# LAMPIRAN

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PENGALAMAN PENELITIHAN

| PENELITIAN | TAHUN |
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| PERANCANGAN ALAT *SPIROMETRY* UNTUK MENGUKUR DAN MEMONITOR VOLUME PARU–PARU PEROKOK ELEKTRIK BERBASIS I*NTERNET* of *THINGS* | 2023 |

PENGHARGAAN/PENCAPAIAN

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Pada hari ini ..Kamis... tanggal..27 Juli...... 2023 telah sepakat untuk melakukan konsultasi bimbingan Tugas Akhir (TA).

Konsultasi bimbingan sekurang- kurangnya 1 (satu) kali dalam satu minggu. Pelaksanaan bimbingan pada setiap hari .................... pukul......... tempat di Politeknik Negeri Sriwijaya.

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|---|---|---|---|
| 1. | 22-5-2023 | BAB I Pengajuan Judul | [signature] |
| 2. | 30-5-2023 | BAB I Revisi survey lokasi Penelitian rumah sakit | [signature] |
| 3. | 6-6-2023 | BAB I Acc lanjut BAB 2 | [signature] |
| 4. | 19-6-2023 | BAB III Pembahasan Metode Penelitian | [signature] |
| 5. | 30-6-2023 | BAB IV Pembahasan Penelitian Revisi BAB IV | [signature] |
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| 9. | 17-7-2023 | Pembahasan Pengambilan data | |
| 10. | 19-7 2023 | Acc BAB IV, konsul jurnal | |
| 11. | 21-7 2023 | Acc BaB V, Acc BAB V | |
| 12. | 26-7-2023 | Submit jurnal | |
| 13. | 27-7-2023 | Acc sidang TA | |
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| 4. | 7, Juni 2023 | Revisi BAB III<br>Perbaikan metode | [signature] |
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| 10. | 19, Juli 2023 | Revisi Bab IV Source code program | |
| 11. | 26, Juli 2023 | Revisi BAB IV Grafik Hasil | |
| 12. | 2, Agustus 2023 | Acc BAB IV Acc BAB V | |

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Mahasiswa tersebut telah memenuhi persyaratan dan dapat mengikuti Ujian Tugas Akhir (TA) pada Tahun Akademik 2022/2023

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Telah melaksanakan revisi terhadap Tugas Akhir yang diujikan pada hari Kamis tanggal 10 bulan Agustus tahun 2023 . Pelaksanaan revisi terhadap Tugas Akhir tersebut telah disetujui oleh Dosen Penguji yang memberikan revisi:

| No. | Komentar | Nama Dosen Penguji*) | Tanggal | Tanda Tangan |
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# LETTER OF ACCEPTANCE

Date: 2nd August 2023
Number: 90.AJESH.VI.2023

Dear(s)

**Nizhom Rofid Robbani, Ahmad Taqwa, Suroso**
Telecommunication Engineering Study Program, Sriwijaya State Polytechnic
Emails: osorus11@gmail.com, taqwa@polsri.ac.id, 061940351952@student.polsri.ac.id

Title: **"Design of Spirometry for Measure and Monitor Electric Smokers Lung Volume Based on Internet of Things"**

After peer review process, your article has been provisionally accepted for publication in the **Asian Journal of Engineering, Social and Health (AJESH)**, in the forthcoming issue, Volume 2 Number 9, September 2023. All papers are published in the English language. All submitted manuscripts are subject to peer-review by the leading specialists for the respective topic.
Thus this information is conveyed, it is hoped that cooperation during the publication process is expected.
Thank you

Best Regards,
**Chief Editor**

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# DESIGN OF SPIROMETRY FOR MEASURE AND MONITOR ELECTRIC SMOKERS LUNG VOLUME BASED ON INTERNET OF THINGS

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**ABSTRACT:**
Health is the primary necessity in human life. Without health, human cannot carry out their daily activities. Some people have unhealthy lifestyles, such as smoking habits, both conventional cigarettes and e-cigarettes. Smoking can cause dyspnea resulting in shortness of breath and decreased lung function. As the main organ in breathing, a spirometry test can be done to test whether lung function is normal or abnormal. Spirometry tools can measure forced vital capacity (FVC) and First Expiratory Volume (FEV1). In general, spirometry tools used are analog and have not integrated with the Internet of Things and can only be done in certain hospitals. This spirometry tool is designed with a flowmeter sensor YF-S201 that can measure a volume or fluid flow and the microcontroller NodeMCU ESP8266 to carry out microcontroller functions and connect devices to the internet network. The volume value will be calculated and sent to the smartphone through Blynk Application for monitoring and assessing the percentage of lung volume ratio. Percentage above 80% is normal, 80% - 60% is mild damage, 60% - 40% is moderate damage, and below 40% is severe damage. With this research, it is hoped that it can be a solution to help a doctor diagnose and monitor patient health.

**Keywords:** Spirometry**,** e-cigarettes **,**YF-S201**,** NodeMCU ESP8266**,** Blynk, IoT

## INTRODUCTION

Health is an essential need in human life; without health, humans cannot carry out daily activities optimally. One of the organs that play an essential role in the health of the human body is the lungs. The lungs are organs in the human body that play a role in the respiratory process. If the lungs are disturbed, it will cause various dangerous diseases. The World Health Organization (WHO) states that by 2030 noncommunicable diseases such as cancer, heart disease, diabetes mellitus (DM), and Chronic Obstructive Pulmonary Disease (COPD) will experience a significant increase. Noncommunicable diseases result from unhealthy living habits and are common in people's lives. One of these bad habits is smoking.

A cigarette is a cylinder of paper measuring between 70 to 120 mm long with a diameter of about 10 mm containing chopped tobacco leaves. Along with the times, cigarettes have developed from tobacco to electronic cigarettes consumed with special liquids and special devices. Smoking can cause dyspnea which causes shortness of breath to run lung function because cigarettes contain various harmful chemicals. Smoking is one of the highest causes of death from noncommunicable diseases. 7.2 million people die each year, making cigarettes the world's most preventable cause of death.

As the main organ in the respiratory process, a test to measure lung volume is a spirometry test. A spirometry test is a lung function test used to measure the volume of air that can be inhaled and exhaled for some time so that the condition of a person's lung function can be known, whether normal or abnormal. Forced Vital Capacity (FVC) and First Second Forced Expiratory Volume (FEV1) are indicators to see the lungs' condition. FVC indicates the amount of air a person can expire quickly and forcefully after full inspiration. FEV1 indicates the amount of air a person can express in the first second of the FVC test. The ratio between FVC and FEV1 indicates the size of a person's lung volume. Sometimes, the *spirometry test* medical examination can only do in certain hospitals.

As in a study entitled, Design and Build a Lung Fitness Detection Device for TNI Personnel (Spirometer) Based on Arduino Uno, which uses Python programs to measure results. Then there is also a study entitled Design and Build a Lung Force Vital Capacity Measuring Instrument with Arduino-Based Pressure Sensor and Labview, which uses the Webview application to read measurement results. In the research of Lung Volume Measurement Based on Arduino Microcontroller by Utilizing MPX5700DP Sensor which uses Arduino and Bluetooth module to read measurement results with a smartphone. The research entitled Arduino Atmega328 Portable Spirometer Using Gas Pressure Sensor for FVC And FEV1 Measurement. In research, lung Volume Measuring And Monitoring Systems Using Pressure Sensors And The Internet Of Things, Use The Blynk Application To Display Measurement Data. Existing studies there have been no studies on measuring spirometry with a flowrate sensor YF-S201 and measuring in the lungs of electric smokers. Therefore, spirometry measuring instruments are needed to help doctors diagnose diseases. Especially integrated with the Internet of Things.

## RESEARCH METHODS

In this study, the spirometry measurement is designed using the YF-S201 flowmeter sensor that can measure force vital capacity (FVC) and Forced Expiratory Volume (FEV1). The measurement results then be calculated by the NodeMCU ESP8266 microcontroller, which is, integrated with the Blynk application as an Internet of Things service provider that smartphones can access. This research will use study literature methods, software and hardware design, experimental observation, and data collection.

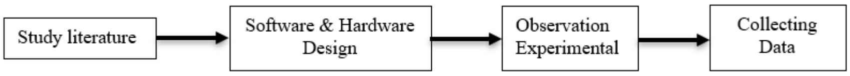


**Figure 1.** Methods

### System Design

Based on Fig. 2. Block diagrams. The system design divides into hardware and Software. The hardware comprises a YF-S201 Flow meter sensor, Power Supply, DC-to-DC converter, I2C LCD, and NodeMCU 8266 Microcontroller. The Software is for processing microcontrollers to collect data, and the Blnyk App displays notifications of the data on smartphone devices.

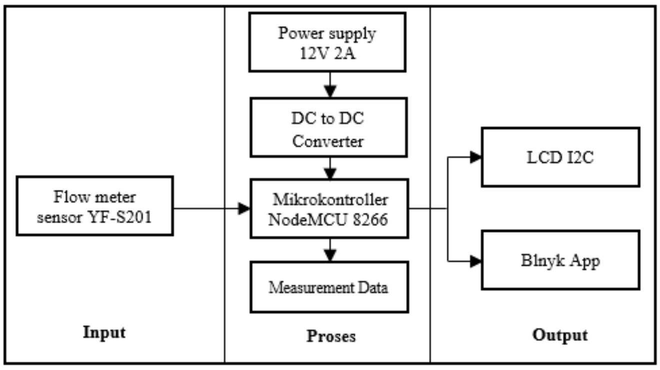


**Figure 2.** Block diagram

In this study, The Measurements will be carried out twice. Two Forced Vital Capacity (FVC), and two Forced Expiratory Volume (FEV1) samples will be obtained in one measurement, so four samples will obtain from one subject. Then the sample results get calculated to be the average value to determine the tolerance differentiation value and the classification ratio, equation (1) to determine the Tolerance difference value and equation (2) to determine the classification Ratio.

$$\text{Difference Tolerance} = \frac{(\text{FVC}_1 - \text{FVC}_2)}{((\text{FVC}_1 + \text{FVC}_2)/2)} \times 100 \quad (1)$$

$$\text{Classification Ratio} = \frac{((\text{FEV1}_1 + \text{FEV1}_2)/2)}{((\text{FVC}_1 + \text{FVC}_2)/2)} \times 100 \quad (2)$$

After the microcontroller processes the measurement data, the spirometry device will divide the measurement results into five categories according to the vital capacity of the subject that has been measured, but if the measurement results exceed the differential tolerance limit, the measurement value will be considered invalid. The device will return to standby mode then the subject will be asked to repeat the measurement.

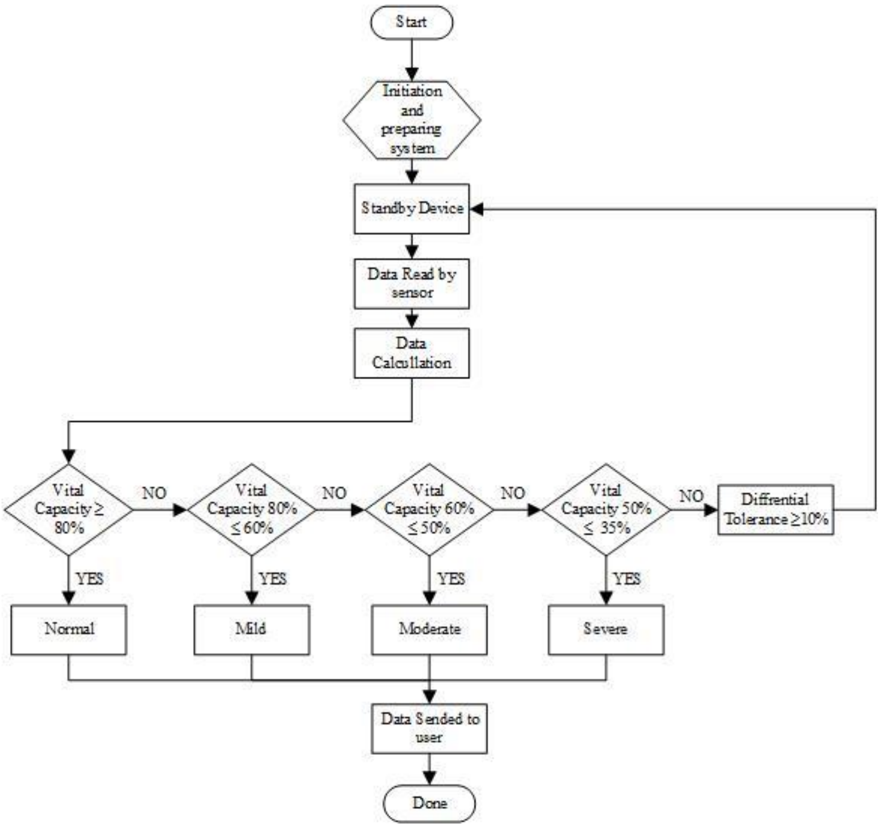


**Figure 3.** System Design flowchart

The air volume of the lungs FEV1/FVC is normal if the value is ≥80% with vital capacity. ≤80% will then be declared abnormal and classified according to the value sent by the device. Obstructive pulmonary sufferers will experience an apparent reduction in lung function due to the closure of the airway regulator. The pulmonary function status is examined by comparing the %FEV1 with the FVC value, whether it is in normal, obstructive, mixed obstructive, or restrictive conditions. Table 1 shows the classification category of lung volume ratio values.

**Table 1**
**Volume Lung Classification**

| Class | Classification | Restrictive | | Obstructive | |
|---|---|---|---|---|---|
| | | VC% | FEV1/FVC | VC% | FEV1/FVC |
| 0 | Normal | >80 | >75 | >80 | >75 |
| I | Mild | 60-80 | >75 | >80 | 60-75 |
| II | Moderate | 50-60 | >75 | >80 | 40-60 |
| III | Severe | 35-50 | >75 | >80 | <40 |

### Hardware Prototype

Based on fig.4. There are several main components of hardware, including NodeMCU ESP8266 Microcontroller as the central control of incoming data processing and outgoing commands, YF-S201 Sensor that functions to assess the volume of fluid in the vacuum valve chamber; when the fluid passes through the rotor, the magnetic rotor will rotate. The rotor's rotation depends on the fluid flow rate; then, the hall sensor readings will be read by the microcontroller and the Liquid Cristal Display component that functions as a display in the form of text and measurement numbers. In addition to hardware, there are other supporting devices, including pipes that function as air ducts to drain the measured air volume, an air filter that filters the incoming air, and a disposable mouthpiece placed in the mouth to blow air.

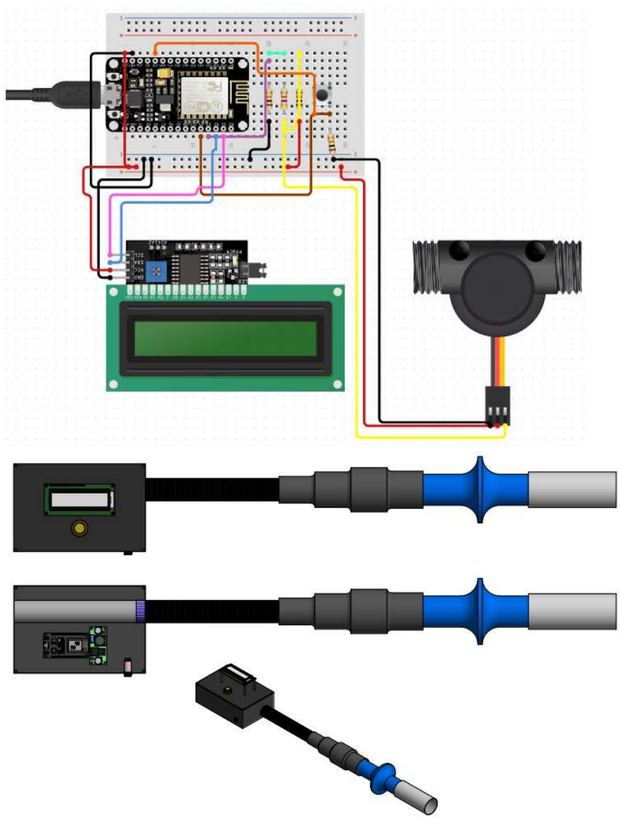

**Figure 4.** Prototype Design

**Software Development**

Software is developed and embedded in microcontrollers to process and transmit data. Measurement with the YF-S201 flow meter sensor will produce the flow rate in units of l / h (liters per hour) and convert it into l / S (liters per second). Based on the amount of this flow rate, if multiplied by time, it will produce a volume value. This volume value will be the basis for the volume of the subject's lungs to be measured. There be four measurement modes, with the aim of an average value.

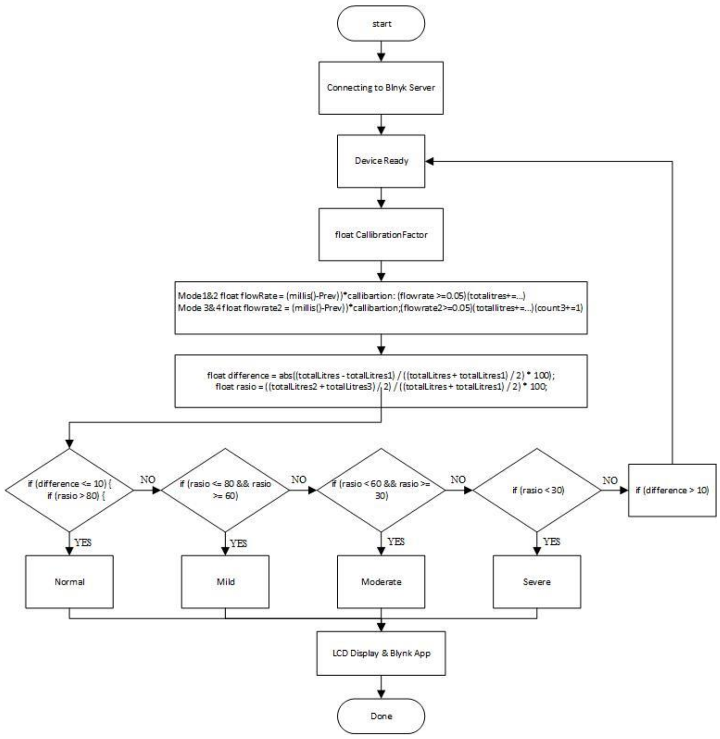


**Figure 5.** Computation code

After the YF-S201 sensor successfully measures the volume value, the microcontroller will process the data into different tolerance and classification ratio values. The different tolerance values will calculate the tolerance value from the measurement read by the sensor. The tolerance value is needed because the flow rate value read by the sensor will sometimes be different. This flow rate value depends on the maneuver of the subject blowing the mouthpiece, and if the subject blows with the wrong maneuver, then the reading value will be very much different. The tolerance value should not be ≥10%; if it exceeds ≥10%, the program will ask the subject to re-measure. So that the subject must blow with constant maneuvers so that the value successfully measured by the sensor can be accurate. This classification ratio value will calculate the ratio between the average total flow volume of the previous four measurement modes and multiplied by 100 to get the value in percentage form. Furthermore, both different and ratio values displayed on the LCD screen and the microcontroller will send notifications to user-friendly applications to support the Internet of Things. The application used is Blnyk Apps which can be accessed via Android and IOS Smartphones by logging in with an account registered on the microcontroller.

## RESULTS AND DISCUSSION

As a measuring instrument, spirometry needs to be calibrated periodically to ensure accurate and consistent results. The spirometry tool designed has already been calibrated using the Hans Rudolph 5530 Syringe Calibrator tool. The syringe for calibration is executed manually by sucking in and pushing out the airflow.

**Figure 6.** Calibrating Proses

Spirometry performance measurement is carried out by the 3-liter method, with a volume range of 1-3 liters. Standard input 1.0 liters get 1.0 liters, standard input 1.5 get 1.6 liters, standard input 2.0 get 2.1 liters, standard input 2.5 get 2.5 liters, and standard input 3.0 get 3.2 liters. From the results, the value of spirometry correction has been deemed fit for use based on the allowable deviation value of ≤15%. Table 2 shows the values of spirometry calibration results.

**Table 2**
**Calibration Result**

| Permissible deviations | Standard Settings | Correction |
|---|---|---|
| 15% | 1.0 liters | 1.0 liters |
| | 1.5 liters | 1.6 liters |
| | 2.0 liters | 2.1 liters |
| | 2.5 liters | 2.5 liters |
| | 3.0 liters | 3.2 liters |

For the measurement data collection process, the spirometry tool will measure twice with the aim of obtaining good results, with subject five electric smoker subjects aged 21-31 years, with a height of 150-177 cm, a body weight of 45-90 kg, and with room temperature ± 25ºc. Measurement will use a disposable mouthpiece placed in the mouth to blow air so that the sensor will read the value of the flowing volume. Subjects are required to be smoke-free for 2 hours and wear a nose clip. In the measurement, the subject should be in a standing position and will be asked to breathe as much air as possible and then as soon as possible exhale as much air as possible through the mouthpiece. Table 3 shows the results of the first measurement and Table 4 Shows the result of the first measurement.

**Table 3**
**First Measurement**

| First Measurement | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Gender** | **Age** | **Height** | **Weight** | **Mode 1 FVC** | **Mode 2 FVC** | **Mode 3 FEV1** | **Mode 4 FEV1** | **Diff Ratio** | **Class** |
| 1 | M | 22 | 165 | 60 | 2.57 | 2.66 | 3.63 | 3.60 | 0.65% 72.19% | Mild |
| 2 | M | 24 | 168 | 90 | 4.22 | 4.43 | 3.77 | 3.82 | 4.68% 87.74% | Normal |
| 3 | M | 31 | 177 | 75 | 3.40 | 3.40 | 2.98 | 3.33 | 0.16% 92.82% | Normal |
| 4 | F | 21 | 150 | 50 | 4.75 | 4.92 | 3.00 | 3.87 | 3.55% 71.08% | Mild |
| 5 | F | 25 | 160 | 55 | 3.15 | 3.34 | 2.57 | 2.56 | 5.83% 79.00% | Mild |

**Table 4**
**Second Measurement**

| Second Measurement | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Gender** | **Age** | **Height** | **Weight** | **Mode 1 FVC** | **Mode 2 FVC** | **Mode 3 FEV1** | **Mode 4 FEV1** | **Diff Ratio** | **Class** |
| 1 | M | 22 | 165 | 60 | 3.04 | 3.09 | 4.59 | 4.71 | 2.49% 65.94% | Mild |
| 2 | M | 24 | 168 | 90 | 3.80 | 3.84 | 3.77 | 3.63 | 1.04% 96.85% | Normal |
| 3 | M | 31 | 177 | 75 | 3.60 | 3.41 | 3.34 | 3.57 | 5.40% 98.59% | Normal |
| 4 | F | 21 | 150 | 50 | 4.82 | 4.72 | 3.77 | 3.84 | 2.01% 79.72% | Mild |
| 5 | F | 25 | 160 | 55 | 3.11 | 3.09 | 1.95 | 2.51 | 0.47% 71.98% | Mild |

Based on FVC and FEV1 measurements, there is a difference in measurement values in comparing the first and second measurement values. This difference in values, caused by several factors, such as the subject's breath, cannot be controlled to be generalized in conducting the test. The maneuver of the subject is assumed to change in making measurements, the breath exhaled by the subject does not run out, which causes inconstancy of values, and the mouthpiece used by the subject did not use properly, so leakage occurs.

Obstructive and restrictive classification gives the results of 5 subjects measured, stating that three subjects are classified as mild, and two subjects are declared normal. This obstructive and restrictive classification is affected by cigarette consumption during their life history. During this study, it was found that five subjects consumed ±60 ml of e-cigarette liquid over 1-2 weeks. Smokers who consumed 60ml of liquid for one week had a lower ratio than those who consumed 60ml for two weeks.


**Figure 8.** Blynk Notification

Figure 8 shows the results of the Internet of Things service. The Blynk service displays notifications of test results, notifications sent in the form of obstructive class classification, test date, and time. If a test failure is caused by a ratio difference value exceeding 10%, the microcontroller will not send data into the Blynk application.

## CONCLUSION

In conclusion, the Design of Spirometry for Measure and Monitor Electric Smokers Lung Volume Based on the Internet of Things has worked well. This spirometry device can also be used on any subject other than electric smokers. E-cigarettes can cause a decrease in lung function, but the lung function caused by e-cigarettes is not as severe as tobacco cigarettes.

The system device successfully measures FVC / FEV1 with different tolerance values of <10%. The microcontroller sends Classification data to the Blynk application with a time delay of ± 30-60 seconds. This delay depends on the internet speed received by the microcontroller.

In the future, it is necessary to redevelop, such as selecting sensors with better accuracy to reduce reading errors, it is necessary to add a data storage system to store the personal data of subjects so that they can store the measurement results obtained, and it is necessary to add Peak Expiratory Flow (PEF) measurements.

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GLOBAL INTI
PUBLIKASIANA

# CERTIFICATE
## OF APRECIATION

The Certificate Is Presented To:

*Nizhom Rofid Robbani*

As a writer in the Asian Journal of Engineering, Social and Health Published in September 2023
Title:
***Design of Spirometry For Measure and Monitor Electric Smokers Lung Volume Based on Internet of Things***

Chief Editor

Muhammad Iqbal

**Balai Pengamanan Fasilitas Kesehatan**
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KAN
Komite Akreditasi Nasional
Laboratorium Kalibrasi
LK-110-IDN

# BUKTI PENERIMAAN PEKERJAAN KALIBRASI

Nama Perusahaan : NIZHGM ROFID ROBBANI
Alamat : Jl. Musyawarah komp. griya mitra 2 blok C.09
Telepon / Faksimili : 0819 94 91 08 60 / Nichomr@gmail.com
NPWP :

Nomor :
Nomor KUK :
Tanggal barang diterima : 17 Juli '23
Tanggal selesai yang diharapkan :
Lokasi pelaksanaan : ☑ in-house ☐ in-situ

| No. | Nama Alat | Merk / Tipe | Spesifikasi | Banyaknya | Tarif Satuan | Jumlah |
|---|---|---|---|---|---|---|
| 1. | Spirometer | Spirometri IOT | SN. NRR01 | 1bh | 156.000,- | 156.000,- |
| | | | | | | |
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Catatan : - Carger set

| | |
|---|---|
| Sub total | |
| PPN 10% | |
| Total | 156.000,- |

Yang menyerahkan barang :
[signature]
Tandatagan & nama jelas

Yang menerima barang :
[signature]
Purri Oktarina
Tandatagan & nama jelas

PEMBAYARAN TELAH DILUNASI
Jakarta, ..............................
Bendahara Penerima,

..............................
Tandatagan & nama jelas

4-3/FPO-LK-BPFKJ/Rev.1/06.09

**LEMBAR KERJA PENGUJIAN DAN KALIBRASI**
**SPIROMETER**

| Metode Kalibrasi |
|---|
| 28-45/IK-MK-BPFKJ |

| | | |
|---|---|---|
| **Nomor Order** | : | **Lab.2307.52** |
| **Merk** | : | **SpirometriIOT** |
| **Model/Type** | : | **-** |
| **Nomor Seri** | : | **NRR.01** |
| **Resolusi** | : | **0,1 liter** |
| **Lokasi Kalibrasi** | : | **Lab. UPFPFK** |
| **Tanggal Kalibrasi** | : | **18 Juli 2023** |

**A. Kondisi Ruangan**

1. Suhu : ( 25,1 ± 0,6 )°C
2. Kelembaban : ( 62,5 ± 2,2 )% RH
3. Sumber Tegangan : 12 Vac

**B. Pengamatan Kondisi Fisik dan Fungsi**

1. Fisik Alat : Baik
2. Fungsi Alat : Tidak Baik

**C. Alat yang digunakan**

| Nama Alat | Merk | Model/type | Nomor seri |
|---|---|---|---|
| Syringe Calibrator | Hans Rudolph | 5530 | 553-45040 |
| Electrical Safety Analyzer | Fluke | Esa 615 | 2519026 |
| Thermohygrometer | Greisinger | GFTB 200 | 34901991 |

**D. Pengukuran Kinerja**

**1. Force Vital Capasity (liter)**

| Setting Standar | Koreksi | Penyimpangan yang diijinkan |
|---|---|---|
| 1,0 | -0,56 | 15% |
| 1,5 | -0,90 | |
| 2,0 | -1,28 | |
| 2,5 | -1,67 | |
| 3,0 | -2,05 | |
| **Ketidakpastian Pengukuran : 0,07 liter** | | |

**E. Kesimpulan dan Saran**

1. Kesimpulan : Alat dinyatakan Tidak Laik Pakai
2. Saran : Lakukan perbaikan dan kalibrasi ulang

Catatan :

- Nilai sebenarnya adalah penunjukan alat ditambah koreksi
- Ketidakpastian pengukuran diestimasi pada tingkat kepercayaan 95 %
- Pengukuran keselamatan listrik, pemeriksaan fisik dan fungsi serta kesimpulan hasil kalibrasi dicantumkan sesuai Permenkes RI No. 54 tahun 2015 dan Prosedur Pengujian / Kalibrasi alat kesehatan Departemen Kesehatan RI, Tahun 2001
- Hasil kalibrasi yang dilaporkan tertelusur ke Sistem Satuan Internasional (SI) melalui LK-032-IDN

Kepala Instalasi Laboratorium
Pengujian dan Kalibrasi Alat Kesehatan

Dodi Giantara, ST
NIP. 197305301998031001

Jl. Percetakan Negara No. 23A Jakarta Pusat 10570
Telp. : (021) 4240406, 42882249, Fax. : (021) 4244168, 42882237
Email : kontak@bpfkjakarta.or.id - Website : http://bpfkjakarta.or.id

## LEMBAR KERJA PENGUJIAN DAN KALIBRASI
## SPIROMETER

| Metode Kalibrasi |
| --- |
| 28-45/IK-MK-BPFKJ |

**Nomor Order** : **Lab.2308.18**
**Merk** : **SpirometriIOT**
**Model/Type** : **-**
**Nomor Seri** : **NRR.01**
**Resolusi** : **0,1 liter**
**Lokasi Kalibrasi** : **Lab. UPFPFK**
**Tanggal Kalibrasi** : **07 Agustus 2023**

**A. Kondisi Ruangan**

1. Suhu : ( 25,1 ± 0,6 )°C
2. Kelembaban : ( 62,5 ± 2,2 )% RH
3. Sumber Tegangan : 12 Vac

**B. Pengamatan Kondisi Fisik dan Fungsi**

1. Fisik Alat : Baik
2. Fungsi Alat : Baik

**C. Alat yang digunakan**

| Nama Alat | Merk | Model/type | Nomor seri |
| --- | --- | --- | --- |
| Syringe Calibrator | Hans Rudolph | 5530 | 553-45040 |
| Electrical Safety Analyzer | Fluke | Esa 615 | 2519026 |
| Thermohygrometer | Greisinger | GFTB 200 | 34901991 |

**D. Pengukuran Kinerja**

**1. Force Vital Capasity (liter)**

| Setting Standar | Koreksi | Penyimpangan yang diijinkan |
| --- | --- | --- |
| 1,0 | 0,18 | 15% |
| 1,5 | 0,28 | |
| 2,0 | 0,13 | |
| 2,5 | 0,11 | |
| 3,0 | 0,31 | |
| **Ketidakpastian Pengukuran : 0,07 liter** | | |

**E. Kesimpulan dan Saran**

| | | | |
|---|---|---|---|
| 1. | Kesimpulan | : | Alat dinyatakan Laik Pakai |
| 2. | Saran | : | Lakukan kalibrasi ulang sesuai jadwal secara berkala |

Catatan :

- Nilai sebenarnya adalah penunjukan alat ditambah koreksi
- Ketidakpastian pengukuran diestimasi pada tingkat kepercayaan 95 %
- Pengukuran keselamatan listrik, pemeriksaan fisik dan fungsi serta kesimpulan hasil kalibrasi dicantumkan sesuai Permenkes RI No. 54 tahun 2015 dan Prosedur Pengujian / Kalibrasi alat kesehatan Departemen Kesehatan RI, Tahun 2001
- Hasil kalibrasi yang dilaporkan tertelusur ke Sistem Satuan Internasional (SI) melalui LK-032-IDN

Kepala Instalasi Laboratorium
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Email : kontak@bpfkjakarta.or.id - Website : http://bpfkjakarta.or.id

KEMENTERIAN KESEHATAN REPUBLIK INDONESIA
DIREKTORAT JENDERAL PELAYANAN KESEHATAN
BALAI PENGAMANAN FASILITAS KESEHATAN JAKARTA

BPFK JAKARTA

# SERTIFIKAT PENGUJIAN DAN KALIBRASI

**Nomor YK.05.02/D.LIII/28466/2023**
Berlaku sampai dengan 07 Agustus 2024

No. Order : Lab.2308.18

**IDENTITAS ALAT**

| | | |
|---|---|---|
| Nama Alat | : | Spirometer |
| Merk | : | Spirometri1OT |
| Tipe / Model | : | - |
| Nomor Seri | : | SN. NRR01 |

**IDENTITAS PEMILIK**

| | | |
|---|---|---|
| Nama Pemilik | : | Nizhom Rofid Robbani |
| Alamat | : | Jl. Musyawarah komp. griya Mitra 2 Blok C.04 |
| Hasil Kalibrasi | : | Laik Pakai, |
| Sertifikat ini terdiri dari | : | 3 (Tiga) halaman |
| Diterbitkan tanggal | : | 08 Agustus 2023 |

**Kepala Balai Pengamanan Fasilitas Kesehatan Jakarta**

**Subadri, ST, M.Si**
**NIP. 197611122005011003**

** Sertifikat ini telah ditandatangani secara elektronik yang diterbitkan oleh Balai Sertifikat Elektronik (BSrE), BSSN*
** Sertifikat ini hanya berlaku untuk peralatan dengan spesifikasi yang dinyatakan diatas*
** Dilarang mengutip atau mempublikasikan isi sertifikat ini tanpa izin*

KAN
Komite Akreditasi Nasional
LK-110-IDN
LP-465-IDN
LI-076-IDN
PUP-020-IDN

Sex: Male Age: 22
Factor: 100(Caucasian)
Height: 164cm Weight: 61kg BMI: 22.7
Smoking: 1-10 per day

Turbine Transducer

(* is for auto best; ^ for manual best)

| | FEV1 | FVC | FEV1/FVC | PEF | Var | Warning | Time: |
|---|---|---|---|---|---|---|---|
| Base Date: 17/07/23 | | | | | | | |
| Base | 2.53 | 2.79 | 90.7 | 4.80 | * | Short blow | 06:10 |
| Base | 2.42 | 2.76 | 87.7 | 3.21 | -2% | Slow start | 06:11 |
| Base | 2.44 | 2.72 | 89.7 | 3.84 | -3% | Poor effort | 06:11 |
| Base | 2.52 | 2.69 | 93.7 | 5.22 | -2% | Slow start | 06:12 |
| Base | 2.61 | 2.80 | 93.2 | 5.50 | 1% | Slow start | 06:12 |
| Base | 2.51 | 2.67 | 94.0 | 4.85 | -2% | Poor effort | 06:12 |
| Base | 2.56 | 2.68 | 95.5 | 4.56 | -1% | Abrupt end | 06:13 |

Variation is based on FEV1 + FVC.

ATS/ERS Quality Criteria (Forced):
Base: Not Met. Need 2 more good blow(s).

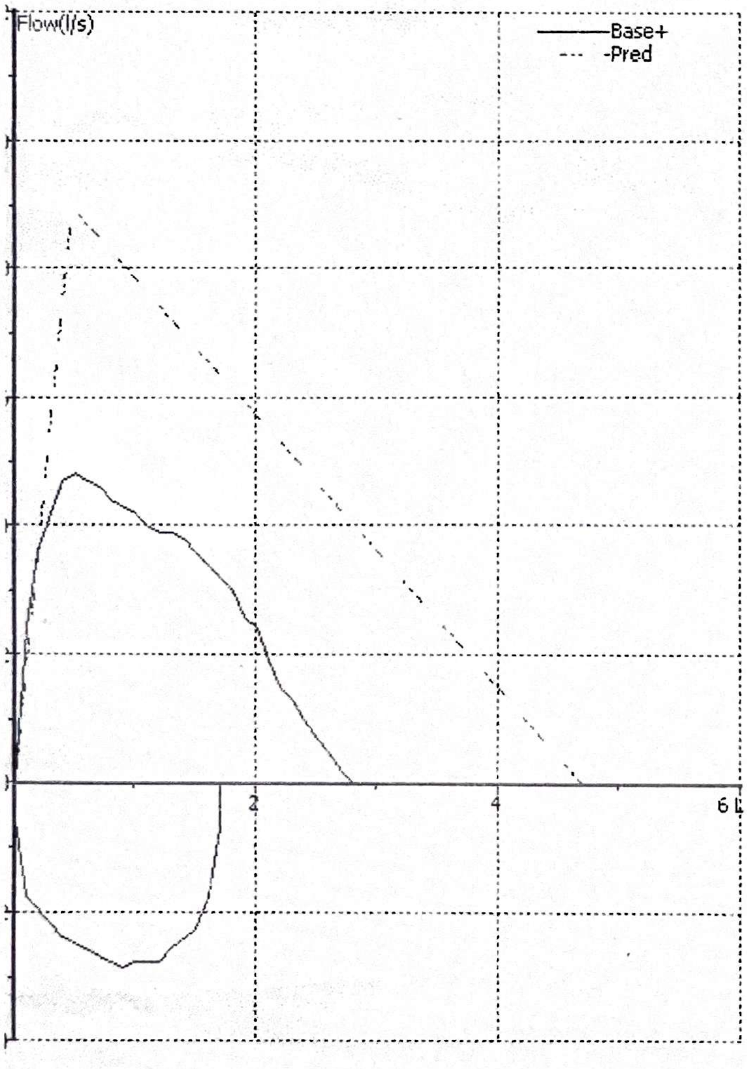
Any forced data and graphs following are either best individual values or composite curve.

Best Spirometry Result:

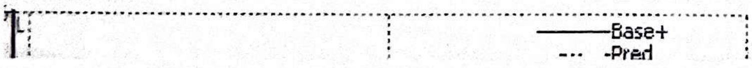
| | Base | %Pr | Min (Normal) | Pred (Normal) | Max (Normal) | Post (PostI) | %Pr (PostI) | %Chg (PostI) | |
|---|---|---|---|---|---|---|---|---|---|
| FEV1 | 2.53 | 64 | 3.31 | 3.98 | 4.65 | | | | l |
| FVC | 2.79 | 59 | 3.91 | 4.70 | 5.50 | | | | l |
| PEF | 4.80 | 54 | 6.99 | 8.96 | 10.9 | | | | l/s |
| FEV1/FVC | 91 | 109 | 74 | 84 | 93 | | | | % |
| FEF25 | 4.53 | | | | | | | | l/s |
| FEF50 | 3.64 | | | | | | | | l/s |
| FEF75 | 1.67 | | | | | | | | l/s |
| FEF25-75 | 3.21 | 73 | 3.03 | 4.38 | 5.74 | | | | l/s |
| FET | 2.2 | | | | | | | | s |

Lung Age < 25 yrs
Interpretation (ATS): Moderate restriction.

Flow Volume Loop




Volume Time Curve




Spirometry v1.33 17/07/23 05

Nizom ID: 009987
Sex: Male Age: 21
Factor: 100(South East Asian)
Height: 155cm Weight: 61kg BMI: 22.4
Smoking: 1-10 per day

Turbine Transducer

(* is for auto best; ^ for manual best)

| | FEV1 | FVC | FEV1/FVC | PEF | Var | Warning |
|---|---|---|---|---|---|---|
| Base Date: 17/07/23 | | | | | | |
| Base | 2.53 | 2.89 | 87.5 | 5.80 | -1% | Poor effort |
| Base | 2.57 | 2.95 | 87.1 | 5.77 | * | Short blow |

Variation is based on FEV1 + FVC.

ATS/ERS Quality Criteria (Forced):
Base: Not Met. Need 2 more good blow(s).

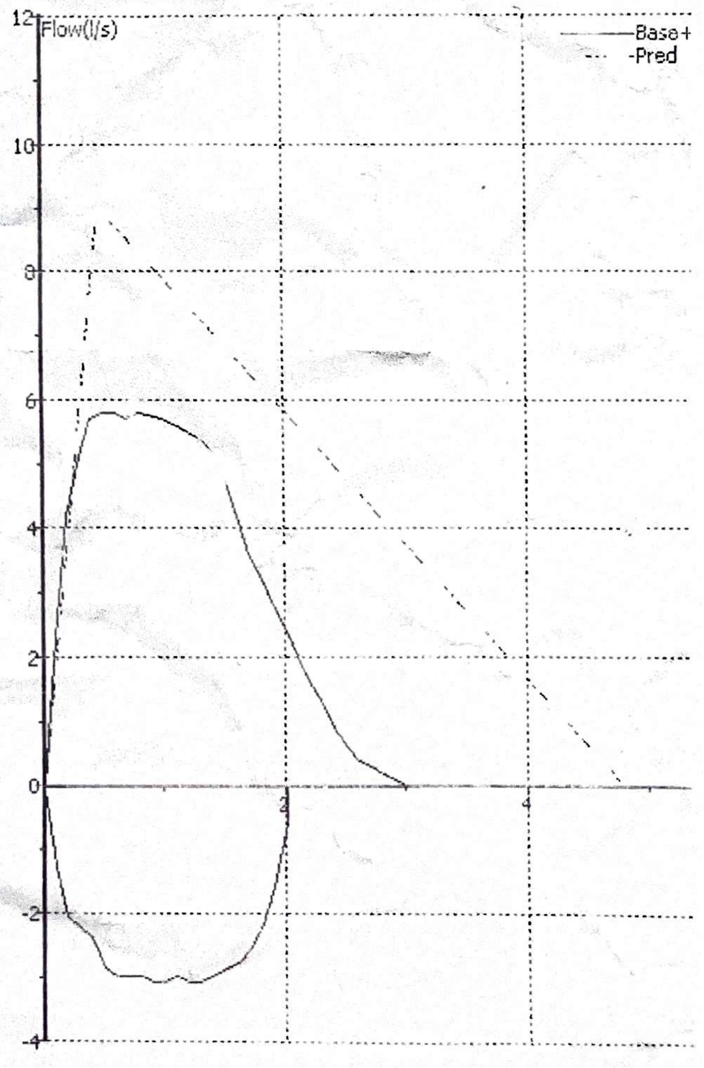
Any forced data and graphs following are either bes[t] individual values or composite curve.

Best Spirometry Result:

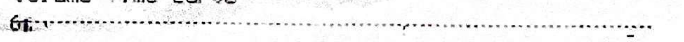
| | Base | %Pr | Min (Normal) | Pred (Normal) | Max (Normal) | Post (PostI) | %Pr (PostI) | %Chg (PostI) | |
|---|---|---|---|---|---|---|---|---|---|
| FEV1 | 2.57 | 64 | 3.36 | 4.04 | 4.72 | | | | l |
| FVC | 2.95 | 62 | 3.97 | 4.78 | 5.58 | | | | l |
| PEF | 5.77 | 64 | 7.02 | 9.01 | 11.0 | | | | l |
| FEV1/FVC | 87 | 104 | 74 | 84 | 93 | | | | % |
| FEF25 | 5.67 | | | | | | | | l |
| FEF50 | 4.53 | | | | | | | | l |
| FEF75 | 1.41 | | | | | | | | l |
| FEF25-75 | 3.41 | 76 | 3.09 | 4.47 | 5.84 | | | | l |
| FET | 3.1 | | | | | | | | s |

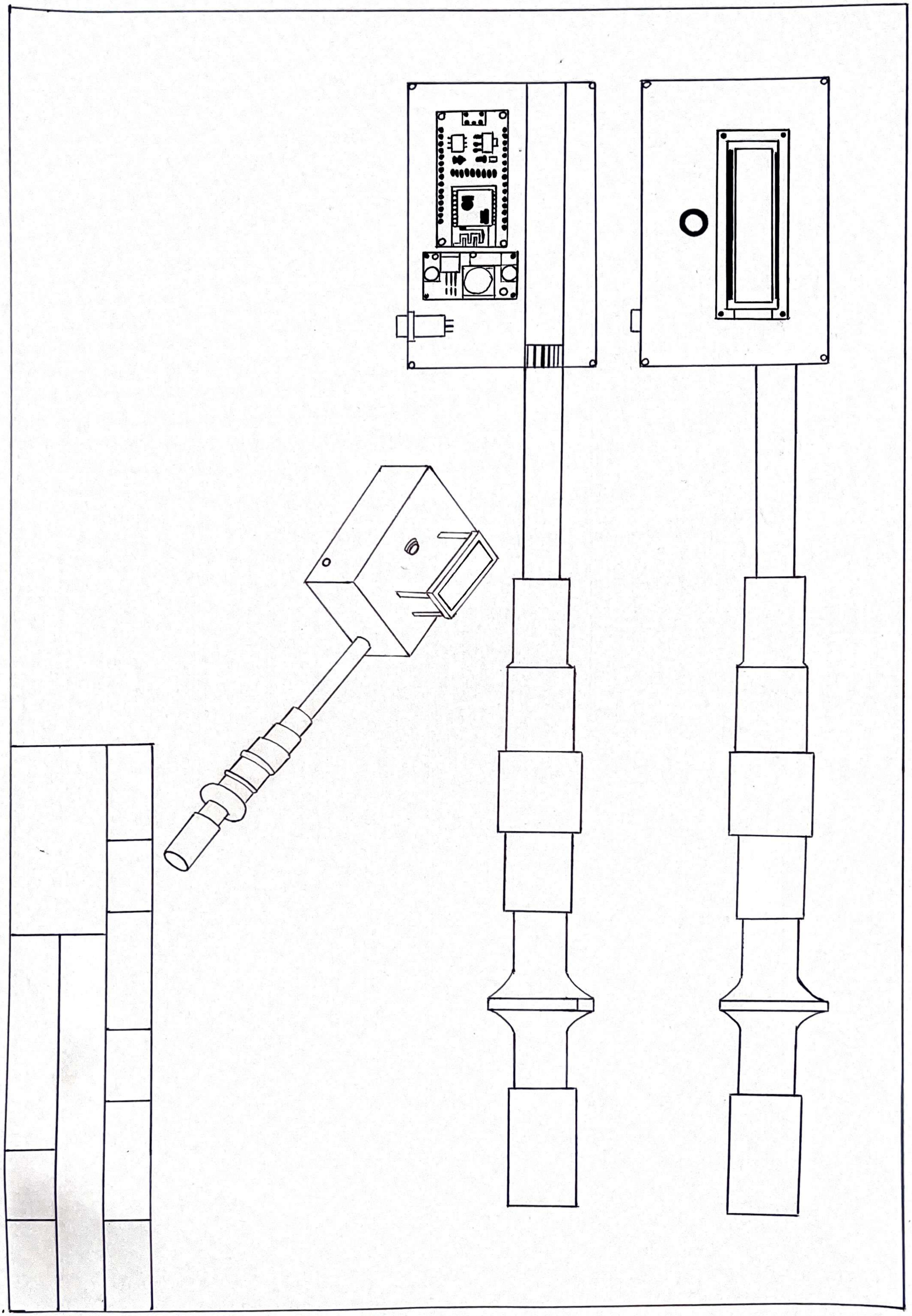
Lung Age < 25 yrs
Interpretation (ATS): Moderate restriction.

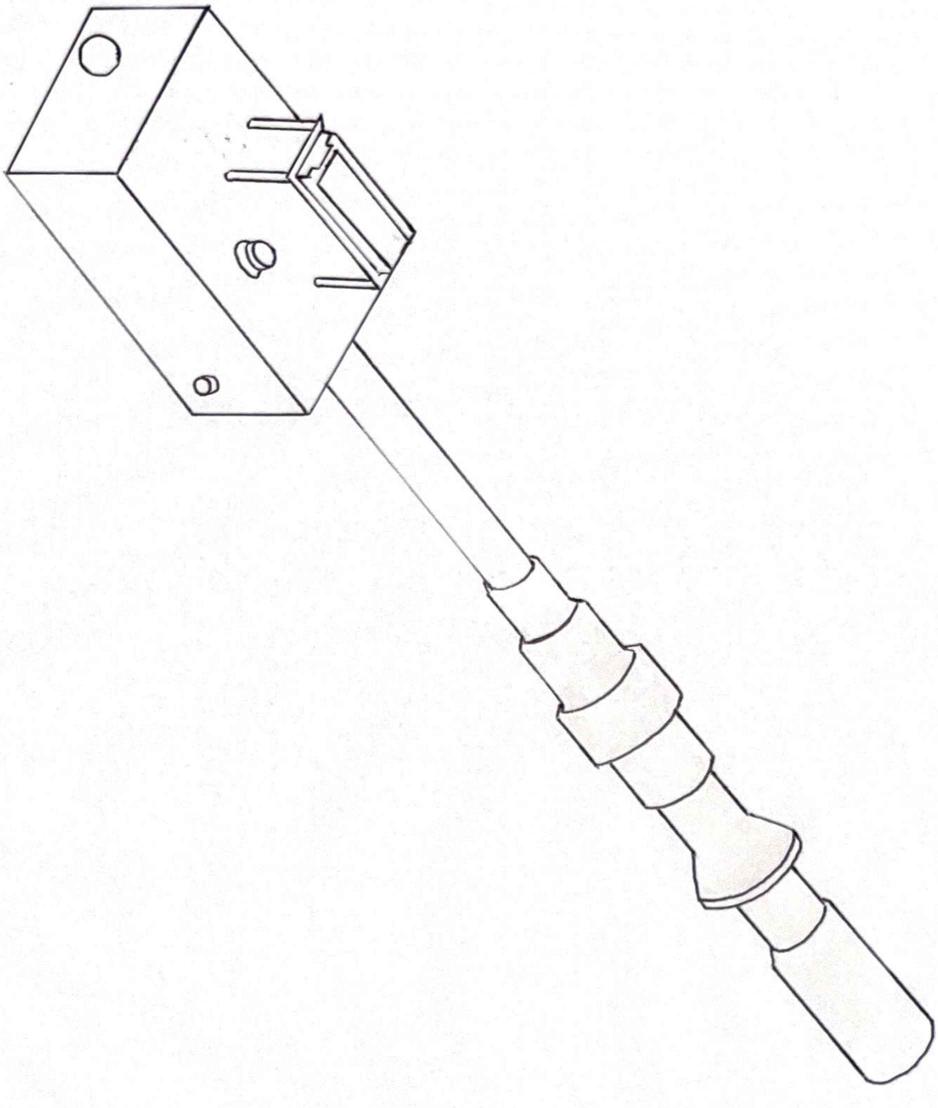
Flow Volume Loop




Volume Time Curve







**Kalibrasi Spirometry di BPFK Jakarta**

# Dokumentasi Pengambilan data


#LUCKISLOVE


LUCKY HOUR


# Lampiran *Source Code*

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#define BLYNK_TEMPLATE_ID "TMPL6JIGU9j9N"
#define BLYNK_TEMPLATE_NAME "Spirometer"
#define auth "4uD--34IZZbGR7c8JYphgexUpSfjOA_J"
char ssid[] = "Jooem";
char pass[] = "kalikali";
int Hasil = 0;

#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

//#include "HX710B.h"
const int DOUT = D6;   //sensor data pin
const int SCLK  = D5;   //sensor clock pin
float pressure = 0;
//HX710B pressure_sensor;
#define SENSOR  D3
#define button D7
#define vcc D8
int i = 0 ;
int logic = 0;
float samp = 0;
int ButtonPres;
int modde = 0;
long previousMillis = 0;
int interval = 1000;
boolean ledState = LOW;
float calibrationFactor = 1.1;  //awalnya 2 awal pertama 0,428
byte pulse1Sec = 0;
byte pulse1Sec1 = 0;
byte pulse1Sec2 = 0;
byte pulse1Sec3 = 0;
int count3 = 0;
int count4 = 0;

float flowRate;
unsigned long flowMilliLitres;
unsigned int totalMilliLitres;
float flowLitres;
float totalLitres;
volatile byte pulseCount;

float flowRate1;
unsigned long flowMilliLitres1;
unsigned int totalMilliLitres1;
float flowLitres1;
float totalLitres1;
volatile byte pulseCount1;
```

```
float flowRate2;
unsigned long flowMilliLitres2;
unsigned int totalMilliLitres2;
float flowLitres2;
float totalLitres2;
volatile byte pulseCount2;

float flowRate3;
unsigned long flowMilliLitres3;
unsigned int totalMilliLitres3;
float flowLitres3;
float totalLitres3;
volatile byte pulseCount3;

float difference, rasio;

void IRAM_ATTR pulseCounter()
{
  pulseCount++;
}

void setup() {
  pinMode(vcc, OUTPUT);
  pinMode(button, INPUT_PULLUP);
  digitalWrite(vcc, LOW);
  lcd.begin();
  Serial.begin(57600);
 // pressure_sensor.begin(DOUT, SCLK);
  pinMode(SENSOR, INPUT_PULLUP);
  pulseCount = 0;
  flowRate = 0.0;
  flowMilliLitres = 0;
  totalMilliLitres = 0;
  previousMillis = 0;
  attachInterrupt(digitalPinToInterrupt(SENSOR), pulseCounter, RISING);
  lcd.setCursor (0, 0); lcd.print("Spirometer      ");
  Blynk.begin(auth, ssid, pass);
  yield();
  delay(5000);
}

void loop() {
  ButtonPres = digitalRead(button);
  Serial.print("Hasil = ");
  Serial.println(Hasil);
  if (ButtonPres == 0) {
    logic = 1;
    flowRate = 0.0;
    i = i + 1;
    Serial.println(i);
    delay(50);
    if (i > 30) {
      lcd.setCursor (0, 0); lcd.print("   Pengujian    ");
      lcd.setCursor (0, 1); lcd.print(" Telah Selesai  ");
```

```
    Blynk.run();
    delay(3000);
    if (Hasil == 1) {
      Blynk.logEvent("spirometer_result", "Hasil Uji Paru-Paru Normal") ;
    }
    if (Hasil == 2) {
      Blynk.logEvent("spirometer_result", "Hasil Uji Paru-Paru Obstruksi Ringan") ;
    }
    if (Hasil == 3) {
      Blynk.logEvent("spirometer_result", "Hasil Uji Paru-Paru Obstruksi Sedang") ;
    }
    if (Hasil == 4) {
      Blynk.logEvent("spirometer_result", "Hasil Uji Paru-Paru Obstruksi Berat") ;
    }
    if (Hasil == 5) {
      Blynk.logEvent("spirometer_result", "Hasil Tidak Valid") ;
    }
  }
}
if (ButtonPres == 1 && logic == 1 && i <= 30) {
  modde = modde + 1;
  logic = 0;
  i = 0 ;
}
if (ButtonPres == 1 && logic == 1 && i > 30) {
  modde = 0;
  logic = 0;
  i = 0 ;
  totalLitres = 0;
  totalLitres1 = 0;
  totalLitres2 = 0;
  totalLitres3 = 0;
  Hasil = 0;
}
if (modde == 8) {
  modde = 1;
}
if (modde == 0) {
  //i = 0;
  lcd.setCursor (0, 0); lcd.print("   Spirometer   ");
  lcd.setCursor (0, 1); lcd.print("  Push to Start ");
}
if (modde == 1) {
  digitalWrite(vcc, HIGH);
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis > 100)
  {
    pulse1Sec = pulseCount;
    pulseCount = 0;
    flowRate = ((100.0 / (millis() - previousMillis)) * pulse1Sec) * calibrationFactor;
    flowMilliLitres = (flowRate / 60) * 1000;
    flowLitres = (flowRate / 60);
    if (flowLitres >= 0.05) {
      totalLitres += flowLitres;
    }
```

```
    Serial.print("Flow rate: ");
    Serial.print(float(totalLitres));  // Print the integer part of the variable
    Serial.print("L");
    Serial.println("\t");
    previousMillis = millis();
  }
  //    totalLitres = map(totalLitres, 0, 51, 0, 40);
  lcd.setCursor (0, 0); lcd.print("Pengujian 1 FVC ");
  lcd.setCursor (0, 1); lcd.print("FVC = ");
  lcd.setCursor (5, 1); lcd.print(totalLitres); lcd.print("           ");
}

if (modde == 2) {
  digitalWrite(vcc, HIGH);
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis > 100)
  {
    pulse1Sec1 = pulseCount;
    pulseCount = 0;
    flowRate1 = ((100.0 / (millis() - previousMillis)) * pulse1Sec1) * calibrationFactor;
    flowMilliLitres1 = (flowRate1 / 60) * 1000;
    flowLitres1 = (flowRate1 / 60);
    if (flowLitres1 >= 0.05) {
      totalLitres1 += flowLitres1;
    }
    Serial.print("Flow rate: ");
    Serial.print(float(totalLitres1));  // Print the integer part of the variable
    Serial.print("L");
    Serial.println("\t");
    previousMillis = millis();
  }
  //    totalLitres = map(totalLitres, 0, 51, 0, 40);
  lcd.setCursor (0, 0); lcd.print("Pengujian 2 FVC ");
  lcd.setCursor (0, 1); lcd.print("FVC = ");
  lcd.setCursor (5, 1); lcd.print(totalLitres1); lcd.print("           ");
}
if (modde == 3) {
  digitalWrite(vcc, HIGH);
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis > 100) {
    pulse1Sec2 = pulseCount;
    pulseCount = 0;
    flowRate2 = ((100.0 / (millis() - previousMillis)) * pulse1Sec2) * calibrationFactor;
    flowMilliLitres2 = (flowRate2 / 60) * 1000;
    flowLitres2 = (flowRate2 / 60);
    if (flowLitres2 >= 0.05) {
      count3 = count3 + 1;
    }
    if (count3 >= 3 && count3 < 11) {
      totalLitres2 += flowLitres2;
    }
    Serial.print("Flow rate: ");
    Serial.print(float(totalLitres2));  // Print the integer part of the variable
    Serial.print("L");
    Serial.println("\t");
```

```
    previousMillis = millis();
  }
  lcd.setCursor (0, 0); lcd.print("Pengujian 3 FEV1");
  lcd.setCursor (0, 1); lcd.print("FEV1= ");
  lcd.setCursor (5, 1); lcd.print(totalLitres2); lcd.print("           ");
}
if (modde == 4) {
  digitalWrite(vcc, HIGH);
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis > 100) {
    pulse1Sec3 = pulseCount;
    pulseCount = 0;
    flowRate3 = ((100.0 / (millis() - previousMillis)) * pulse1Sec3) * calibrationFactor;
    flowMilliLitres3 = (flowRate3 / 60) * 1000;
    flowLitres3 = (flowRate3 / 60);
    if (flowLitres3 >= 0.05) {
      count4 = count4 + 1;
    }
    if (count4 >= 3 && count4 < 11) {
      totalLitres3 += flowLitres3;
    }
    Serial.print("Flow rate: ");
    Serial.print(float(totalLitres3));  // Print the integer part of the variable
    Serial.print("L");
    Serial.println("\t");
    previousMillis = millis();
  }
  lcd.setCursor (0, 0); lcd.print("Pengujian 4 FEV1");
  lcd.setCursor (0, 1); lcd.print("FEV1= ");
  lcd.setCursor (5, 1); lcd.print(totalLitres3); lcd.print("           ");
}
if (modde == 5) {
  count3 = 0;
  count4 = 0;
  lcd.setCursor (0, 0); lcd.print("1= "); lcd.print(totalLitres); lcd.print("    ");
  lcd.setCursor (9, 0); lcd.print("2= "); lcd.print(totalLitres1); lcd.print("    ");
  lcd.setCursor (0, 1); lcd.print("3= "); lcd.print(totalLitres2); lcd.print("    ");
  lcd.setCursor (9, 1); lcd.print("4= "); lcd.print(totalLitres3); lcd.print("    ");
}
if (modde == 6) {
  difference = (totalLitres - totalLitres1) / ((totalLitres + totalLitres1) / 2) * 100;
  difference = abs(difference);
  rasio = ((totalLitres2 + totalLitres3) / 2) / ((totalLitres + totalLitres1) / 2) * 100;
  lcd.setCursor (0, 0); lcd.print("Diff FVC="); lcd.print(difference); lcd.print("%      ");
  lcd.setCursor (0, 1); lcd.print("Rasio   ="); lcd.print(rasio); lcd.print("%        ");
}
if (modde == 7) {
  if (totalLitres == 0 || totalLitres1 == 0 || totalLitres2 == 0 || totalLitres3 == 0) {
    Hasil = 5;
  }
  if (difference > 10) {
    lcd.setCursor (0, 0); lcd.print("Diff Uji FVC>10%");
    lcd.setCursor (0, 1); lcd.print("Ulangi Pengujian");
  }
  if (difference <= 10) {
```

```
    if (rasio > 80) {
      lcd.setCursor (0, 0); lcd.print("Hasil Uji Paru :");
      lcd.setCursor (0, 1); lcd.print("Normal          ");
      Hasil = 1;
    }
    if (rasio <= 80 && rasio >= 60) {
      lcd.setCursor (0, 0); lcd.print("Hasil Uji Paru :");
      lcd.setCursor (0, 1); lcd.print("Obstruksi Ringan");
      Hasil = 2;
    }
    if (rasio < 60 && rasio >= 30) {
      lcd.setCursor (0, 0); lcd.print("Hasil Uji Paru :");
      lcd.setCursor (0, 1); lcd.print("Obstruksi Sedang");
      Hasil = 3;
    }
    if (rasio < 30) {
      lcd.setCursor (0, 0); lcd.print("Hasil Uji Paru :");
      lcd.setCursor (0, 1); lcd.print("Obstruksi Berat ");
      Hasil = 4;
    }
  }
  Serial.print(totalLitres);
  Serial.print("  ||  ");
  Serial.print(totalLitres1);
  Serial.print("  ||  ");
  Serial.print(flowRate);
  Serial.print("  ||  ");
  Serial.print( flowRate1);
  Serial.print("  ||  ");
  Serial.println(modde);
 }
}
```