Networks and Systems
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Lecture-1
Systems, Signals, Networks

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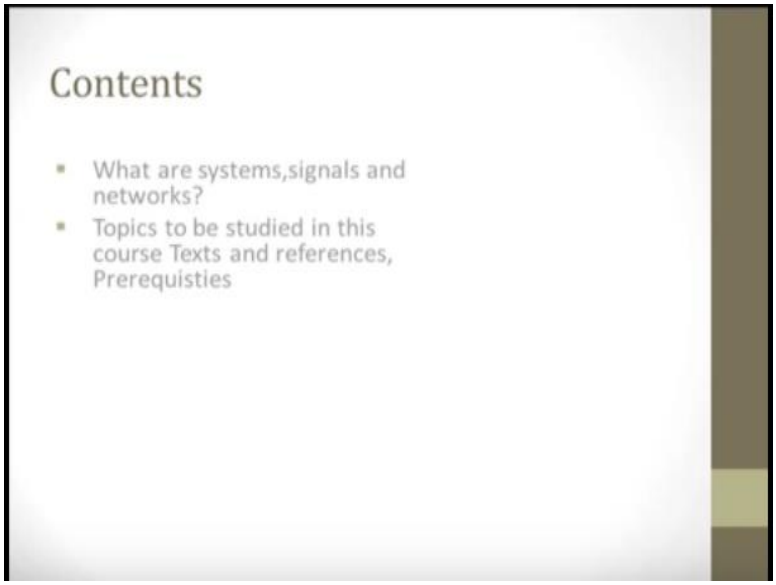

Hello, this is an introductory course on circuits and systems or networks and systems suitable for an under graduated students major in electrical engineering with either to power or communication option. In this course, we will study the dynamic behavior of systems and networks. You will be expose to a variety of tools and techniques which are used to study the behavior of the systems under with the dynamic inputs.

So that you can gain an appreciation of what particular techniques to choose under a given situation. When talking about systems we should also talk about signals. The input variables to a system, the response variable that where looking for and the various intermediate variables which occur a different points in the system are all collectively called signals and this is the term which we will use to describe this variables associated with systems.

Later on, we will say that a network is a special kind of systems and the voltage and current variables associate with a circuit or a network therefore are also called signals in the particular contest of a electrical work. These signals are usually functions of time a study of the characteristic of the signals and there analysis therefore it an integral component of our course. As a matter of fact, it is the interplay between the signals and systems that will be the main theme and focus of our course.

Among the topics which will study or for your methods for your transform Laplace transform method, network functions and network theorems, Z-transform methods and state variable techniques these will be the various topics that will be broadly covered under this course. We shall for the most part confine ourselves largely to the discussion of linear time invariant systems. The meaning of these two adjectives linear and time invariant will become clear as we go along.

Suppose is to say that the form a large class of useful systems so at the end of this course you will have with you a tool kit of available techniques. So that you can choose one of these took techniques for the solution of with a dynamic behavior of a network and system belonging to this very large class of linear time invariant systems. Before we proceed further to discuss the meaning of a system let me first talk about the various text books and reference books that we may like to refer to during the your study of the material under this course.

You may use this book to have some of your doubts clarify to deepened your understanding of a particular topic may be to get additional information related to some of the topics that are discussed here. But most importantly you should this book for working out the various problems and answering the various questions that are given as exercises in this book. Particularly for a subject with an analytic orientation like network and systems.

It is very important that you should work out a large number of this quantitative problems and answer this various questions. It is only through such exercises that you can from your understanding with the subject make your grip of the various techniques stronger and another

important aspect with this is that like an any other discipline in network and systems also there will be always a number of approaches to solve a particular problem.

Only through working out to this various exercises you will be having the ability to choose a the most direct method of attack for any one problem you have necessary expertise to gain the insight so that you can select the most appropriate method of attack for the solution of a problem and not only that to carry out the solution correctly and in quick time. So, I would once again emphasize the importance of working out a variety of problems and you can use some of the text books which I am going to mention right now as a source material for these problems.

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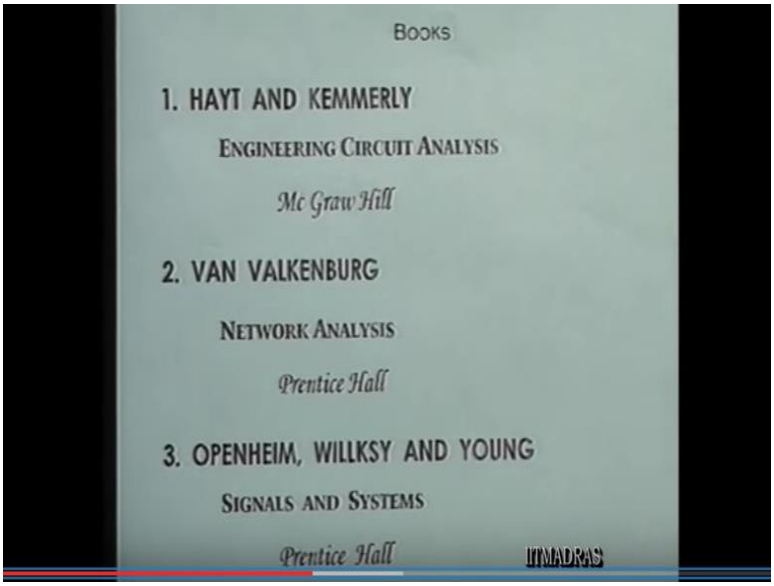

Now the particular text books that I would like to recommend are Hayt and Kemmerly, Engineering Circuit and Analysis, Van Valkenburg, Network Analysis these two are very popular books in this field. Openheim, Willksy and Young Signals and Systems is a very comprehensive gives a very comprehensive coverage of the topic that are covered in this course that's an additional topics and this also contains a wealth of problems and exercises.

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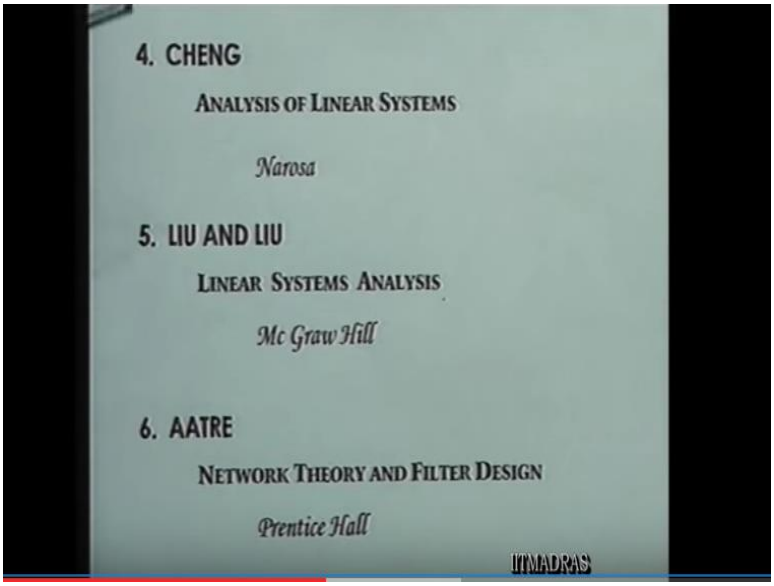

In addition to these three books you have a book by Cheng titled Analysis Of Linear Systems, Liu and Liu Linear Systems Analysis and a sixth book by Aatre Network Theory and Filter Design it contains discussion of some other topics we are going to cover in this course like state variable methods and so on which are not perhaps found in some of the other books. By way of a background I expect of you to follow this course let me mention that I expect the students to have a background on the following topics.

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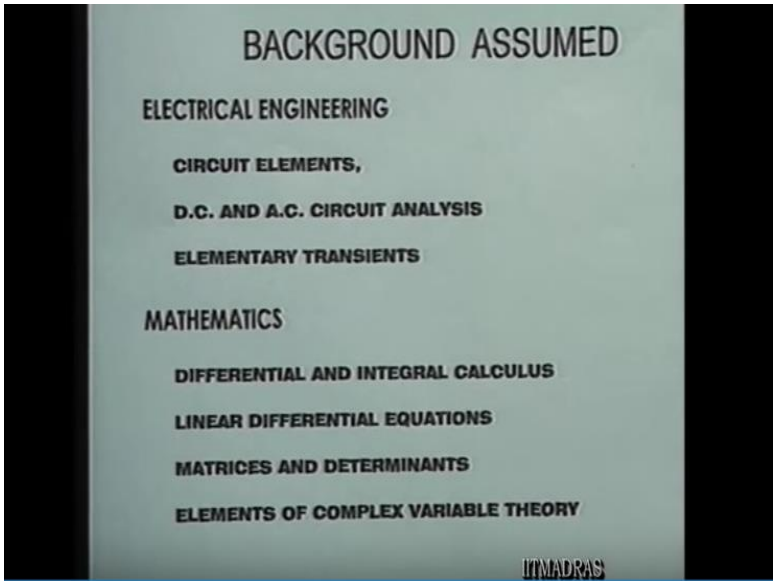

I assumed that you had a basic course in electrical circuit analysis which includes the discussion of the properties of various circuits elements. D.C and A.C. circuits analysis A.C. circuit analysis on the study state sinusoidal conditions and an idea of elementary transients time, constants and

R.C. circuit, R.L. circuit and so on and setting up the differential equation pertaining to simple circuits. This is a background in Electrical Engineering that I would assume.

As per Mathematics systems and you should be familiar with elements of differential and integral calculus solution of simple linear differential equations ordinary differential equations a constant coefficient. You should also have an idea of matrices and determinants solution of linear algebraic equations and then elements of complex variable theory is also expected a few to follow this course. So this is the background what one would expect you to have follow this course.

Now let us discuss what a system means. All of us intuitively have an idea what a system is constituted of through its usage in every day terminology. We may formally say a system is a collection of components put together to serve a particular purpose. These components are system components as they are called are unified through some kind of inter dependence among them. They react with each other so that the whole system function as a whole to serve a particular purpose.

You may think of a power system The National Educational system, Hospital systems, Railway systems, Transportation systems and so on and so forth. Many of these systems also have as a integral component the interaction of people for example in social economic system all these are constituents of systems. Now therefore a system is a collection of objects united through some form of interdependence among the various components or sub systems as you may call.

Now the variables that describe the status of this various components and a system may be quite diverse depending upon the nature of the component, the nature of the system and so and so forth. For example if you are talking about an electro mechanical system you may have the electrical variables voltage and current associate with a electrical components and mechanical variables like force and velocity which describe the status of the mechanical components at the particular point of in the system at a particular point in the system.

Therefore system is a omnibus type of concept which includes the whole variety of situations that once comes across. Now what about a network literally speaking a network is a structure which resembles a kind of net. But in our particular contest the term network to describe a system in which all the components are of a related kind. That means the variables which are of importance in this system are all of the same kind.

So in a particular electrical network for example is a special kind of a system in which the variables are voltages and currents most often that is these are the two variables which are the interest towards the electrical network. Similarly, we can have a network representing a mechanical system which will call a mechanical network we use the variables may be velocities and then force and so on and so forth. So, we can think of a network as a special kind of a system. In electrical network in particular is what constitutes the focus of our discussion here.

Now we analyzing these systems and networks the first up usually is to model the system in terms of idealized components put together in a particular fashion. This evolution of the model is done with two conflicting requirements in our mind what are the two conflicting requirements. First of all we should like to have the model as realistic as possible so that it stimulates the real system. In other words we should like to make the model as complex as possible so that we loose as little information about the system as possible.

On the other hand we should also like to make the model as simple as possible to lend itself to convenient mathematical analysis. So that the person uses this model for analysis and synthesis we retain a sanity in a sense because if it is going to be a huge a complex type of model we will be never to able solve it. Therefore, these are the two conflicting requirements in the evolution of a model of a given physical system.

The on one hand it should be as complex as possible so that it will loose as little information about the system as possible at the same time it has got to be simple enough to be lend itself to convenient mathematical analysis. Now we are very often refer to the model itself as a system even though we must always keep at the back of our mind that the model is a mathematical representation is an idealized representation the actual physical system is something different and

in some ways a physical system may not the characteristic may not agree with a model and if it so then we have to the find the model to make it more realistic where ever it is warranted.

Now in arriving at a model for a particular system the derivation of the model is specific to the particular discipline you must study the physics of the situation you must know the characteristic of these and arrive a suitable model. But once we have evolved a model then a whole lot of the system can be analyses through a common frame work a common set of mathematical tools which can be used to analyze a whole lot of this different system models because the mathematical equations that govern the operation of the various system are more or less the same.

Therefore, there is a unifying body of techniques and knowledge which come under the general title, system theory, at principle of the system analysis which will be the main scope of our study in under this course.