Electronics for Analog Signal Processing - I
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Lecture - 6
Full Wave Rectifier
and
Peak Detector

In the last class, we had seen how a half wave rectifier peak detector functions and how we can design a power supply, dc power supply, using such a scheme. Let us see how this half wave rectifier or peak detector can be converted to a full wave by using a center tapped transformer.

This, we had mentioned earlier itself. If I use a center tapped transformer, when this voltage goes positive and this induces similar voltage here, this diode conducts and pumps charge into the capacitor in this direction; develops a voltage v naught in this fashion.

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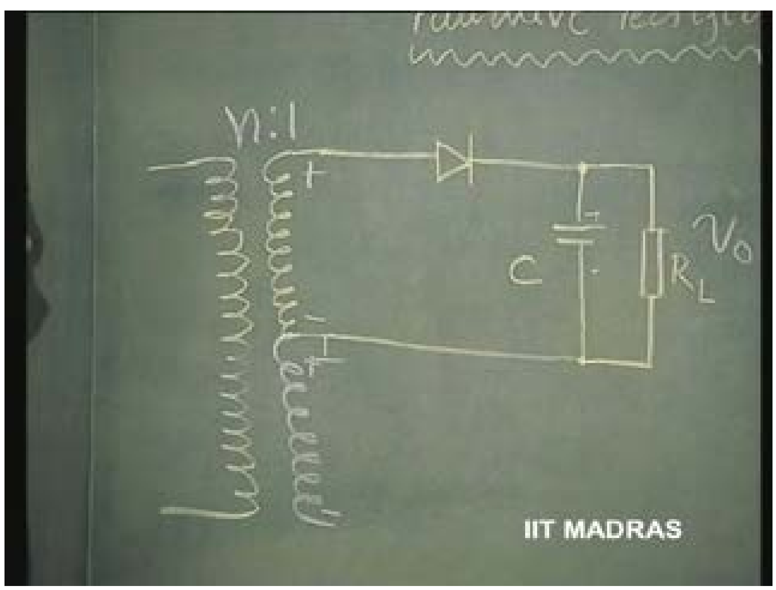

When we have the voltage changing polarity here; this is minus, this is plus; this becomes minus, this plus. At that point of time, this diode is not conducting; and, we would like to have another diode put here so that it is going to pump current in the same direction so as to replenish the charge that is now lost.

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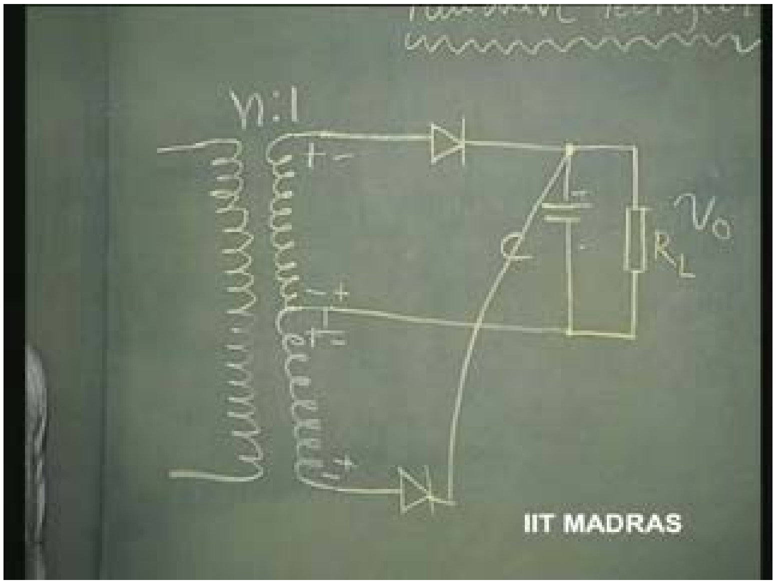

Now, charge is going to be lost now only during T by 2 period as you can readily see as against T that was happening earlier with our half wave rectifier scheme. In the case of half wave rectifier, this portion of the waveform is removed; and therefore, if the charge that is lost by the capacitor is to be replenished, it has to be done after the next positive cycle appears.

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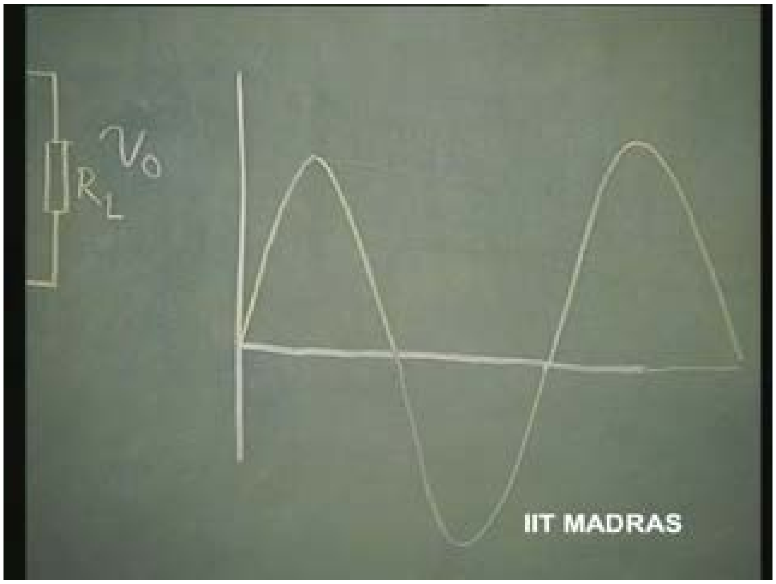

Therefore, the capacitor which is going to discharge will keep on discharging up to this point. So, the peak to peak ripple is going to be greater in the half wave rectifier situation than in the current situation, where, I am now going to make another diode conduct. This diode is going to conduct when this is minus, plus, minus, plus. Therefore, it is going to replenish the charge that is already lost by the capacitor during lesser time than earlier.

So, the capacitor is going to discharge now in the following fashion. It is going to charge again, discharge, charge, discharge. So, earlier, it had to wait up to time T; now, it has to wait only up to T by 2.

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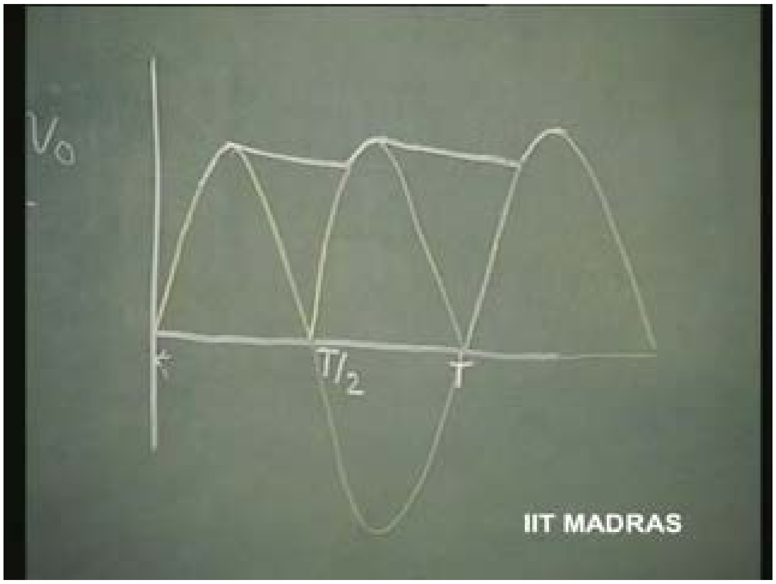

So, if the discharge rate is assumed to be linear, very low, because we have chosen the capacitor to be very large; if this discharge rate is very low, then, we can see that the V p into, V p is the voltage here, let us say and n is to 1. So, this will become V p by n sin omega t and this also is V p by n sin omega t, center tapped transformer. So, this becomes V p by n 1 minus t by RC. This is the rate at which it is going to discharge; and the time taken T for it to discharge and then restart recharging is going to be approximately equal to T by 2; not exactly T by 2. It is going to be approximately equal to T by 2.

So, we can say that the peak to peak ripple, in this case, of the full wave rectifier, is going to get reduced by a certain extent. That is, V p divided by n. So, this is going to be V p by n into T by 2 RL C.

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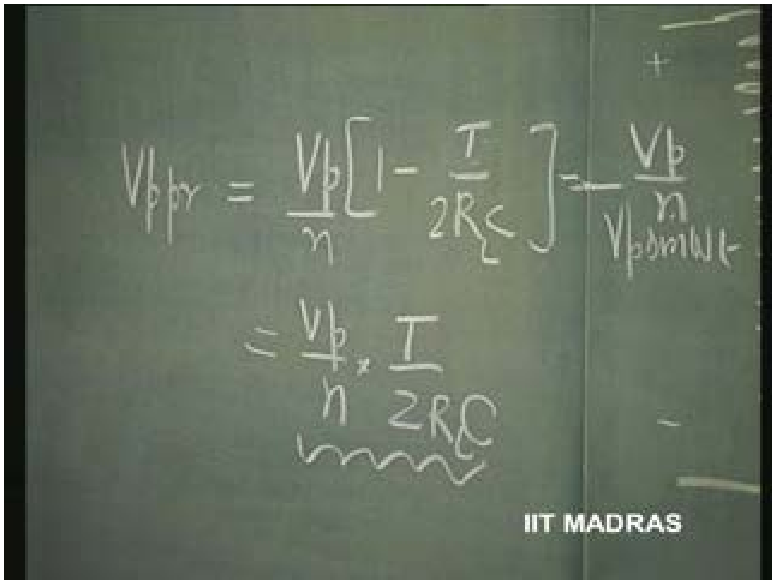

So, compare this with the result that we got earlier. These expressions remain the same except for this factor of 2 here. So, it is reduced by a factor of half. So, we can therefore use this kind of scheme for obtaining a reduced ripple.

The average voltage remains essentially the same. It is going to be v naught. V dc is going to be very nearly equal to V peak divided by n as before. There is no change in that; except that, we are using a center tapped transformer and an additional diode in order to reduce the ripple for the same load by a factor of 2.

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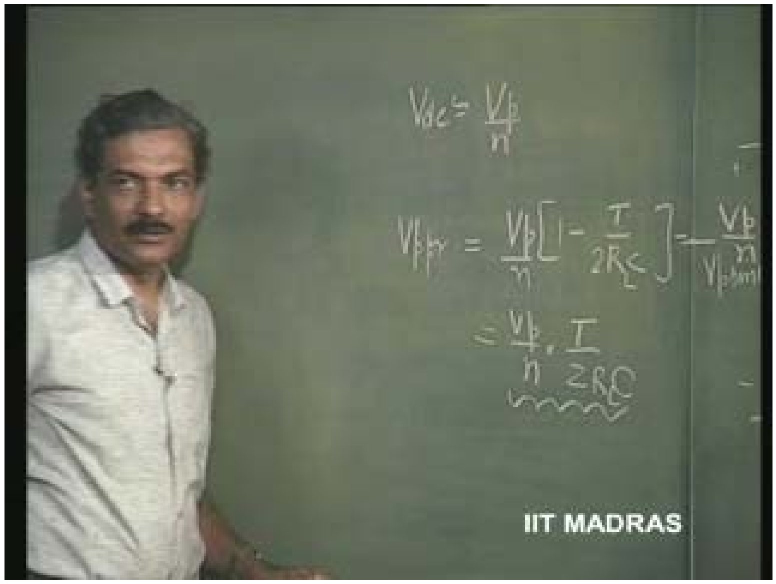

So, same scheme of full wave rectification can be done not necessarily by using a center tapped transformer; by using an ordinary transformer with a turns ratio of n is to 1. This, we can do, by using what is called as bridge rectifier or we will call this our peak detector.

Let us see how a transformer with a turns ratio equal to n is to 1 with same excitation, let us say, V p sin omega t. Here therefore, it is going to be V p by n. Now, what is going to be done by us is, we use a diode and connect it to a load; but instead of completing it like this, we will put a diode here in the opposite direction, so that, the circuit is complete. For the voltage which is, plus here and minus here, the current is going to flow in this direction.

So, instead of one diode and a resistance as earlier, we will put two diodes in series. Both of it will be biased in the same direction. So, when this voltage is positive with respect to this, both the diodes will conduct. So, the load RL is connected here and the capacitor is put as before in this manner.

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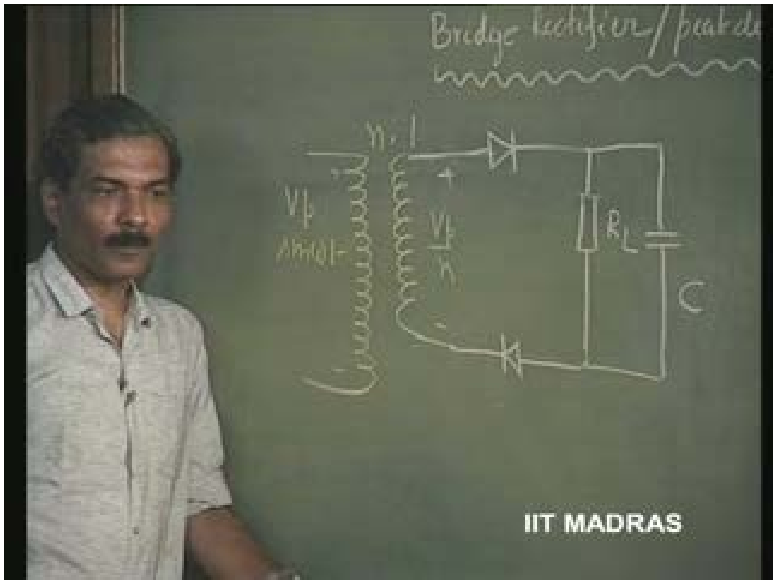

Now what happens? The idea now is slightly different. When this becomes positive and this becomes negative, for the next cycle, that is, for the next negative half of the cycle, we want the direction of charging of the capacitor or current in the load to remain the same.

So, we have to now present the diode in such a manner; for this positive, the diode still conducts and therefore it will now carry current in this direction; but voltage is presented in the reverse manner using a pair of diodes which will conduct this way; look at it, plus here, so, it will conduct current in this direction; go to minus this way.

So, for one half of the cycle, the path of current will be this, this and this; for the other half, the current path is going to be this; and here, it is going to be same, and current is going to flow in this direction.

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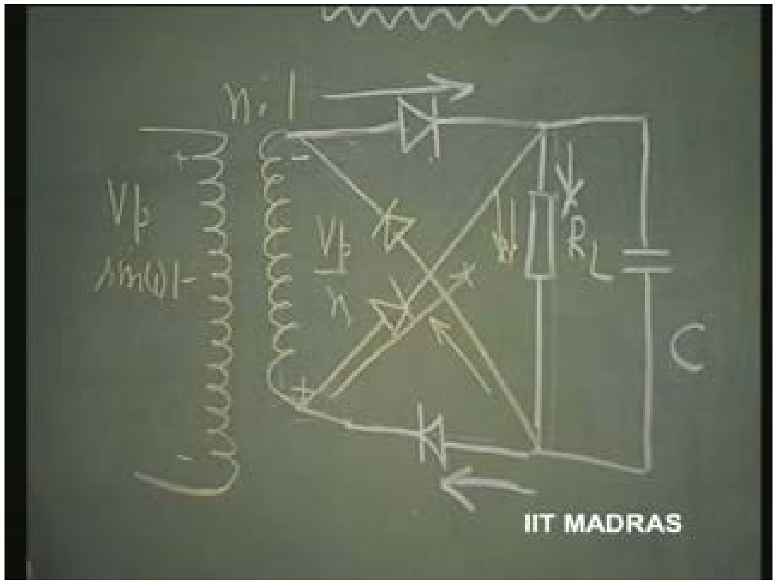

So, this is the arrangement of the bridge. Therefore, instead of using a center tapped transformer, we are turning the transformer voltage in the same direction by using the diode switches, which will get switched on by voltage now. So, we can therefore use four diodes instead of the two diodes and no center tapped transformer, and get the same result.

The disadvantage of this obviously is that the transformer primary cannot be grounded, if you want a grounded supply, DC supply, as far as the output is concerned. So, the transformer primary cannot be grounded; whereas here, the transformer secondary is going to be grounded at the center tapped. Transformer primary can be grounded anywhere you want; transformer transformer secondary cannot be grounded.

So, these two are the rectifiers which externally give you the same output voltage with the same amount of ripple. Another point to be noted as far as the difference in performance of this with that of the half wave rectifier is that the frequency of the ripple itself is going to be double the frequency of the incoming waveform.

If the incoming waveform has 50 hertz, then, the output waveform ripple has only 100 hertz as the ripple frequency. In the case of the half wave rectifier, this is going to be 50 hertz itself. So, this is double the frequency and it is reduced. So, this is the difference between a full wave rectifier and a half wave rectifier.

Now, in the next session, we will work out an example of a full wave rectifier in order to design a given supply of a certain output voltage delivering a certain amount of current on to a load.

Now in order to see whether we have understood the concepts involved in designing the so called power supply or the battery eliminator, it is popularly called, let us take an example.

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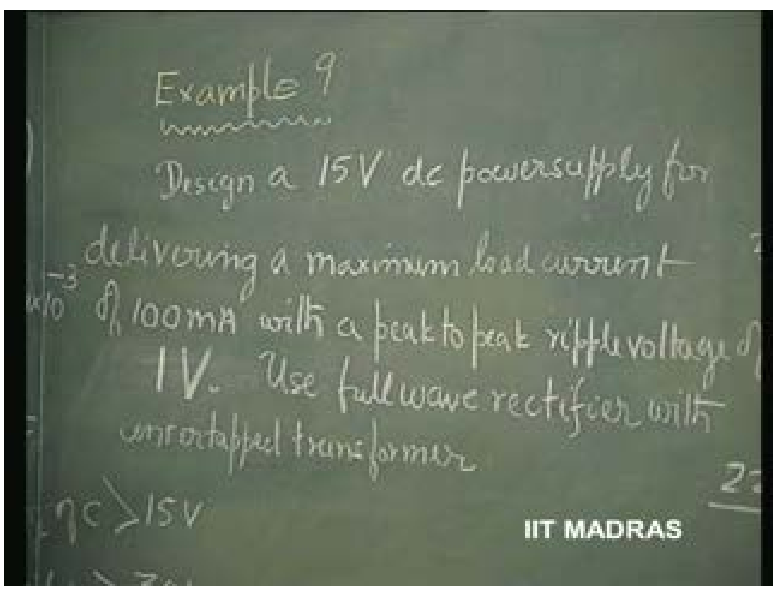

Design a 15 volts dc power supply for delivering a maximum load current; this is how it is normally given, of 100 milliamperes with a peak to peak ripple voltage of 1 volt, peak to peak ripple voltage of 1 volt. Use full wave rectifier with center tapped transformer.

So, let us start solving the problem here. This is the circuit arrangement that we have to design; a center tapped transformer with a turns ratio n is to 1 as before, with two diodes connected to RL and C.

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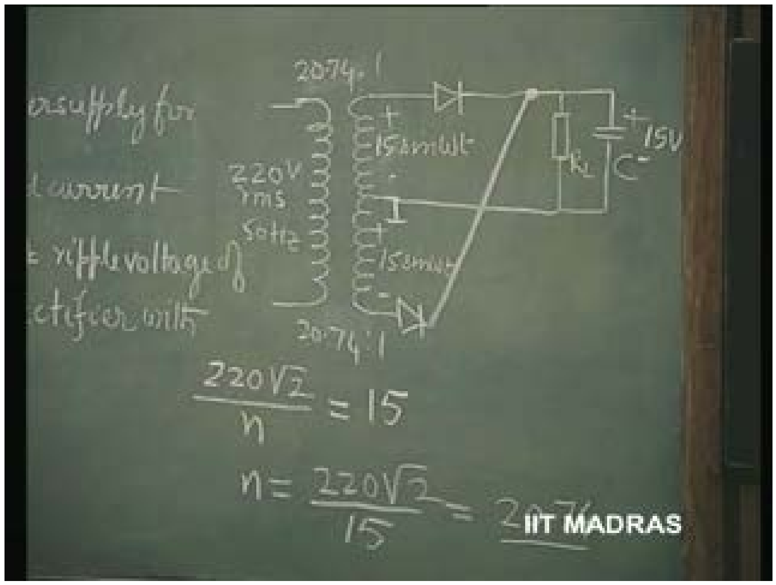

It is required that we should develop a 15 volts supply here, which means that, the voltage here should be 15 sin omega t so that this peak detector gets charged to 15 volts; whether it is full wave or half wave, it hardly matters in this aspect. So, this is going to be 15 sin omega t, this is 220 volts rms, which means, 220 volts root 2 sin omega t. So, we have here, 220 volts root 2 divided by 15 as the turns ratio.

220 volts root 2 divided by n is the secondary peak voltage and that should be made equal to 15. In our design therefore, n comes out as 220 root 2 divided by 15, which, is 20 point 74. So, we have solved one part of design. That means, that means we have to use a center tapped transformer with a turns ratio of 20 point 74 is to 1, 20 point 74 is to 1. So, this is the aspect of the transformer that is taken care of.

Let us now go to the other aspect. We have been told that the peak to peak ripple should be maintained at 1 volt. So, this is 1 volt and we know that peak to peak ripple in the case of a full wave rectifier, which we have already worked out is, V p divided by RL C into T by 2.

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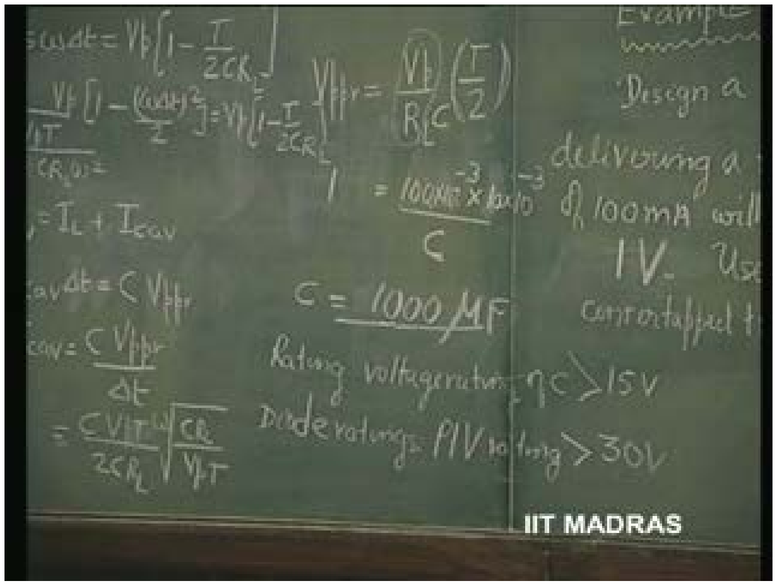

V p is the peak voltage, which is 15 volts. V p by RL is the maximum current, that is, DC current that is likely to. In this particular problem, it has been given that maximum load current is 100 milliamperes with a supply of 15 volts; which means, RL is such that V p by RL takes on a maximum value of 100 milliamperes. So, 100 into 10 to power minus 3 amperes, this portion is substituted here; 100 into 10 to power minus 3; that is, 100 milliamperes into T by 2.

T is 20 milliseconds, we know; 50 hertz means 20 milliseconds. T by 2 is 10 milliseconds and C should be put in such a manner that this value is 1 volt. So, V p by RL is 100 milliamperes, T by 2 is 10 milliseconds, divided by C should become equal to 1 volt; so, from which, we get the value of C as 1000 microfarad. So these are available. These capacitors are however big in size; and, we should know the rate, rating of, voltage rating of these capacitors. Rating voltage for the capacitor should be anything greater than 15 volts, because it has to sustain only 15 volts across it. Any voltage greater than 15 volts can serve our purpose.

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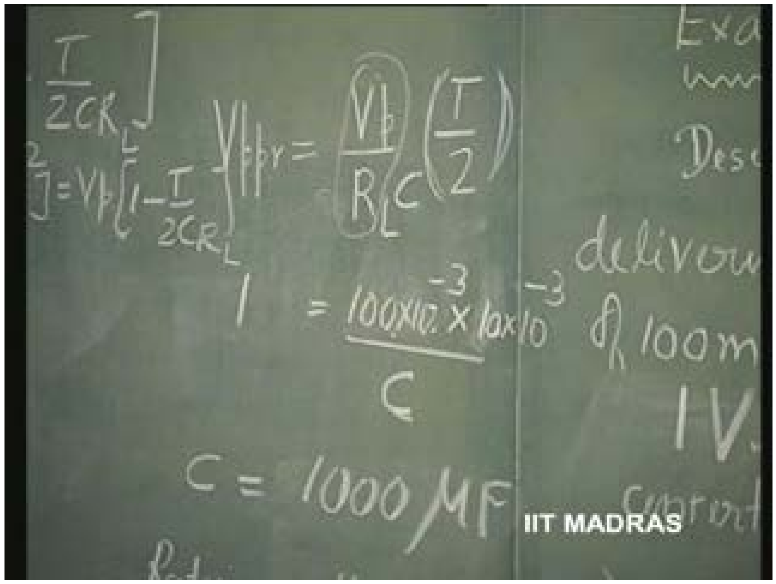

Now, diode rating - this is another important... We are using capacitors, diodes and transformers. So, diode ratings; in the diode, there is a rating called peak inverse voltage rating.

I told you that a rectifier diode breaks down at a certain voltage. So, this peak inverse voltage rating, in this case, should be greater than 30 volts because, you see here, this voltage can at most become equal to 15 volts in this direction as well as in the opposite direction.

But this voltage remains at all times at 15 volts; so, when this becomes minus here and plus here, total of reverse bias of 30 volts is there to sustain, either this or this. Whenever these diodes are not conducting, they are supposed to sustain a total voltage of 30 volts.

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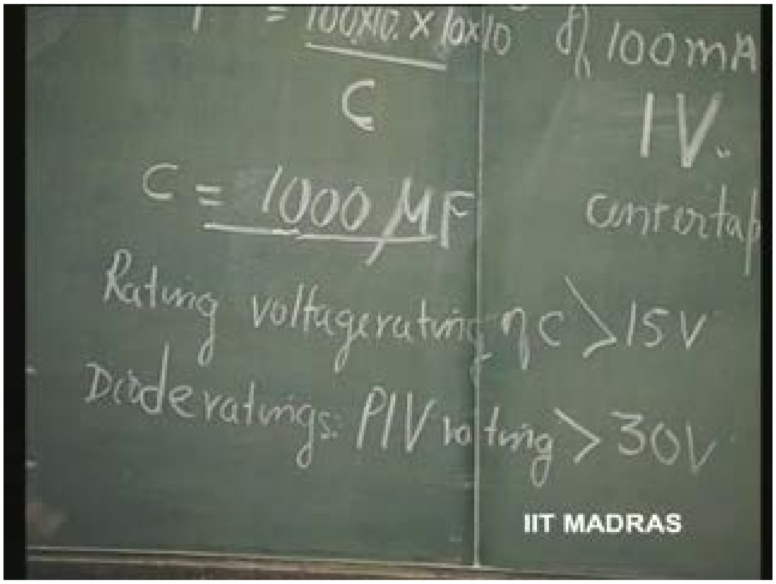

This is the case whether it is a full wave rectifier or a half wave rectifier, because, in the case of half wave rectifier, this portion will not be there; even then, this is going to reverse its polarity, and this is going to be sustained at 15 volts. Therefore, the diode rating should be the same whether it is a full wave rectifier or a half wave rectifier, when we use a peak detector.

So, peak inverse voltage rating should be greater than 30 volts. Next rating is very important - diode current rating, because, most of these diodes and this same current is likely to flow in the transformer also. So, the transformer also carries this DC current. Let us see how this capacitor is getting charged through the diode whenever it is getting connected to the capacitor.

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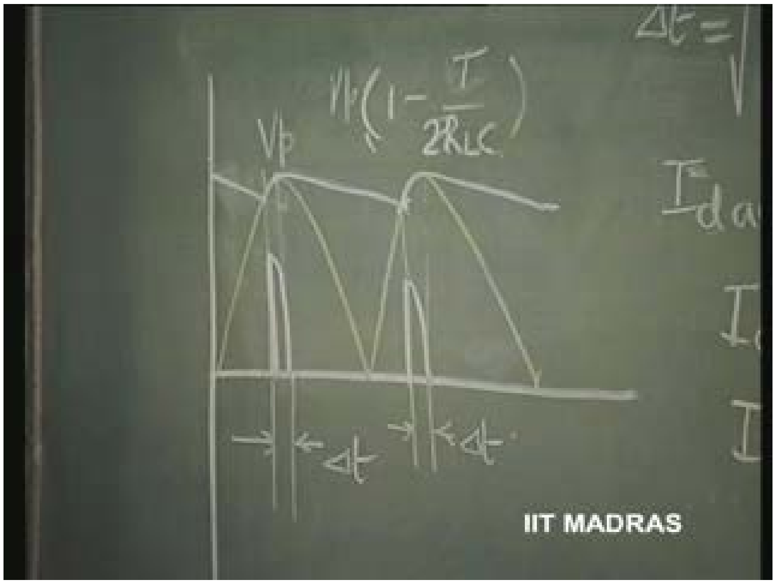

So, let us see. This waveform V p is getting reduced linearly in the following manner. V p into 1 minus T by C RL; that is the way it is falling, V p into 1 minus T by RL C. At this point, where it is very nearly equal to T by 2, the value of this is given approximately by this. That we have noted there earlier, while finding out the peak to peak ripple. So, we know this value; so, this value is known.

At that particular point, please remember that the diode is conducting. So, the diode is conducting, capacitor is getting charged and the diode is also delivering the required DC current now to the load. So, we have the DC current which we will call as I L, which is the DC current, and the capacitor current, which we will call as this; if this voltage is V at any instant of time, the voltage, the current through the capacitor is C dv by dt.

You know this relationship where the capacitor value is C, the voltage across the capacitor being V, the current through the capacitor is C dv by dt. So, the average, the instantaneous value of current is going to be the DC current, which is actually speaking, varying also slightly. It is V by RL and since V is very nearly equal to V p, we can assume it to be constant. So, this is going to be very nearly equal to V p by RL, whereas, dv by dt keeps changing.

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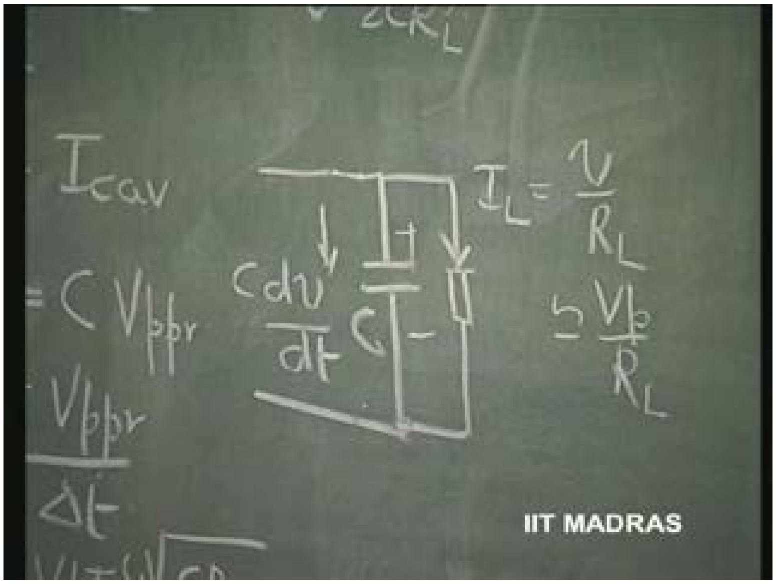

We can look at this; dv by dt is highest at this point and keeps on reducing to zero as we go up. So, the charging current of the capacitor starts with the peak value at this point and comes to zero, the moment, the voltage at the input becomes less than the voltage at the output. The capacitor, the diode gets disconnected and the discharge is going on like this, very slowly, where as the input voltage is falling faster.

So, the moment that happens, the current in the diode has become equal to zero, because the capacitor is fully charged now. So, this is the process of charging of the capacitor.

So, current is going to be flowing in this circuit, that is, the diode circuit, whenever the capacitor is getting connected to the input and it is going from a maximum to zero. We would like to know what the average value of this current is. Assuming that this is some what a triangular waveform, we can say that if we know the peak, since it is going to zero, the average is going to be, peak divided by 2.

That is the average current in the diode, we can estimate. Now, that time interval for which the diode current is flowing, let us put it as Delta t, it is made very small. So, you can imagine that the entire charge that is lost in the capacitor is replenished during this time interval, which is Delta t. The capacitor is made very large; then, the discharge takes place very slowly and the charge that is lost is small. But, time taken by the capacitor to replenish the charge is extremely small; so you must have now large currents flowing in the circuit. That is why this current may become much greater than the DC current that is flowing in that. So, the diode might have to carry higher average current than the average current that is flowing in the load.

So, let us investigate this. So, diode average current is going to be equal to the load current which is almost nearly constant, plus the capacitor average current. Now, how do we determine the capacitor average current? We would like to make an approximation. We know that the charge that is lost by the capacitor is C into the voltage. So, the voltage that is lost by the capacitor is from V p to V p minus V p T by 2 RL C. So, this is the voltage that is lost; nothing but peak to peak ripple. So, C into peak to peak ripple is the charge that is lost.

That has to be replenished within a time interval Delta t, with an average current I c average, whatever it is. So, we can get the value of I c average, if we know Delta t; we already know C, we already know V pp ripple. So I c average is C into V pp ripple divided by Delta t.

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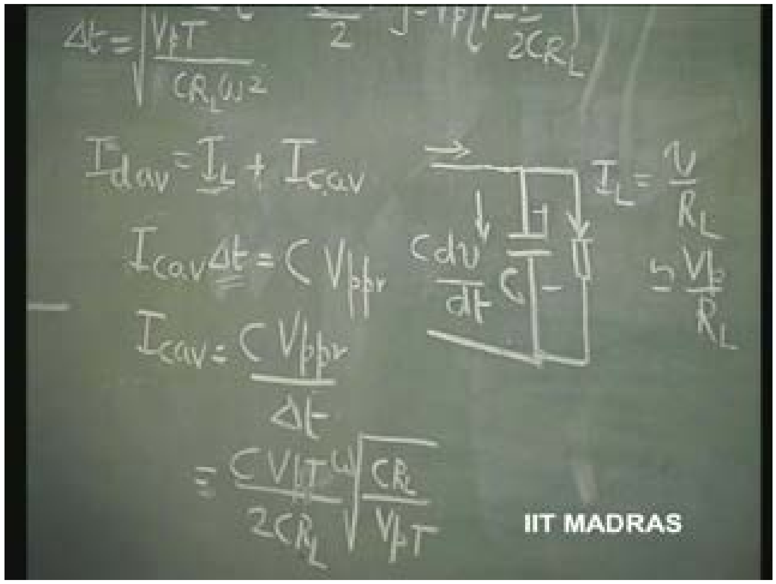

Now, how do we.. We know V pp ripple as V p into T by 2 C RL. V p into T by 2 C RL. How to find out Delta t? This is also very simple, if you can make approximation.

This, if it is V p, and this time interval is Delta t, the value here is nothing but V p cos omega delta t. Delta t, when it is zero, it is V p itself, cos zero is one; so, this equation is that of a cosine waveform; cos, cosine omega delta t, this angle, into V p will give you this voltage. What is that voltage? V p into 1 minus T by 2 C RL. So, we get this – V p, V p getting cancelled. And therefore, Delta t is going to be, Delta t is equal to omega into delta, omega square into Delta t square, is equal to T divided by C RL.

So, let us put down these things properly. Delta t into omega whole square; that is going to be equal to, divided by 2, this is equated to T by 2 C RL. So, this 2 gets cancelled with this 2; and, you can put a root here. Therefore, Delta t is going to be 1 over omega of root of T divided by C RL. So, this is the value of Delta t which we can substitute here.

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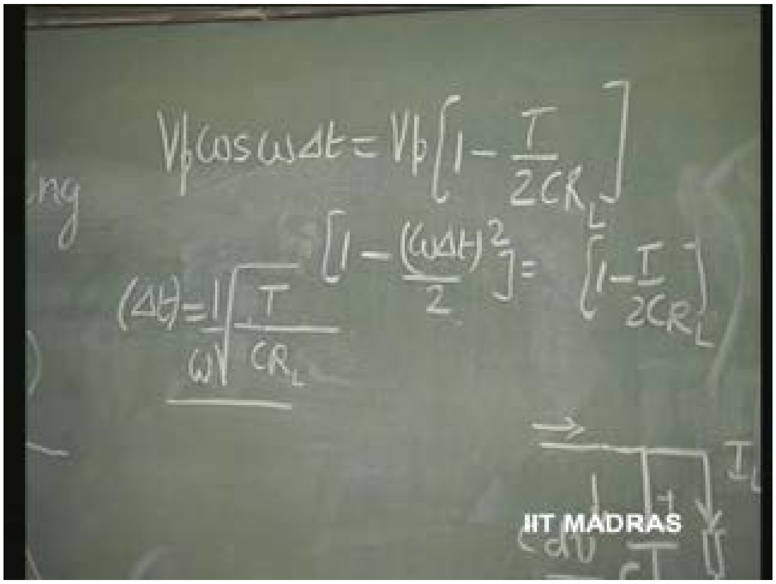

Let us find out the charge equation. I c average into Delta t; that is the charge locked that is lost, was equal to C into V peak to peak ripple. So, I c average is going to be C V peak to peak ripple divided by Delta t. Now, Delta t can be substituted here. So, C V peak to peak ripple, let us substitute that also. That is nothing but V p T divided by 2 C RL. That is, V peak to peak ripple; and Delta t itself is 1 over omega into root of C RL by T.

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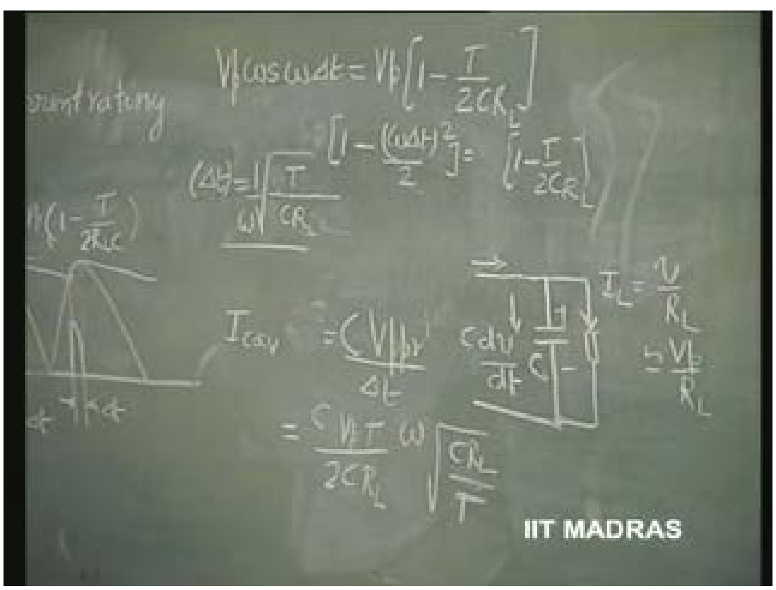

So, C gets cancelled here and we get I c average as equal to V p divided by RL. What is that equal to? It is nothing but I L itself. So, V p by RL; that into omega t, what is it? Omega is equal to 1 over T. So, omega t is equal to 1, right? In fact, sorry, omega is equal to 2 pi into f; f is equal to 1 over T. So, f is equal to one over T. So, we get here, this is getting cancelled; so, we get this as, I L into pi root of C RL by T.

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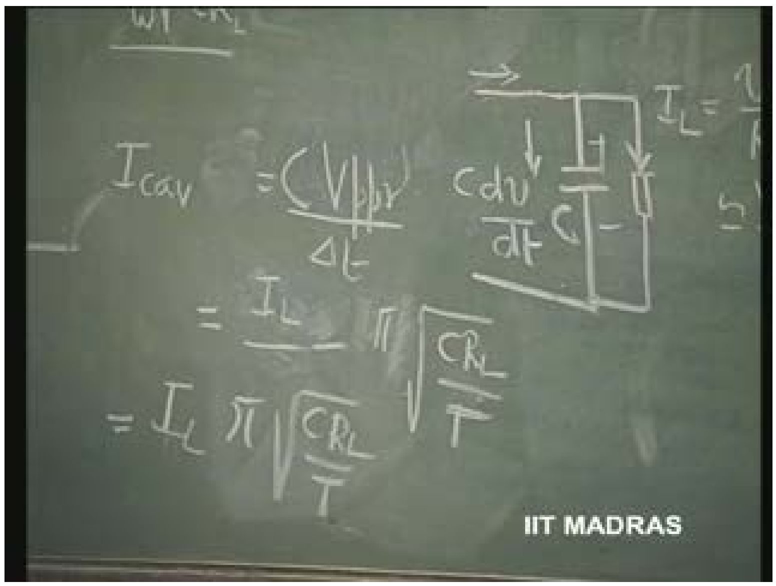

Now, this gives you clearly the fact that if you want the ripple to be very small, you will make C RL very large compared to T. This is what we have made. Ripple has to be very small; so, T has to be made, that is, C RL has to be made very large compared to T. That means, this factor is a huge factor. So, you can see here that the average, I c average, is going to be a huge factor into pi into I L.

So, it is much greater than I L itself. So, this is the thing that you have to remember in designing a circuit like this. That means, what is going to be the current through the diode? Current through the diode now is going to be, I diode average is going to be, I L plus I c average. This is an important equation, design equation, that you have to remember.

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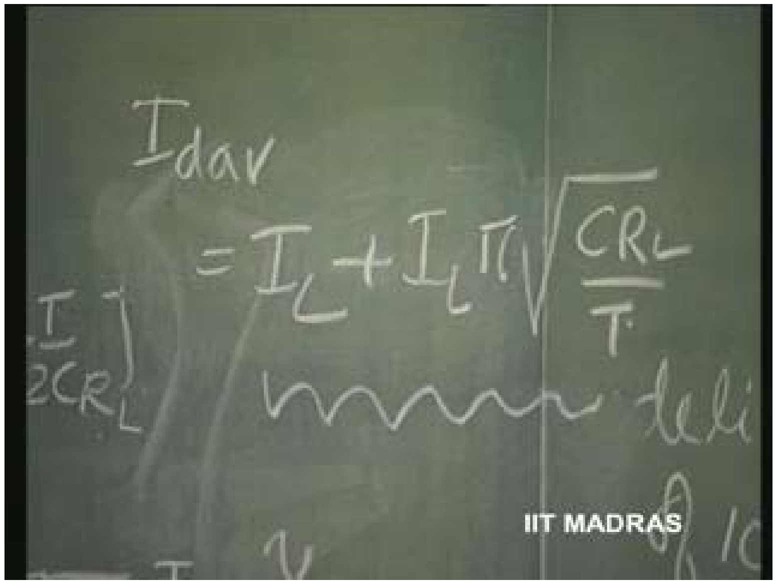

And in our case, I L is going to be 100 milliamperes; so, this is 100 plus 100 milliamperes into pi into C into RL. Now, already, we have chosen this. We already know this C as 1000 micro farad.

RL is nothing but 15 volts divided by 100 milliamperes, which is nothing but 15 volts divided by 100 milliamperes. I think I will redo this here so that it is not fixing at the …

Plus 100 milliampere into pi into … In fact, you can get C RL divided by T from this expression directly, instead of, because, we know, peak to peak ripple is nothing but V p into T by 2 into C RL. This is known to us. This is given as 1 volt.

We want to know the value of C RL by T, T by C RL. So, we can just obtain this by this expression that, C RL by T therefore is equal to, directly from this information, is nothing but 1 volt. C RL by T goes there; V p by 2, that is, 7 point 5 volts divided by 1 volt.

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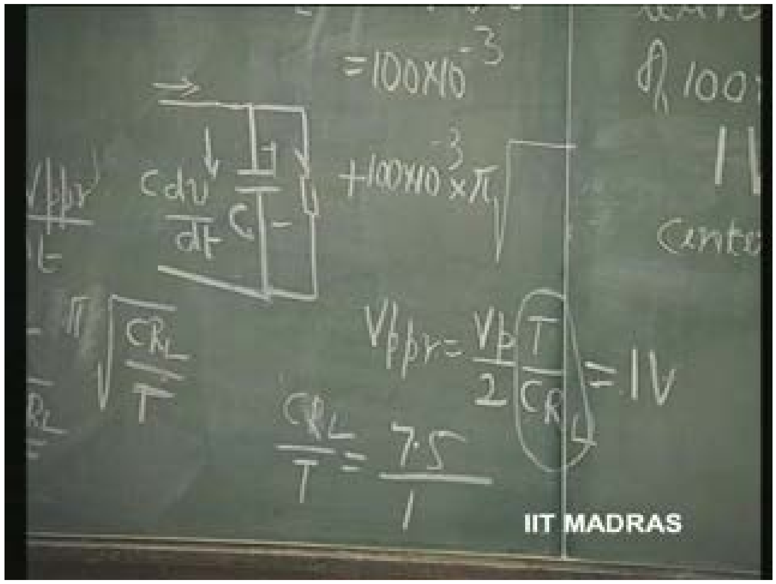

Simple. Is this clear? Instead of substituting the calculated values, from the given values, we can get, directly obtain, C RL by T in the following manner. V peak to peak ripple is given as V p by 2 into T by C RL. That is given as equal to 1 volt. So, C RL by T is nothing but V p by 2 divided by 1, 7 point 5. So, we have this here as 7 point 5.

So, will somebody calculate this and tell me what this is? This factor of pi into root of 7 point 5; pi into root of 7 point 5 is the factor by which the load current is going to be multiplied. That is the excess current, average current, that is going to flow through the diode as well as the transformer. So, please remember that this is much greater than the load current.

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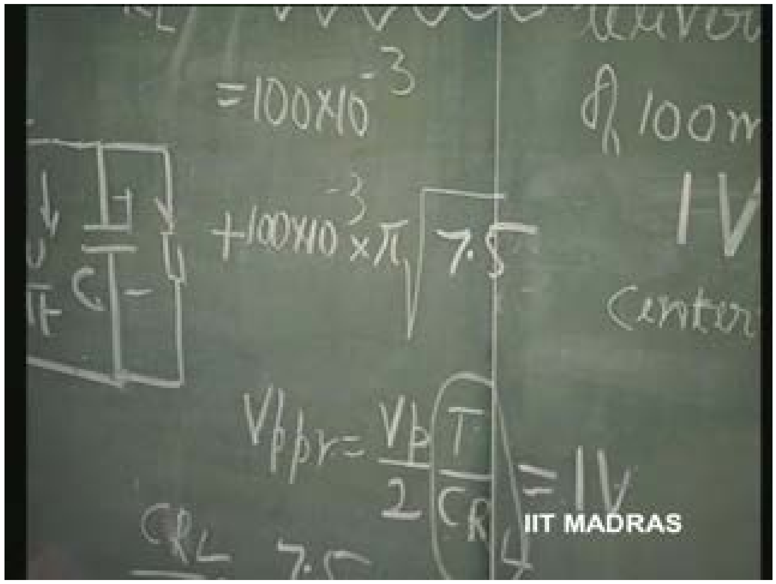

So, continuing with our earlier discussion about the capacitive current, we have seen once again that V p cos omega delta t, this is the time interval delta t, this is the cos waveform, is equal to V p into 1 minus T by 2 C RL. This is the waveform.

At this point, the value of is V p into 1 minus T by 2 C RL. That can be approximated as, cos theta is 1 minus theta square by 2. This approximation, you know. So, 1 minus omega delta t square by 2. V p, V p getting cancelled, this is 1 minus T by 2 C RL. So, omega delta t square is T by C RL. So, delta t is 1 over omega into root of T by C RL.

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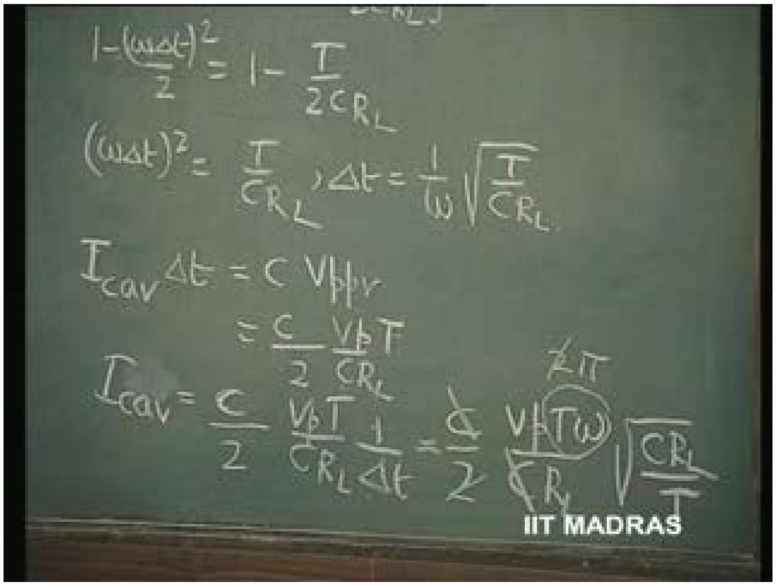

So, I c average, the capacitive current, into delta t, the charge, replenished is equal to C into charge lost, C into V p peak to peak ripple. So, this is equal to, C into V p by 2, Vp by 2 into T by C RL. I c average is therefore equal to T by 2 V p by C RL into T, 1 by delta t. So, if you substitute, these two get cancelled and omega into t is equal to 2 pi. So, these two get cancelled.

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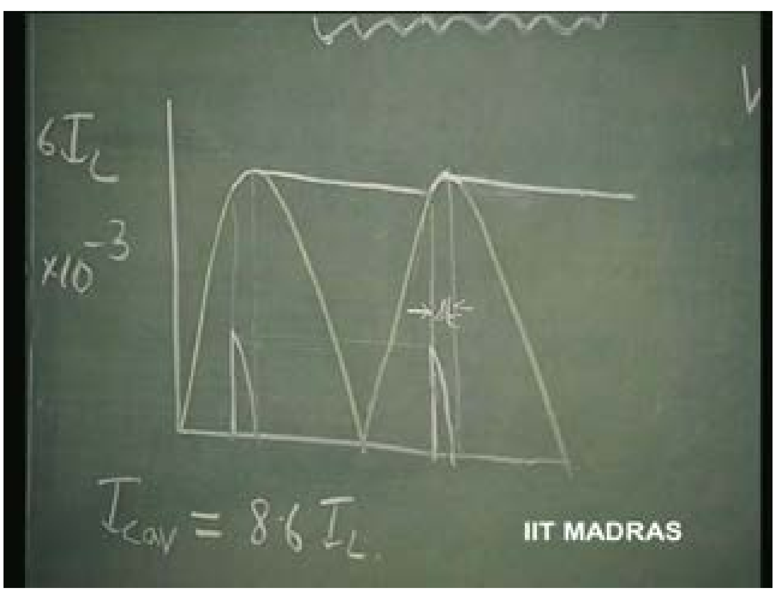

So, ultimately, we see that I c average is V p by RL, which is I L into pi into root of C RL by T. That is what we got; and that factor for this problem comes out to be how much? 8 point 6 times I L. This is I c average.

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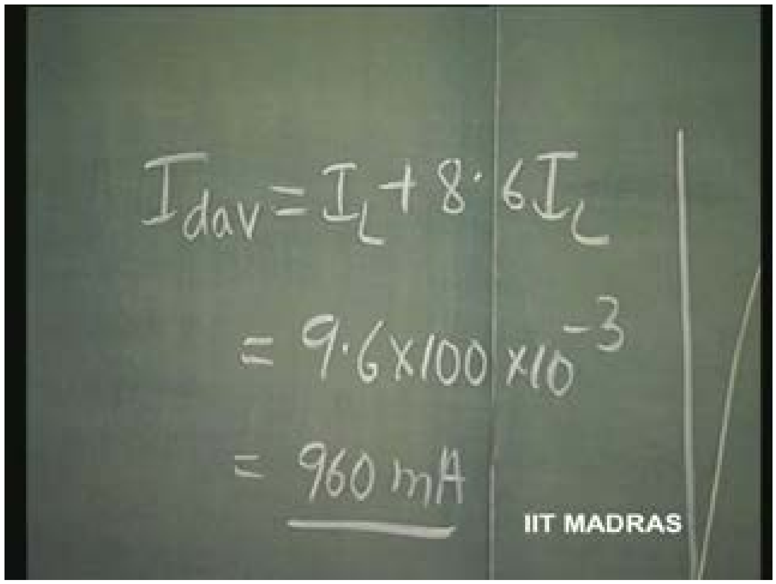

And, I diode average is therefore equal to I L plus 8 point 6 times I L or 9 point 6 times 100 milliamperes or equal to 960 milliamperes. That is the average current that the capacitor, that is, the diode gets because of the additional charging current due to the capacitor. So, 960 milliamperes is the average repetitive current. This is going to happen whenever the diodes conduct repetitively, after every T by 2 time interval.

So, this is the repetitive current rating, please remember. Average current in the whole circuit is 100 milliamperes; so, this is the repetitive current. Of course, it is going to be a pulsed average current.

Now, if we assume that this Delta t interval is very small and this is going to be dropping fairly linearly and this is a triangular waveform, then, the peak current, peak current as I told you occurs at this point when the capacitor is just starting to charge; so that peak current, that is going to flow through the diode, is going to be the I L, that is, plus, average is going to be 8 point 6 times I L.

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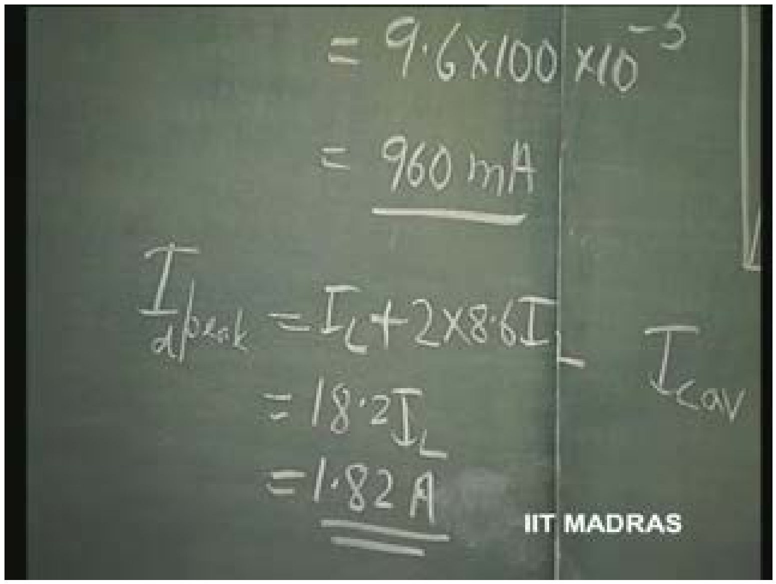

Therefore, the peak is going to be twice this, so that, it is going from peak to zero here. So, the capacitive average current is going to be half of the peak. You make that assumption; this is going to be two times 8 point 6 times IL. So, this is going to be 6, 17 point 2 plus 1, 18 point 2 times I L, which is, 1 point 82 Amperes. So, that is the kind of rating that you should have for the diode.

This is a peak repetitive current rating for the diode which is also going to be mentioned in your specification for the diode. This should be 1 greater than 1 point 82 Amperes for the diode. Peak repetitive current rating for the diode should be greater than this one. The average current should be greater than about 1 ampere for a load current of 100 milliamperes.

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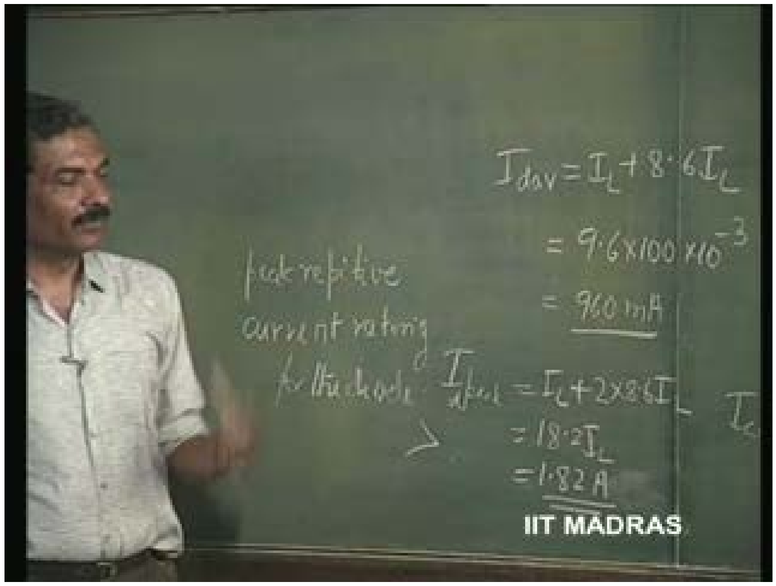

Now, these ratings are very important and you can see that for a reasonable design, where these are, the ripple is going to be extremely small, all these approximations are perfectly valid; and therefore, for a design, these equations can be taken. Therefore, we can come out with a very good design for a power supply that will work satisfactorily for you.

Now, there are certain other points which I have to mention for completion sake. There is what is called as a surge current rating. Whenever you connect these rectifiers etcetera, since you are putting a capacitor there, there is what is go on going to be called a surge current rating. Let us say, this is the… Suppose, you are now talking of a situation where this is getting a power supply connected.

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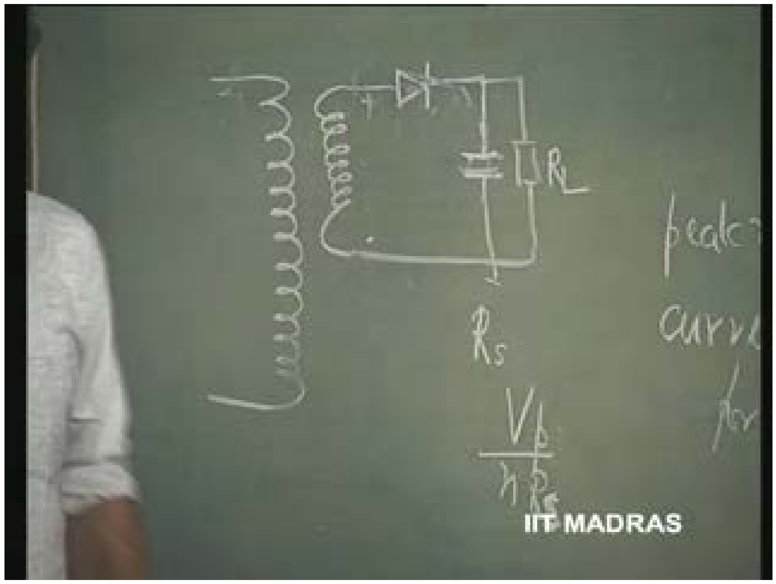

So, the voltage here is going to suddenly change to some value, may be up to the peak value, which is 220 into root 2. At the time of switching on, the voltage can be any value; it can be zero also, in which case, the surge is not occurring. But, you cannot switch on exactly at that point, we do not know. Therefore, this is what happens even in…when you switch on your ordinary switches in your home, the bulb suddenly gets fused; only when you switch on.

Sometimes, it happens. Why? Because, the time of switching on, you might be having a voltage, which is almost reaching the peak. If it is going through zero, there is no surge current.

Therefore, this surge current now is caused by a sudden switching on of the voltage here; and that voltage can be anywhere up to the peak. Then, that voltage will induce a voltage here, which is going to peak divided by n there; and that voltage is going to be directly shorted by the capacitor, because, for a sudden change in voltage, all the current will flow through the capacitor. Capacitor will act as a short circuit.

So, there is no limitation of current here. It can only occur if the capacitor is non-ideal, if the diode is non-ideal and if the transformer is non-ideal. This non-ideality saves your circuit, for that matter, saves your diode. If the transformer is ideal, there is no resistance in the transformer; the diode is ideal, then the capacitor is ideal, the surge current is going to be infinity.

At T equal to zero, this is a short. This is an ideal transformer and therefore there is no resistance at all in this circuit. So, the voltage is suddenly changing across the capacitor; infinite current should flow. So, it is good that most of our capacitors are non-ideal and there will be a series resistance associated with the capacitors.

Please remember, apart from series resistance, there will be also a leakage resistance across it. The leakage resistance does not save the thing but the series resistance of the capacitors saves the diode. Not only that, the series resistance associated with the diode will also come. Then, the series resistance associated with the transformer winding.

So, all these resistances put together, let us say, we call it R s. It will be including the series resistance of the transformer, the diode series resistance and the capacitor series resistance; and therefore, whatever voltage to which surge occurs, let us say, V p by n divided by R s is the surge current rating, R s, R L does not come into picture at all. R L is this.

So, this R s is what comes into picture. That will be the sort of current that will flow through the diode and the capacitor; so, the diode surge current rating should be such that it is higher than this. If we say that this is, V p by n is 15 volts, in our case, maximum worst case; so suddenly, there may be a surge of 15 volts across the secondary. So, 15 volts divided by, let us say, 1 ohms. Even it is 1 ohm, 15 ampere, if it is a good circuit, it may be point 1 ohm; and then, you see 150 ampere is the rating, surge current rating.

This sometimes might be the culprit in spoiling the circuit. You do not have any apparent reason; but the circuit, simply the diode, gets spoiled because of the fact that you have not bothered about surge current rating.

You had done a very good design, wherein, you have kept the transformer losses to the minimum; and the transformer resistance is low, good diodes you have chosen, good capacitor you have put. All good for your performance there. If there is a series resistance in series with the capacitor, then the ripple will be further increased because, apart from the capacitive current which is C d v by d t, there will be this voltage, which is I into R which is dropping across this.

So, that current will also cause a voltage. So, this resistance has to be necessarily kept very small in order to reduce the ripple; and the transformer resistance is also going to be kept very low for good circuit design. Therefore, this surge current rating, please remember, must be borne in mind before finalizing the design of a power supply.

Now, as far as the transformer is concerned, you should also remember that the transformer winding, the copper winding, that you have to have here will also depend upon the current rating etcetera that it is supposed to carry.

So, this rating is going to be common for both diode as well as the secondary of the transformer. Of course, there is a turns ratio. The current up to which this has to work is going to be, I mean, sort of different from this in terms of the turns ratio. The lower, the current here is, the voltage is lower on this side and therefore, current is higher; the current is lower and voltage is higher on this side.

So, this completes our discussion about how to design a good battery eliminator or power supplier using AC input, whatever it be. Now, for you to gain further experience in designing power supplies, we will give a problem for you to work out on similar lines that we have done in example, just the previous example.

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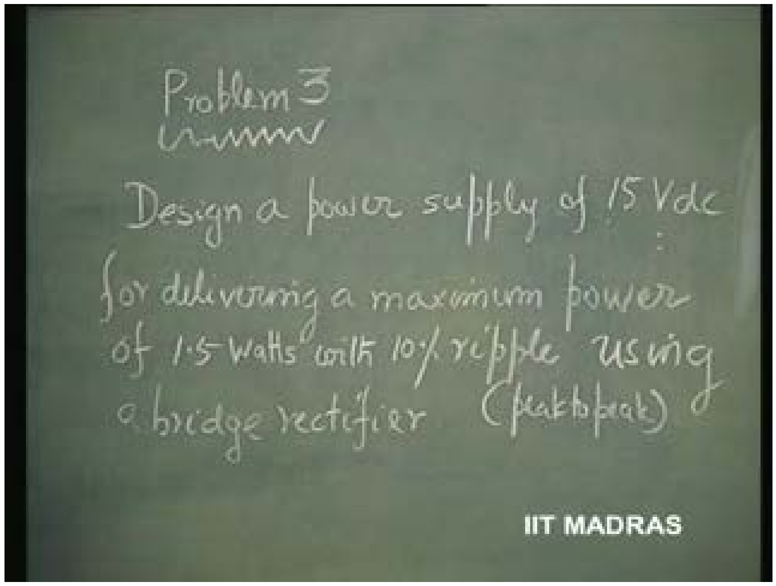

Design a power supply of 15 volts DC for delivering; now I am indicating the load in a different fashion, a maximum power of 1 point 5 watts. We know that it is 15 volts DC and power is 1 point 5 watts, so you know the current.

15 volts DC into I dc L max corresponds to 1 point 5. You can conclude about the current, with ten percent ripple, instead of saying peak to peak ripple of 1 volt here, I am giving the way ripple can be given; 10 percent ripple. 10 percent compared to the output voltage; that means, 1 point, 15 volts divided by 10. 1 point 5 volts peak to peak ripple; so this is peak to peak.

Whenever it is not mentioned, you must assume that it is peak to peak; otherwise, ripple can also be indicated in terms of rms value using a bridge rectifier. Now, instead of using the center tapped transformer as we have done in the last design, I would like you to work out the same problem using a bridge rectifier. That means, instead of using center tapped transformer, you will use an ordinary transformer with a turns ratio n corresponding to the same value as got in the earlier problem, because, output voltage is same, 15 volts; so, n remains the same. But, there is no center tapped here; but instead, you will be using four diodes and obtaining the DC voltage.

So, the turns ratio remains the same as the last class turns ratio. Now, as far as ripple is concerned, it is slightly different from … Earlier it was 1 volts ripple for which you have to design; here, it is 10 percent. That means, 1 point 5 volts ripple.

That means, capacitor is going to be smaller than the earlier situation, bridge rectifier. So, please remember that this arrangement, you have to now give the specification for the diode, capacitor and the transformer, most of which we have already done.

You have to go about doing it in a similar fashion as we have done; the peak repetitive ratings for the diode, all these things, you have to recalculate based on the ((48:20))

So, in the next class, we will discuss more about other applications of the diode.