Prince Mohammad University
Department of Electrical Engineering

*Power Monitoring System

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Outline

- Project definition
- Project Objectives
- Project Specifications
- Project Architecture
- Planning
- Background & Previous Projects
- Design: Subsystems and Component Selection
- Testing
- Project Management & Team Work
- Completed
- Budget
- References

Project Definition

In this project, a smart energy meter is designed which is used to measure voltages and current to calculate power consumption. This would enables us to calculate energy consumption and control home appliances by using WiFi enabled control device.

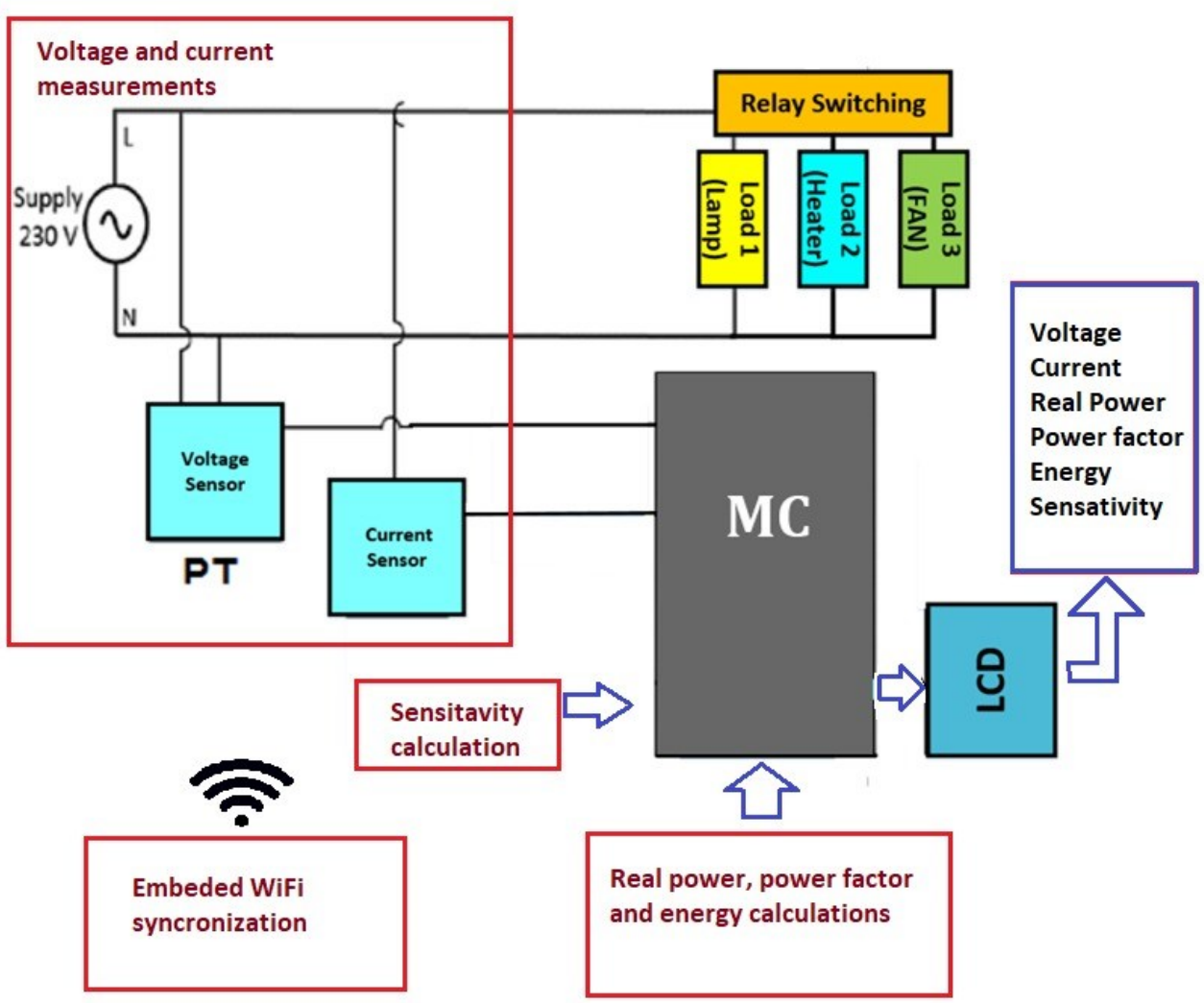
Project Objectives

* Increase public awareness about impact of high electricity consumption
* Encourage adoption of energy conservation, efficiency and demand control measures
* Demonstrate smart energy metering and automated appliances control
* Make a single solution to monitor the energy consumption and control of appliances that is one of the solution provided for constructing smart HOMES.
* Help consumers find which node is best to connect big loads.

Project Specifications

* Assumes home powered from grid (220V, 60Hz)
* Digitally measure consumption of electricity by measuring current, voltage, power factor.
* Digitally measure consumption of electricity by measuring voltage to load sensitivity and energy consumed.
* A mobile application is developed to remotely communicate with the Main Control Energy system.
* WiFi enabled appliances/load control switching control system
* Control all appliances remotely to save energy
* Compact design with a dimension of 10.5 in * 8.5 in * 2 in.

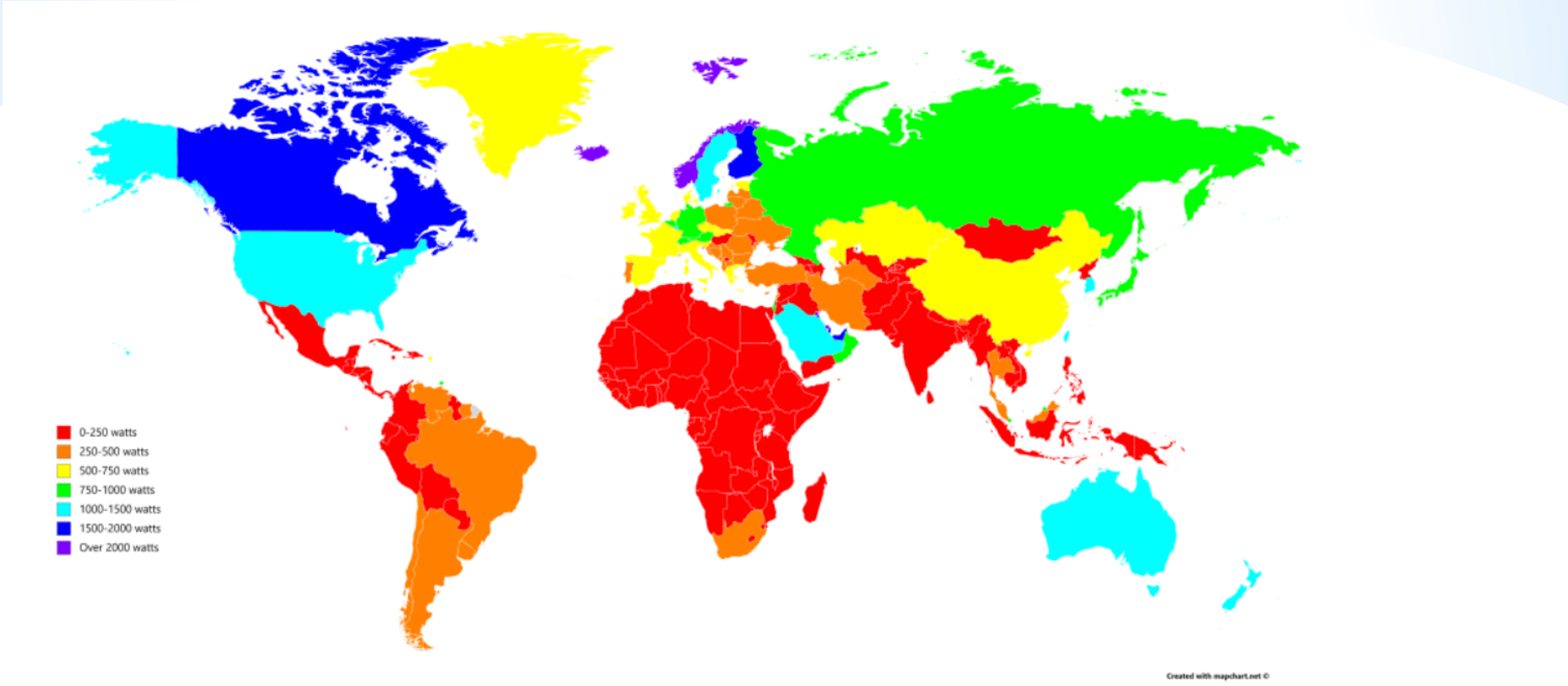
Project Architects



Planning

* Initial Pre-feasibility is performed with an objective to verify the demand of such system locally, our finding are
  - Taking samples from complaints to the Saudi Power Company from social media
  - considering the Increasing in the prices of energy
  - How our proposed smart energy metering system will help the society
  - Most of the components of this project are available locally while we need some component to order, we can get these components within a period of 1 weeks.
* All the testing of this project can be performed at PMU Lab facilities

* Background: Electricity Consumption Per Person Around The World



Background: Smart Energy System

* The present system of energy metering as well as billing in Saudi Arabia uses electromechanical and somewhere digital energy meter.
* It consumes more time and labour.
* One of the prime reasons is the traditional billing system which is inaccurate.
* Many times slow, costly, and lack in flexibility as well as reliability.

Background: Smart Energy System

* Today accuracy in electricity billing is highly recommended.
* The smart energy meter gives real power consumption as well as accurate billing.
* It provides real time monitoring of electricity uses
* It is less time consuming and cost effective.

Background: Smart Energy Meter Advantages

Existing Energy Meter	Smart Energy Meter
Electromechanically	Digital
No voltage senstivity	Accurate billing
No load control	Wifi Load control

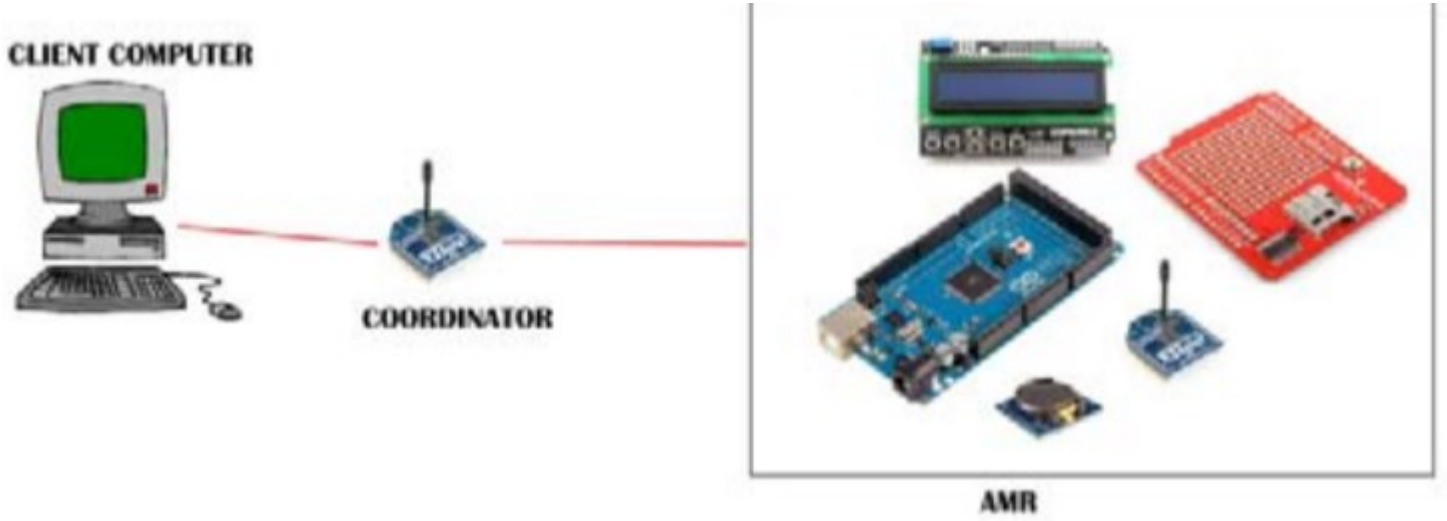
Previous Projects (1)

* **Design of an Automatic Meter Reading System By** Universiti Teknologi MARA System

  * Billing

  * Design a communication system between client and Arduino Dataa

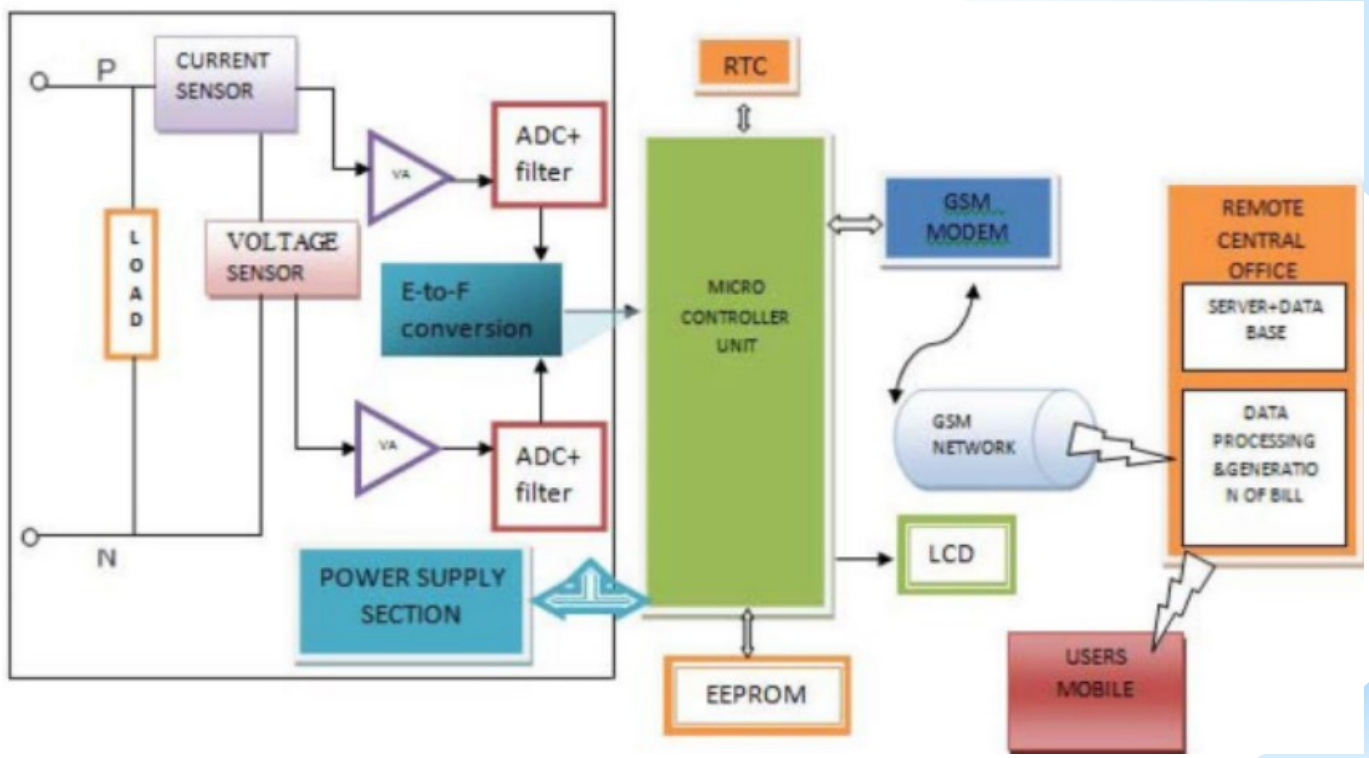
  * Based on Arduino Mega zigbee and pulse sensor



Previous Projects (2)

* Automated Meter Reading System, University OMR, Kalavakkam Tamilnadu, April 2015

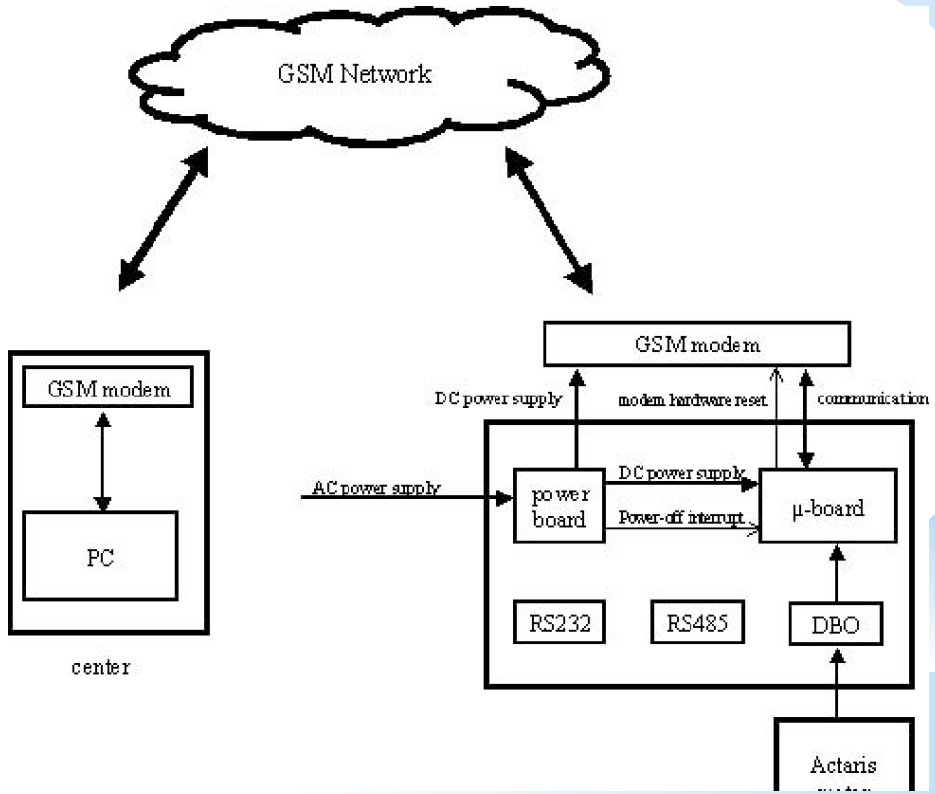
* GSM network.
* LCD.
* RTC (Real Time Clock).



Previous Projects (3)

* SMS-based Reconfigurable Automatic Meter Reading System by Abdollahi Ali, Marjan Dehghani, and Negar Zamanzadeh. IEEE International Conference on Control Applications. IEEE, 2007.

* Power measuring using uboard and Power board IC
* GSM communication



Previous Projects Summary

Projects	1	2	3	Our Project
Smart meter	√	√	√	√
Communication GSM, Zigbee, WiFi	Zigbee	Wi-Fi	GSM	Wi-Fi
monitoring	√	√	√	√
Energy	√	√	√	√
Sensitivity Measuring				√

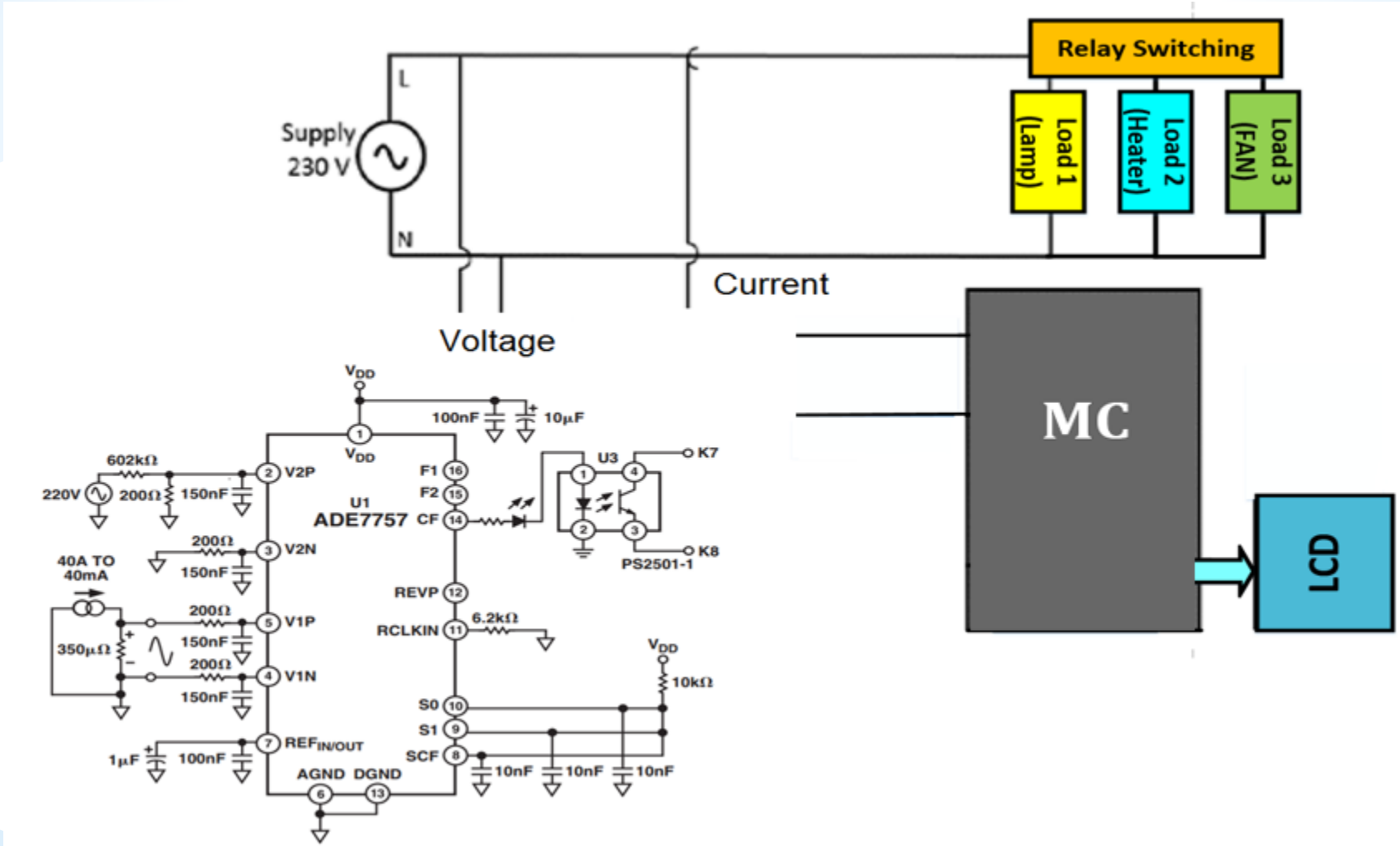
Design: Subsystem 1 – Power Measurement

We needed to measure the voltage and the current accurately and display it on a screen

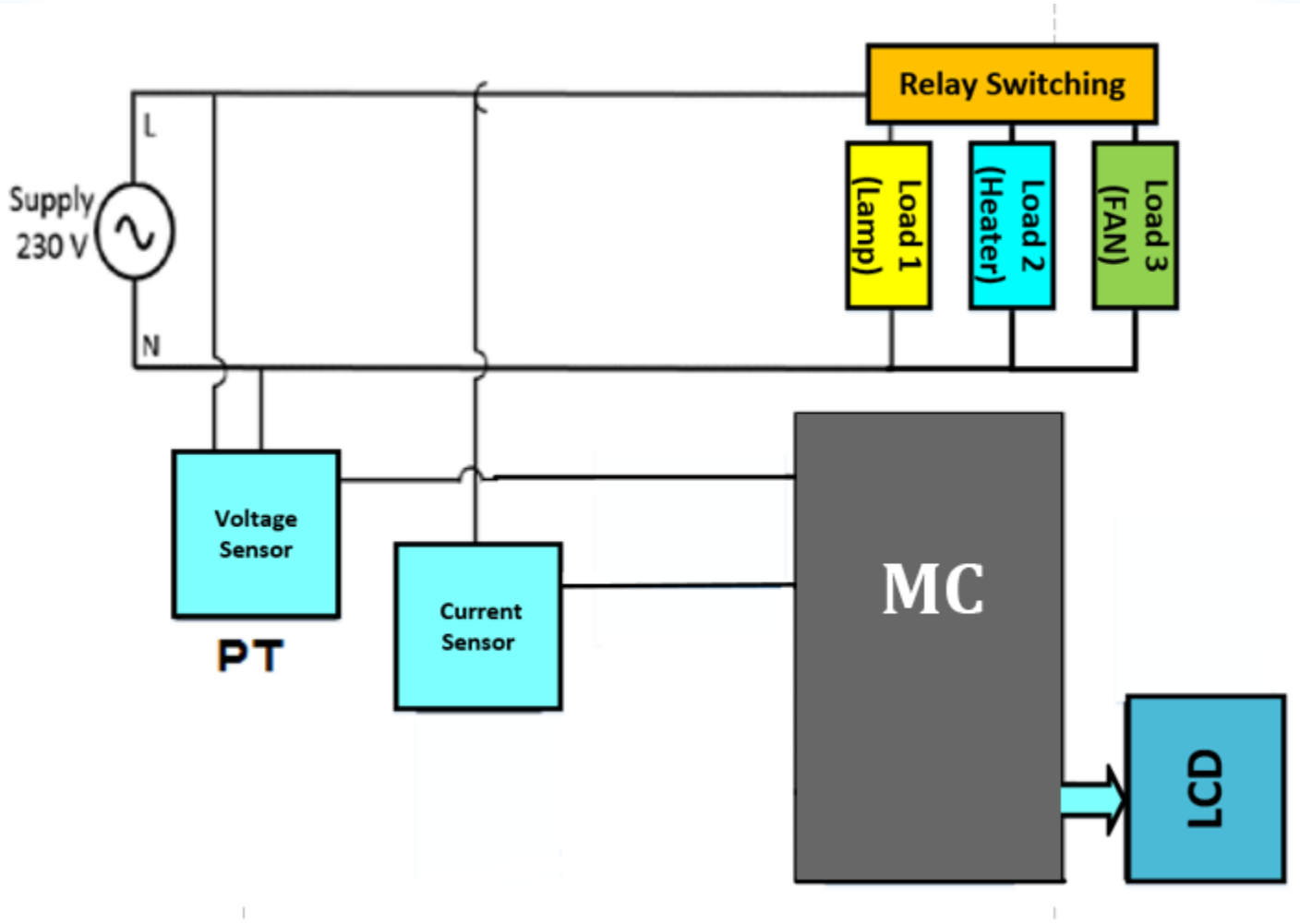
Things we needed to take into consideration:

- No DC measurement because our next step is measuring the power factor
- The controller can not read below zero values
- Both Current and Voltage need to be accurate

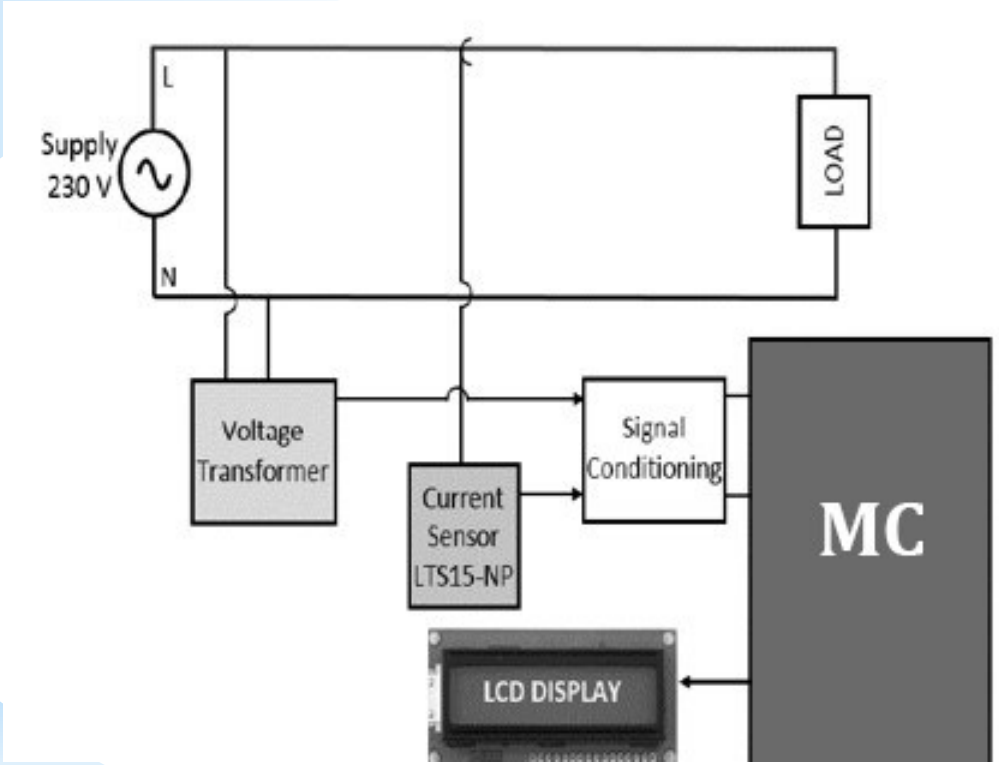
Design: Structure Option-1

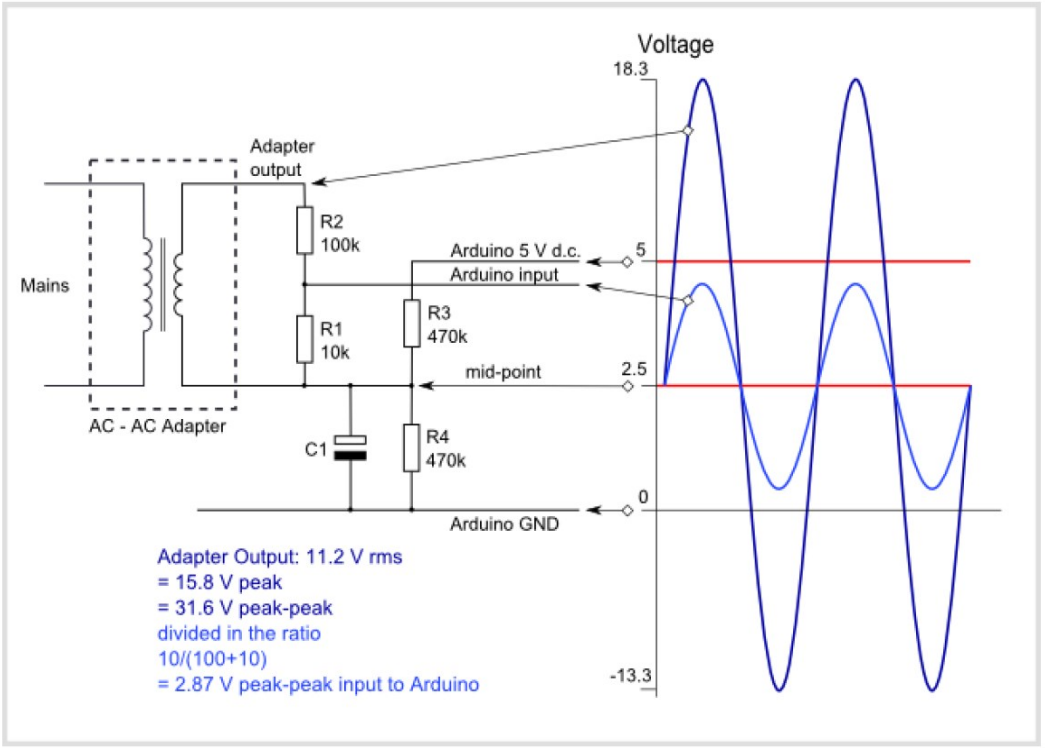


Design: Structure Option-2

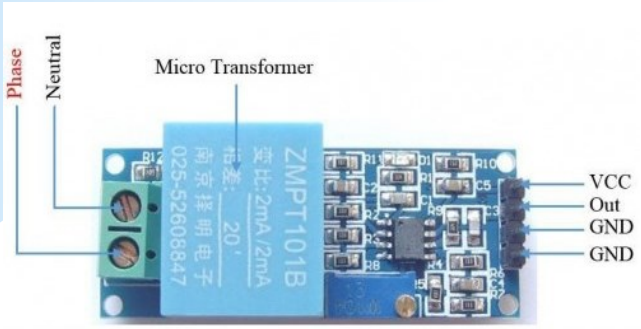


*DESIGN: STRUCTURE OPTION-3





Design: Subsystem 1 – Alternative component list



Magnelabe **split-core** CT:

Voltage sensor

Design: Subsystem 1 - Components used

Voltage Transformer

Design: Subsystem 1 – why select these component

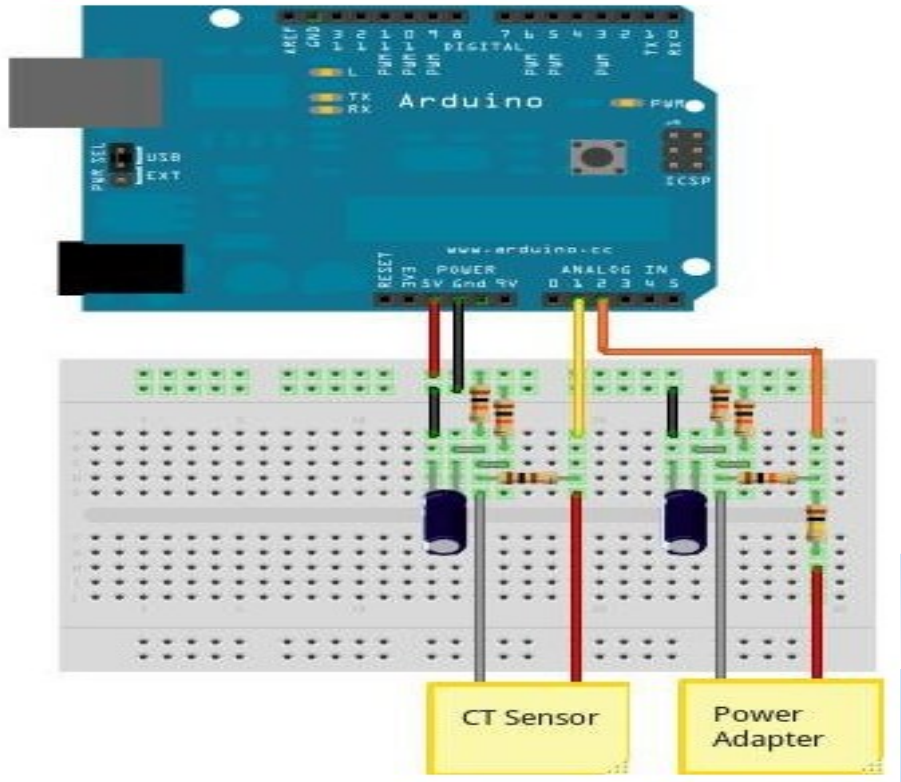
	CT	Voltage transformer	Voltage sensor	Current sensor	Power meter IC
Easy availability	√	√	√	√	
Can be replaced easily	√	√	√	√	
Economical	60sr	140sr	150sr	90sr	1500-5000 sr
Accurate	√	√	√		√
Can use emon.lib with the selected components	√	√		√	
Precision	√	√		√	√

*Design: Subsystem 2 – Power Factor

In electrical engineering, the power factor of an AC electrical power system is defined as the ratio of the real power absorbed by the load to the apparent power flowing in the circuit

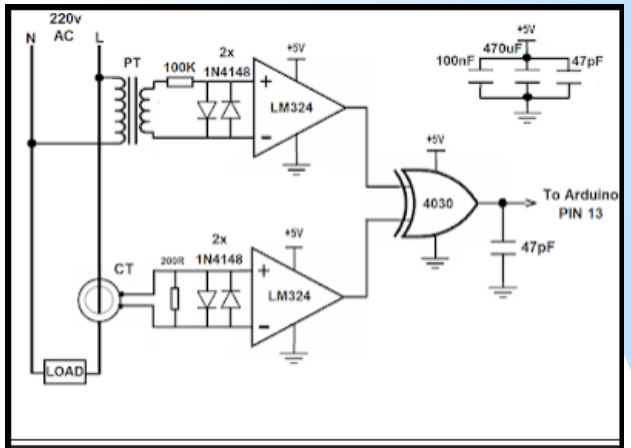
Option 1

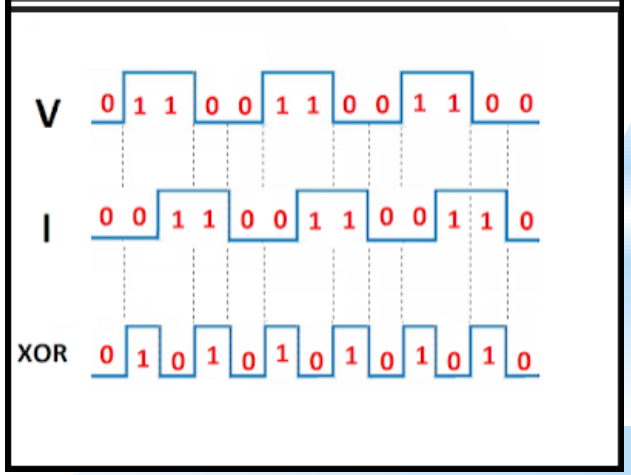
Using Electricity monitoring library on Arduino IDE to measure mains voltage and current time difference, so we can display the power factor



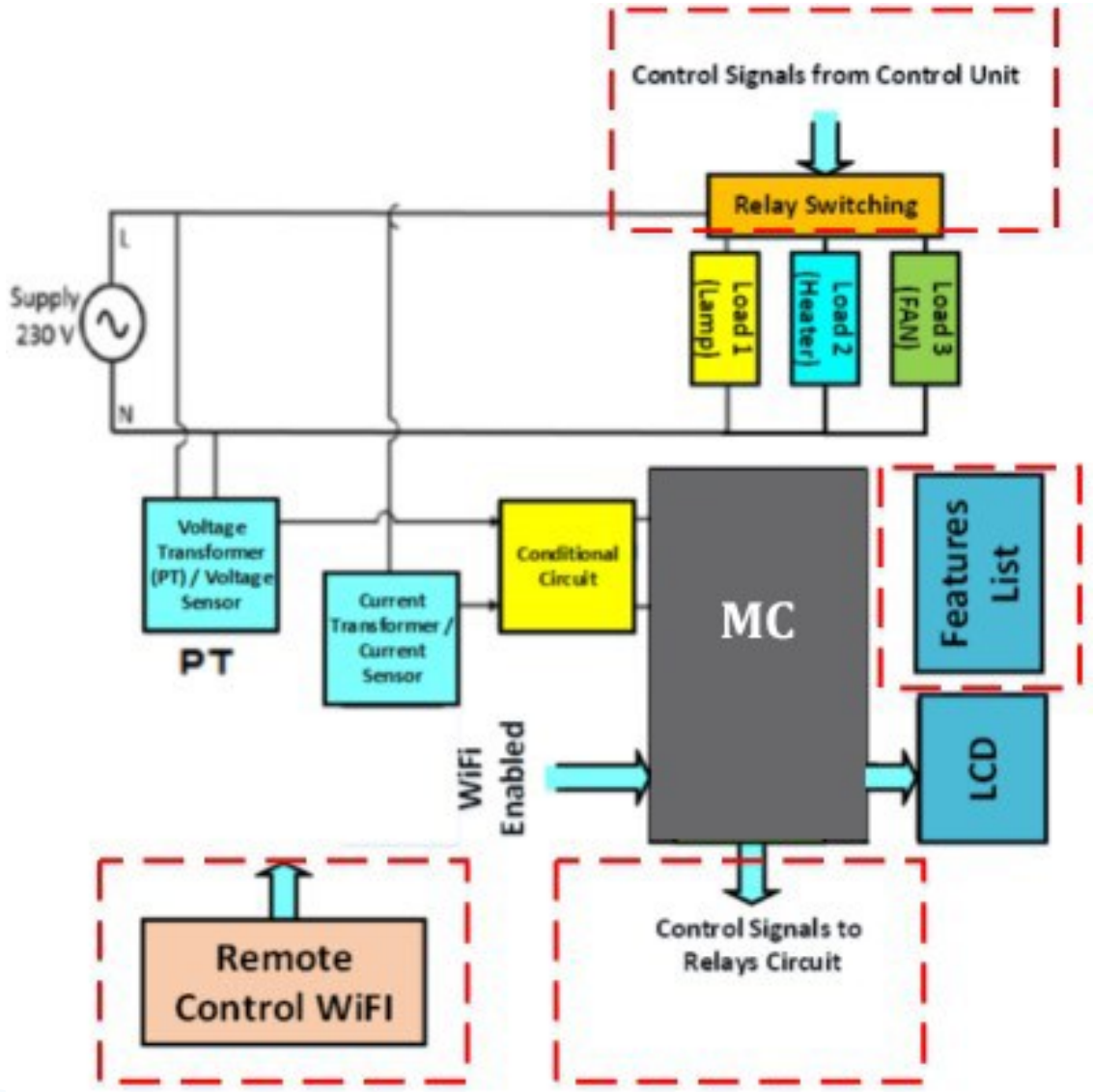
Design: Structure Option-2

The circuit consists of Current transformer(CT) and Voltage or potential transformer(PT). Filtering capacitors in this circuit is important to removing power supply noise(voltage ripple) to insure logic gate works well.





Design: Subsystem 3 – WIFI and Billing



Design: Subsystem 4 – Voltage to load sensitivity

* Voltage to load sensitivity is used measure how far and close the node is to the grid.

Application:

* Optimal battery placement
* Controlling renewables generation
* Controlling electric vehicles charging rate

Project: Completed Work

*Subsystem 1: Power measuring system is completed successfully.

*The testing and measurement of the systems are performed.

*Successfully measured the power and displayed it on the LCD

- Subsystem 2:Research done on the options to implement it
- Implementing the various option that we have presented.
- Testing
- Subsystem 3: Research done

Project: Completed work

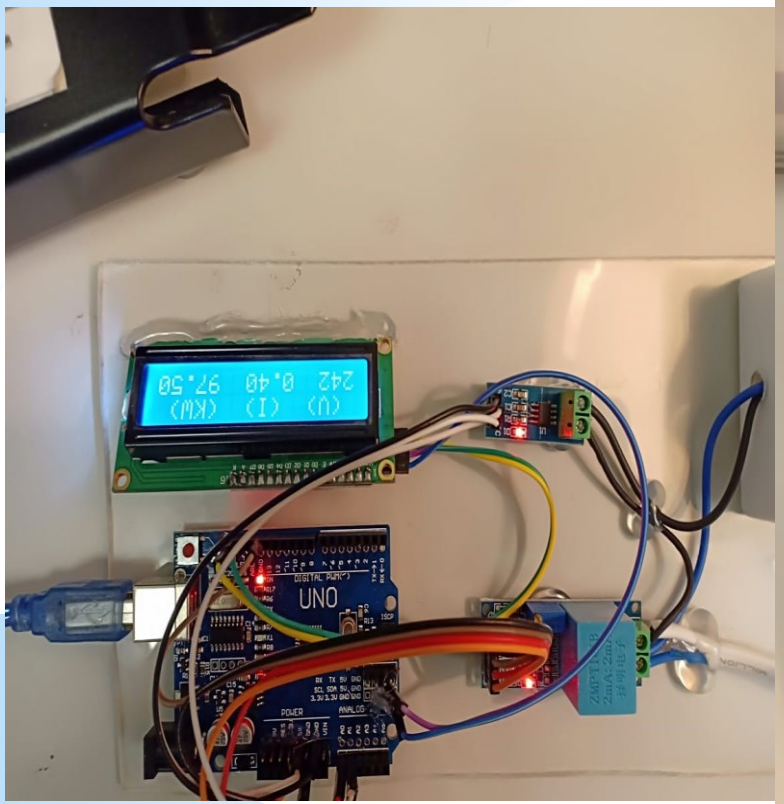
Subsystem 3:

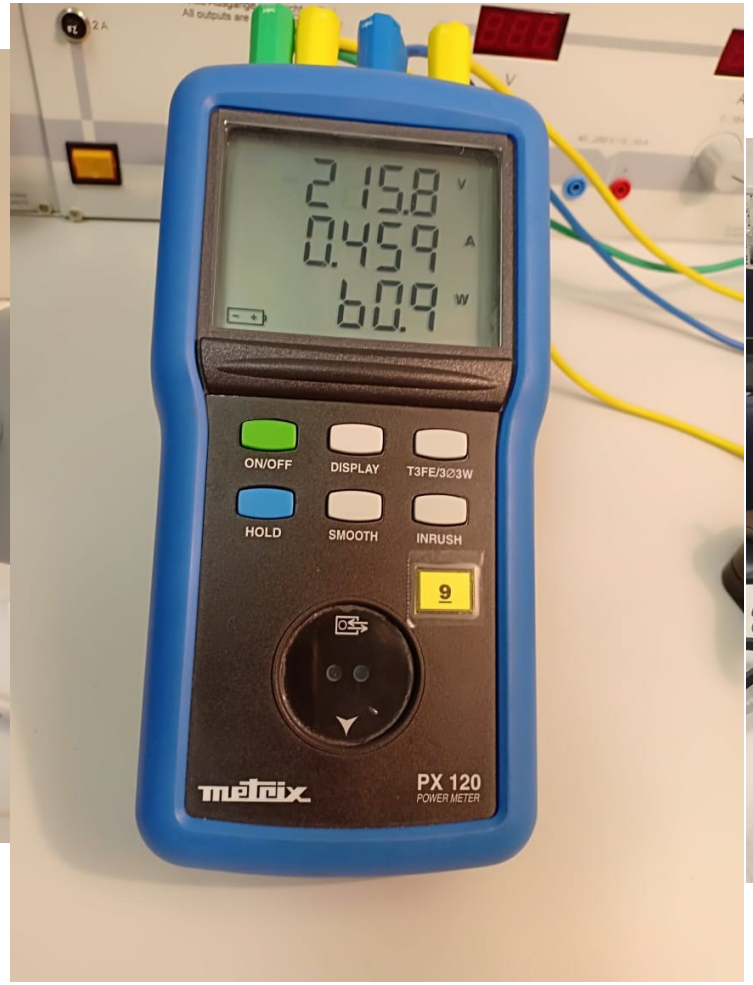
* The third phase of the project is the complete system implementation.
* The loads could be controlled using WiFi
* The status of power consumption could be displayed to the consumer
* We will notify the consumer for their consumption weekly.

Subsystem 4:

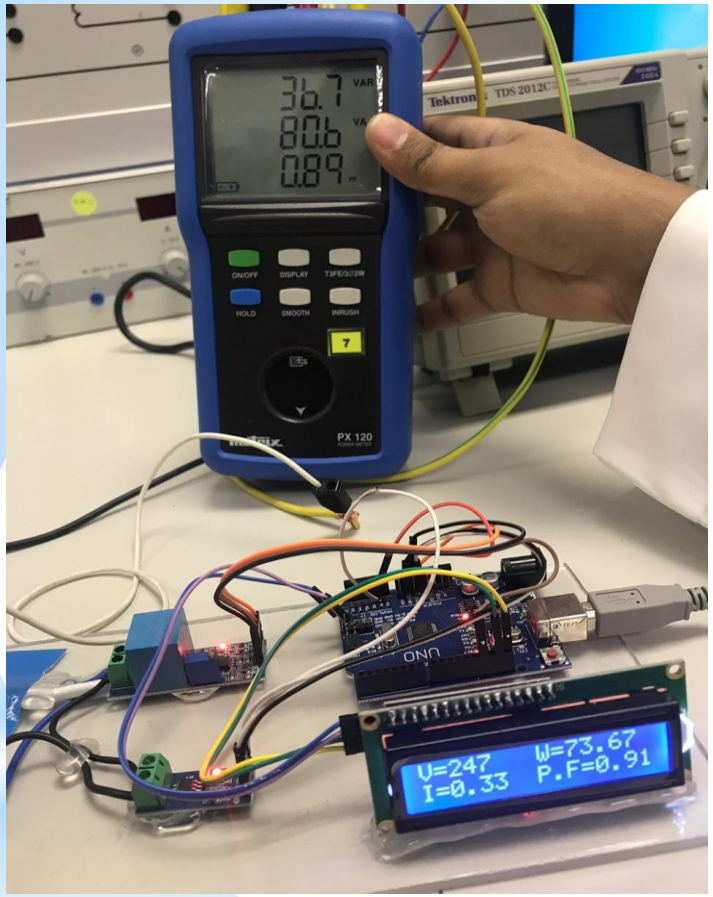
* Finish the research on the Voltage sensitivity due to power flow
* Writing the code.

Testing

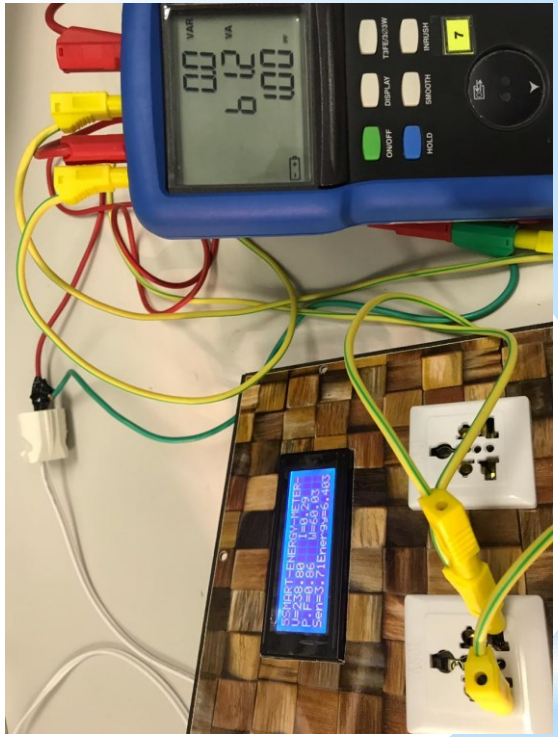

UNO


215.8
0.459
60.9
ON/OFF
DISPLAY
T3FE/3Ø3W
HOLD
SMOOTH
INRUSH
9
metrix
PX 120
POWER METER

Testing


V=247 W=73.67
I=0.33 P.F=0.91


SMART-ENERGY-METER-
V=238.86 I=0.33
P.F=0.95 W=72.75
Sen=3.67Energy=6.529



Testing

Load	Power factor (cos(θ))	Energy (KWmin)	Voltage to load Sensitivity V(t)-V(t-u) / P(t)-P(t-u)
Lamp 60 W	0.97	6.4	0.2
Lamp 30 W	0.92	5.2	0
Fan	0.83	5.6	0
Heater	0.97	115	2.3

Testing

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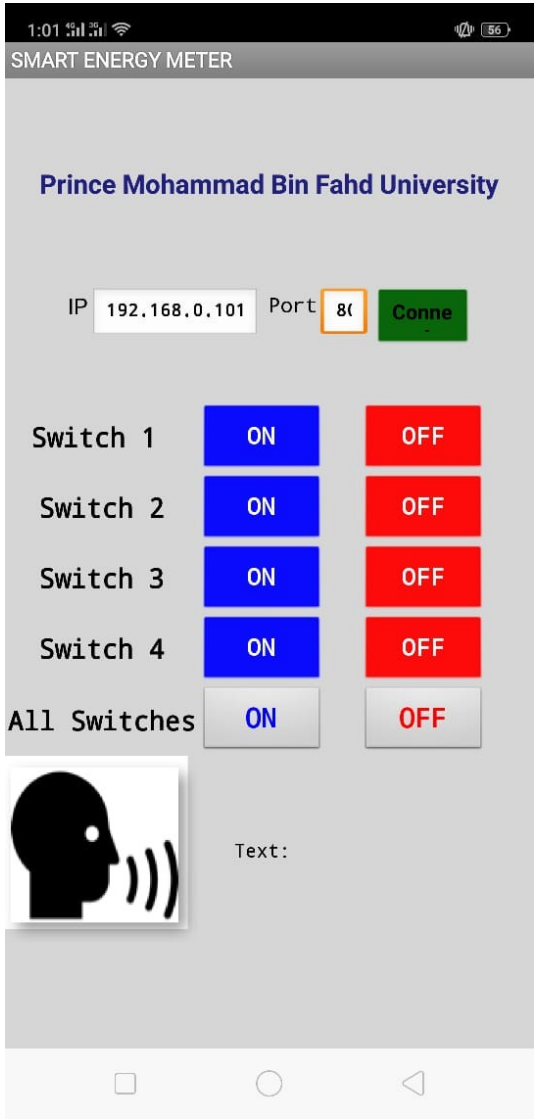
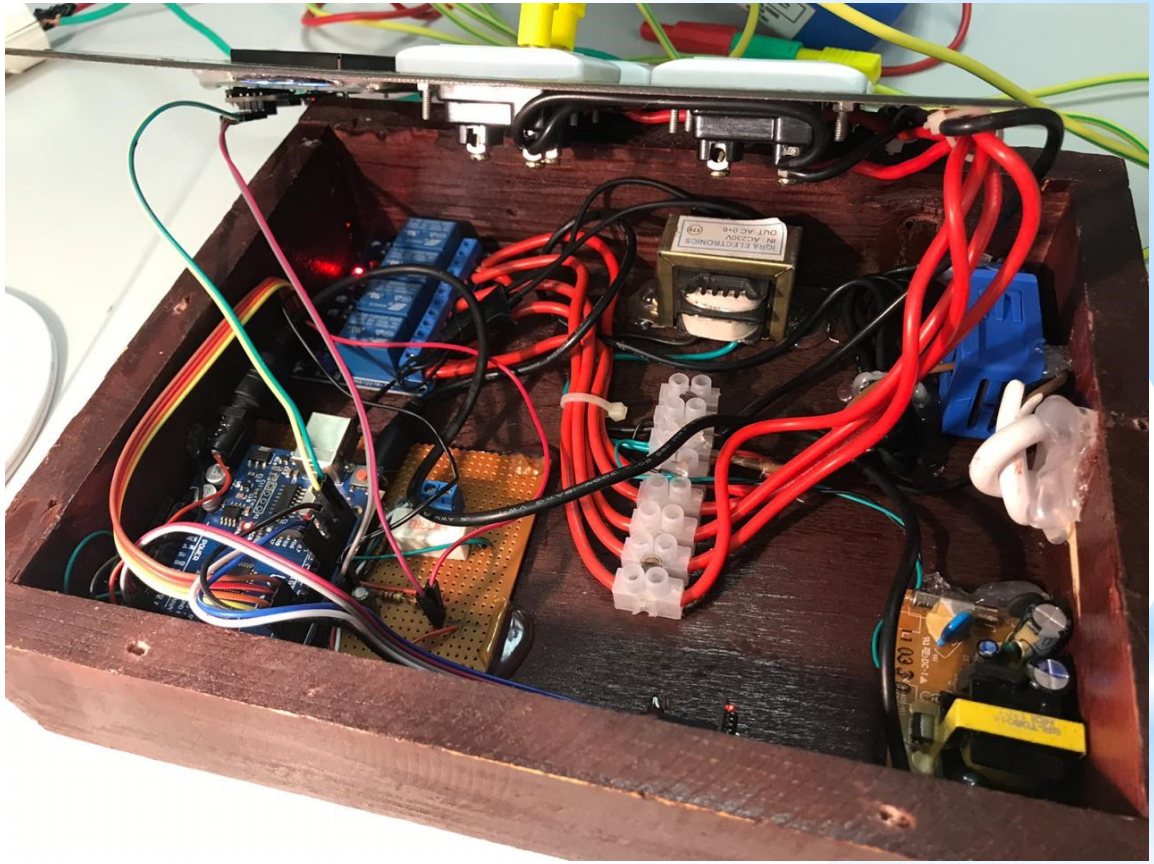
*Final product



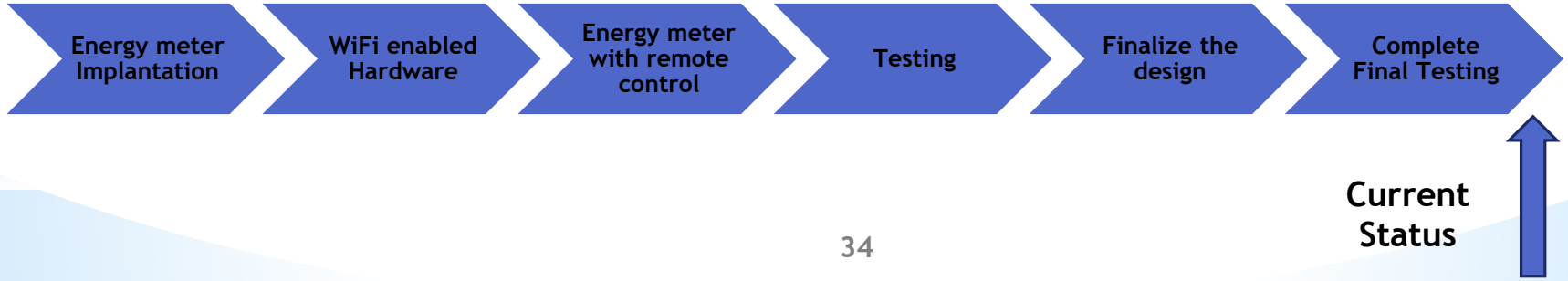


Project Management & Team Work

* Project Management Plan

Phase-1

Phase-2



Project Management & Team Work

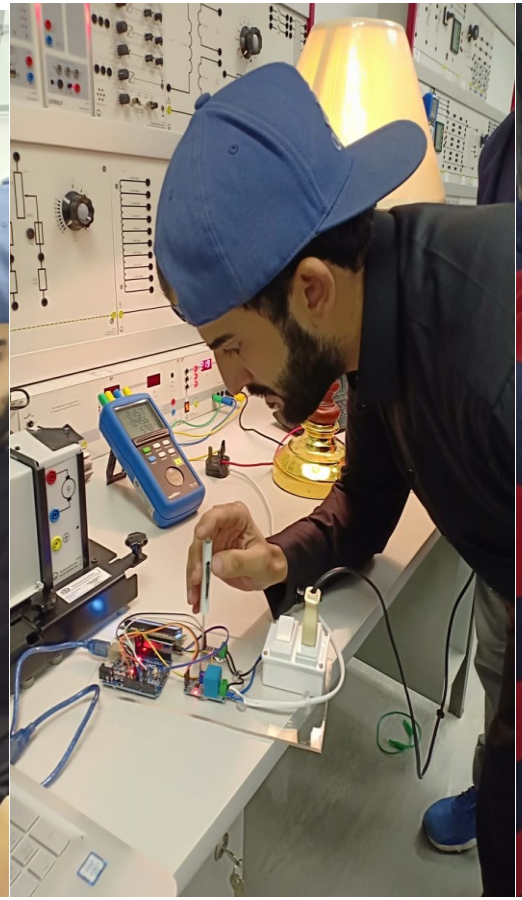
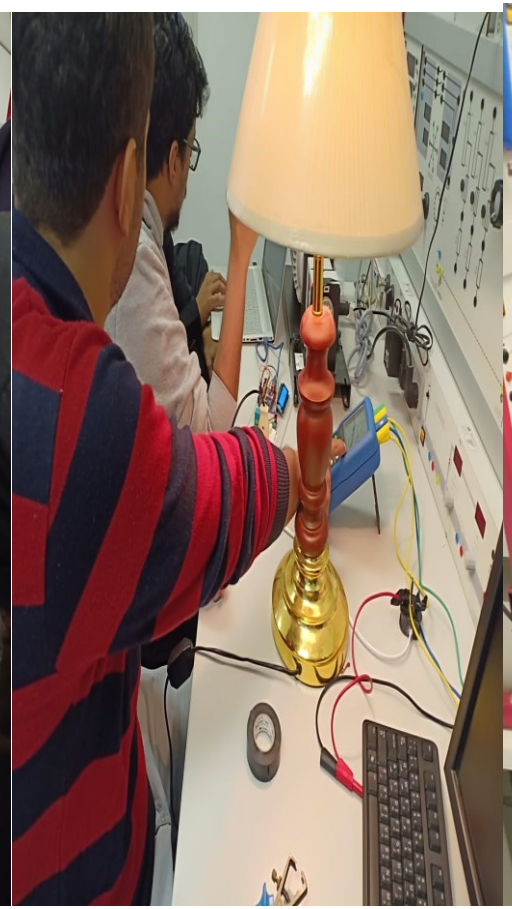
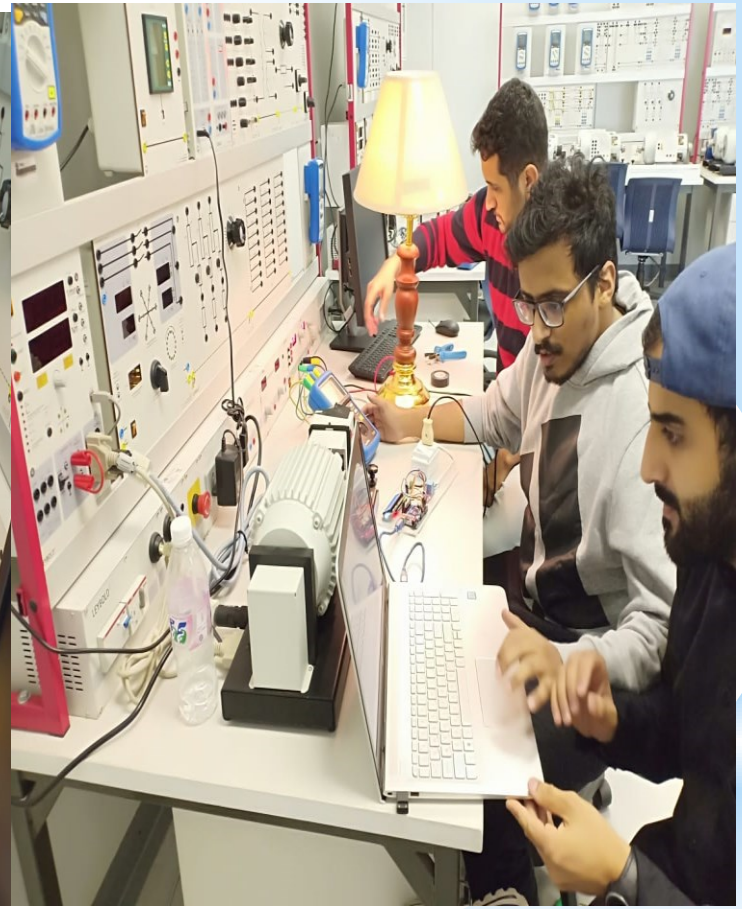
Task	Abdullah	Khalid	Ahmed	Mohammed	Task Total
Search & acquire components	30%	20%	35%	15%	100%
Design Subsystems	25%	30%	20%	25%	100%
Test Subsystems	30%	25%	15%	30%	100%
Write Reports & Presentations	25%	25%	20%	30%	100%

Project Management & Team Work

* **Challenges & Decision Making**

1. Design of the Energy-meter
2. Project components selections
3. Design strategies to implement the power meter
4. Detailed study on how to use PT, CT, current sensor and voltage sensor
5. Calibration issues of voltage sensor

Project Management &Team Work

Budget

	Component Used	Price (SAR)
1	Arduino Uno	100
2	LCD 20 x 4	150
3	ESP8266 Wi-Fi Module	100
4	4-Channel Relay Module	75
5	Current Transformer SCT-013	60
6	Step-Down 220v -12V Transformer	50
7	Resistor 0.33k Ohms 5Watt	2
8	Connectors	10
9	Jumper Wires	5
10	Sockets	30
11	Plug	2
12	Electric Board	150
13	Electric Wire	20
14	Resistor 10K Ohms	5
15	Resistor 100K Ohms	5
16	220VAC – 5VDC Power Supply	140
17	I2C Protocol Module For LCD	45

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