Functional and Conceptual Design
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Laboratory Exercise – 5

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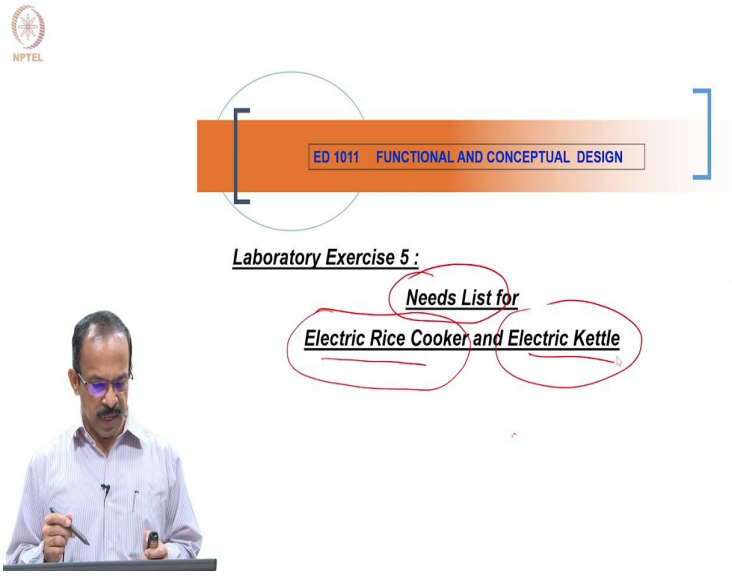

Welcome to the fifth laboratory session. So, in the last few classes, we saw how to do a systematic dissection of a product and identify the parts and then prepare a parts list as well as the assembly chart of a product for a product and the technical assistants are helping you to do this task. And I hope now you are familiar with how to do the first part of the dissection process where you do in a systematic way of opening the product, identify the parts and subassemblies and then looking at the functions of these parts.

Now today we will be looking at a different product. This product is going to be the electric kettle and a rice cooker. We will be doing two products, an electric rice cooker and an electric kettle. Both of them have some kind of common things that is why we club these two together. You will be looking at these two products, doing the product dissection. At the same time, you will be practicing a theoretical concept that we learned in the class, which is how to prepare the needs list for a product.

Looking at the customer requirements, how do you identify the customer needs and then prepare a list of needs based on the priority of the needs. During the theory class, we saw how to conduct a proper need identification exercise using Like/Dislike methods and then doing a sorting of the needs, using the affinity diagram and then finally coming to the list of needs for a product.

In this case also, we will be going for the preparation of needs list by following the procedure that we already learned of getting the needs identified. So, the product that we are going to use is an electric rice cooker and electric kettle.

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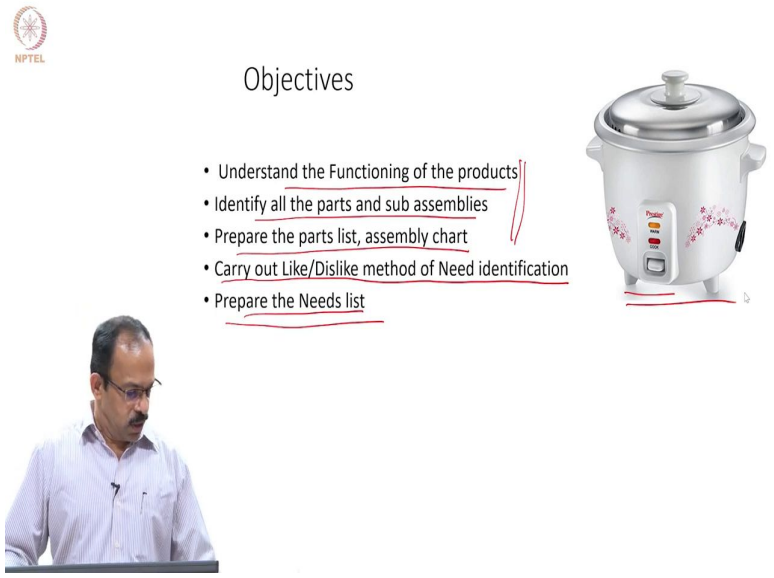

The objective of this exercise is to understand the function of the product and identify all the parts in subassemblies and prepare the parts list in the assembly chart, which is common for all the exercises. Now in this exercise, what we will be doing different from the previous exercise is the carrying out the Like/Dislike method of need identification.

You know how to do this, need identification using Like/Dislike method. We have seen a few examples in the theory class. So, each one of you will be having a format

for the need Like/Dislike method. Then you write down your likes and dislikes and then convert that into interpreted needs and then prepare a needs list.

Each one of you will be having a set of needs. As a group, you sort out these needs using the affinity diagram method and finally come up with the needs list with the priority. That is what is expected from you as part of this exercise or outcome of this exercise. One of the products we will be using is the electric rice cooker. Most of you might have seen this product. It is a very simple product.

There are not many complex mechanisms or systems inside. It is a very simple product with electric modules for heating and sensors and some switches for cut off of the electricity based on the status of the process going on.

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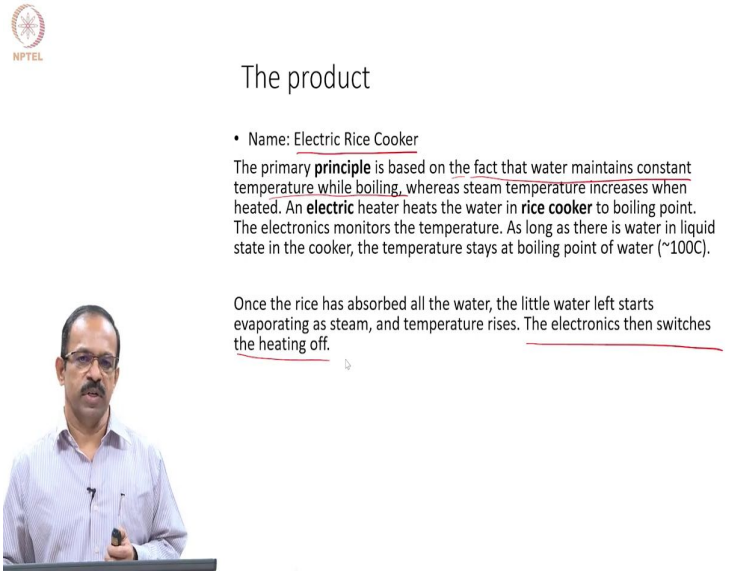

The product is an electric rice cooker, and the primary principle is based on the fact that water contains constant temperature while boiling. The TA will explain the working principle to you. When there is water inside, the temperature will be always constant and when the water is completely drained, then the temperature will start

increasing and when the temperature starts increasing, the system will cut off the power supply. The rice is already cooked.

That is the basic principle. So, you will be looking at the electronics and the heating, what is happening inside the product that will be able to see and the TA will explain to you the functioning of different elements.

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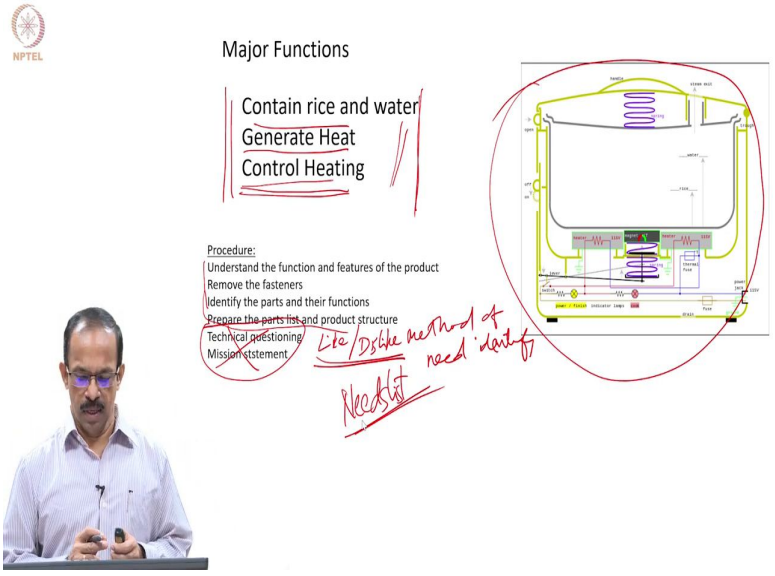

The major function of the product is to cook the rice and to achieve that one, you need to have many functions in the product. One is basically just being able to contain rice and water. You should be able to have the rice and water inside the product that is containing the elements, the materials, rice and water, and then it has to generate heat. And at the same time, you need to have control of heating also. So that it does not overcook or it would not get burnt. That is why you need to have control of heating. So, these are the main 3 functions we can say.

Then you need to see how these functions are achieved through the different elements in the product, so you will be able to see the generic diagram need not be the same as in the product that you are using, but generally there will be a heating element. There will be a circuitry which actually measures the temperature through a sensor. And then using this data is used for cutting off the power supply or to stop the heating process. So, that is basically what is there in the product.

So, the procedure is the first 4, this technical questioning and mission statement is not necessary. We will not be doing the technical questioning and mission statement in this case. But what you will be doing here is the Like/Dislike methods, Method of

need identification. You need to identify the needs of this product, suppose you are going to redesign this product, if you are going to redesign this product, or you find that there is some problem with this product.

How will you identify the needs of the customer for this product? That is basically the need identification. You use the Like/Dislike method of need identification that like dislike formats are available. So, use this format and identify all the needs and then use the affinity diagram method to sort out the needs and then get the needs list as an outcome. You need to prepare the needs list. So, the report should contain the needs list apart from the other details asked for in the reports, I hope you understood this.

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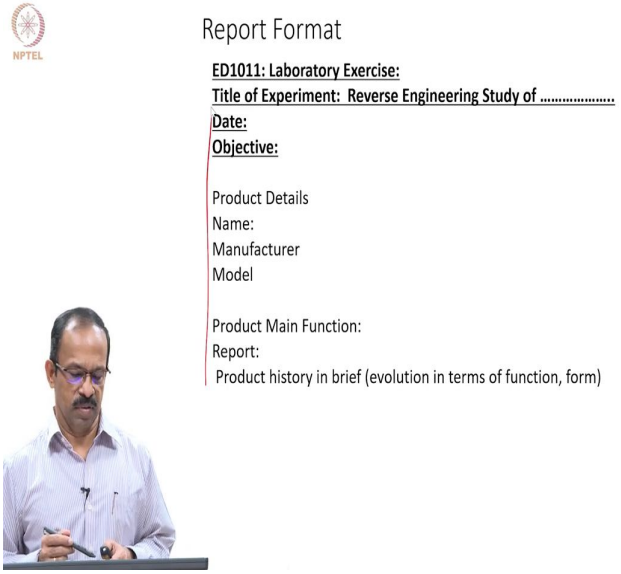

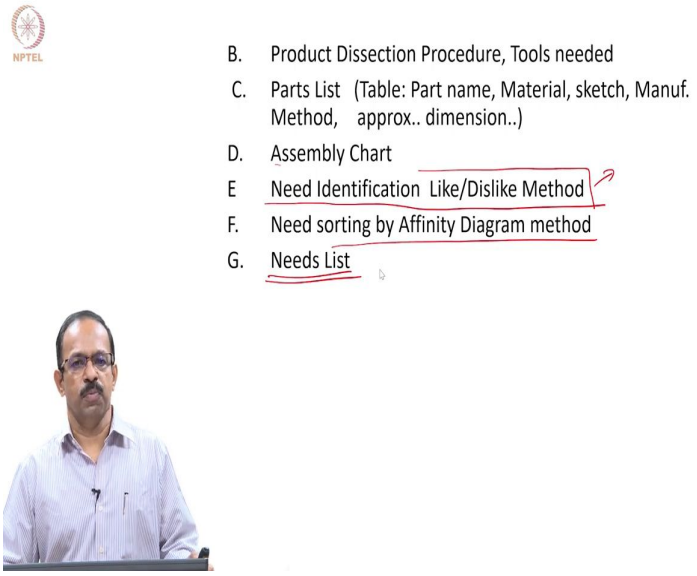

So, the report format, the first part will be the same as in the previous cases. But the difference will be the assembly chart. You need to have a need identification by Like/Dislike method. So, you need to show the format you use for the Like/Dislike method of need identification and then getting other interpreted needs and then how the interpreter needs are sorted out to get the top needs of the product and then provide a needs list.

Once you prepare the needs list your exercise is complete. So, the TA will help you to look at the product and product's technical details. And after that, as a group, you need to look at the product and then find out what kind of needs will be there for the customer and then how do you sort out the customer needs and then get the needs list. I hope you understood this. You can go to the TA and then the TA will help you with the experiment.

TA: Do you know the concept of bimetallic strips? So, there are 2 metallic strips of different melting points, when the melting point is reached by one and the other does not actually reach the melting point and there is a bending of one strip while the other expands. So, have you come across a thermostat? So, it follows the same concept.

So, we are going to look into two products today both working on similar principles, but the sensor is going to be different. Here we are going to use something called as a Ferrite thermostat and here we will be having the bimetallic strip, but both of them work on the same principle that detection of heat, the current, which is going to pass through the coil will heat the coil due to resistance offered.

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We will start dissecting the electric cooker today. So, let us start with the parts. This is the metal lid and we have the next part, which is a hot pan and it has a sieve. So, the metal pan is anodized, so that there is an equal distribution of heat. And why do we have the sieve, just to avoid the rice getting stuck to the base of the pan. You need not only cook rice with your automatic cooker. It also can cook your normal vegetables.

So, what is the process of rice cooking? There is this four process, 4 steps, of cooking rice. The first step is that you are going to add water, rice, there is going to be an increase in the temperature due to heating the coil, rice absorbs water and gets

cooked. Now there is no water inside the pan. What happens? Will the temperature remain the same? Why does it get burnt, correct, why does it get burnt?

Don't you feel there is an increase in the temperature than the actual? What is the boiling point of water? 100°C. Does this remain the same at all altitudes? No. So, you have to choose a sensor which works perfectly for higher altitudes at sea level and below sea level. Let us look into the other parts also. If you are able to see. The coil is actually inside this heating base. Now, let us dissect, keep the screw safely. It is the base of the pan and it has all the ratings of these electric cookers.

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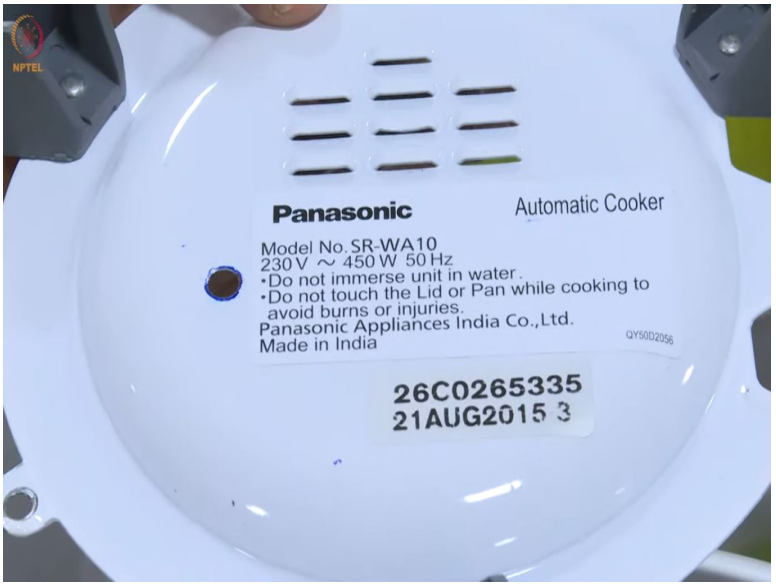

So, by ratings, what do I mean here exactly? Voltage ratings and power ratings. So, if you see closely there is 230 Volts and 50 Hertz rating, what does that mean? So, is… is the same when you go to the US, if you are going to develop a product which is going to be of 230 Volts 50 Hertz and use the same abroad. Will that work? What do you need? You need an adaptor.

So, the point is you should be able to understand the standards of the market and where you are going to apply the product. The next that we will be looking at is the

power cord. So, the power cord, what actually is happening is you are connecting to the power. It is being connected to the heating coil that we saw. We spoke about it. We will be dissecting it and removing it out. So, for now you are able to see that it is connected to the heating coil and you are also able to see a limiting switch.

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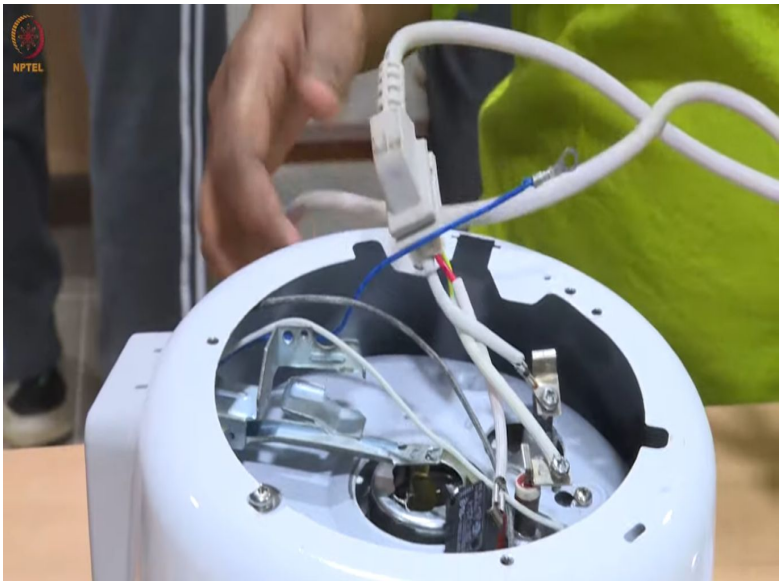

So, this will be placed here, which is going to be attached to the switch, you're on and off switch. There is basically a lever mechanism. Once you switch this on, it is connected to the thermostat, which is inside and the heating begins once the heating comes to a point above a 100ºC, assume, it is the metal lever, which is in the thermostat it is going to release. And this push button that we have switched on will also release. As a result, power is cut off. Do you follow? We need not set the temperature. The temperature is

Student: Predetermined.

TA: Yes, not the surroundings, the thermostat. So, the one the portion that you see here. It is going to be based on the material of the thermostat this is called as what we

use here is a ferrite thermostat. I will be telling in deep about it… so about this and. So, this your power cord with two wires connecting to the heating coil and one to the limiting switch.

See, this is your heating base and this is the thermostat. If you are able to see there is a metal lever to the thermostat, this is where you are going to connect the power cord. The cup and heating coil is anodized so that there is an equal distribution of heat. Now this is for spreading heat also. So, here is where the actual heating up starts and it is going to spread throughout here is where you fill the heat. Let us also remove this thermostat.

The working principle of this Ferrite thermostat, I will be explaining. If you are able to see this metal lever here, the metal lever gets attached to the magnet inside it. So, here is the actual magnet. And this is the metal lever. What happens is, once the 100ºC, once I switch it on once this lever, once I am going to switch this on, it tries to push it down. And the metal lever which is attached to this end, attaches to the magnet. Have you heard about para magnetism?

So, a normal material at Curie point will transform into a paramagnetic metal. So, at 100 º C, this metal lever becomes paramagnetic, detaches itself from the magnet and tries to push it off, which means it is trying to cut the contact from power, understood. That is the working of the Ferrite thermostat. Let us dissect this also.

The advantage here is the complete lever mechanism, which is going to automatically switch it off. So, if you come up with another method, or another thermostat or another sensor to do this using another mechanism, not probably the lever mechanism. So, whichever is less costly, it has to be cost effective first. Correct? And also it has to abide by the 100 º C. You are able to follow. It is inside.

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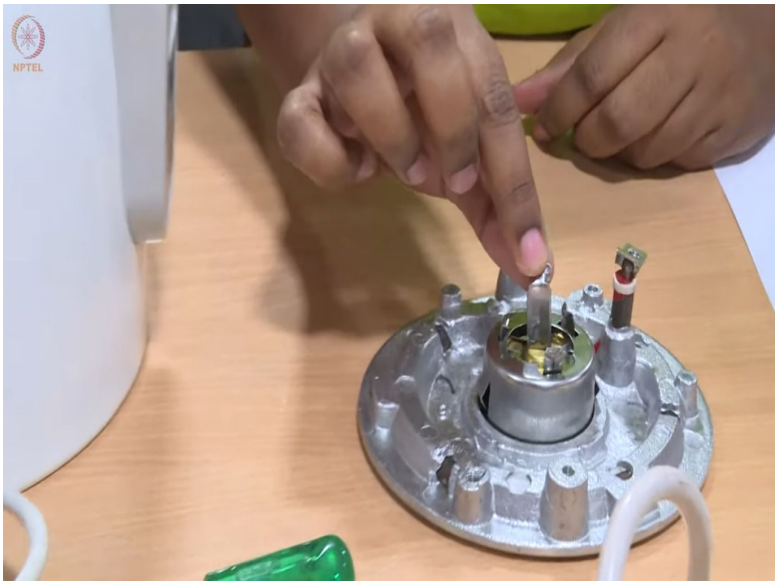

So, basically this metal lever, which is the switch here, this on off switch, it is being connected to this end of the metal lever. Once you switch it on, it gets attached, everything is in contact with the power supply. So, what happens is 100 ^{o} C is reached and the curve point of the metal lever behaves like a paramagnetic metal and it detaches itself. As a result, there is a switch off and a cut off from all of this is also part of the thermostat so I want this as a separate subsystem or a subassembly.

Let us now remove the other. So, you're on and off, and you have no indicator LED which will be placed and the other end these two ends will be connected to power, this is ground, that is an indication of looking, is there an LED mode, is there a light in mode. So, this is your switch, metal lever on and off. And then you have a simple color coded strip to show whether it is cooking mode or not cooking mode.

What other modes. So, what other modes can you think of in an automatic cooker? What other modes would you want that just provides you with warming the food? So,

you have only one pan here. How would you add compartments? Can someone tell me the working of this electrical cooker working principle?

Student: So, we press this lever, lever then locks the Ferrite thermostat into on position which is then fixed to the magnet hence completing the circuit. Now the current passes through a heating coil, because of existence, it builds up heat then this heat is transferred to the heating pad and thereby increasing the temperature in the water or cooking substance.

TA: Once it is cooked, what happens?

Student: Then when it becomes sufficiently heated, then the magnet or the lever that we locked into the magnet, it will become paramagnetic and detaches from the.

TA: What is the point?

Student: 100 ^{o} C.

TA: It is called the Curie point.

Student: Curie point yeah. When it reaches the Curie point of the material, then it becomes paramagnetic and hence the current gets disconnected.

TA: The lever

Student: The lever, lever gets disconnected.

TA: You are able to see in this metal lid there is a hole, you are able to absorb. So, have you seen a pressure cooker? How do you compare this pressure cooker and our electric cooker? Even if there is a blockage that is why we are providing an extra spacing on the sides. To prevent pressure build-up.

TA: No, that is what. See the side holes and there is an opening here. These are all safety concerns. The complete water gets absorbed. So, once the complete water gets absorbed is when your actual temperature rises. So, if you are going to add excess water, then there is a problem. There are specific measures as to how much rice and how much water should be added for an automatic cooker, which is different from that of a pressure cooker, different from that of a normal cooker.

Moving on to the next product. This is our electric kettle. I would not mention it as a water kettle. What else can we do with this?

Student: Boil water.

TA: Boil water, stored water. So do you guys not cook anything with the kettle? So, if you are able to actually see the coil inside is open here, can you cook Maggi in this, can you cook Maggi in this. So, what happens when the coil heating coil is in direct contact with water and it is being at a surface below. So, this is your support bracket. Support bracket for the switch.

Here is the actual switch on and off that we do. It is connected to a lever again. And here if you are able to see, we have a coil, this is the one socket, support base which connects to the power base. Once the jar sits on the power base, it comes in contact with the. So, it comes in contact with the power cord and automatically heating begins. What is the principle of heating that we are using here?

Student: Joule's heating.

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TA: This is a support base here. We have this switch we will be able to remove the switch also. So, this is a switch. And we have a light indicator which will be present below the switch, the switch is connected to the lever that goes up or down, and it is connected to this one. The other end of this lever is connected to a bimetallic strip. So, this bimetallic strip is placed exactly beneath this smoke tube or the not smoke, vapour chamber or steam tube.

Once water starts heating, the steam gets into the steam tube and this bimetallic strip which is placed in direct contact with the steam tube is going to be heated up. Once heating is detected, the strip melts and if you are able to watch. Ok. So, we are, switching it on, once the heating or the steam comes in contact with the bimetallic strip. What happens is it melts and it opens.

So, once this switch is open, again, the same concept power is cut off and you cannot heat it up until some period have you noticed that. So, exactly you have to think like that. So, where can you compensate for all these components?

TA: There was a separate LED indicator to show whether it is connected to power or not if there is so but the point is for you to just have the heating. So, this is the washer, no… not some here from the water. If it is not properly grounded and if there is current passing through the heating coil there are two designs one with direct contact one. So, what do you think?

Here if you see the heating coil is being connected to this washer separates water, which is on this site, and here it is going to be connected to the power cord. It will be sitting like this. Basically it sits like this without your water kettle. If you see this is the actual structure. So, if you are able to cover this up and provide a passage for heat to actually go into this water flask, what would it be? What kind of designs would you come up with? Metal base should not pass the heat as and how much it gets. So, if it is in direct contact.

Student: Washer.

TA: So, washer is a problem. So, one thing that you are suggesting is to provide a better washer size and the other one is to completely lock it out from water. Correct? So, why do we have such a complicated design for the heating coil?

Student: It cannot be bigger than this?

TA: So, how would you change the mechanism? So, that comes in direct contact with this heating coil.

Student: This is for steam, right?

TA: This is for steam. This comes in contact with your heating coil.

Student: Why two strips?

TA: If it is open, if your lid is open, then the steam will not enter directly here. Now, this has to add. So, I want to ask a question, why this model of heating coil, why can't it just be a plain, circular?

Student: Increased area of contact.

TA: More area of contact. So?

Student: So, it heats better.

TA: So, if you are going to I just have a question. So, if you are going to place resistors in series and resistors in parallel, which would provide more heat, more heat.

Student: Series.

TA: What is the equation in terms of V because here you're I varies, V is constant.

Student: Parallel.

TA: So your parallel connection has better heating than your series connection, fine. So, if you are going to alter the heating coil design what better can you suggest. So, if you see it is like protruding if you are going to place it inside a compartment, should it be like this or you need some other model?

TA: So, you have to increase the number of coils probably.

Student: Spiral may work.

TA: Spiral.

Student: Mesh.

TA: Mesh. So, if you are having a mesh and you should also understand that it is going to heat. Will it be able to hold that much of the heat?

TA: So, think about the designs. It can be a coil.

Student: Expanding coil.

TA: Yes. You did not see any facility for it to expand, right. It was just a washer. So, probably you could think of this, if it is going to expand what would happen.

Student: It could break.

TA: Exactly. So, do you need that much heating to happen? Cannot you go in for a metal, which is going to accommodate all of this because we are just going to heat water? You are thinking of… okay. So it goes in with your uses also. I am not able to get you.

Student: This is an old model.

TA: Can you see the name. This is Usha. Yes, the middle name is given here, this is ek612. So, we will also open up this. So, can you open it up so open this? It will be sitting over the heat base, so it is supposed to come in contact with this, whatever protrusions you are able to see here, will come in contact with the power cord. So, we will open that. Can you open it? So, you can see the bimetallic strip.

Student: Slide touch.

TA: Yes, it is supposed to detect. So, it basically depends upon the material or your bimetallic strip. So, your sensor has to be effective enough to detect a change in temperature.

Student: Small amount of heat?

TA: No, not a small amount of heat. That is what so it has to be with a melting point, boiling point of water? So, yes, the washer will go in the separation to places. Place it like this. This comes in and then you place.

So, this is the power supply connection. And here your switch will, lead indicator will be placed here and the switch comes in, this is your filter and you can see the steam tube here. It is open, the coil is open, right? So, that is open. So, if you see this is the power cord. You have to plus, minus and ground. So, what. You are able to see.

So, when you place your pan on top of this automatically this will open up and it gets exposed and this is just a simple spring mechanism. So, you should be able to appreciate the little, little designs that they have put in, okay. So, this is not powered. What if it is not close.

Student: Anyone can come in contact.

TA: You can touch it even when it is not on? Yes you can. See no it is not all the time that I mean adults use it. So, what if children are there. No, this is not a switch. This is just a power cord, which is going to be connected, and once you connect it to your actual sitting base, it will provide power the switch is different. Here is your actual switch. So, have you taken enough pictures?

Student: Can the coil be placed in a different compartment?

TA: Yes, so that should be one of your design improvements. So, when you place it in a different compartment and you place it in direct contact with water the design is

going to change and whatever the mechanisms involved in this direct contact of a water kettle is going to be different from that of a non-contact water kettle. That is how the current water kettles. Have you seen another version of this water kettle… not this new one.

TA: So, it will be open and you just have to place it on top.

TA: So, there the opening or closing whatever comes in, it will come along with the coil. Instead of placing the coil with the.

Student: So, can you keep the water warm?

TA: Here it cuts off at 100 once it starts boiling, it cuts off. So, if you want to keep it warm, you have to add another mode. So, have you heard of fuzzy logic concepts, fuzzy logic, so can you incorporate any of your warm mode, hot mode? Can you explain? So, it is basically like a condition where you assign a parameter to a set of values it need not be either 0 or 1. It can take any value between 0 and 1 and you can assign a state to it. So, if in case you take 0 to be your off mode on to be your full I mean, say cook mode in between is your warm mode so you can incorporate any number of logics into this and create your other modes without actually incorporating another mechanism, mechanical point of view. In spite of that, you can just add in logic and create a separate circuitry to provide the heat that you actually want. So, what if you reduce the amount of current that is actually passing through?

Student: Because the water is as such heating, adding another circuit might help.

TA: Yes, you should.

TA: So, start assembling the product. Any questions? Yes. Whoever is in direct contact has more heating than the top layer. So, if you want to make it, we have a question guys, if you want to provide equal heating like throughout the, I mean water which is present in the can.

Student: Maybe the vessel can be changed.

TA: What else can happen?

Student: Maybe the vessel can be more on the base.

TA: So, if you are going to change the design so as to go.

Student: Change the material of the case.

TA: Exactly if you are going to change the container metal to an anodized one so that it provides even distribution of heat. Instead of going for a vertical heating.

Student: Why should we anodize?

TA: No that is base. This is basic. Anodize for just providing equal amounts of heat or equal distribution. See it is you are going to coat something. The coating that you are

doing is a material. Yes, it is a material which provides an even distribution of heat. Yes, no this is a model. This is a model. It will be. So, what you see here is an anodized pan. This is an anodized pan. The rest of the material is just metal. This is basically a sieve.

Student: Where do you place it?

TA: Below water. Ok. Assembled? Any questions on this product. So, for the design improvement, what all we discussed.

Student: Coil.

TA: Direct contact of the heating coil. Other one was?

Student: Change material.

TA: Material. So, we can go in for metal. If we are going for a metal, would it cost more, less?

Student: More.

TA: It costs more. So, that is also a factor. Third. We talked about even distribution of heat. So, if… if the coil is going to be vertical or coating of the entire inner layer. So, one other thing that you spoke of was to store the water and keep it in warm mode.

So, any other additions that you want to make? Moisture, washer. Open, support bracket, button and here we are fixing back the support bracket. And here we will be placing this entire thing. So, your product actually consists of your water and it also has an indicator for how much water. It should not go above this value. So, what is the capacity of this? So, what happens if you can, if you go above this limit?

Student: Water will spill.

TA: Spillage.

Student: Doesn't get heated.

TA: Okay. So, the whole point of equal… equal heating does not happen it actually goes one layer to one layer, right. So, this is a maximum limit of 1.2L

Student: The coil is present below, what is the advantage?

TA: Coil below. One is there is no direct contact. And you are trying to place the heating coil below that is actual. And also the… the consumption of heat from the coil happens from below. They are not trying, they are not trying to replace this whole heating coil problem. They are just trying to place it not in contact. So, there is less. No, uniform heating happens only with a material which is going to be completely anodized. So, if you are going for a steel water kettle. Any questions?

Student: Is it for this?

TA: This is just an add-on to it. Is there a compartment? You want it open. So, shall we go in for the discussion? So, for this lab, we saw two products. One is the automatic cooker, automatic electrical cooker, and the other one is your automatic electric kit, or your electric kettle. And you can also, here this product is going to be just cooking mode on and off mode the same way as this electric kettle, which has direct contact with the heating coil, is going to switch on. And once the water boils it is going to switch off. These two are what we looked at today.

Thank you.

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