**Inverse Methods in Heat Transfer**
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**Lecture No # 01**
**Module No # 01**
**Introduction to the Inverse Methods in Heat Transfer Course**

Hello and welcome once again to this course inverse methods in heat transfer offered on the NPTEL Swayam platform. I am Balaji Srinivasan. I am a professor of mechanical engineering at IIT Madras. As you would have seen in the introductory video for this course this entire course is about how to apply inverse methods for problems within heat transfer. This video is or the series of the video within this week just to provide you a non-technical semi-technical introduction to the entire subject of what inverse problems are?

Where they are applied? What their history is? And what some of the backgrounds you need within heat transfer for this course are.

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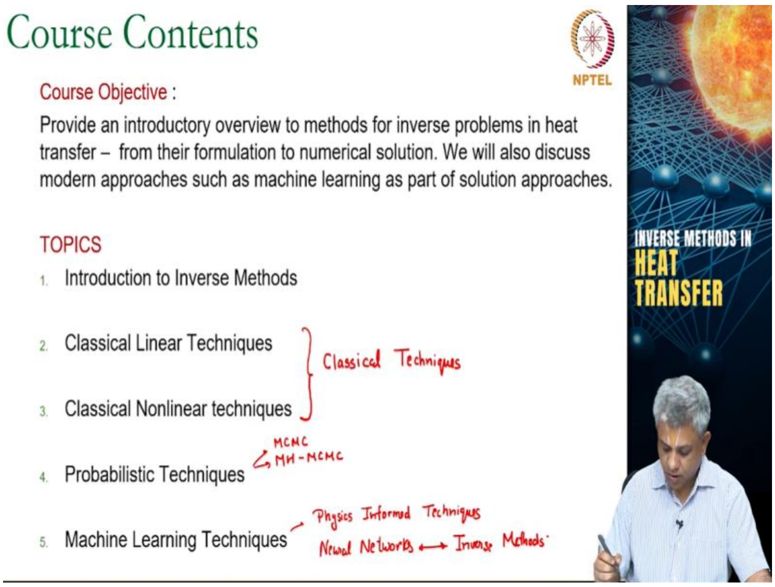


So let us move on to this course just to quickly tell you what the course contents are. So the objective of this course as I said is to provide an introductory overview of methods for inverse problems within heat transfer. Now we want to see both how to formulate these inverse problems as well as how to solve them? Within the context of this course, I will be doing a lot of analytical solutions.

But in actuality when you solve actual real-life problems you will need invariably a numerical solution. A numerical solution involves programming or coding we will be using Matlab within this course. This will be offered for those people taking it on live this will be offered by NPTEL a platform will be offered to you so as to be able to do these problems in Matlab also.

More importantly for those of you who are doing this at home perhaps you do not have access to Matlab you can use any other programming language for this. Of course, for people doing live, I will be offering some coding Snippets for these things. Within the context of the exams that we will do within this course in case you are taking this course for credit with the NPTEL platform.

We will be doing mostly analytical problems within the class as well as the exercise homework problem. Some problems will involve Matlab the final exam of course is by hand. But I want to emphasize that when you use these problems within the industry or Academia you have no other course but to solve this numerically as any practical problem nowadays requires.

Now an important new contribution of this course or a new component of this course you might not find in similar courses elsewhere, currently within the world, we have a component on machine learning. So machine learning as most of you would know now sort of started invading many portions within science and engineering. In inverse problems, machine learning does have some history but there are some modern approaches that are come up over the last couple of years known as physics-informed approaches.

So we will look at those 2 towards the end of this course. One important distinction between this course and perhaps some other course that exists is its actually being offered at a simpler level than other parallel courses on inverse methods that are offered. I am primarily teaching it to undergraduate students or this will be taught at the level for undergraduate students who have studied heat transfers.

So that assumption of course is that since we are discussing inverse problems in heat transfer. You would have done some amount of heat transfer. Though the techniques are general, we will still be applying them primarily to heat transfer and within this week I will do some portions which are relevant to heat transfer also. So the topics that we will be covering within this course in the first week will simply have an introduction to inverse methods what are inverse problems? what is their history? What is there an application?

Again like I said mostly non-technical I will also be reviewing some heat transfer material that you should know. but really speaking many of the examples in the course are directly accessible for somebody who has done the heat transfer. For those of you who have not done heat transfer, you might still find it useful provided you are able to understand the context a little bit.

Now for the next several weeks, we will look at what are known as classical techniques. So there are 2 sorts of classical techniques that we will use techniques that are useful for linear problems and techniques that are used for non-linear inverse problems. So both these put together actually form a broad set of techniques that I will call classical techniques. this is usually the mainstay of most inverse problems discussions.

After that, we will follow this up with probabilistic techniques. These are also extremely useful within inverse methods. So within this, we will be covering what are known as Markov Chain, Monte Carlo techniques, some Bayesian techniques, and another technique called metropolis techniques, Markov Chain Monte Carlo these are also broadly useful not necessarily just in heat transfer problems but across the domain.

But their philosophical emphasis is different from the classical techniques. Classical techniques typically use some algebraic techniques whereas probabilistic techniques use some probability and statistics. Finally, as I said an important new contribution or a new component of this course's machine learning techniques and specifically the final week also involve what is known as the physics-informed technique for inverse problems.

But we will also offer a general introduction to machine learning as well as neural networks. Now interestingly enough as you will see later and I will talk about a bit within this week too. Machine learning techniques themselves or neural networks themselves are an example of inverse techniques. So we will sort of be recursively using this within this course. so neural networks involve inverse techniques and inverse techniques will involve neural networks.

So there is sort of a symbiotic relationship between neural networks and inverse methods.

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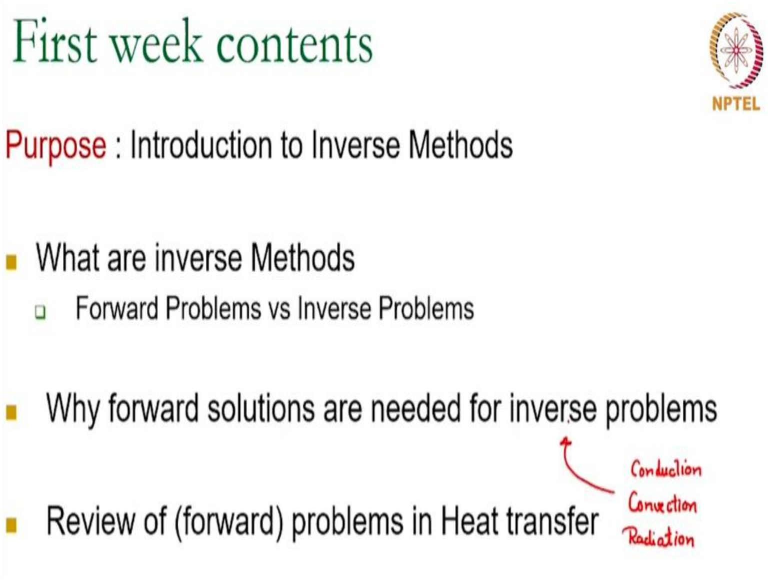


You will see that towards the end of the course. (refer time: 06:47) just a brief overview of what we will be covering this week now that we have seen what we are going to look at in the entire course. So the purpose of this first week is just to give you a brief sort of soft introduction to inverse methods we will not be doing any hardcore techniques within this week. We will look at starting from the next sections what are inverse methods?

So we will specifically distinguish between what are forward problems versus inverse problems I will discuss a little bit of history and what their applications are? And what their uses and then we look at why you need the forward solutions or what is usually what you would have seen within your heat transfer courses, why you need that, in order to solve inverse problems.

And then based on that, I will review some forward problems in heat transfers. again these will be some very simple problems in conduction convection and radiation. All of this is something that you should already be familiar with but it can just serve as a refresher since this is just the first week of the course. So some very simple ideas within these 3 but we will need this finally to solve inverse problems as well.