Advanced Dynamics
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Lecture - 58
Symmetries and Conservation Laws - III

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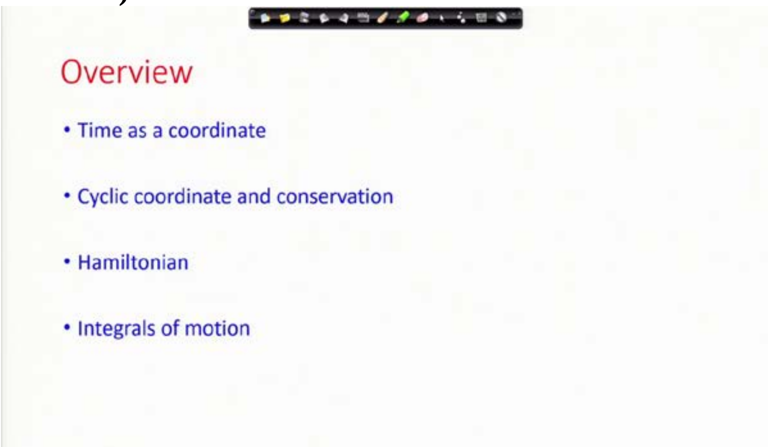

We discuss further on symmetries and the associated conservation laws. The overview of the lecture is shown above. We will consider now time as a coordinate and discuss the consequences of time as a cyclic coordinate.

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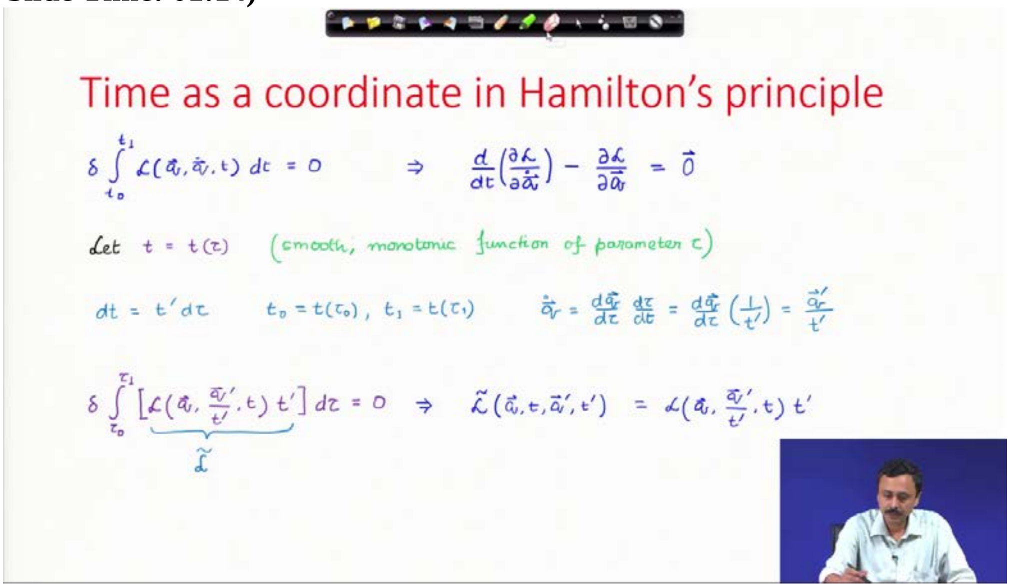

We start with introducing time as a coordinate in Hamilton's principle. Consider the parameterization of time by another parameter τ as shown in the slide above.

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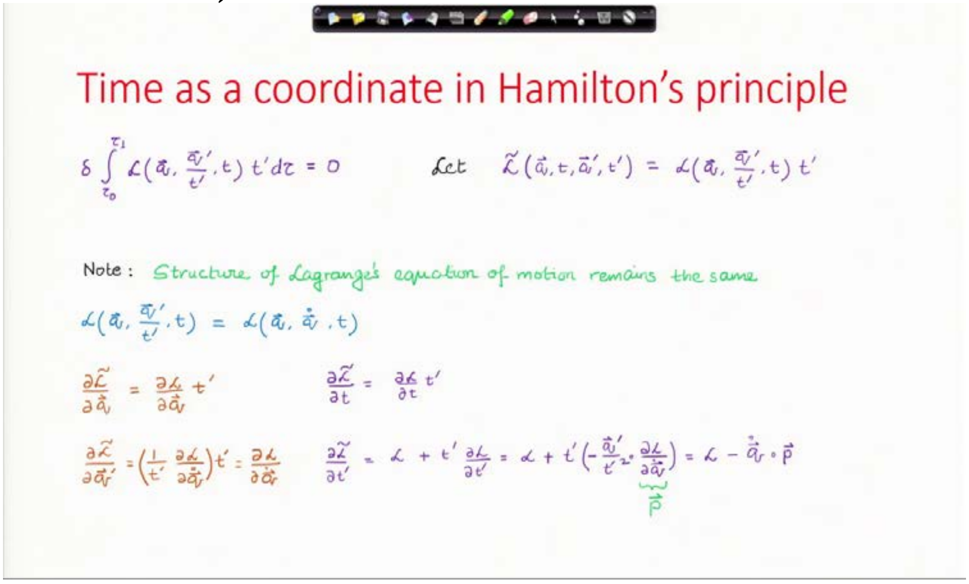

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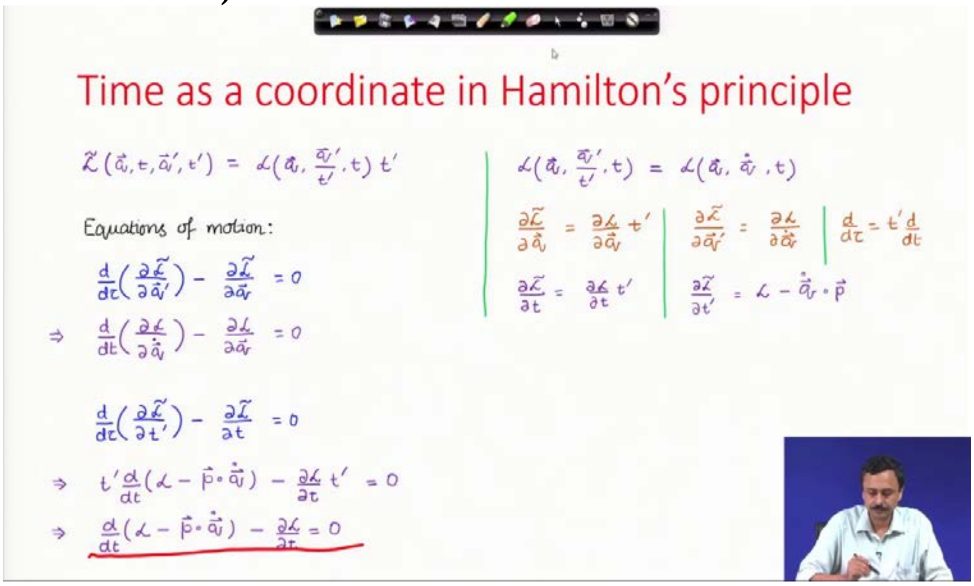

The Lagrange's equations of motion are derived in detail in the 2 slides above. We obtain a new equation corresponding to the coordinate t.

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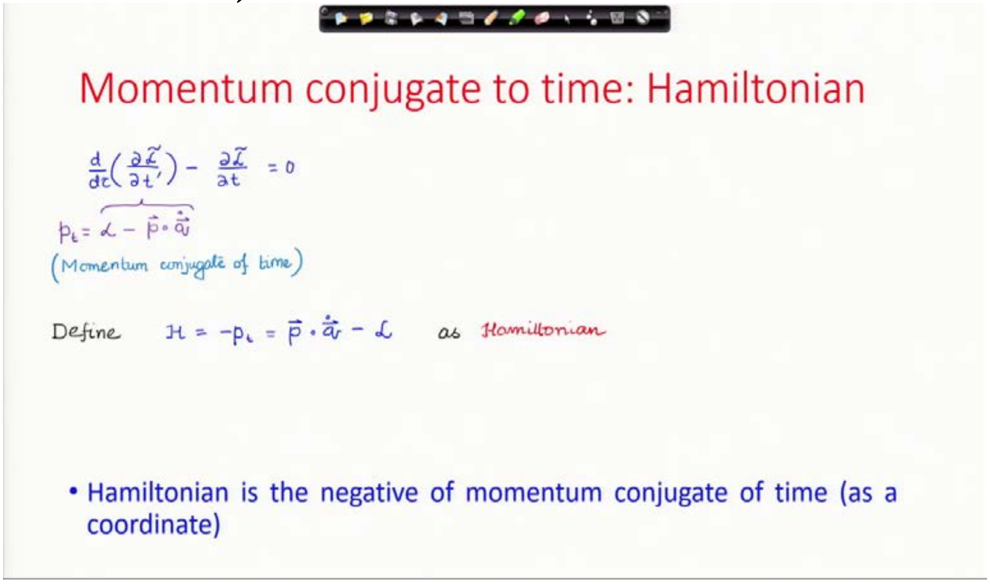

We concentrate on this new equation, as shown in the slide above and define the Hamiltonian as negative of the momentum conjugate to the time coordinate.

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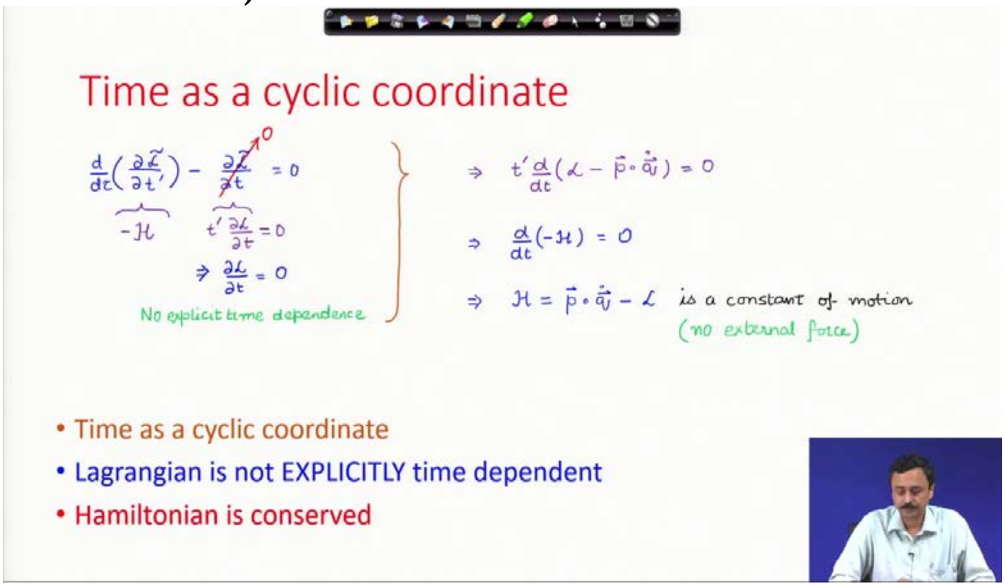

Next, we consider the situation where time is a cyclic coordinate. If the system has no external forcing, and time is a cyclic coordinate, then the momentum conjugate to time, the Hamiltonian, is conserved.

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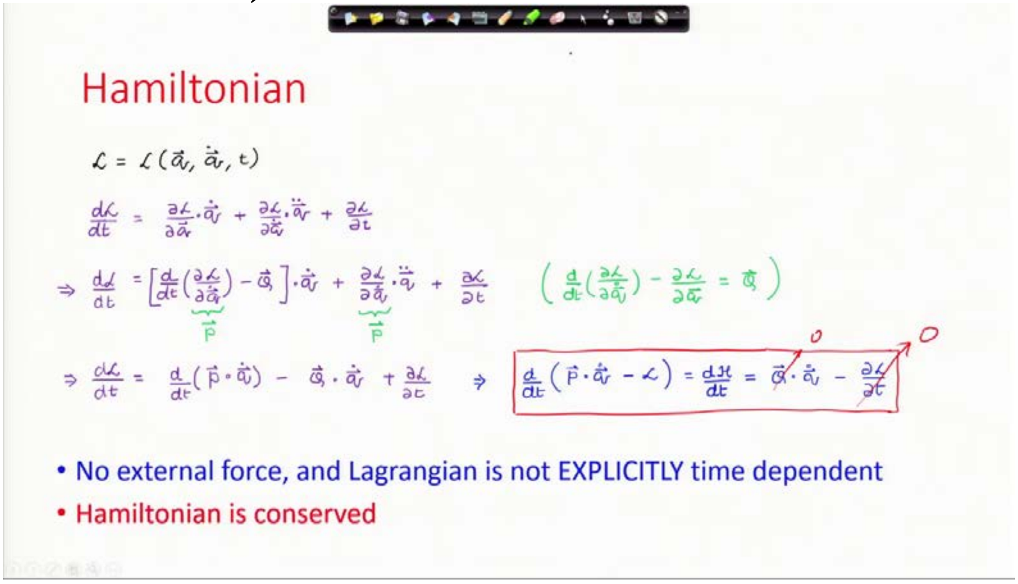

An alternative approach presented in the slide above.

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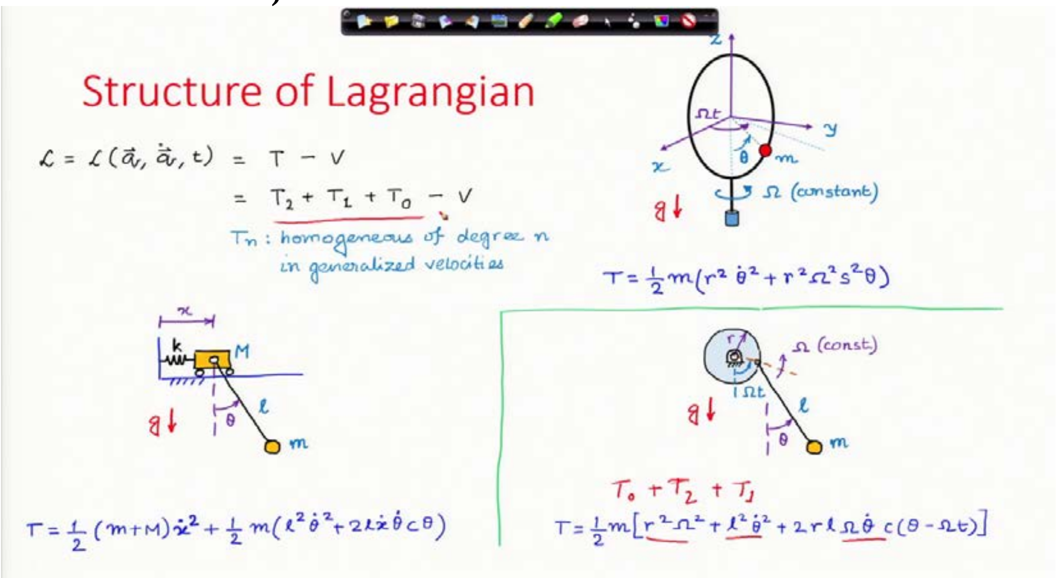

In the above slide, we discuss the structure of the Lagrangian. It is observed that the kinetic energy term may be decomposed as $T=T_0 + T_1 + T_2$, where T_0, T_1, and T_2 are, respectively, terms that are independent, linear and quadratic in the generalized velocities.

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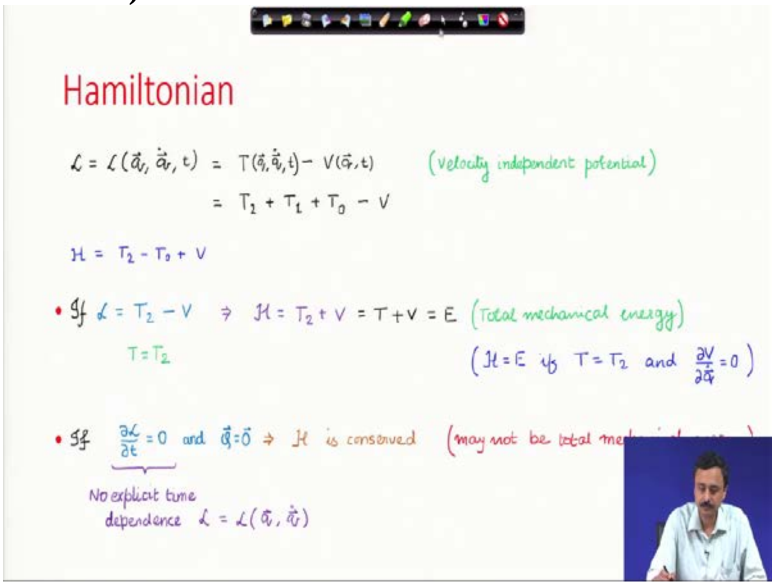

Based on the structure of the Lagrangian, an interpretation of the Hamiltonian is provided in the above slide.

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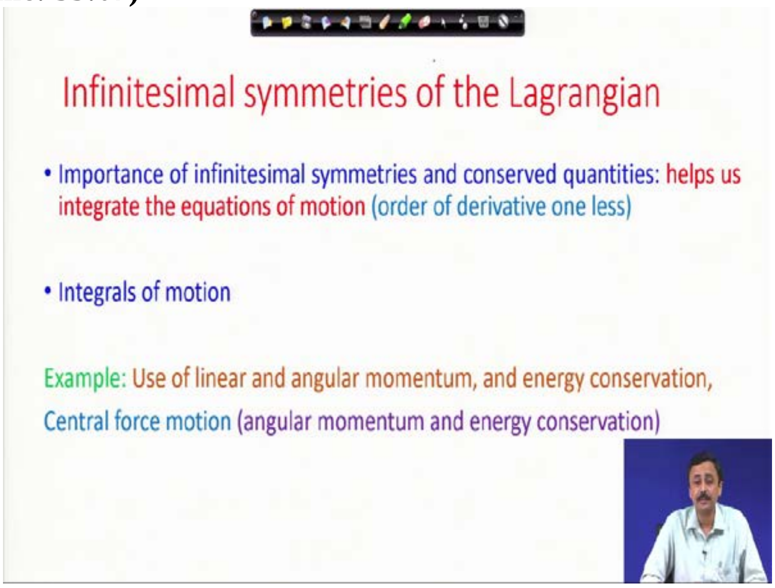

The reasons why we are interested in infinitesimal symmetries of the Lagrangian are presented in the above slide.

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The summary if provided in the slide above.