Electrical Measurement And Electronic Instruments
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Lecture - 84
Ramp generator

Hello and welcome. So, previously I promised that I will talk about a Ramp generator circuit because you know ramp generator is essential in oscilloscope to get the time base circuit and also in linear ramp type volt meters we have studied. So, there are many applications and I promised that I will talk about this and since we are studying transistor based circuits, so, I will also have a transistor based somewhat transistor based implementation of ramp generator ok.

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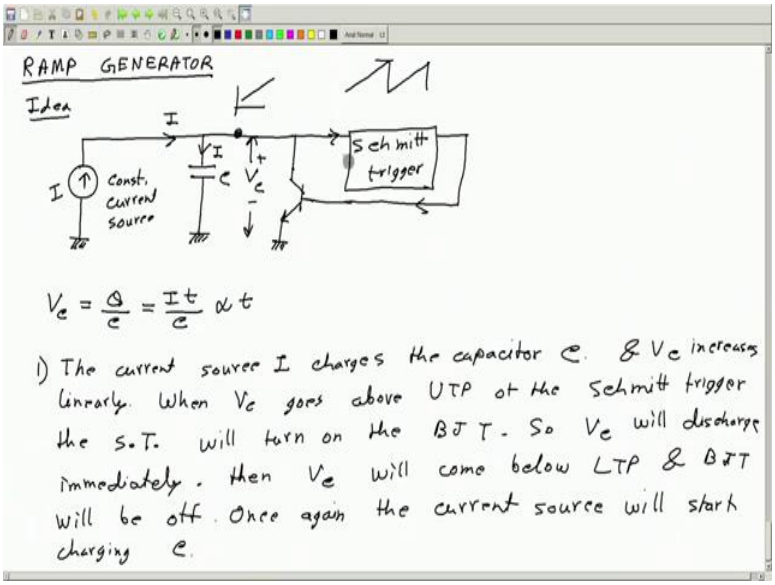

So, let us start. Let me first tell you the idea, the block diagram schematic, then we will go into detail. The idea is that we will take a constant current source. And so, this is a constant current source and this we will use to charge a capacitor. This current is constant which means the voltage across this capacitor call it V c plus minus this will increase linearly right, why because you know the voltage V c it is given by c = Q / V.

Vc = Q/C = I t/C

So, this voltage will increase therefore, at this point this voltage increases linearly. So, this is actually a one part of our ramp. I mean we know the ramp is basically a linear voltage then it falls down and again linearly increases and so on. Now we have to essentially realize this discharging or falling of the voltage.

So, what we will do? We will feed it to a Schmitt trigger circuit and this Schmitt trigger will activate say a switch which could be ok. And so what will happen? I mean we have seen some similar thing while talking about oscillator circuits 5 5 5 timer you recall ok. So, this is not a very detailed circuit diagram, but this is a schematic the idea ok.

So, the idea is that when this voltage goes up above some threshold maybe this threshold then this Schmitt trigger will be turned on and this switch will be on. So, now, the capacitor will discharge and it will discharge immediately and quickly ok. So, this voltage will come down very quickly and once this comes down then these Schmitt this voltage comes down.

So, this me trigger output will change and this switch will be off and once this switch is off. So, this is off then the current will again this current will come and again charge this capacitor ok. So, the idea is so, let me just write these essential points. The source I the current source I charges the capacitor C and V c increases linearly. When V c goes above UTP of the Schmitt trigger this Schmitt triggered insert S T will turn on the transistor the BJT ok.

So, V c will discharge immediately to 0 or whatever maybe in this case you ok. So, it will discharge immediately fine and then V c will come below lower trigger point and BJT will be off BJT will be off. Once again, the source the current source will start charging the capacitor this is the idea ok. So, now, we have if you want to draw better scheme better detail then we have to give some circuit for this current source, some circuit for this Schmitt trigger etcetera. So, let us try that ok.

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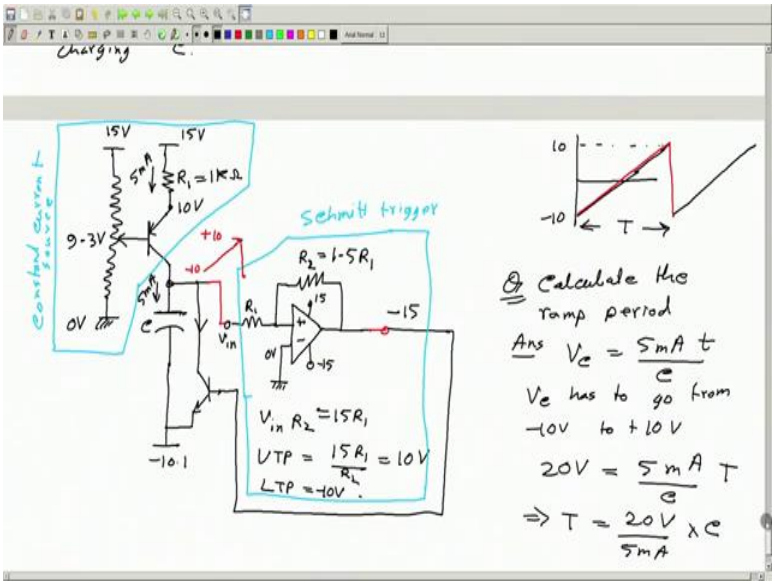

So, first voltage first let me draw the capacitor. And we want the capacitor voltage to change from a say from a negative value to up to some positive value and we need a current source. Now how can we realize the current source? We did it when we studied linear ohmmeter ok.

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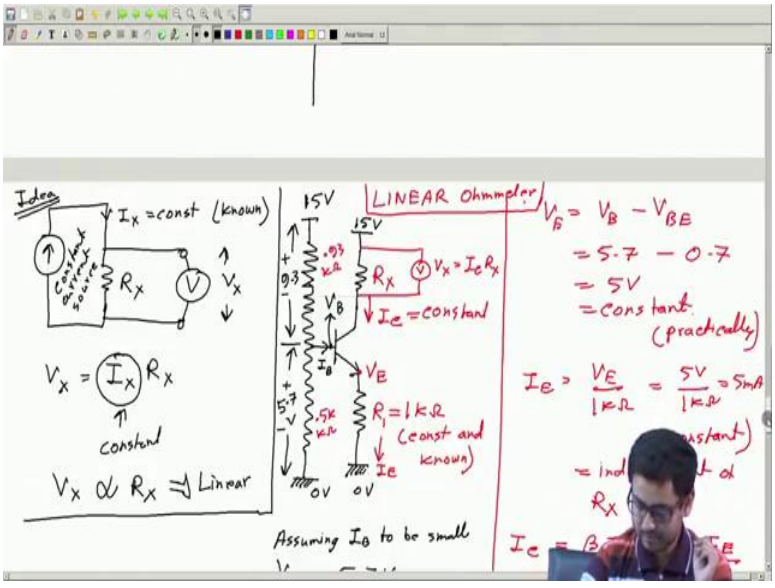

So, this you know is a constant current source ok. Let me first draw the current source. I am taking a PNP transistor unlike the NPN in the previous case. I can do it with the other one as well no problem. And then what I will do? I will take a potential divider ok. So, to

make if say this voltage is 15 volt and I want this voltage drop to be so, I want to say 5.7 volt drop maybe. So, this voltage will be 9.3 volt ok.

So, you can take the ratio of these resistances accordingly. So, this voltage will be at 10 volt, you can take this and now so, therefore, and this at R 1, so, if I take R 1 = 1 kilo ohm, then this current will be how much? This current will be this is 5 volt /1 kilo ohms. So, this will be 5 milli Ampere constant.

Now, this 5 milli Ampere current I will take to a capacitor ok. So, this capacitor voltage will increase and the other side I will keep possibly at a negative voltage ok. So, I will keep it at a negative voltage may be minus 10 volt some negative value ok. So, that when there is no charge across the capacitor this is also negative this is also negative. So, and then it will start to grow from this negative value first to 0 and then to positive ok. And this you can keep at 0 volt ok. So, this is at minus 9.3, fine; no sorry plus 9.3. So, that this gap is 5.7 and this is 5 volt ok. So, essentially this voltage I want to be constant and this current to be constant ok. So, now, this voltage will increase like a ramp from minus 10 to some positive value.

Now, I will feed this to a Schmitt trigger. What kind of a Schmitt trigger is useful? I will take a non-inverting type so that when this voltage increases output will also increase. So, I will take a non-inverting Schmitt trigger, this is just non inverting Schmitt trigger and let me take this R 1; R 1 = R 2. If so, and if these voltages are say plus minus 15 volt then let me quickly calculate the trigger point lower trigger point and upper trigger point ok.

So, for to do that you know if this is 15 volt, so, at any moment if this is plus 15 volt then I want to make it above sorry if this is let us start from this if this is minus 15 volt I want to make it let this point at 0 volt, if this is 0 then the output will change ok.

$$\frac{Vin\ R2 - 15\ R1}{R1 + R2} = 0$$

$$\text{UTP} = 15\ \frac{R1}{R2}$$

So, yes so, in this case the trigger point will be 7.5, but suppose what I want is this suppose I want the ramp to vary from -10 to +10 ok, you just see that I am actually designing this circuit while I am talking to you. So, this is I mean this is up fact that I want to stress is

that do not try to memorize anything, try to understand and make things on your own then you will enjoy it you will learn it ok.

So, I suppose now I want the output voltage sorry graham voltage to go up to 10 volt. If so, then I want the upper trigger point also to be 10 volt. So, what I want this to be 10 volt. If so I will take R 2 = 1.5 R 1 ok, if this is equal to 1.5 R 1 then this will be 10 volt fine. So, when this goes to 10 + 10 volts then this Schmitt trigger will be activated and it is output will be plus 15 volts ok.

Now, what we will do, we will use this to drive up drive the base of a transistors be switched. So, we what we will have we will let me elongate it minus 10 volt, here I will take a transistor-based switch this is at minus 10 volt. If I connect 15 volts there, we may need some voltage adjustment maybe I am not going into that much detail.

So, if this 15 volt is applied here, this is minus 10 volt definitely then this will be forward biased and this will act like a short circuit we may need some resistance to save it from high current that much did tell I am not going into, but definitely this is forward biased. So, this current will flow and the trunk and this capacitor will get discharged also this constant current source will deliver it is current at that moment through this.

So, this is the constant current source this part is the constant current source in our block diagram, this is this Schmitt trigger you know this is the Schmitt trigger and it is upper trigger point is 10 volt similarly the lower trigger point will be minus 10 volt you can calculate it anyway it is always symmetric. So, I know it is if this is 10 volt then this is going to be minus 10 volt ok.

So, then let me repeat a current was coming through this and it was charging this capacitor. So, the capacitor voltage went from - 10 to +10 at that moment this Schmitt trigger is triggered. So, the output became positive this positive output made this transistor for base emitter junction forward biased. So, the transistor was on the entire current flowed through this and the capacitor got discharged. So, then this voltage will fall down to minus 10 volt this voltage across capacitor will be 0.

So, this is -10 volts. So, this point will go down to -10 volt right. So, this will come to minus 10 volt almost in no time because this is almost a short circuit or it will take very small time. So, the capacitor voltage went from -10 to +10 then it came down very rapidly

to minus 10 and the moment it comes to minus 10 this is also equal to the lower trigger point of this transistor ok.

Maybe then I keep as a safety margin I can keep it minus 10.5. So, that it is allowed to come below 10 even 10.1 or something is fine. So, that it comes below 10 and the moment it comes below 10 this output will become negative minus 15 and if this is minus 15 you know this is lower than the emitter.

So, this transistor will be off once this transistor is off again this current comes here and the capacitor gets charged. So, again from here the voltage will increase, this is this Schmitt trigger, this is the capacitor and this is the constant current source, we are done we have generated the ramp ok. So, we are so happy that we have done it and now just some small things as I always do as I always ask ok.

If question: can we calculate the ramp period ok. So, can we do that? So, for that I just need to know the value of this capacitor ok. So, very quickly we can do it with these numbers with this data, if we change these numbers answer will change, I will use the same number. So, you know this current this is 5 milli Ampere. So, this is approximately 5 milli Ampere.

$$Vc = \frac{5mA\ t}{c}$$

$$20\ V = \frac{5mA\ t}{c}$$

$$T = \frac{20V}{5mA}\ C$$

$$F = 1/T$$

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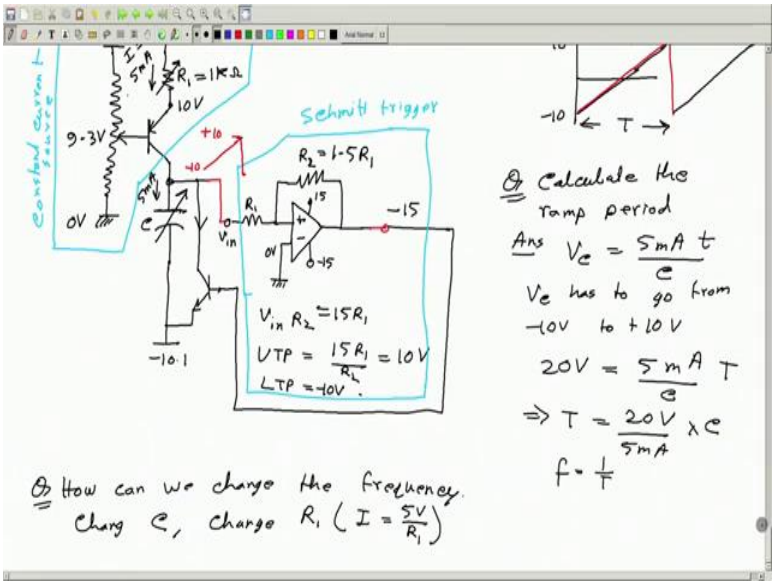

And can we calculate the height of theta I mean this we already have know? So, it need not calculate. So, this is from minus 10 to plus 10 ok. So, how can we change how can we change the frequency or ok. So, you can take a variable capacitance definitely because we have c in the expression of the time period.

So, change c or else what you can do you can change this R 1 because if you change R 1 then this current you call this current I where do I write I write here. This current I just the same as this current is same as 5 volt / R 1 right . So, if you change this current definitely the time required for this voltage to go from minus 10 to plus 10 will increase or decrease right. So, you can change this and thereby you can have a controllable ramped generator ok.

And this here in this circuit we have taken a constant current source which is realized using a transistor base circuit thank you I think this is the point where I will conclude this course we have gone through a lot of topics some of the topics at least towards the end I myself felt I had to last because of the availability of time.

But if you feel if you have any doubt any query please post that in the forum, if required we will make more videos later on if you want. Sometimes we have gone very slowly a this is with the assumption that all of you might not have studied all the required background. So, that all of you can understand I have sometimes tried to go very slow this course has gone longer than the expected much longer than the expected duration and if

you have come so far with me I really congratulate you from the deep of my heart deepest point of my heart.

And sometimes the course was boring because I have gone so slow, I hope the study materials that from the book which I have pointed out you can study that much quicker without having to wait for this long and delayed boring of videos. Anyway thanks a lot if you have any query post us in the forum we will try to help you and thanks a lot to all the team members in the NPTEL whom you possibly do not see, but without whom this effort would not have been come up to this point ok. Thanks to all the team member of the NPTEL I know how many times I have retaken the videos they have helped us without getting disturbed, without getting bored at all, thanks to all of you.

Thank you.