Advanced Dynamics
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Lecture - 56
Symmetries and Conservation Laws - I

In this lecture, I am going to discuss some finer issues that are associated with Lagrangian mechanics. We are going to discuss symmetries and their corresponding conservation laws. This is our first lecture on symmetry and conservation laws.

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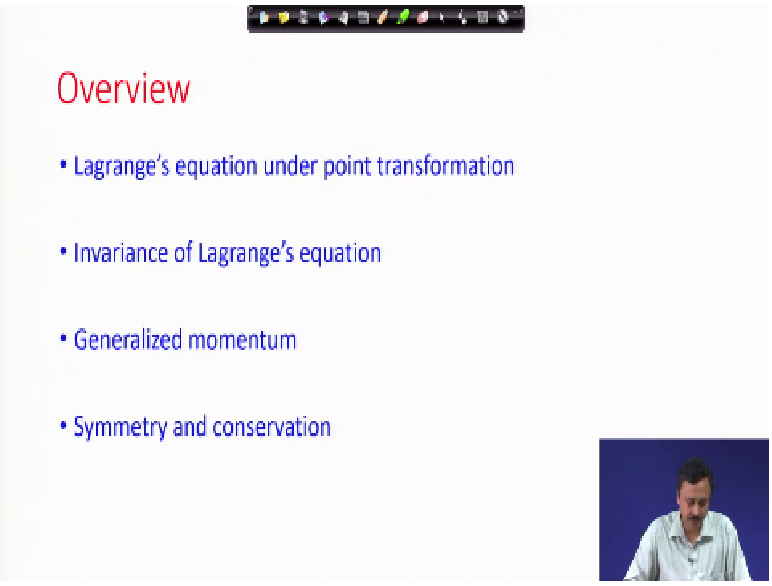

We will start with point transformation and see the invariance of the Lagrange's equation structure under point transformation. Next, we will introduce the concept of generalized momentum, and I am going to show you how the structure of Lagrange's equation of motion compares with Newton's second law of motion.

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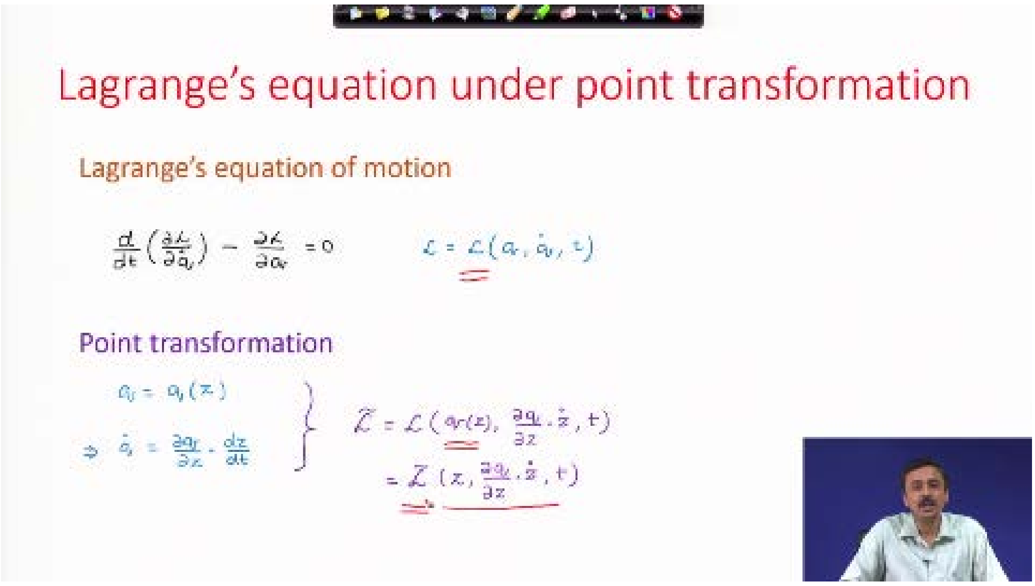

The above slide introduces the concept of point transformation.

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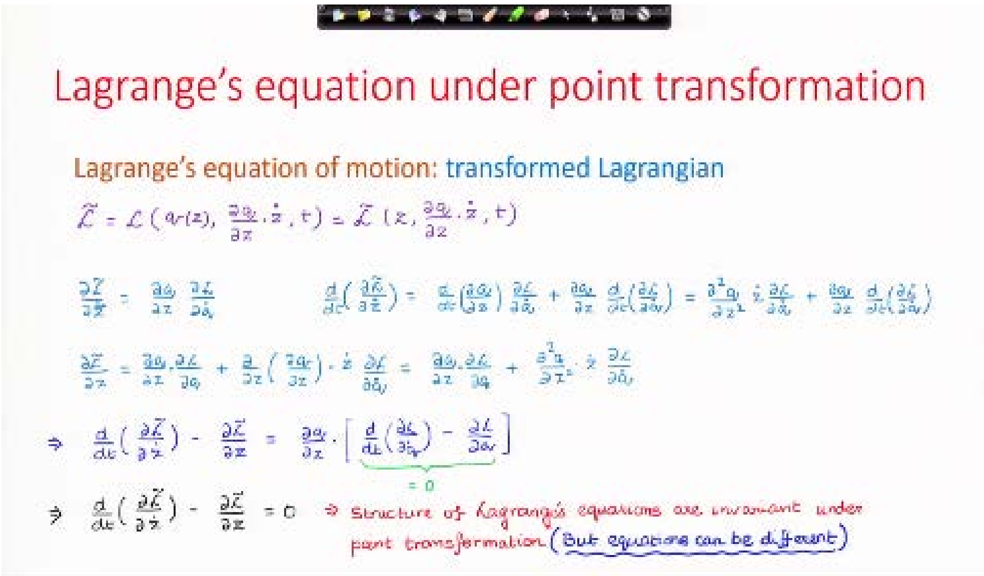

As shown in the above slide, the structure of Lagrange's equation of motion remains invariant under point transformation.

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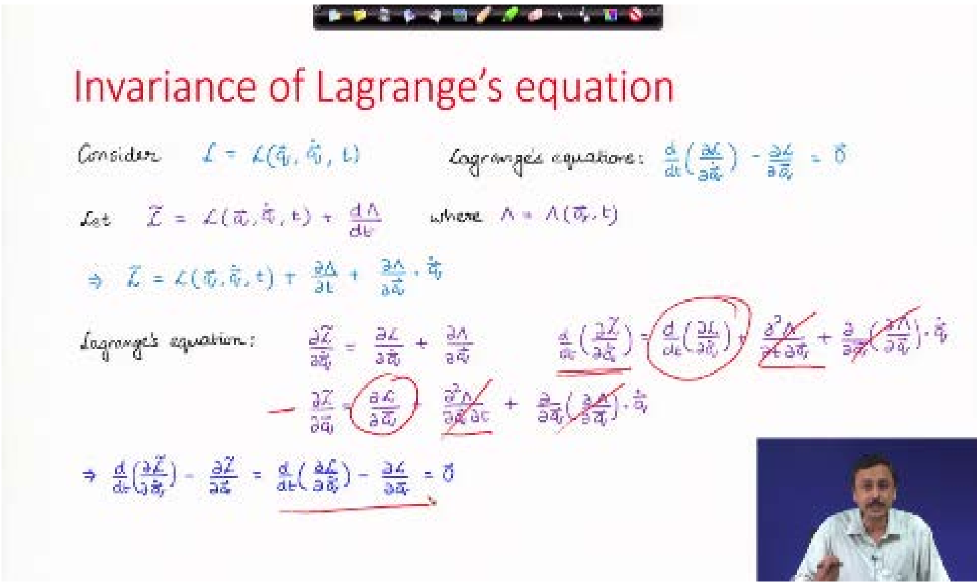

Next, we look at the effect of adding a total time derivative to the Lagrangian. It is to be noted that the function Λ is a function of only the generalized coordinates and time.

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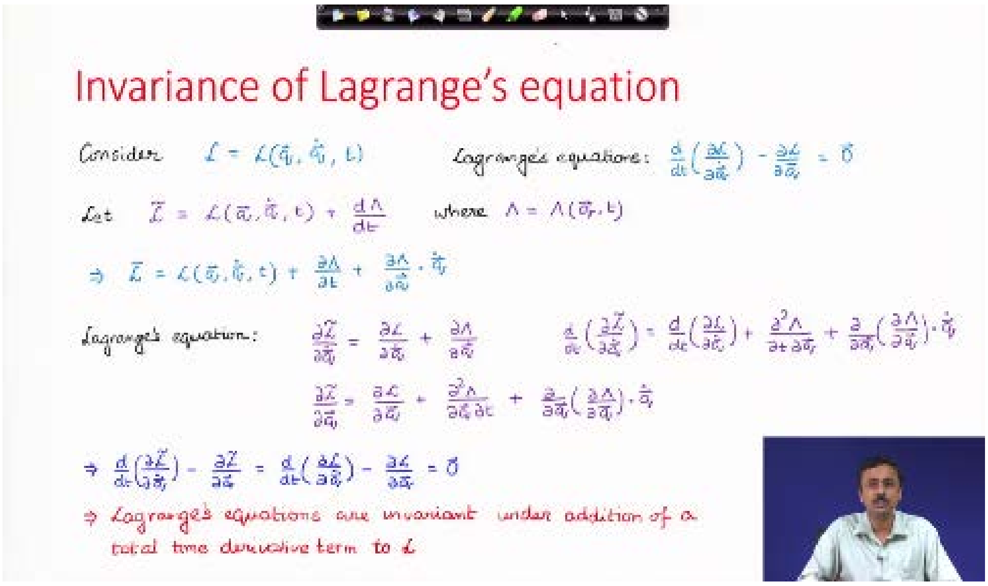

It is observed that the Lagrange’s equations are invariant under the addition of a total time derivative term to L. This idea can be used to simplify the Lagrangian by removing any part of the Lagrangian that is a total time derivative of a function involving the generalized coordinates and time.

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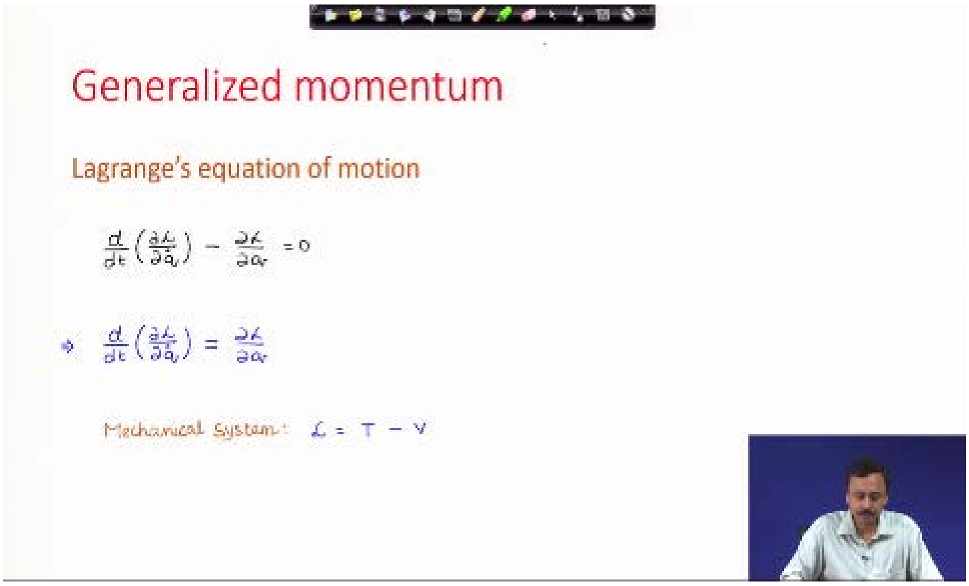

Now, we will introduce this very important concept of generalized momentum.

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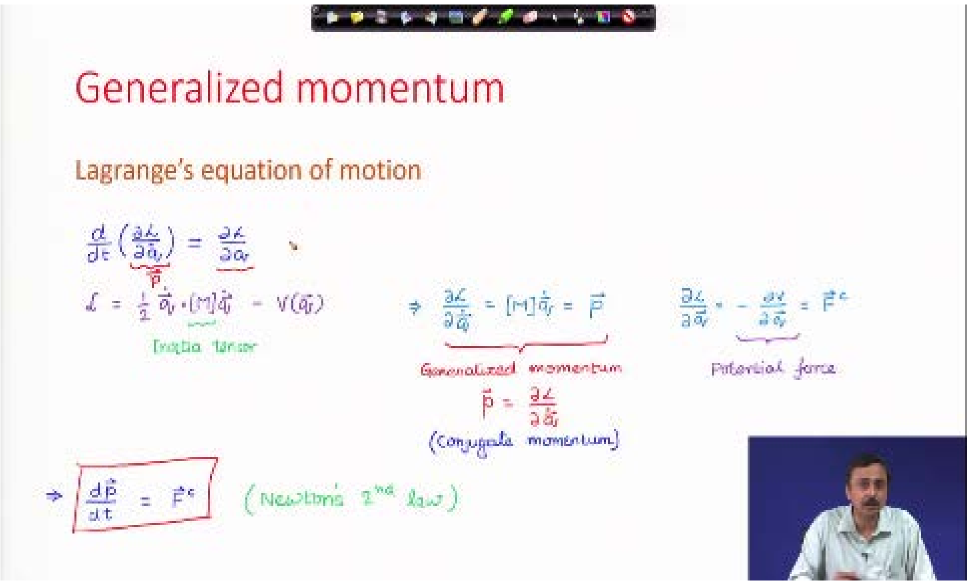

Using a conventional structure of the Lagrangian, we show the correspondence of the Lagrange's equation of motion with the Newton's second law in the above slide.

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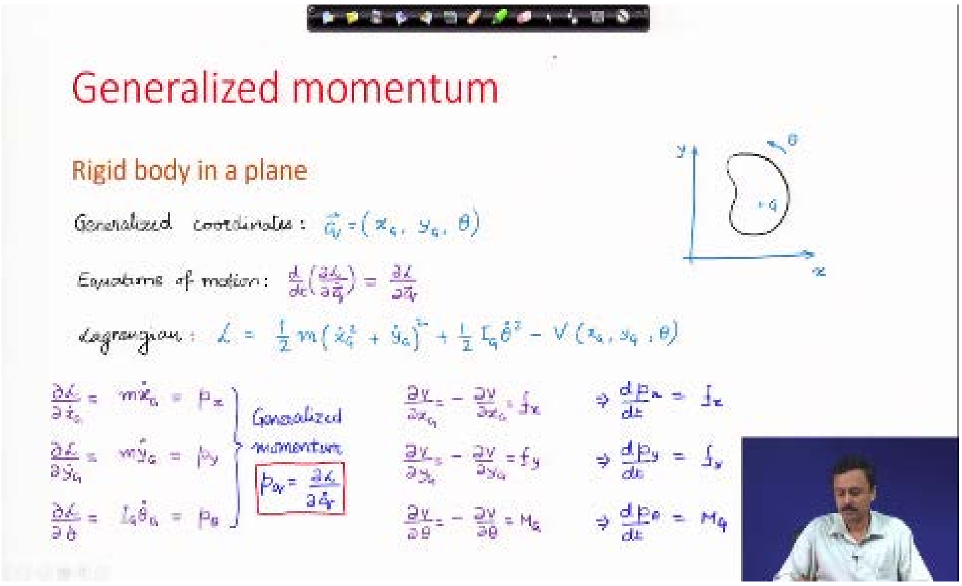

The above slide considers a generic example of a rigid body in a plane. The equations of motion obtained from the Lagrange's equation correspond to the structure of Newton-Euler equations of motion through the concept of generalized momentum.

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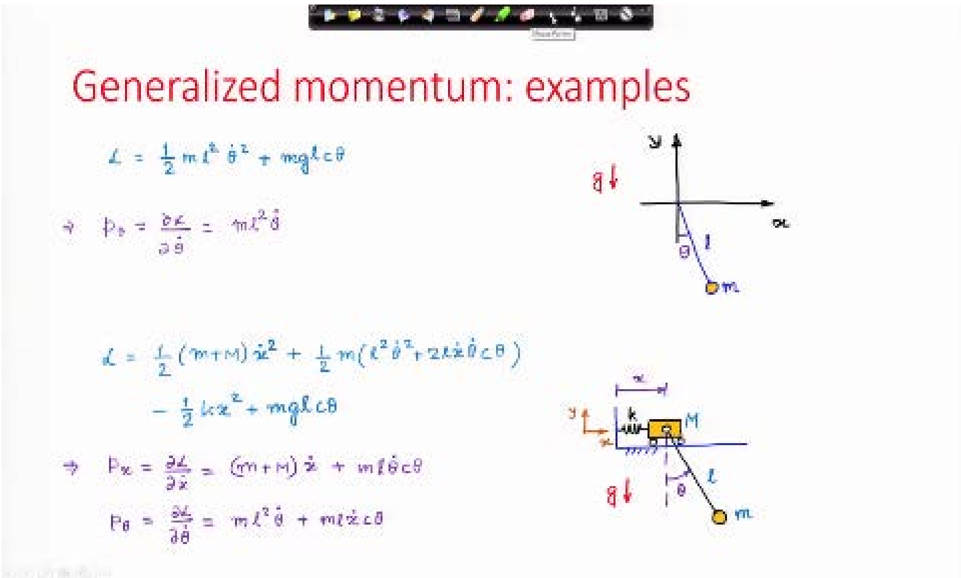

Two examples are used to explain the concept of generalized momentum.

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