**Introduction to Photonics**
**Department of Electrical Engineering**
**Indian Institute of Technology, Madras**
**Semiconductor Sources Lab Demonstration**

Welcome back to laboratory session, today we will be doing characterization of the optical sources and we have two optical sources with us, one is semiconductor light emitting diode and short led and the second one is semiconductor laser diode and short led. So we will be doing majoring voltage versus current and power versus current of both laser diode and light emitting diode.

Let us start with the LED light emitting diode, so as discussed in class led is nothing but a simple PN junction diode and to get radiation from led, so we had to connect led in a forward bias mode, so also discussed in class that if we connect led in forward bias mode because of the electron hole pairing combination happening in a diffusion region and we get the radiation and need to have also very much true that when we increase the forward bias current there a combinations increases and we get more power from the led.

So we will verify this current versus power characteristics of led with the experiment.

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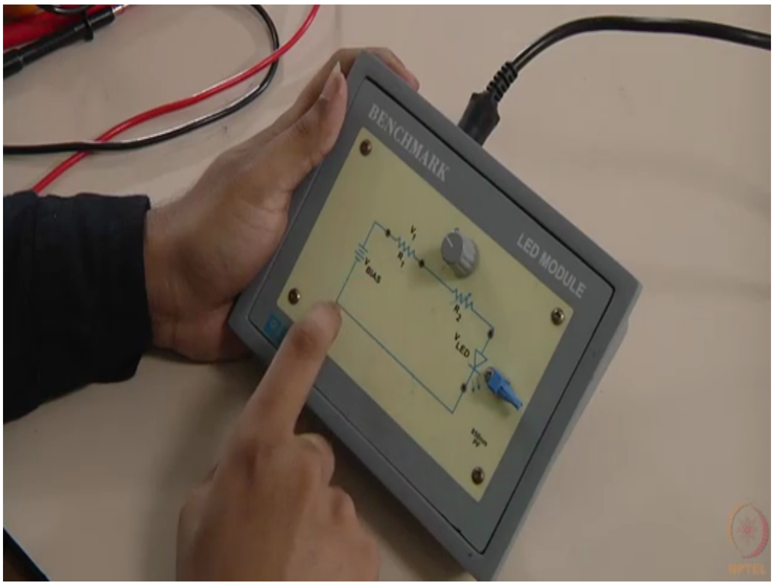


So we have led module with us here, it has an a led which emits 850 nanometer wavelength and this led is driven by a voltage source, which is connected in series, this voltage source gives a voltage value of 10 volts, so and we have a restart here which way which can wary the current in the circuitry, so and we have also a fixed resistance in the circuitry this is 180 ohm resistance.

So to measure the current in the circuitry what we measure is the voltage value or this resistance and we divide that with the resistance value and we get the current within the circuitry. So to measure power emitted from this led module we have to connect the output of the led to a power meter.

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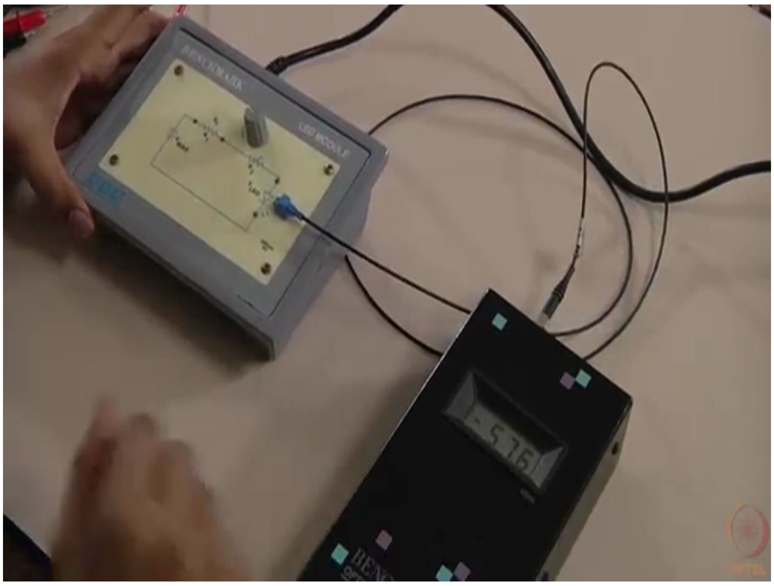

So this is the power meter switch on the module, so it shows the power value in dBm scale. So what we do here is I will connect the power meter I will connect the led output to the power meter using the patch cord, so this is the experimental setup we have.

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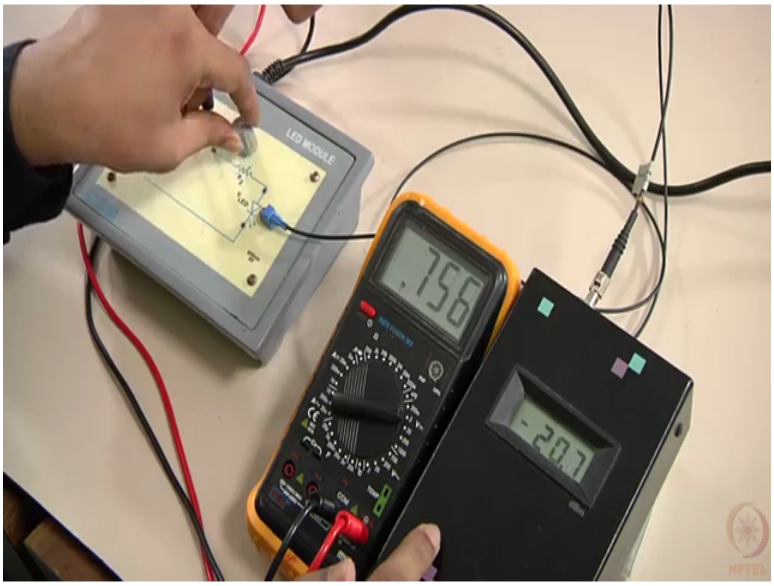


So this is the multimeter which we have with us, this is use to measure voltage across this resistance R 1 and this is the power meter it will measure the power coming from the led source we have here.

So using this voltage value in the multimeter we get the current reading and the corresponding power we can see it in the power meter, so it is needs to be plot power versus current plot and then we will confine the slope efficiency from the plot and similarly we will measure voltage across led and we will plot I versus V plot for led as well, to start with the rear start is operated at maximum resistance position and it gives a minimum current in the circuitry, so he see the voltage value here which (corres) which is directly proportional to the current value and the corresponding power reading or here which is minus 59 point 4 dBm.

So when I decrease the resistance value the current in the circuitry increases, so we can see the change here the voltage keeps raising, this means that the current in the circuitry is increasing and in parallel with that the power emitted by the led will keep on increasing. So yeah, so now it is minus 31 point 4 dBm, so when I still decrease the resistance in the circuit so the power still keeps on increasing, yeah.

So we will take down the readings and then we will plot the current versus density plot. So let us move to the second part of our experiment that is measuring the current versus power of laser diode, so as discussed in class laser diode is also a simple PN junction diode but with a fabry perot cavity, so we have seen that for an led which is connected in the forward bias mode, so similar to that laser diode is also connected in forward bias mode and when we increase the current in the circuitry, so the power emitted by the laser diode will increase.

So we will see that in today is experiment but should also understand that the key difference between the laser diode and led, so as discussed in class for a laser diode to emit light so it equates some threshold current it means that the laser diode will be should be operated above the threshold current to get the light.

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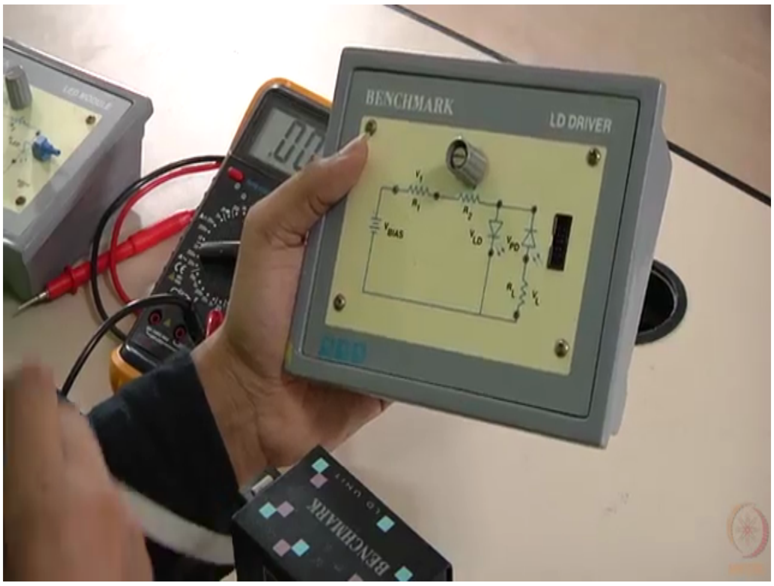


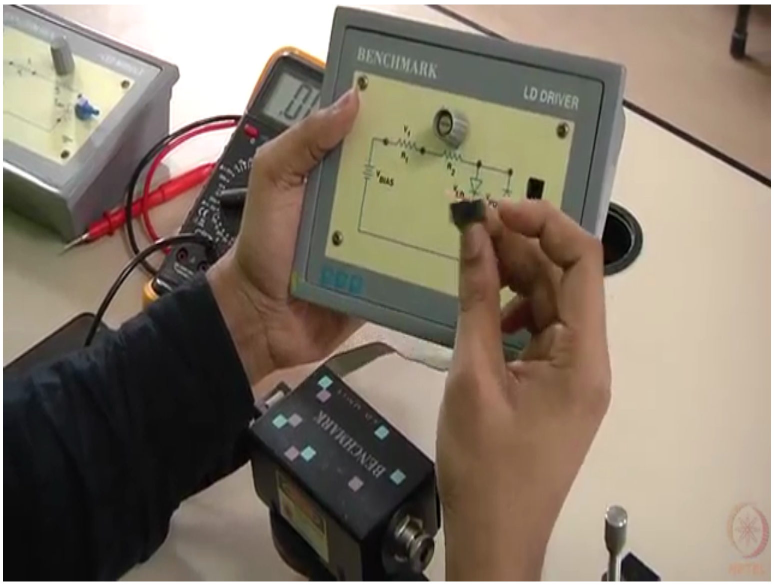


Yeah, this is the laser diode driver we have with us, so this laser diode is connected to this driver using this cable, ok so this laser diode driver is very much similar to what we seen led circuitry, so to drive this laser diode we have a voltage source here which again emits around 10 volts and we have a variable resistance that is rear start in the circuitry to change the to vary the current in the circuit and then we have a fixed resistance here and using this resistance and the voltage across this resistance we measure the current in the circuitry.

So the light emitted from this laser diode we need to measure the power value.

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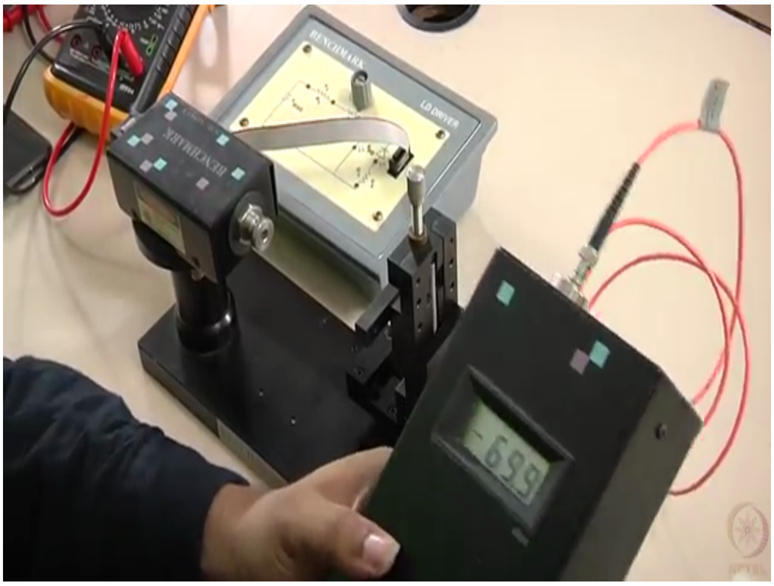


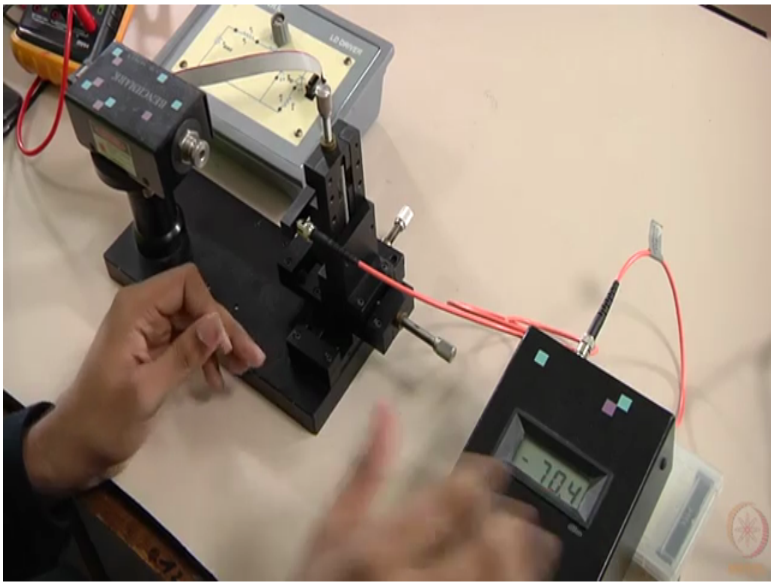


So we again use a power meter to measure the power value, so here the light a coming from the laser diode is coupled to a multimode fiber, so this multimode fiber, so light comes from this laser diode is coupled to a multimode fiber which is kept on a translation stage and that is connected to a power meter.

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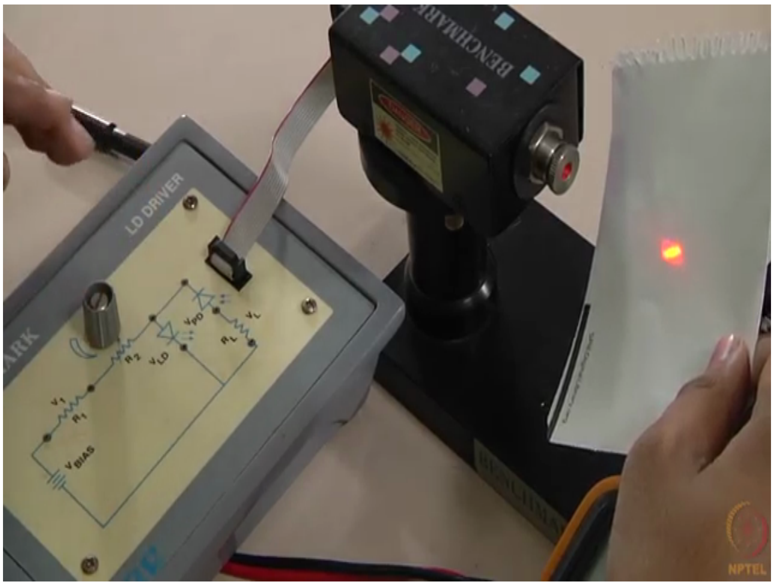


Since the laser diode which you operating is at a visible wavelength that is a 650 nanometer we can qualitatively see the variation in the intensity or the power coming from the laser diode by simply varying the current in the circuitry, you see that now I am changing the resistance value that is nothing but change in the current circuitry, you can see that the power emitted by the laser diode keeps changing, so higher the current higher the intensity value at the output.

So to qualitatively characterize this laser diode characteristics, so what we do is that we coupled the laser diode power to a optical fiber see is essentially multimode fiber and then we connect this optical fiber cable output to power meter.

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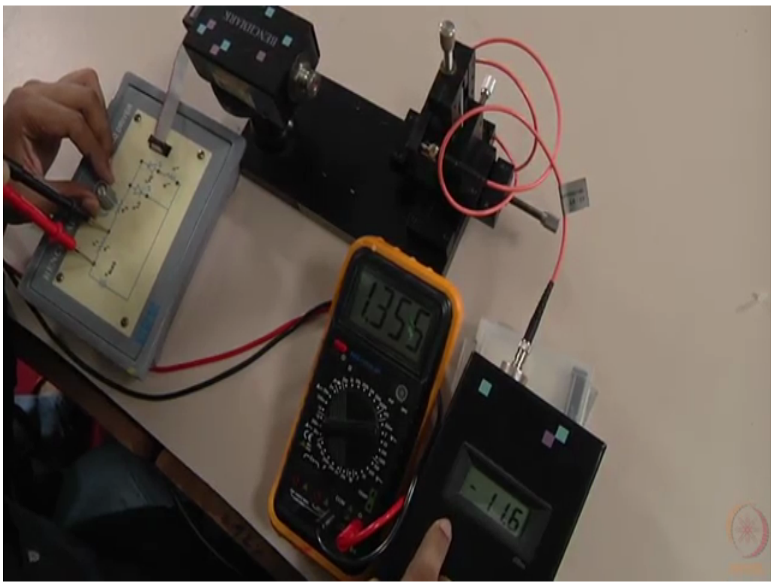

So slight alignment has to be done here to properly couple light into the optical fiber and then we can start the experiment. Let us begin the experiment, so initially we are setting up the resistance value to be high in the circuit, so that we get a minimum current value so here we are seeing a voltage value again this is proportional to current and the corresponding power value you can see here this around minus 37 point 5 dBm.

So as I keep increasing the current in the circuitry that you can see here the voltage value is increasing, we see you see the power value is almost the same, it is not increasing as much and if we keep on increasing the current value the increasing the power value is not significant, so as I keep on increasing so you see that the power has come to minus 30 dBm, still moving forward so we reach around minus 26 point 2 dBm, I am still increasing the current in the circuit so you see that here now the power has start raising significantly.

Now even if you slightly increase the voltage value that is nothing but the current value you see that there is a significant increasing the power, so it means that so we have reached the threshold current and at that threshold current so the laser the lasing action begins and the power emitted by the laser diode increases significantly. So to conclude we have characterized light emitting diode and laser diode.

So if you look at the plot shown here first plot is I versus V plot for led and dled, so the plot looks quite similar for both of the optical sources.

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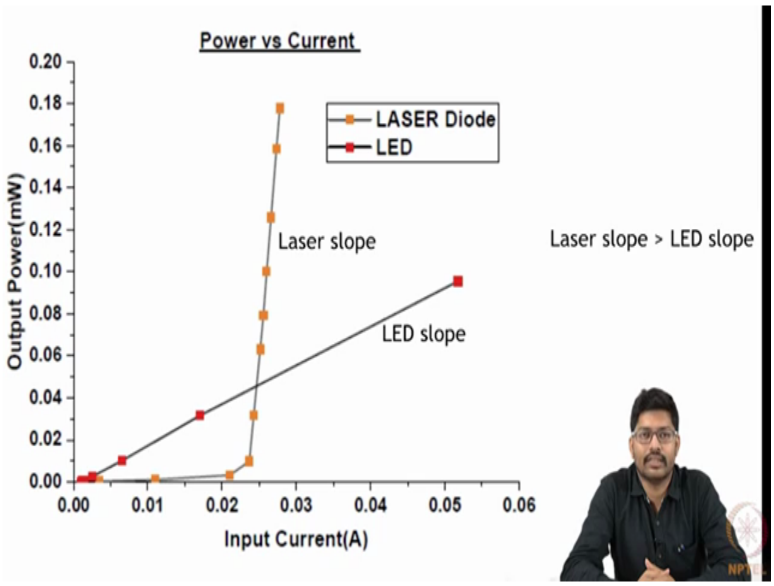


And let us have look at the power versus current plots of laser diode and dled, so there are two key differences between these two plots one is the a threshold current, so this laser diode require some threshold current to start the lasing action whereas the led request no the threshold current, so it the power starts increasing all the way from zero current and the second key difference is that for a laser diode the slope efficiency is far greater than the led.