LAMPIRAN

A. Perhitungan Teknik Analisis Data

1. Perhitungan rata-rata

Rumus rata-rata = $\left(\overline{X}\right) = \sum \frac{Xn}{n}$

Diketahui data sebagai berikut :

Pengukuran pada Ventilator (%)	Pengukuran Alat %			
	1	2	3	4
21	20,8	21	21	21,2
30	29,6	29,4	29,5	29,5
40	40,5	40,6	40,6	40,6
50	49,7	49,8	49,8	49,8
60	59,8	60,2	60,2	60,2
70	69,7	69,8	69,8	69,8
80	79,8	80	80	80
90	89,8	90,1	90,2	90,2

Rata-rata hasil pengukuran :

a) Kadar oksigen = 21%

$$\overline{X} = \frac{20,8+21+21+21,2}{4} = \frac{84}{4} = 21$$

b) Kadar oksigen = 30%

$$\overline{X} = \frac{29,6 + 29,4 + 29,5 + 29,5}{4} = \frac{118}{4} = 29,5$$

c) Kadar oksigen = 40%

$$\overline{X} = \frac{40,5 + 40,6 + 40,6 + 40,6}{4} = \frac{162,3}{4} = 40,6$$

d) Kadar oksigen = 50%

$$\overline{X} = \frac{49,7 + 49,8 + 49,8 + 49,8}{4} = \frac{199,1}{4} = 49,8$$

e) Kadar oksigen = 60%

$$\overline{X} = \frac{59,8 + 60,2 + 60,2 + 60,2}{4} = \frac{240,4}{4} = 60,1$$

f) Kadar oksigen = 70%

$$\overline{X} = \frac{69,7 + 69,8 + 69,8 + 69,8}{4} = \frac{279,1}{4} = 69,8$$

g) Kadar oksigen = 80%

$$\overline{X} = \frac{79,8 + 80 + 80 + 80}{4} = \frac{319,8}{4} = 80$$

h) Kadar oksigen = 90%

$$\overline{X} = \frac{89,8 + 90,1 + 90,2 + 90,2}{4} = \frac{360,3}{4} = 90,1$$

2. Perhitungan simpangan (error)

Rumus simpangan = $Simpangan = Xn - \overline{X}$

Diketahui data sebagai berikut :

Pengukuran pada Ventilator (%)	**Rata-rata Pengukuran Alat**
21	21
30	29,5
40	40,6
50	49,8
60	60,1
70	69,8
80	80
90	90,1

a) Kadar oksigen 21%

$Simpangan = 21 - 21 = 0$

b) Kadar oksigen 30%

$Simpangan = 30 - 29,5 = 0,5$

c) Kadar oksigen 40%

$Simpangan = 40 - 40,6 = -0,6$

d) Kadar oksigen 50%

$Simpangan = 50 - 49,8 = 0,2$

e) Kadar oksigen 60%

$Simpangan = 60 - 60,1 = -0,1$

f) Kadar oksigen 70%

$Simpangan = 70 - 69{,}8 = 0{,}2$

g) Kadar oksigen 80%

$Simpangan = 80 - 80 = 0$

h) Kadar oksigen 90%

$Simpangan = 90 - 90{,}1 = -0{,}1$

3. Perhitungan error (%)

Rumus error (%) = $\frac{Simpangan}{Xn} x100\%$

Diketahui data sebagai berikut:

Pengukuran pada Ventilator (%)	**Rata-rata Pengukuran Alat**	**Simpangan**
21	21	0
30	29,5	0,5
40	40,6	-0,6
50	49,8	0,2
60	60,1	-0,1
70	69,8	0,2
80	80	0
90	90,1	-0,1

a) Kadar oksigen 21%

Error (%) = $\frac{0}{21} x100\% = 0{,}00\ \%$

b) Kadar oksigen 30%

Error (%) = $\frac{0{,}5}{30} x100\% = 0{,}017\%$

c) Kadar oksigen 40%

Error (%) = $\frac{0{,}6}{40} x100\% = 0{,}014\%$

d) Kadar oksigen 50%

Error (%) = $\frac{0{,}2}{50} x100\% = 0{,}004\%$

e) Kadar oksigen 60%

Error (%) = $\frac{0{,}1}{60} x100\% = 0{,}002\%$

f) Kadar oksigen 70%

Error (%) = $\frac{0,2}{70} x100\%$ = 0,003%

g) Kadar oksigen 80%

Error (%) = $\frac{0}{80} x100\%$ = 0,001%

h) Kadar oksigen 90%

Error (%) = $\frac{0,1}{90} x100\%$ = 0,001%

4. Perhitungan standar deviasi

Rumus Standar Deviasi = $\sqrt{\frac{(x1-\overline{X})^2+(x2-\overline{X})^2+(x3-\overline{X})^2}{n-1}}$

Diketahui data sebagai berikut:

Pengukuran pada Ventilator (%)	Pengukuran Alat %				Rata-rata Pengukuran Alat
	1	2	3	4	
21	20,8	21	21	21,2	21,0
30	29,6	29,4	29,5	29,5	29,5
40	40,5	40,6	40,6	40,6	40,6
50	49,7	49,8	49,8	49,8	49,8
60	59,8	60,2	60,2	60,2	60,1
70	69,7	69,8	69,8	69,8	69,8
80	79,8	80	80	80	80,0
90	89,8	90,1	90,2	90,2	90,1

a) Kadar oksigen 21%

SD = $\sqrt{\frac{(20,8-21,0)^2+(21-21,0)^2+(21-21,0)^2+(21,2-21,0)^2}{4-1}}$

= 0,16

b) Kadar oksigen 30%

SD = $\sqrt{\frac{(29,6-29,5)^2+(29,4-29,5)^2+(29,5-29,5)^2+(29,5-29,5)^2}{4-1}}$

= 0,08

c) Kadar oksigen 40%

SD = $\sqrt{\frac{(40,5-40,6)^2+(40,6-40,6)^2+(40,6-40,6)^2+(40,6-40,6)^2}{4-1}}$

= 40,6

d) Kadar oksigen 50%

$$SD = \sqrt{\frac{(49,7-49,8)^2+(49,8-49,8)^2+(49,8-49,8)^2+(49,8-49,8)^2}{4-1}}$$

= 0,05

e) Kadar oksigen 60%

$$SD = \sqrt{\frac{(59,8-60,1)^2+(60,2-60,1)^2+(60,2-60,1)^2+(60,2-60,1)^2}{4-1}}$$

= 0,2

f) Kadar oksigen 70%

$$SD = \sqrt{\frac{(69,7-69,8)^2+(69,8-69,8)^2+(69,8-69,8)^2+(69,8-69,8)^2}{4-1}}$$

= 0,05

g) Kadar oksigen 80%

$$SD = \sqrt{\frac{(79,8-80)^2+(80-80)^2+(80-80)^2+(80-80)^2}{4-1}}$$

= 0,1

h) Kadar oksigen 90%

$$SD = \sqrt{\frac{(89,8-90,1)^2+(90,1-90,1)^2+(90,2-90,1)^2+(90,2-90,1)^2}{4-1}}$$

= 90,1

5. Perhitungan ketidakpastian (Ua)

Rumus Ketidakpastian (Ua) $= \frac{SD}{\sqrt{n}}$

Diketahui data berikut ini:

Kadar Oksigen (%)	Simpangan	Error (%)	Standar Devisiasi	Ketidakpastian (Ua)
21	0,00	0,00	0,16	0,08
30	0,50	0,02	0,08	0,04
40	-0,57	0,01	0,05	0,03
50	0,22	0,00	0,05	0,02
60	-0,10	0,00	0,20	0,10
70	0,22	0,00	0,05	0,02
80	0,05	0,00	0,10	0,05
90	-0,07	0,00	0,19	0,09

a) Kadar oksigen 21%

(Ua) = $\frac{0,16}{\sqrt{4}} = \frac{0,16}{2} = 0,08$

b) Kadar oksigen 30%

(Ua) = $\frac{0,08}{\sqrt{4}} = \frac{0,08}{2} = 0,04$

c) Kadar oksigen 40%

(Ua) = $\frac{0,05}{\sqrt{4}} = \frac{0,05}{2} = 0,03$

d) Kadar oksigen 50%o

(Ua) = $\frac{0,05}{\sqrt{4}} = \frac{0,05}{2} = 0,02$

e) Kadar oksigen 60%

(Ua) = $\frac{0,2}{\sqrt{4}} = \frac{0,2}{2} = 0,1$

f) Kadar oksigen 70%

(Ua) = $\frac{0,05}{\sqrt{4}} = \frac{0,05}{2} = 0,02$

g) Kadar oksigen 80%

(Ua) = $\frac{0,1}{\sqrt{4}} = \frac{0,1}{2} = 0,05$

h) Kadar oksigen 90%

(Ua) = $\frac{0,19}{\sqrt{4}} = \frac{0,19}{2} = 0,09$

B. Perhitungan rumus rangkaian PSA

Diketahui data sebagai berikut:

Penguatan dilakukan sebanyak 4 kali penguatan, digunakan IC LM358 dengan Resistor Feedback (Rf) = 1kΩ, dan resistor menuju ground (Rg) = 1kΩ. Tabel dibawah ini adalah data *output* sensor tanpa dilakukan penguatan.

Pengukuran pada Ventilator (%)	Output Sensor (mV)
21	50,3
30	68,8
40	92,0
50	114,0
60	134,4
70	154,4
80	176,9
90	201,1

Rumus *Non-Inverting*:

Vout = $\left(1 + \frac{Rf}{Rin}\right) x\ Vin$

a) Kadar oksigen 21%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 50,3 mV = 100,6 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 100,6 mV = 201,2 mV

b) Kadar oksigen 30%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 68,8 mV = 137,6 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 137,6 mV = 275,2 mV

c) Kadar oksigen 40%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 92 mV = 184 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 184 mV = 368 mV

d) Kadar oksigen 50%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 114 mV = 228 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 228 mV = 456 mV

e) Kadar oksigen 60%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 134,4 mV = 268,8 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 268,8 mV = 537,6 mV

f) Kadar oksigen 70%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 154,4 mV = 308,8 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 308,8 mV = 617,6 mV

g) Kadar oksigen 80%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 176,9 mV = 353,8 mV

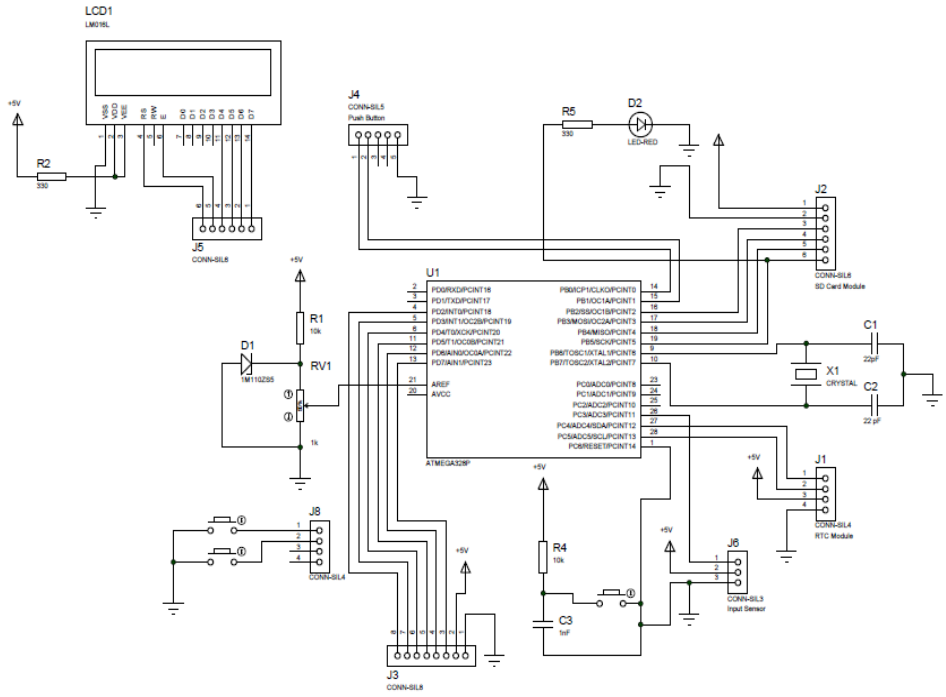
Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 353,8 mV = 707,6 mV

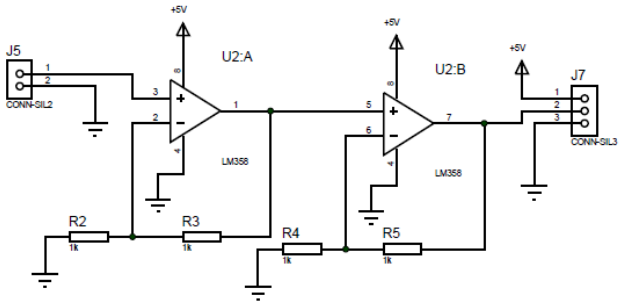
h) Kadar oksigen 90%

Penguatan 1 = $\left(1 + \frac{1k}{1k}\right) x$ 201,1 mV = 402,2 mV

Penguatan 2 = $\left(1 + \frac{1k}{1k}\right) x$ 402,2 mV = 804,4 mV

C. Rangkaian keseluruhan alat



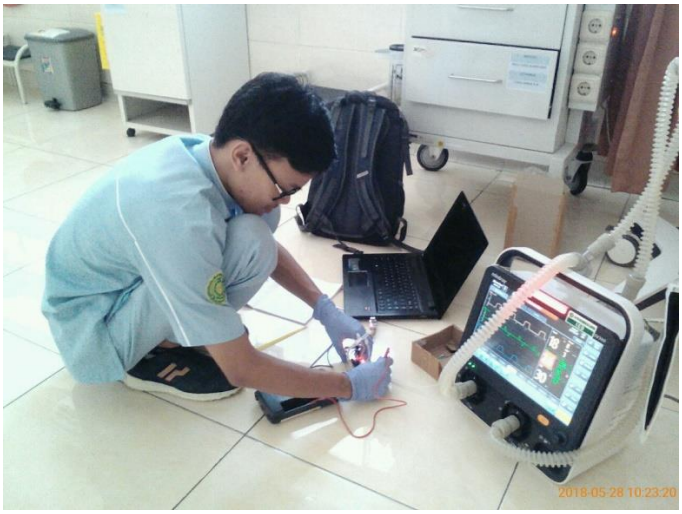


D. Listing program alat

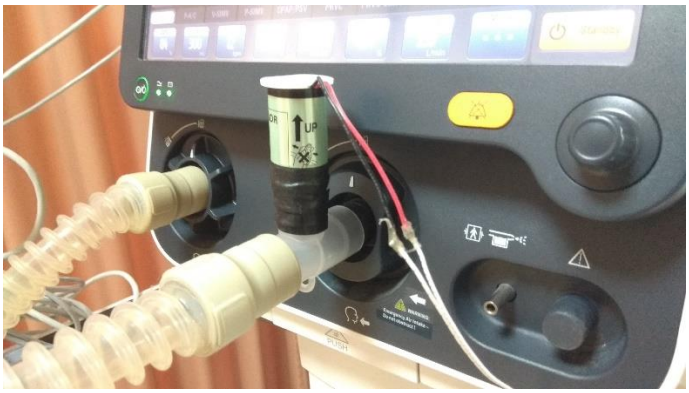
```
#define cs 10 #define adc A3
LiquidCrystal lcd(2, 3, 4, 7, 6, 5);
File myFile;
DS3231 rtc(SDA, SCL);
float vRef,nilaisensor1,nilaisensor2;
const int tombol1=0,tombol2=1;
int measure,save;
int a=0,b=0;
void setup() {
pinMode(tombol1, INPUT_PULLUP);
pinMode(tombol2, INPUT_PULLUP);
pinMode(cs, OUTPUT);
analogReference(EXTERNAL);
lcd.begin(16, 2);
Serial.begin(9600);
vRef = 2.507;
  if (!SD.begin(cs))
  {lcd.clear();
  lcd.print("SDC ERROR !");
  delay(1000);}
  else
  {lcd.clear();
  lcd.print("SDC OK !");
  delay(1000);}
rtc.begin();
  lcd.clear();
  lcd.setCursor(3,0);
  lcd.print("O2 ANALYZER");
  lcd.setCursor(3,3);
  lcd.print("20153010060");
```

```
void loop() {
measure=digitalRead(tombol1);
if (measure==LOW)
{a=1;
 lcd.clear();
 delay(100);}
if (a==1)
{lcd.setCursor(0,0);
 lcd.print("Kadar Oksigen %");
 lcd.setCursor(4,2);
 lcd.print(nilaisensor2, 1);
 float tampung,data;
 for(int a = 0; a<10; a++)
 {unsigned long buff=0;
  for (int i = 0; i<50; i++)
 {nilaisensor1 = analogRead(adc);
 buff+=nilaisensor1;}
 tampung = (float) buff/50;
 if(tampung>data){data=tampung;}}
 nilaisensor1 = (data*2.507/1023)*1000;// jadi volt
if (nilaisensor2 >= 0 && nilaisensor2 < 29.99 )
{nilaisensor2 = (0.1184*nilaisensor1)-2.4658;}
save=digitalRead(tombol2);
 if(save==LOW)
 {myFile = SD.open("O2ANLYZ.txt", FILE_WRITE);
 if (myFile)
 {myFile.print(rtc.getDOWStr());myFile.print(",");
myFile.print(rtc.getDateStr());myFile.print(",");
myFile.print(rtc.getTimeStr());myFile.print("  Kadar
Oksigen : ");
myFile.println(nilaisensor2);myFile.close(); }}
```

E. Dokumentasi



Pengukuran *Output* tegangan sensor



Pemasangan sensor oksigen pada alat pembanding

Pengukuran Nilai ADC pada mikrokontroler