**Principles of Vibration Control**
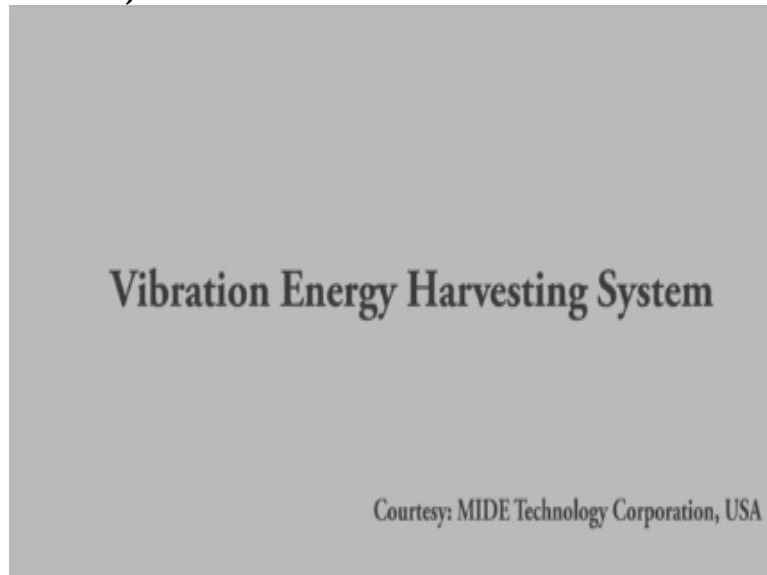**Prof. Bishakh Bhattacharya**
**Department of Mechanical Engineering**
**Indian Institute of Technology-Kanpur**

**Lecture-21**
**SMSS Laboratory Demonstration**

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Courtesy: MIDE Technology Corporation, USA

One of the last principles of vibration control what we have discussed in our theory class is related to the transformation of mechanical energy into electrical energy and in that process control in the vibration of a system. Now here we are in the laboratory today where we have one such system which is known as a energy harvesting system. This is actually a (()) (00:41) energy harvesting product.

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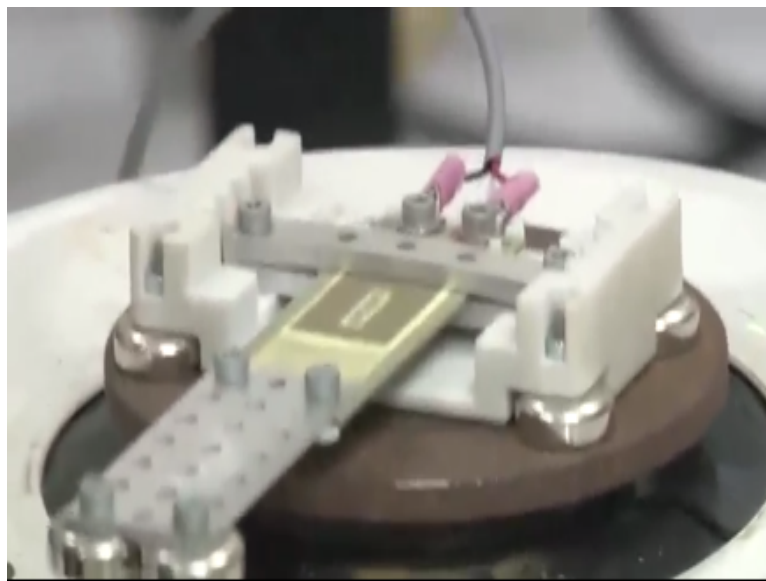
If we look at it closely that we have a beam and the beam is having an energy harvesting (())
(00:55) and what we have do is that we are exciting the beam which is in the continuing
mode with the help of a shaker and the beam can be excited with the help of the shaker at
various modes. So this shaker excitation then we actually control from the function generator
and then to a power amplifier.

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This comes here in the shaker, so that I can excite the system at various frequency ranges and
the output of this (()) (01:26) where we can see what is the peak to peak voltage that we are
generating from the vibration.

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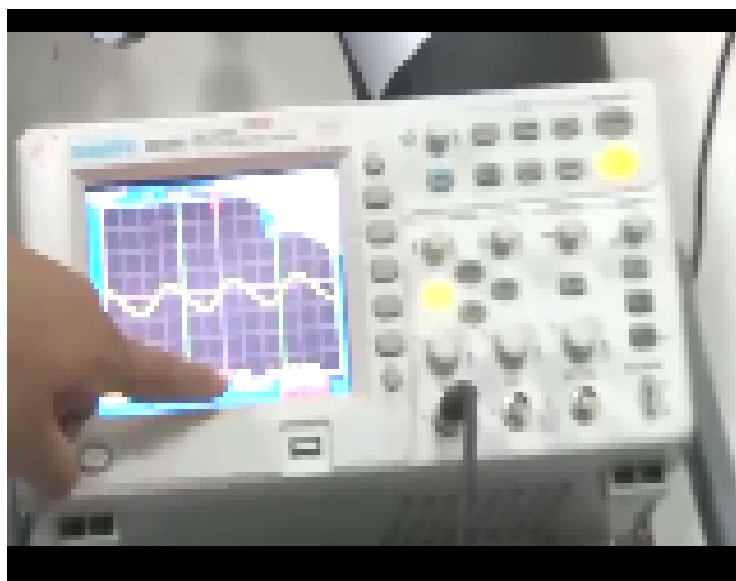


So to begin with what we are going to show here (()) (01:39) electric energy harvester is able
to generate a peak to peak voltage of about 5.8 to 6 volt. So this kind of a vertical coin signal

it is able to generate from the vibration. Now if we double next the frequency from 15 hz to 30 hz so we will doubly talk and see the effect of each one.

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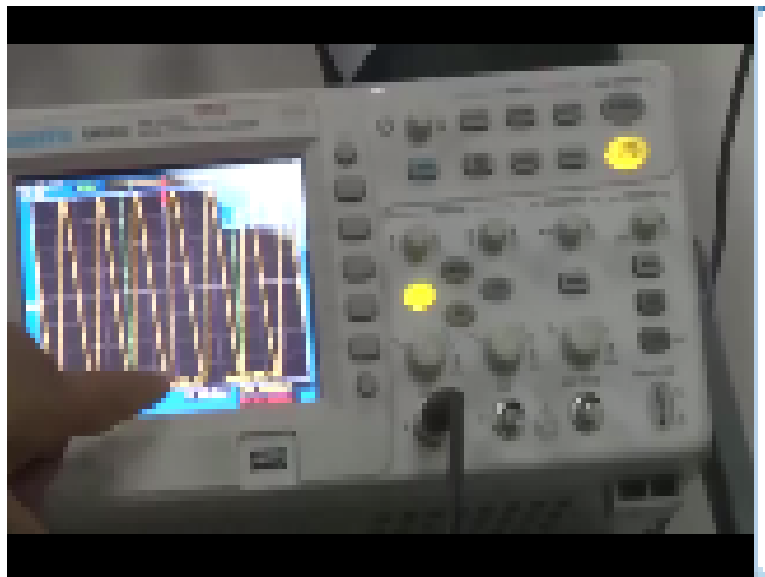


We now have a 30 hz excitation signal and we have not changed any other parameters but just with this doubly of the frequency what we can see here that are peak to peak voltage is that in change he has to 38.4 volt. So we have increased the peak to peak voltage from 6 volts to more than 6 times to 38.4 volt just by doubling the frequency which means also that the higher the frequency the going with mechanical energy and we will be able to convert more of these mechanical energy to electrical energy.

So depending on the ambience source of excitation we will become to extract the energy from the ambience and we will be able to convert it to electrical energy. Subsequently this electrical energy can be stored in the form of battery and for example you have developed a various types of electric energy harvesters some of the things which can be actually used for charging low power electronic devices.

So this is one set up through which we can see that how these energy harvesting system can be developed and can be neutralized in a very useful manner for both the purposes for controlling the vibration of a system as well as for generating electrical output which can be used for useful purposes.

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A green harvesting device for low power electronic equipments

Indian Design Patent No. 232707

Inventor's Name:
Dr. Bishakh Bhattacharya
Mr. Atul R. Sultane

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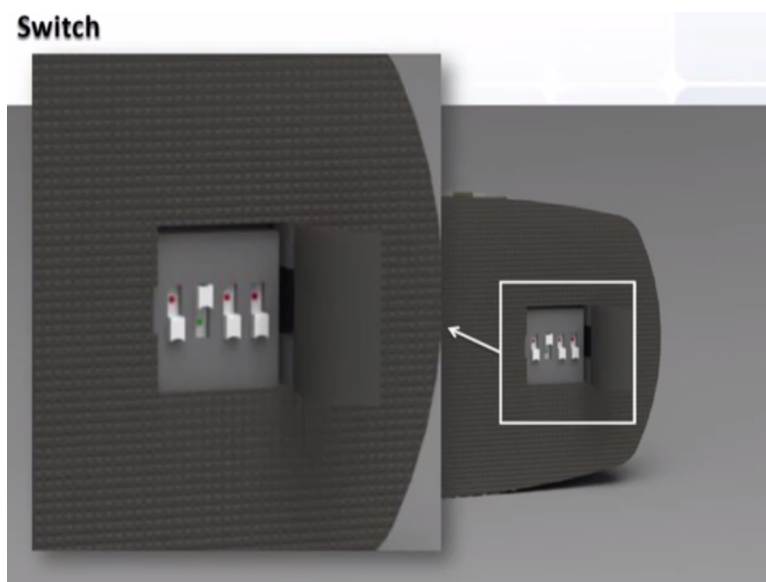Top View

Power Pro

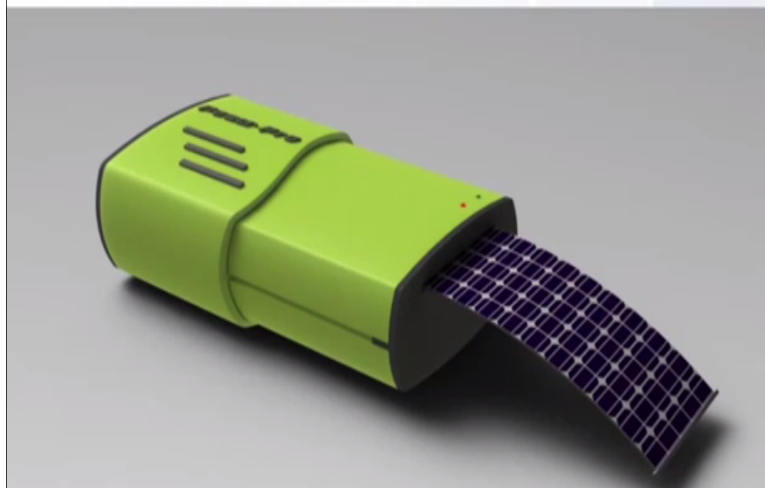**(Refer Slide Time: 03:56)**

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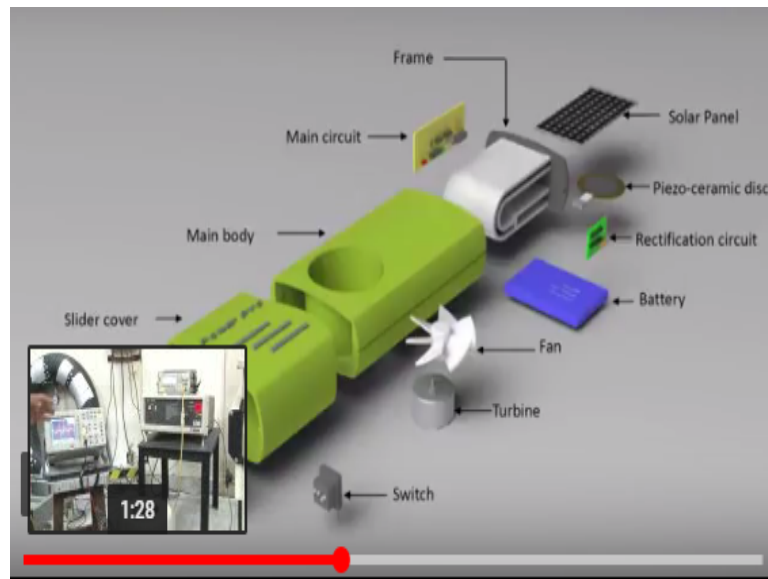**(Refer Slide Time: 03:59)**

**Wind Turbine**



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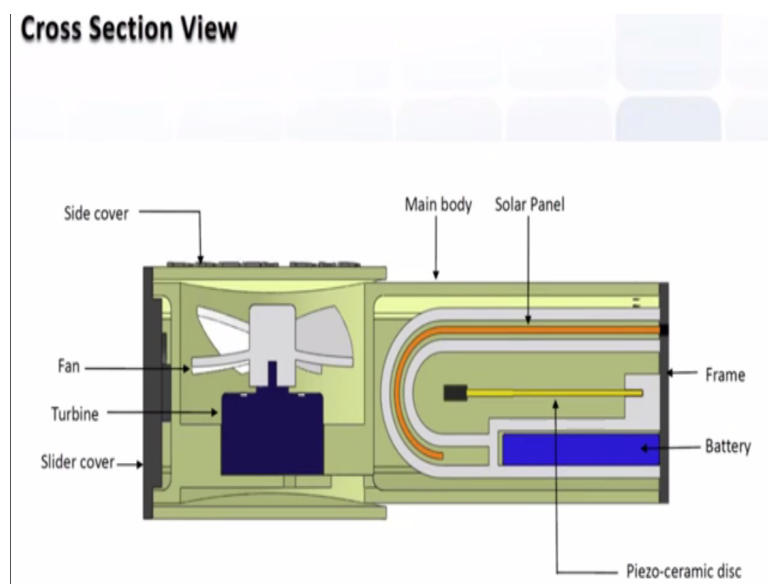
**Solar panel**
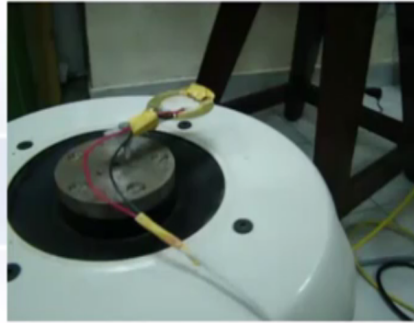


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**Testing On Piezo-ceramic disc:**
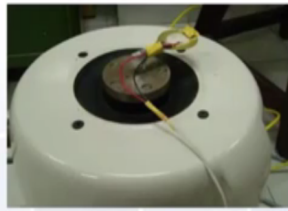


| Frequency | Voltage Produced (Volt) |
|-----------|------------------------|
| 25 Hz | 2.1 V |
| 30 Hz | 4 V |
| 35 Hz | 5 V |
| 40 Hz | 3.5 V |
| 45 Hz | 3.76 V |
| 50 Hz | 3.88 V |

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## Technical Specification

**Wind Turbine**
• Diameter: 20 mm
• Height: 15 mm
• Output: 1 watt
• Volt: 2.5 to 3.5 volts

**Solar panel:** 4.2V 50mA Flexible Solar Panel
• Output: 50 mA at 4.2 V
• Open circuit voltage: 5.9 V
• Total size: 3.3" x 1.5" ( 84 mm x 38 mm)
• Total solar cell area: 2.8" x 1.5"
• Total thickness: 0.22 mm

**Piezo-ceramic:**
• Disc Diameter 30 mm
• Thickness 0.8 mm

**Battery:** 3.7 V / 800mA lithium ion

**Diode:** 1N5817 (It is recommended to prevent the solar module from draining the battery when the solar panel is in dark and Wind turbine are not running.)

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Attachment could be provided for the product to be fastened with the window of the train, bus or in cycles or even to the user's shoulders.
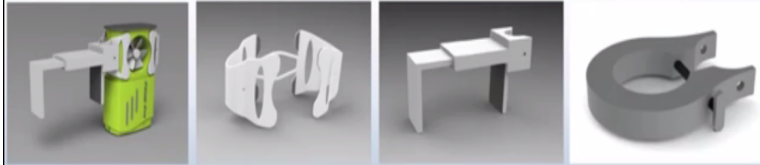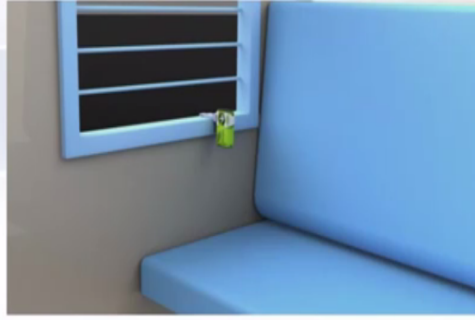
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Magnetic Levitation System

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What we have here is a practical system where we can demonstrating how a PID control can be designed. Now in this system as you can see that if it is a power loop system there you have a reference signal, then a pre-calibration control unit, and it goes to power source then from power source we go to magnetic levitation and then there is a sensor, it senses it. For that as per as the open loop system concept.

How the effect an open view system cannot actually control these ut and hits the levitation is not achieved there is no way to rectify our self. Whereas if you look at the second system here you have a reference position and then there is a error and then there is a control of here like a PID controller, then the power source and the magnetic reputation, that is the plant and then there is a sensor which is sensing the location and it is getting a feedback through the PID controller and this whole system can actually rectify itself.

So what is the advantage that in this case for example if I give an open loop system I may have an output yt which may for or may not form. Whereas in this case if I give a open loop signal then we will see that after started point of try this state is going to follow that reference signal that it can rectify itself and PID control are takes care of the rectification in the loop and the whole thing happens in the very very small time. We can actually now demonstrate it to you to the magnetic levitation system which can be control with the help of the PID control.

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What we have here is a magnetic levitation system and here in this system this one is the electromagnet whose power can be controlled and there is a sensor here. The sensing systems such that trace a light which is coming from this point and the shadow of this light it getting generated here and depending on the shadow the electrical signal is generated and that actually controls the magnetic field.

So that is the whole close room control system. Now let say if I take this small planet and try to actual levitate it now are artificial you know flit artificial universe inside the lab. We can see that as we take it here the light is actually going to get shine and then there is a shadow here and according the current it control very quickly by the PID control or and as a result we can see that the magnetic force almost it happens instantly.

But it is actually to these close room control system that this actually happens within a microsecond that the magnetic force is quickly calibrated and the whole thing starts to float.
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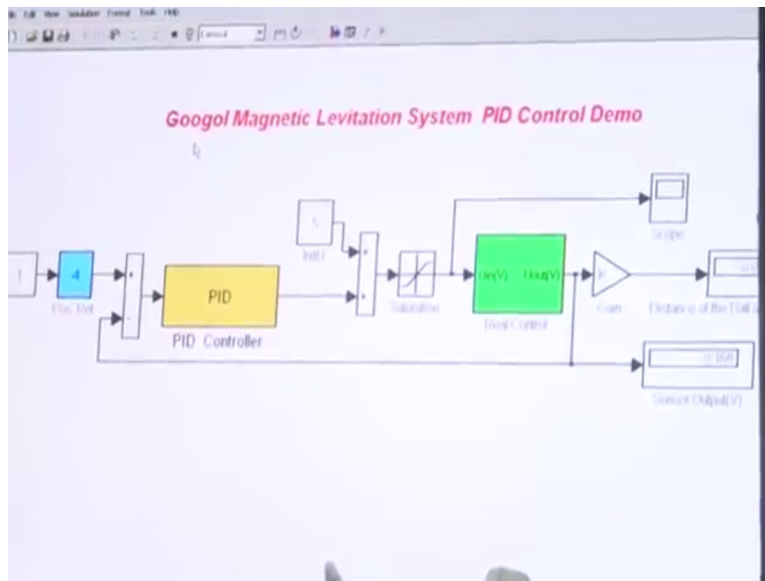
At this system we can also show that the beauty of this system is that this is fair glow fast. If this mass of the planet suddenly changes suppose the planet starts to have one satellite. Yet this is still with the actually at just itself.

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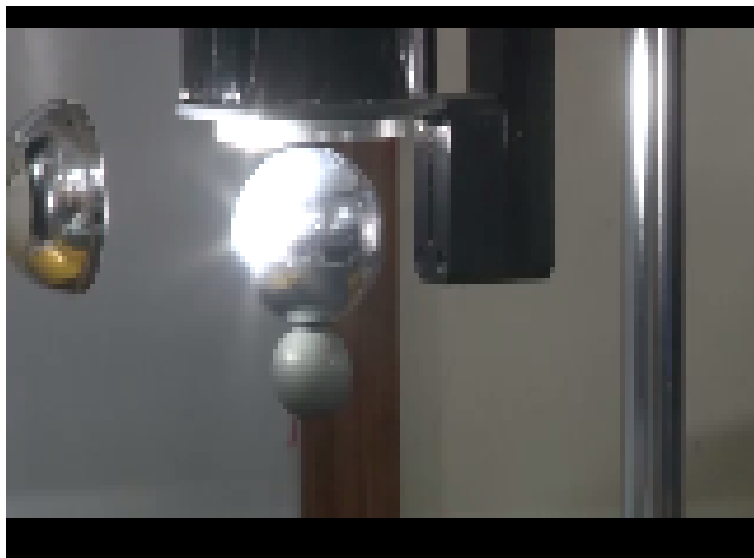


So you can add a satellite here. Yet the system is able to quickly adjust the (()) (08:05) the system. So essentially what is happening is that this flaw it across the light is getting you know reflected back the shadow is generating a coil which is controlling the magnetic field and as a result entire thing is levitating.

And then it all these things I have changing the mass the you know the gravitational force is what we gain here the gravity gain correspond to magnetic field is automatically getting adjusted, so that it can accommodate up to a certain extend launcher mass of the system or so

to say a change to the original mass of the system. So this is the beautiful demonstration of close room PID control. Thank you.