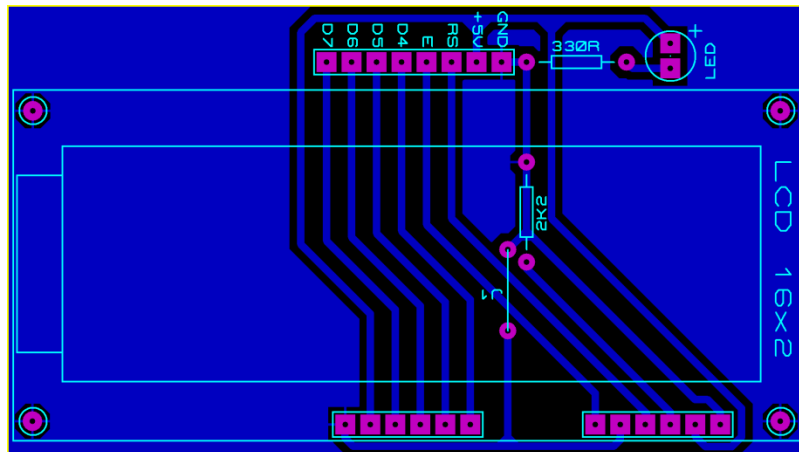


## LAMPIRAN

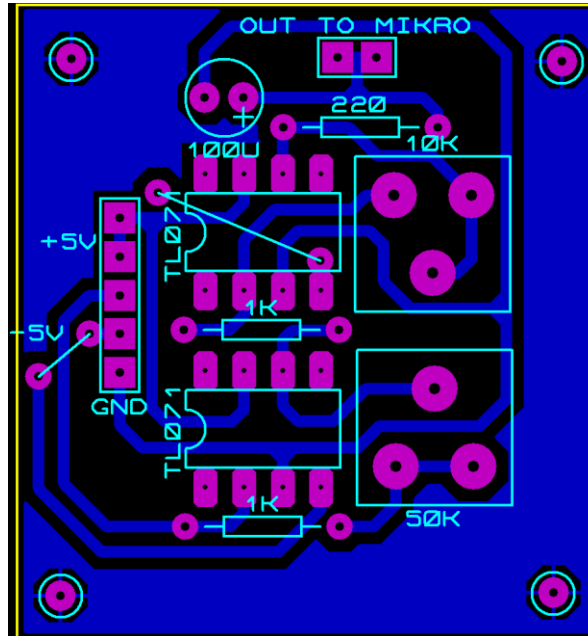
- Lay Out PCB
- Lay Out Minimum Sistem dengan *ATMega8*



- Lay Out LCD



▪ *Lay Out Instrumentasi (Op-Amp)*



1. **List Program**

```
#include <mega8.h> //preprocessor menyertakan library IC
ATmega 8

#include <delay.h> //preprocessor menyertakan library delay

#include <alcd.h> //preprocessor menyertakan library lcd

#include <stdlib.h> //preprocessor menyertakan standard
library

#define ADC_VREF_TYPE 0x00 // fungsi otomatis pembacaan
library ADC dari wizard

// Read the AD conversion result

unsigned int read_adc(unsigned char adc_input)
{
    ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);

    // Delay needed for the stabilization of the ADC input voltage
    delay_us(10);
```

```

// Start the AD conversion
ADCSRA|=0x40;

// Wait for the AD conversion to complete
while ((ADCSRA & 0x10)==0);

ADCSRA|=0x10;

return ADCW;

}

int data_adc1,data_adc2; //variable dengan type data integer
sebagai variable data nilai pertama pembacaan output sensor
flexiforce untuk selanjutnya akan di inputkan ke PIN ADC

float Kilogram,Newton,Kilogram_1,Newton_1; //variable dengan
type data float sebagai variable data yang akan ditampilkan ke
LCD 2 x 16 untuk menjadi nilai akhir Kilogram dan Newton

char temp[10]; //variable untuk menyimpan sementara
karakter/angka yang akan di tampilkan

void konvert_Kilogram() //Fungsi pembacaan sensor flexiforce
untuk nilai Kilogram

{

data_adc1=read_adc(1); //sensor flexiforce terpasang di bit 1
ADC pada PORT.C

Kilogram=((float)data_adc1/1024)*3; //rumus untuk mengubah
nilai ADC Pembacaan sensor flexiforce kedalam nilai Kilogram

Kilogram_1=((float)Kilogram*6); //rumus tambahan untuk
mengubah Nilai ADC Pembacaan sensor flexiforce kedalam nilai
Kilogram namun nilai yang dihasilkan dari rumus ini lebih real
dengan nilai koma

}

void membaca_Kilogram() //fungsi penampilan data output sensor
flexiforce ke LCD 2 x 16, data yang ditampilkan ke LCD sudah
bernilai data nilai Kilogram

{

lcd_gotoxy(0,0); //menulis karakter di baris 0 kolom 0 LCD 2 x
16

lcd_putsf("KILOGRAM :"); //menampilkan karakter "KILOGRAM : "
di baris 0 kolom 0 LCD 2 x 16

```

```

konvert_Kilogram(); //menjalankan sub program fungsi
konvert_Kilogram()

ftoa(Kilogram_1,2,temp); //float to ascii rumus penampil data
ADC ke LCD menggunakan karakter simpanan pada variable temp
dengan tampilan nilai real dan 2 digit angka di belakang koma

lcd_gotoxy(5,0) ; //menulis karakter di baris 0 kolom 3 LCD 2
x 16

lcd_puts(temp); //data hasil nilai akhir Kilogram tersimpan
pada variable temp dan selanjutnya ditampilkan ke LCD 2 x 16

delay_ms(1000); //tunda waktu selama 1000 ms

}
void konvert_Newton() //Fungsi pembacaan sensor flexiforce
untuk nilai Newton
{
data_adc2=read_adc(1); //sensor flexiforce terpasang di bit 1
ADC pada PORT.C
Newton=((float)data_adc2/1024)*5; //rumus untuk mengubah nilai
ADC Pembacaan sensor flexiforce kedalam nilai Newton
Newton_1=((float)Newton*2); //rumus tambahan untuk mengubah
Nilai ADC Pembacaan sensor flexiforce kedalam nilai Newton
namun nilai yang dihasilkan dari rumus ini lebih real dengan
nilai koma
}

void membaca_Newton() //fungsi penampilan data output sensor
flexiforce ke LCD 2 x 16, data yang ditampilkan ke LCD sudah
bernilai data nilai Newton
{
lcd_gotoxy(0,1); //menulis karakter di baris 0 kolom 1 LCD 2 x
16
lcd_putsf("NEWTON :"); //menampilkan karakter "NEWTON : " di
baris 0 kolom 1 LCD 2 x 16
konvert_Newton(); //menjalankan sub program fungsi
konvert_Newton()
ftoa(Newton_1,2,temp); //float to ascii rumus penampil data
ADC ke LCD menggunakan karakter simpanan pada variable temp
dengan tampilan nilai real dan 2 digit angka di belakang koma
lcd_gotoxy(9,1); //menulis karakter di baris 9 kolom 1 LCD 2 x
16
lcd_puts(temp); //data hasil nilai akhir Newton ersimpan pada
variable temp dan selanjutnya ditampilkan ke LCD 2 x 16
delay_ms(1000); //tunda waktu selama 1000 ms
}
void main(void)
{
// Declare your local variables here

```

```

// ADC initialization
// ADC Clock frequency: 1000.000 kHz
// ADC Voltage Reference: AREF pin
ADMUX=ADC_VREF_TYPE & 0xff;
ADCSRA=0x84;

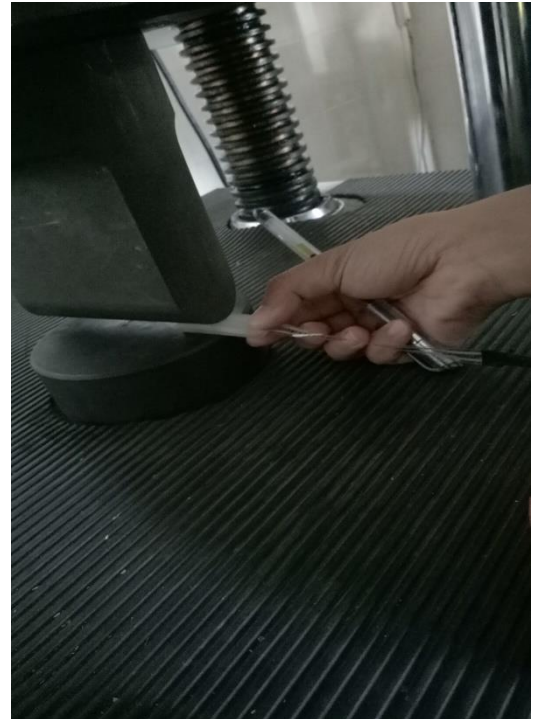
// Alphanumeric LCD initialization
// Connections specified in the
// Project|Configure|C Compiler|Libraries|Alphanumeric LCD
menu:
// RS - PORTB Bit 0
// RD - PORTD Bit 0
// EN - PORTB Bit 1
// D4 - PORTB Bit 2
// D5 - PORTB Bit 3
// D6 - PORTB Bit 4
// D7 - PORTB Bit 5
// Characters/line: 16
lcd_init(16);
lcd_gotoxy(4,0);
lcd_putsf("BISMILLAH");
delay_ms(2000);
lcd_clear();
lcd_gotoxy(1,0);
lcd_putsf("NUR RURIOKTARI");
lcd_gotoxy(3,1);
lcd_putsf("20143010014");
delay_ms(2000);
lcd_clear();
//Inisialilasi awal LCD 2 x 16, ketika alat pertama kali
dinyalakan maka program akan mengeksekusi program inisialisasi
terlebih dahulu

while (1)
{
membaca_Kilogram(); //menjalankan sub program fungsi
membaca_Kilogram()
membaca_Newton(); //menjalankan sub program fungsi
membaca_Newton()
}
}

```

## Lampiran Foto

- Pengujian di laboratorium Mesin UMY



- Tampilan Angka Hasil Pegujian



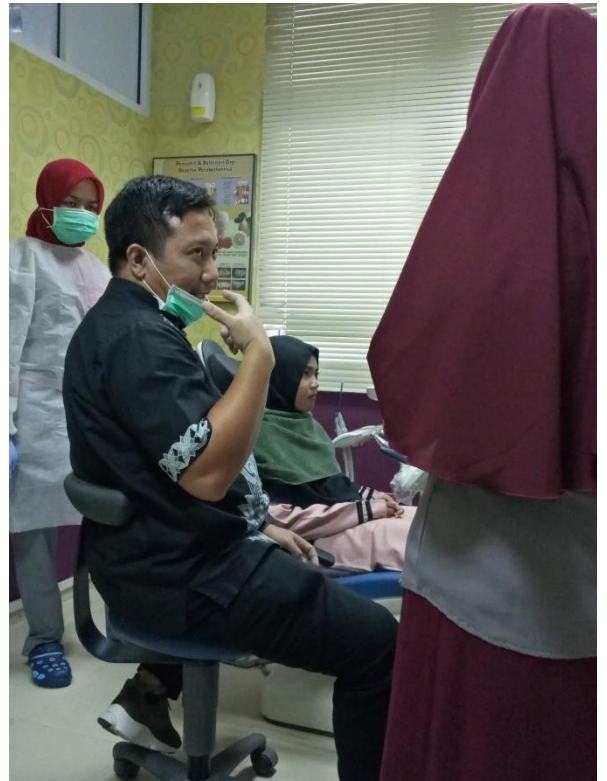
- Pengujian Fungsi pada Manusia







- Konsultasi Ke Dokter Gigi





## PERHITUNGAN STATISTIK

### A. Rata-rata (Mean) Perbandingan Nilai Modul TA dengan Alat Pembanding

$$\text{Mean } (\bar{X}) = \frac{\sum Xi}{n}$$

Dimana :

$\bar{X}$  = rata – rata

$\sum Xi$  = Jumlah nilai data

n = Banyak data

#### 1. Pengukuran sensor flexiforce pada settingan tekanan 1 Kg (9,8 N)

$$\begin{aligned}\bar{X} &= \frac{1,00+1,02+1,04+0,98+0,99+1,00+1,00+1,02+1,02+0,98}{10} \\ &= 1,005 \text{ Kg}\end{aligned}$$

$$\begin{aligned}\bar{X} &= \frac{9,86+10,00+10,02+9,81+9,86+9,92+10,02+10,00+9,90+9,80}{10} \\ &= 9,91 \text{ N}\end{aligned}$$

#### 2. Pengukuran sensor flexiforce pada settingan tekanan 2 Kg (19,6 N)

$$\begin{aligned}\bar{X} &= \frac{2,02+1,98+1,99+1,98+2,02+2,00+1,99+2,00+2,00+2,01}{10} \\ &= 1,99 \text{ Kg}\end{aligned}$$

$$\begin{aligned}\bar{X} &= \frac{20,01+19,85+19,50+20,00+20,02+20,00+19,74+19,80+20,00+20,00}{10} \\ &= 19,85 \text{ N}\end{aligned}$$

3. Pengukuran sensor flexiforce pada settingan tekanan 3 Kg (29,4 N)

$$\begin{aligned}\bar{X} &= \frac{3,02+3,07+3,00+2,99+2,98+3,01+3,05+2,96+3,00+3,02}{10} \\ &= 3,01 \text{ Kg}\end{aligned}$$

$$\begin{aligned}\bar{X} &= \frac{30,00+30,03+29,80+29,34+29,30+29,68+30,00+29,43+29,65+30,00}{10} \\ &= 29,72 \text{ N}\end{aligned}$$

4. Pengukuran sensor flexiforce pada settingan tekanan 4 Kg (39,2 N)

$$\begin{aligned}\bar{X} &= \frac{3,99+4,02+4,01+4,07+4,01+4,00+4,00+3,95+3,98+4,03}{10} \\ &= 4,006 \text{ Kg}\end{aligned}$$

$$\bar{X} = \frac{39,55+40,03+39,67+40,37+40,00+39,97+39,84+39,35+39,29+40,00}{10}$$

10

$$= 39,807 \text{ N}$$

5. Pengukuran sensor flexiforce pada settingan tekanan 5 Kg (49 N)

$$\bar{X} = \frac{5,08+5,03+4,98+5,03+4,95+5,00+5,03+5,03+5,00+5,00}{10}$$

$$= 5,011 \text{ Kg}$$

$$\bar{X} = \frac{50,00+49,92+49,78+49,92+49,84+49,65+49,96+49,92+49,80+49,79}{10}$$

$$= 49,858 \text{ N}$$

6. Pengukuran sensor flexiforce pada settingan tekanan 15 Kg (147 N)

$$\bar{X} = \frac{15,03+15,01+15,00+15,06+14,95+14,96+14,98+15,02+15,00+15,00}{10}$$

$$= 14,995 \text{ Kg}$$

$$\bar{X} = \frac{148,01+147,90+147,92+148,05+147,85+147,85+147,98+148,05+148,00+147,98}{10}$$

$$= 147,959 \text{ N}$$

7. Pengukuran sensor flexiforce pada settingan tekanan 17 Kg (166,6 N)

$$\bar{X} = \frac{17,06+17,03+17,00+16,95+17,06+17,04+17,06+17,00+16,90+17,06}{10}$$

$$= 17,016 \text{ Kg}$$

$$\bar{X} = \frac{167,35+167,30+167,28+167,12+167,31+167,28+167,30+167,25+167,10+167,31}{10}$$

$$= 167,26 \text{ N}$$

8. Pengukuran sensor flexiforce pada settingan tekanan 18 Kg (176,4 N)

$$\bar{X} = \frac{18,00+18,00+17,96+17,90+17,96+18,05+18,05+18,00+17,90+18,00}{10}$$

$$= 17,985 \text{ Kg}$$

$$\bar{X} = \frac{177,10+177,05+176,90+176,85+176,90+177,10+177,10+176,98+176,90+177,05}{10}$$

$$= 176,993 \text{ N}$$

9. Pengukuran sensor flexiforce pada settingan tekanan 19 Kg (186,2 N)

$$\bar{X} = \frac{20,03+20,00+19,98+19,90+19,80+19,90+20,00+20,00+20,05+20,00}{10}$$

$$= 19,966 \text{ Kg}$$

$$\bar{X} = \frac{186,80+187,00+187,02+187,05+187,10+186,75+186,80+187,00+187,00+186,80}{10}$$

$$= 186,932 \text{ N}$$

10. Pengukuran sensor flexiforce pada settingan tekanan 20 Kg (196 N)

$$\bar{X} = \frac{20,03+20,00+19,98+19,90+19,80+19,90+20,00+20,00+20,05+20,00}{10}$$

$$= 19,966 \text{ Kg}$$

$$\bar{X} = \frac{197,10+197,00+196,78+196,75+196,70+196,60+197,03+197,00+197,10+197,03}{10}$$

$$= 196,909 \text{ N}$$

11. Pengukuran sensor flexiforce pada settingan tekanan 25 Kg (245 N)

$$\bar{X} = \frac{25,05+25,00+25,08+25,00+24,90+24,96+25,00+25,05+24,90+24,95}{10}$$

$$= 24,989 \text{ Kg}$$

$$\bar{X} = \frac{246,15+246,10+245,20+246,00+245,70+245,80+246,00+246,10+245,65+245,70}{10}$$

$$= 246,74 \text{ N}$$



B. Simpangan dan Error (%) Dari Data Modul TA terhadap Nilai Pembanding

$$\text{Error\%} = \frac{\text{SIMPANGAN}}{\text{Rata-rata nilai pembanding}} \times 100\%$$

$$\text{SIMPANGAN} = \text{Rata-rata nilai pembanding} - \text{Rata-rata nilai modul}$$

1. Pengukuran sensor flexiforce pada settingan tekanan 1 Kg (9,8 N)

Rata-rata nilai pembanding = 1 Kg dan 9,8 N

Rata-rata nilai modul = 1,005 Kg dan 9,91 N

- Simpangan dalam satuan Kilogram =  $1 - 1,005$   
= 0,005

- Error dalam satuan Kilogram =  $\frac{0,005}{1} \times 100\%$   
= 0.5%

- Simpangan dalam satuan Newton =  $9,8 - 9,91$   
= 0,11

- Error dalam satuan Newton =  $\frac{0,11}{9,8} \times 100\%$   
= 1,1 %

2. Pengukuran sensor flexiforce pada settingan tekanan 2 Kg (19,6 N)

Rata-rata nilai pembanding = 2 Kg dan 19,6 N

Rata-rata nilai modul = 1,99 Kg dan 19,85 N

- Simpangan dalam satuan Kilogram =  $2 - 1,99$

$$= 0,01$$

- Error dalam satuan Kilogram =  $\frac{0,01}{2} \times 100\%$   
= 0.5%

- Simpangan dalam satuan Newton =  $19,85 - 19,6$   
= 0,25

- Error dalam satuan Newton =  $\frac{0,25}{19,6} \times 100\% = 1,2 \%$

3. Pengukuran sensor flexiforce pada settingan tekanan 3 Kg (29,4 N)

Rata-rata nilai pembanding = 3 Kg dan 29,4 N

Rata-rata nilai modul = 3,01 Kg dan 29,72 N

- Simpangan dalam satuan Kilogram =  $3 - 3,01$   
= 0,01

- Error dalam satuan Kilogram =  $\frac{0,01}{3} \times 100\%$   
= 0.33%

- Simpangan dalam satuan Newton =  $29,72 - 29,4$   
= 0,32

- Error dalam satuan Newton =  $\frac{0,32}{9,29,4} \times 100\%$   
= 1,08 %

4. Pengukuran sensor flexiforce pada settingan tekanan 4 Kg (39,2 N)

Rata-rata nilai pembanding = 4 Kg dan 39,2 N

Rata-rata nilai modul = 4,006 Kg dan 39,807 N

- Simpangan dalam satuan Kilogram =  $4 - 4,006$   
= 0,006

- Error dalam satuan Kilogram =  $\frac{0,006}{4} \times 100\%$   
= 0.15%
- Simpangan dalam satuan Newton =  $39,2 - 39,807$   
= 0,807
- Error dalam satuan Newton =  $\frac{0,807}{39,2} \times 100\%$   
= 2,05 %

5. Pengukuran sensor flexiforce pada settingan tekanan 5 Kg (49 N)

Rata-rata nilai pembanding = 5 Kg dan 49 N

Rata-rata nilai modul = 5,011 Kg dan 49,858 N

- Simpangan dalam satuan Kilogram =  $5 - 5,011$   
= 0,011
- Error dalam satuan Kilogram =  $\frac{0,011}{5} \times 100\%$   
= 0.22%
- Simpangan dalam satuan Newton =  $49 - 49,858$   
= 0,858
- Error dalam satuan Newton =  $\frac{0,858}{49} \times 100\%$   
= 1,7 %

6. Pengukuran sensor flexiforce pada settingan tekanan 10 Kg (98 N)

Rata-rata nilai pembanding = 10 Kg dan 98 N

Rata-rata nilai modul = 10,011 Kg dan 98,56 N

- Simpangan dalam satuan Kilogram =  $10 - 10,011$   
= 0,011

- Error dalam satuan Kilogram =  $\frac{0,011}{10} \times 100\%$   
= 0.11%
- Simpangan dalam satuan Newton =  $98,56 - 98$   
= 0,56
- Error dalam satuan Newton =  $\frac{0,56}{98} \times 100\%$   
= 0,57 %

7. Pengukuran sensor flexiforce pada settingan tekanan 15 Kg (147 N)

Rata-rata nilai pembanding = 15 Kg dan 147 N

Rata-rata nilai modul = 14,995 Kg dan 147 N

- Simpangan dalam satuan Kilogram =  $15 - 14,995$   
= 0,005
- Error dalam satuan Kilogram =  $\frac{0,005}{15} \times 100\%$   
= 0.03%
- Simpangan dalam satuan Newton =  $147 - 147,959$   
= 0,959
- Error dalam satuan Newton =  $\frac{0,959}{147} \times 100\%$   
= 0,6 %

8. Pengukuran sensor flexiforce pada settingan tekanan 17 Kg (166,6 N)

Rata-rata nilai pembanding = 17 Kg dan 166,6 N

Rata-rata nilai modul = 17,016 Kg dan 167,26 N

- Simpangan dalam satuan Kilogram =  $17 - 17,016$   
= 0,016

- Error dalam satuan Kilogram =  $\frac{0,016}{17} \times 100\%$   
= 0,09%
- Simpangan dalam satuan Newton =  $167,26 - 166,6$   
= 0,66
- Error dalam satuan Newton =  $\frac{0,66}{166,6} \times 100\%$   
= 0,39 %

9. Pengukuran sensor flexiforce pada settingan tekanan 18 Kg (176,4N)

Rata-rata nilai pembanding = 18 Kg dan 176,4 N

Rata-rata nilai modul = 17,98 Kg dan 176,993 N

- Simpangan dalam satuan Kilogram =  $17,98 - 18$   
= 0,02
- Error dalam satuan Kilogram =  $\frac{0,02}{18} \times 100\%$   
= 0,11%
- Simpangan dalam satuan Newton =  $176,993 - 176,4 = 0,59$
- Error dalam satuan Newton =  $\frac{0,59}{176,4} \times 100\%$   
= 0,3 %

10. Pengukuran sensor flexiforce pada settingan tekanan 19 Kg (186,2 N)

Rata-rata nilai pembanding = 19 Kg dan 186,2 N

Rata-rata nilai modul = 18,98 Kg dan 186,932 N

- Simpangan dalam satuan Kilogram =  $19 - 18,98$   
= 0,02

- Error dalam satuan Kilogram =  $\frac{0,02}{19} \times 100\%$   
= 0.10%
- Simpangan dalam satuan Newton =  $186,932 - 186,2$   
= 0,73
- Error dalam satuan Newton =  $\frac{0,73}{186,2} \times 100\%$   
= 0,39 %

11. Pengukuran sensor flexiforce pada settingan tekanan 20 Kg (196 N)

Rata-rata nilai pembanding = 20 Kg dan 196 N

Rata-rata nilai modul = 19,966 Kg dan 196,909 N

- Simpangan dalam satuan Kilogram =  $20 - 19,966$   
= 0,034
- Error dalam satuan Kilogram =  $\frac{0,034}{20} \times 100\%$   
= 0.17%
- Simpangan dalam satuan Newton =  $196 - 196,909$   
= 0,909
- Error dalam satuan Newton =  $\frac{0,909}{196} \times 100\%$   
= 0,46 %

12. Pengukuran sensor flexiforce pada settingan tekanan 25 Kg (245 N)

Rata-rata nilai pembanding = 25 Kg dan 245 N

Rata-rata nilai modul = 24,989 Kg dan 246,74 N

- Simpangan dalam satuan Kilogram =  $25 - 24,989$

$$= 0,011$$

- Error dalam satuan Kilogram =  $\frac{0,011}{25} \times 100\%$   
= 0.044%
- Simpangan dalam satuan Newton =  $245 - 246,74$   
= 1,74
- Error dalam satuan Newton =  $\frac{1,74}{245} \times 100\%$   
= 0,71 %

C. Perbandingan pengukuran dan hasil perhitungan Test Poin

1. Perhitungan pada input 1 Kg

Diketahui: Output sensor = 0,021 V

Vout Op-Amp1 Terukur = -0,040 V

Vout Op-Amp2 Terukur = 0,20 V

Vin=Output sensor

Vin Op-Amp2=Output Op-Amp1

- Perhitungan Op-Amp 1

$$\text{Gain} = -\frac{Rv1}{R3} = -\frac{2k}{1k} = -2 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -2 \times 0,021 = -0,042 \text{ V}$$

- Perhitungan Op-Amp 2

$$\text{Gain} = \frac{Rv2}{R4} = \frac{5k}{1k} = 5 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -0,042 \times 5 = 0,21 \text{ V}$$

- Selisi antara nilai terukur dan terhitung

$$\text{Op-Amp1} = -0,040 - (-0,042) = -0,002 \text{ V}$$

$$\text{Op-Amp2} = 0,20 - 0,21 = 0,01 \text{ V}$$

2. Perhitungan pada input 5 Kg

Diketahui: Output sensor= 0,107 V

Vout Op-Amp1 Terukur = -0,212 V

Vout Op-Amp2 Terukur = 1,07 V

Vin=Output sensor

Vin Op-Amp2=Output Op-Amp1

- Perhitungan Op-Amp 1

$$\text{Gain} = -\frac{Rv1}{R3} = -\frac{2k}{1k} = -2 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -2 \times 0,107 = -0,214 \text{ V}$$

- Perhitungan Op-Amp 2

$$\text{Gain} = -\frac{Rv2}{R4} = -\frac{5k}{1k} = -5 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -0,214 \times -5 = 1,07 \text{ V}$$

- Selisi antara nilai terukur dan terhitung

$$\text{Op-Amp1} = -0,212 - (-0,214) = -0,002 \text{ V}$$

$$\text{Op-Amp2} = 1,07 - 1,07 = 0 \text{ V}$$

### 3. Perhitungan pada input 10 Kg

Diketahui: Output sensor= 0,205 V

Vout Op-Amp1 Terukur = -0,396 V

Vout Op-Amp2 Terukur = 1,98 V

Vin=Output sensor

Vin Op-Amp2=Output Op-Amp1

- Perhitungan Op-Amp 1

$$\text{Gain} = -\frac{Rv1}{R3} = -\frac{2k}{1k} = -2 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -2 \times 0,205 = -0,41 \text{ V}$$

- Perhitungan Op-Amp 2

$$\text{Gain} = -\frac{Rv2}{R4} = -\frac{5k}{1k} = -5 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -0,41 \times -5 = 2,05 \text{ V}$$



- Selisi antara nilai terukur dan terhitung  

$$\text{Op-Amp1} = -0,396 - (-0,41) = -0,014 \text{ V}$$

$$\text{Op-Amp2} = 1,98 - 2,05 = 0,07 \text{ V}$$

4. Perhitungan pada input 15 Kg

Diketahui: Output sensor = 0,298 V

$$\text{Vout Op-Amp1 Terukur} = -0,590 \text{ V}$$

$$\text{Vout Op-Amp2 Terukur} = 2,95 \text{ V}$$

$$\text{Vin} = \text{Output sensor}$$

$$\text{Vin Op-Amp2} = \text{Output Op-Amp1}$$

- Perhitungan Op-Amp 1

$$\text{Gain} = -\frac{Rv1}{R3} = -\frac{2k}{1k} = -2 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -2 \times 0,298 = -0,596 \text{ V}$$

- Perhitungan Op-Amp 2

$$\text{Gain} = -\frac{Rv2}{R4} = -\frac{5k}{1k} = -5 \text{ X}$$

$$\text{Vout} = \text{Vin} \times \text{Gain} = -0,596 \times -5 = 2,98 \text{ V}$$

- Selisi antara nilai terukur dan terhitung  

$$\text{Op-Amp1} = -0,590 - (-0,596) = -0,006$$

$$\text{Op-Amp2} = 2,95 - 2,98 = 0,03$$

5. Perhitungan pada input 20 Kg

Diketahui: Output sensor = 0,418 V

$$\text{Vout Op-Amp1 Terukur} = -0,829 \text{ V}$$

$$\text{Vout Op-Amp2 Terukur} = 4,099 \text{ V}$$

$$\text{Vin} = \text{Output sensor}$$

$$\text{Vin Op-Amp2} = \text{Output Op-Amp1}$$

- Perhitungan Op-Amp 1

$$\text{Gain} = -\frac{Rv1}{R3} = -\frac{2k}{1k} = -2 \text{ X}$$

$$V_{out} = V_{in} \times \text{Gain} = -2 \times 0,418 = -0,836 \text{ V}$$

- Perhitungan Op-Amp 2

$$\text{Gain} = -\frac{Rv2}{R4} = -\frac{5k}{1k} = -5 \text{ X}$$

$$V_{out} = V_{in} \times \text{Gain} = -0,836 \times -5 = 4,18 \text{ V}$$

- Selisi antara nilai terukur dan terhitung  
Op-Amp1 =  $-0,829 - (-0,836) = -0,007 \text{ V}$   
Op-Amp2 =  $1,98 - 2,05 = 0,07 \text{ V}$

#### 6. Perhitungan pada input 25 Kg

Diketahui: Output sensor = 0,497 V

$$V_{out} \text{ Op-Amp1 Terukur} = -0,975 \text{ V}$$

$$V_{out} \text{ Op-Amp2 Terukur} = 4,864 \text{ V}$$

$$V_{in} = \text{Output sensor}$$

$$V_{in} \text{ Op-Amp2} = \text{Output Op-Amp1}$$

- Perhitungan Op-Amp 1

$$\text{Gain} = -\frac{Rv1}{R3} = -\frac{2k}{1k} = -2 \text{ X}$$

$$V_{out} = V_{in} \times \text{Gain} = -2 \times 0,497 = -0,994 \text{ V}$$

- Perhitungan Op-Amp 2

$$\text{Gain} = -\frac{Rv2}{R4} = -\frac{5k}{1k} = -5 \text{ X}$$

$$V_{out} = V_{in} \times \text{Gain} = -0,994 \times -5 = 4,97 \text{ V}$$

- Selisi antara nilai terukur dan terhitung  
Op-Amp1 =  $-0,975 - (-0,994) = -0,019$   
Op-Amp2 =  $4,864 - 4,97 = 0,10$

#### D. Perhitungan Rata-rata dan Tingkat Presisi dari Hasil Pengujian Pada Manusia

1. Pengukuran Rata-Rata dan Tingkat Presisi dari Hasil Pengujian pada Anak Usia 7-13 Tahun

a. Elfa Umur 10 Tahun

$$\begin{aligned} - \bar{X} \text{ P.Kanan} &= \frac{13,29+13,47+13,57+13,30+13,49}{5} = 13,42 \text{ Kg} \\ &= \frac{130,24+132,00+132,07+130,58+131,70}{5} = 131,31 \text{ N} \end{aligned}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(13,29-13,42)^2+(13,47-13,42)^2+(13,57-13,42)^2+(13,30-13,42)^2+(13,49-13,42)^2}{5-1}} = 0,12$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,12}{13,42}\right) = 98\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(130,24-131,31)^2+(132,00-131,31)^2+(132,07-131,31)^2+(130,58-131,31)^2+(131,70-131,31)^2}{5-1}} = 0,84$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,84}{131,31}\right) = 98\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{10,59+10,68+10,59+10,58+10,65}{5} = 10,61 \text{ Kg}$$

5

$$= \frac{103,78+104,29+103,77+103,67+104,37}{5} = 103,97 \text{ N}$$

$$\begin{aligned} \text{- SD (p.Kiri) satuan Kg} &= \sqrt{\frac{(10,59-10,61)^2+(10,68-10,61)^2+}{5-1} \\ &\quad (10,59-10,61)^2+(10,58-10,61)^2+(10,65-10,61)^2} \\ &= 0,05 \end{aligned}$$

$$\text{- Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,05}{10,61}\right) = 98\%$$

$$\begin{aligned} \text{- SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(103,78-103,97)^2+(104,29-103,97)^2+}{5-1} \\ &\quad (103,77-103,97)^2+(103,67-103,97)^2+ \\ &\quad (104,37-103,97)^2} \\ &= 0,40 \end{aligned}$$

$$\begin{aligned} \text{- Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,40}{103,97}\right) \\ &= 98\% \end{aligned}$$

b. Dika Umur 8 Tahun

$$\begin{aligned} \text{- } \bar{X} \text{ P.Kanan} &= \frac{10,98+10,87+10,73+10,80+10,75}{5} = 10,83 \text{ Kg} \end{aligned}$$

$$= \frac{107,83+106,84+105,75+106,15+105,39}{5} = 106,39 \text{ N}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(10,98-10,83)^2+(10,87-10,83)^2+(10,73-10,83)^2+(10,80-10,83)^2+(10,75-10,83)^2}{5-1}} = 0,17$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,17}{10,83}\right) = 96\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(107,83-106,39)^2+(106,84-106,39)^2+(105,75-106,39)^2+(106,15-106,39)^2+(105,39-106,39)^2}{5-1}} = 0,66$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,66}{106,39}\right) = 98\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{9,09+8,89+9,12+9,20+8,85}{5} = 9,03 \text{ Kg}$$

$$= \frac{89,70+87,23+90,00+90,18+86,86}{5} = 88,79 \text{ N}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(9,09-9,03)^2+(9,12-9,03)^2+(8,89-9,03)^2+(9,20-9,03)^2+(8,85-9,03)^2}{5-1}} = 0,15$$

$$- \text{Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,15}{9,03}\right) = 96\%$$

$$- \text{SD (p.Kiri) satuan Newton} = \sqrt{\frac{(89,70-88,79)^2+(87,23-88,79)^2+(90,00-88,79)^2+(90,18-88,79)^2+(86,86-88,79)^2}{5-1}}$$

$$= 1,60$$

$$- \text{Presisi (p.Kiri) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 1,60}{88,79}\right)$$

$$= 95\%$$

c. Berliana Umur 11 Tahun

$$- \bar{X} \text{ P.Kanan} = \frac{8,09+7,88+8,17+8,00+7,90}{5} = 8,00 \text{ Kg}$$

$$= \frac{79,30+77,74+80,06+78,60+77,00}{5} = 78,54 \text{ N}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(8,09-8)^2+(7,88-8)^2+(8,17-8)^2+(8,00-8)^2+(7,90-8)^2}{5-1}} = 0,12$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,12}{8,00}\right) =$$

$$96\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(79,30-78,54)^2+(77,74-78,54)^2+(80,06-78,54)^2+(78,60-78,54)^2+(77,00-78,54)^2}{5-1}}$$

$$= 1,47$$

$$\begin{aligned} - \text{ Presisi (p.Kanan) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 1,47}{78,54}\right) \\ &= 95\% \end{aligned}$$

$$\begin{aligned} - \bar{X} \text{ P.Kiri} &= \frac{10,67+10,70+10,79+10,80+10,65}{5} = 10,72 \text{ Kg} \\ &= \frac{104,45+104,86+105,72+106,00+104,42}{5} = 105,09 \text{ N} \end{aligned}$$

$$\begin{aligned} - \text{ SD (p.Kiri) satuan Kg} &= \sqrt{\frac{(10,67-10,72)^2+(10,70-10,72)^2+}{5-1} \frac{(10,79-10,72)^2+(10,80-10,72)^2+(10,65-10,72)^2}{5-1}} \\ &= 0,07 \end{aligned}$$

$$\begin{aligned} - \text{ Presisi (p.Kiri) Satuan Kg} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,07}{10,72}\right) = 98\% \end{aligned}$$

$$\begin{aligned} - \text{ SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(104,45-105,09)^2+(104,86-105,09)^2+}{5-1} \frac{(105,72-105,09)^2+(106,00-105,09)^2+}{5-1} \frac{(104,42-105,09)^2}{5-1}} \\ &= 0,72 \end{aligned}$$

$$\begin{aligned} - \text{ Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,72}{105,09}\right) \\ &= 98\% \end{aligned}$$

d. Surya Umur 8 Tahun

$$\begin{aligned}
 - \bar{X} \text{ P.Kanan} &= \frac{10,58+10,69+10,73+10,66+10,56}{5} = 10,64 \text{ Kg} \\
 &= \frac{103,68+104,80+105,19+104,54+103,69}{5} = 104,38 \text{ N}
 \end{aligned}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(10,58-10,64)^2+(10,69-10,64)^2+(10,73-10,64)^2+(10,66-10,64)^2+(10,56-10,64)^2}{5-1}} = 0,072$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,072}{10,64}\right) = 98\%$$

$$\begin{aligned}
 - \text{SD (p.Kanan) satuan Newton} &= \sqrt{\frac{(103,68-104,38)^2+(104,80-104,38)^2+(105,19-104,38)^2+(104,54-104,38)^2+(103,69-104,38)^2}{5-1}} \\
 &= 0,67
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kanan) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,67}{104,38}\right) \\
 &= 98\%
 \end{aligned}$$



$$\begin{aligned}
 - \bar{X} \text{ P.Kiri} &= \frac{7,56+7,48+7,30+7,58+7,45}{5} = 7,47 \text{ Kg} \\
 &= \frac{74,07+73,40+72,00+74,60+73,00}{5} = 73,41 \text{ N}
 \end{aligned}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(7,56-7,47)^2+(7,48-7,47)^2+(7,30-7,47)^2+(7,58-7,47)^2+(7,45-7,47)^2}{5-1}} = 0,11$$

$$- \text{Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,11}{7,47}\right) = 96\%$$

$$\begin{aligned}
 - \text{SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(74,07-73,41)^2+(73,40-73,41)^2+(72,00-73,41)^2+(74,60-73,41)^2+(73,00-73,41)^2}{5-1}} \\
 &= 1,01
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 1,01}{73,41}\right) \\
 &= 96\%
 \end{aligned}$$

e. Alya Umur 12 Tahun

$$\begin{aligned}
 - \bar{X} \text{ P.Kanan} &= \frac{12,54+12,48+12,67+12,56+12,43}{5} = 12,53 \text{ Kg} \\
 &= \frac{122,80+121,97+124,28+123,15+121,84}{5} = 122,80 \text{ N}
 \end{aligned}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(12,54-12,53)^2+(12,48-12,53)^2+(12,67-12,53)^2+(12,56-12,53)^2+(12,43-12,53)^2}{5-1}} = 0,09$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,09}{12,53}\right) = 98\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(122,80-122,80)^2+(121,97-122,80)^2+(124,28-122,80)^2+(123,15-122,80)^2+(121,84-122,80)^2}{5-1}} = 0,99$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,99}{122,80}\right) = 98\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{12,93+12,89+12,76+12,89+12,75}{5} = 12,84 \text{ Kg}$$

$$= \frac{126,71+126,35+125,03+126,30+125,26}{5} = 125,95 \text{ N}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(12,93-12,84)^2+(12,89-12,84)^2+(12,76-12,84)^2+(12,89-12,84)^2+(12,75-12,84)^2}{5-1}} = 0,08$$

$$- \text{ Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,08}{12,84}\right) = 98\%$$

$$- \text{ SD (p.Kiri) satuan Newton} = \sqrt{\frac{(126,71-125,95)^2 + (126,35-125,95)^2 + (125,03-125,95)^2 + (126,30-125,95)^2 + (125,26-125,95)^2}{5-1}}$$

$$= 0,73$$

$$- \text{ Presisi (p.Kiri) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,73}{125,95}\right)$$

$$= 98\%$$

2. Pengukuran Rata-Rata dan Tingkat Presisi dari Hasil Pengujian pada Dewasa Usia 30-50 Tahun dan Lansia Usia 55-70 Tahun

a. Pak Kirno Umur 55 Tahun

$$- \bar{X} \text{ P.Kanan} = \frac{5,50+5,48+5,36+5,43+5,58}{5} = 5,47 \text{ Kg}$$

$$= \frac{54,00+53,70+52,53+53,20+54,58}{5} = 53,20 \text{ N}$$

$$- \text{ SD (p.Kanan) satuan Kg} = \sqrt{\frac{(5,50-5,47)^2 + (5,48-5,47)^2 + (5,36-5,47)^2 + (5,43-5,47)^2 + (5,58-5,47)^2}{5-1}} = 0,08$$

$$- \text{ Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,08}{5,47}\right) = 96\%$$

$$- \text{ SD (p.Kanan) satuan Newton} = \sqrt{\frac{(54,00-53,20)^2 + (53,70-53,20)^2 + (52,53-53,20)^2 + (53,20-53,20)^2 + (54,58-53,20)^2}{5-1}}$$

$$= 0,90$$

$$- \text{ Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,90}{53,20}\right) = 95\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{6,72+6,65+6,82+6,70+6,69}{5} = 6,72 \text{ Kg}$$

$$= \frac{65,85+65,17+66,84+65,67+65,50}{5} = 65,80 \text{ N}$$

$$- \text{ SD (p.Kiri) satuan Kg} = \sqrt{\frac{(6,72-6,72)^2 + (6,65-6,72)^2 + (6,82-6,72)^2 + (6,70-6,72)^2 + (6,69-6,72)^2}{5-1}}$$

$$= 0,06$$

$$- \text{ Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,06}{6,72}\right) = 97\%$$

$$\begin{aligned}
 - \text{ SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(65,85-65,80)^2+(65,17-65,80)^2+}{(66,84-65,80)^2+(65,67-65,80)^2+} \\
 &\quad \frac{(65,50-65,80)^2}{5-1}} \\
 &= 0,6
 \end{aligned}$$

$$\begin{aligned}
 - \text{ Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,6}{65,80}\right) \\
 &= 97\%
 \end{aligned}$$

b. Ibu Surani Umur 52 Tahun

$$\begin{aligned}
 - \bar{X} \text{ P.Kanan} &= \frac{4,28+4,33+4,30+4,33+4,27}{5} = 4,30 \text{ Kg} \\
 &= \frac{41,90+42,34+42,00+42,38+41,86}{5} = 42,10 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 - \text{ SD (p.Kanan) satuan Kg} &= \sqrt{\frac{(4,28-4,30)^2+(4,33-4,30)^2+}{(4,30-4,30)^2+(4,33-4,30)^2+} \\
 &\quad \frac{(4,27-4,30)^2}{5-1}} = 0,02
 \end{aligned}$$

$$\begin{aligned}
 - \text{ Presisi (p.Kanan) Satuan Kg} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,02}{4,30}\right) = \\
 &98\%
 \end{aligned}$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(41,90-42,10)^2+(42,34-42,10)^2+(42,00-42,10)^2+(42,38-42,10)^2+(41,86-42,10)^2}{5-1}}$$

$$= 0,24$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,24}{42,10}\right)$$

$$= 98\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{5,45+5,64+5,50+5,53+5,50}{5} = 5,52 \text{ Kg}$$

$$= \frac{53,41+55,10+54,04+54,27+53,90}{5} = 54,14 \text{ N}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(5,45-5,52)^2+(5,64-5,52)^2+(5,50-5,52)^2+(5,53-5,52)^2+(5,50-5,52)^2}{5-1}} = 0,07$$

$$- \text{Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,07}{5,52}\right) = 96\%$$

$$- \text{SD (p.Kiri) satuan Newton} = \sqrt{\frac{(53,41-54,14)^2+(55,10-54,14)^2+(54,04-54,14)^2+(54,27-54,14)^2+(53,90-54,14)^2}{5-1}}$$

$$= 0,6$$

$$- \text{Presisi (p.Kiri) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,6}{54,14}\right)$$

$$= 97\%$$

c. Ibu Hati Sutrisno Umur 70 Tahun

$$\begin{aligned}
 - \bar{X} \text{ P.Kanan} &= \frac{1,74+1,75+1,80+1,82+1,72}{5} = 1,76 \text{ Kg} \\
 &= \frac{17,23+17,15+17,64+17,73+17,02}{5} = 17,35 \text{ N}
 \end{aligned}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(1,74-1,76)^2+(1,75-1,76)^2+(1,80-1,76)^2+(1,82-1,76)^2+(1,72-1,76)^2}{5-1}} = 0,04$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,04}{1,76}\right) = 94\%$$

$$\begin{aligned}
 - \text{SD (p.Kanan) satuan Newton} &= \sqrt{\frac{(17,23-17,35)^2+(17,15-17,35)^2+(17,64-17,35)^2+(17,73-17,35)^2+(17,02-17,35)^2}{5-1}} \\
 &= 0,3
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kanan) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,3}{17,35}\right) \\
 &= 95\%
 \end{aligned}$$

$$- \bar{X} \text{ P.Kiri} = \frac{2,34+2,28+2,17+2,31+2,24}{5} = 2,27 \text{ Kg}$$

5

$$= \frac{23,00+22,35+21,56+22,59+21,92}{5} = 22,28 \text{ N}$$

$$\begin{aligned} \text{- SD (p.Kiri) satuan Kg} &= \sqrt{\frac{(2,34-2,27)^2+(2,28-2,27)^2+(2,17-2,27)^2+(2,31-2,27)^2+(2,24-2,27)^2}{5-1}} \\ &= 0,08 \\ \text{- Presisi (p.Kiri) Satuan Kg} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,08}{2,27}\right) = 90\% \end{aligned}$$

$$\begin{aligned} \text{- SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(23,00-22,28)^2+(22,35-22,28)^2+(21,56-22,28)^2+(22,59-22,28)^2+(21,92-22,28)^2}{5-1}} \\ &= 0,5 \\ \text{- Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,5}{22,28}\right) \\ &= 93\% \end{aligned}$$

d. Pak Suparyono Umur 61 Tahun

$$\begin{aligned} \text{- } \bar{X} \text{ P.Kanan} &= \frac{3,79+3,87+3,80+3,68+3,80}{5} = 3,78 \text{ Kg} \\ &= \frac{37,12+37,96+37,20+37,39+37,34}{5} = 37,51 \text{ N} \end{aligned}$$



$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(3,79-3,78)^2 + (3,87-3,78)^2 + (3,80-3,78)^2 + (3,68-3,78)^2 + (3,80-3,78)^2}{5-1}} = 0,03$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,03}{3,78}\right) = 98\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(37,12-37,51)^2 + (37,96-37,51)^2 + (37,20-37,51)^2 + (37,39-37,51)^2 + (37,34-37,51)^2}{5-1}} = 0,25$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,25}{37,51}\right) = 98\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{3,81+3,70+3,75+3,88+3,78}{5} = 3,78 \text{ Kg}$$

$$= \frac{37,40+37,36+37,85+38,02+37,04}{5} = 37,53 \text{ N}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(3,81-3,78)^2 + (3,70-3,78)^2 + (3,75-3,78)^2 + (3,88-3,78)^2 + (3,78-3,78)^2}{5-1}} = 0,03$$

$$- \text{ Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,03}{3,78}\right) = 98\%$$

$$- \text{ SD (p.Kiri) satuan Newton} = \sqrt{\frac{(37,40-37,53)^2 + (37,36-37,53)^2 + (37,85-37,53)^2 + (38,02-37,53)^2 + (37,04-37,53)^2}{5-1}}$$

$$= 0,32$$

$$- \text{ Presisi (p.Kiri) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,32}{37,53}\right)$$

$$= 98\%$$

e. Ibu Tri Handayani Umur 50 Tahun

$$- \bar{X} \text{ P.Kanan} = \frac{15,98+15,84+15,96+15,86+15,96}{5} = 15,92 \text{ Kg}$$

$$= \frac{156,50+155,40+156,32+155,48+156,08}{5} = 155,95 \text{ N}$$

$$- \text{ SD (p.Kanan) satuan Kg} = \sqrt{\frac{(15,98-15,92)^2 + (15,84-15,92)^2 + (15,96-15,92)^2 + (15,86-15,92)^2 + (15,96-15,92)^2}{5-1}} = 0,06$$

$$- \text{ Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,06}{15,92}\right) = 99\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(156,50-155,95)^2+(155,40-155,95)^2+(156,32-155,95)^2+(155,48-155,95)^2+(156,08-155,95)^2}{5-1}}$$

$$= 0,49$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,49}{155,95}\right)$$

$$= 99\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{14,50+14,56+14,45+14,58+14,50}{5} = 14,52 \text{ Kg}$$

$$= \frac{142,10+142,78+141,61+142,88+142,25}{5} = 142,32 \text{ N}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(14,50-14,52)^2+(14,56-14,52)^2+(14,45-14,52)^2+(14,58-14,52)^2+(14,50-14,52)^2}{5-1}}$$

$$= 0,05$$

$$- \text{Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,05}{14,52}\right) = 99\%$$

$$- \text{SD (p.Kiri) satuan Newton} = \sqrt{\frac{(142,10-142,32)^2+(142,78-142,32)^2+(141,61-142,32)^2+(142,88-142,32)^2+(142,25-142,32)^2}{5-1}}$$

$$= 0,52$$

$$\begin{aligned}
 - \text{ Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,52}{142,32}\right) \\
 &= 99\%
 \end{aligned}$$

3. Pengukuran Rata-Rata dan Tingkat Presisi dari Hasil Pengujian pada Remaja Usia 17-25 Tahun

a. Ummu Umur 21 Tahun

$$\begin{aligned}
 - \bar{X} \text{ P.Kanan} &= \frac{17,52+17,47+17,59+17,65+17,58}{5} = 17,56 \text{ Kg} \\
 &= \frac{171,75+171,26+172,32+173,00+172,24}{5} = 172,11 \text{ N}
 \end{aligned}$$

$$- \text{ SD (p.Kanan) satuan Kg} = \sqrt{\frac{(17,52-17,56)^2 + (17,47-17,56)^2 + (17,59-17,56)^2 + (17,65-17,56)^2 + (17,58-17,56)^2}{5-1}} = 0,07$$

$$- \text{ Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,07}{17,56}\right) = 99\%$$

$$\begin{aligned}
 - \text{ SD (p.Kanan) satuan Newton} &= \sqrt{\frac{(171,75-172,11)^2 + (171,26-172,11)^2 + (172,32-172,11)^2 + (173,00-172,11)^2 + (172,24-172,11)^2}{5-1}} \\
 &= 0,65
 \end{aligned}$$

$$\begin{aligned}
 - \text{ Presisi (p.Kanan) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,65}{172,11}\right) \\
 &= 99\%
 \end{aligned}$$

$$\begin{aligned}
 - \bar{X} \text{ P.Kiri} &= \frac{16,76+16,80+16,85+16,68+16,80}{5} = 16,78 \text{ Kg} \\
 &= \frac{164,28+164,67+165,13+163,89+164,46}{6} = 164,49 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 - \text{SD (p.Kiri) satuan Kg} &= \sqrt{\frac{(16,76-16,78)^2+(16,80-16,78)^2+(16,85-16,78)^2+(16,68-16,78)^2+(16,80-16,78)^2}{5-1}} \\
 &= 0,06
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kiri) Satuan Kg} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,06}{16,78}\right) = 99\%
 \end{aligned}$$

$$\begin{aligned}
 - \text{SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(164,28-164,49)^2+(164,67-164,49)^2+(165,13-164,49)^2+(163,89-164,49)^2+(164,46-164,49)^2}{5-1}} \\
 &= 0,46
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,46}{164,49}\right) \\
 &= 99\%
 \end{aligned}$$

b. Okta Umur 21 Tahun

$$\begin{aligned}
 - \bar{X} \text{ P.Kanan} &= \frac{17,12+17,26+17,30+17,29+17,14}{5} = 17,22 \text{ Kg} \\
 &= \frac{167,77+169,01+169,23+169,44+167,97}{5} = 168,68 \text{ N}
 \end{aligned}$$

$$- \text{SD (p.Kanan) satuan Kg} = \sqrt{\frac{(17,12-17,22)^2+(17,26-17,22)^2+(17,30-17,22)^2+(17,29-17,22)^2+(17,14-17,22)^2}{5-1}} = 0,08$$

$$- \text{Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,08}{17,22}\right) = 99\%$$

$$- \text{SD (p.Kanan) satuan Newton} = \sqrt{\frac{(167,77-168,68)^2+(169,01-168,68)^2+(169,23-168,68)^2+(169,44-168,68)^2+(167,97-168,68)^2}{5-1}} = 0,76$$

$$- \text{Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,76}{168,68}\right) = 99\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{17,93+17,87+17,77+17,90+17,85}{5} = 17,86 \text{ Kg}$$

$$= \frac{175,71+175,12+174,36+175,52+174,93}{5} = 175,13 \text{ N}$$

$$- \text{SD (p.Kiri) satuan Kg} = \sqrt{\frac{(17,93-17,86)^2+(17,87-17,86)^2+(17,77-17,86)^2+(17,90-17,86)^2+(17,85-17,86)^2}{5-1}} = 0,06$$

$$- \text{ Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,06}{17,86}\right) = 99\%$$

$$- \text{ SD (p.Kiri) satuan Newton} = \sqrt{\frac{(175,71-175,13)^2 + (175,12-175,13)^2 + (174,36-175,13)^2 + (175,52-175,13)^2 + (174,93-175,13)^2}{5-1}}$$

$$= 0,53$$

$$- \text{ Presisi (p.Kiri) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,53}{175,13}\right)$$

$$= 99\%$$

c. Gusti Arya Umur 21 Tahun

$$- \bar{X} \text{ P.Kanan} = \frac{13,68+13,80+13,79+13,70+13,79}{5} = 13,75 \text{ Kg}$$

$$= \frac{134,30+135,15+134,89+134,62+135,03}{5} = 134,80 \text{ N}$$

$$- \text{ SD (p.Kanan) satuan Kg} = \sqrt{\frac{(13,68-13,75)^2 + (13,80-13,75)^2 + (13,79-13,75)^2 + (13,70-13,75)^2 + (13,79-13,75)^2}{5-1}} = 0,05$$

$$- \text{ Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,05}{13,75}\right) = 99\%$$

$$- \text{ SD (p.Kanan) satuan Newton} = \sqrt{\frac{(134,30-134,80)^2 + (135,15-134,80)^2 + (134,89-134,80)^2 + (134,62-134,80)^2 + (135,03-134,80)^2}{5-1}} = 0,38$$

$$- \text{ Presisi (p.Kanan) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,38}{134,80}\right) = 99\%$$

$$- \bar{X} \text{ P.Kiri} = \frac{13,52+13,46+13,59+13,40+13,59}{5} = 13,51 \text{ Kg}$$

$$= \frac{132,56+131,90+133,06+131,46+133,10}{5} = 132,42 \text{ N}$$

$$- \text{ SD (p.Kiri) satuan Kg} = \sqrt{\frac{(13,52-13,51)^2 + (13,46-13,51)^2 + (13,59-13,51)^2 + (13,40-13,51)^2 + (13,59-13,51)^2}{5-1}}$$



$$= 0,08$$

$$- \text{ Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,08}{13,51}\right) = 98\%$$

$$- \text{ SD (p.Kiri) satuan Newton} = \sqrt{\frac{(132,56-132,42)^2 + (131,90-132,42)^2 + (133,06-132,42)^2 + (131,46-132,42)^2 + (133,10-132,42)^2}{5-1}}$$

$$= 0,73$$

$$- \text{ Presisi (p.Kiri) Satuan Newton} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,73}{132,42}\right)$$

$$= 98\%$$

d. Afriza Umur 21 Tahun

$$- \bar{X} \text{ P.Kanan} = \frac{18,78+18,98+18,77+18,88+18,96}{5} = 18,87 \text{ Kg}$$

$$= \frac{184,54+186,00+184,36+185,14+185,47}{5} = 185,10 \text{ N}$$

$$- \text{ SD (p.Kanan) satuan Kg} = \sqrt{\frac{(18,78-18,87)^2 + (18,98-18,87)^2 + (18,77-18,87)^2 + (18,88-18,87)^2 + (18,96-18,87)^2}{5-1}} = 0,09$$

$$- \text{ Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,09}{18,87}\right) = 98\%$$

$$\begin{aligned}
 - \text{ SD (p.Kanan) satuan Newton} &= \sqrt{\frac{(184,54-185,10)^2+(186,00-185,10)^2+}{(184,36-185,10)^2+(185,14-185,10)^2+} \\
 &\quad \frac{(185,47-185,10)^2}{5-1}} \\
 &= 0,67
 \end{aligned}$$

$$\begin{aligned}
 - \text{ Presisi (p.Kanan) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,67}{185,10}\right) \\
 &= 98\%
 \end{aligned}$$

$$\begin{aligned}
 - \bar{X} \text{ P.Kiri} &= \frac{17,33+17,47+17,42+17,30+17,44}{5} = 17,39 \text{ Kg} \\
 &= \frac{169,74+171,00+170,71+169,71+170,82}{5} = 169,80 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 - \text{ SD (p.Kiri) satuan Kg} &= \sqrt{\frac{(17,33-17,39)^2+(17,47-17,39)^2+}{(17,42-17,39)^2+(17,30-17,39)^2+(17,44-17,39)^2} \\
 &\quad \frac{}{5-1}} \\
 &= 0,07
 \end{aligned}$$

$$- \text{ Presisi (p.Kiri) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,07}{17,39}\right) = 98\%$$

$$\begin{aligned}
 - \text{ SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(169,74-169,80)^2+(171,00-169,80)^2+}{(170,71-169,80)^2+(169,71-169,80)^2+} \\
 &\quad \frac{(170,82-169,80)^2}{5-1}}
 \end{aligned}$$

$$= 0,9$$

$$\begin{aligned} - \text{ Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,9}{169,80}\right) \\ &= 98\% \end{aligned}$$

e. Nabilla Sitya Putri Umur 20 Tahun

$$\begin{aligned} - \bar{X} \text{ P.Kanan} &= \frac{17,46+17,57+17,45+17,55+17,44}{5} = 17,50 \text{ Kg} \\ &= \frac{171,08+172,16+171,00+171,93+171,00}{5} = 171,43 \text{ N} \end{aligned}$$

$$- \text{ SD (p.Kanan) satuan Kg} = \sqrt{\frac{(17,46-17,50)^2 + (17,57-17,50)^2 + (17,45-17,50)^2 + (17,55-17,50)^2 + (17,44-17,50)^2}{5-1}} = 0,06$$

$$- \text{ Presisi (p.Kanan) Satuan Kg} = 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,06}{17,50}\right) = 99\%$$

$$\begin{aligned} - \text{ SD (p.Kanan) satuan Newton} &= \sqrt{\frac{(171,08-171,43)^2 + (172,16-171,43)^2 + (171,00-171,43)^2 + (171,93-171,43)^2 + (171,00-171,43)^2}{5-1}} \\ &= 0,56 \end{aligned}$$

$$\begin{aligned} - \text{ Presisi (p.Kanan) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,56}{171,43}\right) \\ &= 99\% \end{aligned}$$

$$\begin{aligned}
 - \bar{X} \text{ P.Kiri} &= \frac{16,85+16,74+16,94+16,84+16,79}{5} = 16,83 \text{ Kg} \\
 &= \frac{165,23+164,25+165,57+165,02+164,54}{5} = 164,92 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 - \text{SD (p.Kiri) satuan Kg} &= \sqrt{\frac{(16,85-16,83)^2+(16,74-16,83)^2+(16,94-16,83)^2+(16,84-16,83)^2+(16,79-16,83)^2}{5-1}} \\
 &= 0,07
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kiri) Satuan Kg} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,07}{16,83}\right) = 99\%
 \end{aligned}$$

$$\begin{aligned}
 - \text{SD (p.Kiri) satuan Newton} &= \sqrt{\frac{(165,23-164,92)^2+(164,25-164,92)^2+(165,57-164,92)^2+(165,02-164,92)^2+(164,54-164,92)^2}{5-1}} \\
 &= 0,52
 \end{aligned}$$

$$\begin{aligned}
 - \text{Presisi (p.Kiri) Satuan Newton} &= 100\% \left(1 - \frac{3SD}{\bar{X}}\right) = 100\% \left(1 - \frac{3 \times 0,52}{164,92}\right) \\
 &= 99\%
 \end{aligned}$$