Electronics for Analog Signal Processing - II
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Lecture - 34
AGC/AVC

We had just discussed some time ago about a control system; that is, voltage regulator; how a D C output voltage can be maintained constant by comparing the output voltage with the reference and making a series pass transistor have the drop across it controlled by a comparator output.

Similarly, we are going to now discuss what is called A C voltage regulator; or I would call it as automatic gain control system. It is popularly called automatic volume control system A G C, A V C or in another application, it is also termed as amplitude stabilization of oscillators.

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The output amplitude of the oscillator is maintained constant at a certain value. Here, input comes from an external source and therefore output is maintained constant. Here, input is actually generated within itself in an oscillator but its amplitude has to be maintained constant.

So, that is the difference between these. But both of these require similar type of gain control system so that output remains constant. So, such an A C stabilization scheme is what is going to be talked about. So, before we go to this sort of theory proper, why it comes into picture in multiplier? Multiplier we know is nothing but an amplifier whose gain can be controlled. So basically, a multiplier is the ideal block into which this control system can be incorporated. So, as an application of multiplier, we can use these systems.

So basically, I would now take a multiplier itself as a block to which we will now apply a control system. What is it? I have V i applied to V x and this is the control voltage. I...if I ask you to maintain the output constant, you will ask me, at what value? I will say: at a certain value, 5 volts peak or 10 volts peak. So, this is a sine wave. So, this is understood that this has to be a sine wave. So this, or a single frequency or a narrow band of frequency, output. So, this is V p i sin Omega t, is the input. Output therefore is V c by 10 times V p i sin Omega t.

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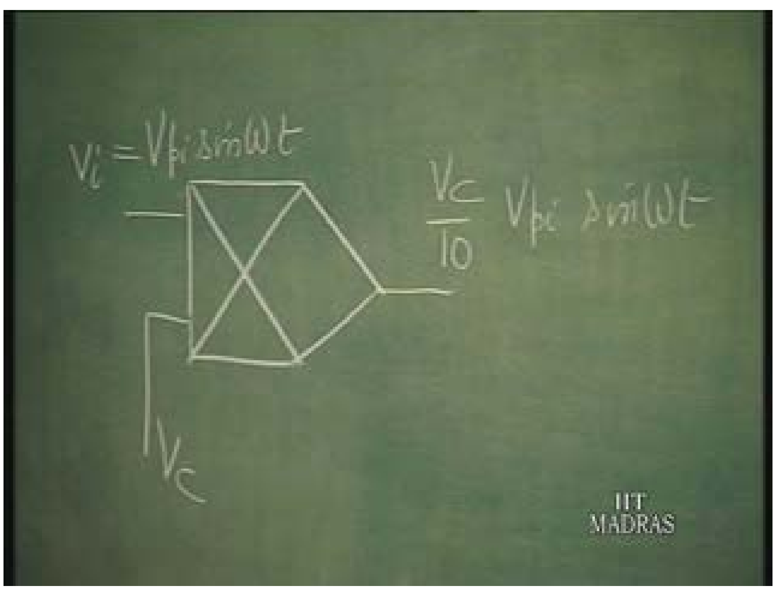

So, what is asked is that, this should remain a constant at a certain value. Let us say, this is going to be V R. So, how do we maintain this constant? V p i, if it decreases, V c should increase so that V p i into V c remains a constant. So, that means if I ask you to maintain this constant for a certain V p i, you will apply a certain V c so that V p i into V c by 10 becomes equal to some V R p, V R p let us call it.

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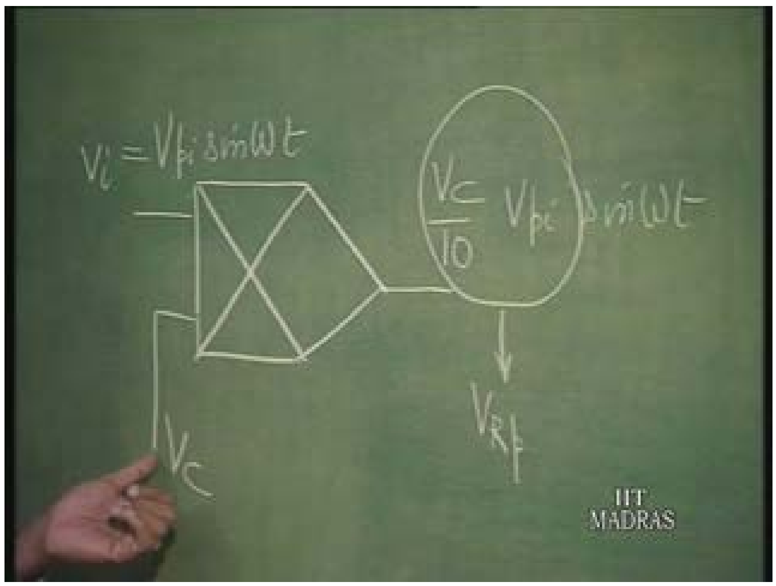

So, this is the automatic gain control scheme or automatic volume control scheme. What it needs is an amplifier whose gain is controlled by means of a voltage or current; and these amplifiers' name...should be working at a single frequency or a narrow band frequency.

Now, where do we really apply these A G C, A V C schemes? These are all applied to receivers. At the receiving end, you receive the carrier and this might be amplified by an R F amplifier and applied to a mixer; and mixer, it is converted to I F; and this I F is furthered processed, amplified and then detected; the modulated frequency is detected.

So, the entire chain of receiver where this information gets amplified or the sensitivity of the receiver is sort of primarily to do with gain of I F as well as R F so that the sensitivity is packed. So, if I have the signal that is being received very large, then the output will have large magnitude of output and my audio state may get over loaded; distortion may occur. If the input is very small, output will be very small and I might not get any detected output, though this kind of thing occurs normally because the received signal keeps on fading due to atmospheric conditions; attenuation keeps on fluctuating at every moment.

So, this kind of variation, this fading, at some times, the received signal is large; at some times, the received signal is small. This kind of thing when it happens particularly, you want your automatic gain control system to function so that the output of the I F is fairly constant so that at this constant value, the distortion is not there; and also there is sufficient signal output so that you can hear this.

So, this is absolutely necessary in almost all receivers, television or audio; that is radio receivers. So, you will see that the gain of I F stage and R F stage as well as mixer is controlled by some current or voltage and that controlling current or voltage is derived from the detector, D C. The D C information that is outputted at the detector is directly dependent upon the amplitude of the I F received.

So, how do we receive this D C information? You have to convert the A C into D C. So for that, we have to have rectifier diode arrangement. So, we will discuss that also. Essentially there are two points. This is normally applied to an amplifier which is working at a single frequency or a narrow band of frequency. That is why we can take the signal as sine wave and output is going to be a sine wave and this is going to be rectified and filtered in order to derive a D C which is dependent upon the peak value of the signal and this D C information is used to convert, control, the gain of the amplifier.

So, if this is increasing, input is increasing, gain is decreased. If the input is decreasing, gain is increased, so as to keep the output constant. So this principle is the principle on which this is operating.

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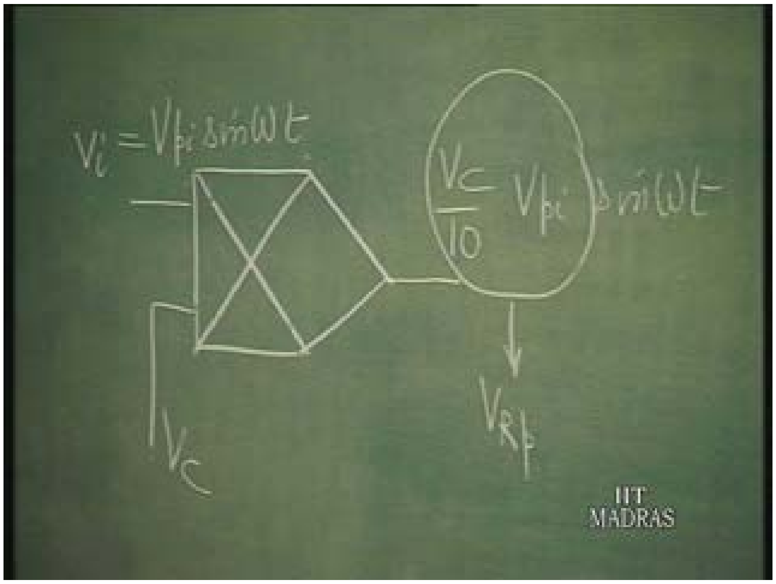

Now, what is the range in which this A G C system will work? Let us see. V c utmost can be equal to 10 volts. So, when V c is 10 volts, V p i has to be equal to V R p.

So, when V c utmost becomes equal to 10 volts, V p i has to be equal to V R p; or when V p i is equal to V R p, V c will become equal to 10 volts. If V p i is less than, let us say V R p, let us say V p i is less than V R p, V c has to be greater than 10 volts which is not possible. That means V p i cannot take any value which is less than V R p, for this structure. So, V p i minimum is equal to V R p.

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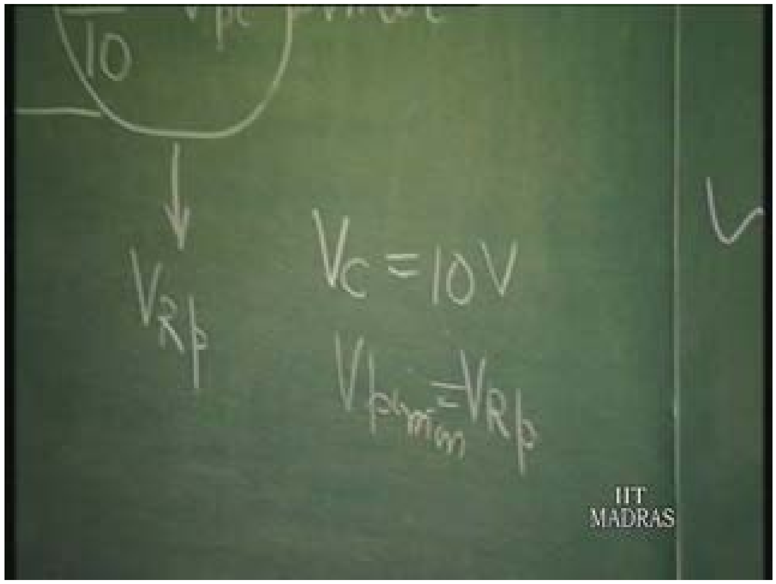

That is the range in which this system will work. That is the maximum gain you can give from your amplifier. So, the maximum gain times the minimum voltage should be equal to whatever value you get. That is number one.

Then, when V c is equal to V c minimum... now, V c minimum can be very nearly zero; V p i can be any large value. So, any large value greater than V R p it could be. So, for all those large values, V c can take on the minimum value. So, there is no problem. So, as far as this A G C system is concerned, it is going to work for a variation of voltage starting from V R p up to very large values of the signal.

This is because this is basically an attenuator, not really an amplifier. So, this particular thing, this V c minimum is going to be fixed by...what will be the order of minimum voltage that is necessary for the multiplier at which multiplier will satisfactorily multiply in fact?

That is normally about 10 times the offset voltage of any of the op-amps and things like that that are used in the multiplier so that there is certainty about the value that you are considering here.

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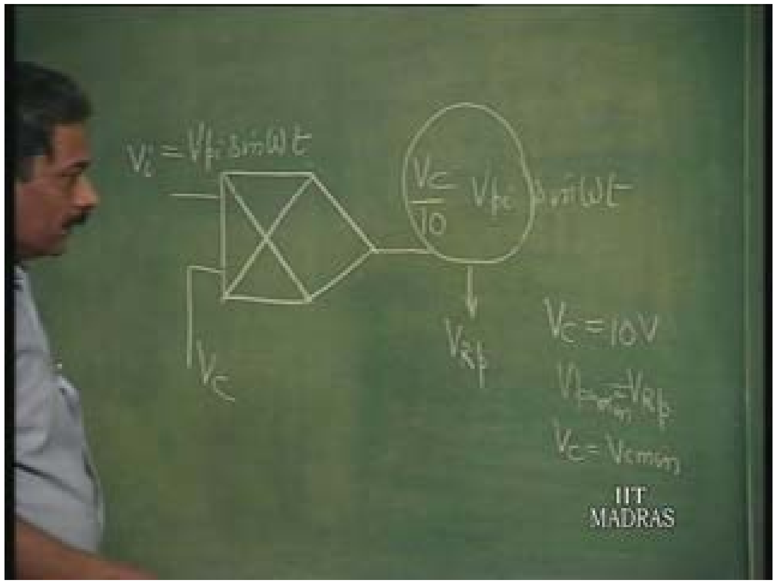

So basically therefore, you will see that if I apply V i versus V naught, V i peak versus... V p i versus V naught, V naught is this, V naught peak. It will be just that this will get stuck at 10 volts when V p i is low because it is trying its best to give the maximum gain for it.

So, it is not working at that point of time. So, what will be the gain? Gain is going to be 1. That means it is going to follow like this. They are of the same scale. There will be 45 degree line, up to the point when this becomes equal to 10 volts. That is, this also can become equal to 10 volts now. So up to, let us say V p R, V R p, or 10 volts, whichever is going to be the lower one. So, we say that we want it to be adjusted to 10 volts then. Thereafter, it is going to get control.

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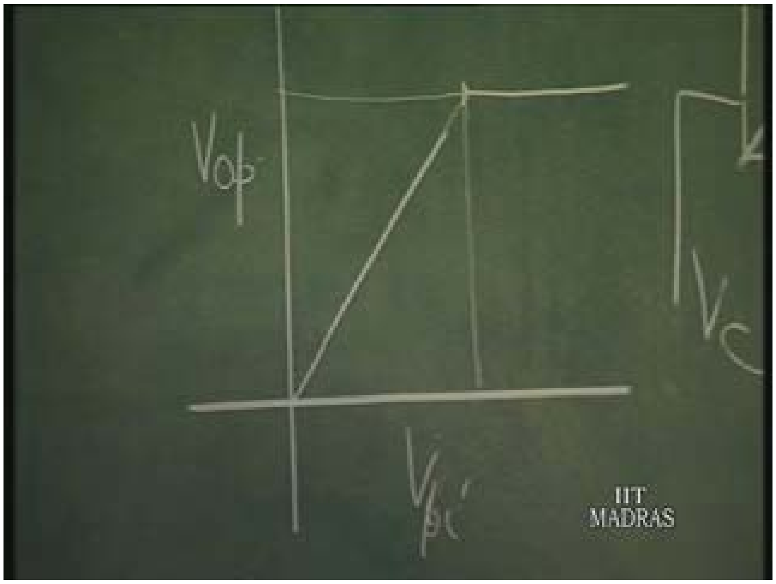

V p i minimum equal to V R p; up to that point it is going to be V r p. Then it will be controlled. If V R p is 10 volts, this will be limited to 10 volts. So...but then, V o p also cannot be greater than 10 volts because this is a multiplier.

So, you have to make V R p less than 10 volts. So, let us say I am adjusting this to be 5 volts. So, this is this limit is at 5 volts. So, the moment V o p becomes equal to 5 volts, it will start controlling. Then I should not apply V p i greater than 10 volts for this.

So, up to that point it will work; the A G C will work. So, this is the characteristic. This is the characteristic within which it is simply acting as an amplifier without any control after this control takes over and output will remain constant. So, every A G C system will have a dynamic range within which it is satisfactorily functioning. So, this is the dynamic range; from this value up to 10 volts. So, have I decided that V R p shall be 1 volt, then this is it. You will see that it will be constant. This is the characteristic of the A G C system.

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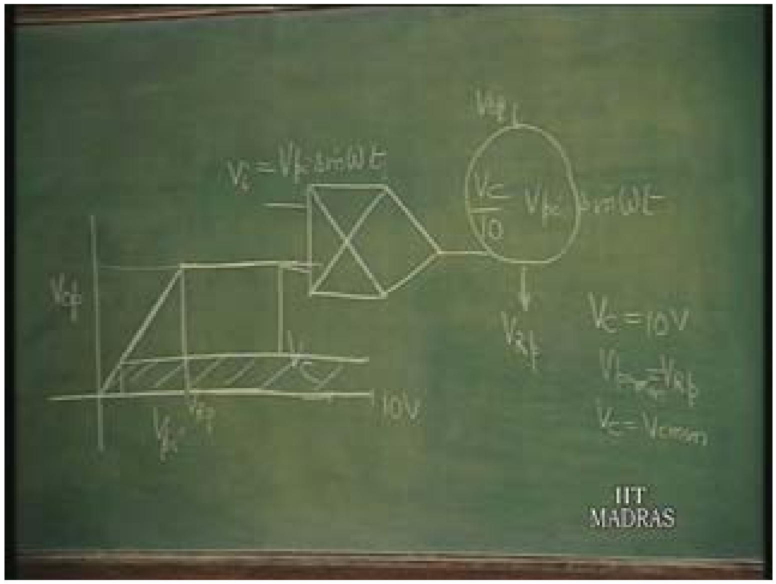

If it is...should be point 5 volts, you can see that as I restrict the value of these two lower values, the A G C dynamic range keeps increasing. As I keep on increasing it, let us say I have it at 10 volts. That is no range at all for the A G C system because my multiplier here will stop functioning beyond 10 volts. So, this is how we can arrive at the dynamic range of such systems. Now, how to implement this system. First, let us see how this information can be converted into a D C.

So, this information can be converted into a D C simply by connecting a, let us say rectifier here. So, if this is connected to a half wave rectifier here, the output of this will be going up to the peak value. This we have learnt in our earlier course itself.

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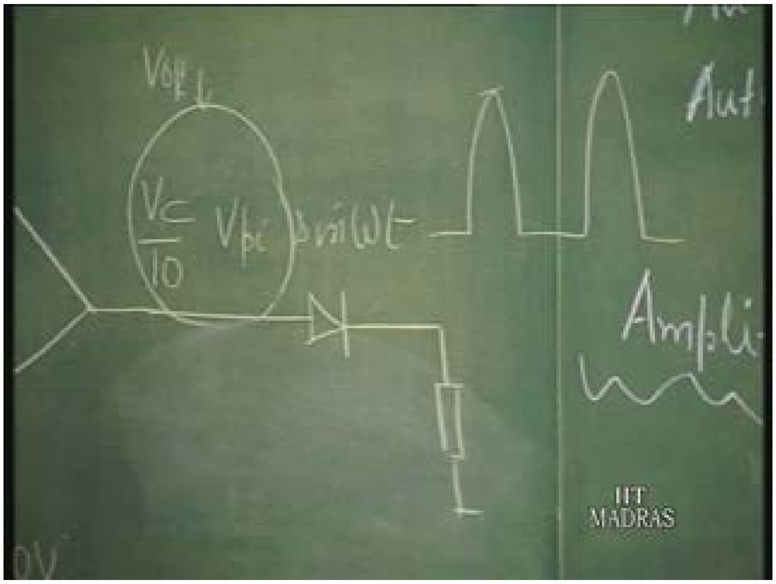

Let us say, after generating this rectifier wave form, I want to filter this. How can I do that? That can be done by putting a low pass filter. This is the arrangement of the low pass filter.

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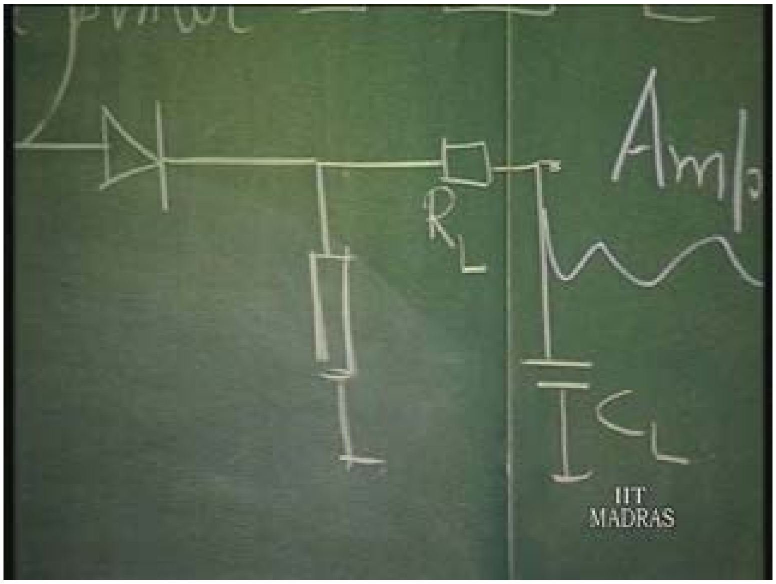

It is assumed that this low pass filter is not loading this particular resistance R. This resistance R is the one which unlikely fixes up the current in this diode so that this is not loading it. So, we can have a low pass filter like this now. So, what will be the low pass filter now determining? It will take the average of this. So, if this peak is given as V naught p as specified here, this will give us V naught p divided by pi. This, we have evaluated earlier also in the half wave rectifier. This average D C voltage here, if I put a sufficiently large value of capacitor, how do I fix up the R C time constant? This R L into C L should be much greater than the time period T. Time period T is the time period of this half wave rectifier. This we know.

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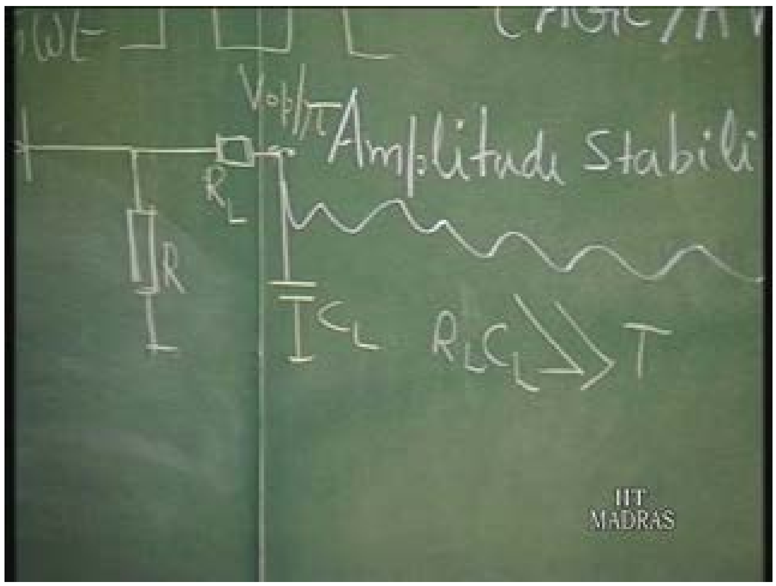

In such a situation, the D C output voltage here is going to be V naught p by pi and this D C voltage can be used assuming that the diode is an ideal diode. We have got this much information, that the D C voltage is V naught p by pi. Let us see. If this increases, this voltage is going to increase. So, this information gives straightaway the fact that I have to decrease the gain.

So, I use this to control...I compare this with another voltage called let us say V reference; and this voltage I am going to apply to the controller here. So, when this voltage goes above V reference, let us see how to put the polarity. I am putting the polarity here in this manner because I know that when this voltage increases, I want this voltage to decrease.

If I put plus minus here, when this voltage increases, this voltage will increase. So, minus plus, that is what is called negative feedback. So, when this voltage increases above V reference, this voltage will start decreasing.

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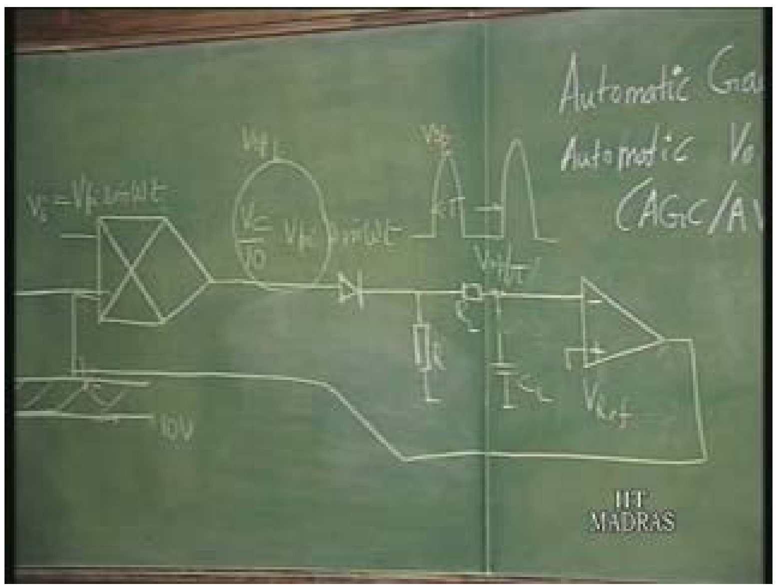

So, it will start decreasing and it will control the control voltage here, control voltage here such that the gain reduces. So, let us say V naught increases above what we want. What we want is this average should be same as V reference. If it is more, then this will go towards negative saturation.

That means it will become less positive. If this becomes less positive, this decreases because V c is decreasing. When this decreases, this difference becomes smaller now. Ultimately, this should decrease until this voltage becomes equal to this voltage and that voltage will remain constant there. As long as this is remaining constant, this will remain constant. So, this is the basis of negative feedback A G C.

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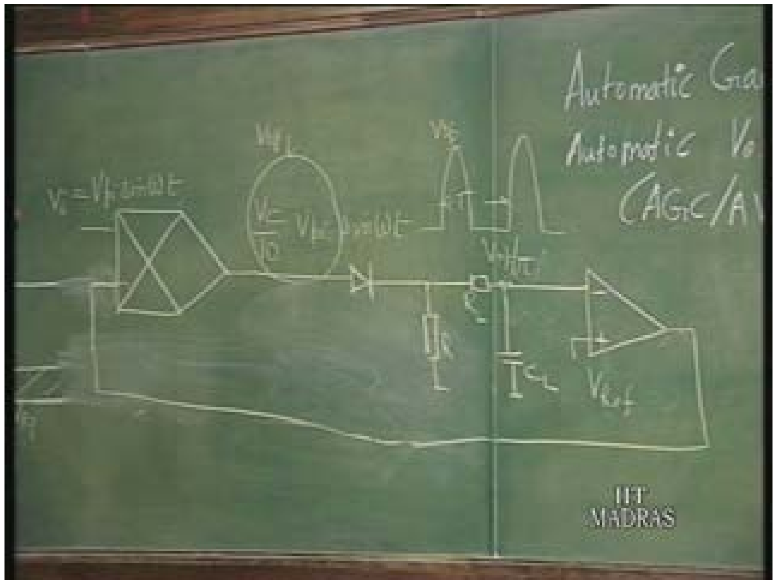

So, we have now built a system which is called automatic gain control or automatic volume control. This rectifier filter combination will measure the peak value voltage and compare it with V reference and have the control voltage controlled in such a manner that the gain is decreased if the amplitude is increasing, and the gain is increased if the amplitude is decreasing.

So, basis of such automatic gain control and automatic volume control, the rectifier filter combination is one part that is necessary there. Normally, if the voltage that is inputted to such system in communication area, this voltage is very small, then, V Gamma of this diode will enter this rectification properly. So for that purpose, we can use what is called a precision rectifier here. So, I will discuss how we can replace the diode resister combination here by what is called as a precision rectifier which can rectify very small voltages as half wave, even if the peak value of the voltage is less than V Gamma of cut-in voltage of the diode.

We had seen how this A G C system involves basically an amplifier with gain control, rectifier with filter and voltage reference.

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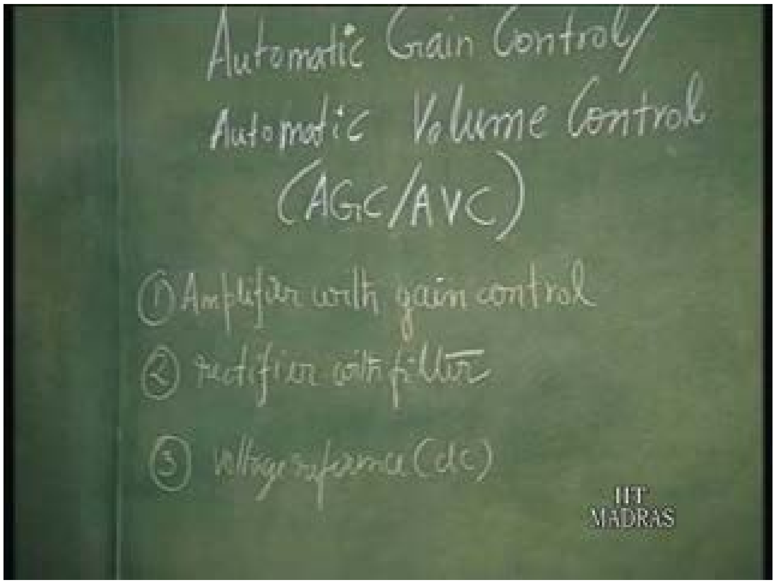

So, these are the three basic components of any A G C or A V C system. If it is an amplitude stabilization of oscillator, it becomes oscillator with gain control there and then rectifier with filter and voltage reference.

Now the rectifier, we would like to discuss a circuit for precision rectification using op-amps. We had seen this phenomenon in the removal of distortion, cross over distortion, in Class B amplifiers using op-amps. Same thing.

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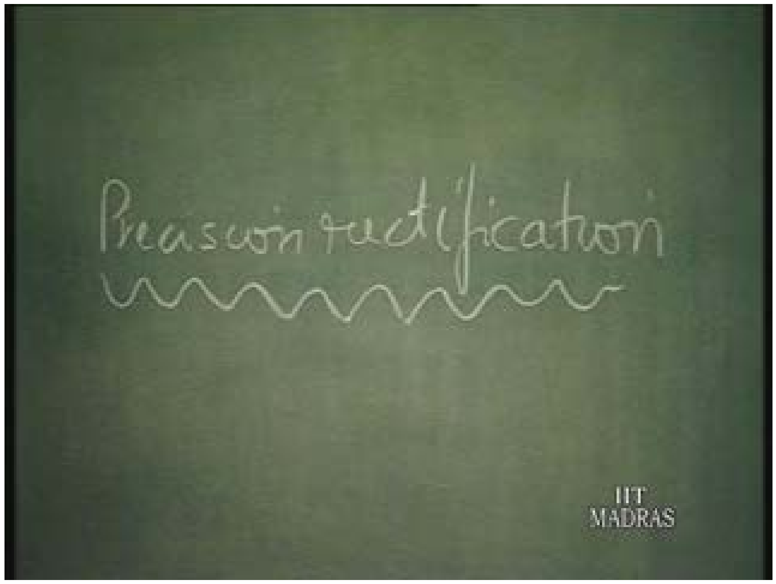

We can use...same principle we can use, of feedback. I have a resistance here which will convert the voltage into current. Negative feedback therefore is going to be made available through a resistance where the diode conducts. So, the diode conducts based on current, not based on voltage. If this voltage is positive and this current is positive, that current has to go into the diode. That is the minimum, irrespective of the value of the current. So, the diode is going to conduct even if the current is pretty low.

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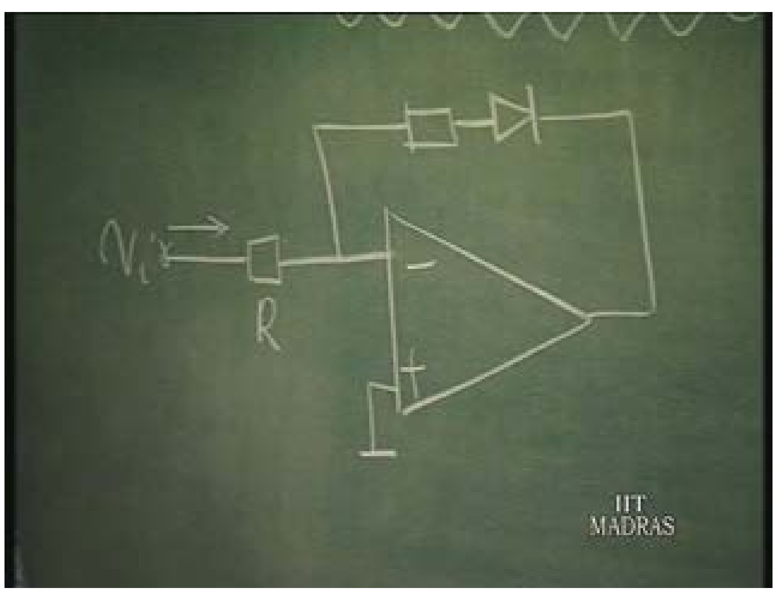

So, as long as V i is greater than zero, this current is positive and the diode automatically conducts. Why? Let us try to understand. If the diode does not conduct, then this is an open circuit. If this is an open circuit, this voltage will directly appear here and this voltage will try to go to negative saturation. That means this diode will be forced to conduct because this voltage will go towards negative value.

So, if the op-amp is such that op-amp does not get negative feedback, then the open loop causes this voltage to appear here. Even if it is a small positive value, micro volts, this will try to go to negative saturation and the diode will jump to V Gamma. So, this is what is happening. This op-amp will try to make the diode conduct even if the voltage is a small positive.

So, if therefore this is small positive and this is R and this is R, this is going on becoming positive like this; say half wave. This half wave is exactly reproduced here, but it is going to be inverted because this current will flow like this. This will flow like this and this potential being zero, virtual ground, there is an inversion here. So, if this is V p, this minus V p for a voltage which is taken here... Therefore, you should not take the voltage at the output of the op-amp because what will it show us? It will show us a jump initially at the zero cross over because this is going towards minus saturation at... As soon as the V Gamma is reached, this diode is going to conduct and thereafter it will show this half of the wave.

So, this is minus V Gamma and this is minus V Gamma plus... minus V Gamma minus V p so that, this particular point is going to have, in addition to this voltage, the diode voltage here which is minus V Gamma. So, this is not what you should take.

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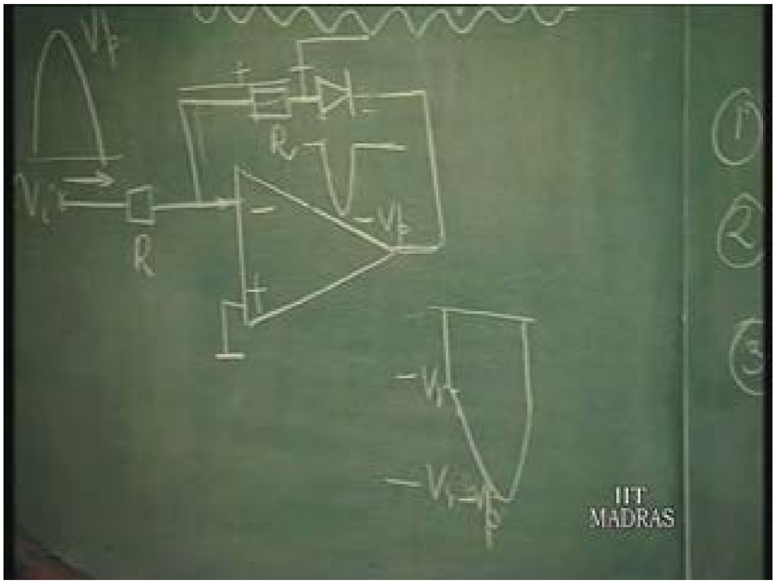

In fact, if V p is let us say 1 millivolt, this V Gamma is about 700 millivolts. So actually, you will not see this peak at all. It will look almost like a square wave here; whereas it will be a nice rectified half wave here; 1 millivolt with 1 millivolt peak.

So, this is what is called a precision rectifier. This is not over because if this voltage now goes positive, this is understood...it is going to half wave rectifier. When it goes negative, what happens? When it goes negative, we want this voltage to be at zero. When it goes negative, no diode is there. Op-amp is not conducting. Op-amp is not having negative feedback and therefore this negative voltage will directly appear here and this will go to positive saturation.

So, this voltage will appear here and this negative voltage appearing here will make it look like a full wave rectifier wave form.

But then, I cannot draw any current from here because the moment I draw a current here R L, that will get attenuated because op-amp is not coming to picture. This resistance in series with R L is going to cause an attenuation. That means this peak amplitude will keep varying depending upon R L; whereas earlier, when this was going positive, this was negative. The R L did not matter at all because the...it is the op-amp which was giving the current to the load.

So, current was not being taken by the load resistance from input. It was the op-amp which was delivering the current to the load. Now, op-amp does not come into picture. So, the peak value of this will keep changing with respect to R L. So, how to make it constant at zero? The only way is to connect a diode in the reverse direction. So, what will it... it is...this diode will now conduct and maintain this voltage at zero, whenever this goes negative.

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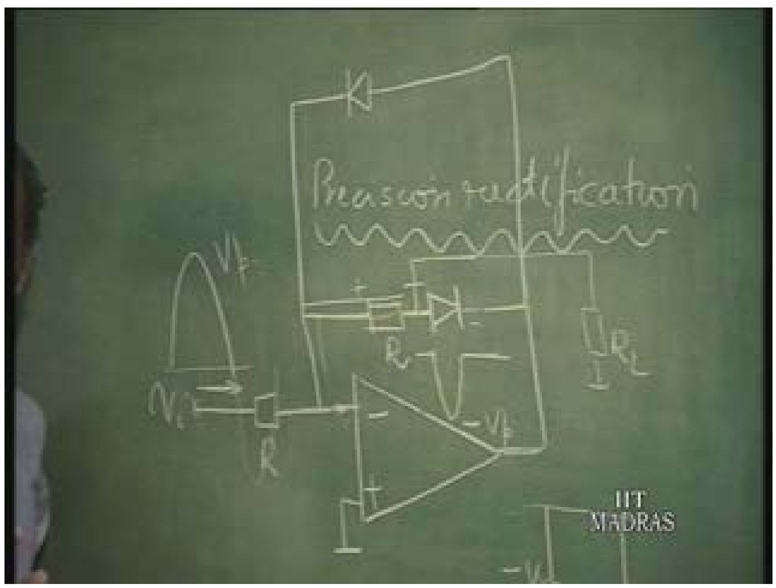

So, a half wave rectifier for a precision diode requires two diodes with op-amp: one to maintain the negative half of the wave form when this is going positive; other to maintain during the other cycle, the voltage equal to zero. So, this will maintain the virtual ground. That is, negative feedback will come into picture even when the voltage is going negative; and therefore, the op-amp will still function now. But, this is the wave form. This is the output wave form at the op-amp. The op-amp is conducting on both the cycles. That is necessary so that the negative feedback is there.

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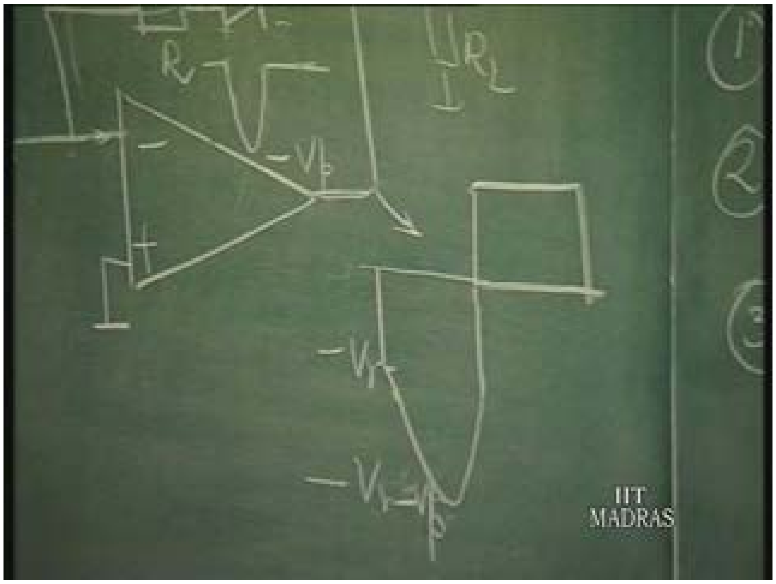

Only when it is going positive, the output is coming as negative at this point. So, this is the point at which output is going to be taken. So, please remember that both diodes are necessary. If it is positive half you want to select, you will invert the diode here and put the other diode in the other direction. So, this is the circuit for a half wave rectifier, precision rectifier.

You can use this therefore as your rectifier for the circuit that we have mentioned. Put a low pass filter here. After this, we put a low pass filter R l C l and then put the comparator.

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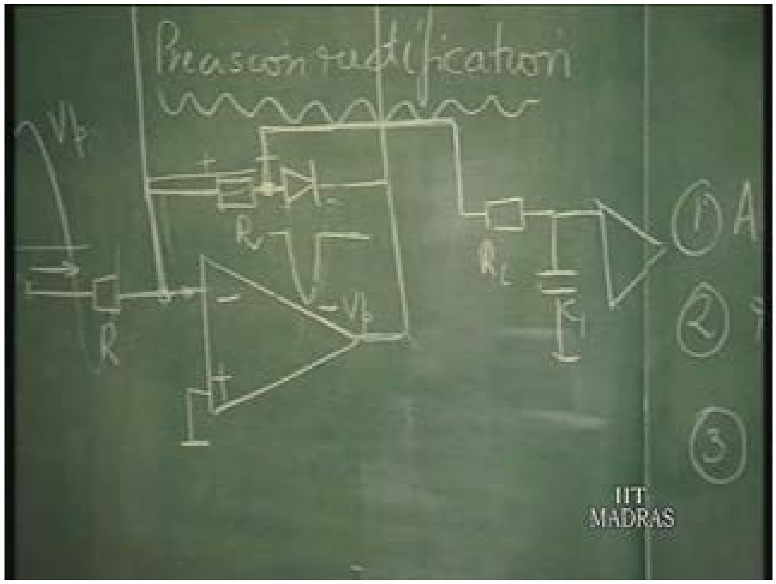

Please see here that, now I have obtained the negative voltage as the peak. So, it will be...this voltage will be minus V p divided by pi. So, I can compare it with...again with V reference which is negative because this voltage will always be negative. So, I have to have V reference which is negative and appropriately apply the feedback here so that this system now functions satisfactorily. Is it clear?

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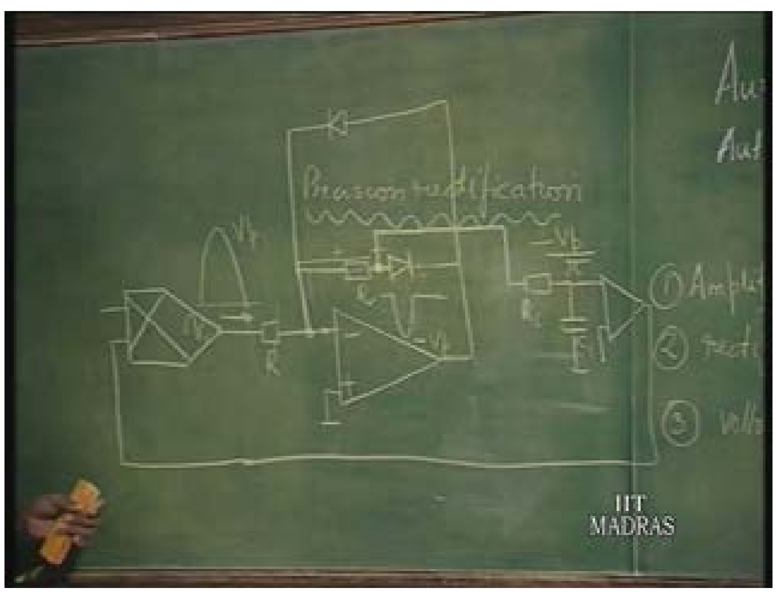

So, I would leave it as an exercise for you to find out what should be the polarity here; should it be negative or positive so that the entire feedback system becomes negative feedback system. How do you find out that? Assume that this amplitude is growing...this becomes more negative than this. It has been compared with negative voltage. If it becomes more negative, what should happen to this voltage such that the gain is reduced?

Now again, here the voltage can be negative or positive. For both negative as well as positive, this will work as a voltage controlled amplifier; but one case there is a phase shift of 180 degree, in other case there is no phase shift. That is the only difference. As far as the phase shift is concerned for amplitude, it does not matter at all. So, the phase shift of this is of no consequence for the amplitude here.

But, if you decide that this will work for negative only, then correspondingly you have to select the polarity here. If you decide that this shall work for positive only, then correspondingly this polarity will be different for negative feedback. So, this is some point that you should bear in mind.

Let me do it only for one polarity now. Let us assume that this is working only for positive; in which case, this becomes more negative than this reference, let us say, this minus V reference. This is more negative than this and I am putting it here positive, let us say. This becomes more negative. That means this is going to become more negative or it will go to negative saturation. This is going to more negative but I am assuming that it is working for positive voltage. That means it becomes less positive. That means gain reduces.

So, this is negative feedback here. If I am assuming that it is working for negative voltage, then the polarity will be opposite. Is this clear? So this arrangement, you can see that this capacitor has to be very huge because R c should be much greater than T.

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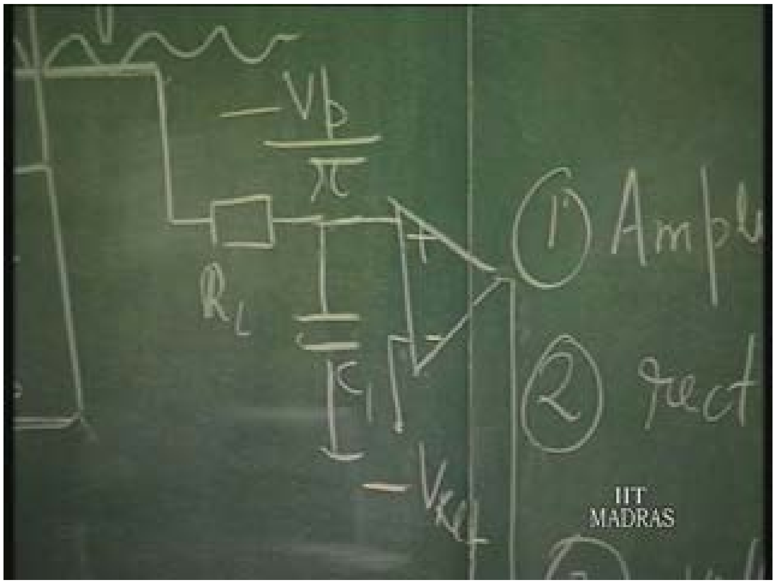

So, you can make it work actually by putting here negative and positive and assuming that this is working only for negative voltage here. So, then I can put this capacitor as a feedback capacitor. This is called Miller effect. That also I have discussed earlier. So, this capacitor appears as a huge capacitor at this end point. That is possible only if this is negative because this tries to give negative feedback. So, this controller now becomes this way.

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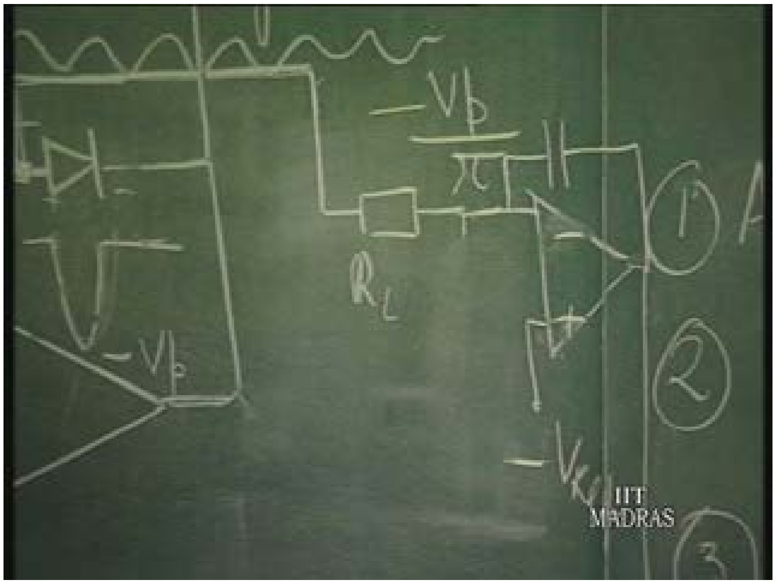

Another variation of this is, instead of using minus V reference and connecting it here, I can remove this and connect it here and make this plus V reference and this also R l.

So, if now this is giving you a current, I mean taking a current which is minus V p by pi divided by R, then I have to pump in the same current so that this voltage is maintained at zero. This is called current comparator. The other one is called voltage comparator. Here, the voltages are compared. Here, the two currents are compared so that this voltage is maintained at zero. Both of these things work satisfactorily without any problem but it is more common to use this kind of thing. You can see that this uses what is called an integrator here; and this according to the control system people is called integral control system, integral control system.

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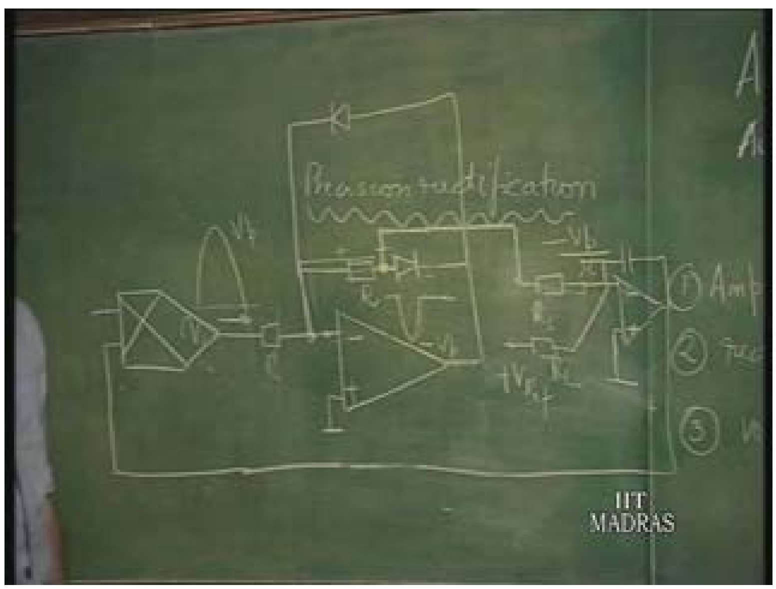

So, the error, steady state error is supposed to be zero in an integral control system even though it is very slow. It is a slow control system, but steady state error is zero. That means what is the amplitude of stabilization? V p by pi becomes equal to V reference. So, V p is equal to pi into V reference. I can therefore vary V reference and adjust it to any voltage I want, output.

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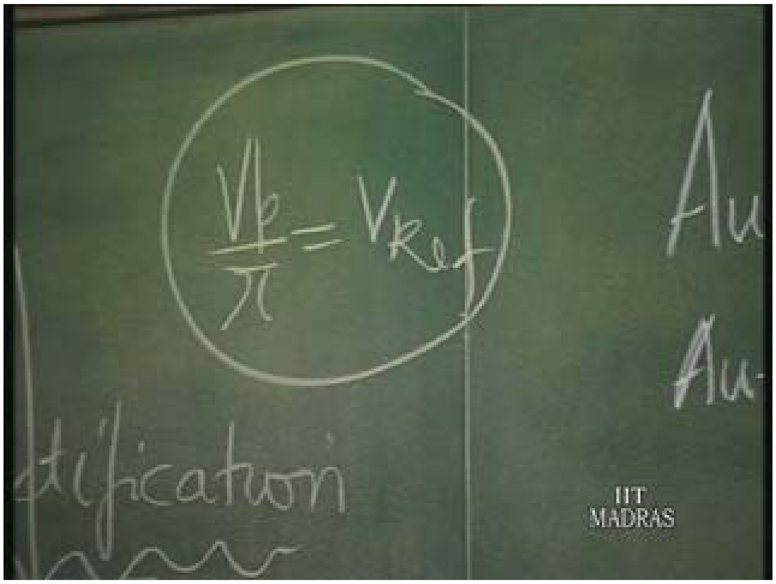

So, this control system is very popular in most of the so called proportional integral control system. It is called proportional integral differential. If it is...instead of integrator I use a differentiator, it is called differential; but normally, these are all used only for improving the transient response of the...this thing. It is basically proportional because an amplifier is used for comparing: integral, if a capacitor is used; differentiate, if a differentiator is used. Its normal control system is called P I D controller; this is called integral control system.

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So, take Example 26. Design an A G C / A V C system using a precision multiplier to keep the output peak amplitude at 100 millivolts.

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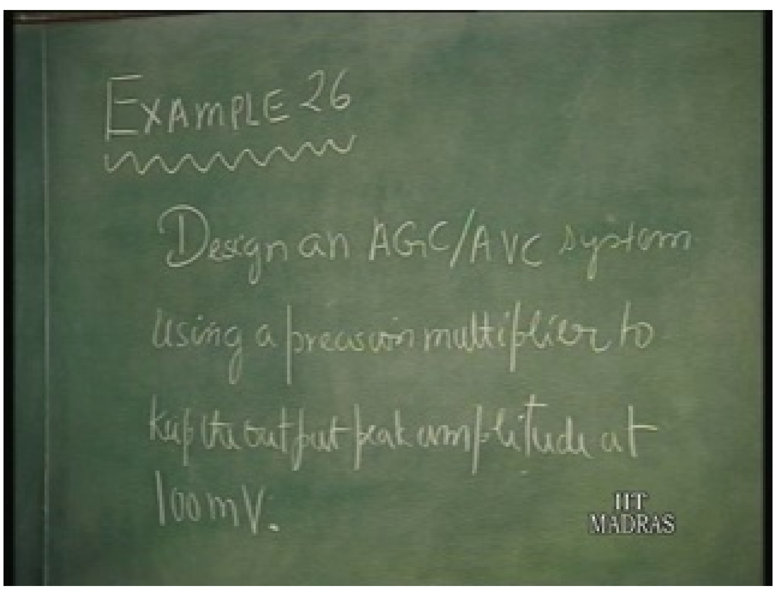

The fact that I have chosen 100 millivolts immediately tells us that we must necessarily use a precision rectifier. That is why I have chosen this example.

So straightaway, let us put the precision rectifier. I am going to take a sort of different configuration here. Instead of...so the negative going thing, I will take the positive going thing. So, you connect this kind of structure, R, R, when you have a wave form like this going here, going up to V p, this particular thing is going to conduct only when this goes negative. So, this will be positive and that will be negative. So, output here if you take, this will be going positive, zero, positive, zero, positive.

So, this is the kind of output you get out of this; and if I therefore put a low pass filter here, you will get V p by pi.

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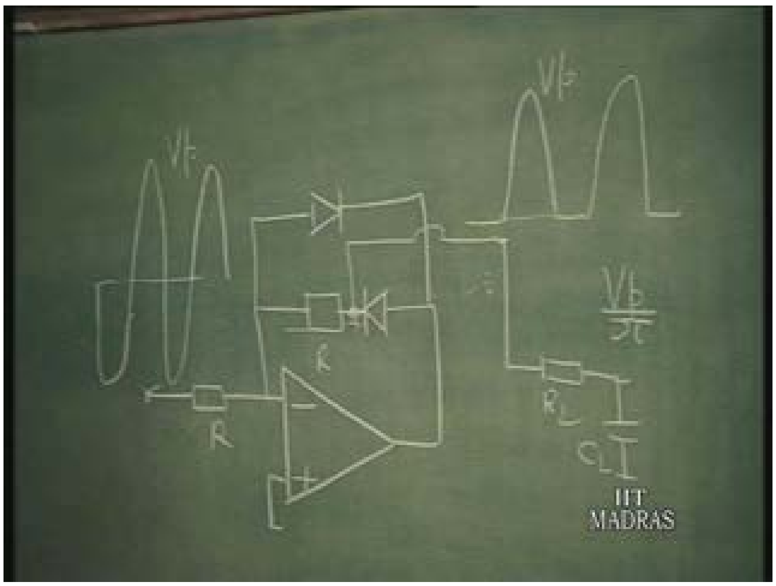

So, I now compare this again with, let us say, I will put this and put minus V reference here and R L here. Now C L is going to be put now... Between this and this, this shall be negative. I want to prove that this shall work now for a certain polarity of voltage as negative feedback.

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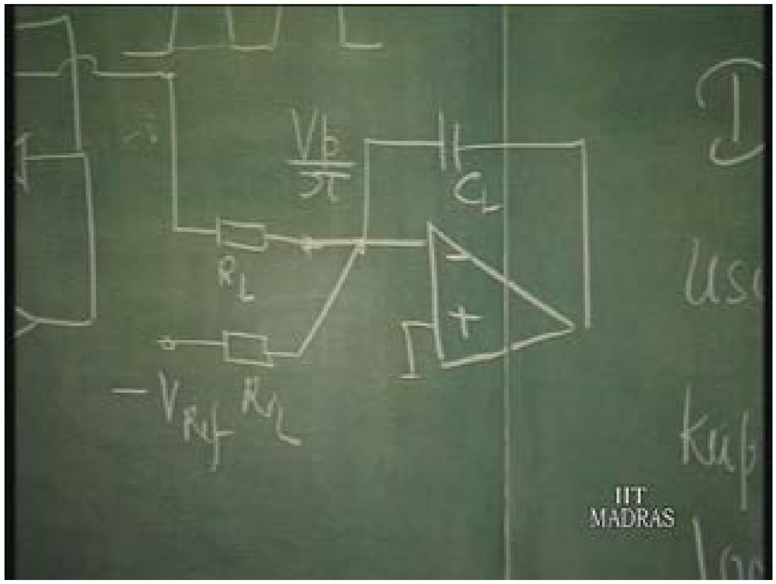

Let us consider this. So, this is the V i which is V p i sin Omega t. So here, we have V c V p i sin Omega t divided by 10 as the output. The V c can be positive or negative. We want to see for which one it is negative feedback. That is all, because all the other things are frozen here. So, we have now the choice to see whether it is positive feedback or negative feedback, for positive or negative voltage. Let us see.

So, this output is what is coming here. This is rectified and this is what is coming here. It is compared with this and when this current is the same as this current, there is steady state reached. That means V reference into...V reference is equal to V p by pi, if these resistors are the same.

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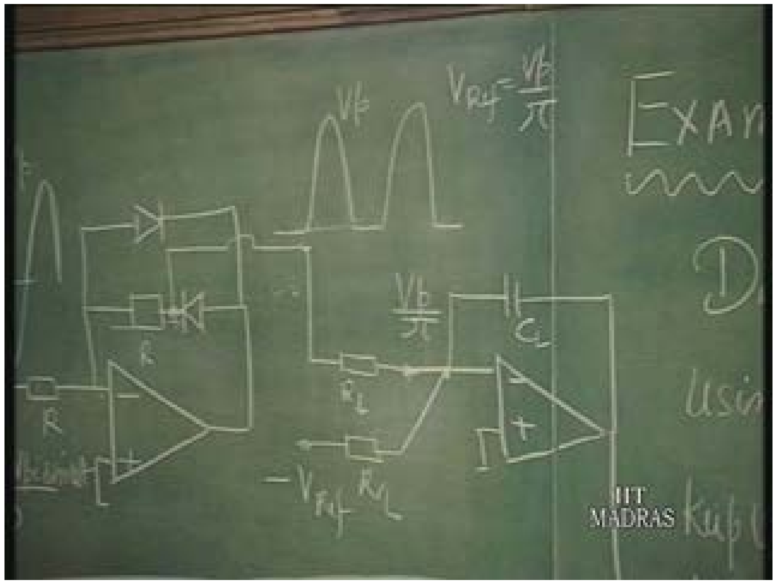

So, in our case, we want this peak to be equal to 100 millivolts. So, V p is equal to 100 millivolts. So, that is equal to pi into V reference. So, we have V reference equal to 100 millivolts divided by pi millivolt. How much? 31 point 8. So, that is the V reference that you have to connect here in order to make the peak voltage equal to 100 millivolts, constant.

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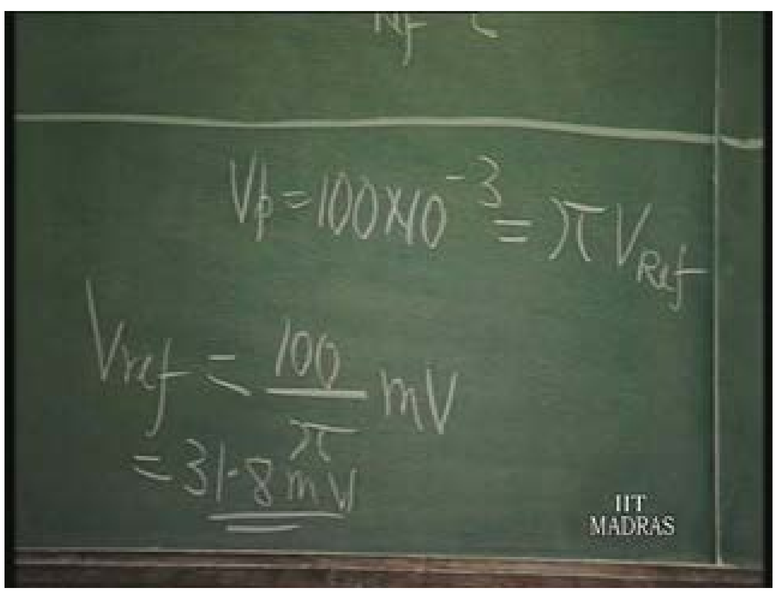

Now, if this becomes more than this 31point 8, then this is going more positive. When this goes more positive, this current is going to be injected here more into the capacitor and this will go more negative. This will go more negative. That means let us assume that this is positive, this becomes less positive; and therefore, the gain reduces. So, this is negative feedback for V c, which is positive.

So, I have to prevent it from ever going negative. This should not go negative. So, what should I do? That is done by introducing a diode like this. What will it do? The moment this voltage tries to go to negative, this diode will conduct and this will make it climb down to zero. So, this has come down to zero.

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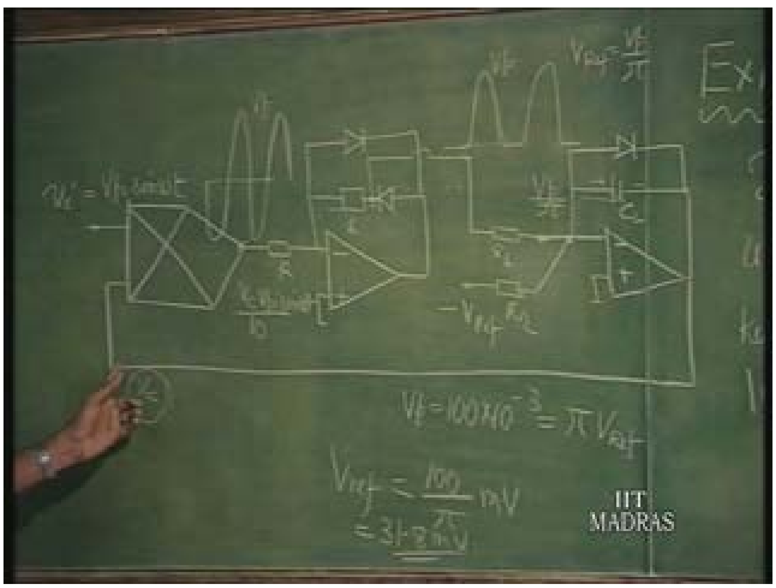

So, this is the technique of sort of preventing it from going negative and causing us problem. Now, if it has climbed down to zero ideally, then there is some problem. There is no gain. So, there is no gain at all here. That means the output will not come at the output of the multiplier. So, we do not want it to be stuck down at that particular situation.

So now, let... is that the problem? To start with, let us say this particular thing, input is not applied or input is very low. At that time, there is nothing coming here. This is zero. Only V...minus V reference is applied to this. So, minus V reference apply...is applied to minus... So, this will go to positive saturation. If that is plus 10 volts, let us say, then this has the highest gain at that time. So, output will come. So, there is no question of this ever going to negative here as long as this is applied. So this, even accidental situation of this going to negative saturation is prevented by this. That is all.

But to start with, this has good starting point because at the starting point, this amplifier is giving the highest gain. That could be when the input is not there or input is too low. Both the situations, it should be kept in waiting for the input to come. So, for every control circuit, there is what is called starting point to be verified, whether it is starting properly or not.

So, when the control circuit is not functioning, there should be proper starting voltage applied here. So, in that situation, this proper starting voltage for this circuit is plus 10 volts. So, supply voltage is plus minus 10 volts, let us say. So this has gone to that plus 10 volts and maintained the highest gain and then output appears that is compared and this gain is reduced.

So, this whole circuit is going to satisfactorily function and all these additional components are necessary. In fact, if these two resistances are different, then what you have to do is V reference divided by, let us say R 2 we will put it, and this is R 1. So, V reference by R 2 should be equal to V p by pi divided by R 1, with of course a minus sign there.

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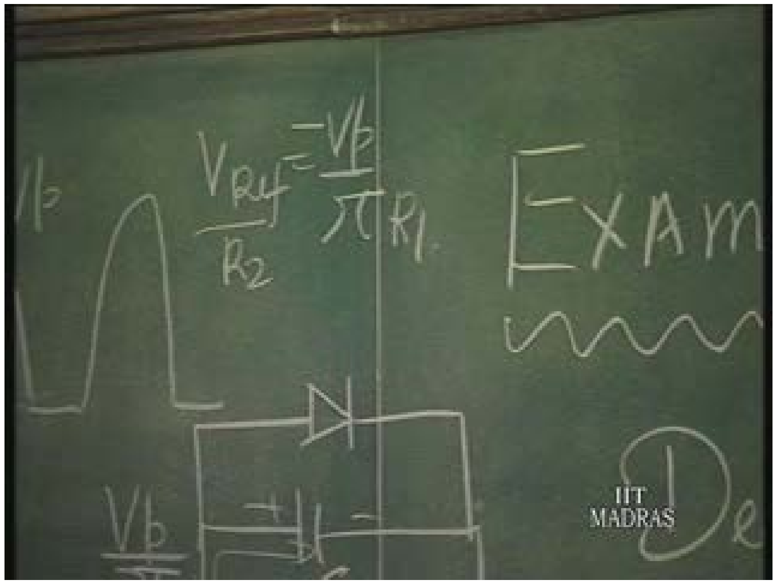

So, minus V reference divided by R 2 plus V p by pi divided by R 1 is equal to zero. So, this is the current equation. In general therefore, this could be made different. R 2 can be made different from R 1. Let us say this equation is what is important.

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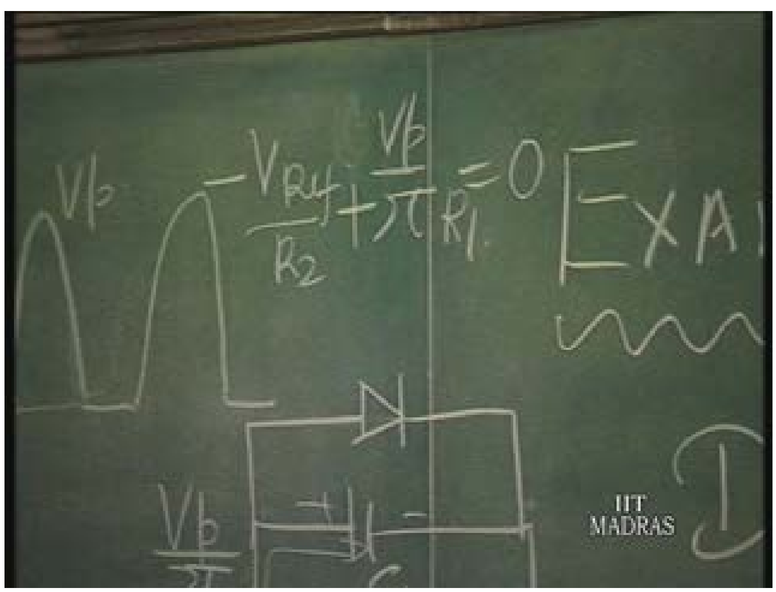

So, please remember that this time constant has to be pretty huge in this case. Otherwise, this whole loop may go into oscillation. There is one possibility so that this time constant is 1, which is made dominant pole in this whole control circuit. Like, for the operation amplifier, we have fixed up a dominant pole, if this capacitance and resistance time constant is too small and it becomes comparable with the other time constants, this whole system may become a third order system and it may go into oscillation. What does it mean? This V c is not going to be maintained a constant D C. This itself will change at a certain frequency which is called the natural frequency of this whole system.

So, if you find an oscillation here, it is... see, simply because you have chosen too low a value of capacitor... So, that kind of frequency in stability can occur in this control system also. This has nothing to do with positive feedback. This has been made negative feedback. Under negative feedback, this whole system may become a third order system; that has to be prevented.

If it becomes a third order system and the phase shift of this entire thing becomes, let us say 180 degrees when the magnitude of the loop gain is still greater than 1, it is becoming unstable and this oscillates at the natural frequency of the system. So, instead of getting A G C, you will get an amplitude modulated output because there is a carrier here; and that amplitude modulation frequency corresponds to the natural frequency of the system.

If you find that, then you must change the value to a higher value of the capacitor. This is another important point in the design of such systems. Now, as far as oscillator is concerned, this can form part of the oscillator system like this.

For example, a wien bridge oscillator. So, instead of using a sort of resistive feedback, I can put a multiplier in the negative feedback because this feedback factor is always less than 1. So, the multiplier is put in the feedback part of the sort of non-inverting amplifier. Then, what will be the gain? This actually is V c and this is V c by 10 into V naught, V naught.

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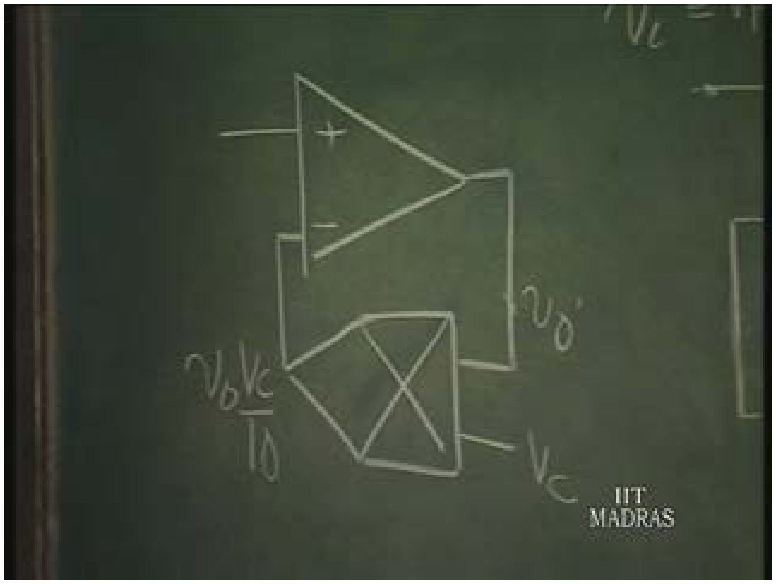

So, Beta factor is nothing but V c by 10 or gain of this amplifier is 10 by V c. So, by controlling V c, I can control the gain. So, this particular thing therefore can be used with a wien bridge oscillator like this R, C, R, C and then positive feedback. So, it is supposed to oscillate at Omega equal to 1 over R C. So, this particular thing has Omega equal to 1 over R C and gain is equal to 10 over V c because Beta is V c over 10; and therefore initially, the gain should be such that it is able to oscillate.

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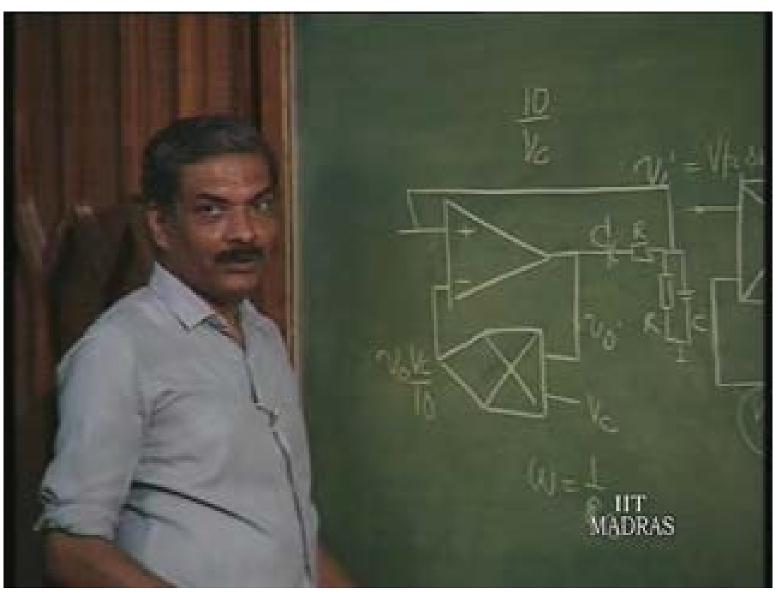

So, we have to fix V c such that the gain is greater than, let us say 3, that is needed for this. So, V c should be such that gain is greater than 3; or V c should be, in fact less than 3 point 33. So, if V c is kept less than 3 point 33, it will start oscillating. Then at the required amplitude of oscillation, V c will be exactly equal to 3 point 33.

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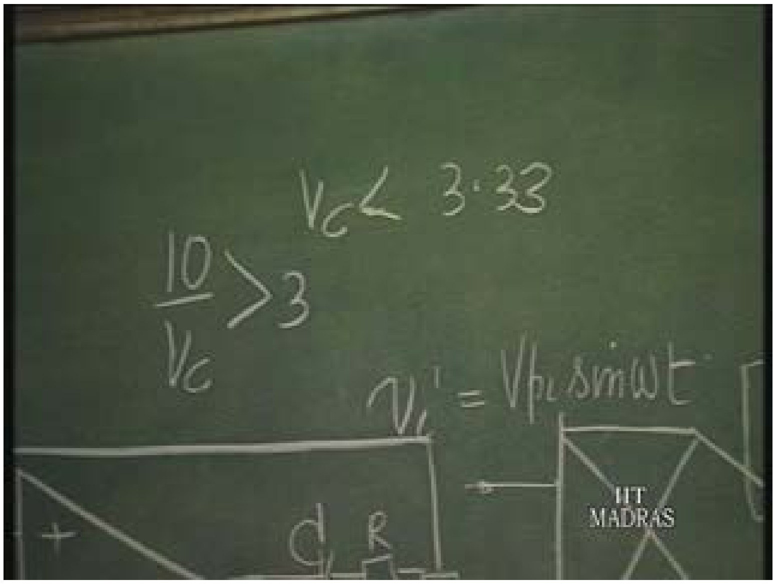

That is what such a system will control. In fact, if you just therefore apply this output to this kind of rectifier and the control voltage here, this is what is going to be happening for the oscillator also. So, you can also control the amplitude of oscillation of oscillator in this manner. The only difference is: here, external input is given; here, the input is generated from within itself. For you to assure that input is generated, you must have the gain of this greater than 3 so the amplitude is growing.

Then the control voltage will be exactly equal to 3 point 33 at the required amplitude of oscillation; whatever it be if you put exactly similar system in this case. So, as far as amplitude stabilization of oscillator is concerned, it is just like A G C. Only thing is gain need not vary by a wide margin here, you can see. It should be just greater than 3 or this V c should be just less than 3 point 33.

So, it can be initially at 3 point 3 and change to 3 point 33 at the required amplitude of oscillation. So, the gain need not vary widely in this case. So, you need not use such sophisticated precision rectifier; and you need not use a precision multiplier for this purpose. You can just use an amplifier whose gain is controlled by a FET because the gain variation is very low - 3 point 3 to 3 point 33; whereas in the case of an A G C system, gain has to vary from a low value to a high value because we do not know how much the signal varies. So, these are the differences in design of such A G C systems.