Basics of Noise and Its Measurements
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Lecture - 01
Introduction

Hello. Welcome to this lecture on Basics of Noise and its Measurement.

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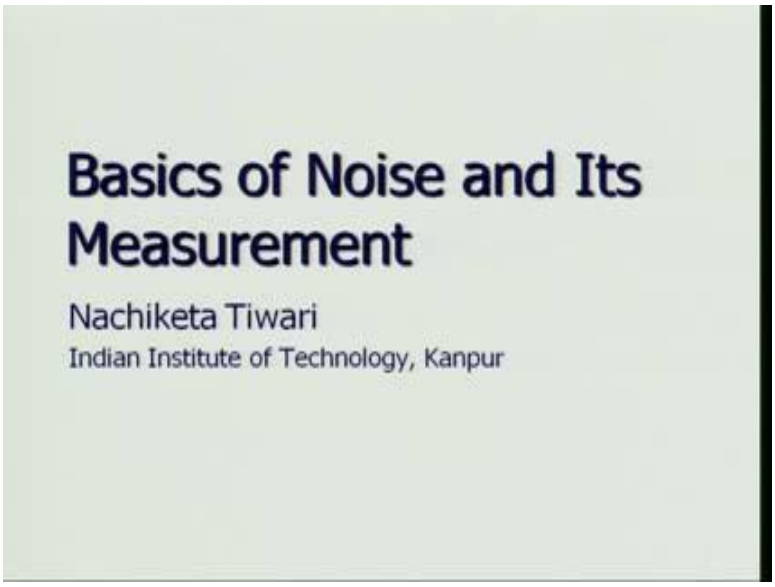

Today is our first day of the lectures. In a series of lectures, this particular course is going to run for eight week period. Each week we will have 6 modules, each module will be something about 18-25 minutes long and in each of these weeks, we will cover a very large or not necessarily very large, but our comprehensive set of topics which relate to this particular MOOC. As you see, the title is basics of noise and its measurement and before we start digging deep into the details of this course, I just wanted to share my understanding of why is measurement of noise important.

Well as it turns out that noise is behaving increasingly a very important parameter in terms of our lifestyle influencing our lifestyle, you get up in the morning, you go out, you are on the road, you hear a lot of noise, you go to your kitchen and you use mixer or

a food processor. It generates noise. You have a refrigerator and they could be less noising refrigerator or more noising refrigerator. You have a washing machine, it generates noise. You have aircraft, ships, rockets and whatever you have, a lot of noise and in general the overall level of noise in our country is going up very significantly.

So, if you are involved in manufacture and design in production of consumer goods, your consumer goods to be less noisy because that makes them you know competitively better. If you are involved in design of and running of complex transportation systems, such as aircrafts or railways, again from the stand point, from the side of the government as well from the stand point of the users of this, there is an increasing desire to reduce the noise levels which are generated by trucks, by buses, by cars, by trains, by planes and so on and so forth.

So, what this course does is that it looks at this overall comprehensive picture and as a step 1; it gives you a fundamental understanding of what is sound. So, we will cover range of very basic themes are related to sound and then, we will proceed in terms of how do we measure sound, how do we measure noise and how to analyze the signals which we have measured.

So, before we start going into the details, I would like to share some of the resources in this particular context.

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These particular resources may turn out be very helpful for you as you did deeper into this particular area. So, in this particular context, you may also want to look at some of the video courses and web based courses on acoustics and sound propagation through media which I have been offered by NPTEL. So, you have to go to NPTEL dot ac dot in and look for these courses and I have developed 40 video courses and another 40 web based lectures on sound propagation through media and if you have time to go through them and learn a little bit more about acoustics and sound propagation, it will be really helpful for you in context of this course, but as a prerequisite you do not have to necessarily learn all those things whichever I have taught in acoustics and sound propagation through media to be a part of this course, but if you learn that, then it will certainly be helpful. Then of course, I am doing this mock on acoustic.

So, we will generate a lot of supplementary material, but then there is also virtual lab on acoustics and we at IIT, Kanpur we have generated this, created this laboratory and this is the URL for the lab. It is not very imaginative URL, but right now this is what we have. Hopefully in next few weeks, we will be able to change the URL to something more meaningful, but if you go to this particular website http slash slash 202.377.8.2, you will be able to access a large number of acoustics tools, software tools using which you can generate lot of files.

If you want to create a 400 hertz tone, you can generate that. If you want to generate a sweep signal, a hash signal and so on and so forth, you should be able to do that. If you have a particular signal and if you want to do a 50 of it, you should be able to do that at this website. So, feel free to use it. There is no charge for it and more people use it, the better it will be in terms of utilization of this resource and then finally, we have tiny labs which again labs where we do a lot of research in area of sound and acoustics and noise and this is the URL for that.

So, if you go here, you will learn something more about what kind of resources we have in terms of people, in terms of equipment, in terms of other tools and you should be able to capitalize on these resources and if you have any questions and if your research interest in this particular area of noise and vibrations, it grows. We welcome to use all these facilities. So, let us now look at the structure of our course. So, we will have series of lectures or brief lectures and each lecture will be something like 20-25 minutes and this will be supplemented by some additional material.

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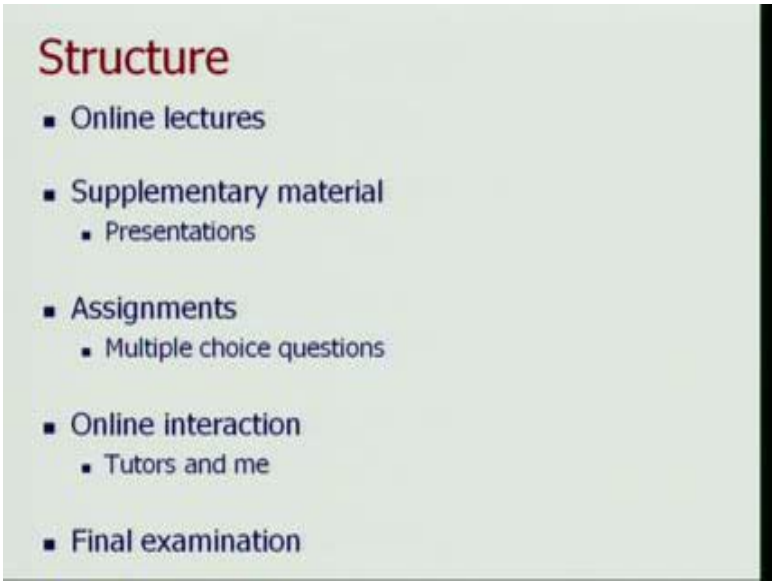

So, with these lecture we will also have series of presentations, power point presentations. So, you are free to look at those and at the end of each assign, each lecture we will have an assignment and by enlarge most of the assignments which you will have

to finish would be multiple choice formats. So, there will be objective questions of MCQ type. So, if you have understood the concept, then you should be able to answer them. These questions in MCQ format, I am certain as we proceed into the course, you will have doubts and questions and need for clarification of specific concepts.

So, there will be tutors and of course, I will be available through for online interaction. So, you should be able to pass on your questions and interact with the tutors and also, me through this online interaction methodology and as the course draws to close, there will be final examination and that will help us evaluate the performance of all of you on this course.

So, that is going to be the overall structure of this course and I look forward to having you on this particular course. Now, let us look at briefly about what is it that we are going to discuss in this particular course. So, of course there is going to be an introductory part.

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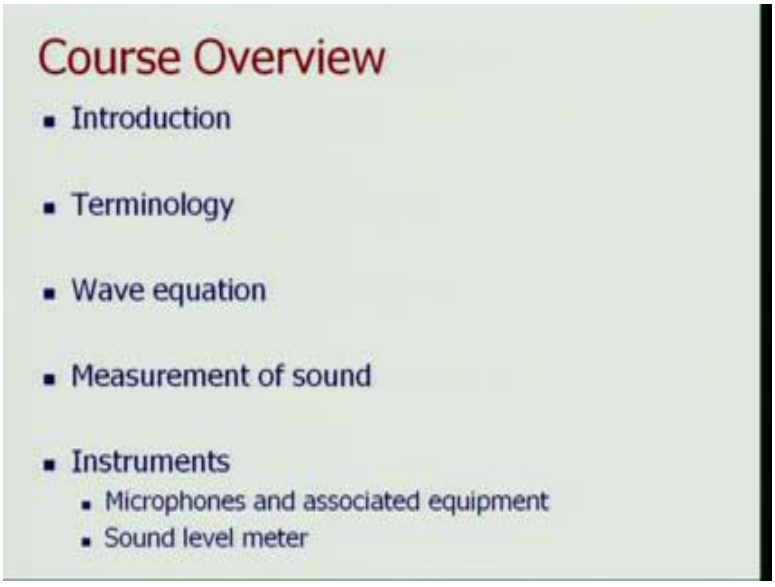

After that what we will do is that we will look at some of the key terminologies because a lot of terminology of noise and acoustics is somewhat specific like we have terms like octaves and decades and decibels and del eq and power intensity and it is important that

we understand these terms accurately, bandwidth what else weighting, a weighting filters. So, it is important that you understand this terminology clearly and explicitly and that will help you discuss about acoustics and noise and noise related measurements and they appears in very clear and objective way.

Once we have discussed the terminology, then we will proceed to look at a very fundamental mechanics of sound how the sound propagate from point A to point B and that is governed by a differential equation known as the wave equation. So, understanding the basics of this wave equation is important in this course because not necessarily in the sense that you have to be super experts in solving these differential equations, but rather because a lot of times if you understand what the wave equation is, then you would be able to relate the underlying mechanics associated with this, wave equation with several principles of noise measurement because their things like impedance and the concept of impedance comes directly out of the wave equation because we take the ratios of pressure and velocity and then, as a function of the pressure and velocity, we define something known as impedance.

So, how are these things related and how do they relate to some these terms which we will be measuring. It is important that we understand the wave equation. So, once we are done with the understanding, the wave equation we will use it, we will cover this wave equation over a period of two or at the most three hours and then, we will actually proceed to actually measuring sound.

So, in that particular context we will look at a large range of equipment, microphones, data acquisition systems, analog to digital converters, what types of cables do we use, sound level meters and so on and so forth. We will look at all these from a practical stand point and in this lab, we will also actually show you some of these specific instruments and tools and familiarize you with the basic operating principles as well as specifications of these tools, so that once you walk out of this mock after having successfully completed this course, you should be able to intelligently figure out what kind of measurements you have to do and what kind of instruments will be helpful in achieving your goals.

So, once that is done, then what? So, once you have a tool and you use this tool to record sound or noise, then you have analyzed all that information and because most of the information you record is in time domain, you best basically measure pressure as a function of time or velocity or volume velocity as function of time and once you record that, then you would like to extract a lot of other information which may be of interest. You may be interested in trying to figure out what is the energy level in a particular bandwidth or what is the sound pressure level at a particular frequency.

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So, what is needed at that stage is that you should have reasonable grounding in analyzing all the data which you have acquired experimentally and all that analysis is done through some mathematical methods and those are the mathematical methods which we will discuss in this particular course. Specifically we will cover FFT or Fast Fourier Transform method and how can we make FFT more accurate what is the resolution of a FFT, what is the maximum frequency which we can get once we FFT some data and so on and so forth.

Then, we also look at another tool known as the spectrogram and also, the short term Fast Fourier Transform method and once we are done with it, then we will learn little bit more about how we can use these tools and these techniques for different applications

and we will discuss some of these technical terms later which are shown on this particular power point.

So, how can we apply these tools and techniques to free field measurements to reverberant field measurements to near field measurements, how is the near field measurement different fundamentally from a far field measurement and what is the use of something known as anechoic chamber? We will discuss that what is weighting, what are octave bands and so on and so forth. So, once we are done with this, then we will continue our journey in the area of noise measurements and then, we will learn to define and measure experimentally a very important parameter which is a function of pressure and velocity and this known as impedance.

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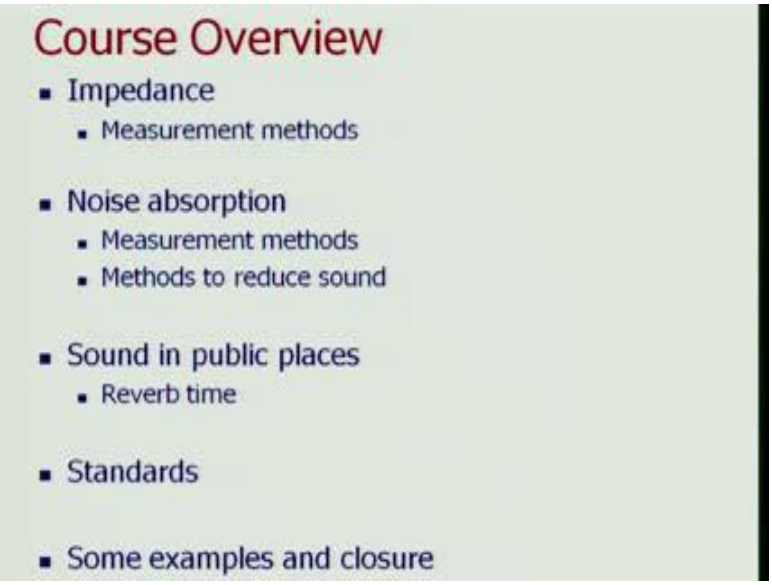

We will discuss at least two different methods to measure impedance. We will also describe the equipment which is used to measure impedance and actually give a demonstration of one of those equipments for impedance measurement and then, we will show that how we can use this equipment to measure the noise absorption characteristics of different materials. For instance, you have a foam or a piece of cork which you want that it should be able to absorb sound in an Artio game which you are designing. So, you would like to know that for specific frequency bandwidth let us say 100 to 200 hertz, 200

to 400 hertz, 400 to 800 hertz and so on and so forth. How much noise this particular piece of foam or cork felt or concrete or curtain it absorbs and what we will teach you is how you can actually do these measurements using this impedance related tools because then once you know how to do this, then how you can calculate the absorption coefficients of these materials and through some quick mathematical models actually design or detoriums with some better.

So, it will be in that sense, fairly effective tool for you all and then, once we have done that then you will be ready at that point of time to discuss and learn how are measurement made for designing better public places. So, in public places what you want is that there should not be necessarily too long or reverberation time because that confuses people and also, it should not be too short. So, there is always an optimum level of reverberation time and how do you design public places from an acoustical stand point, how do you design a classroom, a lecture hall and auditorium.

Some very basics of that by relying on some of the measurement techniques which you would be learning in this particular course and then, finally we will look at some of the national as well as international standards as they relate to sound and noise and what kind of levels are permissible in specific areas, what kind of sound level or noise level is permissible in a public area, in hospital, in airport when inside, a car or when a car goes by something, there is something known as pass by noise.

So, what kind of standards do we have and regulatory standards as well as operational standards which are important to look at as you execute your responsibilities as a noise engineer or sound engineer or as an operations manager in your organization. So, that is something we will be covering in this course and lastly, once again I look forward to having you in this course and I am sure that this will be a fun journey and it will be highly interactive and I don't think it will be consuming an excessively large amount of time from your stand point in terms of learning, but I am fairly certain that you will find this course to be rewarding, enriching and something you will be learning which will be very useful and rewarding from a practical stand point.

So, welcome to the course and this completes the first module of this course and now, we

will proceed to the second module.