Lezione 1 - Intro +

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Diana, Kelly: Dynamics of Mechanical Systems.

Exam:

- → Parte A: Form with filling in matrix
- → Parte B: 1 hour, 3 excercise
- → Parte C: Oral Exam

Mechanics of Vibrations

- → Air vibrates to allows us to hear eachother.
- → We can also hear in water, there is a media for which the vibration passes.
- → Have a mechanical system

macchine vs. mechanical system

→ mechanical system that transforms energy

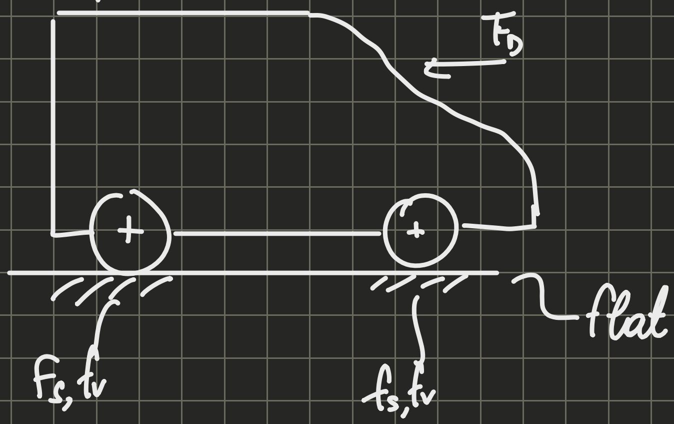
→ 2 kinds:
- → are not moving
- → can move with a degree of freedom

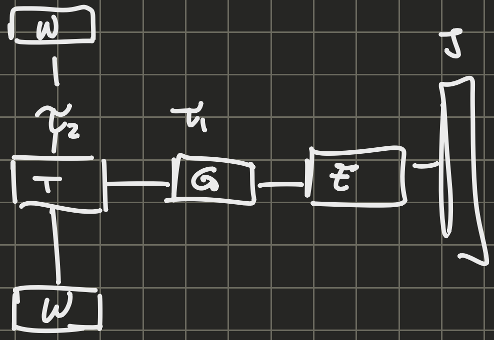
→ Rigid bodies connected to eachother by constraints.

We use mathematical models to describe mechanical systems.

→ we can build mathematical models with different precision and complexity depending on my purpose.

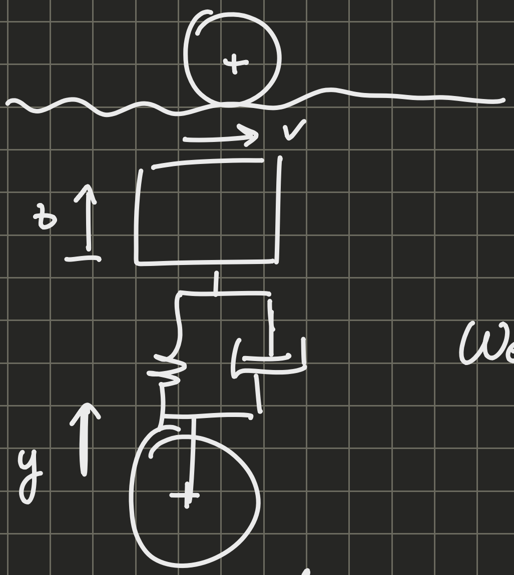
Example about models:





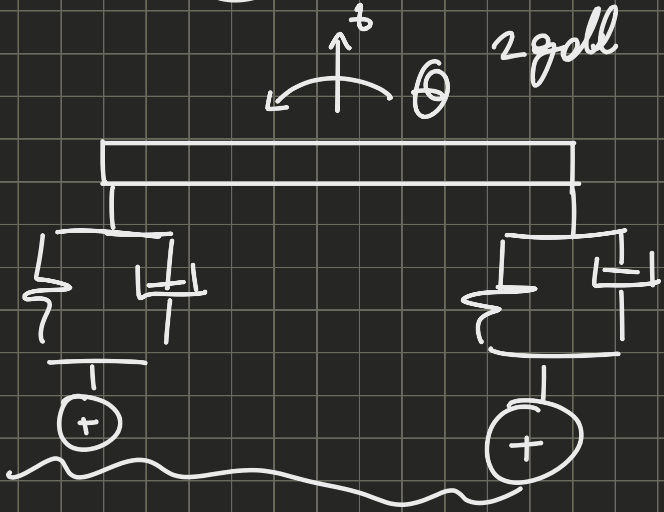
We can find the motor, which will get us to 200 km/h, this is mass independent.

If the road is not flat:



We want to be comfortable so we need to find the position of the car body.

We can dimension the suspension.

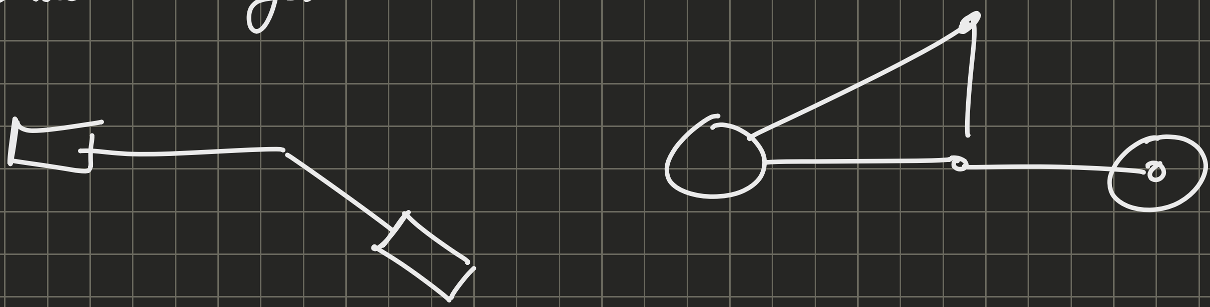


If we can to dimention the force, we can find the angle this allows us to dimension the breaking force.

We can find the rotation and the vertical position.

If we want to turn we can make a single model

Like the bicycle:



The more want to find the more degrees of freedom do we need to get.

We will only look at these, finish with systems of 3, 4 or 5 gdl.

Equation of Motion → x gdl → x equations of motion.

Equation of Motion vs. Pure Equation of Motion

Unknown:
- degree of freedom (dof)
- derivate of the dof

↳ Pure if the unknowns are only these

If there are more unknowns they are not pure, like contact forces.

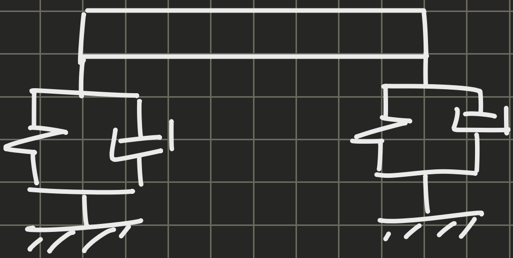
Law of Motion

↳ Linear System with n dof

$$[M]\ddot{\underline{x}} + [R]\dot{\underline{x}} + [k]\underline{x} = \underline{F}$$

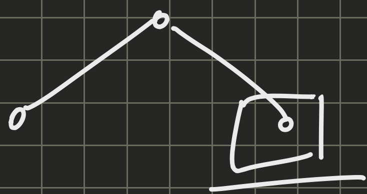
Law of Motion is the solution to this, in the form $\underline{x}(t)$

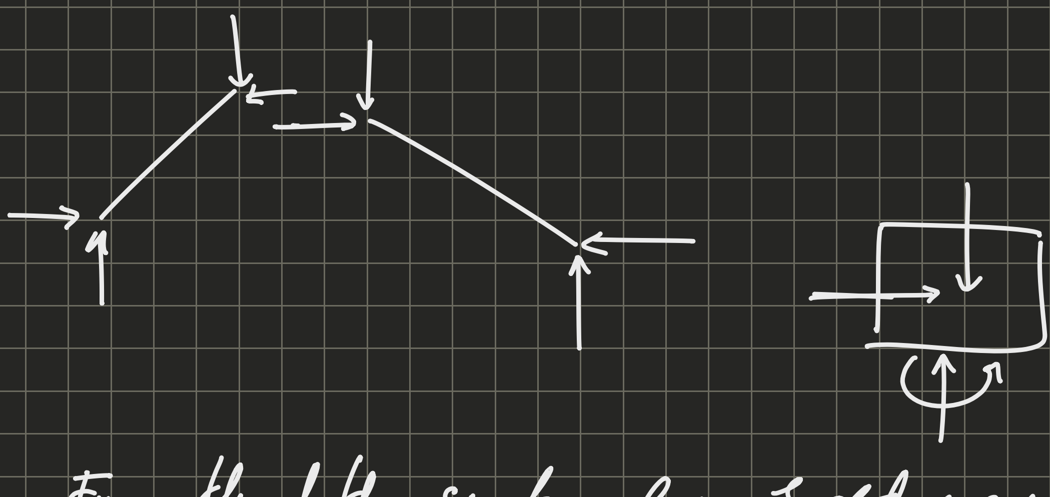
For non-linear $M(\dot{\underline{x}}), R(\dot{\underline{x}}), k(\underline{x})$



We can describe the system through dynamic equilibrium or energy balance.

Dynamic equilibrium, we have to dissemble the system and pointing ab the reaction forces between each.
This means that for each body we will have 3 dof.
meaning that we need 9 equations.
The unknown are the forces and the dof and their derivatives.





Even though the system has 1 dof we need to have 9 equations.

Instead using the approaches of energy (virtual power) we only need to focus on the forces generating work.
this mean that we only need one equation for any

n - dof system.

If we don't need to know the internal forces and only the motion then we use the energy (Lagrangian)

Lagrangian equation

E_c , V , $\delta^* \mathcal{L}$, D

Kinetic

potential

Dissipation Function

connected to springs

Virtual Work

$$\frac{d}{dt}\left(\frac{\partial E_c}{\partial \dot{\underline{q}}}\right) - \frac{\partial E_c}{\partial \underline{q}} + \frac{\partial V}{\partial \underline{q}} + \frac{\partial D}{\partial \dot{\underline{q}}} = \underline{Q}$$

Most important part of this course.

$\underline{q}$ → vector of the degree of freedom

$\dot{\underline{q}}$ → derivative of the vector of the degree of freedom

$E_c = E_c(\underline{q}, \dot{\underline{q}})$

$V = V(\underline{q})$

$D = D(\dot{\underline{q}})$

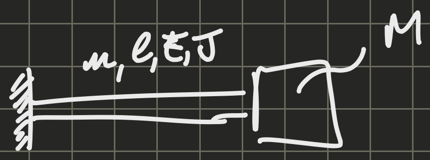
To work with this equation we need to remove our geometric intuition.

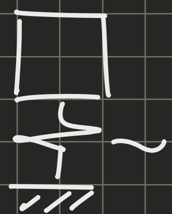
We will write for one-non linear, the linearize.

Then we will look at the oscillator.

We will look at higher degree of freedom, non-linear and then linearise.

We will look at small oscillations around the point of equilibrium.





$\sim \dfrac{3EJ}{l^3}$ } Equivalent to the spring

This is a model which allows us to calculate the motion.

We will finally look at different types of forces and the real applications.

Giorgio Diana, Federico Cheli — Advanced Dynamics of Mechanical Systems