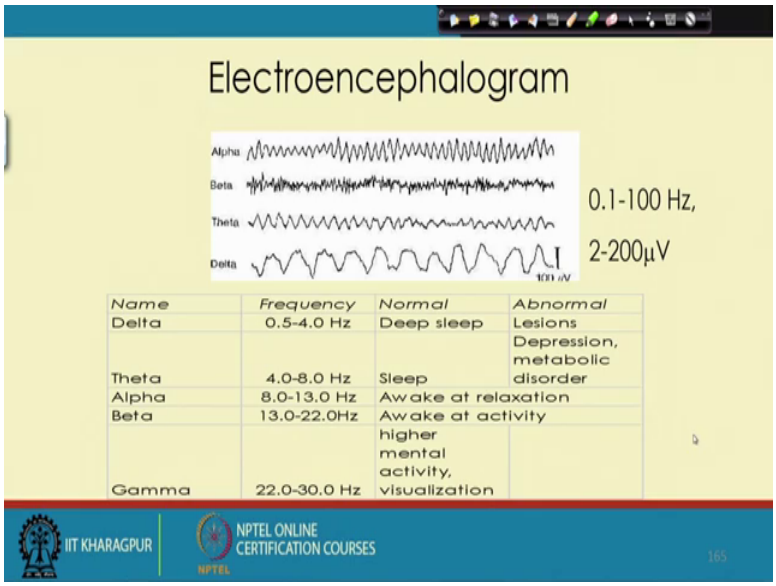
Biomedical Signal Processing
Prof. Sudipta Mukhopadhyay
Department of Electrical and Electronics Communication Engg
Indian Institute of Technology, Kharagpur

Lecture – 21
Event Detection (Contd.)

So, in the last session we have actually looked into the EEG signal, and for that EEG signal the point of attack was we are targeting the QRS complex and if you can find out the QRS complex or to be more specific the arc wave, then with respect to that we can actually find out that the other waves. So, that is a the way that ECG signal is actually analyzed. So, today we now look for the EEG signal or electroencephalogram. So, the common type of the EEG that is alpha beta theta and.

(Refer Slide Time: 01:05)



Delta let us have an recap upon that that we get that bandwidth is 0.1 to 100 hertz, oh that is very similar to the ECG, but if you look at the magnitude, the magnitude is much less than the ECG signal it is 2 to 200 micro volt no because the that voltage is less.

So, we need to be more careful about removal of artifacts and when will look at this signal the this signals are primarily they are random signals or in other word that we hardly can find any shape in these waves this alpha beta theta delta. So, the way they are

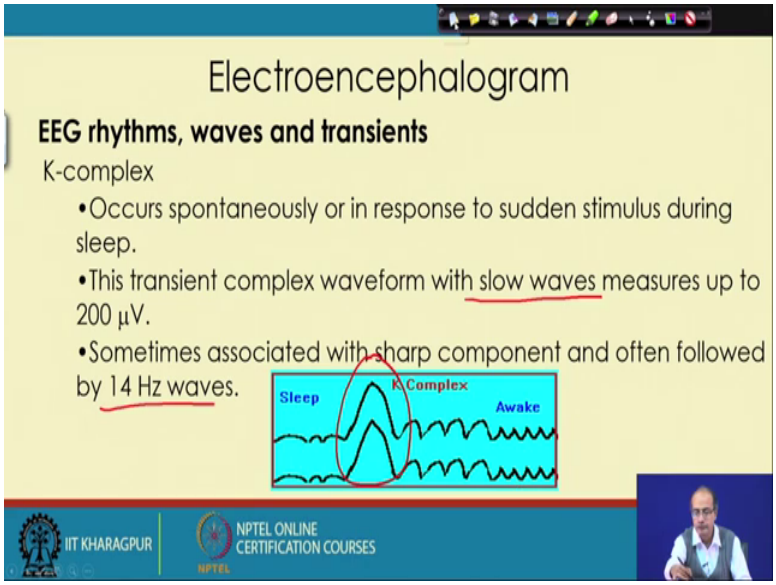
described is in terms of actually the frequency band, because none of them they are actually monotone signal they do not give any discrete frequency, we get the energy of the signal is actually dominant in some actually that range.

So, depending on that we define some band of frequencies the lowest band that 0.5 to 4 hertz that is for the delta then 4 to 8 hertz that is for the theta, and alpha starts from 8 hertz and that ends at 13 hertz, then beta starts from 13 and ends at 22 hertz, and gamma starts from 22 goes up to 30 hertz. Now each of these wave delta theta alpha beta gamma they are actually predominant at different kind of normal conditions, delta is common in deep sleep the theta will get.

When the people are sleeping, but not in deep sleep, the normal awake condition that the people are relaxed and awake in that case will get alpha and will get beta when the brain is active and gamma is for higher mental activity visualization we are trying to conceptualize the thing in that kind of scenario. And at the same time this nature can change that at different kind of abnormalities or pathogenic conditions also you may get some of these waves for example, in if you have a legion a person has legion developed; that means, a tumor has developed in the brain, then in that part even the person when he is awake may be relaxed or at activity, will still may get delta wave in the nearby region. So, that can help us actually to diagnose and localize also that where is the tumor is located.

Again that if the person is in depression, then we can get theta wave even if that person is not in sleep, he may be awake or doing some activity, but because of depression we may get the theta wave. So, that is a general description. So, the first thing what we notice in case of EEG signal, that the descriptions are based on the frequency band because all these signals are random in nature and you cannot quantify them as a shape based actually description like we could get for p q r s and t wave. So that, that is the main the difference. However, it does not mean that there are no waves which shape and now will go for that description of it.

(Refer Slide Time: 04:56)

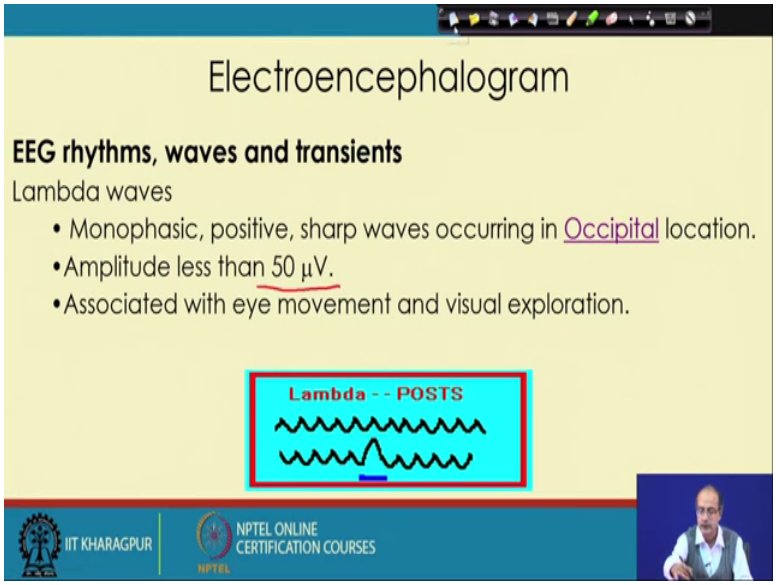


That apart from this that what are the things are present which have some shape. So, for the EEG rhythms, first we look at the K-complex. This one this K-complex occurs spontaneously in response to sudden stimulus or during the sleep, and if you look at that what is a the magnitude of a signal that it is 200 micro volt.

So, comparing the that magnitude of the that EEG signal it has a good magnitude and this wave is a slow wave. So, evolution is very slow, and sometimes it is associated with some sharp component and after that we get actually that 14 hertz wave. So, this is a the pipilarity of the k wave. So, here we get some description that someone is at sleep or actually when some stimulus is given got when awake also that we get the K-complex and after that that 14 hertz means that person is awake and the brain gets busy kind of thing. So, after that that person becomes awake suddenly. So, and if you look at that to be see that it has a sufficient magnitude and it is a very slow wave compared to that both the sides are the EEG waves ok.

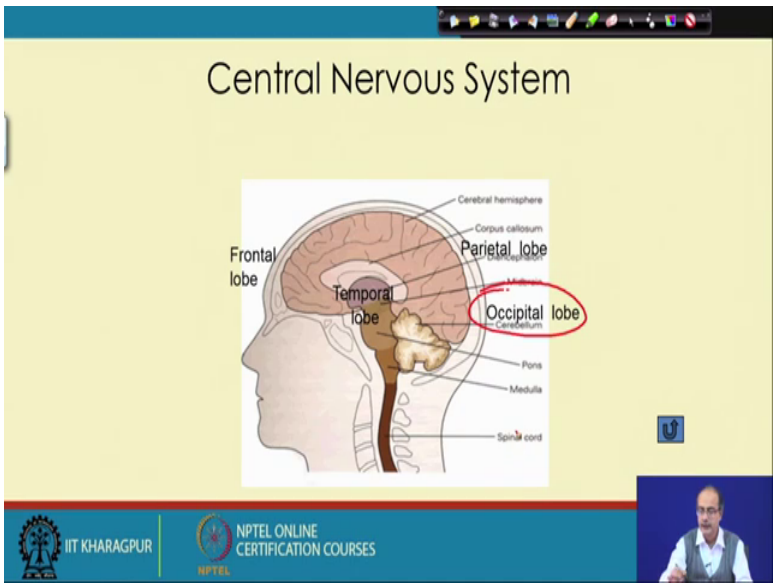
So, that is a typical characteristics of the that K-complex. Now let us look for one more let us look for the lambda wave.

(Refer Slide Time: 07:05)



The lambda wave it could be mono phasic positive sharp wave occurring at occipital lobe. So, first let us look at that what is occipital lobe, that this is a the region of the ocipital lobe.

(Refer Slide Time: 07:20)

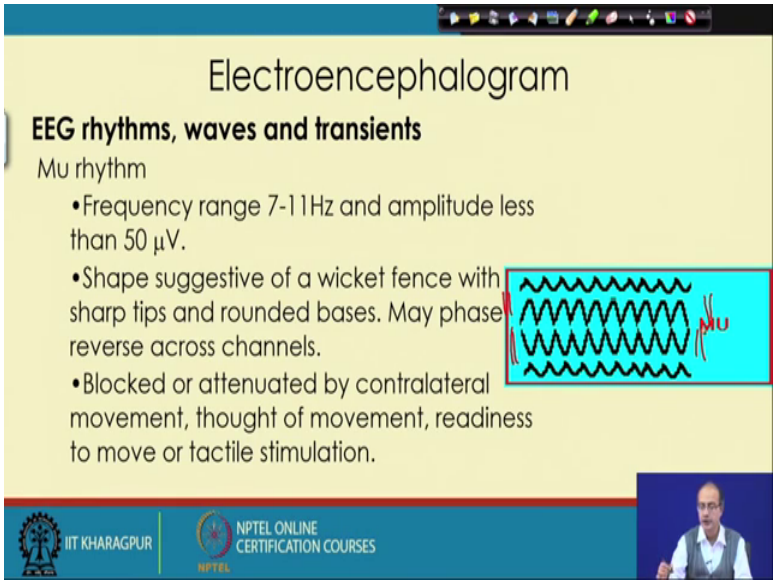


This part let me mark the occipital lobe; that means, at the back of the brain and that in

this region if you put the electrode and we take that. So, here we look at the next wave that is the lambda wave, it is a monophasic positive sharp wave occurring at the occipital region. So, here we see the occipital region it is the back of the brain, if we put some electrode there. So, what will happen in that case that we may get this kind of lambda wave and this lambda wave bar monophasic; that means, it could have where it should have one peak, it is positive and sharp and; however, the magnitude is less than 50 micro volt.

That means that magnitude is much less than the K-complex, and it is associated with the eye movement or that other visual exploration; that means, some work is going on that is related to the visual activity. So, here we show that the lambda wave that we get the lambda wave and we get an idea also that how the amplitude actually changes that with respect to the wave that is present at that time. So, that is another wave which has a particular shape or shape based description. Now let us look at that mu rhythm. In case of mu rhythm the frequency range it is between 7 to 11 hertz and amplitude is less than 50 micro volt.

(Refer Slide Time: 09:20)

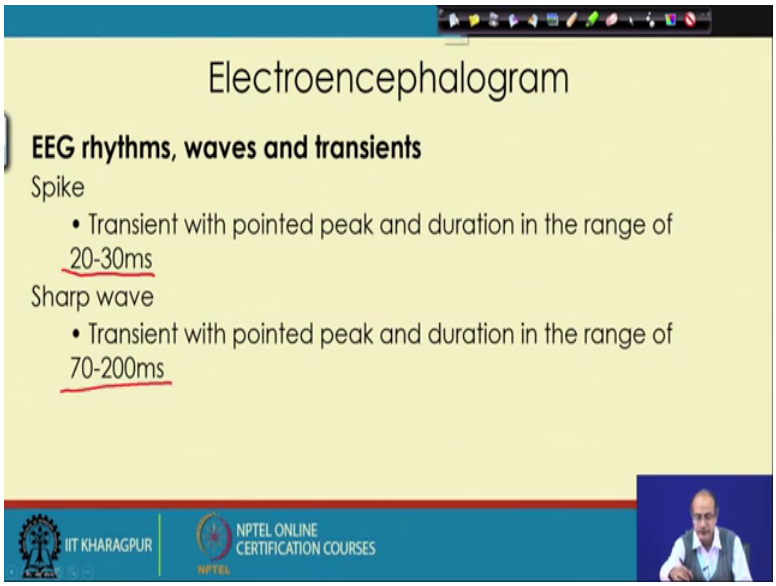


So, amplitude wise if we look at that it is similar to the previous one and; however, we it is a repetitive kind of thing that there is a unlike that it is not a single actually wave. Now in this case the shape is looks like a wicket with sharp tip and rounded base.

That if you look at this part that we get that nature here, that sharp tip and rounded base; however, what may happen that these things can be actually we can get just the opposite, because when we are taking that bipolar actually that recording if the that terminals are changed we may get just the opposite; that means, bellow we get the sharp spikes and upper part that is rounded. And blocked or attenuated by the contralateral movement or thought of movement. So, it is associated with the movement of thought of movement this mu wave comes for a certain kind of situation when we are thinking about the movement or we are moving really.

At that time we can get these kind of wave and again mu rhythm is something, which is described by the shape of the wave.

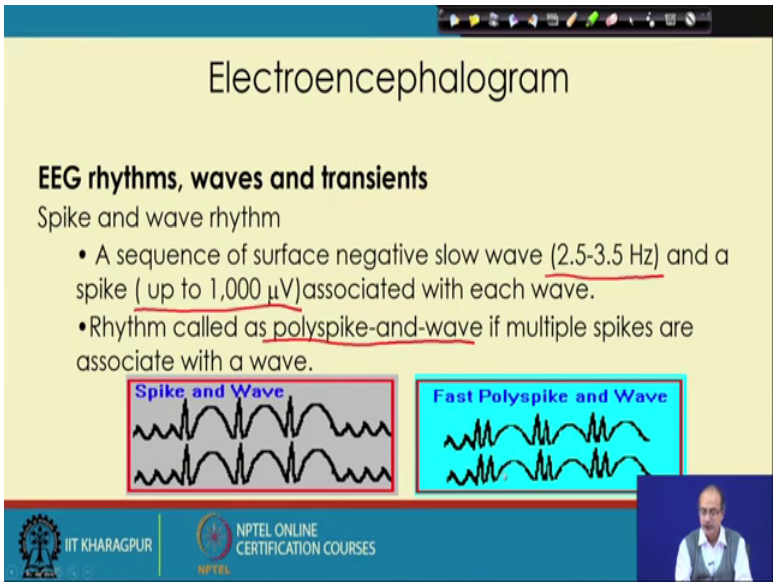
(Refer Slide Time: 11:25)



Now the next one we look we get the spike; the spike is a transient which is a pointed peak and duration in the range of 20 to 30 milli second, and almost similar description is there for the sharp wave in this at they at the transients with pointed peak and duration is; however, is much bigger 70 to 200 micro second. So, what we get actually that compared to the spike and the sharp wave the difference is, the sharp waves the width is 3 to 10 times now that is a difference now what is the importance of the spike? That we know the people has some people suffers from epilepsy, they become unconscious all over a sudden for them.

What is found that this actually the occurrence of this is associated with some spikes in the EEG signal. So, if in the EEG recording get the spikes then that could be taken as pre cursor of such kind of epileptic attack. So, they are important to actually monitor and they have actually clot of clinical significance.

(Refer Slide Time: 12:58)

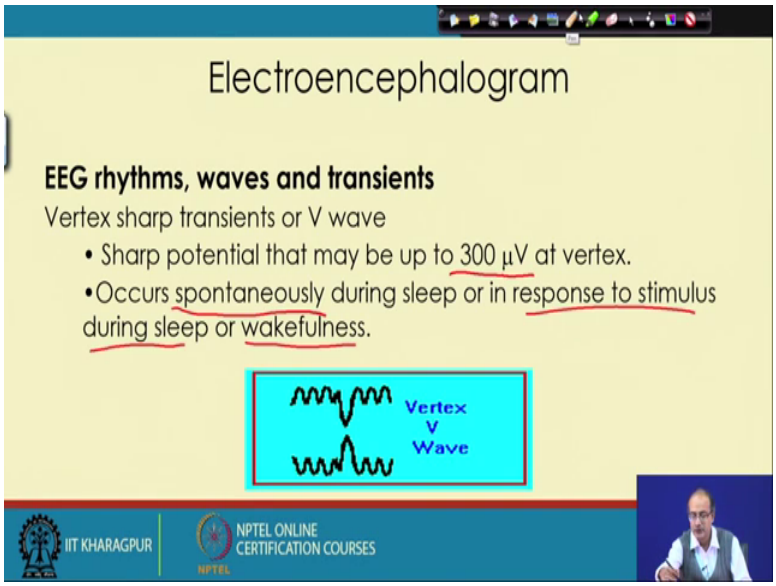


Next we get the spike and wave rhythm. A sequence of surface negative that is in the range of 2.5 to 3.5 hertz and; however, the amplitude could be much bigger up to 1000 micro volt 1000 micro volt means about milli volt that kind of actually that spike, and that that is associated with each wave.

So, one spike would be there, one slow wave will be there slow wave is having a very low frequency 2.5 to 3.5 hertz and a spike has a large actually that amplitude and this kind of rhythm if e it is associated with multiple spike then we call it poly spike and wave usually one spike will be there, but if we get multiple of them together. So, that is called as poly spike. So, here we get some example of spike and wave that we get here the spike followed by the wave, and again the same repetition is going on in a very similar way we can have that poly spike and wave. So, that the spike is predominant that that because of it is amplitude and we cannot miss the following the low frequency wave also because it has some shape. So, that is why it got a separate existence unlike that that delta or theta wave ok.

So, that makes it actually different from those that predominant waves.

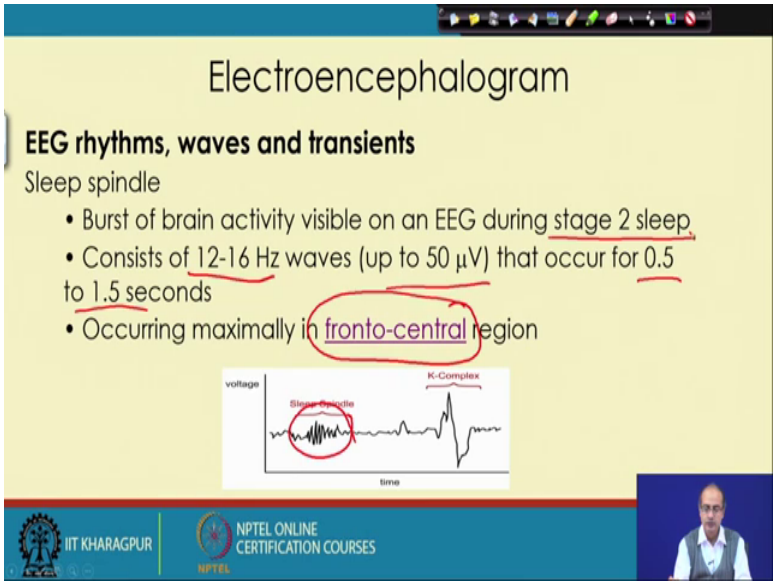
(Refer Slide Time: 15:09)



Now let us look at next we look at the vertex sharp transient or V wave. In case of V wave that let us look at some example that why the name has come it looks like a actually V. So, a it could be the positive V that or it could be inverted V depending on that configuration that the how the that leads are connected for the recording and it has a sharp actually changing potential up to magnitude 300 micro volt. So, 300 micro volt means it is a actually bigger than the usual magnitude of the that EEG signal, and it occurs spontaneously during the sleep or in response to a stimulus during sleep or wakefulness.

So, during the sleep it comes it comes spontaneously and it can also be found in response into a stimulus, when the person is sleeping or awake. So, both is possible and we get that a particular actually that amount of that magnitude of this wave and a particular shape with respect to that actually we have defined this wave as a vertex sharp transient or V wave.

(Refer Slide Time: 16:52)



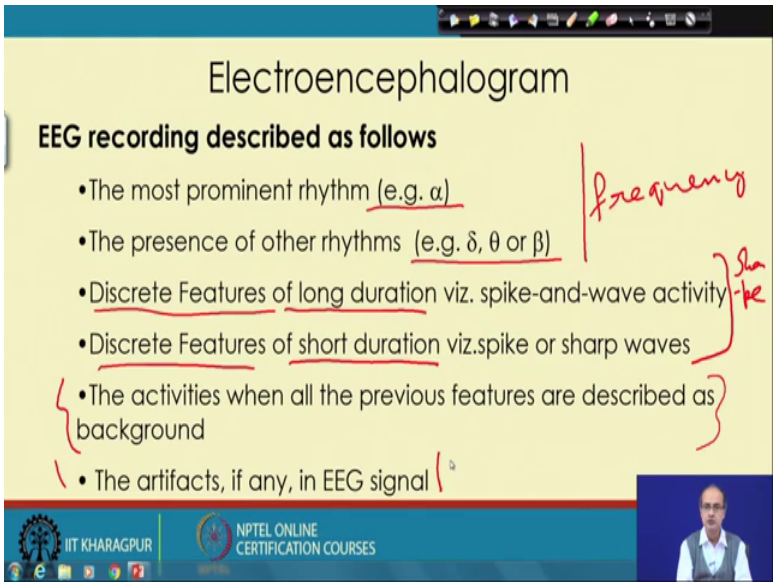
Now we get another that wave that is called sleep spindle, and it occurs in a particular region called fronto central region; that means, the front part of the brain that that that part will a we can expect to get that that from those leads not everywhere, and that it gives a burst of brain activity. Suddenly there is a actually few change in the this signal a lot of actually waves are coming as if the activity has increased in the brain.

So, as you get here in this place that sleep spindle, and it comes in the stage two sleep we know that there are four stages of sleep that non rapid eye movement sleep and there is rapid eye movement sleep. So, it comes in the comes in the stage two; that means, the first stage that when the person is going for sleep and now when in the first stage actually he gets into the sleep and comes out and in the next step the stage that it is becoming little deep.

So, in that that stage this sleep spindle comes, and we get that a quantification of that that it comes within this range12 to 16 hertz and it has a cap on the magnitude also that is 50 micro volt, and there is a temporal window that how long it can occur it is in between 1 to 1.5 seconds. So, there is some localization in terms of that where we can get it that fronto central region of the brain and we get it in the that as a time we get it in stage two sleep that and what we get that the description of the wave that now comes that a it is in 12 to 16 hertz will be the predominant energy, and if we look at the amplitude it would be

about 50 micro volt and that the span of this would be 0.5 to 1.5 second. So, that gives us some idea about the signal.

(Refer Slide Time: 19:37)



Now let us look at that how the whole thing is actually described; when the EEG recording takes place there is a certain way that reporting is done depending on their importance. The first thing that is actually given is what is the predominant wave for example, that when the recording is done if that person is awake and relaxed then we are supposed to get the alpha wave. So, that would be the first description.

Now the person lying on the bed and we are collecting the data, that person may get into the sleep and or like sleep kind of thing and again becoming awake as the instructions are given. So, there could be presence of other rhythm or that person could become busy in thinking some other problem that the patient means that he is like a any other normal person and he has other duties. So, while physically at rest that person may think about the responsibilities what are the that duties he has to discharge after this session. So, other waves also may come in. For example, if he gets into the that that sleep or feel sleepy then theta wave may come if that person actually thinks about his about his other work then it may go towards beta.

So, there are a contamination we can say along with that alpha wave. So, these are the that the first two points actually need to be given. Next we should talk about the discrete features of long duration. So, when we get now first two if you look at they are frequency based frequency based these are actually frequency based descriptions we would say next we look for that the shape based one the first among them would be the long duration one if we have a spike and wave activity. So, that long duration discrete feature that should be mentioned followed by if there is any discrete features of short duration. So, like spike or sharp wave or V wave. So, these are the things we can talk about, then that apart from this if we have any other that observation such activities.

So, that can be told about the activities when all the previous features are described as background, if there are special any other change like we told that, in case of a person having a brain tumor in that location we may get that that delta wave even if the person is awake and maybe that in relaxation or actually having any mental task. So, in that case that that could be a description which would come here. So, first is frequency based description. So, the first one is actually a must then all the other things are actually optional based on their occurrence, that if there is any that mix we should tell that then we talk about these two that is long duration and the short duration, the wave description that is shape based one.

Then keeping these things as a background we are talking about any special occurrences of EEG any special observations what we have made. So, that need to be reported and at the end we should talk about the artifacts that is present. Why we you should mention about the artifacts that actually talks about that what is a risk we run, for taking this actually measurement that when we are analyzing this scenes or taking a the doctor is taking a subjective actually judgment about the waves, then these artifacts are actually coming in the way. So, if any artifact is present that need to be mentioned. So, we get that how good actually this signal can be analyzed and used for this purpose. So, this is a short description about the EEG signals, which will help us to go for the next stage that is how to identify some of them which is required for the reporting of EEG.

Thank you.