INDIAN INSTITUTE OF SCIENCE, BANGALORE

NPTEL

NATIONAL PROGRAMME ON TECHNOLOGY ENHANCED LEARNING

Course Title
Electronic Modules for Industrial
Applications using Op-Amps

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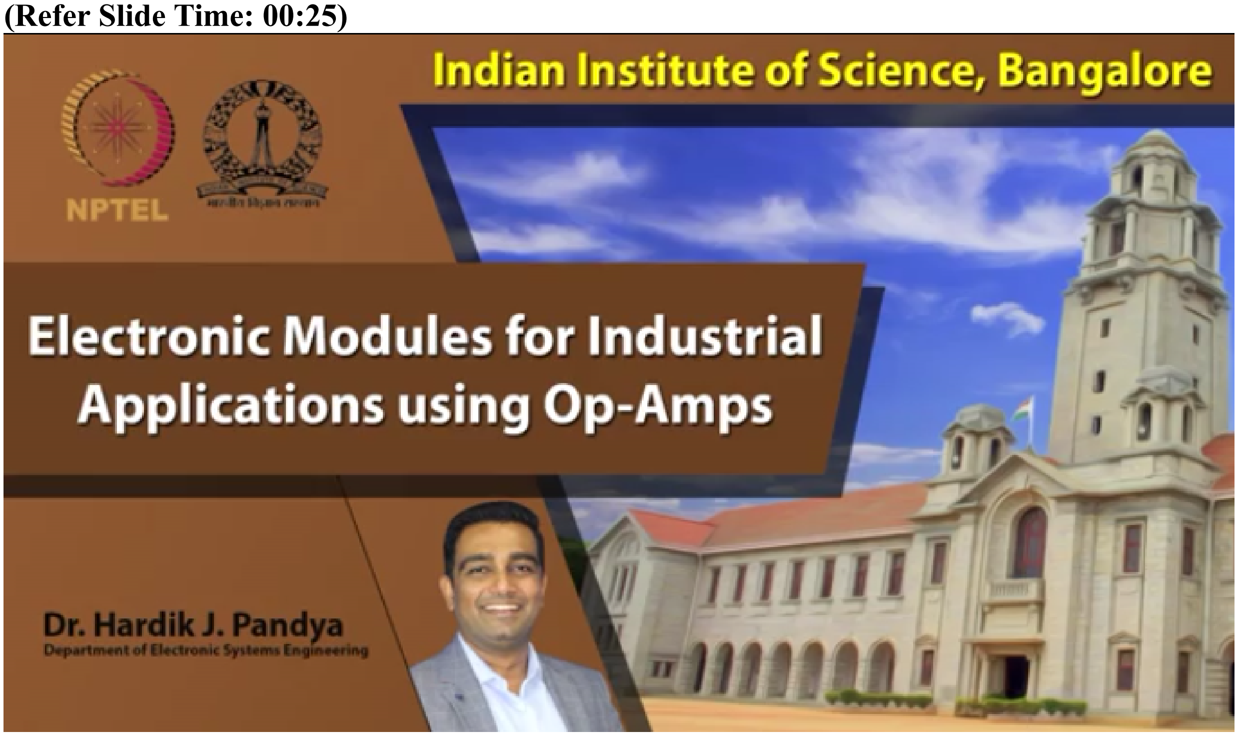

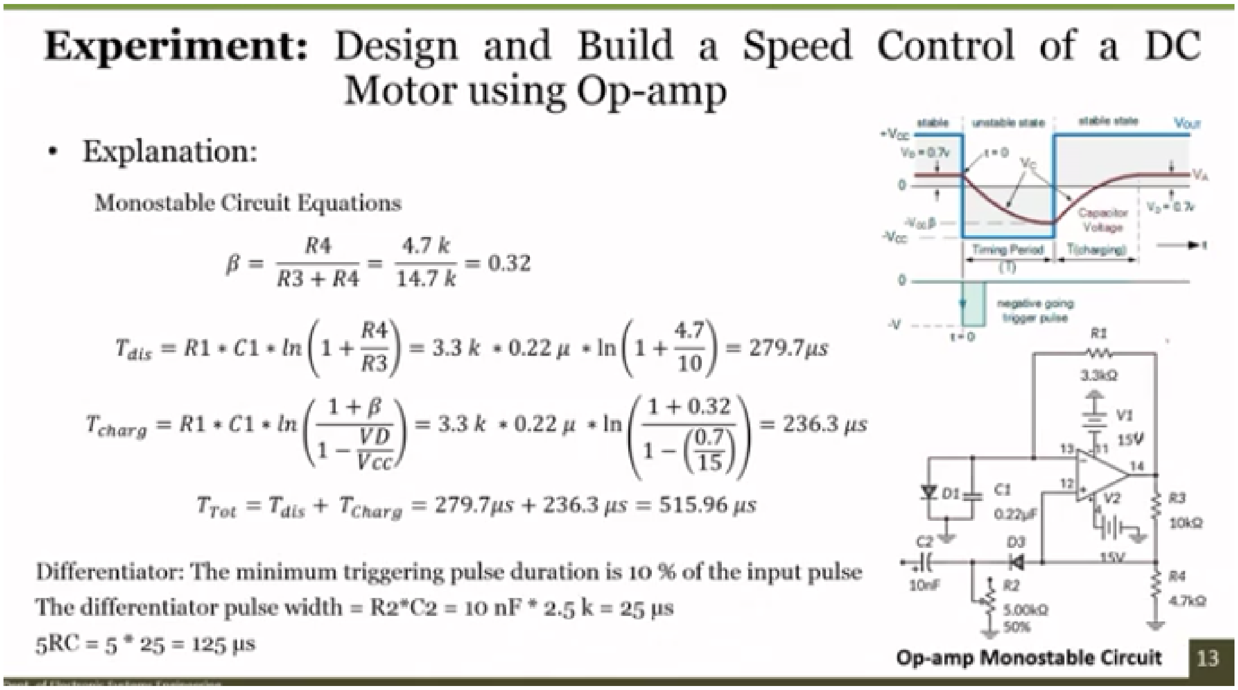

So now what we do is that we will simulate this monostable multivibrator and see whether we are getting the same pulses that whatever we have seen, so for simulation let me see the circuit, this is the circuit that we require, so one thing is that I required op-amp, so I will take 5 terminal op-amp here, connecting in the same fashion what we have seen there, or you can also swap then I need one diode and I also need one capacitor, one more resistor which is R1, then I need R3 and R4 too, right, I also need a ground I'm taking the ground, then I need a power supplies I will go with sources and DC voltage, so this particular block should be connected with +VCC and we are using 15 volts so I'm changing into 15 volts. We have used TL074 for this, if you don't have TL074 you can also go with the 741, but TL084 is load op-amp, or TL074 or the length 358 anything.

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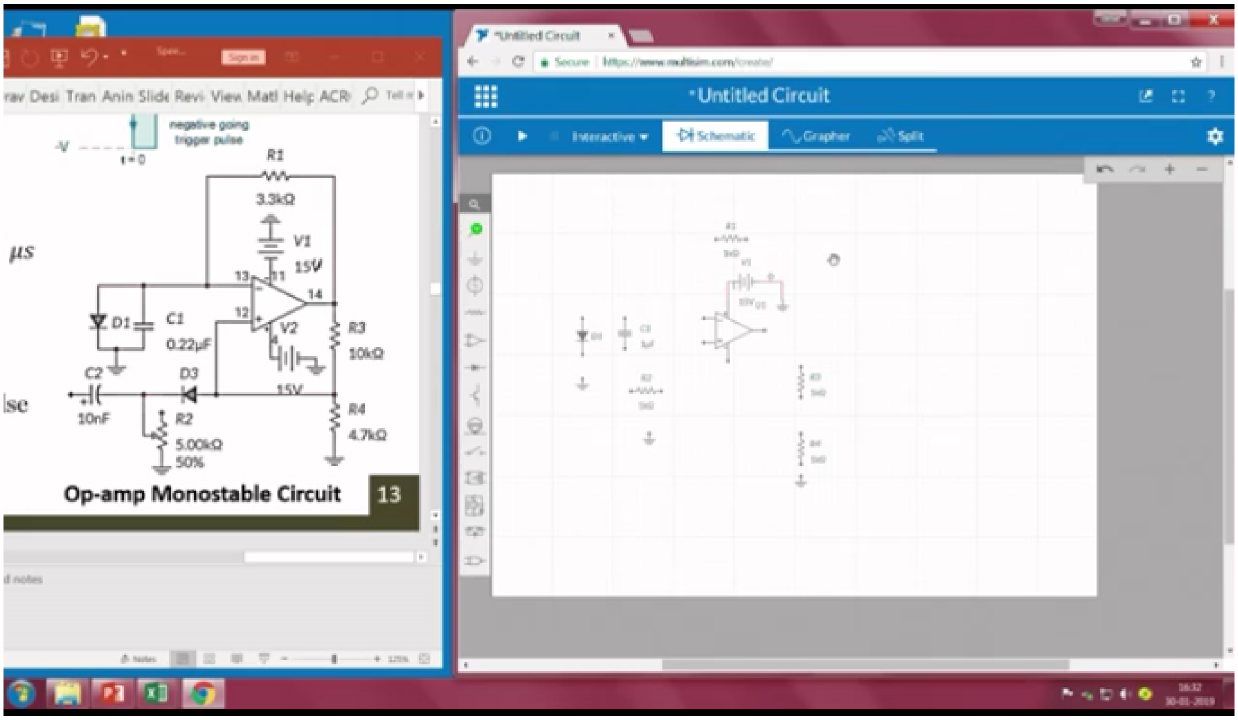

Then we also need another power supply for the negative –VCC, so V1 corresponds to +VCC, V2 corresponds to –VCC and the ground, ground again connected to ground, the positive terminal, so everything should be a common ground in this case.

Output of operational amplifier has to connected to R3 resistor, and other terminal of R3 resistor should be connected to R4, and other terminal of R4 should be grounded, but the values of R3 should be 10K, and R4 should be 4.7K, the positive terminal should be connected it here, so slightly lowering it down and connecting it here, and the diode should also be connected here, then the other terminal should be ground, this is ground, okay, so this part, this particular part is done, then we need one resistor which is of 3.3K, 3.3 kilo ohms resistor, as a feedback resistor which decides that charging time of our capacitor.
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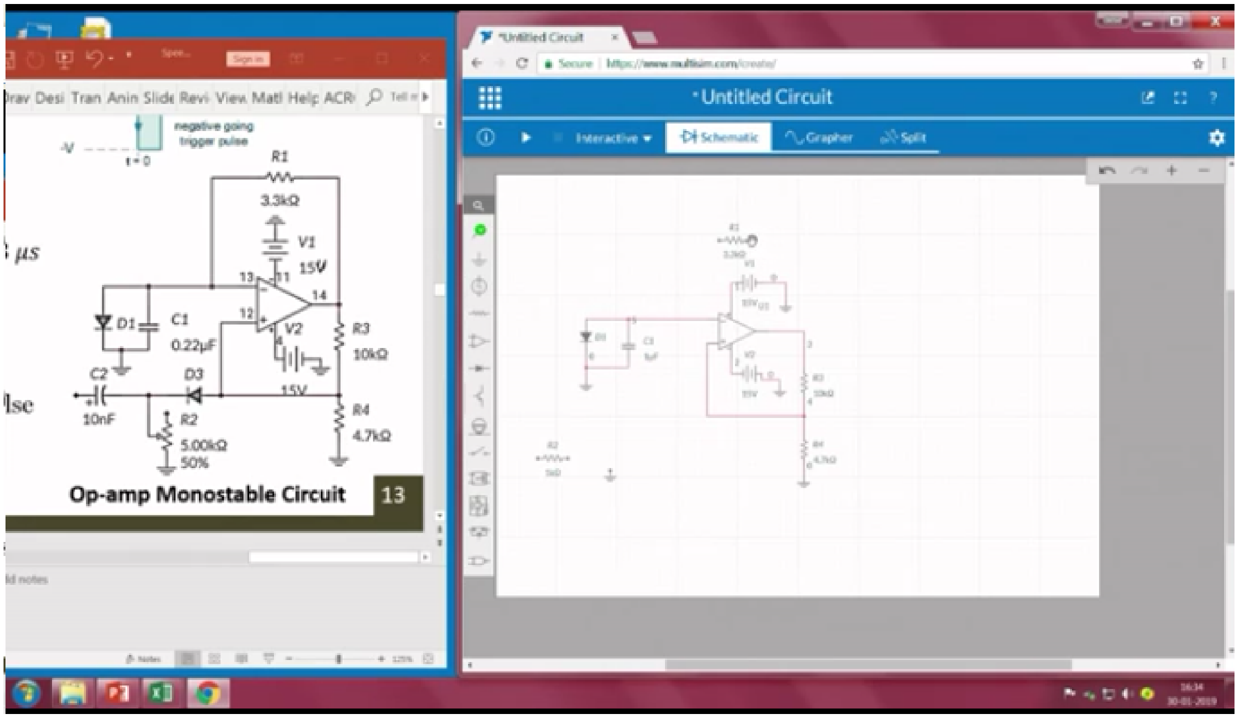

And the value of C1 for our design requirement is 0.22 microfarad, so all set now just before providing a triggering circuit my plan is to just have a look, so I just gave 2 sources, 2 scopes, one is at 2 probes,

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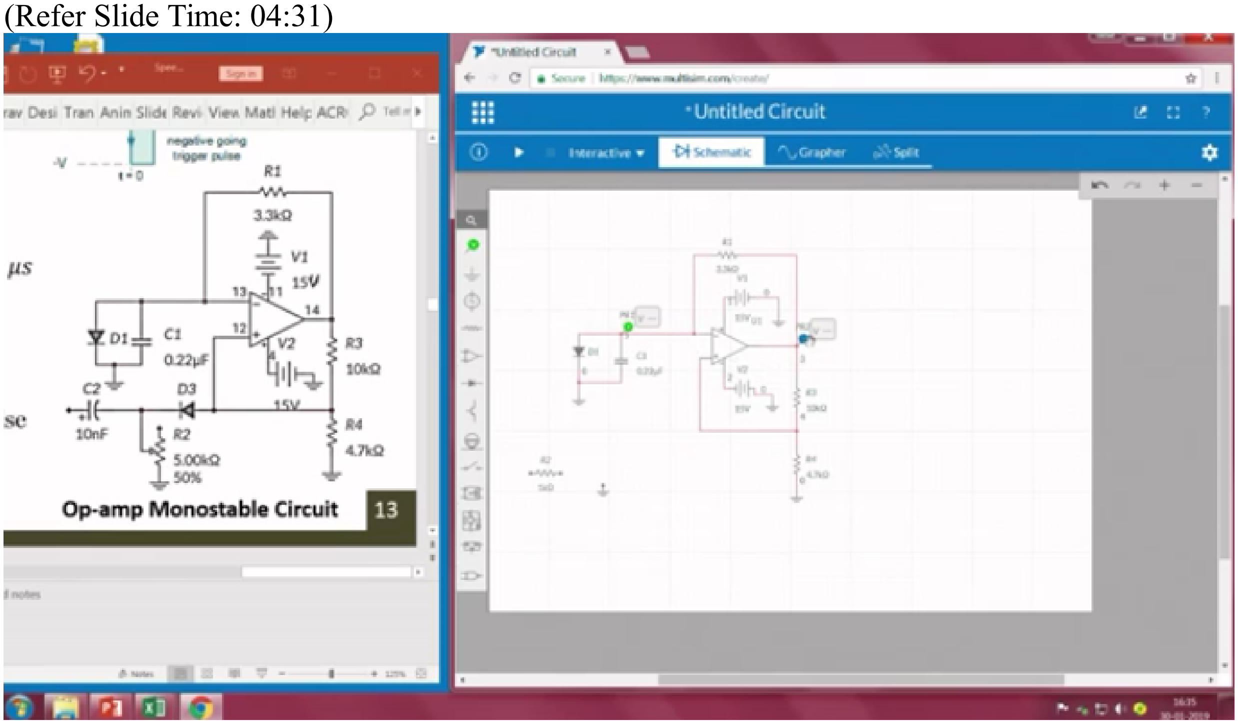

one is at negative terminal, other one is at output voltage, let me design the green part too, so I will take capacitor which is of 10 nano-farad, then I go with port rather than this, I will take potentiometer and connecting from here to here and I also need a diode so I'm taking a diode, right, so before connecting the output, this particular terminal to positive terminal let me check whether it is giving me the spikes or not, or required value, so in order to test it what I'll do is that I'll take a function generator which is nothing but in this case clock voltage, so I need a negative triggering so I'm reversing the voltage, so what we have also seen in the previously, I just reversed it, I'll take a ground connected the positive terminal, this is what even we have done, this voltage I'm connecting it here, because right now I'm not interested at this position, let me check it here, and PR2 the probe will be connected at this point and one more probe should be connected at this point, but since it is floating you cannot see anything, so what I have to,

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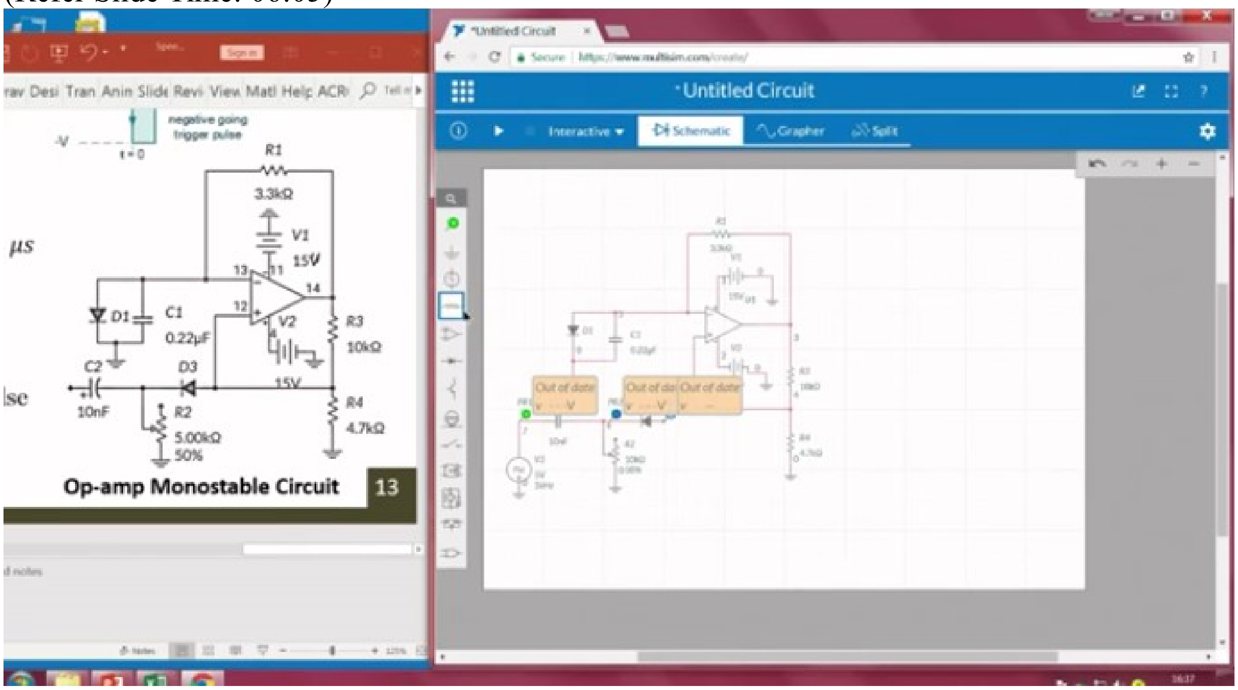

what I'll be taking is I'll take one more resistor, but the resistance value should be little higher enough, otherwise it will, it may load, so I will go with, it is good to go with always higher resistance value so that it will not draw much current, so it will not load the system too, so right now the circuit is done, so what I will do is that I'll select the circuit part, I'll keep it aside, let me select this, then keep it a side, now the intention was to check this, let me check this particular first.

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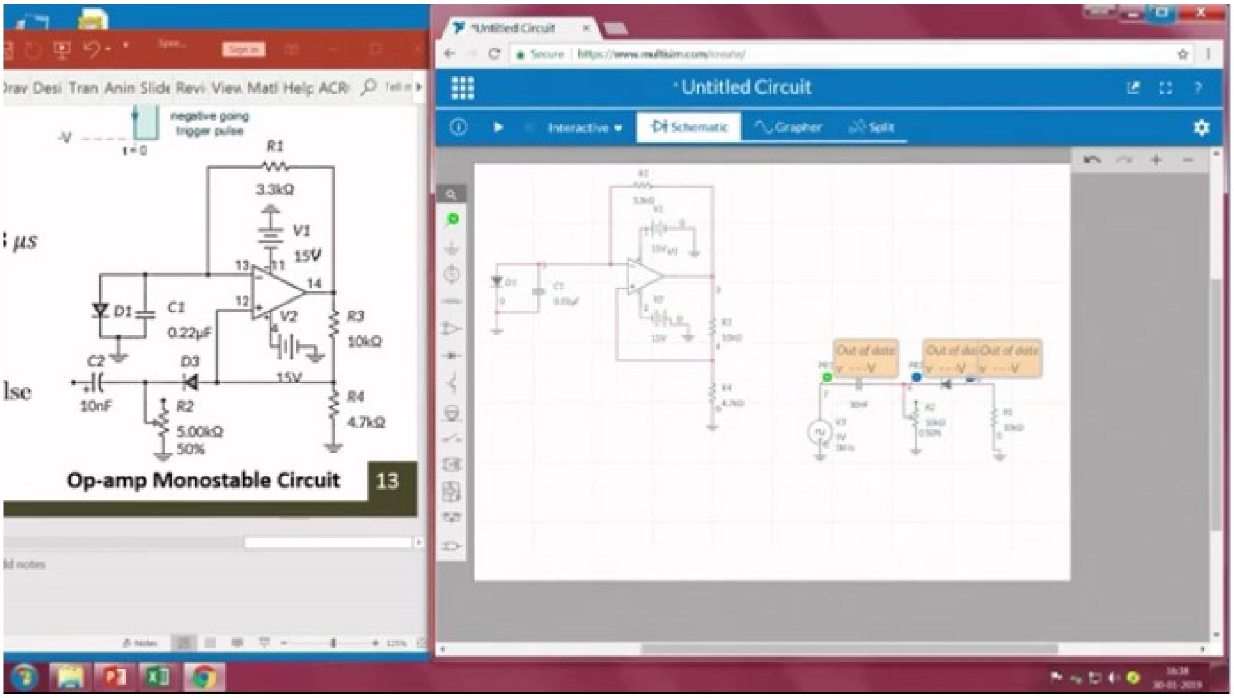

Right, now before running we need to also check the same settings what we have get from the encoder, so that it shows this particular portion shows the signal that we are received from the encoder, so we are also getting a clock voltage of 5S, since we have reversed the terminals here which means that we'll get a -5 here, when there is a positive 5 here, if it is 0 it will be 0.

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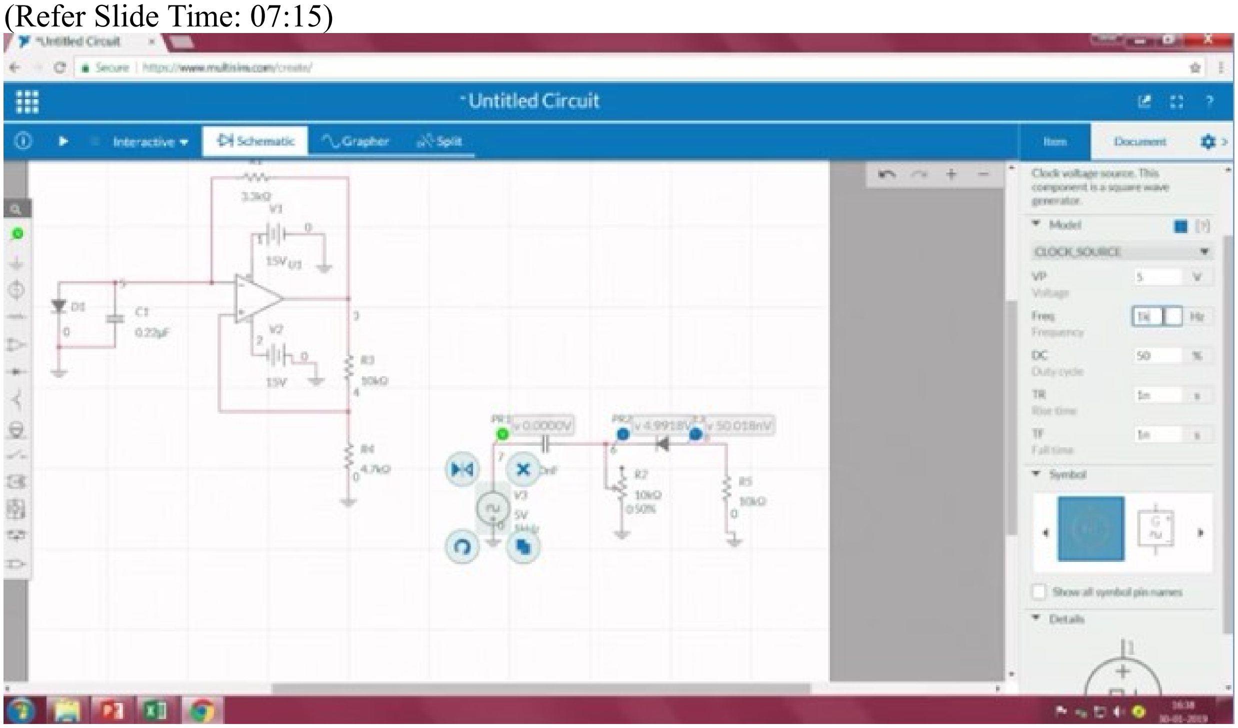

Then the frequency, the maximum frequency we got somewhere around 1.5 that we have seen in the excel, or we can go with whatever we have recorded values,

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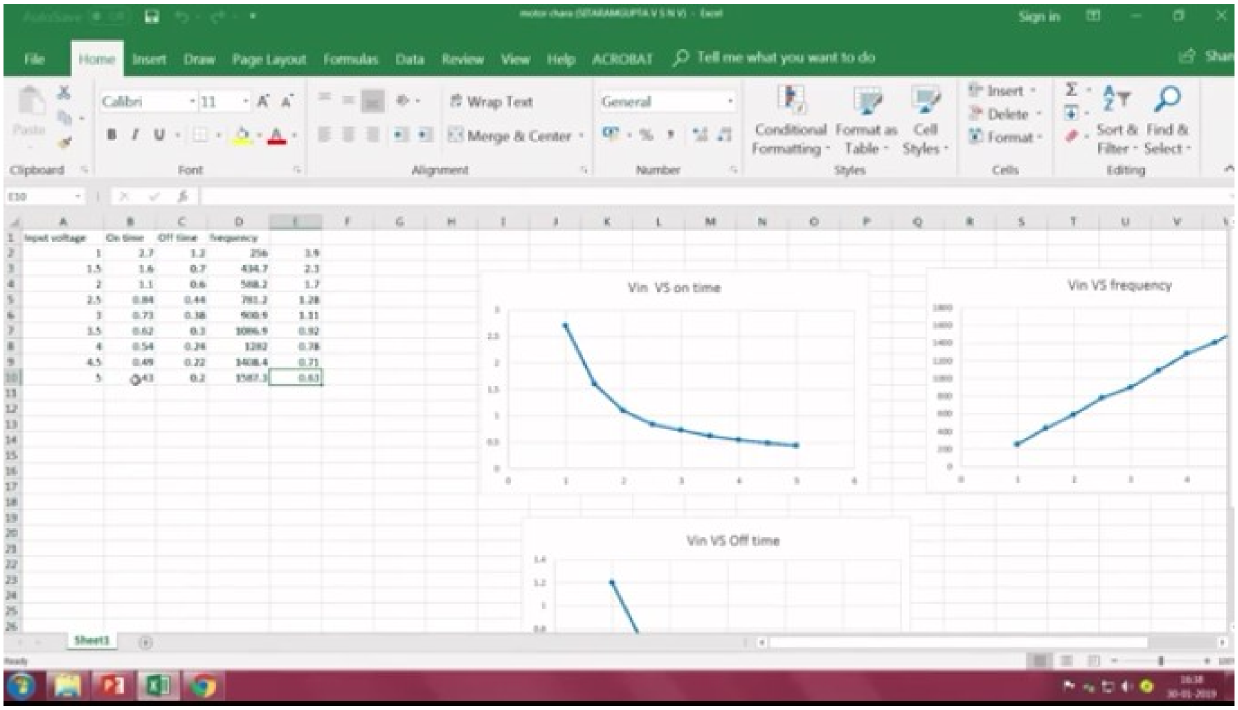

so if you see at this point, 0.43 and 0.2, 1.58, so I will go with 1.5K just for an understanding right now 1.5K, and here it also, it is clearly indicated that the on time and off time in this case is not fixed, right, so I'll go with 1.5K and on time as 430, okay 1.587, 1.5873 kilo, now when we calculate the you know, the duty cycle because we have to give only input as duty cycle, so on time by total time is the duty cycle 0.43 divided by 0.63, so 70,

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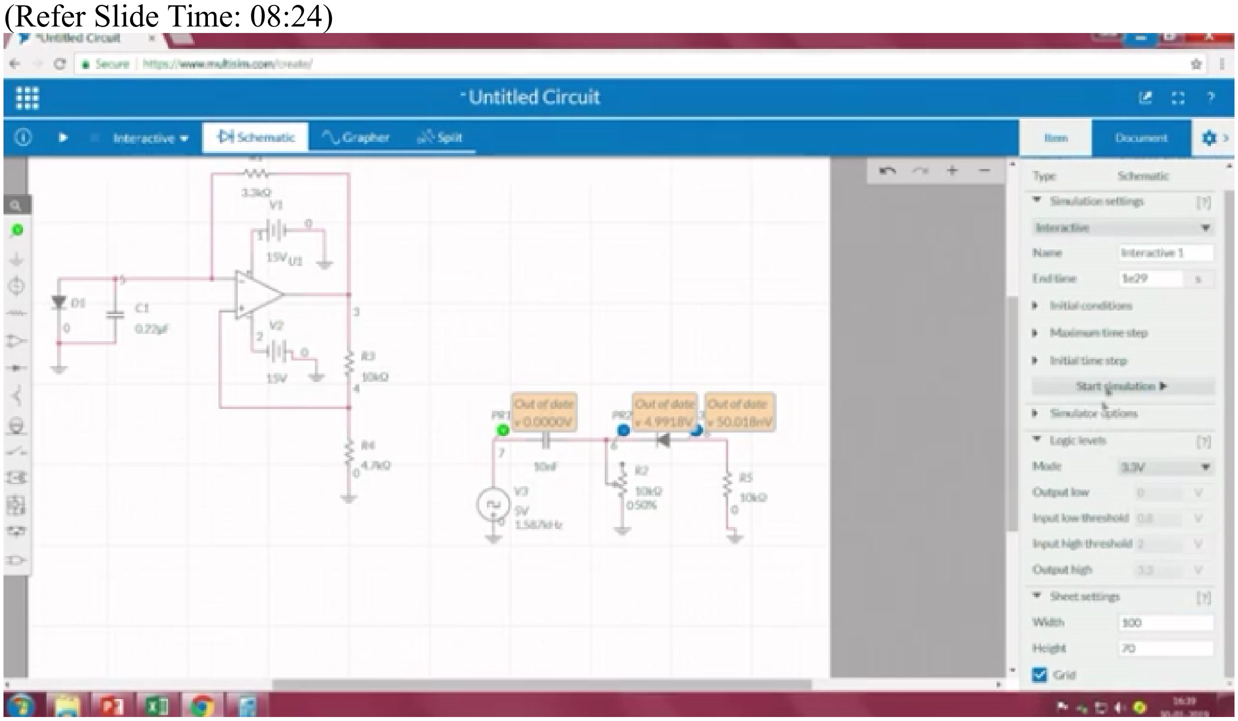

approximately of 70% duty cycle, even when you reverse it, it remains the same, so the duty cycle should be 70, so what I will do is that, I'll go here change it to 70, so that's a reason we are designing a monostable multivibrator, the reason is that when we look into the signal it is clear that no matter what you are on time as well as off time, so always fluctuating with respect to time, so if I directly integrate the output of at the encoder without using a monostable multivibrator, it is very difficult to analyze, you may get an analog output voltage but it is very difficult to correlate with respect to the RPM, because the on-time as well as off-time is keep on varying.

What if we make it, what if we fix it any one particular value? If we can fix one value and integrated, since the value on-time is constant throughout the operation or one particular is constant throughout the operation, if the motor is rotating at very higher RPM, the number of the constant pulses will also be higher as a result on an average the area and the curve if you see, we can see the more amount of area of on-time we can observe, as a result if you integrate that particular signal which gives you the varying voltage, so with that intention we have used the monostable multivibrator, let's see whether it will work or not.

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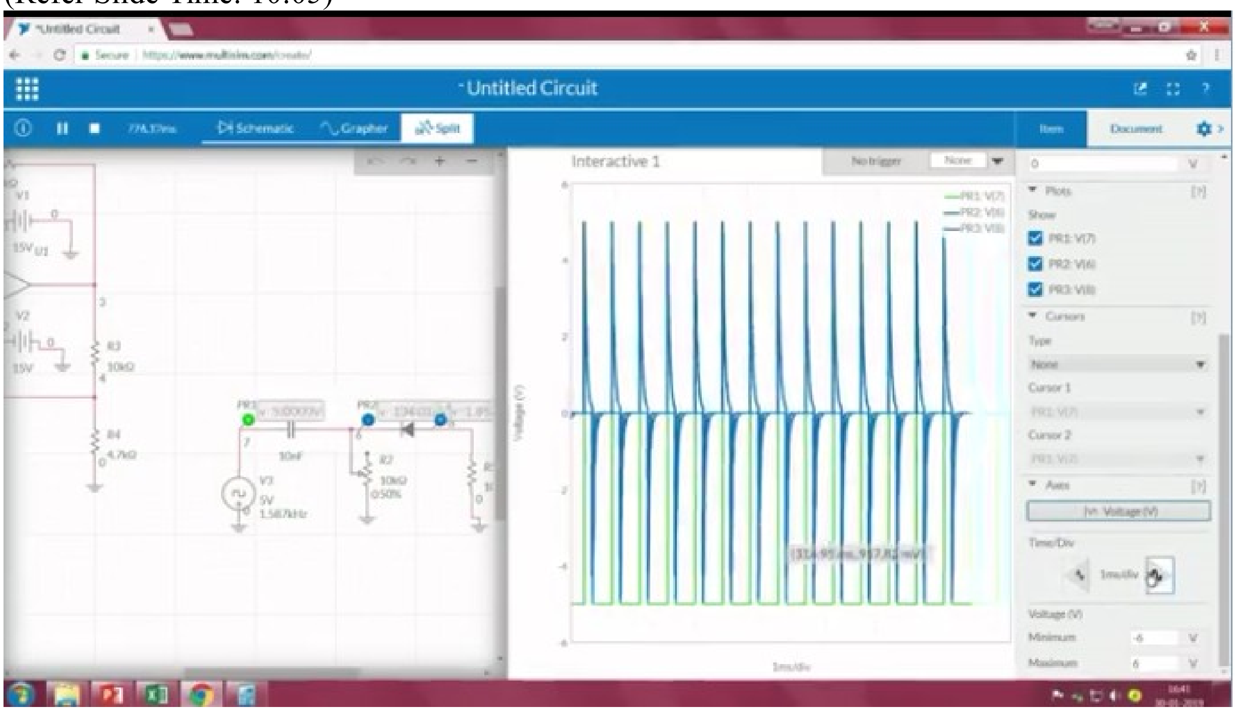

Now let me run, keep it split, okay, so fixing it, looks good, but difficult to understand, so to grapher directly, okay,

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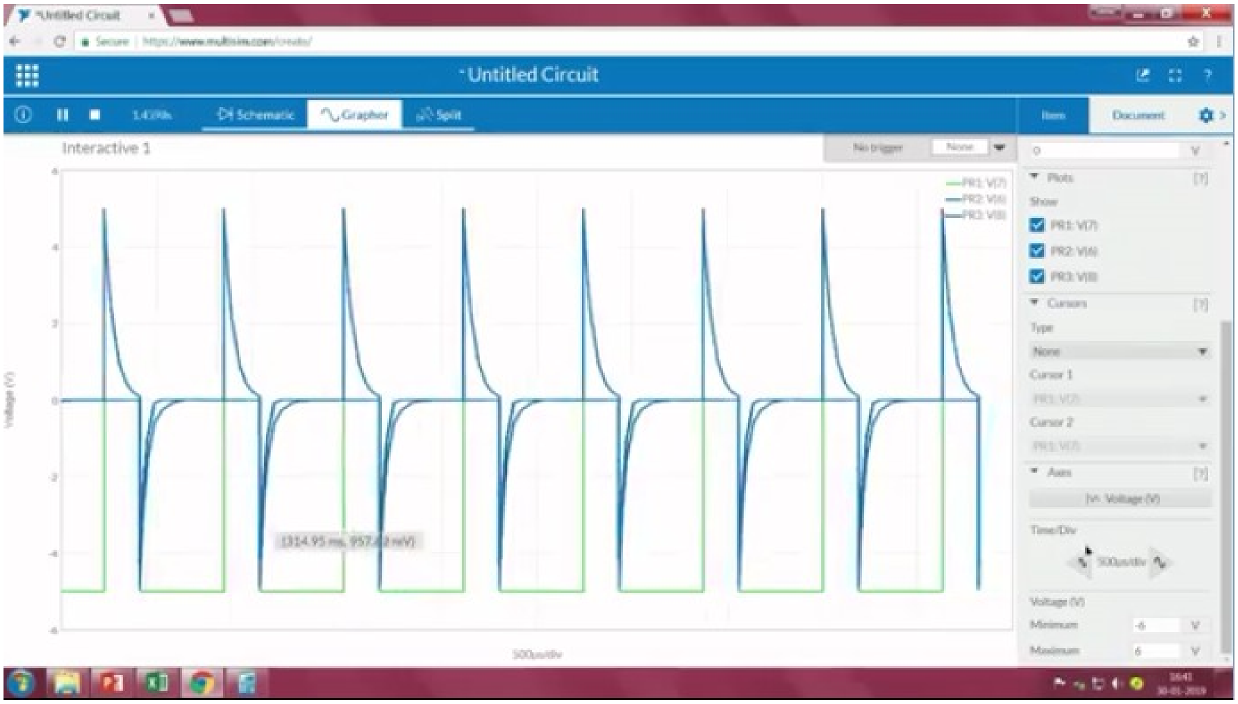

one by one we will see, so PR1 corresponds to the input, PR2 corresponds to the differentiator output C and R, and the PR3 blue colour, this is sky blue and this is blue, blue colour indicates about output, so when I go to the grapher, so I will first enable PR1, disabling PR2 and PR3, it is clear we are getting on-time as well as off-time, on-time as well as an off-time,

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similar to the previous one but since you have a shift you have this two, right.

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Then when you see PR2, right, the pulse rate is little higher but during the negative cycle if you see, because we require only the negative pulses it is good to go, then when you only see the PR3 you are getting only the negative pulses, so one thing is clear that this particular circuit is giving me the negative pulses.

Now what I will do? I will connect this at this point because it is giving me the negative pulse right now, so I will connect this circuit, so let me shift a little bit here, okay, so I am just removing the probes and now I don't need this resistor because you already have R4 here, that is just for our visualization purpose we have connected, I'm connecting to this,
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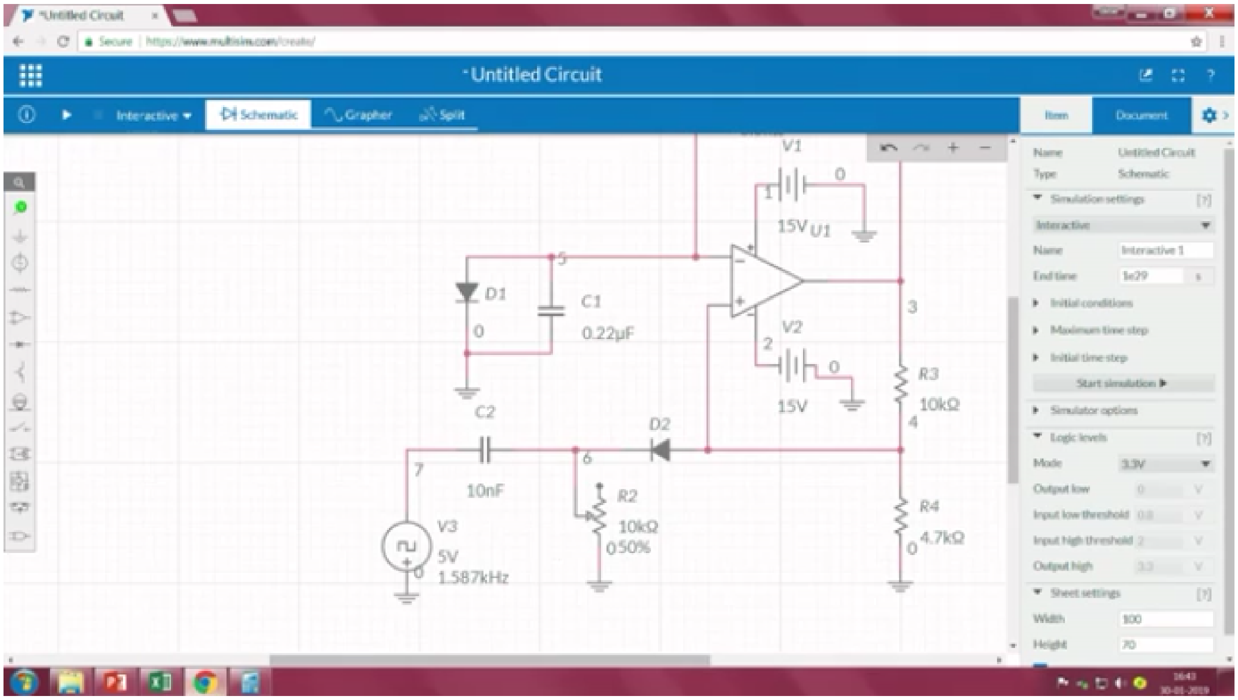

so replace with 5K, so I will take 2 probes, sorry, one at this point, other one at this point, when I look into the characteristics of the diode if you see the potential, the junction potential is showing us 1 volt, let me change it to 0.7 volt which is a realistic to 4007, now the required time for the capacitor, maximum voltage will only go to 0.7 volt, here we can see, okay, so the idea was not even that we have to see the pulses whether it is proper or not,

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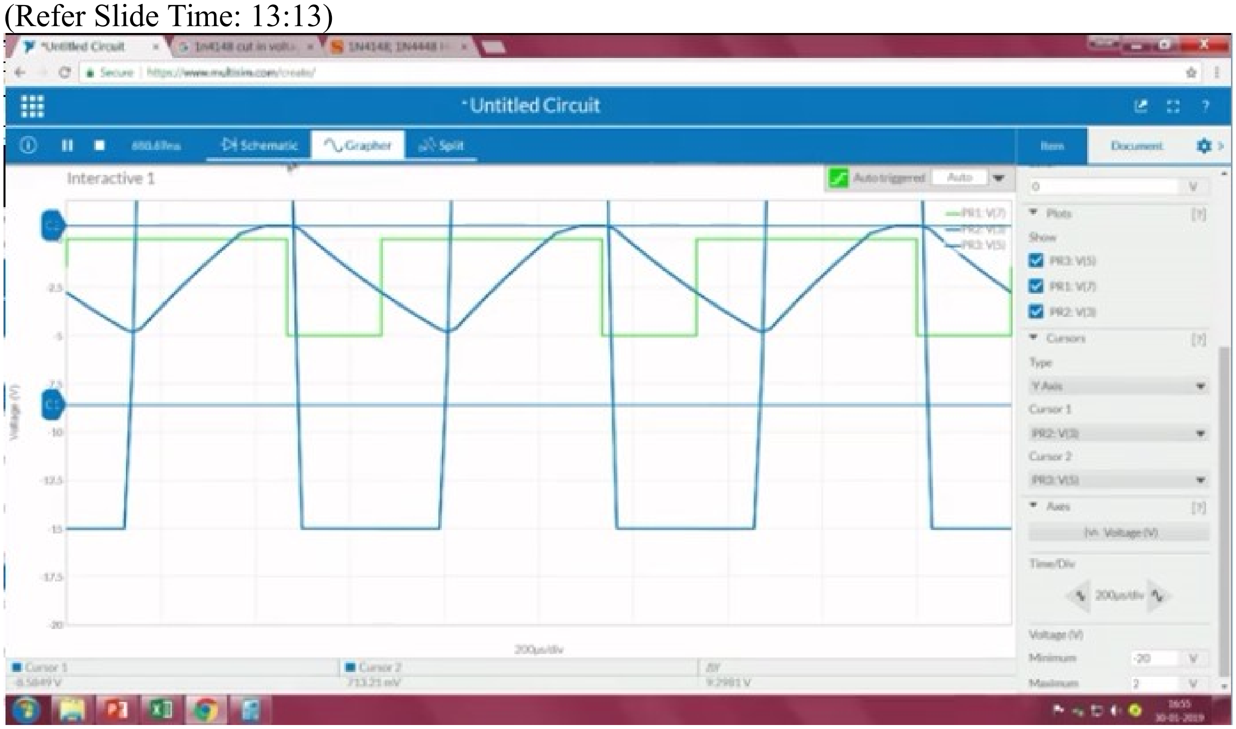

so let me close PR3, grapher, then zoom on, so one thing it is clear that at this point I'm getting a negative spike, this point I will get a positive spike, whenever I have a negative spike the capacitor started discharging, discharging, discharging, so that's why since the capacitors,

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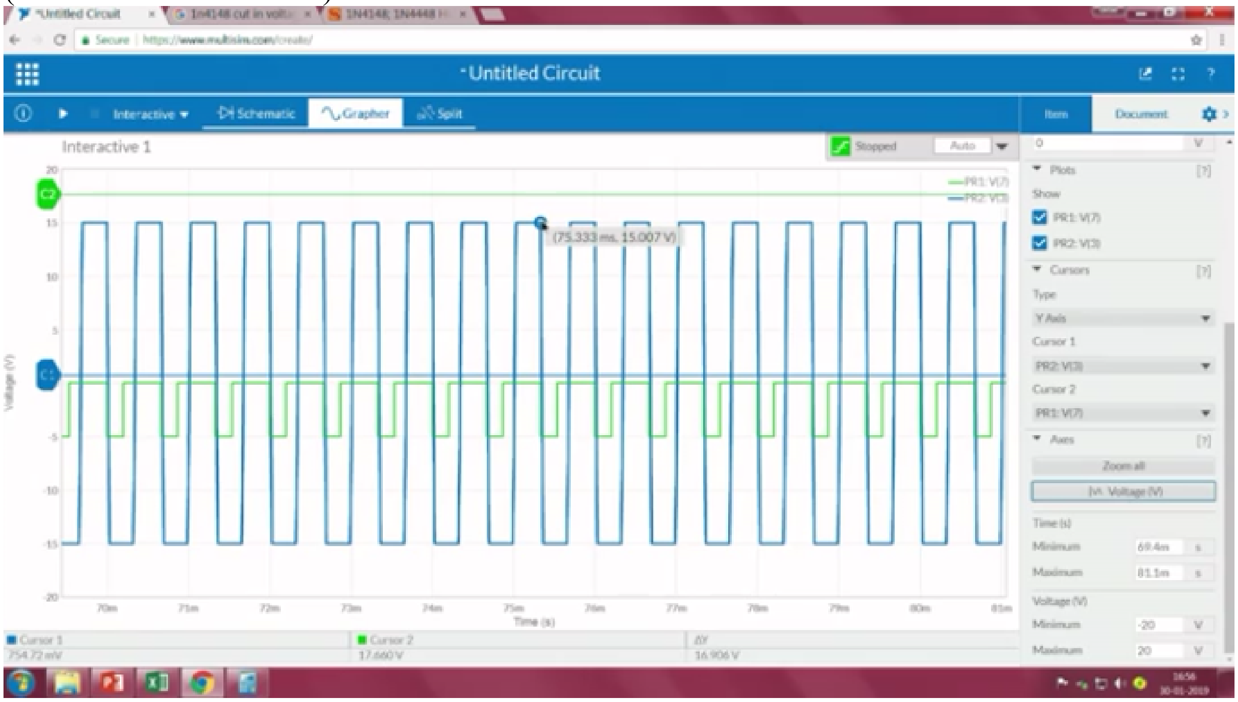

because of the negative spike the output of an operational amplifier you will go from +VCC state to –VCC state, so +VCC in this case is 15, -VCC is -15 so it will start discharging from +15, from 0.7 volt to –beta VCC, so the time it takes for the capacitor to go from 0.7 volt to –beta VCC will be the designed R and C value, RC into log 1+R2/R1, in this case R3/R4 so which we have seen at this point R4/R3, right, so this time duration when if we observed it was somewhere around 280 microsecond.

Let's see whether we are getting 280 microsecond, let me create a cursor for PR2 and it should be X axis cursor,

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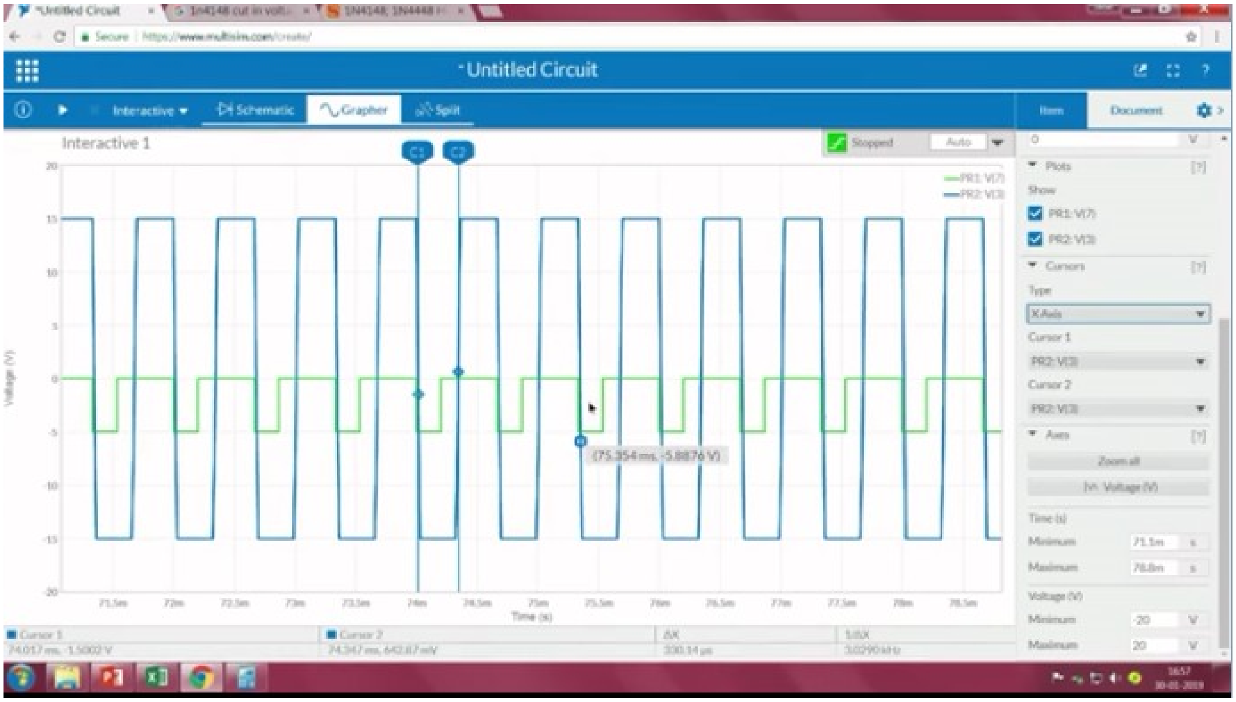

so we are getting somewhere around 330 microbe, so there will be always say you know this is a simulated value, the reason is because of you know the diode characteristics that we have considered also so many other parameter, the tolerances everything, then when you see the complete pulse value, this value is 666.89 microsecond, this is almost close to what we have required, which should be less than 620 but it supposed to be 515.96,

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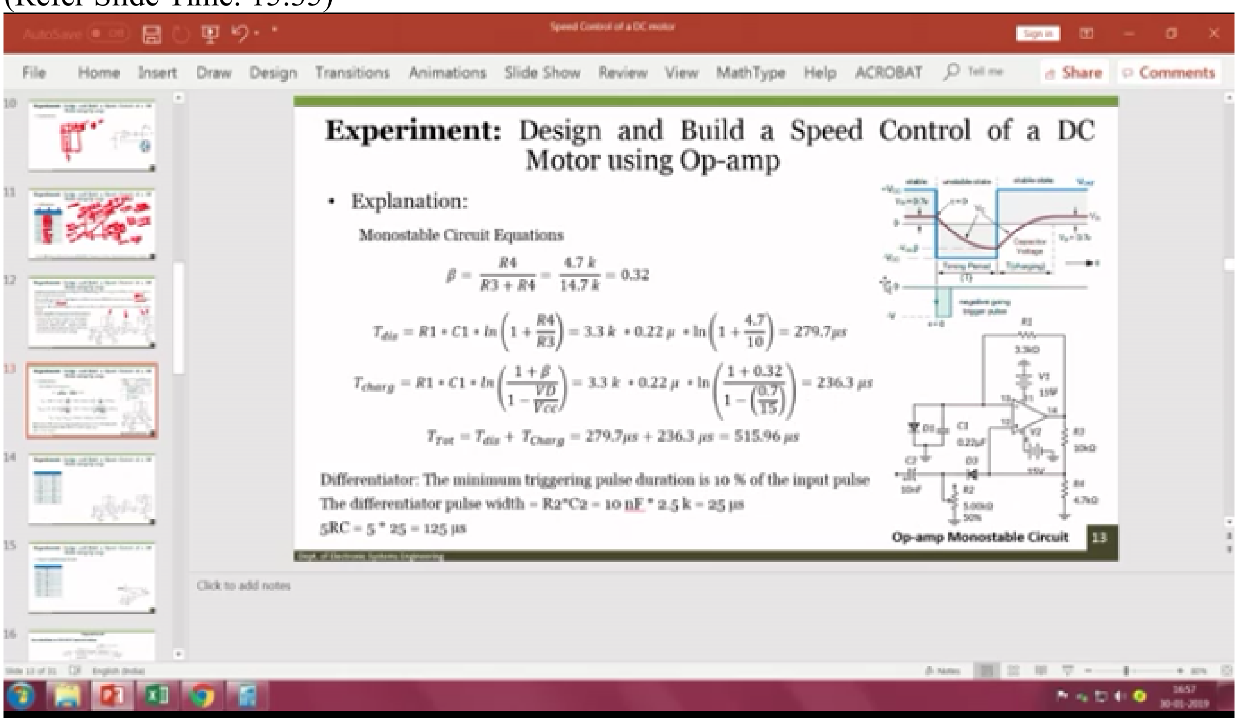

but one thing it is clear that no matter what our signal, the complete signal time duration is not deviating, right, so wherever I have a negative spike I'm getting on-time everything, and we also have enough room for the capacitor to charge to 0.7, so there are no chances of missing the signal.

But what if the time duration is higher? What I mean to say is that for example say I will go R1 with 5K, just for our understanding what will be the effect of it, when we look into the grapher, observe this, so green represents our encoder pulses, sky blue represents our output, so whenever I have a negative pulse I got on-time, but if you observe since I don't have enough room for the capacitor to discharge, right,

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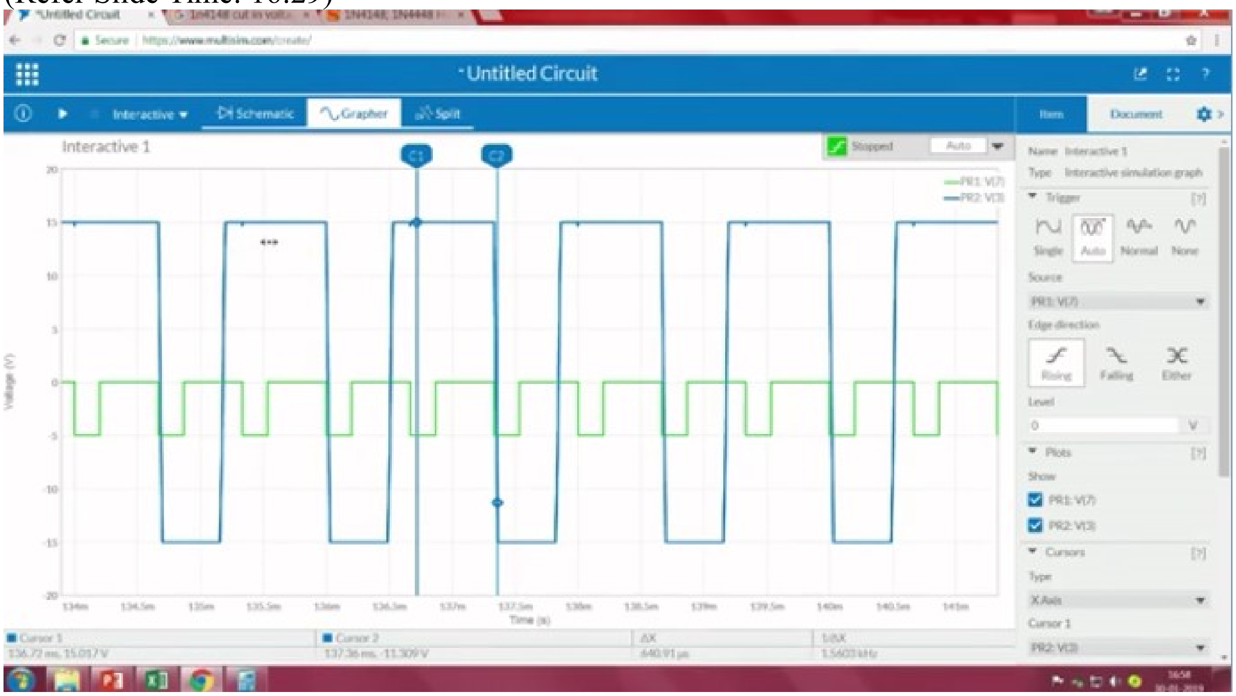

it is not able to detect the negative signal from the encoder pulse, and it is again becoming low only when the next sequence is getting, so as a result over 5 or 6 signals we are losing 2 or 3 peaks, so the accuracy of the system is decreasing, this is because of design constrain, for not properly choosing or charging and discharging rate of your capacitor, that entirely depends upon our R1 and C1 resistance and capacitance that we have chosen in the design.

So we have followed all the requirements that is required, we have already looked into the all the cases, we have optimize the resistance and capacitance value and we have chosen 3.3 and 0.22 micro farad, right, so in our case we are not missing anything, this part is clear to us, so let me keep aside, right, so we will change a different frequencies now, starting from whatever we have recorded 227 hertz, so one we will keep it at 227 hertz, so the duty cycle is also 30% for everything, on-time should be higher so it should be 70% for everything, okay, let me run, right, now so since the charging,

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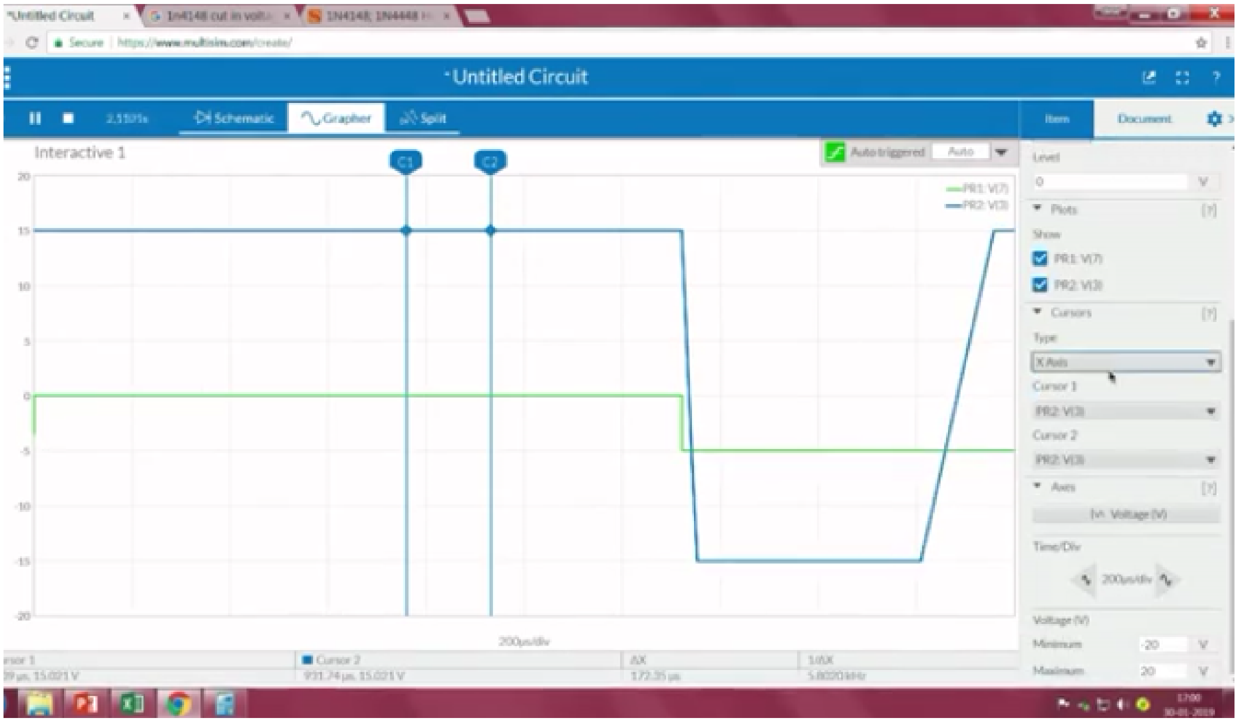

since the you know our time duration is smaller, so in this case there won't be any problem because we are operating at very lower frequency, when you inverse it which is time we have enough room for the capacitor charging and discharging.

Now when we see even in this case whenever I have a negative trigger I have a pulse till I get to the next negative trigger, because in this case we'll get a positive trigger, in this case I'll get a negative trigger, so this will not be considered and only during the negativity there I'm getting fixed duration of this on-time, then on-time so there are now missing of signals.

Then we will see for another value which is 357, so I will change it to 357, and let me run the value, right, even in this case all the signals are there, no missing of any pulse, then I will go with the 515,
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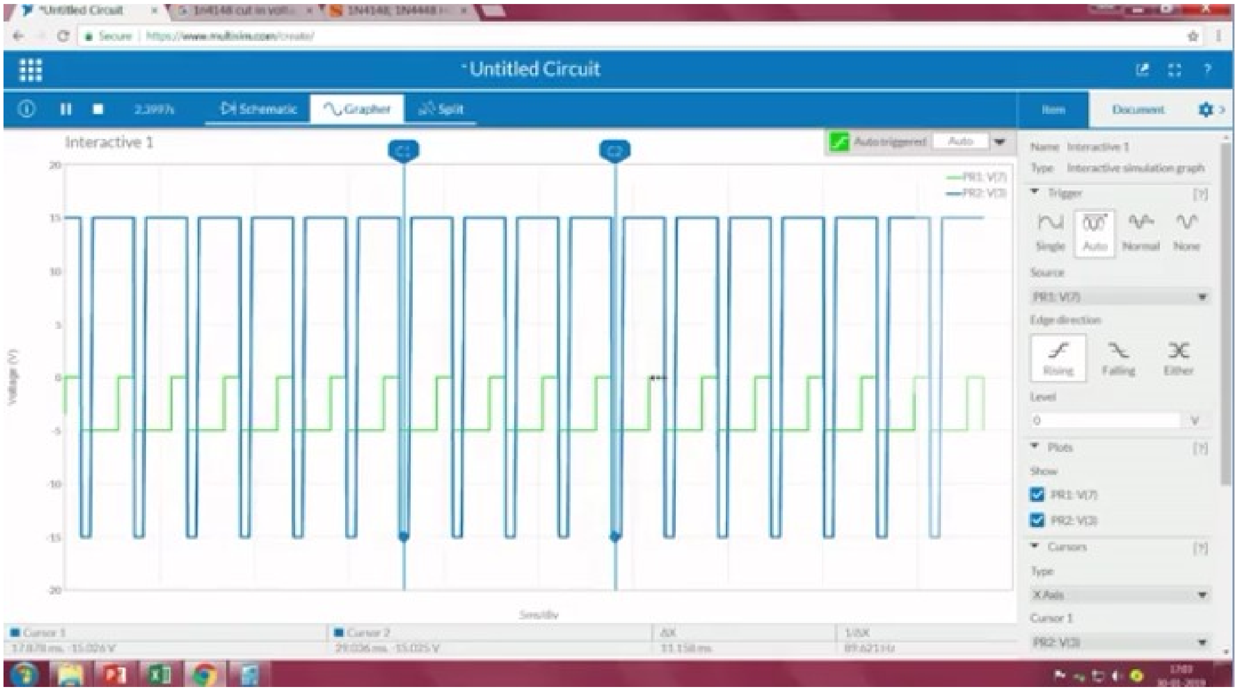

I will change the frequency to 515, because the voltage is fixed so that's why I'm not changing the voltage, so one thing is clear that no matter what since it is a monostable multivibrator it will always have a fixed on-time, and fixed off-time, and the on-time entirely depends upon the next triggering pulse that we require, right, so because of that reason we are going with, we have chosen this particular the resistance and capacitance value, not only that please be careful when we are giving a signal at the triggering input, any changes will ultimately effect the output results, so this should be always a negative triggering pulse, so now I hope it is clear why we are doing it, so in the next part, the next part so since if you observe here we are getting a negative,

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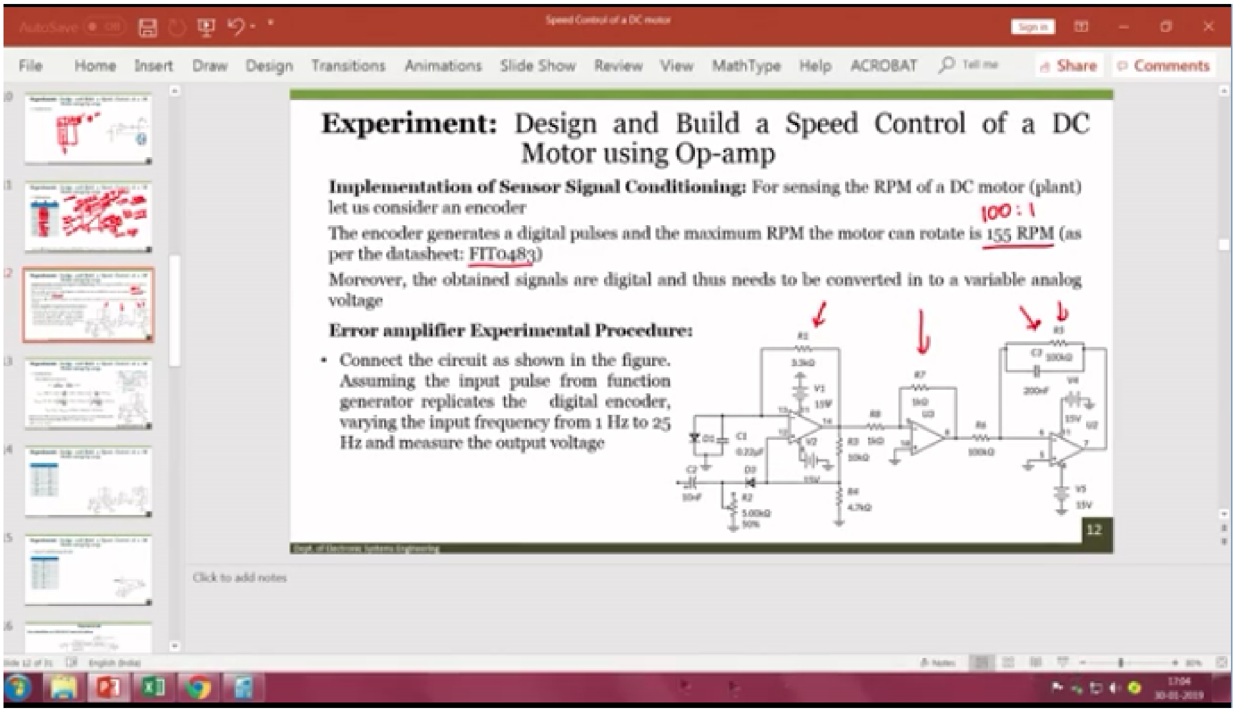

so if you observe here we are getting on-time, the T1 duration fixed duration during the negative pulse, and the stable state, this is unstable state, this is the stable state, the stable is in positive but we required in a ulta way, so what we are doing is if I integrate it, integrate and then pass through an integrator so that we'll get the signal right now, right now we have the output from this is this way, right,

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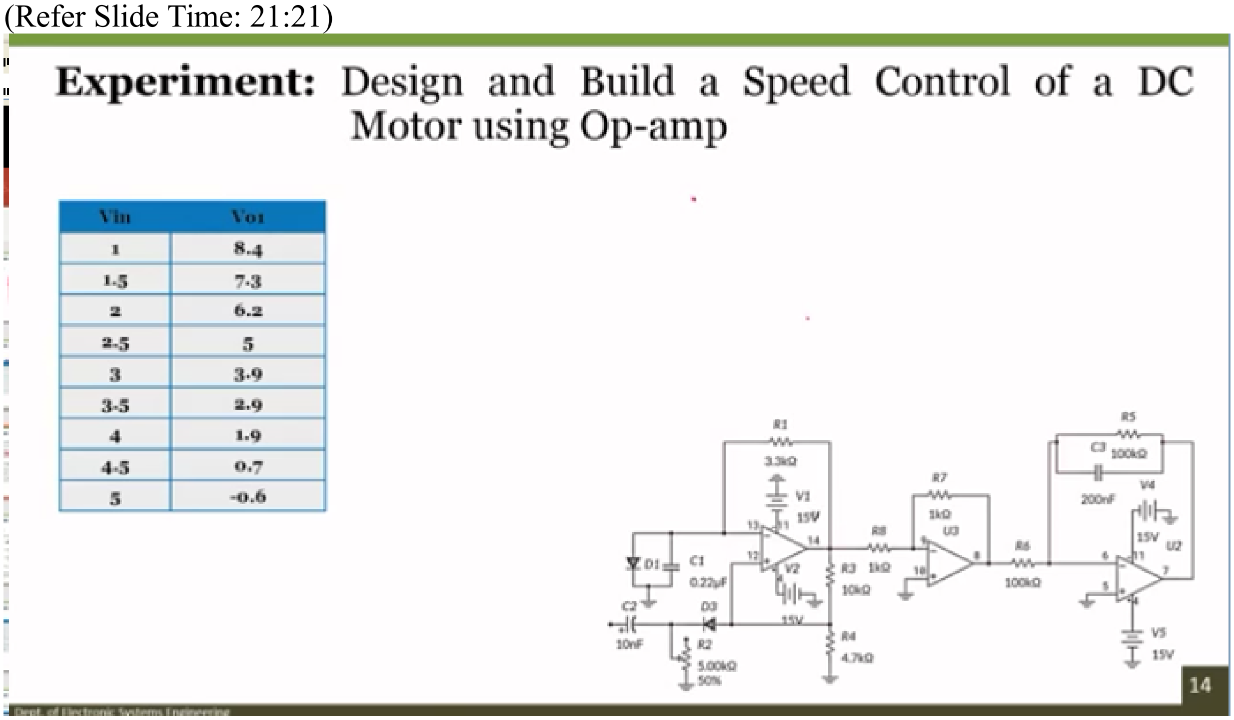

Vin	Vo1
1	8.4
1.5	7.3
2	6.2
2.5	5
3	3.9
3.5	2.9
4	1.9
4.5	0.7
5	-0.6

when I pass through this I'll get a signal, so this will be -15, this will be +15, right now this is +15 and this is -15, so that I will be integrating this, so depends upon RPM, depends on the RPM per second the number of pulses that we are getting will be always varying, but since it is a fixed duration when you integrate it the area will be keep on increasing, based upon the increasing RPM, as a result we can see the linear.

So in the next class we will see the simulation of this as well as simulation of this, once everything is done we'll integrate it together and changing the RPM,

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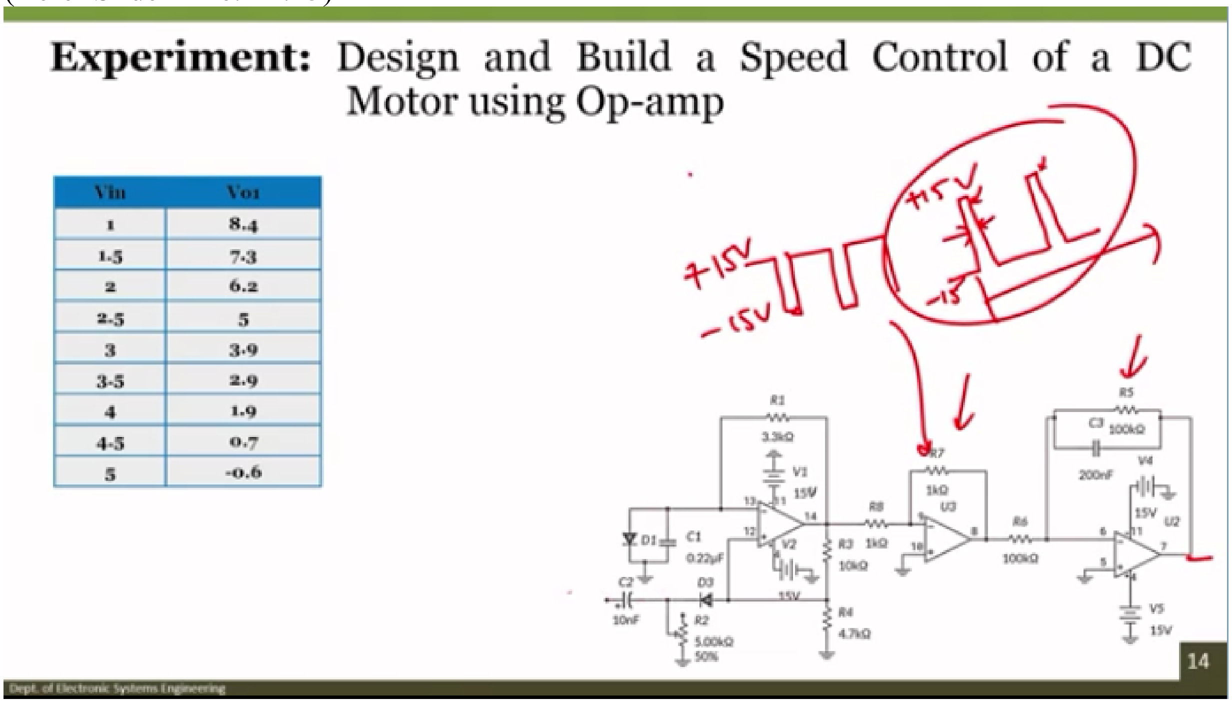

changing the encoder frequency at this point, with this frequencies changing this frequencies we will observe what is an integrator output we are getting it, okay,

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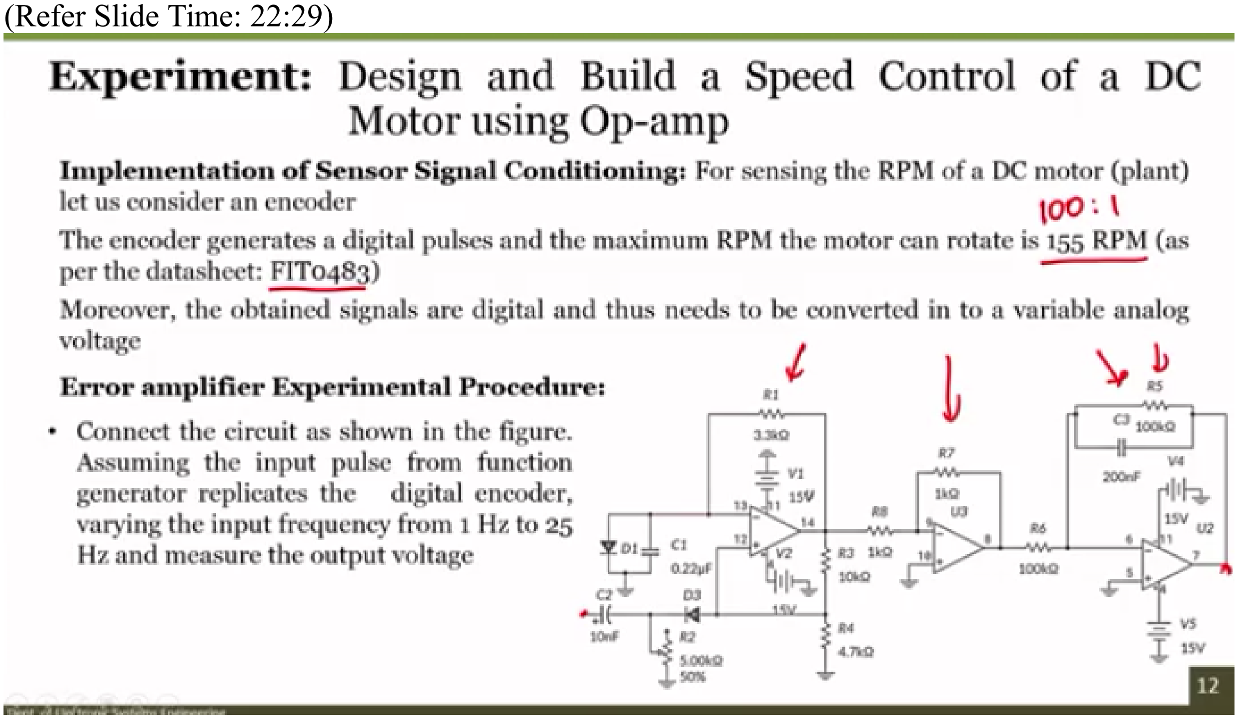

till then take care.