LAMPIRAN

Listing Program

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(5, 6, 7, 8, 9, 10);
//RS.E,D4,D5,D6,D7

// TCS230 or TCS3200 pins wiring to Arduino
#define S0 A0
#define S1 A1
#define S2 A2
#define S3 A3
#define sensorOut 2
//tombol START
#define tombol 4
//sensor jarak
#define triger 1
#define echo   0
#define BAT A4

int blueFrequency=0;
int uw;

//jarak
int mydistance;
```

```
float rawV;
float batC;
//int batC//
//int graph;;

void setup()
{
  // Setting the outputs
  pinMode(S0, OUTPUT);
  pinMode(S1, OUTPUT);
  pinMode(S2, OUTPUT);
  pinMode(S3, OUTPUT);

  // Setting the sensorOut as an input
  pinMode(sensorOut, INPUT);
  pinMode(tombol, INPUT_PULLUP);

  pinMode(echo, INPUT_PULLUP);
  pinMode(triger, OUTPUT);

  // Setting frequency scaling to 20%
  digitalWrite(S0,HIGH);
  digitalWrite(S1,LOW);

  lcd.begin(16, 2);
```

```
lcd.clear();
lcd.setCursor(0,0);
lcd.print("RADIOMETER");
lcd.setCursor(0,1);
lcd.print("UKUR BLUE LIGHT");
delay(1000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("TIYAS SULISTIYA");
lcd.setCursor(0,1);
lcd.print("20153010096");
delay(800);
}

void loop()
{
   while(1)
   {
   lcd.clear();
   lcd.setCursor(0,0);
   lcd.print("MULAI PENGUKURAN");
   lcd.setCursor(0,1);
   lcd.print("TEKAN START ");
   if(digitalRead(tombol)==LOW)break;
```

```
delay (100);
}
lcd.clear();
delay(200);

while(1)
{
int jarak=read_ultra();

 rawV=analogRead(4);
 batC=(rawV*5)/1024;

  if(blueFrequency <= 3)
  {
  uw=1;
  }
    else if(blueFrequency ==3)
  {
  uw=1998*(blueFrequency)-3995;
  }
  else if(blueFrequency >= 3 && blueFrequency <= 4)
  {
  uw=-149*(blueFrequency)+2446;
  }
  else if(blueFrequency >= 4 && blueFrequency <= 5)
```

```
{
uw=-531*(blueFrequency)+3974;
}
 else if(blueFrequency >= 5 && blueFrequency <= 6)
{
uw=-19*(blueFrequency)+1414;
}
 else if(blueFrequency >= 6 && blueFrequency <= 7)
{
uw=-110*(blueFrequency)+1960;
}
else if(blueFrequency >=7 && blueFrequency<=10)
{
uw=-146*(blueFrequency)+2310;
}
else if (blueFrequency>=10&&blueFrequency<=13)
{
  uw=-56.667*(blueFrequency)+1416.7;
}
   else if (blueFrequency>=13&&blueFrequency<=15)
{
  uw=-50*(blueFrequency)+1320;
}
   else if (blueFrequency>=15&&blueFrequency<=17)
{
```

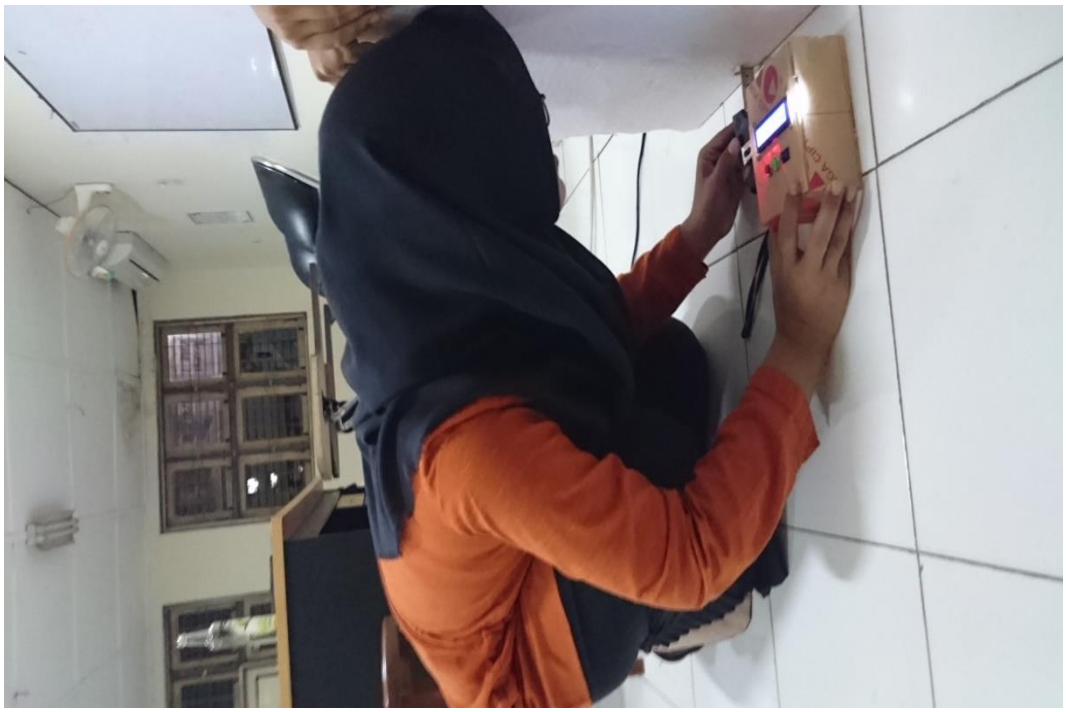
```
  uw=-25*(blueFrequency)+945;
}
   else if (blueFrequency>=17&&blueFrequency<=20)
{
  uw=-15.667*(blueFrequency)+786.33;
}
   else if (blueFrequency>=20&&blueFrequency<=23)
{
  uw=-19.333*(blueFrequency)+859.67;
}
   else if (blueFrequency>=23&&blueFrequency<=26)
{
  uw=-21*(blueFrequency)+898;
}
   else if (blueFrequency>=26&&blueFrequency<=30)
{
  uw=-12.75*(blueFrequency)+683.5;
}
   else if (blueFrequency>=30&&blueFrequency<35)
{
  uw=-5.2*(blueFrequency)+457;
}
   else if (blueFrequency>=35&&blueFrequency<=40)
{
  uw=-7.6*(blueFrequency)+541;
```

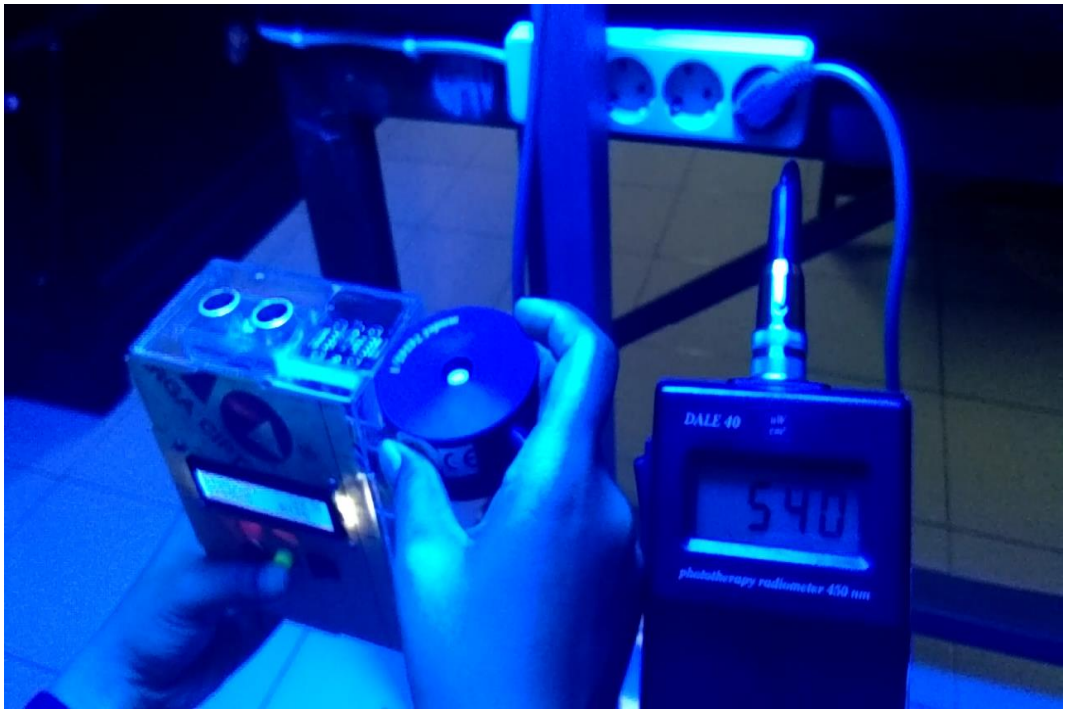
```
    }
      else if (blueFrequency>=45&&blueFrequency<=50)
    {
     uw=-4.4*(blueFrequency)+410;
    }
      else if (blueFrequency>=50&&blueFrequency<=55)
    {
     uw=-3.8*(blueFrequency)+380;
    }
      else if (blueFrequency>=55&&blueFrequency<=60)
    {
     uw=-3.2*(blueFrequency)+347;
    }
      else if (blueFrequency>=65&&blueFrequency<=75)
    {
     uw=-1.7*(blueFrequency)+252.5;
    }

    else // (>=75)
    {
     uw=0;
    }

lcd.clear();
lcd.setCursor(0,0);
```

```
  lcd.print("Jarak :");
  lcd.print(jarak);
  lcd.print("CM");
  lcd.setCursor(0,1);
  lcd.print("uW/cm2:");
  lcd.print(uw);
  //lcd.setCursor(10,1);
  //lcd.print("B:");
  //lcd.print(blueFrequency);
  lcd.setCursor(12,1);
  lcd.print(batC);
  lcd.setCursor(15,1);
  lcd.print("V");


  bacabiru_TCS3200();
    }}

float read_ultra()
{
  float mydistance;
// suara ultrasonik on
    digitalWrite(triger, HIGH);
    delayMicroseconds(10);
    // suara ultrasonik off
```

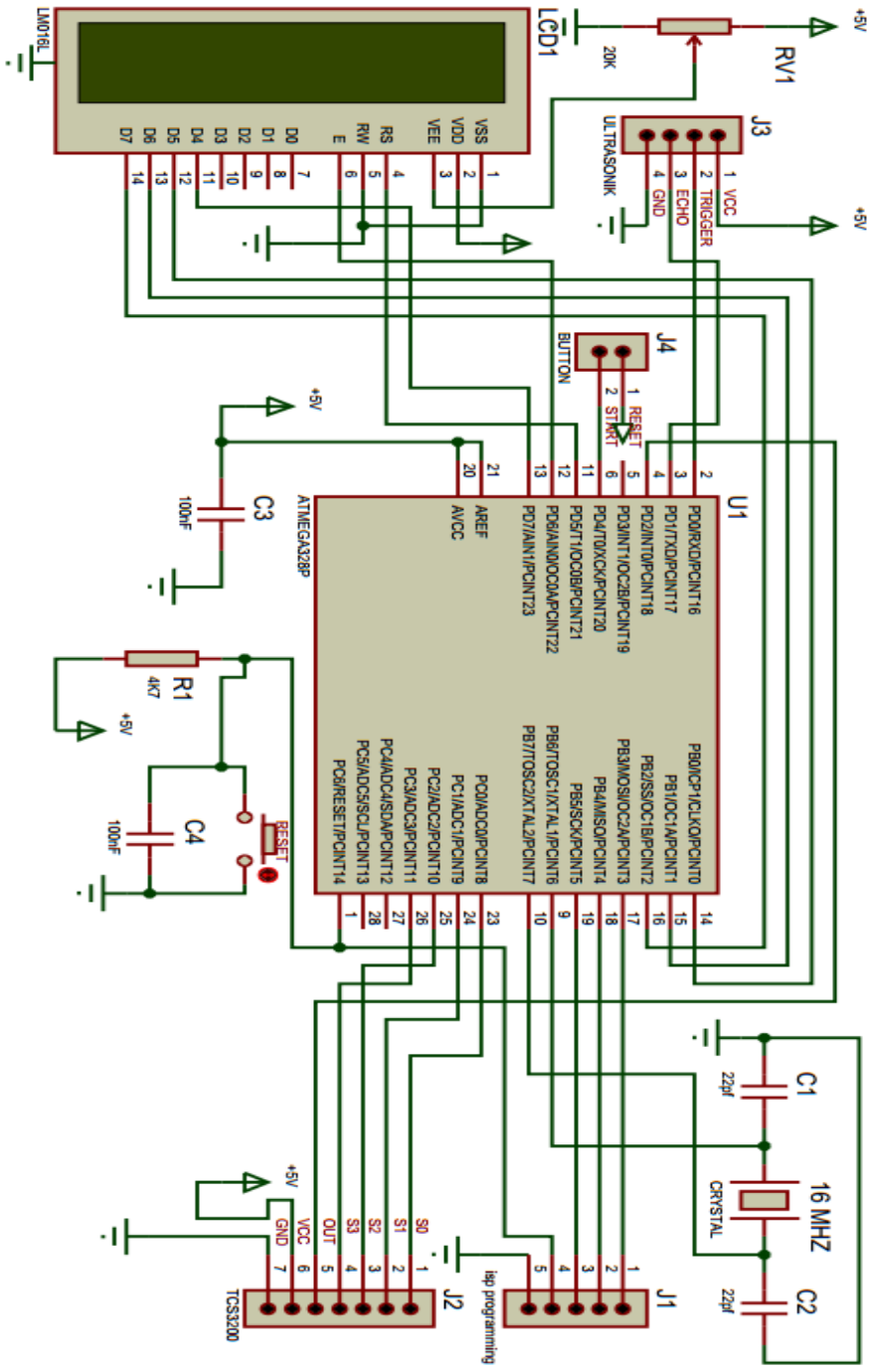
```
  digitalWrite(triger, LOW);
  // baca pulsa dan konvert ke cm
  mydistance=(float)pulseIn(echo,HIGH)/58;
  return mydistance;
}
 void bacabiru_TCS3200()
 {
 unsigned long buf=0;
  for(int i=0;i<800;i++)
  {
    digitalWrite(S2,LOW);
    digitalWrite(S3,HIGH);
    //delay(10);
    // Reading the output frequency
    blueFrequency= pulseIn(sensorOut, LOW);
    buf+=blueFrequency;
    //delay(100);
  }
  blueFrequency = buf/800;
 }
```

Foto Pengambilan Data




DALE 40
540
phototherapy radiometer 450 nm

Gambar Rangkaian Keseluruhan



Pehitungan

1. Analisis Hasil Perhitungan Pengukuran Jarak Terhadap Meteran

   a. Jarak 5 cm

      1). Rata-Rata Data Pengukuran Modul

      $$\bar{X} = \frac{\sum Xi}{n}$$

      $$\bar{X} = \frac{5 + 5 + 6 + 5 + 5 + 5}{6}$$

      $$\bar{X} = \frac{31}{6}$$

      $$\bar{X} = 5{,}16 \text{ cm}$$

      2). Error

      $$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

      $$\% \text{ Error} = \frac{5 - 5{,}16}{5} \times 100\%$$

      $$\% \text{ Error} = 3{,}3\ \%$$

   b. Jarak 10 cm

      1). Rata-Rata Data Pengukuran Modul

      $$\bar{X} = \frac{\sum Xi}{n}$$

      $$\bar{X} = \frac{10 + 10 + 10 + 10 + 10 + 10}{6}$$

      $$\bar{X} = \frac{60}{6}$$

      $$\bar{X} = 10 \text{ cm}$$

      2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{10 - 10}{10} \times 100\%$$

$$\% \text{ Error} = 0\ \%$$

c. Jarak 15 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{15 + 15 + 15 + 15 + 15 + 15}{6}$$

$$\bar{X} = \frac{90}{6}$$

$$\bar{X} = 15 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{15 - 15}{15} \times 100\%$$

$$\% \text{ Error} = 0\ \%$$

d. Jarak 20 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{20 + 20 + 20 + 20 + 21 + 20}{6}$$

$$\bar{X} = \frac{121}{6}$$

$$\bar{X} = 20{,}17 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{20 - 20{,}17}{20} \times 100\%$$

$$\% \text{ Error} = 0{,}8\ \%$$

e. Jarak 25 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{25 + 25 + 26 + 25 + 25 + 24}{6}$$

$$\bar{X} = \frac{149}{6}$$

$$\bar{X} = 24{,}83 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{25 - 24{,}83}{25} \times 100\%$$

$$\% \text{ Error} = -0{,}6\ \%$$

f. Jarak 30 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{30 + 29 + 30 + 30 + 30 + 30}{6}$$

$$\bar{X} = \frac{179}{6}$$

$$\bar{X} = 29{,}83 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{30 - 29{,}83}{30} \times 100\%$$

$$\% \text{ Error} = -0{,}5\ \%$$

g. Jarak 35 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{35 + 35 + 35 + 36 + 35 + 35}{6}$$

$$\bar{X} = \frac{211}{6}$$

$$\bar{X} = 35{,}17 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{35 - 35{,}17}{35} \times 100\%$$

$$\% \text{ Error} = 0\ \%$$

h. Jarak 30 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{40 + 40 + 40 + 40 + 40 + 40}{6}$$

$$\bar{X} = \frac{240}{6}$$

$$\bar{X} = 40 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{40 - 40}{40} \times 100\%$$

$$\% \text{ Error} = 0\ \%$$

i. Jarak 45 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{45 + 45 + 45 + 45 + 45 + 45}{6}$$

$$\bar{X} = \frac{270}{6}$$

$$\bar{X} = 45 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{45 - 45}{45} \times 100\%$$

$$\% \text{ Error} = 0\ \%$$

j. Jarak 50 cm

1). Rata-Rata Data Pengukuran Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{50 + 50 + 50 + 50 + 49 + 50}{6}$$

$$\bar{X} = \frac{299}{6}$$

$$\bar{X} = 49{,}83 \text{ cm}$$

2). Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{50 - 49{,}83}{50} \times 100\%$$

$$\% \text{ Error} = -0{,}3\ \%$$

2. Analisis Hasil Perhitungan Pengukuran Iradiasi *Blue Light* Pada Jarak 30 cm

   a. Rata-Rata Data Kalibrator

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{1145 + 1176 + 1286 + 1296 + 1304 + 1312}{6}$$

$$\bar{X} = \frac{7519}{6}$$

$$\bar{X} = 1253{,}16\ \mu W/cm^2$$

   b. Rata-Rata Data Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{1190 + 1190 + 1300 + 1300 + 1300 + 1319}{6}$$

$$\bar{X} = \frac{7599}{6}$$

$$\bar{X} = 1266{,}5\ \mu W/cm^2$$

   c. Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{1253.16 - 1266{,}5}{1253{,}16} \times 100\%$$

$$\% \text{ Error} = -1{,}06\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(X_i - \overline{X})^2}{n-1}}$$

$$SD = \sqrt{\frac{(1190 - 1266{,}5)^2 + (1190 - 1266{,}5)^2 + (1300 - 1266{,}5)^2 + (1300 - 1266{,}5)^2 + (1300 - 1266{,}5)^2 + (1319 - 1266{,}5)^2}{6-1}}$$

$$SD = \sqrt{\frac{17827{,}5}{5}}$$

$$SD = 59{,}71$$

e. Ketidakpastian (Ua)

$$U_a = \frac{SD}{\sqrt{n}}$$

$$U_a = \frac{59{,}71}{\sqrt{6}}$$

$$U_a = \frac{59{,}71}{2.4}$$

$$U_a = 24{,}87$$

3. Analisis Hasil Perhitungan Pengukuran Iradiasi *Blue Light* Pada Jarak 40 cm

a. Rata-Rata Data Kalibrator

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{902 + 884 + 833 + 821 + 806 + 820}{6}$$

$$\bar{X} = \frac{5066}{6}$$

$$\bar{X} = 844{,}33\ \mu W/cm^2$$

b. Rata-Rata Data Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{920 + 912 + 890 + 840 + 780 + 840}{6}$$

$$\bar{X} = \frac{5182}{6}$$

$$\bar{X} = 863{,}67\ \mu W/cm^2$$

c. Error

$$\% \text{ Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\% \text{ Error} = \frac{844{,}3 - 863{,}6}{844{,}3} \times 100\%$$

$$\% \text{ Error} = -2{,}29\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(X_i - \overline{X})^2}{n-1}}$$

$$SD = \sqrt{\frac{(920 - 863{,}67)^2 + (912 - 863{,}67)^2 + (890 - 863{,}67)^2 + (840 - 863{,}67)^2 + (780 - 863{,}67)^2 + (840 - 863{,}67)^2}{6-1}}$$

$$SD = \sqrt{\frac{2857{,}44}{5}}$$

$$SD = 53{,}4$$

e. Ketidakpastian (Ua)

$$U_a = \frac{SD}{\sqrt{n}}$$

$$U_a = \frac{53{,}4}{\sqrt{6}}$$

$$U_a = \frac{53{,}4}{2.4}$$

$$U_a = 53{,}4$$

4. Analisis Hasil Perhitungan Pengukuran Iradiasi *Blue Light* Pada Jarak 50 cm

a. Rata-Rata Data Kalibrator

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{624 + 654 + 656 + 676 + 671 + 664}{6}$$

$$\bar{X} = \frac{3945}{6}$$

$$\bar{X} = 657{,}5\ \mu W/cm^2$$

b. Rata-Rata Data Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{680 + 680 + 640 + 680 + 680 + 680}{6}$$

$$\bar{X} = \frac{4040}{6}$$

$$\bar{X} = 673{,}3\ \mu W/cm^2$$

c. Error

$$\%\ \text{Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\%\ \text{Error} = \frac{657{,}5 - 673{,}3}{657{,}5} \times 100\%$$

$$\%\ \text{Error} = -2{,}4\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum (X_i - \overline{X})^2}{n - 1}}$$

$$SD = \sqrt{\frac{(680-673{,}3)^2+(680-673{,}3)^2+(640-673{,}3)^2 \\ +(680-673{,}3)^2+(680-673{,}3)^2+(680-673{,}3)^2}{6-1}}$$

$$SD = \sqrt{\frac{291{,}05}{5}}$$

$$SD = 7{,}62$$

e. Ketidakpastian (Ua)

$$U_a = \frac{SD}{\sqrt{n}}$$

$$U_a = \frac{7{,}62}{\sqrt{6}}$$

$$U_a = \frac{7{,}62}{2.4}$$

$$U_a = 3{,}17$$

5. Analisis Hasil Perhitungan Pengukuran Iradiasi *Blue Light* Pada Jarak 46 cm dititik Kanan

a. Rata-Rata Data Kalibrator

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{528+526+521+528+528+526}{6}$$

$$\bar{X} = \frac{3157}{6}$$

$$\bar{X} = 526{,}16\ \mu W/cm^2$$

b. Rata-Rata Data Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{570 + 545 + 545 + 545 + 545 + 545}{6}$$

$$\bar{X} = \frac{3295}{6}$$

$$\bar{X} = 549{,}16\ \mu W/cm^2$$

c. Error

$$\%\ \text{Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\%\ \text{Error} = \frac{526{,}16 - 549{,}16}{526{,}16} \times 100\%$$

$$\%\ \text{Error} = -4{,}37\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(X_i - \overline{X})^2}{n-1}}$$

$$SD = \sqrt{\frac{(570 - 549{,}16)^2 + (545 - 549{,}16)^2 + (545 - 549{,}16)^2 + (545 - 549{,}16)^2 + (545 - 549{,}16)^2 + (545 - 549{,}16)^2}{6-1}}$$

$$SD = \sqrt{\frac{608{,}17}{5}}$$

$$SD = 11{,}02$$

e. Ketidakpastian (Ua)

$$U_a = \frac{SD}{\sqrt{n}}$$

$$U_a = \frac{11{,}02}{\sqrt{6}}$$

$$U_a = \frac{11{,}02}{2.4}$$

$$U_a = 4{,}59$$

6. Analisis Hasil Perhitungan Pengukuran Iradiasi *Blue Light* Pada Jarak 46 cm dititik Tengah

a. Rata-Rata Data Kalibrator

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{773 + 759 + 770 + 769 + 759 + 729}{6}$$

$$\bar{X} = \frac{4559}{6}$$

$$\bar{X} = 759{,}83\ \mu W/cm^2$$

b. Rata-Rata Data Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{735 + 795 + 793 + 793 + 793 + 736 + 735}{6}$$

$$\bar{X} = \frac{4585}{6}$$

$$\bar{X} = 764{,}16\ \mu W/cm^2$$

c. Error

$$\%\ \text{Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\%\ \text{Error} = \frac{759{,}83 - 764{,}16}{759{,}83} \times 100\%$$

$$\%\ \text{Error} = -0{,}57\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum (X_i - \overline{X})^2}{n - 1}}$$

$$SD = \sqrt{\frac{(735 - 764{,}16)^2 + (793 - 764{,}16)^2 + (793 - 764{,}16)^2 + (793 - 764{,}16)^2 + (736 - 764{,}16)^2 + (735 - 764{,}16)^2}{6 - 1}}$$

$$SD = \sqrt{\frac{4988,8}{5}}$$

$$SD = 31,58$$

e. Ketidakpastian (Ua)

$$U_a = \frac{SD}{\sqrt{n}}$$

$$U_a = \frac{31,58}{\sqrt{6}}$$

$$U_a = \frac{31,58}{2.4}$$

$$U_a = 13,15$$

7. Analisis Hasil Perhitungan Pengukuran Iradiasi *Blue Light* Pada Jarak 46 cm dititik Kiri

a. Rata-Rata Data Kalibrator

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{533 + 507 + 519 + 547 + 551 + 542}{6}$$

$$\bar{X} = \frac{3199}{6}$$

$$\bar{X} = 533,16\ \mu W/cm^2$$

b. Rata-Rata Data Modul

$$\bar{X} = \frac{\sum Xi}{n}$$

$$\bar{X} = \frac{488 + 504 + 520 + 520 + 545 + 545}{6}$$

$$\bar{X} = \frac{3122}{6}$$

$$\bar{X} = 520{,}33\ \mu W/cm^2$$

c. Error

$$\%\ \text{Error} = \frac{Xn - \bar{X}}{Xn} \times 100\%$$

$$\%\ \text{Error} = \frac{533{,}16 - 520{,}33}{533{,}16} \times 100\%$$

$$\%\ \text{Error} = -2{,}4\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(X_i - \overline{X})^2}{n-1}}$$

$$SD = \sqrt{\frac{(488 - 520{,}33)^2 + (504 - 520{,}33)^2 + (520 - 520{,}33)^2 + (520 - 520{,}33)^2 + (545 - 520{,}33)^2 + (545 - 520{,}33)^2}{6-1}}$$

$$SD = \sqrt{\frac{1949{,}13}{5}}$$

$$SD = 19{,}74$$

e. Ketidakpastian (Ua)

$$U_a = \frac{SD}{\sqrt{n}}$$

$$U_a = \frac{19{,}74}{\sqrt{6}}$$

$$U_a = \frac{19{,}74}{2.4}$$

$$U_a = 8{,}225$$