Biomedical Signal Processing
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Lecture - 18
Event Detection

So, today we will start the new session on event detection.

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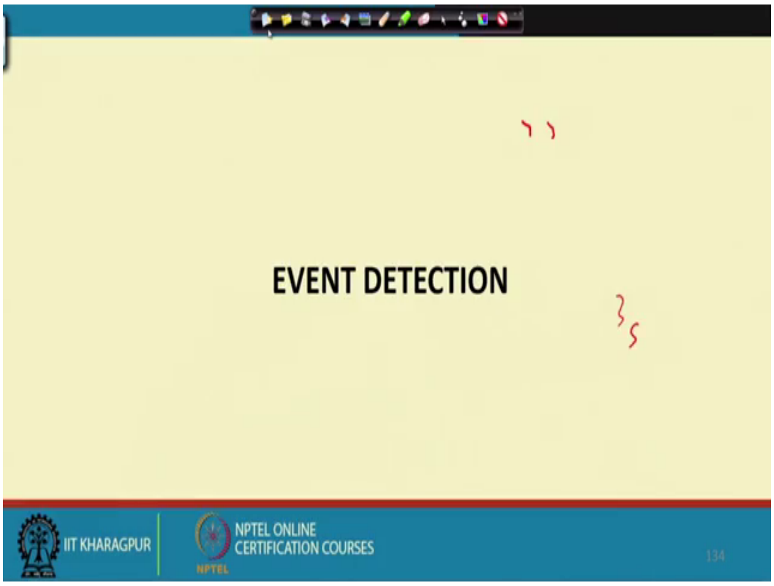

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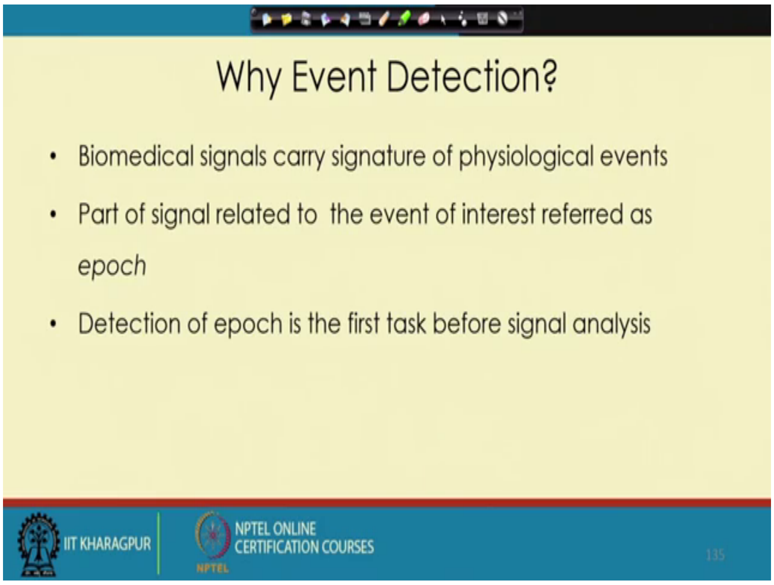

Event detection it is a phenomena, what we can tell it is comparable with say the fact that we have a room and there is some activities going in the room, and what is going inside if the doors are not open and we are not in the room, we can actually look through the window and get that what is going on.

So, similarly within the body a lot of physiological activities are going, on all the time a lot of activities are going on, and we want to actually notice them in a noninvasive way; that means, we do not want to go inside or insert any sensor inside, but we want to observe that what is going on how it is going on. And for that we take the help of the biomedical signals. Because biomedical signals they are associated with these physiological changes.

So, if we have the good idea about the process. So, from that biomedical signals, we can actually get that how this physiological activities are going on at what stage they are. So, from that idea about that process and from the information about that biomedical signal we can get that. If we take an example we can tell that if there is a fire in the room, how we can get that? That we can see the flame, through the flame we can get that the fire is there inside the room ok.

Same way if we get actually heat wave that the heat is spreading then we can get that there is there must be some source of fire, otherwise from where the heat will come. So, even if we cannot see that actually flame. So, these two are associated with the fire. So, from that knowledge we can infer that there is a fire and we can take the appropriate action to distinguish the fire in the room.

So, same way here through that biomedical signals we can get actually that what is going inside the human body, and the word event is associated with that fact that all the physiological activity it is it does not give any clear signal. So, whenever it is giving a clear signal that we call as an event. So, we will go through different examples then these meanings will be more clear to you.

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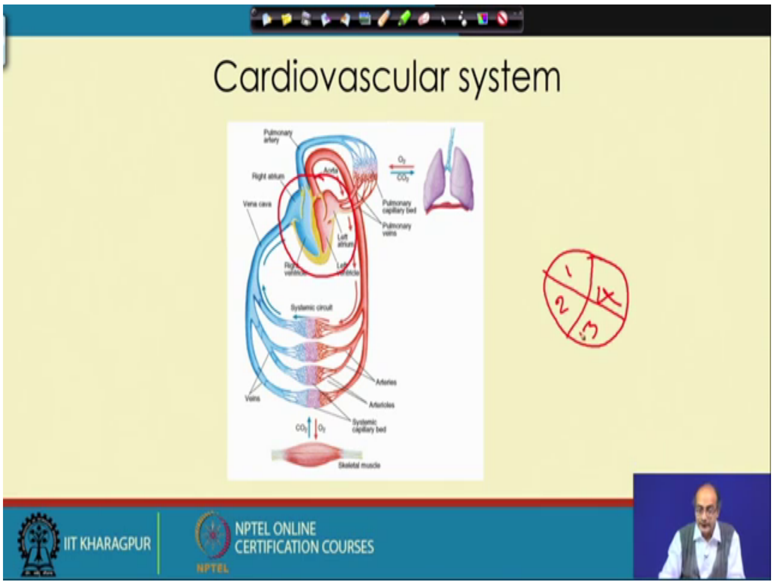

So, let us first take one such system that is the cardiovascular system. In fact, if you look at the system it is nothing, but a circulated system, it is circulating the blood throughout the body. What we have here that we have the main thing is the pump, that there is heart here which has actually four chambers that we can say 1, 2, 3, 4 these four chambers the upper chambers these are the atria.

So, for the right upper chamber that we get the blood oscillator blood from the lung, and it is discharge to the that lower ventricle that that lower atria it is discharging the that the blood to the lower ventricle. Lower ventricle is responsible for actually distributing the blood throughout the body from toe to the head; and as it gets distributed through the different arteries it reaches to the different branches and that the smaller blood vessels.

So, those at the end it goes through the capillaries and reaches each of the cell and from each of the that capillaries there that the cells actually they give the carbon dioxide reach blood, and that again is collected by the capillaries and they are collected accumulated in the veins and they come back to the right upper chamber that is right atrium. And right atrium the full job is to collect that blood, it gives it to the right ventricle that is the chamber number three we have marked, from there it goes to the lung; lung actually helps for the exchange of the that oxygen from the ear to the blood and release of the carbon dioxide from the blood to the ear and the oxygen rich blood that comes to the left atrium.

So, this is the circulation going on and we are interested in it, because that if these actually activity gets disturbed then all our cells they would actually deprived of the oxygen. And if they are deprived of the oxygen they would not be able to release the energy, which is very essential for any metabolic activity and they will first when the stub of oxygen, they would not be able to get actually the energy and they will start dyeing ok.

And then if I will get that that a person if he cannot actually heart stop for some time, that person may be revive, but the patient the doctors actually diagnose that kind of person as brain dead; that means, by the time the brain cells have actually stopped working they have died. So, even if you see that the heart is going on, and the patient has revive got back the life, but he would not be able to do anything ok.

So, here, it is a very major actually that activity and for that that we should be very careful about actually this how this activity is going on. So, look at that it is going in a proper way and we will go through the different stages of it, and the signal associated with it for the cardiovascular system the signal associated with it is the ECG signal.

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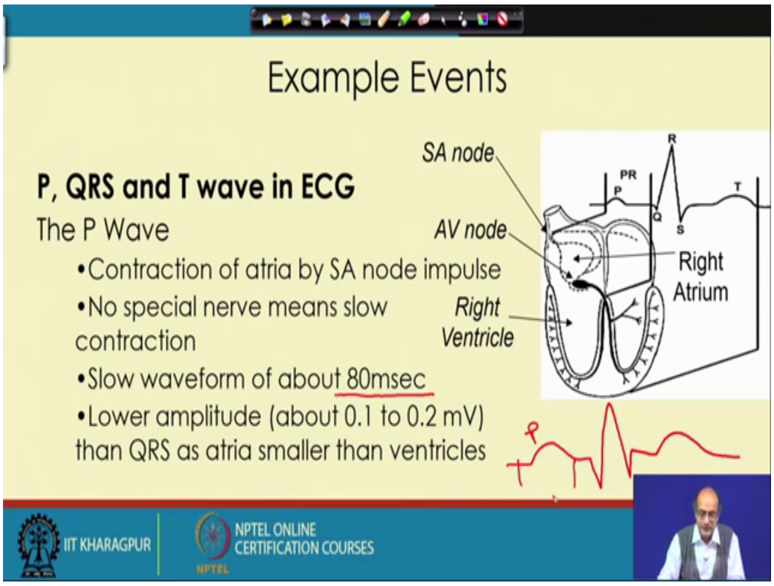

Now, for the ECG signal first what we get that is the p wave. So, let us recall that that how the ECG wave looks like that the overall signal could be like this, this is the p-wave and. So, first part we are looking at. So, p-wave it is actually started by a that node or a set of actually the cells, which gives a electrical impulse there that is called S A node. S

A node actually is a lead in this, but there are more cells or more nodes as near by the S A node, who also helps S A node to strengthen that signal.

Now, as soon as the S A node gives a signal which acts as a stimulus to the muscles that the upper two chambers are atriums a they start actually the contraction. However, here in this actually image we show the desk line that is showing the propagation of that signal.

But in this that atrium there is no special set of a nerves to carry the signal. So, this pretty slow and that is why the contraction takes place slowly and this p-wave which is associated with the that contraction of the muscle, that is slow waveform with about 80 millisecond the time span. If you look at the time span that the p that that is the time we will get, and it has the small amplitude that about 0.1 to 0.2 millivolt, and specially it is small when we compare with the QRS complex ok.

However if we compare with the other signals like EG or. So, which are at microvolt level then you would feel that no p-wave is also have a lot of strength. So, that is the first actually that the part or first event and what it signifies? It signifies the atriums have started contracting and what is associated with it? As it is getting actually contracted or they are contracting, there are some valves in between the that the left atrium to that drifts ventricle, same way for the right ventricle to right that atrium.

So, these valves they open because of the pressure and the blood starts actually getting released from the atrium to the ventricles, from the left atrium to left ventricle right atrium to right ventricle. So, that activity is started. So, we get that from that ECG signal or the p-wave of the ECG signal.

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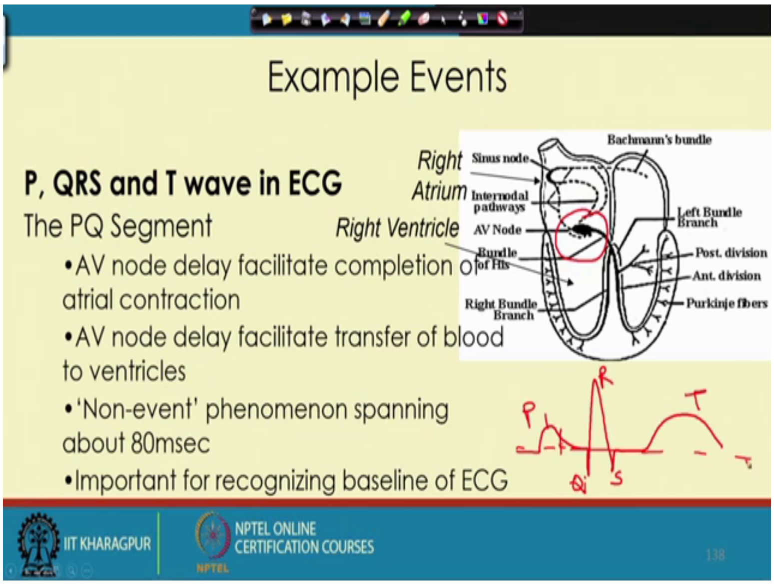

Now, let us look that what is next. Next is we get the P Q segment; that means, that the signal we have seen that P QRS T here is the P Q. So, in between that that from P to Q. So, there is a time lag between the p-wave and that QRS complex or the starting point of the QRS complex.

Now, that time is actually that you can say the gap between the two events and that in this period what happens? As the that the contraction has happened for the atrium the blood actually flows from the that atrium to the ventricle, and here is in node called A V node features the very interesting job it acts as a register that. It simply takes a signal and arise that signal for some time just like in a computer program we have a nop operation we added delay same way, if we know that arise that signal, it does not allow you to decay also that and it just delays that signal and the basic motivation for that, that at that moment if that signal it goes to the ventricle the ventricle also will start contraction and that will actually dratted the that or after the process of the transfer of the blood from the atrium to the ventricle.

So, at that moment it is desirable that the ventricles should be relax, they should allow the blood to flow. So, for that A V node stops that signal and that helps for the transfer of the blood. And because there is no electrical activity that if you look at after the p-wave is completed then there is actually it is almost going through the isoelectric line. So, there is no activity or special signature we can get. So, it is called as a nonevent phenomenon ok.

So, and this is about again of the same actually time period as the p wave, that is 80 millisecond. And this helps actually to get this base line that isoelectric line what we are talking about this actually helps to find that that varies that base line of the ECG, that we have we are aware about that the baseline drift. So, there it is important to know the baseline that whether any baseline drift is there. So, it helps to get that ok.

So, this P Q that segment, though it is a nonevent phenomenon it is very important because the blood unless it is completely transferred to the ventricle, then in the next actually part the ventricles will not be able to actually distributed throughout the body for that true for; the left ventricle and for the right ventricle that it need to send it to the lung. So, that part will not take place properly unless the transfer of blood is complete. So, that way though that this nonevent phenomenon is important.

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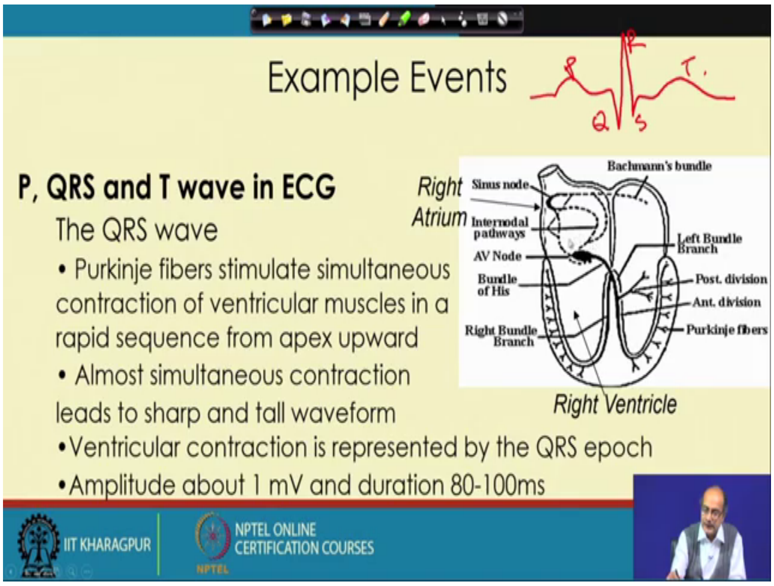

Now, let us go for that the next part that is the most important part that is QRS complex. So, if we take this look at the sketch of that P Q R S T. So, in this QRS is having the maximum amount of energy, and that it has actually the maximum not only energy that the whole signal because of the that amplitude and the speed, we get that is the most important event ok.

So, that. So, we need to look at that the QRS complex, now after the P Q that part that is over that when the QRS actually will start, when the A V node will release actually this signal and allows it to go to the ventricle.

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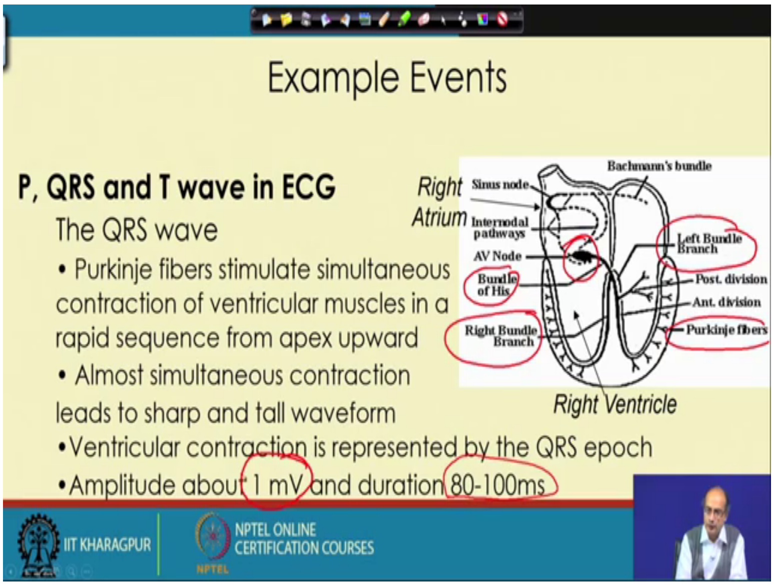

When it allows to go there in the ventricle, then what happens at that there is a number of nerves in the ventricle. First is that bundle of his which carries the signal in the first part then it has the two branches; that right bundle branch and the left bundle branch, they helps to actually distribute the signal in the two respective ventricles and then there are smaller actually now fibers called the purkinje fibers, they helps to take that signal to all parts of the ventricle.

Now, as the signal comes to these nerves and the speed of the signal is much higher in the that when it moves to the that the nerve fiber, that signal comes almost instantaneously to all parts of the ventricle, and all the muscles they start the contraction together. So, this simultaneous this contraction, that gives rise to a huge pressure and the corresponding that signal that comes as a QRS complex, which is actually a very sharp and tall waveform and that it is also have a duration 80 to 100 millisecond. So, if you look at the duration the duration is not actually smaller than the P Q or that p wave.

But because of the that the amplitude or the strength of it, it looks actually the changes much sharper and sudden if you look at that magnitude compare to the p-wave, it is about 5 times higher. It is 1 millivolt actually signal we get here. So, after that as it contracts actually what is the physiological activity it happens that, as a ventricle start the contraction. So, for the valves in between the atrium and the ventricles which were allowing the flow of the blood from the atrium to the ventricles they will get closed to.

So, the transfer of the blood from the atrium to the ventricles will stop, and that increasing pressure that will open the valves in between the ventricles and the arteries. So, the arteries the they will actually that valves will open, they we start actually carrying the blood outside the this the heart. So, that is the main activity associated with the QRS complex.

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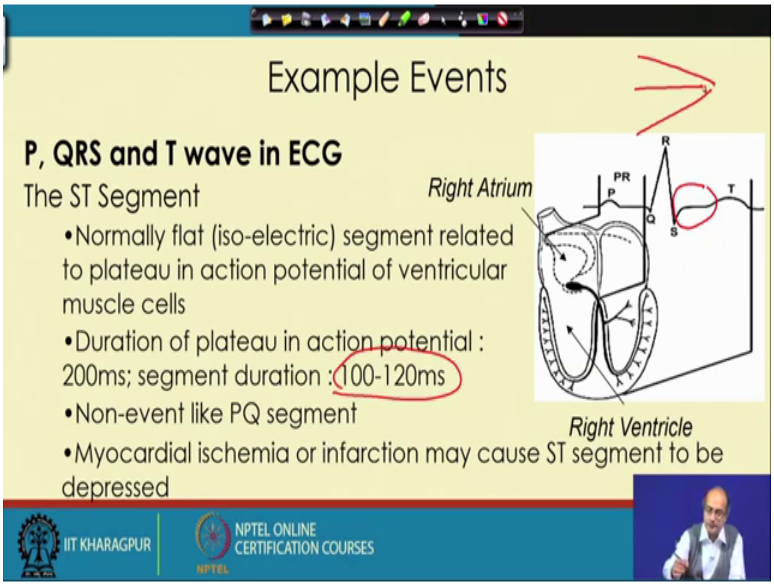

Now, let us look at the next part of it that ST segment, ST segment it is again it is a nonevent actually phenomenon because there is no such electrical special signal. So, it is a plato it is again gives the isoelectric line, and in this period actually what happens that the ventricles remains contracted. And as it remains contracted that the flow of the blood from the ventricle through the arteries that is that will continue, from the right ventricle it will go to the that lung and from the left ventricle it will get distributed throughout the body.

So, that is the way it actually helps to distribute the blood in the body and the duration if you look at that it is actually that that segment duration is about 100 to 120 millisecond and that if we have some kind of disease like myocardial ischemia or infraction, it may actually cause any change in this ST segment. What will happen instead of a isoelectric line it may get elevated or it may get depressed. So, there would be a change it will not remain as a horizontal line anymore. So, that gives an idea about the that, what is the state of the heart or the health of the heart ok.

So, this segment is important. So, that the transfer of the blood from the ventricle to the lung and to the body, takes place we get sufficient time for the transfer of the blood. So, that is the main purpose of this ST segment.

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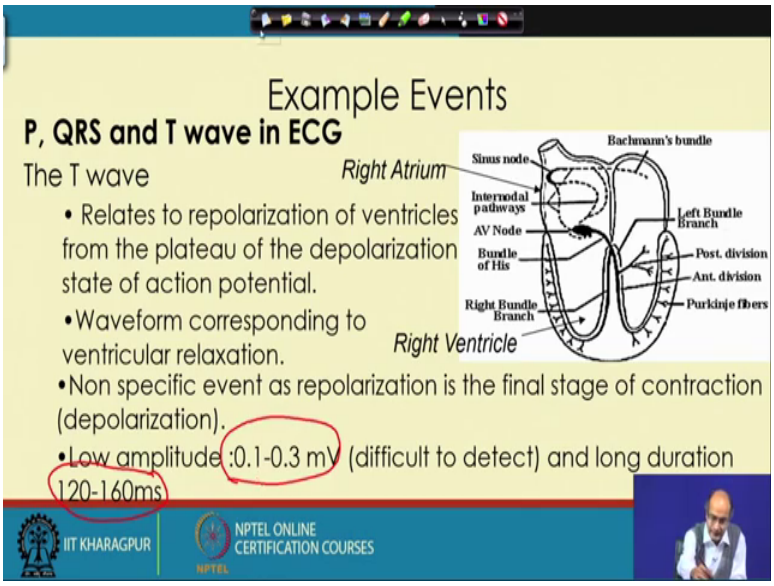

Now let us look at the next part that is the T wave. In the T wave what happens that the muscles in the previous case actually where contracted, that is because of the that depolarization of the muscle cells.

Now, the repolarization happens and as the repolarization happens they get relaxed and that relaxation; that means, that the pressure inside the ventricles will come down and that because of that the valves actually which were allowing the flow of the blood, from the ventricle to the arteries they will get close down. And the blood transfer from the ventricle or the supply will be cut off by there. And this relaxation it is associated with the that with the T wave the relaxation of the ventricles, that what we get here that that the T wave signifies that relaxation of the ventricles, and again that it does not actually show anything more than the that the it is the time for the closure of the valve, and here the if you look at the time duration; time duration again it is about 120enty to 160 millisecond, the amplitude is low that 0.1 to 0.3 millivolts. So, about we can say p-wave sometimes a little more sometimes is low, if it is low it is difficult to detect and there is a long duration of it. So, that is about the T wave and this T wave if you look at that what happened to the that the relaxation of the atria, that was taking place. The only thing it was actually it was taking place with that our the contraction of the ventricle.

So, the that relaxation of the atria that that is not actually becoming apparent in the form of a single eve if there is a signal, which is very weak that gets actually substitute or masked by that is much stronger signal that is the QRS complex. So, the contraction of the that that ventricles.

Now, if we asked that why that some of the signals, they are strong some of them they are weak. The reason is that if you look at the valves of the atria we see the valves are much thinner there on the other hand the ventricular valves are much thicker now what that signifies is there are lot of more muscles in the ventricles and because of that that they because of the presence of large number of that muscles, and they are simultaneous actually action because of presence of the network of the nerves, the signal given by the ventricles that is much stronger whether we talk about the contraction of it or the relaxation of it ok.

So, that is why we see that that QRS complex or the t that they are in a sense actually much stronger than the p. And to the relaxation of the atria that is actually occurrence simultaneously with the time of the QRS complex, and we are unable to get it separately.

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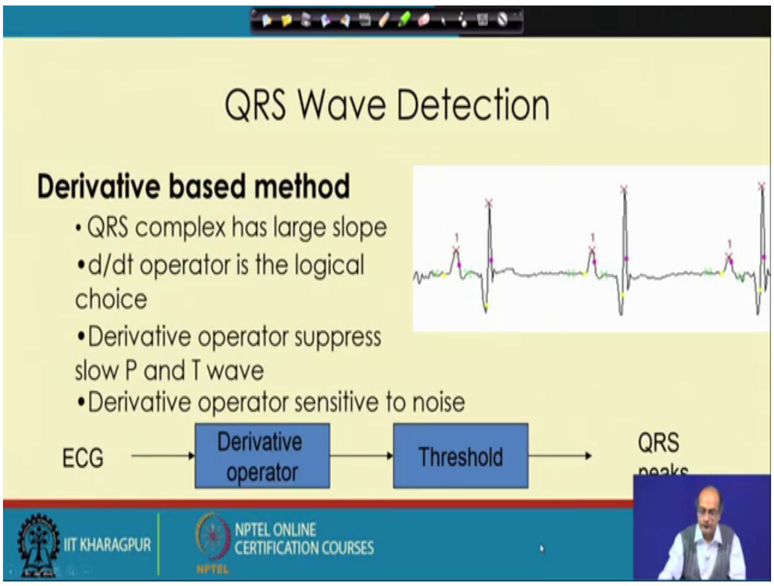

So, we stop here and start with a new topic in the next session.