American International University-Bangladesh
Department of Electrical and Electronic Engineering
EEE 4103: Microprocessor and Embedded Systems Laboratory

# Lab Report Cover Sheet

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| **Course Name** | Microprocessor and Embedded Systems |
| **Lab Report No.** | 07 |
| **Lecturer Name** | NADIA ANAM |
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**Experiment 02:** Building a weather forecast system using Arduino, BMP180 and DHT11 sensor.

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# American International University-Bangladesh

**Department of Electrical and Electronic Engineering**

EEE4212: Microprocessor and Embedded Systems Laboratory

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**Title:** Building a weather forecast system using Arduino, BMP180 and DHT11 sensor.

## Introduction:

The goal of this experiment is to become acquainted with a microcontroller-based weather forecast system and the monitoring of environmental data (temperature, pressure, and humidity).

## Theory and Methodology:

### Weather Prediction

The BMP180 or MPL115A is an absolute device that may be used to discern weather patterns by predicting and measuring barometric pressure. A static position for the sensor and 2-3 hours to assess a whole weather pattern are required for weather prediction. Weather-related pressure changes are often sluggish, taking many hours to identify the slope of the pressure shift. Only weather variations in barometric pressure can cause findings to be hampered by vertical movement or a considerable airflow.
The sensor should be kept in a relatively sheltered region away from any powerful air fluxes, and it should remain in that static location during the examination. Temperature effects can alter the findings of a standard pressure sensor, especially if the test is performed over a period of many hours at various temperatures. MBP180 satisfies these standards due to the nature of the calibration and temperature correction, correcting for temperature changes throughout a wide 0 to 85°C working range. It will not require auto-zeroing for offset or span over temperature changes.

### How Pressure Increases and Decreases with Weather

With its pressure range and resolution, the BMP180 or MPL115A is an excellent equipment for predicting weather patterns. Changes in barometric pressure can be directly related to changes in the weather. Low pressure is commonly regarded as a harbinger to deteriorating weather. Increases in high pressure might be viewed as better or clear weather. A comparison of molecular weights exemplifies the conventional thinking. If air contains roughly 21% O2(g) and 78% N2(g), O2(g) has a molecular mass of 32 and N2(g) has a mass of 28. The molecular mass of H2O (g) is 18. So, if there is a lot of water vapor in the air, it will be lighter than just plain dry air. It's a fascinating fact that explains how weather patterns cause high or low pressure.

If poor weather develops in a region due to the creation of water-vapor clouds, this is shown by lowering pressure on a barometer. As the H2O reduces the mass above that place on the planet, the vapor lowers the atmospheric pressure. As the air dries, high pressure will signify the removal of water vapor.

## Local Weather Stations

When setting up a weather station, it's a good idea to double-check the data with a local prediction. Remember that weather pressures are adjusted for altitude when studying local weather pressures, such as barometric pressure at the nearest airport. Local barometric pressure is shifted to reflect sea level altitude during normalization. The sea level is 101.3 kPa, and a meteorologist may examine the weather pattern across an area by normalizing several places on a map. The influence of altitude on the pressure recorded by collecting stations will result in worthless data if it is not normalized. A mountain data point's pressure will be altered by altitude, and as it descends into the valleys, the pressure point will be greater, providing little information about the weather without normalization.

## Algorithms for weather Simple Approach

How is weather predicted using the barometric sensor? There is a simple approach looking at increasing or decreasing pressure. Simply an increase over time is a trend that approaches “sunny” or “clear” days. Dropping pressure can signal a worsening “cloudy” or “rainy” day. This can be seen typically as a rising or falling bar on many simple solution weather stations. It can be interpreted as an increase/decrease gradient for the user to interpret, but the time interval is not used extensively to reach weather predictions. The user can look at the results for a 12 hour time frame to predict the weather trend.

This table is typically used:

| Analysis | Output |
|---|---|
| dP > +0.25 kPa | Sun Symbol |
| -0.25 kPa < dP < 0.25 kPa | Sun/Cloud Symbol |
| dP < -0.25 kPa | Rain Symbol |

Another approach that is more direct and quicker in calculating the weather in the simple approach is to know the current altitude. This cuts the need to wait and see a “trend”.

By using the equation below:

$$ph = p0 \cdot e^{\frac{-h}{7990m}}$$

Where p0 = 101.3 kPa, and h is the current altitude, the pressure for the local barometric can be calculated. This is the pressure for good sunny weather at current altitude location.

## Advanced Version of Weather Station

A more complicated way would be to measure the P/t and see how the gradient changes over time. This, like the basic strategy, must be kept in a fixed spot during measurement. As time passes, the weather may be divided down into more precise divisions than the simple technique of fundamental symbols.
This can also save time compared to waiting the entire 12 hours to view the pressure shift pattern. Table 3 shows how pressure ranges fluctuate over time, contributing to the formation of weather patterns. It is a shift in pressure over the course of one hour. It takes around 2-3 hours to figure out how the pressure is moving.

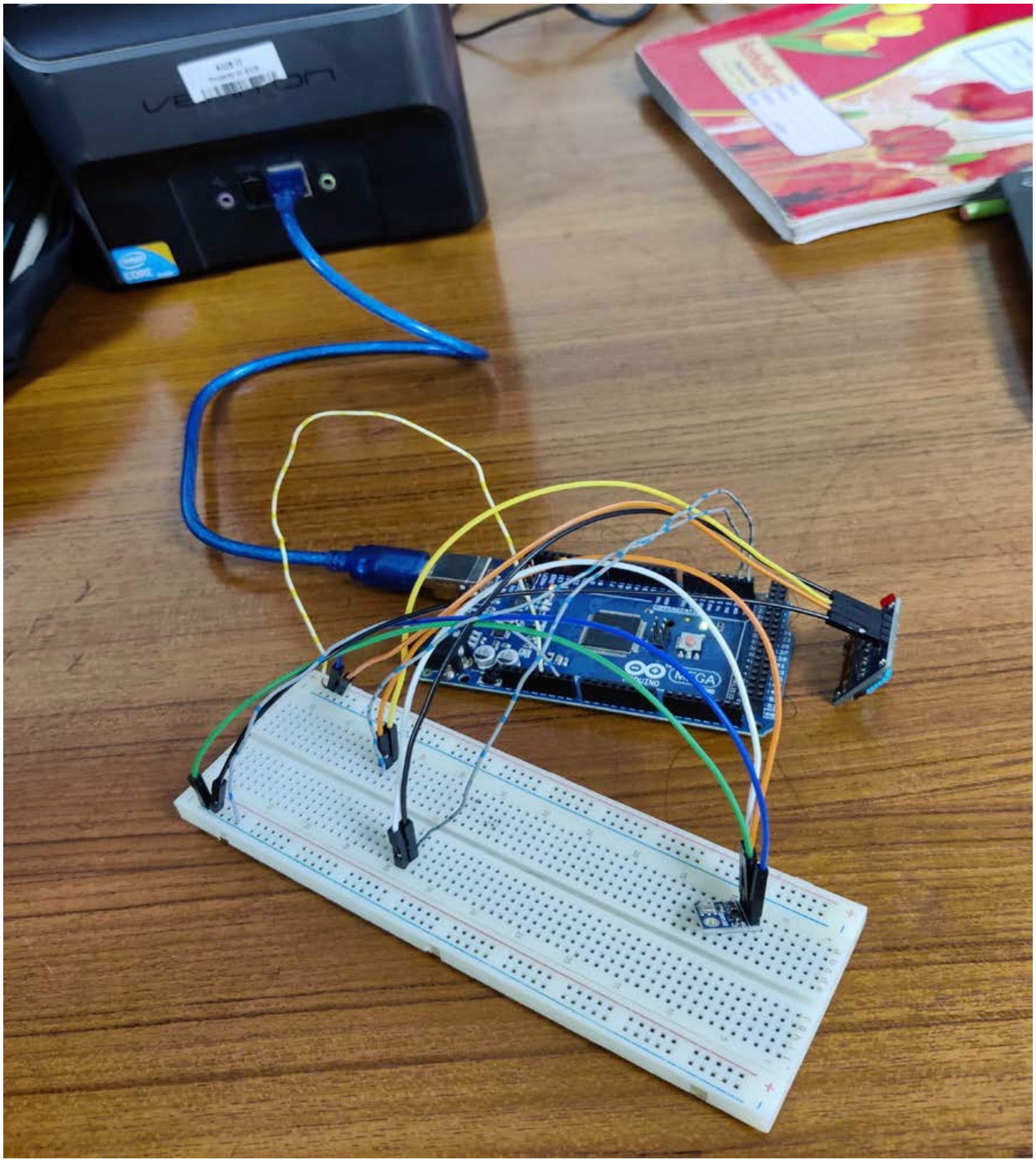
**Table 3. Advanced Weather Determination**

| Analysis | Output |
|---|---|
| dP/dt > 0.25 kPa/h | Quickly rising High Pressure System, not stable |
| 0.05 kPa/h < dP/dt < 0.25 kPa/h | Slowly rising High Pressure System, stable good |
| -0.05 kPa/h < dP/dt < 0.05 kPa/h | Stable weather condition |
| -0.25 kPa/h < dP/dt < -0.05 kPa/h | Slowly falling Low Pressure System, stable rainy |
| dP/dt < -0.25 kPa/h | Quickly falling Low Pressure, Thunderstorm, not |

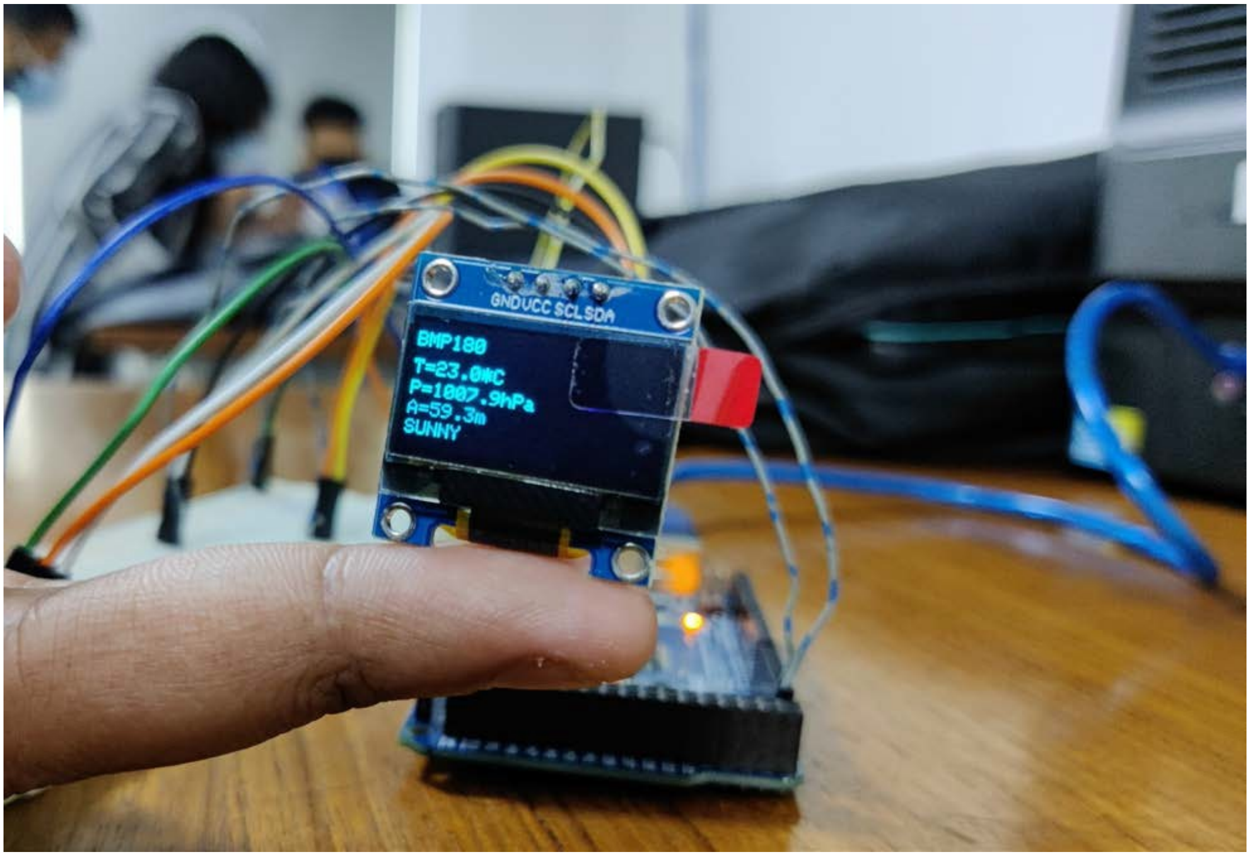
The pressure is sampled every minute for 3 hours/180 minutes into a data array in the flowchart supplied. The first 5 minutes are averaged, then another 5 minutes towards the start of the first 12 hour. 5 minute averaged data-points are retained for consecutive 12 hour marks. This yields seven averaged values over 180 minutes, which illustrate the pressure every 12 hours. The patterns are determined once the data points have been gathered. The procedure for determining the weather pattern is depicted in a flowchart. The original beginning point serves as a benchmark against which every 12 hour data point is measured. The value is compared and split as the pressure declines, such that the change in pressure per hour is compared every half hour.

## Hardware implementation:

Attach our experimental image here



OLED Result Image:



## Components List

- Arduino Uno Board
- DHT11
- BMP180 / MPL115A
- 0.96 inch OLED 128X64
- Breadboard and Jump Wires

## Program to be compiled in Arduino Uno:

```
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <Adafruit_BMP085.h>
#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT);
Adafruit_BMP085 bmp;
#define SEALEVELPRESSURE_HPA (101500)

float simpleweatherdifference, currentpressure, predictedweather, currentaltitude;
void setup() {
  // put your setup code here, to run once:
 display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
 if (!bmp.begin()) {
  Serial.println("Could not find a valid BMP085 sensor, check wiring!");
  while (1) {}
  }
 }

  void loop() {
  // put your main code here, to run repeatedly:

  display.clearDisplay();
  display.setTextSize(1);
  display.setTextColor(SSD1306_WHITE);

  display.setCursor(0,5);
  display.print("BMP180");
  display.setCursor(0,19);
  display.print("T=");
  display.print(bmp.readTemperature(),1);
  display.println("*C");

  /*prints BME180 pressure in Hectopascal Pressure Unit*/
  display.setCursor(0,30);
  display.print("P=");
```

```
  display.print(bmp.readPressure()/100.0F,1);
  display.println("hPa");


    /*prints BME180 altitude in meters*/
  display.setCursor(0,40);
  display.print("A=");
  display.print(bmp.readAltitude(SEALEVELPRESSURE_HPA),1);
  display.println("m");
  delay(6000);

  display.display();

 currentpressure=bmp.readPressure()/100.0;
 predictedweather=(101.3*exp(((float)(currentaltitude))/(-7900)));
 simpleweatherdifference=currentpressure-predictedweather;
 //display.clearDisplay();
 display.setCursor(0,50);
 if (simpleweatherdifference>0.25)
   display.print("SUNNY");

if (simpleweatherdifference<=0.25 && simpleweatherdifference>=-0.25)
display.print("SUNNY/CLOUDY");

  if (simpleweatherdifference<-0.25)
   display.print("RAINY");
   display.display();
delay(2000);

}
```

## Discussion:

In this experiment we learned about weather forecast using pressure and heat index measurement. Here microcontroller has been used for the measurement of weather conditions and transmission of data to the receive and heat index is used for measuring of how hot it really feels when relative humidity is factored in with the actual air temperature. While making the flowchart we faced some problem. The problem was discussed by the faculty and we solved the problem and completed our experiment.

## Conclusion:

We developed a weather prediction system flowchart calculation at the pressure and heat index from temperature measuring in Aurdino. We found some bugs or errors lout we managed to correct those mistakes successfully run the simulation. The flowcharts were large relative tour previous studies lout with the help at our course teacher we manage to do it in short time.