PRINCE MOHAMMAD BIN FAHD UNIVERSITY

College of Engineering
Department of Mechanical Engineering

ASSE 4311: Learning Outcome Assessment III

Senior Design Project Report

Title of Project:

Design of a Renewable Thermoelectrical Power Generator

Team # 2 Sec: 108 Fall 2020-2021

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Abstract

Energy can be found in nature in various forms and generated in multiple methods and processes. These days renewable energy is significantly reducing the consumption of fossil fuels, thus resulting in many advantages such as creating clean environments with zero pollution caused by burning fossil fuels. Renewable energy can be generated by many methods; an example of a well-known renewable generator would be solar panels which are commonly used in Saudi Arabia. However, In this project, our focus will be on the thermoelectric power generators. Our aim is to come up with and design a renewable thermoelectric power generator system that works by harnessing high and low temperatures in the same time at night from natural resources to generate sufficient electricity that has enough voltage to power up an LED light bulb. This report will cover some of the main parts regarding the method, criteria, ideas, and procedures on how we harnessed different temperatures from the atmosphere and were able to generate electricity. Another thing this report will include is information about thermoelectric generators plus their objectives and applications in our daily life and how they can be efficiently utilised.

Acknowledgements

At first, we would like to pay our kind appreciation and gratitude for our project advisor: Dr. Mohamed Elmehdi Saleh who gave us his full cooperation and supplied us with motivation, advice, and assistance that we required in order to reach and achieve our objectives in this project. Secondly special thanks to all the friends and family who gave us various opinions and ideas regarding the project. And lastly and most importantly we salute each team member in this project who worked with full capacity and filled us with his enthusiasm and his effective working skills. Surly without forgetting our headquarters and source of knowledge Prince Mohamed Bin Fahad University for paving our path with knowledge which made us reach where we are now.

List of Figures:

List of Tables:

Table of *Contents*

Chapter 1: Introduction

Thermoelectricity (the Peltier module) has two opposite functions; one of them works by supplying the thermoelectrical generator with an electrical current in which the generator works on heating one side and cooling the other side. The other function would be the opposite of the first function which works by heating one side and cooling the other side which in this case the temperature difference between both surfaces generates an electrical current.

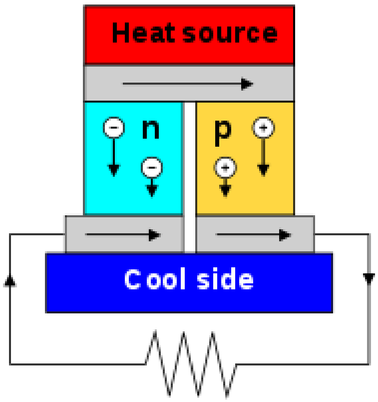


Figure #1.1: Seebeck effect

1.1 Project Definition

In this project, we are going to design a renewable thermoelectric power generating system by using the Peltier module and creating what is called a Seebeck effect. The Seebeck effect requires a thermoelectric generator with its natural source heated and cooled sides of the Peltier module in order to generate electricity. The heat side of the module is heated by placing sea water-filled large tank made out of galvanized steel, which works on absorbing the heat in the daylight and slowly releasing it at night. On the other hand, the cold side uses a similar tank made out of pottery and filled with water. Additional to that a sack-cloth surrounds the pottery tank.

1.2 Project Objectives

Here are some of our most important objectives this project has:

1. To design a renewable thermoelectrical power generator system
2. To design a sufficient operating fully functional system
3. To harness high and low temperatures, & minimizing the total cost
4. To develop an environmentally friendly & clean power source able to work in night time and generate light.

1.3 Project Specifications

In this project, the most challenging part is creating heat and cool natural system which is able to provide the thermoelectrical generator with a hot and cold side in order to transfer it into a useful power source able to work in night time and generate enough power to light an LED light bulb.

1.4 Applications

This project can have multiple applications depending on the required objective. An example of some other useful applications for it would be charging small devices and powering an electrical fan for air circulation. However, in this report, our main application for this project is to be able to supply rural villages that are cut out of electricity and aid them by generating some lightning which could very much assist their vision at night time.

Chapter 2: Literature Review

2.1 Project background

Thermoelectric generators were first discovered in Berlin by academic scientists between 1820-1920. Later on in 1821-3 a scientist named Thomas Johann Seebeck discovered that an electrical circuit is generated by the deviation of temperature between two different metals. (Wei, Gan, Xingxing, Jie, Guiqiang & Xudong. 2014)

Figure #2.1: Thomas Seebeck

Figure #2.1: a tool Seebeck used to investigate the deviation of a compass indicator

At first, Seebeck thought the circuit was generated due to a natural magnetic field from the earth. Later on, he realized that it was an electrical circuit generated by a thermoelectric force he then concluded that the temperature difference generates an electrical voltage in which he can run a current in a closed circuit. This is what nowadays is called the concept of the Seebeck effect. (Mohamed, Bentouba, Stocholm & Bourouis. 2020)

2.2 Previous Work and Comparative Studies

1- Kim, Sun & We, Ju & Cho, Byung. (2014). A Wearable Thermoelectric Generator Fabricated On A Glass Fabric. Energy & Environmental Science. 7. 1959. 10.1039/c4ee00242c.

The research talks about the conversion of body heat into electrical energy using a thermoelectric (TE) power generator is useful for wearable self-powered mobile electronic systems such as medical sensors or smartwatches. They show us and demonstrate a glass fabric-based flexible TE generator using a screen printing technique and the self-sustaining structure of a TE device without top and bottom substrates.

2- Mohamed Amine, Zoui & Bentouba, Said & Stocholm, John & Bourouis, Mahmoud. (2020). A Review on Thermoelectric Generators: Progress and Applications. Energies. 13. 2.

This research explains in general the basics of the thermoelectric effect. It's good to research to generally understand the topic and its uses around the world. This research gives many examples where thermoelectric generators work and examples where it fails to deliver. Essential information for our project.

3- Wei He, Gan Zhang, Xingxing Zhang, Jie Ji, Guiqiang Li, Xudong Zhao. (2014). Recent development and application of thermoelectric generator and cooler. ISSN 0306-2619. https://doi.org/10.1016/j.apenergy.2014.12.075.

This research begins with the basic concepts of the thermoelectric and discusses its recent material research. It also reports the recent applications of the thermoelectric generator, including the structure optimization which significantly affects the thermoelectric generator, the low-temperature recovery, the heat resource, and its application area. Then it reports the recent application of the thermoelectric cooler including the thermoelectric model and its application area. It ends with a discussion of the further research direction.

4- L. Francioso, C. De Pascali, I. Farella, C. Martucci, P. Cretì, P. Siciliano, A. Perrone. (2011). Flexible thermoelectric generator for ambient assisted living wearable biometric sensors, Journal of Power Sources, Volume 196, ISSN 0378-7753. https://doi.org/10.1016/j.jpowsour.2010.11.081. (http://www.sciencedirect.com/science/article/pii/S0378775310020720)

In this research they proposed design, fabrication and functional characterization of a very low cost energy autonomous, maintenance free, flexible and wearable micro thermoelectric generator (μTEG), finalized to power very low consumption electronics ambient assisted living (AAL) applications.

5- Xing Niu, Jianlin Yu, Shuzhong Wang. (2009). Experimental study on low-temperature waste heat thermoelectric generator, Journal of Power Sources. Pages 621-626. SSN 0378-7753. (http://www.sciencedirect.com/science/article/pii/S0378775308023823)

This research looks to further studies on thermoelectric generation, an experimental thermoelectric generator unit incorporating the commercially available thermoelectric modules with the parallel-plate heat exchanger has been constructed. Two experiments to study on.

6- Amatya, R., Ram, R.J. Solar Thermoelectric Generator for Micropower Applications. *Journal of Elec Materi* **.** 1735–1740 (2010). https://doi.org/10.1007/s11664-010-1190-8

This research explores the relation of solar and thermoelectric generator boards. Merging both methods of producing power to make it more efficient and plentiful.

7- Snyder, G. Jeffrey and Ursell, Tristan S. (2003). Thermoelectric Efficiency and Compatibility. American Physical Society. 10.1103/PhysRevLett.91.148301. https://link.aps.org/doi/10.1103/PhysRevLett.91.148301.

This research was done by NASA and its scientist explores the maximum efficiency of thermoelectric effect in all its range and applications. It also studies its capabilities all around.

8- Casano, G., & Piva, S. (2011). Experimental investigation of the performance of a thermoelectric generator based on peltier cells. Experimental Thermal and Fluid Science, 35(4), 660-669. doi:http://dx.doi.org.library.pmu.edu.sa/10.1016/j.expthermflusci.2010.12.016

In this research paper, a trail study was made to identify the efficiency of a Peltier modules, which is basically used for electric power generation. The efficiency of a “Peltier” unit can be utilized as a thermoelectric generator and assessed in terms of the voltage output and the conversion efficiency.

Chapter 3: System Design

Each system has its own identity and functionality. When planning to design a system there are some main aspects to go through before beginning the design procedure. Some of these aspects are as follows. Firstly you must have an idea regarding what the issue you are trying to solve or the idea you want to prove and so on secondly when designing you have to keep in mind what are the constraints and limitation that you might face during the procedure such as the budget you have along with the cost of such system. Another thing is the availability of materials, tools, and manufacturers who are willing to provide you with the equipment you seek. In order to have a successful system design good planning is essential along with testing trails.

3.1 Design Constraints and Design Methodology:

Constraints:

At the beginning of this project we had multiple feelings of fear and confusion due to various aspects which are happening these days regarding the spread of COVID-19 and the closing of borders between countries. All these resulted in a huge drop in the market. Our fear lied in getting the components needed for our project. Some of the parts that we needed were not available in Saudi Arabia and we were not able to order them from other countries due to the delays and other issues. However, based on our knowledge and research we solved this problem by thinking of alternative methods and functionality which relied on parts and objects which can be found in Saudi Arabia.

Another constraint that we discovered during the design process was with one of the parts in the project which was the pottery tank. At first our idea was to build a square shaped tank in order to meet our objective and style required. However after we discussed our design with the pottery maker he told us that if he made the pottery in a shape of a square with our sizes it will lose its strength and might break on us (Al Bakri & Jamaludin & Faheem & Kamarudin & Rafiza & Zarina & Alida. 2014). After some thinking and redesigning we came up with the idea of making the pottery tank shaped as a rounded vase which will still maintain and accomplish our main purpose of the project which is for the water to maintain a cool temperature.

Sustainability:

Sustainability can be defined as an action we perform or come up with which meets our needs in the present time and will not cause any type of harm which might affect our future and the upcoming generation.

While working on this project which is the design of a renewable thermoelectrical power generator we focused on certin areas, one of these areas was sustainabilty. we made sure that our project system can be utilised and provide us with the type of energy we require while on the other hand not harming our lifestyle and future. unlike the burning of fossil fuels and thenumerous types of pollution they develop. Our system is built to generate a clean healthy type of power source by only harnessing the natural resources such as atmospheric temperature.

The parts used in this project are mainly two pieces one of them is the pottery tank which is made to last multiple decades without any modification. However the second part which is the steel tank is subjected to corrosion because of the sea water inside it thus our plan is to apply a galvanized coating to protect the steel tank from any type of corrosion attack and guarantee a longer life out in the open.

Environmental:

Saudi Arabia has and still is encouraging all types of environmentally clean energy sources. It is widely known that renewable and environmentally clean energy is the future for us and the following generation.

One of the requirements of this project was to be able to come up with a clean and renewable system which uses the thermoelectrical generator in order to produce electricity. We managed to generate a sufficient and effective system able to harness the atmospheric air along with the heat coming from the sun thus provide a cooling and heating procedure which allows the thermos electric generator to generate electricity.

Our system design is considered to be outstandingly environmentally friendly due to the fact that it causes zero harm to nature and uses simply water, sunlight and air to function.

Social:

The system is designed and made to serve mainly people in rural villages whose electricity is far from their reach. By implementing and using our system in their village to light up their homes and streets their interactions and social life will rise significantly

Economic:

Speaking economically our project could supply villages with lights without having the trouble of extending and building long towers of cables that run across miles to do that. We also extremely minimized the cost of the project by cancelling the batteries which cost a lot. Another factor which decreased the cost is due to the less maintenance it requires because there isn't much moving parts in the system except a small fan. Using local pottery tank made in Saudi Arabia by Saudis support the local community and economy of the market.

Safety:

Regarding the safety element we have the full confidence to say that this system which we design is considered to be very safe based on multiple aspects which are the fact that implements the safety of this system is that it has no moving parts except for a very small fan attached other than that the system will always be static thus this assures that no friction will be caused between parts which might cause damage and result in failures or even be a risk.

Ethical:

The usage of thermoelectrical power generators is known to the public and multiple researches have similar projects regarding how to generate electricity from a thermoelectric generator. (Kim, Sun & We, Ju & Cho, Byung, 2014). However our idea for this project is unique and there is no previous project with such idea of storing heat in daylight and releasing it at night time as well as the pottery tank which stores natural cool temperature water, all main sources used to generate electricity are from nature.

3.2 Engineering Design standards:

Table #3.1 Fan Engineering standards

Engineering standard	Detail
AMCA Standard 205	“The'fan'operaMng' efficiency'at'all'intended' operaMng'point(s)'shall'not' be'less'than'15'percentage' points'below'the'fan'peak' total'efficiency.”
ASHRAE 90.1-2013	The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan
2014 ASHRAE 189.1	Continuous maintenance proposal

An essential factor of choosing the materials in this project was the high quality used to manufacture in order to ensure a long lasting life and achieve maximum functionality without causing any leaks or failures in the system.

<u>The Pottery Tank:</u> Based on our knowledge and many recommendations we chose a very famous pottery maker store located in the East side of Saudi in a city called AL-Ahsa. This pottery shop is known for its high quality and standard of the clay used in making the pottery plus the experienced artist behind each piece.

<u>The Steel Tank:</u> Steel can be found almost everywhere with the same metal properties all share however steel by itself is not corrosion resistance. In our project this steel tank carries sea water in it thus the steel need to be protected and to apply protection we had to apply a high standard galvanized coating layer on the steel to prevent any type of corrosion attack.

3.3 Theory and Theoretical Calculations

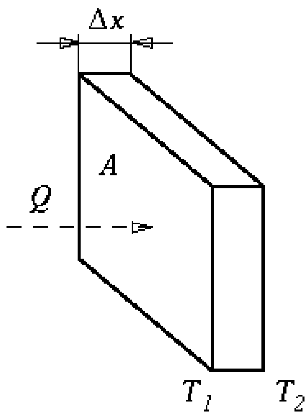
Before we get into the thermo electric generators concept, let's take about heat transfer. Starting with the three main types of heat transfer.

The three main types of heat transfer:

- **Convection:** heat transfer that occurs between a solid and gas/liquid. As the fluid goes faster, convection heat transfer increases.
- **Conduction:** when the particles of matter are touching, and in direct contact they transfer heat by conduction. The higher energy particles vibrate and transfer the higher energy (heat) from high to low energy (low temperature.)
- **Radiation:** transfer of heat in vacuum with no matter, for example energy from the sun heats up the earth.

The thermal conductivity of a material is a measure of its ability to conduct heat. The thermal conductivity is how this experiment came to be, we chose the materials based on their thermal conductivity.

$$k = \frac{Q\Delta x}{A(T_2 - T_1)}$$



Thermal conductivity of materials in this project: taken from *(Engineering ToolBox, 2003)*

1- Steel: 55.2 ($W \cdot m^{-1} \cdot K^{-1}$)

2- Porcelain/clay: 1.90 — 2.27 ($W \cdot m^{-1} \cdot K^{-1}$)

3- Acrylic glass: 0.170—0.200 ($W \cdot m^{-1} \cdot K^{-1}$)

4- Sea water 0.563 ($W \cdot m^{-1} \cdot K^{-1}$)

5- With steel being extremely heat conductive, it will gather a lot of the heat from the sun and make a big temperature difference combined with the water in it. Their heat capacity is a lot.

Thermal electric generators theory and proposed voltage:

The thermoelectric generator works on mainly on the Seebeck effect. The Seebeck effect is the production of EMF (electromotive force) by a temperature difference between hot and cold semi-conductors. It is named after the German physicist Thomas Johann Seebeck.

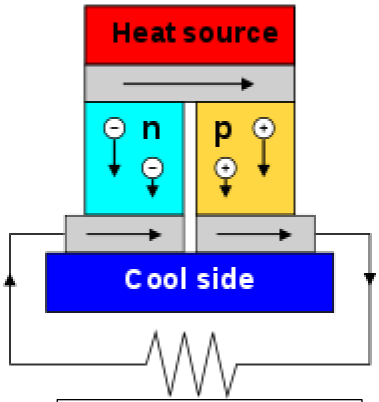


Figure #3.1: Seebuck effect

$$\mathbf{J} = \sigma(-\nabla V + \mathbf{E}_{\mathrm{emf}})$$

The EMF (Electro motive force) is simply electricity produced from not electrical sources, such as in our situation, difference in heat. Examples may include batteries and turbine generators.

The EMF equation is: $$\mathbf{E}_{\mathrm{emf}} = -S\nabla T,$$

Where S is the Seebeck coefficient, every material has its own coefficient, and T is for temperature gradient. As the equation states, the bigger the difference in temperature, the more EMF we will have.

When J=0 the system is in steady state, in the original Seebeck equation above, the equation can be simply put as:

$$\Delta V = S\Delta T.$$

The Seebeck effect only accounts for one Seebeck coefficient. But in different materials this is not the case as there is more than on coefficient. So the gradient here is called the Thompson effect, predicted by William Thomson. Its equation is related to Seebeck:

$$\dot{q} = -\mathcal{K}\mathbf{J} \cdot \nabla T,$$

Where $\mathcal{K}$ is the Thomson coefficient.

Lastly the Peltier effect is the reverse phenomenon of the Seebeck effect, simply states that the electrical current flowing through two materials with produce heat.

$$\dot{Q} = (\Pi_\mathrm{A} - \Pi_\mathrm{B})I$$

Where Π_A and Π_B are the Peltier coefficients of conductor A and B or the two different conductors, and I is the current. Combining all these equations will lead us to the final thermoelectric equation described as

$$\dot{e} = \nabla \cdot (\kappa \nabla T) - \nabla \cdot (V + \Pi)\mathbf{J} + \dot{q}_{\mathrm{ext}}$$

Where K is for thermal conductivity as we talked in the first section of theory. The first term is Fourier’s heat conduction law, third term is heat added by external sources as we did by the sun.

3.4 Product Subsystems and Selection of Components:

The components of this project are and their specifications are as follows:

1- The Pottery Tank (Figure #3.2): made out of clay and placed in an oven with high temperatures as part of the strengthening procedure. As shown in figure #3.2 it has a height of 45cm and a circular diameter is 42cm,

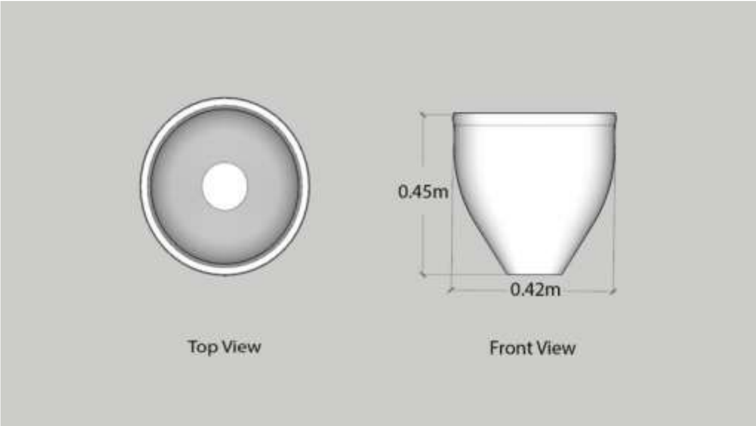


Figure #3.2: The Pottery Tank

2- The Roof-less Steel Tank (Figure #3.3): A simple shaped tank made out of steel with an applied galvanized coating to ensure protection against corrosive attacks, with dimensions of 60cm long, 60cm wide and an elevation of 15cm. On top of the steel tank lies a Fresnel lens glass which covers the roof of the tank and is sealed with the steel tank by a silicon paste.

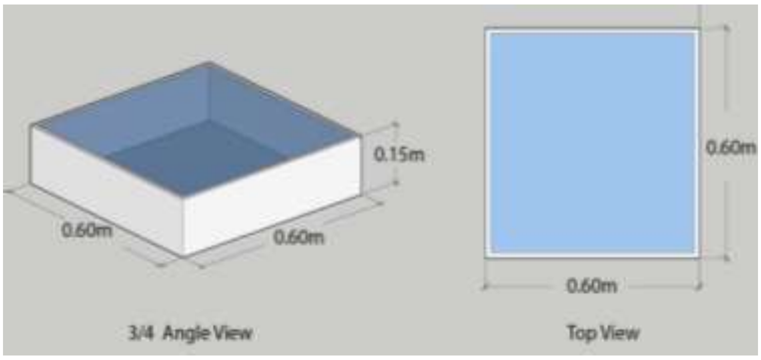


Figure #3.3: Roof-less Steel Tank

3- 30x The beltier module (Figure #3.4): The soul of this project and the master piece. It's a thermoelectric power generator with dimensions of 4cm wide and 4cm long. In our project we will be using 30 pieces of the beltier module to increase the power generated.

Figure #3.4: Beltier Module

4- Fan (Figure #3.5): A small sized direct current 12 volts and 0.30A fan is used to create extra air flow to the system.

Figure #3.5: 12v Fan

5- Voltage booster (Figure #3.6): a voltage booster main objective is to enhance the voltage passing through it. The booster we are using requires a minimum of 3 volts to function and it will amplify that into 30 volts. The diminutions of this device is 4cm long and 1cm wide.

Figure #3.6: Voltage Booster

6- Dried Palm Fronds (Figure #3.7): those dry leaves have very low heat conduction properties. In other words they have high heat resistance properties. An interesting fact is when those dried palm fronds get a little bit wet and some air hits them they immediately act as a natural cooler.

Figure #3.7: Dried Palm Fronds

7- LED light bulb (Figure #3.8)

Figure#3.8: LED light bulb

3.5 Manufacturing and assembly:

In our project two major parts needed to be manufactured. The first part was the Pottery tank. We managed to generate a design that we require for our project and found a great pottery maker in Al-Ahsa who was able to artistically create and build our design. The process of making the pottery tank started with him mixing up clay mud with a small amount of water placed on top of a circular table who had spinning shaft. While the clay rotates the artist shapes it to what we desire after it dries he places the pottery in a furnace with high temperature to strengthen it. The second main part was the roofless steel tank. After creating the shape and measurements of the tank we went to a smith who took multiple pieces of steel and welded them nicely to achieve the desirable shape. After that the metal tank went through a process of galvanic coating. And lastly a Fresnel glass lens was attached to the roof of the steel tank sealed with a silicon paste to avoid any sort of leakage.

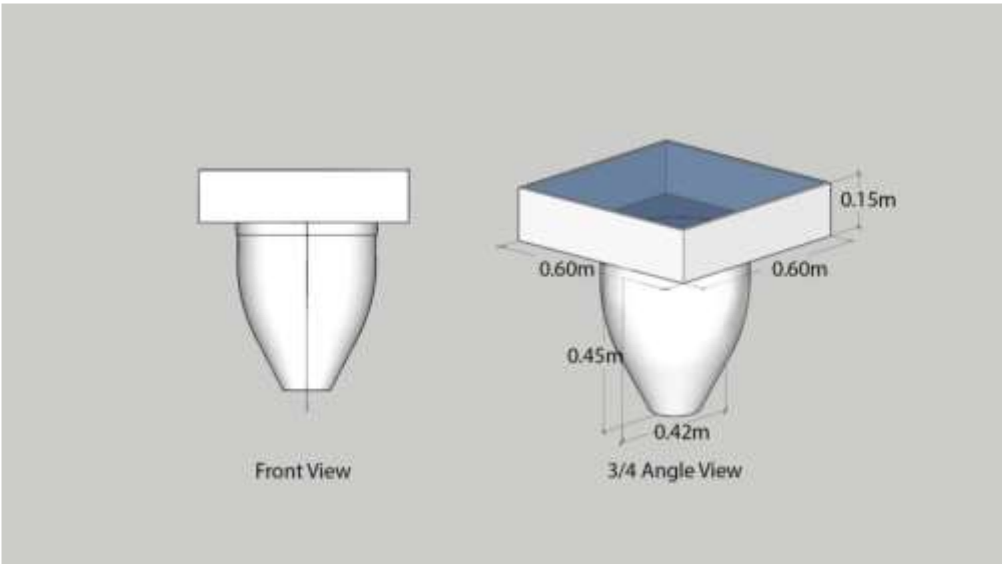


Figure #3.9: Prototype Design

After the pieces were manufactured and collected it was time for the assembly. Starting with key element the beltier module in other words the thermoelectric generator. For the Peltier model to work a hot side and a cold side are required. For this project the hot side will be facing up and the cold side dawn. The first component from the bottom will be the pottery tank which will be filled up until the holes (Figure #3.9) with normal water. Second to that the pottery tank has a character when filled with water it starts to condensate water drops on the outer walls of the tank in this case we will use the dried palm fronds as an outside cover for the tank so they can get slightly wet and help cool the water more.

After that on the bottom of the steel tank there will be 30 pieces of Peltier module all welded together and attached by a heat conductive paste in the bottom of the tank, plus to that a fan will be placed below the steel tank to help blow cold air coming from the pottery tank. The fan will be powered by a battery in winter season and in summer season will be powered by the Peltier module and it will create an air current inside the pottery tank. By looking above at (Figure #3.9) the concept will be clarified and give you an idea on how the system will look like when building the prototype.

Moving on, the galvanized steel tank will be filled with sea water due to the fact that sea water has a significantly low heat conducting factor. This means that sea water is great at storing heat in day light with the help of the Fresnel glass on top of it and releasing the heat slowly at night. The electricity generated from the Peltier module directly goes to the voltage booster and amplified after that the electricity takes two paths one way goes and powers up the fan, and the other way lights up the LED light bulb.

Chapter 4: System Testing and Analysis

4.1 Experimental Setup and data acquisition system:

Our experimenting and testing began by using a device called multi-meter which helped us measure the exact temperature that the Peltier module was subjected to and the voltage outcome it generated. The multi meter we chose was a UNI-T model UT33C+ which was recommended to us by an electrical expert for its durability and accurate results.

Power	**9V Battery (6F22)**
LCD Size	**48 x 16mm**
Product Colour	**Red and Grey**
Product Net Weight	**Around 156g**
Product Size	**130 x 73.5 x 35mm**
Standard Accessories	**Test Lead, Battery, English Manual, Point Contact Temperature Probe, Holster**
Optional Accessories*	**Clip-On Test Lead Light (UT-TL), Built-In Test Lead Light (UT-L1), Built-In Test Lead Light Plus (UT-L2)**
Standard Individual Packing	**Gift Box**
Standard Quantity Per Carton	**60 pcs**
Standard Carton Measurement	**Around 486 x 345 x 310 mm (Around 0.052 CBM Per Standard Carton)**
Standard Carton Gross Weight	**Around 18kg**

Figure #4.1: Multi-meter device and specifications

By using the multi-meter we were able to perform some experimentation involving the Peltier module and applying Heat on one side and cooling the other side of the Peltier module and connecting the Peltier with the multi-meter to measure the voltage generated. In order to incorporate the experiment we used hot water in a metal cup and another cup with cold and ice water to simulate the prototype we wish to build and calculate how much voltage can be generated by one piece of Peltier module.

Figure #4.2: Experimenting

From experimenting we noticed that when one side is subjected to heat and the other side with cold electricity is generated in the experiment shown in figure #4.2 above when the hot water temperature was 40 degrees C and the cold side temperature was 18 degrees C the Peltier module generated 0.35 volts.

Another test was conducted which discovered that when only heat is applied to one side of the Peltier module the other side slowly absorbs the heat until both sides are at the same temperature and that results in producing zero voltage. From this we made other experiments to understand how the Peltier function and reacts to different temperature levels.

Figure #4.3: Experimenting

As seen in figure #4.3 we tried placing hot water at temperature 40 degrees C on top of the Peltier and beneath it was a wooden table as a cold wall to cool it. At first the output voltage was at 0.48 volts however after 5 seconds the heat starts to transfer to the cold side due to the fact that the hot side is much greater than the cold side which results in the heat taking over. From that we concluded that for us to have a sufficient reliable system we needed to make the temperature level of heat applied in balance with the amount of cold temperature applied so that the system won't fail to generate the desired amount of electricity.

After a considerable amount of discussion with team members we came up with a design that will enable us to generate and provide a sufficient amount of hot and cold temperature at the same time. Our design parameter was chosen carefully to satisfy our need to prove that our concept idea works and is able to generate electricity by using a thermoelectric power generator which works on transferring the difference in temperature to become a utilized source of electricity.

Figure #4.4: Completed Prototype

In Figure #4.4 above you can see the outer shape of the prototype along with its components. Each component and parameter was chosen carefully to meet a specific requirement. Starting from the top part the steel tank with a Fresnel lens on top.

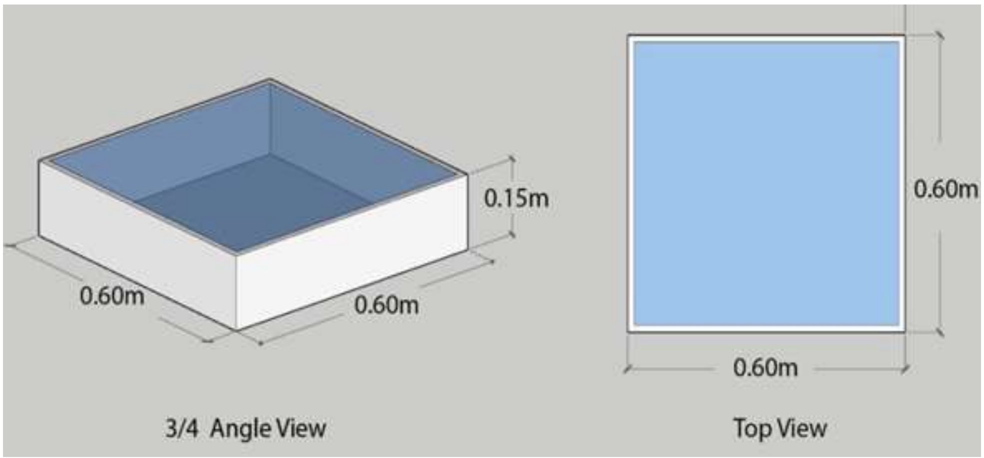


Figure #4.5: steel tank design

The parameters can be seen in figure #4.5, we chose the parameters of the tank based on multiple aspects one of them is the fact that the bigger the size of the tank the more heat storage you can acquire. Our aim was to make the heat in the tank last for about 3 to 4 hours which will enable us to prove our idea and concept that our project is able to generate electricity by using a renewable sourced thermo electric power generator and light an LED. That’s the reason we chose the tank to be 60cm x 60 cm. in the other hand, the height of the tank was chosen to be 15cm because if the height was higher than the water below will take much more time to be heated thus the more surface area affected by the sun the more heat generated. In addition the Fresnel lens works as a magnifier lens and concentrate the sun rays into a single point which becomes super-hot and we utilized that to heat the sea water faster.

Figure #4.6: Pottery tank design

Using a very basic rolled meter to calculate the parameter of the pottery tank. The dimensions of the pottery tank were not chosen by us they were made and sold by professional artist pottery maker in Al-Ahsa city. We later on took measurements using a basic meter.

4.2 Results, Analysis and Discussion:

Below are some of the results, data and analysis which we ended up with after testing and experimentation:

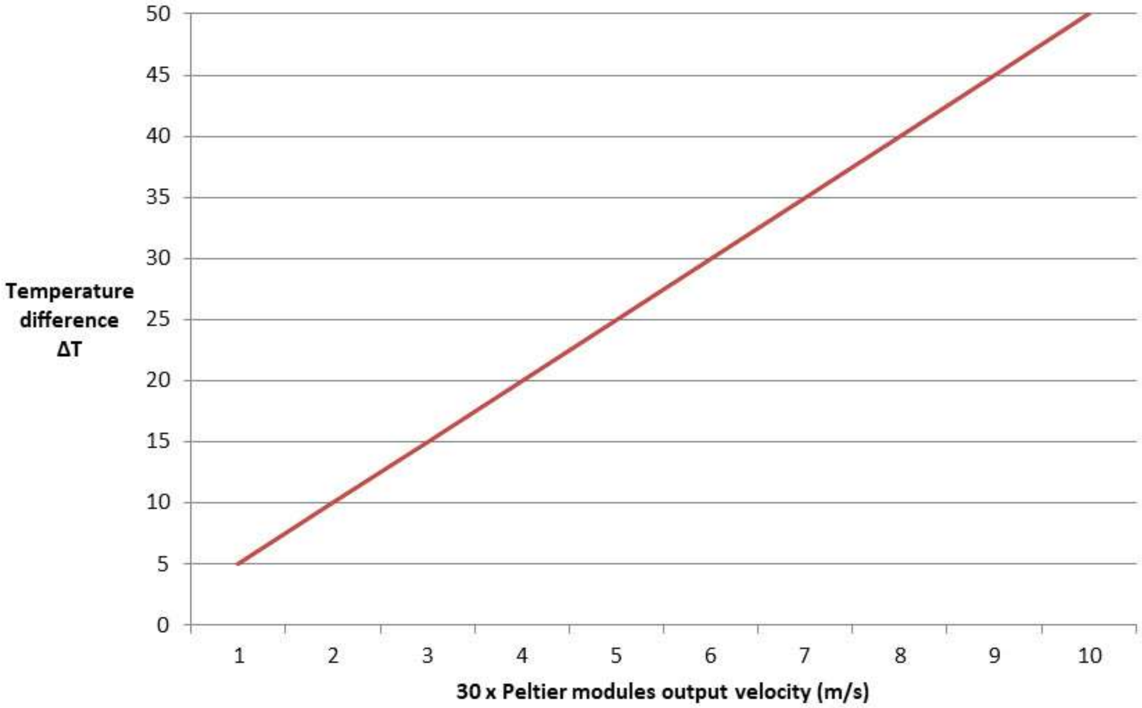


Figure #4.7: Acquired Data Chart

Table #4.1 Data and Results

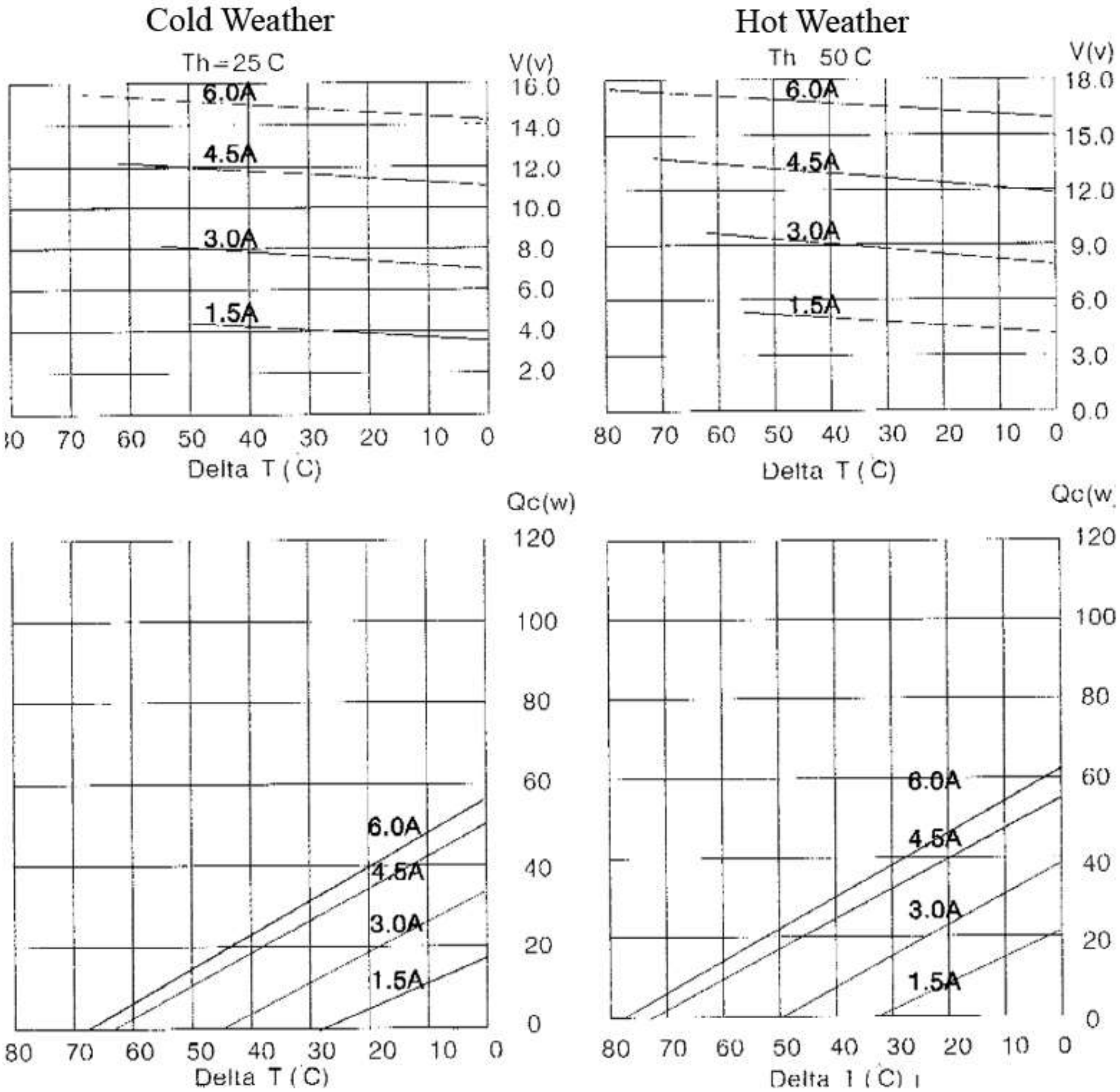
Difference in temperature C degrees	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**
Voltage output (m/s)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Based on our data analysis and experimentation we resulted with some main conclusion regarding our project some of them are:

- When the difference in temperature is low the outcome voltage coming from the Peltier module will be weak, however if the difference in temperature is great then greater voltage will be generated. The relation between both the difference in temperature and voltage are, if one increases the other increases too simple as that.

- Another conclusion is that the amount of heat added to the system should be close or equal to the cooling applied to avoid extensive heat transfer from one side to another which results in reducing the voltage produced.

The Power & Voltage in relation with Delta T (C) in Hot and cold weather



- **Power produced in watts:**

  The results discussed in the section above were considered to be in the winter weather of Saudi Arabia, there are some different calculations when calculating voltage and power in the summer. As a matter of fact the device is more efficient in the summer than it is in the winter. The hotter the ambient temperature the belier's run at the more power and voltage they produce. As seen in the graphs above, the right side accounts for the hot weather temperature and the left side accounts for cold weather. The graphs above are discussing voltage and below discussing power in watts. So in watts, the device will produce from a range of 7 watts at low delta T up to 40 watts in a high difference in delta T. This is in cold weather scenarios were we conducted our experiments in December in Saudi Arabia. Theory the powers produced from the Peltier could go up in hot weather up to 57 watts per single Peltier. We have not tested this, the weather conditions are not right in December for it to run on max efficiency.

Chapter 5: Project Management

5.1 Project Plan:

In order to meet our deadlines and be able to organize our work we generated a table which indicates all of the activities, tasks, responsibilities, duration and the percentage of completion. In table 5.1 below each team member can have a general clear idea of what will be required from him during the semester.

Table 5.1: Project Work Plan

<table>
<tr><th></th><th>ACTIVITY</th><th>Tasks</th><th>Responsible</th><th>Duration</th><th>Percent Complete</th></tr>
<tr><td rowspan="6">Introduction</td><td rowspan="4">Project allocation + introduction</td><td>Project Definition</td><td rowspan="4">Ibrahim+ fahad</td><td rowspan="4">1 Week
From 3/9/2020 to 10/9/2020</td><td rowspan="4">100%</td></tr>
<tr><td>Project Objectives</td></tr>
<tr><td>Project Specifications</td></tr>
<tr><td>Applications</td></tr>
<tr><td rowspan="2">Literature Review</td><td>Project background</td><td rowspan="2">All Team</td><td rowspan="2">3 Weeks</td><td rowspan="2">100%</td></tr>
<tr><td>Previous Work</td></tr>
</table>

		Comparative Study		From:11/9/2020 To: 1/10/2020	
System Design	Design	Design Constraints and Design Methodology	fahad+ Aziz	2 Weeks From:2/10/2020 To: 15/10/2020	100%
	Equipment and material selection (3.4)	selected the appropriate items	Rayan+ Abdulrahman	2 Weeks From:16/10/2020 To : 29/10/2020	100%
	Theory and Theoretical Calculations	main calculations required detailed calculations to your design.	Aziz + ibrahim +rayan	1 Week From:30/10/2020 To : 5/11/2020	100%
	Prototype assemble	System integration, describe , procedures and Implementation	All Team	3 Weeks From:13/11/2020 To :19/11/2020	100%
System Testing and Analysis	Testing and analyses	Experimental Setup, Sensors and data acquisition system	All Team	2 Weeks From:20/11/2020 To :3/12/2020	100%
		Results, Analysis and Discussion			
Project Management and Project Analysis	Project Management	Project Plan	All Team	2 Weeks	100%
		Contribution of Team Members			

		Project Execution Monitoring		From:20/11/2020 To : 3/12/2020	
		Challenges and Decision Making			
		Project Bill of Materials and Budget			
	Project Analysis	Life-long Learning Impact of Engineering Solutions Contemporary Issues Addressed	All Team	1 Week From:25/11/2020 To :3/12/2020	100%
Report submission	Final Report	Writing all chapters	All Team	1 Week From:4/12/2020 To :16/12/2020	80%
	Presentation preparation	Making Slides	All Team	1 Week From:5/12/2020 To : 15/12/2020	80%
	Presentation practice	Practice presenting in front of people	All Team	1 Week From:5/12/2020 To : 15/12/2020	80%

	Booklet	Print the report	All Team	5 days From:10/12/2020 To :15/12/2020	60%
	Banner	Follow rubric	Abdulrahman	3 days	10%
	Brochure	Follow rubric	Rayan	1 day	50%
Monthly progress report		1st progress report	All Team	Monthly, 1 Day	90%
		2nd progress report			

5.2 Contribution of Team Members:

Table 5.2: Tasks the contribution of the members

#	Tasks		Assigned	Cont. %
1	Chapter 1: Introduction		All	100%
2	Chapter 2: Literature Review	Project Background	Ibrahim	33%
			Abdulaziz	33%
			Abdulrahman	34%
		Previous Work	Ibrahim	34%
			Abdulaziz	33%
			Fahad	33%
		Comparative Study	Ibrahim	33%
			Abdulaziz	34%
			Fahad	33%
		Design Constraints and Design Methodology	Ibrahim	30%
			Abdulaziz	30%
			Ibrahim	30%
			Rayan	10%

3	Chapter 3: System Design	Engineering Design standards	Fahad	50%
			Abdulrahman	50%
		Theory and Theoretical Calculations	Ibrahim	50%
			Abdulrahman	30%
			Abdulaziz	20%
		Product Subsystems and selection of Components	Fahad	30%
			Abdulaziz	40%
			Ibrahim	30%
		Manufacturing and assembly	Ibrahim	50%
			Rayan	50%
4	Chapter 4: System Testing & Analysis	Experimental Setup, Sensors and data	All	100%

		Results, Analysis and Discussion	All	100%
5	Chapter 5: Project Management	Project Plan	All	100%
		Contribution of Team members		
		Project Execution Monitoring		
		Challenges & Decision Making		
		Project Bill of Material & Budget		
6	Chapter 6: Project Analysis	Life Long Learning	Ibrahim Abdulaziz Abdulrahman	100%
		Impact of Engineering Solution		
		Contemporary Issues Addressed		
7	Chapter 7: Conclusion & Recommendation	Conclusion	Rayan & Fahad	100%
		Future Recommendation		
8	Design of Prototype	Parts Locations and Connections	All	100%
		Steel Tank Size & shape		
		Pottery tank size & shape	All	100%
9	Parts Purchase	electronics	All	100%
		LED and Wires		
		Peltier Module		
		Pottery Tank		
		Fan		
10	Manufacturing	Structure Welding	Ibrahim Abdulaziz Abdulrahman	100%
		Grinding		
		Soldering		
11	Testing	Adding a Battery	All	100%

5.3 Project Execution Monitoring:

During our time in this semester we had to go through and arrange multiple meetings with team members, advisors and co advisors in order to hear each person's opinion and come up with a greater idea and concept to work with. Other than that we also had to submit some tasks relating to our progress and other tasks to be assessed such as presentations. In table 5.3 below you can find a list of the activities we went through during the course.

Table 5.3: Dates of the activates and events

Time/Date	**Activities/Events**
One time a week	Assessment class
Weekly	Meeting with group members
Monthly	Meeting with the advisor and co-advisor
10 Oct, 2020	Finishing first prototype
12 Nov, 2020	Midterm presentation
19 Nov, 2020	First test of the system
26 Nov, 2020	Finishing final prototype
27 Nov, 2020	Test the system
18 Dec, 2020	Final Submission of the report
17 Dec, 2020	Final presentation

5.4 Challenges and Decision Making:

Considering that this is our first big project and the idea of thermo electric generators was new to us we were faced by many challenges.

- Our first challenge began with generating the idea and concept of our design and how will it work we kept searching and thinking of possible solutions to the main question which was, How can we generate heat and cold both at the same time with only using renewable sustainable methods ?. after 3 to 4 weeks of thinking and investigating proper methods for cooling and heating we came up with the ideas of using a steel tank filled with sea water for heat storage and a pottery tank filled with water and a fan attached to it in order to deliver us cold air.

- The second challenge we faced was regarding the steel tank thickness. At first we chose the steel tank thickness to be 0.7mm which is very thin and will transfer heat faster. However the challenge began when we tried to weld and shape the steel sheet. The justification summary of this issue was that having a very thin layer of steel will get damaged when hot welding is applied to it. To solve this issue we tried cold welding and it still didn’t work the steel sheet also got damaged due to the high temperature hot and cold welding required, another idea that could have worked was spot welding however, because our goal is to fill the steel tank with water we couldn’t perform spot welding to avoid leakage even if we applied silicon to prevent leakage it will still be a temporarily solution. We wanted a permanent and out of risk solution. And to solve this case we concluded that we should increase the thickness of the steel tank from 0.7mm up to 2mm even though it changed our plane we figured some additional ways to make up for our heat loss by firstly painting the tank with black to absorb more sunlight and heat the tank faster which worked and secondly covering the steel tank with a Fresnel lens to concentrate the sun light and give us a high temperature.

- The third challenge contains delayed parts ordered online. Due to our recent pandemic regarding the covid-19, the global market got affected badly. When ordering any part online there is a big percentage of delay that might occur to it. In this project we ordered two parts that we were unable to find locally.

  The first part was a thermal conductor plaster, which is basically a highly heat conductor glue. This part got delayed until we had to improvise and come up with an external product which was the heat sink compound which is very close to the thermal conductor plaster however it lacks the glue property but still we managed to make the heat sink compound work with some pressure applied to it.

  The second part we ordered was a Fresnel lens that we were unable to find locally at first. This part was order at an early stage and yet until this day its location is unknown. After many searches for the part we solved this challenge by discovering that old projection television had a Fresnel lens implemented within the system, luckily one of our team members had an old projection television we took apart and took out the Fresnel lens from it and put it to work.

- Our last challenge contained testing and analyzing our prototype. We realized that our system is harnessing enough heat, however the cooling side needs to be much colder. At first our plan was to not include a battery to minimize the cost. However our need for colder air was more essential so we replaced the small 5 volts fan with a bigger 12 volts fan attached to a 12 volts battery and that resulted in a colder air flow and we were able to pass the challenge.

5.5 Project Bill of Materials and Budget:

During our initial brainstorming session we discussed the project idea and plan and thought deeply about the project materials, specifications and requirements in order to be able to clearly estimate how much the cost will be as well as to set a budget. Our discussion concluded with setting a budget of 2000 Saudi Riyals, however our aim was to lower the cost as much as possible and we did a great job with achieving that by purchasing row materials and cutting, wiring, soldering, painting and other tasks by our self with using appropriate tools.

Table 5.5: Materials and their Cost

Materials	Cost
Fresnel Lens 60cm x 60cm	0
2mm Galvanized Steel Tank	370
7x Black Spray Paint	35
1 inch Metal Valve	48
30x Beltier Module	870.37
2x Heat Sink Compound	30
12v Fan	56
Pottery Tank	80
Dried Palm Fronds	0
LED	2
Capacitor	3
Voltage step up	52
12v DC battery	58
3x ON/OFF switch	10
Total Cost	**1614.37 SAR**

Chapter 6: Project Analysis

6.1 Life-long Learning

Working on this project was extensively educational in multiple areas. It has taught us how to manage our time by planning and distributing the tasks among team members along with that, how to effectively work together and connect as a group. Just like the familiar quote by John C. Maxwell says “Team work makes the dream work”. Another part we learned was regarding the hardware materials such as the voltage step up device, which works on amplifying the voltage. Another main part was the thermo electric power generator also called the Peltier module we learned and understood how it works in order for us to be able to work with it and come up satisfied with the results it generated. The project required specific and detailed materials that we didn’t know about until we needed them such as the heat sink compound which is a silicon paste with high thermal conductivity properties able to absorb and transfer the heat from one side to the other without dissipating any amount of temperature.

On the other hand some parts of the project consisted of manufacturing and assembling which taught us how to cut steel using a grinder to produce the steel tank for our project. Another part was wiring and soldering which was a new experience we gained from this project. In order to know how soldering works and the proper way of soldering we used YouTube and watched videos demonstrating that. And we were very proud of our results. Lastly, working on this project made us go through Google search and lookup for researches on harnessing heat and cold temperatures from the atmosphere, equipment and specific parts which intensively increased our knowledge on this kind of subjects.

6.2 Impact of Engineering Solutions

One of the main purposes of engineering solution is apparently solving problems. However within addressing the problems lays different aspects and elements to consider and surly these aspects defer from one engineer to another based on their passion and honest work. In which a carless engineer might address the issue temporarily with causing air pollution and not caring about the environment factor. On the other side a passionate honest engineer will address the same issue and come up with a better layout for the solution which will result in a clean safe environment. Engineering solutions have a great impact weather its negative or positive its up to the engineers to decide. In this project our team worked honestly and with passion to come up with a design that is beneficial for the society, economy and environment.

Economy:

Our project could supply villages with electricity which can be used to either charge farming equipment to be used in farming and increase the economy level or the electricity can be used in lightning. thus this will enable people to work for longer hours at night and this will have a great beneficial impact for the village economy.

6.3 Contemporary Issues Addressed:

There are some essential issues regarding electricity shortage in rural towns and small villages that could be addressed in Saudi Arabia which could have a significant impact on people in multiple areas such as their regional economy, social life and wellbeing of its local inhibitors in general.

Saudi Arabia is a vast country filled with thousands of rural towns and small villages, some of these places are out of reach and are not connected to any power station weather because their location is challenging or they are considered a minority judging by how many person lives there. Having no electricity nowadays possess a real issue and hardship in our daily life. That is why our project can be the salvation in situations like this, the project is aimed to address this type of issue and solve it by generating enough electricity to power up either lights which could improve social life in the community, or boost the farming equipment that can result in a better economy state and other objectives that can lead to a better life.

Chapter 7: Conclusions and Future Recommendations

7.1 Conclusion:

In conclusion undertaking the learning outcomes assessment 3 course and being able to work on this project, which is the Design of a Renewable Thermoelectric Power generator, has taught us various knowledge both verbally and physically. Knowledge we gained such us working in a team with shared ideas and different skill sets, and how all team members can contribute together in order to achieve a certain goal or idea along with team management skills. Whereas the physical knowledge we gained included hours of searching for project component and understanding the local market products and figuring out how to adjust our plan regarding the availability of products in the local market. Also sketching the prototype and the assembly and construction of the prototype all these kind of processes taught us a lot. Gladly after all of the hard work and effort spent in this project we were able to meet our aim and goal and come up with a considerable amount of successful results.

7.2 Future Recommendation:

For future projects I would prefer to increase the amount of meetings to be able to connect and manage work with team members more effectively and stay ahead of time. Even though we managed to do it just fine in our project. Another thing I would recommend would be to increase the trials and experimentation more, by doing so the amount of data collected will increase thus you will be able to reach better understanding of what is being gained and be able to result with an accurate average output. Lastly it would be a great idea to know the availability of the components and materials you will use in the project and where can they be found to avoid changing the project plan and design just like we did in this project, in which we had confidence in online orders and the result was fortunate due to the COVID 19 some shipments were delayed and some didn’t reach us at all so we had to overcome these challenges by finding substitutes for our main components and gladly we managed it.

Chapter 8: Refrences:

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Appendix A: Progress Reports

	SDP05 Monthly Progress Report
	Department of Mechanical Engineering Prince Mohammad bin Fahd University

SEMESTER:	Fall	ACADEMIC YEAR:	2020
PROJECT TITLE	Design of A Renewable Thermoelectrical Power Generator		
SUPERVISORS	Dr Mohamed Elmehdi Saleh		

Month 1: October

ID Number	Member Name
201602881	*Ibrahim Jamal Daghistani
201502008	Fahad Aljindan
201600434	Abdulrahman Hezam
201502659	Abdulaziz Alfarhan
201501007	Rayan Al-Amer

List the tasks conducted this month and the team member assigned to conduct these tasks

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
	Chapter 3: Design Constraints and Specifications	All Members	100%	
	Chapter 3: Testing	All Members	50%	
	Chapter 3: Calculations	All Members	50%	
	Chapter 3: Fabrication	All Members	95%	

List the tasks planned for the month of November and the team member/s assigned to conduct these tasks

#	Task description	Team member/s assigned
	Building the Prototype	All Members
	Chapter 4: System Testing and Analysis	Ibrahim Abdulraman Rayan
	Chapter 5: Project Management	All Members
	Chapter 6: Project Analysis	Fahad Abdulaziz

- **To be Filled by Project Supervisor and team leader:**
- **Please have your supervisor fill according to the criteria shown below**

Outcome MEEN4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts				
Criteria	**None (1)**	**Low (2)**	**Moderate (3)**	**High (4)**
MEEN4A. Demonstrate an understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental and societal context	Fails to demonstrate an understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts	Shows limited and less than adequate understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts	Demonstrates satisfactory understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts	Understands appropriately and accurately the engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts

Outcome MEEN5: an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives				
Criteria	**None (1)**	**Low (2)**	**Moderate (3)**	**High (4)**
MEEN5A: Ability to develop team work plans and allocate resources and tasks	Fails to develop team work plans and allocate resources and tasks	Shows limited and less than adequate ability to develop team work plans and allocate resources and tasks	Demonstrates satisfactory ability to develop team work plans and allocate resources and tasks	Properly and efficently makes team work plans and allocate resources and tasks
MEEN5B: Ability to participate and function effectively in team work projects to meet objectives	Fails to participate and function effectively in team work projects to meet objectives	Shows limited and less than adequate ability to participate and function effectively in team work projects to meet objectives	Demonstrates satisfactory ability to participate and function effectively in team work projects to meet objectives	Function effectively in team work projects to meet objectives

MEEN5C: Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	Communicates properly and effectively with team members

Indicate the extent to which you agree with the above statement, using a scale of 1-4 (1=None; 2=Low; 3=Moderate; 4=High)

#	Name	Criteria (MEEN4A)	Criteria (MEEN5A)	Criteria (MEEN5B)	Criteria (MEEN5C)
1	Ibrahim Daghistani				
2	Rayan Al-Amir				
3	Fahad aljindan				
4	Abdulaziz Al-Farhan				
5	Abdulrahman Hezam				

SDP05 Monthly Progress Report

Department of Mechanical Engineering
Prince Mohammad bin Fahd University

SEMESTER:	**Fall**	**ACADEMIC YEAR:**	**2020**
PROJECT TITLE	**Design of A Renewable Thermoelectrical Power Generator**		
SUPERVISORS	**Dr Mohamed Elmehdi Saleh**		

Month 2: November

ID Number	Member Name
201602881	***Ibrahim Jamal Daghistani**
201502008	**Fahad Aljindan**
201600434	**Abdulrahman Hezam**
201502659	**Abdulaziz Alfarhan**
201501007	**Rayan Al-Amer**

List the tasks conducted this month and the team member assigned to conduct these tasks

#	Task description	Team member assigned	Progress 0%-100%	Delivery proof
	Building the Prototype	All Members	100%	
	Chapter 4: System Testing and Analysis	All Members	100%	

	Chapter 5: Project Management	All Members	100%	
	Chapter 6: Project Analysis	All Members	100%	

List the tasks planned for the month of December and the team member/s assigned to conduct these tasks

#	Task description	Team member/s assigned
	Chapter 7: Conclusion and Recommendation	All Members
	Create brochures, banner	Rayan Fahad
	Presentation slides and prototype demonstration preparations	All Members
	Proof read the final report and minor adjustments	All Members

- **To be Filled by Project Supervisor and team leader:**
- **Please have your supervisor fill according to the criteria shown below**

Outcome MEEN4:
an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
MEEN4A. Demonstrate an understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental and societal context	Fails to demonstrate an understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts	Shows limited and less than adequate understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts	Demonstrates satisfactory understanding of engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts	Understands appropriately and accurately the engineering professional and ethical standards and their impact on engineering solutions in global, economic, environmental, and societal contexts

Outcome MEEN5:
an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

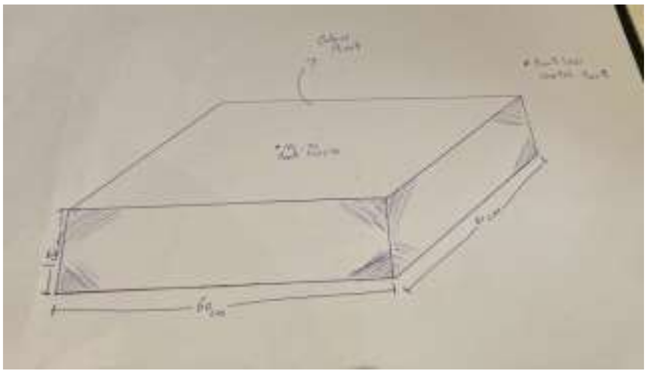
Criteria	None (1)	Low (2)	Moderate (3)	High (4)
MEEN5A: Ability to develop team work plans and	Fails to develop team work plans and allocate	Shows limited and less than adequate ability to develop	Demonstrates satisfactory ability to	Properly and efficently makes team work plans and allocate resources

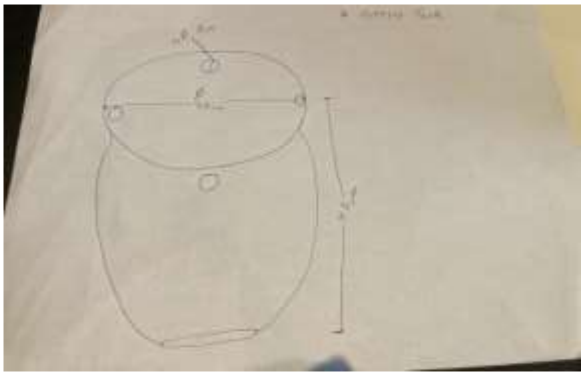
allocate resources and tasks	resources and tasks	team work plans and allocate resources and tasks	develop team work plans and allocate resources and tasks	and tasks
MEEN5B: Ability to participate and function effectively in team work projects to meet objectives	Fails to participate and function effectively in team work projects to meet objectives	Shows limited and less than adequate ability to participate and function effectively in team work projects to meet objectives	Demonstrates satisfactory ability to participate and function effectively in team work projects to meet objectives	Function effectively in team work projects to meet objectives
MEEN5C: Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	Communicates properly and effectively with team members

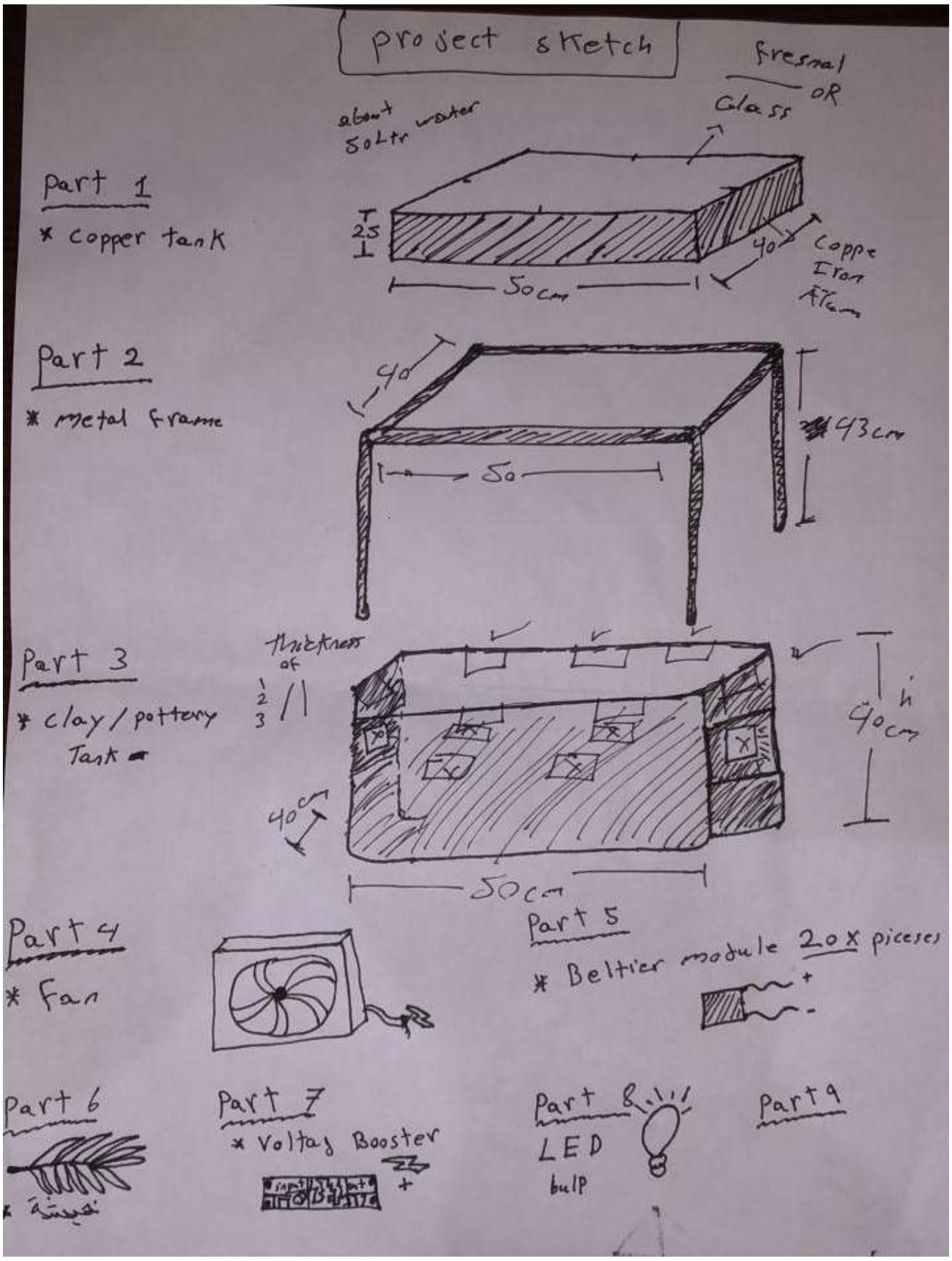
Indicate the extent to which you agree with the above statement, using a scale of 1-4 (1=None; 2=Low; 3=Moderate; 4=High)

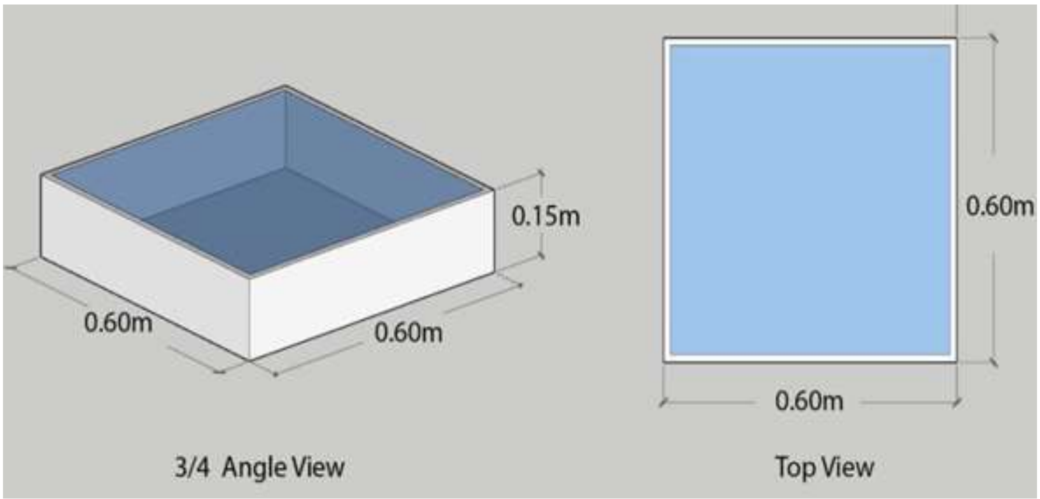
#	Name	Criteria (MEEN4A)	Criteria (MEEN5A)	Criteria (MEEN5B)	Criteria (MEEN5C)
1	Ibrahim Daghistani				
2	Rayan Al-Amir				
3	Fahad aljindan				
4	Abdulaziz Al-Farhan				
5	Abdulrahman Hezam				

Appendix C: drawings and Bill of Materials





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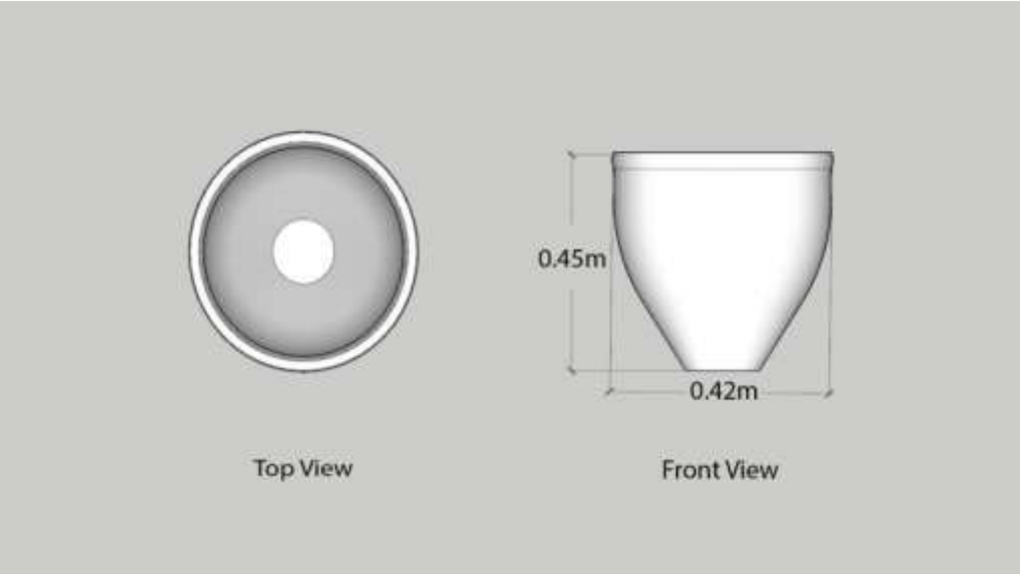
3/4 Angle View
Top View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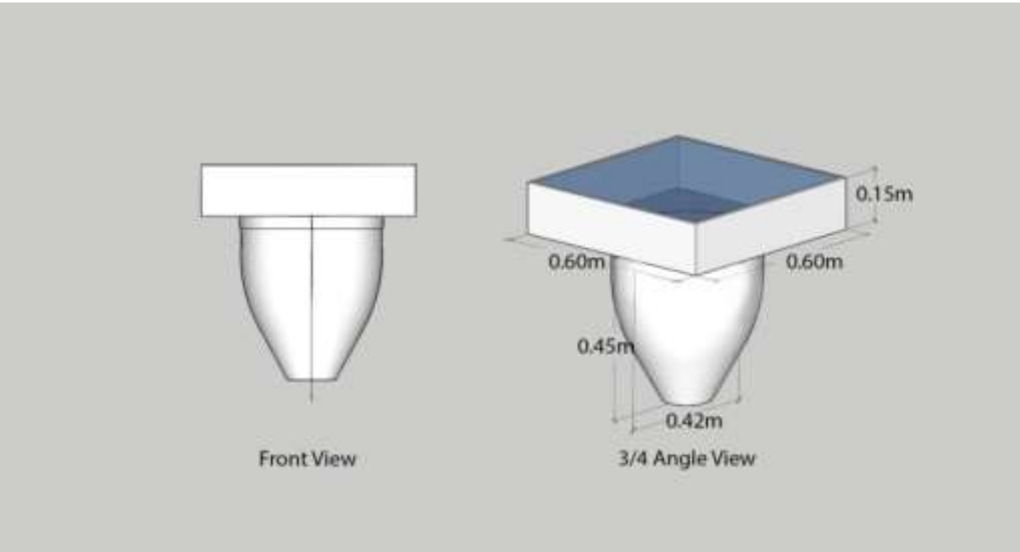
Top View
Front View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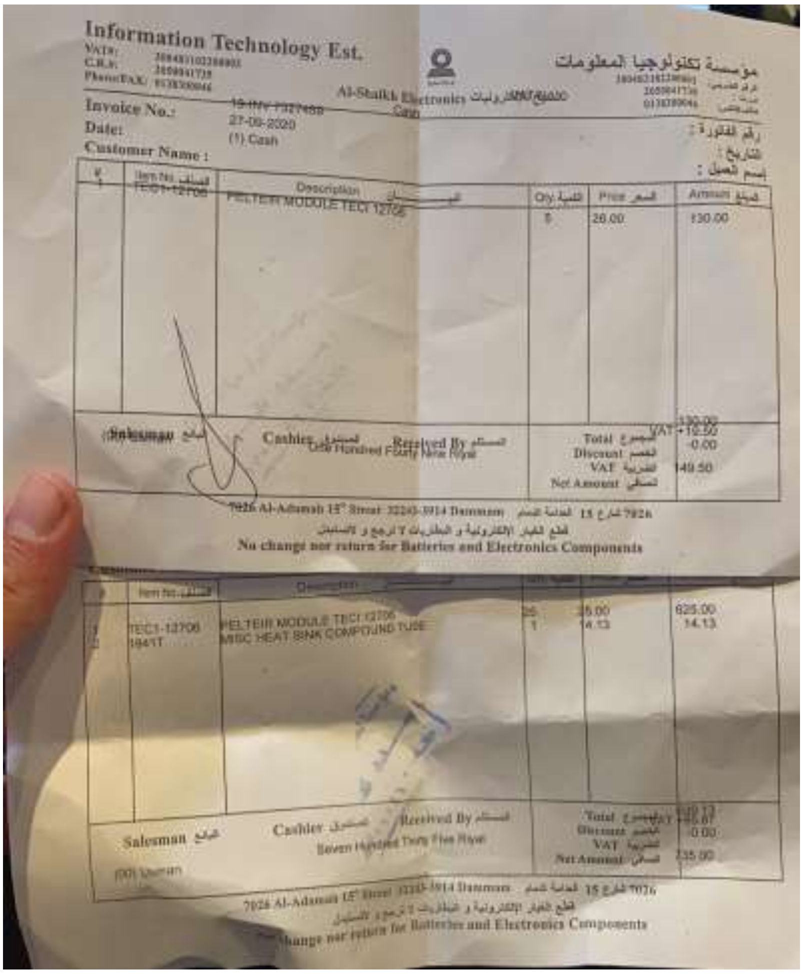
0.60m
0.60m
0.45m
0.42m
Front View
3/4 Angle View



Appendix D: Work Plan

	ACTIVITY	Tasks	Responsible	Duration	Percent Complete
Introduction	Project allocation + introduction	Project Definition	Ibrahim+ fahad	1 Week From 3/9/2020 to 10/9/2020	100%
		Project Objectives			
		Project Specifications			
		Applications			

	Literature Review	Project background Previous Work Comparative Study	All Team	3 Weeks From:11/9/2020 To: 1/10/2020	100%
System Design	Design	Design Constraints and Design Methodology	fahad+ Aziz	2 Weeks From:2/10/2020 To: 15/10/2020	100%
	Equipment and material selection (3.4)	selected the appropriate items	Rayan+ Abdulrahman	2 Weeks From:16/10/2020 To : 29/10/2020	100%
	Theory and Theoretical Calculations	main calculations required detailed calculations to your design.	Aziz + ibrahim +rayan	1 Week From:30/10/2020 To : 5/11/2020	100%
	Prototype assemble	System integration, describe , procedures and Implementation	All Team	3 Weeks From:13/11/2020 To :19/11/2020	100%
System Testing and Analysis	Testing and analyses	Experimental Setup, Sensors and data acquisition system Results, Analysis and Discussion	All Team	2 Weeks From:20/11/2020 To :3/12/2020	100%
Project Management and Analysis	Project Management	Project Plan Contribution of Team Members	All Team	2 Weeks	100%

		Project Execution Monitoring		From:20/11/2020 To : 3/12/2020	
		Challenges and Decision Making			
		Project Bill of Materials and Budget			
	Project Analysis	Life-long Learning	All Team	1 Week From:25/11/2020 To :3/12/2020	100%
		Impact of Engineering Solutions			
		Contemporary Issues Addressed			
Report submission	Final Report	Writing all chapters	All Team	1 Week From:4/12/2020 To :16/12/2020	100%
	Presentation preparation	Making Slides	All Team	1 Week From:5/12/2020 To : 15/12/2020	100%
	Presentation practice	Practice presenting in front of people	All Team	1 Week From:5/12/2020 To : 15/12/2020	100%
	Booklet	Print the report	All Team	5 days	100%

				From:10/12/2020 To :15/12/2020	
	Banner	Follow rubric	Abdulrahman	3 days	100%
	Brochure	Follow rubric	rayan	1 day	100%
Monthly progress report		1st progress report	All Team	Monthly, 1 Day	100%
		2nd progress report			
		3rd progress report			