Statics and Dynamics

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Lecture - 01

Welcome to this course on engineering mechanics – statics and dynamics. As we talked about in the introductory video, static and dynamical systems are quite ubiquitous all aroundness. In this course, we are going to learn the applications of the laws of mechanics, the laws of motion as we were introduce to, to studying moving and stationery systems. Let us first talk of the prerequisites for this course. We do expect a basic understanding of high school physics, which is starting with Newtonian laws of motion – the three laws of motion that we were all introduced to in high school and some elementary calculus – understanding the idea of a derivative, understanding the idea of a higher order derivative, a first derivative, second derivative in time, because Newtonian laws of mechanics are intricately linked to developments that happened in calculus around the same time.

We are going to start discussing static systems first, stationery systems. We are going to understand the idea of a force, a moment or a couple. And we are going to look at both the effect of internal forces and external forces on static systems. The generation of internal forces and internal force distributions in static systems as well as understanding friction – friction like I said in the introductory video is a very interesting force; we are going to look at one or two different models for friction and see what that tells us in terms of the ability to understand a real world system. So, the course title as it goes is engineering mechanics.

Now, engineering systems are always real world systems. They are systems that you and I use on a daily basis. The laws of mechanics on the other hand are somewhat more theoretical. And one of the primary objectives of this course is to show you that, the theoretical laws of mechanics are very much applicable to understanding and analyzing the real world engineering systems as well as natural systems. And in order to apply the laws of mechanics to real world engineering systems, one would have to make a certain number of idealizations, remove certain details in the natural system or the engineering system in order to apply the laws of mechanics in a simplistic fashion in order to apply

the laws of mechanics and generate results that one could apply, relate back to the engineering system.

Let us take a very common ubiquitous example of a static system, a natural system as a matter of fact. Let us take a large tree – a fairly old tree. It is basically a static structure; there is a trunk; there are several branches that we see above ground. And there is a root structure underneath. Now, the result of gravitational pull acting on all of these objects causes internal forces inside the trunk and inside the branches. Those internal forces are responsible for the fact that the tree itself is able to bear a certain external load; let us say an animal walking on the tree. Now, in order for me to apply the laws of mechanics to a tree, if I ask the question – do I have to consider the very scaly nature of the bark covering the trunk? Do I need to include the details of the number of scales covering the trunk O can I just treat this like a vertical rod like a vertical pillar? The answer as you may relate to is it may be sufficient to treat a trunk as a vertical pillar in order to gain an understanding of the force inside that pillar. This is an example of a situation, where we threw out certain details that were not relevant to our analysis. Our analysis is focused on understanding the kinds of forces that are generated inside the tree trunk. And in order for us to understand the forces generated inside the tree trunk, I do not need to consider the structure of the bark covering the trunk. This is one example of where we threw out the details and retained the essential components of our natural system. So, after you throughout the unessential details, what remains is what we will call a model of the real system.

And, we will apply our laws of mechanics to the model system. And in many instances, the application of the laws of mechanics to the model system involves a certain analysis procedure. We will learn that in detail in this class. We will also touch upon intelligent ways of discarding unnecessary details in the real system that we can use to generate these model systems. So, in fact, a human being is more and more necessary in the second part, which is taking a real system and generating an equivalent model system that retains all the necessary details. That requires a certain level of intelligence. Analyzing the model system through the application of the laws of mechanics, in most instances, can be computerized. So, we want to understand what can be computerized and what really cannot be computerized as of now in a generalized sense. And once we realize our value in this chain, we would like to emphasize the learning aspects as well

along those same paths; one – understanding model systems and analyzing model systems; and two – generating these model systems from real engineering systems. So, that is going to be the emphasis of this course on engineering mechanics.

Now, the course itself is going to be structured as primarily a set of solved example problems. The reason for this is analysis as a tool or the application of the laws of mechanics can best be understood by looking at model example problems and understanding the outcomes of the application of the laws of mechanics to those model example problems. So, we will concentrate week by week on solved example problems. So, we will solve examples that would illustrate a concept. And towards the end of that solved example problem, we would learn the concept itself. So, we would always precede a concept with an example that you can relate to. So, through the course of the next eight weeks, we expect to solve between 30 to 40 example problems that would illustrate 30 to 40 different concepts underlying the laws of mechanics.

So, welcome to this course and we hope you all come along for the ride. The example problems solved in this course will span the breath of static and dynamical systems in different contexts. The assignments would also span the same set of static and dynamical systems. So, if you understand the solved example problem, you should be able to make a very good headway in solving the assignment problems that are given week after week. So, come onboard and let us ride together in this journey through engineering mechanics.

Thank you and welcome.