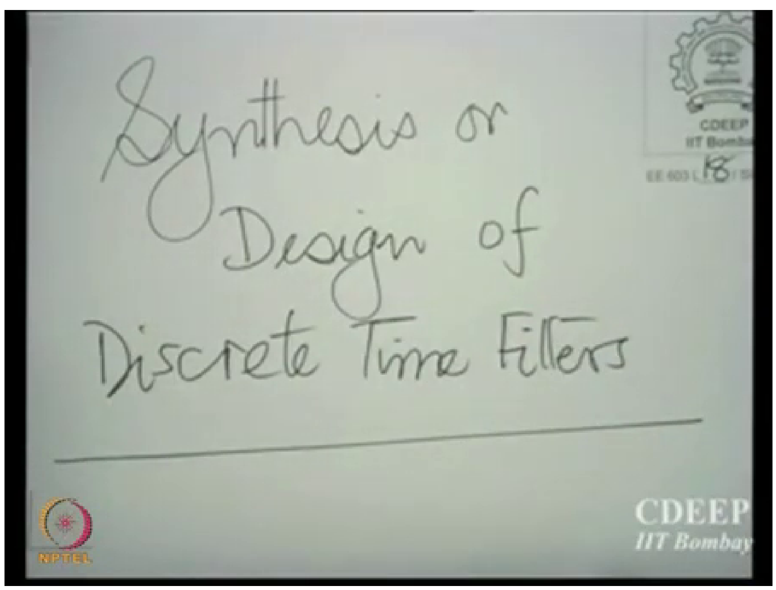
Digital Signal Processing & Its Application
Professor Vikram M. Gadre
Department of Electrical Engineering
Indian Institute of Technology, Bombay
Lecture 18a
Recap of Rational Systems and Discrete Time Filters

A warm welcome to the eighteenth lecture, on the subject of Digital Signal Processing and Its Applications. We have spent quite some time on discussing the Z transform, the systems whose impulse responses have a Z transform. And in particular, a class of both systems called rational systems. We had a good reason to discuss rational systems, rational systems are realizable.

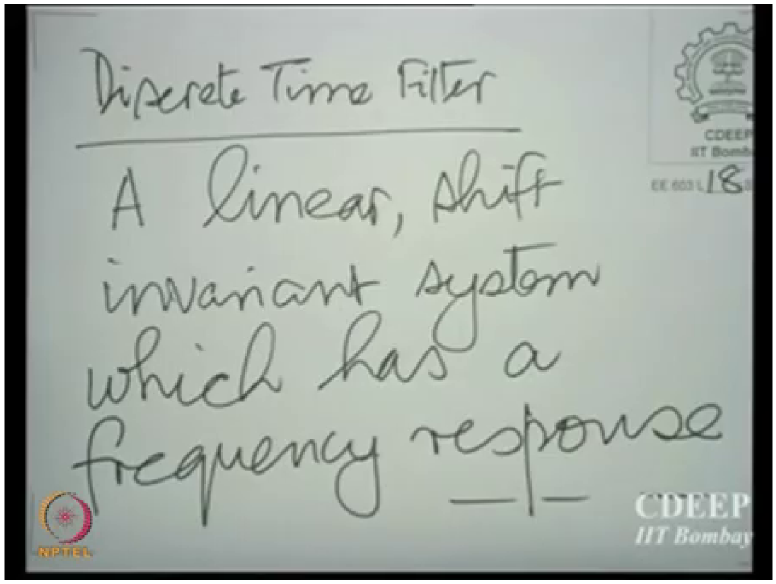
We have also seen how to realize rational systems; I mean one possible way of realizing rational systems. Later on, we will see more ways of realizing rational systems. For all this while we have been talking about analysis of systems. So, it is time we now got down to the important theme of synthesis.

(Refer Slide Time: 01:17)



So, what we are going to begin with today is synthesis or design. And design, of course of discrete time filters. It is filters that we wish to synthesize, for quite some time in this course. We have already introduced the idea of a filter, the discrete time filter. But let us recapitulation.

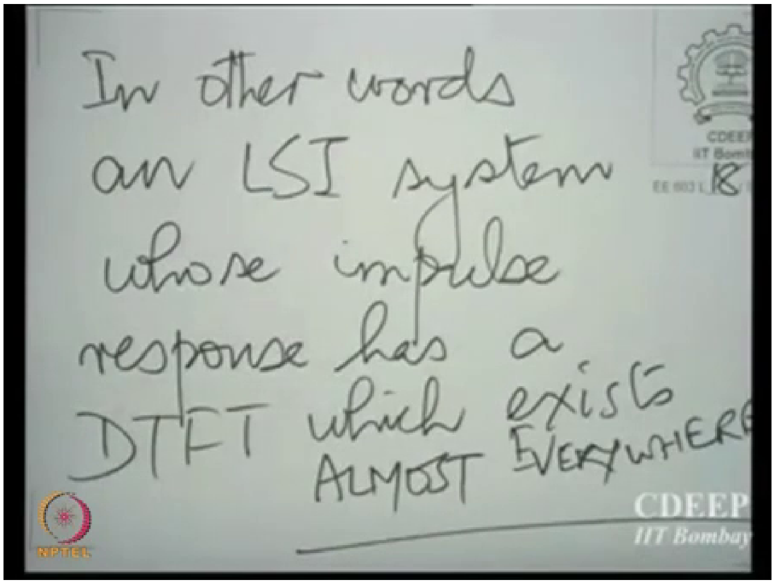
(Refer Slide Time: 01:53)



A discrete time filter is a linear shift invariant system, which has a frequency response. Now, this is interesting. What do you mean by it is has a frequency response or it is having a frequency response. Eventually, you are saying, of course, it has an impulse response, and the impulse response characterizes the linear shift invariant system completely.

But what you are saying is that the, the impulse response has a discrete time Fourier transform, which converges almost everywhere on the unit circle. Almost everywhere means, except for some isolated and a finite, such isolated set of points, it converges everywhere.

(Refer Slide Time: 02:55)



So, we are saying a linear shift in variant system, which in other words, an LSI system, a linear shift invariant system was impulse response has a Fourier transform of a discrete time Fourier transform, which exists almost everywhere. Of course, the moment you say discrete time Fourier transform, you are talking about the angular frequency axis.

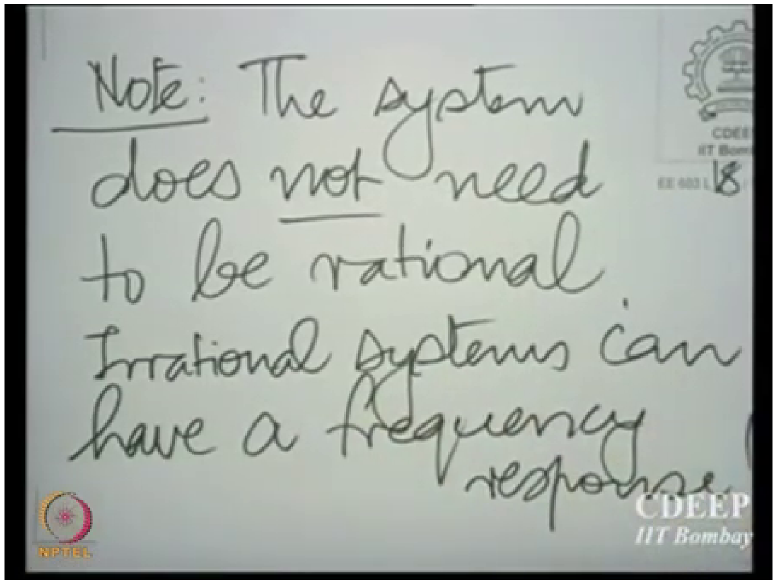
So, it exists almost everywhere on the angular frequency axis. In other words, on the angular frequency axis, between minus pi and pi or on the unit circle in the Z plane, there is at most a finite number of isolated points where there could be non convergence. Otherwise, everywhere else it converges. There is a question.

Student: (())(04:11)

Professor: That is a very interesting question. In fact, I am glad that question was raised. The question is, when we forced this, are we also forcing the system to be stable? Now, we shall answer this question as we go along. It is interesting, the answer is interesting. We will see the answer. In fact, this is one of the things that we are going to do in this lecture, we are going to try and answer this question, does it immediately imply the stability of the system.

Now you must not forget that we are dealing, we are talking here about both rational and irrational systems. It is not only rational systems that have a frequency response; irrational systems can also have a frequency response. So, let us make that remark. That is a very good question raised by Aashish.

(Refer Slide Time: 05:10)



So note, the system does not need to be rational. Irrational systems also have a frequency response. Can irrational systems have a frequency response? Now you know we will see why we need to make this remark as we go along because our purpose is designed, our purpose is synthesis. And when we want to synthesize, of course, we must synthesize to meet certain specifications. We do not synthesize arbitrarily.