# Analog Circuits

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**Week 07**
**Module 05**
**Mono stable Multi vibrator**

Hello, welcome to another module of this course analog circuits, so in the past few modules we had been discussing about multi vibrators we cover the bi-stable multi vibrator and then the Astable multi vibrator, so in this module we will be covering the mono stable multi vibrator, now before going into the description of a mono stable multi vibrator using an opamp first I want to just refresh the concept of the mono stable multi vibrator.

So mono stable multi vibrator is a multi vibrator that has 2 states a circuit whose output can be in 2 states, just like the other 2 that is the Astable and the bi-stable multi vibrator but the difference between the other multi vibrators and a mono stable multi vibrator is that only one of the 2 states is stable.

So by stable I mean if the output is in that part in that stable state then it will continue the circuit will continue to remain in that state unless it is disturbed externally in the other non stable state however if the circuit is present then the output will over time shift back to the stable state so that is the basics of a mono stable multi vibrator.

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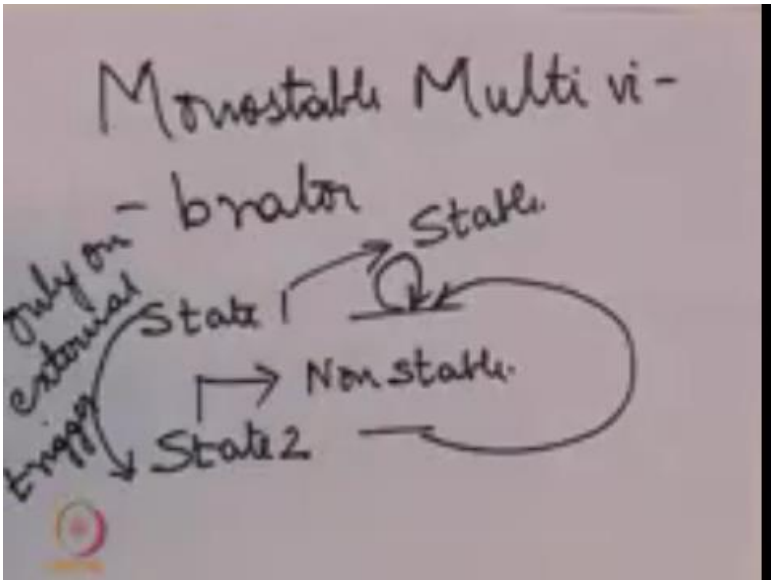


So let us see how what are the details of the mono stable multi vibrator okay, so it has 2 states just like the other 2 multi vibrators but suppose I call the state 1 as the stable and state 2 as the non stable state then over time the circuit will transform from state 2 to state 1 but if it is in state 1 it will continue to be in state 1 unless it is so state 1 to state 2 transition will happen only on external trigger okay, so unless there is an external trigger state one will continue to be in that same state.

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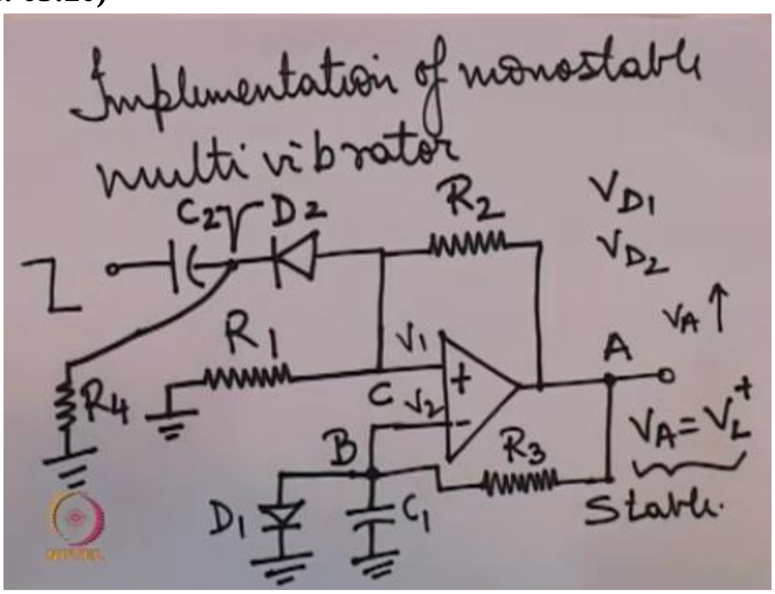


So let us see the circuit details of the circuit of the mono stable multi vibrator using an opamp, the standard circuit for this mono stable multi vibrator is something like this and I must say that it is the most complicated of the 3 multi vibrators this circuit and the reason for that complication is that this mono stable multi vibrator lacks symmetry.

So this is the construction of the mono stable multi vibrator there are 2 diodes D1 D2 the voltage drop across each diode is say = VD1 and VD2 these are the diode drops or diode voltage drops often you know when we were discussing diodes I mention that there is always a threshold voltage a threshold voltage is also sometimes known as the diode drop rather than saying the threshold voltage of the diode we often also refer to it as simply the diode drop, so VD1 is the diode drop of diode D1 VD2 is the diode drop of D2.

Now say initially the output voltage is VA is high or in other words VA is = VL+ where VL+ is the upper saturation voltage of this opamp now this state this VA = VL+ is the stable state as we shall see on the other hand if we have VA = VL- that is the VA that is the output voltage of the opamp is = the lower saturation voltage.

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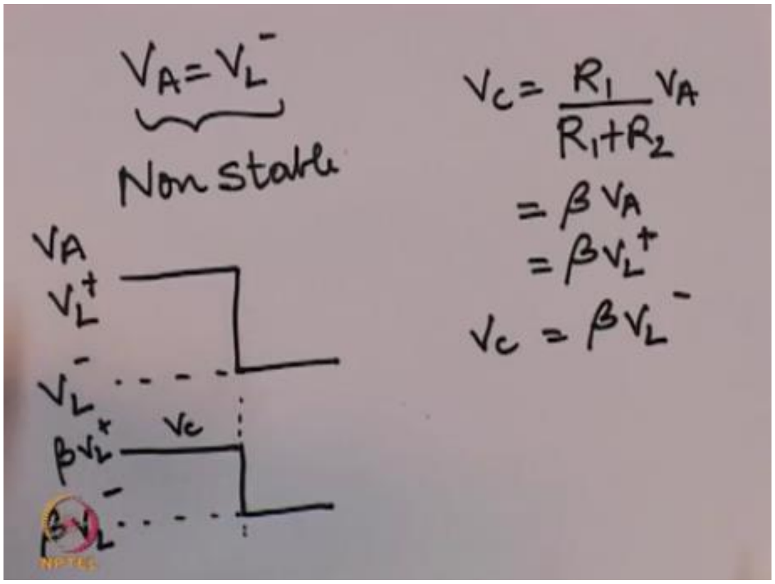


This is the non stable or unstable state now why is this so, so here I have drawn coming back to this main circuit I have drawn a + say VA is = VL+ the upper saturation voltage and I introduce a pulse now because this capacitor will not pass any DC voltage through it, it will only pass the high frequency components of this pulse the voltage at the voltage at this terminal or the this terminal of D2 will be a sharp pulse like this a spike kind of a negative spike.

Now because of this negative spike what happens is D2 becomes monetarily forward biased, because as you can see if I introduce a negative spike at this terminal of diode D2 this terminal will become highly negative whereas this terminal remains whatever voltage it had previously as a result of this D2 becomes momentarily forward biased and this because D2 becomes forward biased this spike voltage is also transmitted to this non inverting terminal of the opamp C.

Once this spike is transmitted to the terminal C what happens the voltage suppose I call this V1 and V2 V1 - V2 V2 becomes momentarily negative now once V1 - V2 becomes momentarily negative it positive before this spike arrived V1 - V2 was positive, now that this spike has arrived at terminal C V1 - V2 become momentarily negative that is V1 momentarily goes to a very low value as a result of which V1 - V2 becomes negative.

Once this terminal the voltage V1 - V2 becomes negative then what will happen because opamp has very high gain so once you feed a negative input voltage the output at VA will invert it will go from VL+ to VL- ok so it is like this.

If we plot the graphs at VA, so this is my VA it was V = VL + initially after the negative spike voltage arrived it when from VL+ to VL- ok and what about VC, VC was also at a certain high voltage then when the spike arrived it went low momentarily and stay at that now the question is what is this high voltage at B.

So let us come back to the circuit once again so initially this voltage VC the voltage at terminal C was high now what was that value the high voltage to find out that high voltage first note that initially this D2 was reverse biased ok if this is reverse bias that means no current will flow through the diode and so then the voltage at VC is simply VA divided by R1 + R2 multiplied by R1.

So then I can at this point the voltage VC was = R1 upon R1 + R2 times VA and this I am calling as beta VA and since initially VA was = VL+ so this was initially = VL+ so this was = this is the value of VC so this VC that I am plotting initially it was VL+.

Now after spike arrived what happened all this happened momentarily once the spike arrived at port C the voltage input that is the voltage difference between the non inverting and inverting terminal became negative and VA went from VL+ to VL- that is what I have shown here once VA become = VL- the voltage at C will be what now see this diode had only momentarily become forward biased once the spike ended it went back to it reverse biased it.

That is no current will flow through it and once this is reverse bias and this no current is flowing through it the voltage at point port C will simply be the resistive division of VL- over these 2 resistance so after the transformation of VA from VL+ to VL- VC now becomes = beta VL- so this voltage is beta VL- what about the voltage at point B so far we have never talked about this the voltage at terminal B.

Now when initially when VA was = VL+ the voltage drop at B was equal to the diode drop isn't it because once if this is if VA is = VL+ then the only voltage drop that is present between point B and ground is the voltage drop across the diode that is if the threshold voltage of D1 so if I try to let me take a fresh page then.

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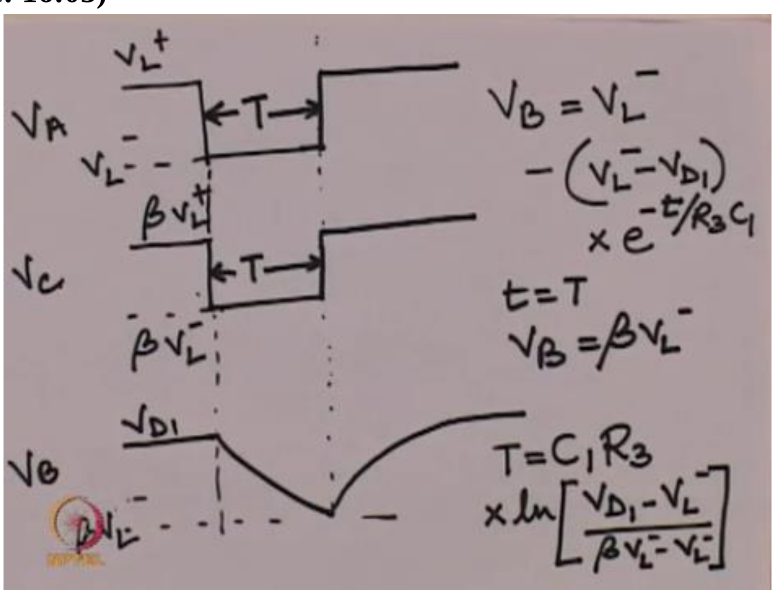


So I have my VA going from VL+ to VL- this is VA then I have my VC going from beta VL+ to beta VL- and I have my VB which was initially = VD1 and then once VA transforms from VL+ to VL- then what will happen now VL- is much more negative as compared to VL+, therefore it will cause the voltage once this voltage becomes = VL- it will cause the voltage at V to go down ok.

Because this is very negative so it will drag down the voltage to a lower value so then VB will be drag down like this but how long will it be dragged down see the voltage at VC is = beta VL- after the transition, so as long as the voltage at C is more negative as compared to the voltage at B VA will continue to remain at VL- but VA being = VL- is also dragging down VB continuously.

So at the point where VB becomes more negative than VC what will happen is again VC will be at a higher value than VB and again we will have a transition in A VA from VL- to VL+, so that is the thing as long as VB is more positive than VC VA will continue to be in VL - but the moment VB becomes more negative or = VL- what will happen is there will be a transition now that the non inverting terminal of the opamp again becomes at a higher voltage than the inverting terminal.

So what we will have is again a transformation in VA from VL- to VL+ like this once VA transforms VC will also simultaneously transform from beta VL- to beta VL+ and once we have VA transitioning back to VL + again now let me come back to the circuit once again once we have VA coming back to VL+ that will again cause the voltage VB that will drag the voltage VB upwards ok and back to its tables value of VD1, so VB after this second transition will slowly go on till it reaches the go up till it reaches the value of VD1.

Now this is the basic understanding of the circuit but we also need to put this whole thing in a mathematical form first thing some design issues that we have to consider is that this R4 has to be much larger than R1, so this so that this spike travels completely or as much as possible to this terminal C if this RF is a very low value then this spike will actually drain out through R4, we do not want we want R4 to appear almost like an open for this spike the second thing is what is the total time that this pulse existed for this negative pulse in VA or VC.

What is the total time that it existed for? So to understand that let us write the equation of VB in this stage that is when VA is = VL - okay then can I write VB as being = VL- - of VL- - of VD1 since VD1 was the initial voltage multiplied by e raise to - t upon R3 C1 so here R3C1 is the time constant because this voltage at point B during the negative when Vi is = VL- the voltage at V is decreasing by a time constant given by R3C1.

So this will continue till at T = T we have VB = beta VL- so if we substitute this value of VB into this equation and then equate for this capital T we will get an expression for the total time taken for the negative pulse and that comes out to be ok so this is the total time for which the negative pulse of the mono stable multi vibrator exists so if suppose we ignore the diode drop that is if suppose VD1 we assume that VD1 is = 0.

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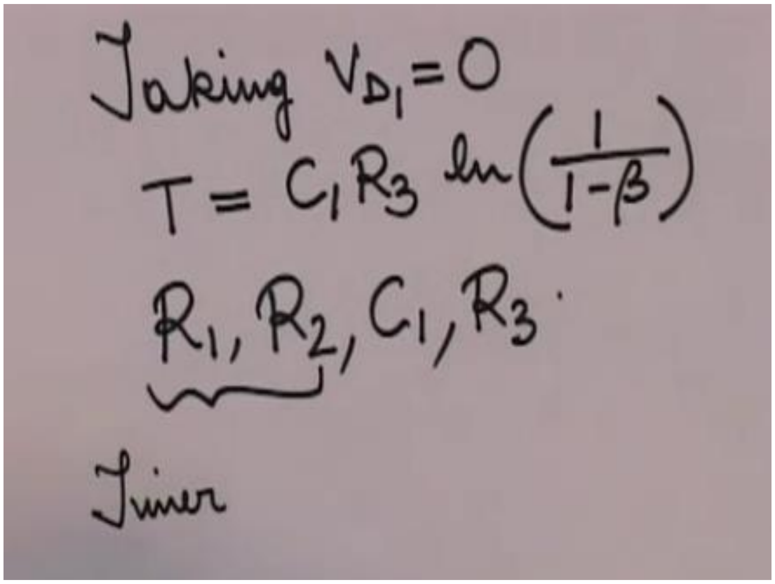


We have T given by C1R3Ln 1 upon 1 - beta so we see that this time for the pulse depends on 3 quantities I beg your pardon depends on 4 quantities one is R1, R2, C1 and R3 usually if the feedback components R1 and R2 are kept constant, so by modifying C1 and R3 we can obtain a pulse for a desired duration usually a mono stable multi vibrator is used as a timer that is it signals it is used to signal the start and stop of certain events.

For example say if we apply the negative spike coming back to the circuit once again if we apply the spike negative spike at the start of an even okay and adjust this R3 and RC1 so that it coincides the total time of the negative pulse of this mono stable multi vibrator coincides with the end of the event then that will give us an accurate representation of how long the even a really existed, so that is one use of a mono stable multi vibrator that it is used often used as a timer circuit.

So in this module we learnt about the mono stable multi vibrator I want to reiterate that mono stable multi vibrator does not have 2 stable states neither does it have 2 unstable states it has 1 stable state and 1 unstable state, in this case the stable state was when the output of the mono stable multi vibrator was = VL+ and the unstable state was when the output of the opamp was = VL-.

When the output is in VL- or the unstable state the input to the inverting terminal of the opamp will slowly be drag down till it becomes more negative than the non inverting input and then once that happens there is again a change of state at the output VA back to it the upper saturation voltage VL+ and this way the circuit return to its stable state, in the next module will be covering about will be discussing about Zener diodes and the Zener effect, thank you.