**Neural Science for Engineers**
**Prof. Vikas V**
**Department of Electronics and Communication Engineering**
**National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru**

# Lecture - 01
# Course Outline and Scope

Good morning, afternoon and evening. The title of the course is Neurosciences for Engineers. So, the course starts from a lot of thought in various for as starting from research to teaching and from the industry. So, neurosciences has become an integral part of the engineering workflow. Thanks to the developments in artificial intelligence. It's become the watchword for most contemporary technological advances.

There is hardly any area of engineering which has not been touched by neural sciences. So, what the course attempts to do is, it tries to give the relevant biological flavor for the engineering faculty, students, and the engineering community at large. This is actually a beginning. It is an attempt to bridge a gap which has always been in existence. I have seen western classes and courses which take care of this particular area of science.

Why now we deal with this course is because, the material needs to be presented in a different way for a non-biology group of audience. Now, that can be done only when you have people who can bridge the gap between the engineering side and the biological sciences. So, I felt that there is a particular need and being a student myself in an engineering domain I felt that the need is acute because there is a lot of stuff which is done by engineering people, but we who do not understand that there is a biological basis for many of it.

Ultimately, all of us are humans we are biological entities and many of the inspirations we take from ourselves as human beings and from nature form the foundation on which we do our work whether it be in many of the physical sciences or engineering sciences. So, that forms the inspiration for this course.

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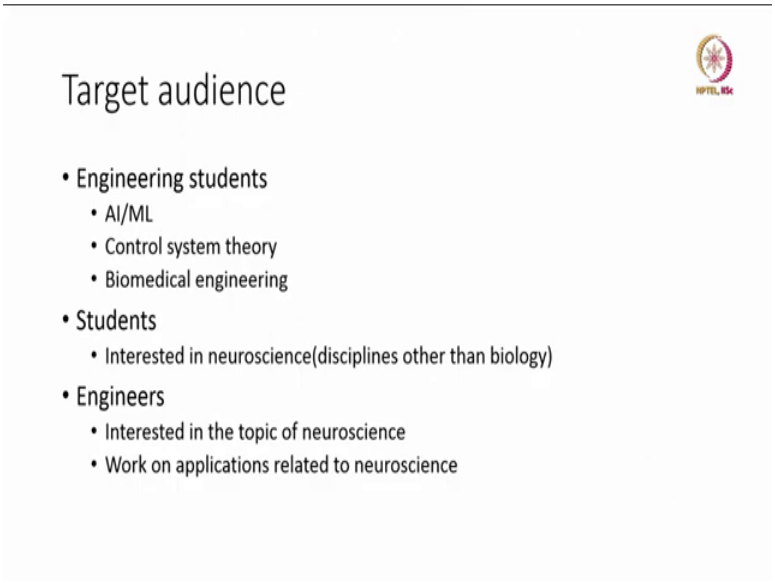


Having said, that I would like to address what forms the target audience. So, at the outset it is engineering students, why engineering students because they are going to be the future generation who is going to build the next level of hardware and software. So, I felt that there is a necessity of showcasing what is known in the biological side or the medical side where there are some advances.

So, the first target is of course, the people who are doing AI and ML because neural networks as you know are the benchmark computing entities on which most of the developments are happening in the research as well as in the commercial areas. So, when I have seen introductory biological introductions, I found them completely inadequate and they do not reflect the richness of the nervous system and the computation of the nervous system.

Also, even in technical papers I have understood that many people actually try to model their work based on biological entities, but there is this gap which stems from a lack of understanding. So, it is to this group that I address the course to. Now, also there are several other domains of engineering where there is a necessity to focus on very unrelated stuff like I say for example, control system theory which I understand.

So, obviously, people who are interested in control system theory would like to know how nature takes care of stuff, how we as human beings are able to perform tasks so

fluid and so controlled, but as yet you know in a very rich environment. So, how does nature or the nervous system take care of this stuff. So, that is the second area of focus.

The third group is biomedical engineering. Biomedical engineering, they are supposed to have neural sciences as a part of the syllabus, and I am sure that they would be taking reading through that. But again, biomedical engineering, the graduates as of now are mostly from the engineering background and they would like to listen to something with an engineering flavor, rather than with a very drawl medical terminology and biological terminology.

Traditionally, we have noted that people who do not like biology going to engineering and who do not like engineering are in biology, but times have changed, and this artificial division exists because the way in which the material is presented. So, material in the biological sciences have fancy names, you are supposed to have a large memory capacity to remember that whereas engineering is generally thought to be of as an analytical science in which there is a lot more work to be done and less of memory.

But there is a meeting point between that between the two sciences and biomedical engineers are exactly in that area where they need to focus on both these fields. So, it is also to give a presentation to these people that you know who can focus on their; focus on their courses better than what they were doing so far.

Now, there are also groups of students, who are not engineers who are not in the biomedical sciences, but they have a keen interest in neurosciences. I have had in my past experiences of conducting science exhibitions, I have noted that some of the better questions come from students who are in their high schools and undergraduate classes and who have never understood or who have never been exposed to neural sciences in general.

Now, if you try looking into neurosciences videos or literature on the topic its very difficult to enter into the topic. You you there you are expected to have a certain level of maturity to listen to understand the topic. What the course tries to do is you find some material which is easily understandable even by a person who does not have a technical background in any of these areas, neither the engineering side nor the medical side of the story.

So, it is for those people that this course should help. It is also sort of trying to inspire people to work into the field because both engineering and neurosciences are hot areas, but you should know what it takes to take a career in either of these or maybe both.

There is also another group of people whom I am trying to address the senior faculty, the people who are actually doing engineering work and somewhere in their work they find that you know you have a problem which requires a solution which is you know you are very good engineer, but then there are some things which you would like to know how nature takes care of it, how humans do it within their heads and bodies and that may form an inspiration to either your research work or your jobs or just you know as something which you add on to your knowledge base which you already richly have.

So, it is this very diverse groups of people that I try to address this course to.

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So, why me? So, that is the next obvious question. This is a difficult question, to answer because anybody who has a medical background can technically produce this course. So, why do you need to listen to me is something which I have to convince you. So, I am a practicing neurosurgeon. My job is regularly to go into the skull and operate on the brain.

So, I have a USP that way, you know I have learnt about the brain, and I also handle diseases of the brain in physical terms. So, going into the skull and seeing parts of the

brain gives a different kind of knowledge which is very different from reading textbooks doing statistics and numbers and working in a lab.

So, its with that pride that I take the opportunity of trying to teach something of what is there within the skull and how it works and why it should be necessary for all of you to understand a part of it; part of it. It is also with humility that I say that of course, there are limitations in my own understanding which you would find at some point of time. There may be discrepancies between what is taught to you, what you understand and what is generally prevalent.

There are places where I take liberty of associating between various things which you may not find in a textbook, please do take it at face value because ultimately there are no authorities in any particular subject. You know you there are people who know stuff and there is a lot of conflicting literature in many areas.

So, as in any branch of science it is an attempt to tell what I know from my background. You would need to be convinced, if you find something unconvincing it is an opportunity to work more in that area and find new stuff. So, that is also another reason.

My background, a professional neurosurgeon who is doing an Engineering PhD gives me a very unique perspective of things. So, when I sit in an ML class when you speak about techniques in convoluted neural networks, how weights and activations are used in neural networks and what back propagation means, it has a completely different meaning for me as a biological person, as somebody who has learned the same stuff in medicine.

So, there is a deeper understanding of this stuff. Of course, I cannot still program, but you know I understand how the engineering side of the topic is dealt with. I also have an understanding of how the biological side works. So, the attempt is to use both of my knowledge backgrounds and make it more sensible to the next generation because you know people so far have been working in very isolated silos. So, I think it is right for me with this kind of a background and somebody who is a hardware engineer on this part of the skull to bridge the gap.

So, what I was actually saying is that there is this opportunity that as neurosurgeons we operate on various parts of the brain. I have operated on I think almost every square centimeter of the brain in various patients over the past 10, 15 years or so.

So, within that duration of time I have seen what happens to people with various kinds of brain diseases and we have taken out parts of the brain, we have not taken out parts of the brain and how these people behave and in fact, it is amazing that for the kind of surgery which we do that people have that much amount of neurological reserve in by which they are able to carry out their routine lives.

So, it is that knowledge base which I would like to transfer to the audience and say how rich it is and what is the opportunity for an engineering student in the domain to carry forth and improve upon to you know at least match on to something what is there in the biological side.

So, scope of discussion: so, you know that we start with that there exists no syllabus. So, what in neurosciences can I teach to an engineering audience? So, how much of that, what depth is required and what is the scope of the topic. So, frankly speaking I have no idea. You know, its a beginning. So, you would have to discount me on that area.

I have tried to cover any topics which are of course, taught in my medical side of the story and I have tried to put it in a packaging that is different because an engineering graduate should not be taught that you know the hippocampus is sitting in the floor of the temporal horn or that the PCOM artery is a branch from the internal carotid artery which joins into the posterior cerebral artery. So, that does not make sense.

But what would make sense is that these vessels have unique functions and damage to these vessels cause unique problems. So, maybe that is to the extent with which I would mix up the biological side to the course. So, that is the focus.

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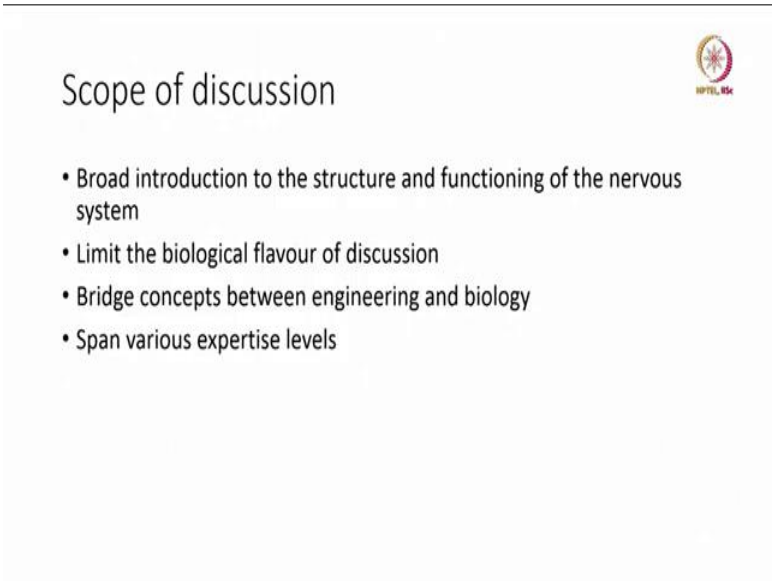


So, we start with a broad introduction to the structure and functioning of the nervous system as we understand it and I will try to put the terminologies as much as possible in a non-biological way. So, non biological in the sense that, I will try to not use medical terminology as much as possible, so that you would have a better understanding especially for people who do not like biology.

There is all the idea that we should be bridging the topics between engineering and biology and that is one of the focuses which I will be starting. And as I told in my earlier discussion, we will be spanning various levels of expertise starting from very fundamental stuff to very advanced stuff, but of course, targeting an audience which is considered naive to neurosciences.

So, we will stop at this and then continue next.