



**POLITECNICO**  
MILANO 1863



# Functional Mechanical Design

Introduction

Simone Cinquemani

Prof. Simone Cinquemani	Eng. Morgan Bono
T: 02-2399-8454	T: 02-2399-8265
<a href="mailto:simone.cinquemani@polimi.it">simone.cinquemani@polimi.it</a>	<a href="mailto:francescomorgan.bono@polimi.it">francescomorgan.bono@polimi.it</a>
There is no official reception hours. Ask for appointment during the class or by email.	



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Eng. Daniele Catelani
<a href="mailto:daniele.catelani@mscsoftware.com">daniele.catelani@mscsoftware.com</a>



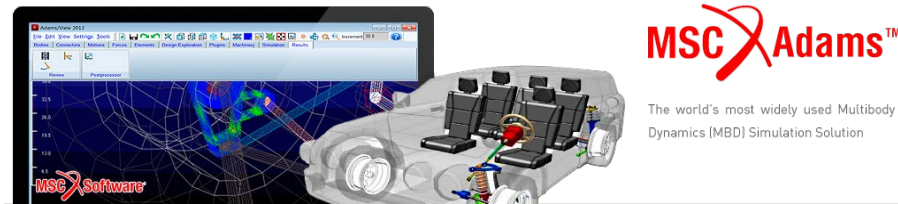
During the course everything you need will be uploaded on BEEP.

There you will find:

- Slides of the lessons (hopefully before the class...)
- Slides of training lessons and additional material
- Some books and papers...



During the course we will use Matlab and Adams to design machines.  
Adams Student Edition can be freely downloaded from:



<http://www.mscsoftware.com/student-editions>

Please download it today as it takes a few days to get the licence!

Real time quizzes will be done during lessons to engage the class, share learnings and do self evaluations. Download on your smartphone the app:  
Socrative Student



The Exam is oral and covers all the topics of the course  
(lessons, practice, workshops, etc.)

**Few rules:**

- Oral test can be attended whenever you want during the academic year
- Ask for an appointment for the exam (by email) with one week notice and enroll to a official exam session
- We'll find a date to do the oral test

**Important:**

During the course you'll have to develop a subsystem of an automatic machine. Check rules at the end to know how to prepare the report to attend the exam

# Why attending this course?

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The most suitable definition can be found in the European Machinery Directive 2006/42/EC.

## Article 2.

For the purposes of this Directive, 'machinery' means:

an assembly, fitted with or intended to be fitted with a **drive system** other than directly applied human or animal effort, consisting of **linked parts** or components, **at least one of which moves**, and which are joined together **for a specific application**.



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## **...for a specific application**

The first step in design a machine is to understand which is the task/function

## **...at least one of which moves...**

To fullfill a task a part of the machine needs to move. Everything in the machine comes from the design of this motion.

## **...linked parts or components...**

Motion is transmitted through elementary or complex transmissions. Most of these transmissions in industrial field are mechanisms and cams

## **...drive system...**

Motion is provided by actuators that provide the power to carry out the task

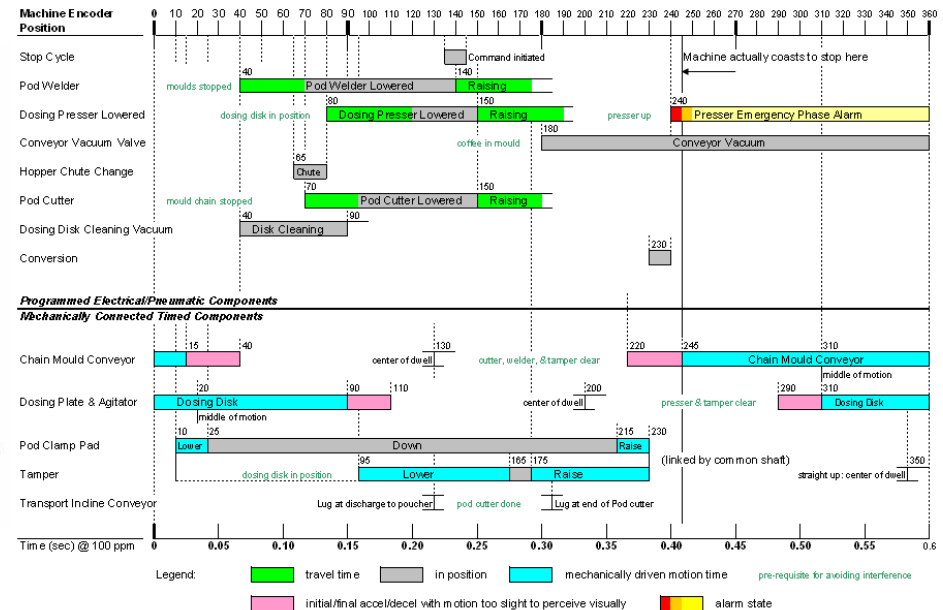
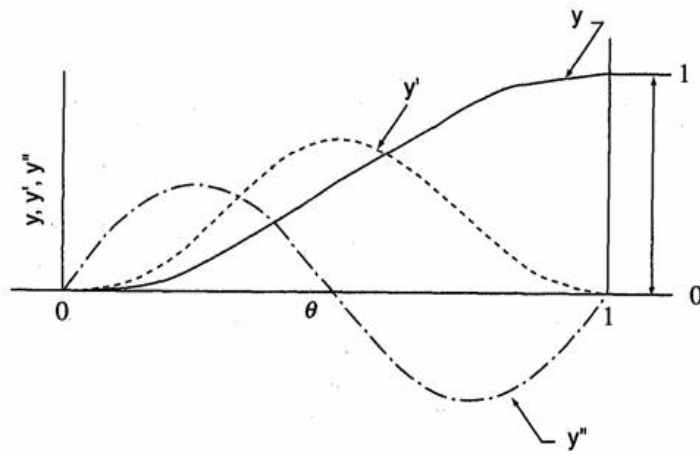


# Topics

...at least one of which moves...

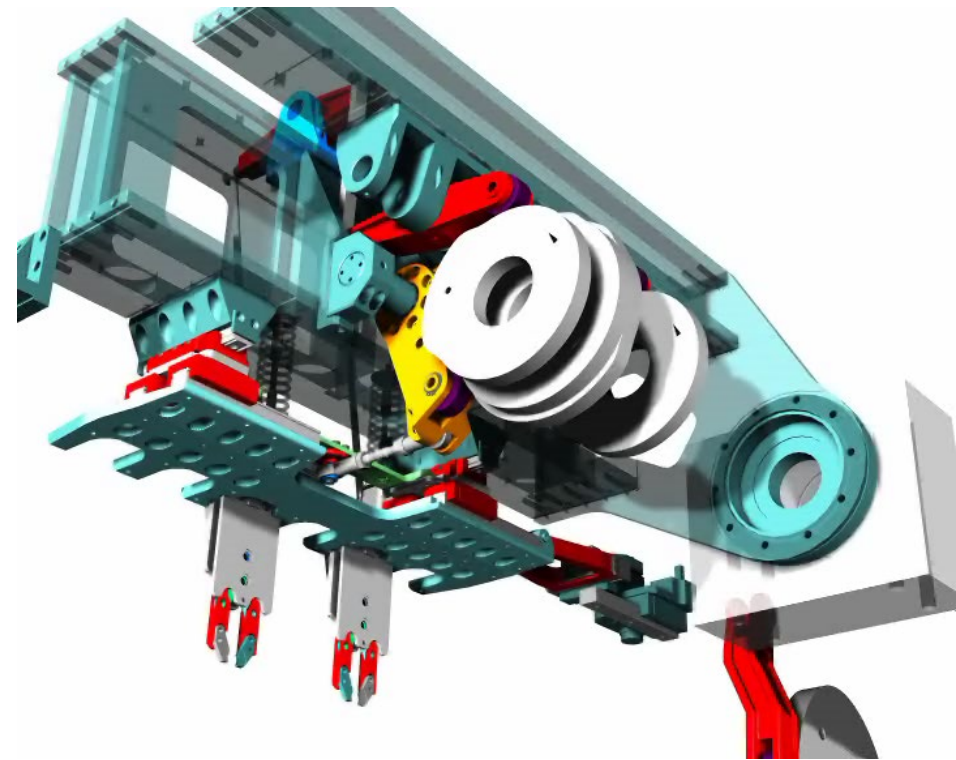
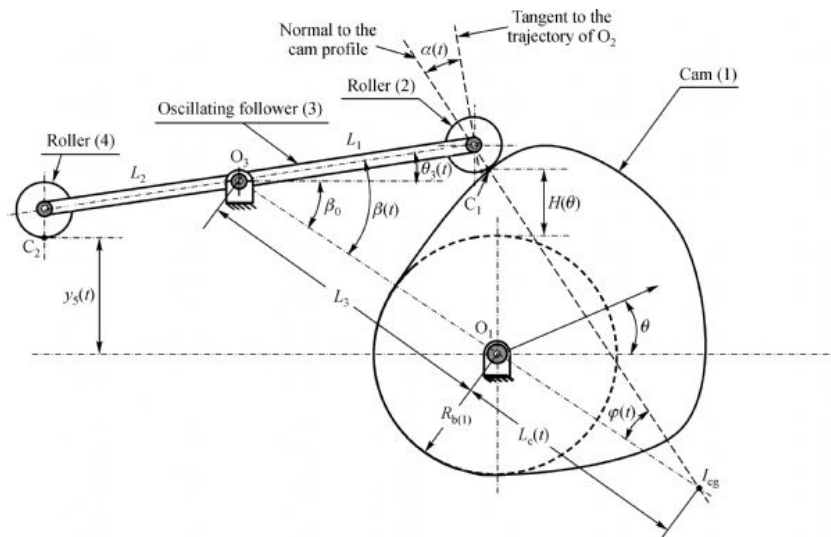
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**Motion laws:** Analysis of motion laws for industrial applications. Definitions, properties, limits of motion laws with particular boundary conditions: starting from zero with no velocity and arriving to total rise (h) with no velocity.



by Eric Allen

**Cam mechanisms:** Synthesis and analysis of planar cam mechanisms used in industrial automation with particular reference to the manufacturing environment.



**Linkage mechanisms:** Analysis and reference to synthesis of linkage mechanisms. Classification of linkage mechanisms based on the number of the links and description of some particular kind of linkage mechanisms among which quick return mechanisms, force multipliers, etc.

A. Weil 2009

**Actuators:** catalogue reading and typical problems in choosing electrical motors and pneumatic actuators.

An induction (AC) motor

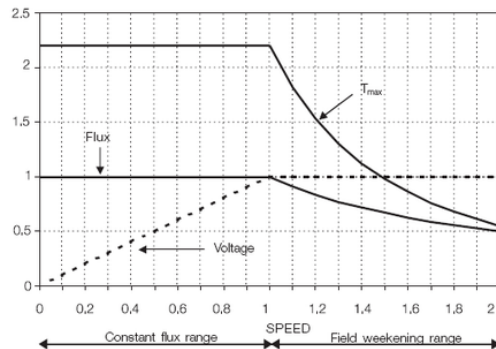
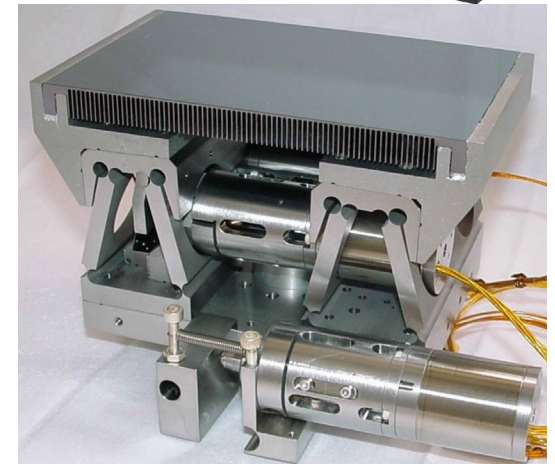
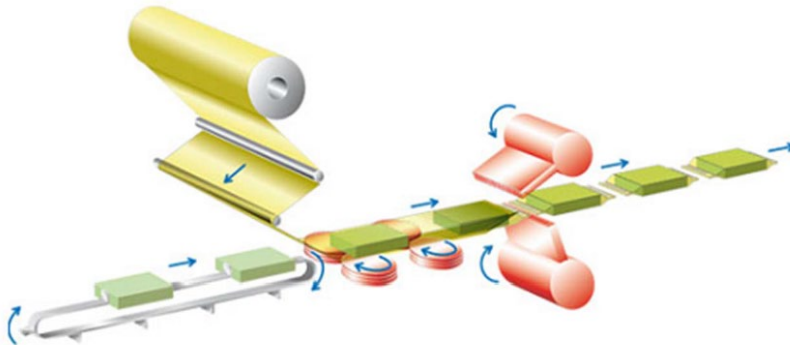
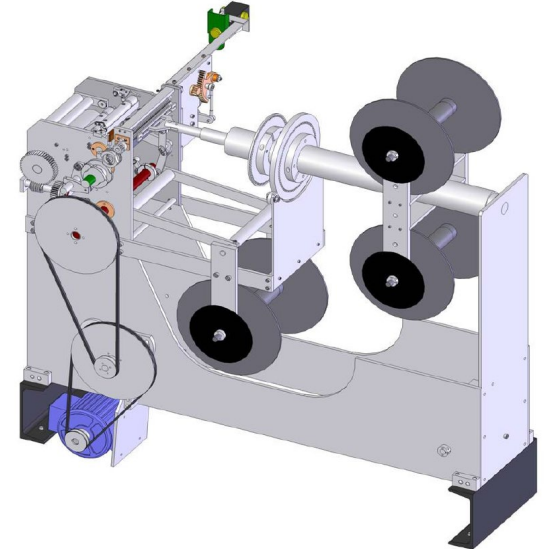
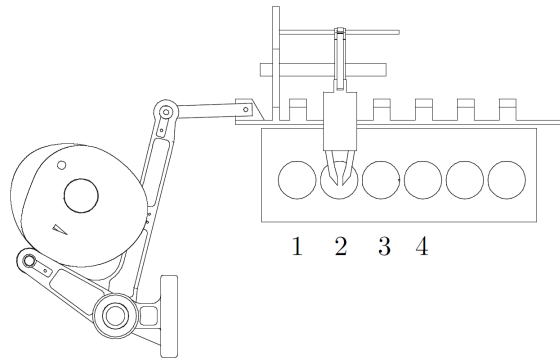


Figure 4.3 Maximum torque, voltage and flux as a function of the relative speed.



During the course our attention will be focused on **machines for industrial applications**.

- Packaging
- Filling
- Mounting
- Pick & Place operations



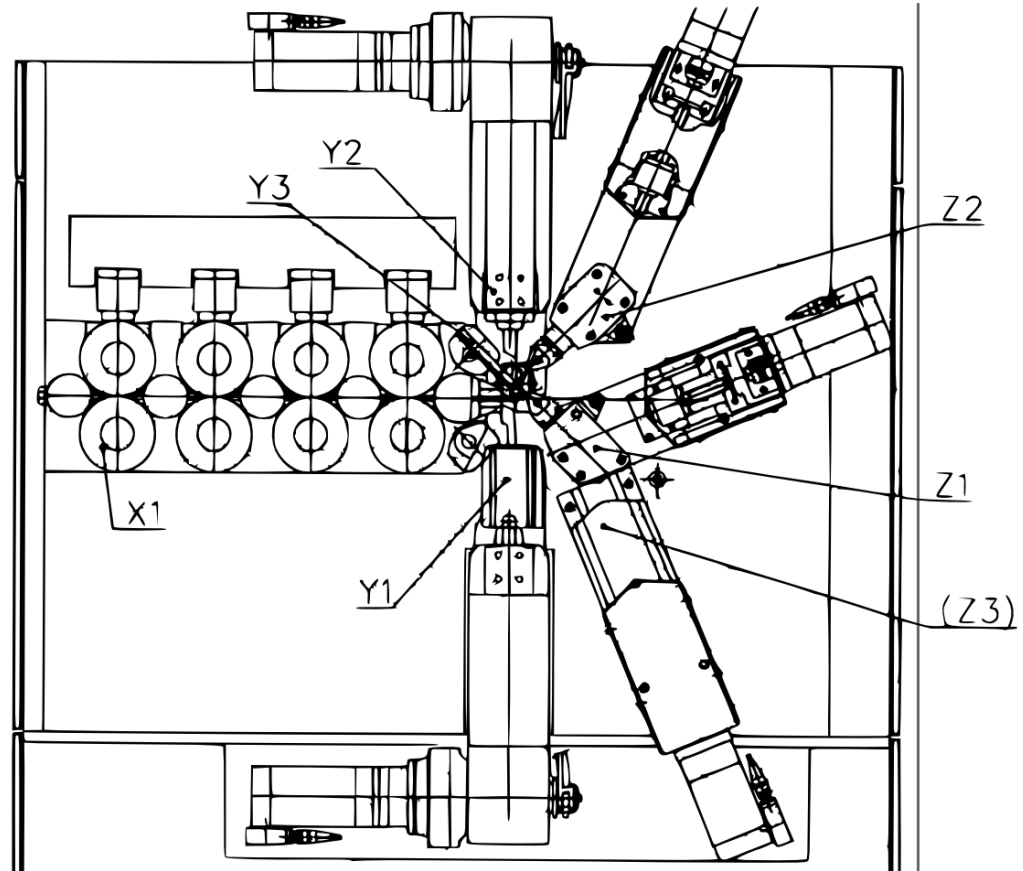
A machine is generally a very complex system and it's quite hard to design it from the beginning as a whole. It's better to split it into **functional groups**, each devoted to fulfill a very simple task, synchronized to get the final result.





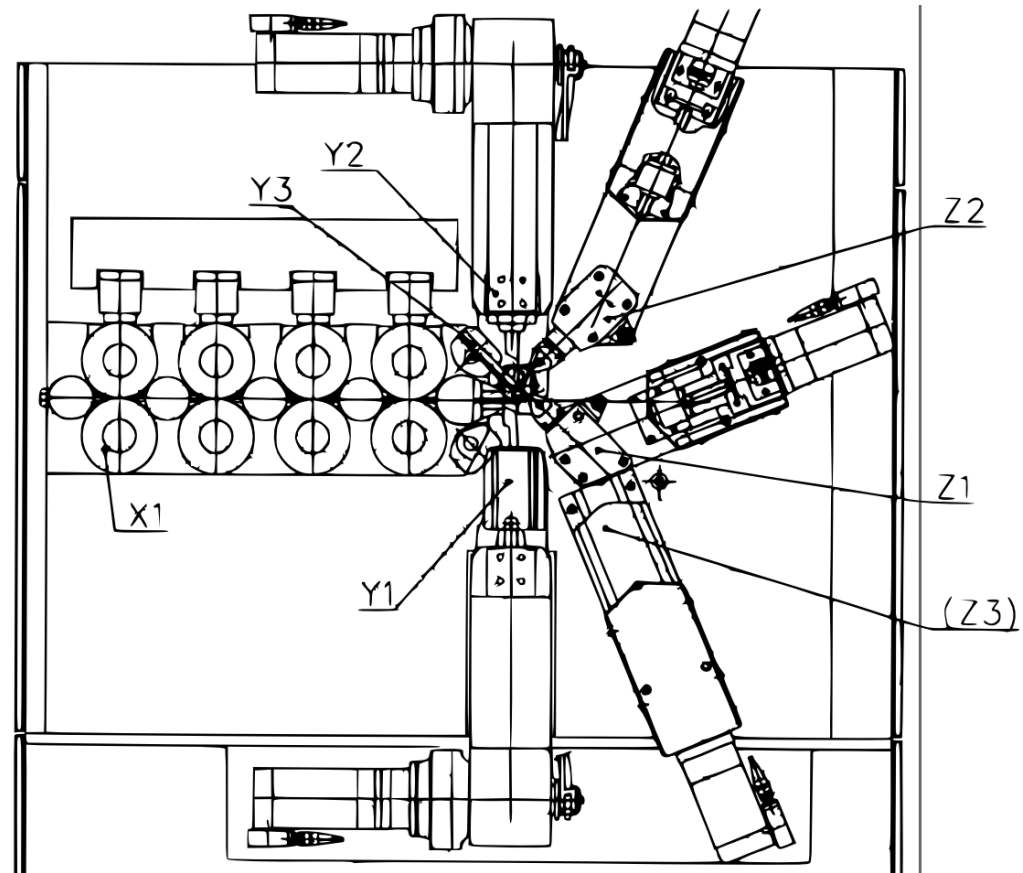
Functional groups are devoted to:

- Move the wire
- Create the spring diameter
- Change the spring distance between coil
- Cut the spring





Each functional group should be designed to fulfill a specific task.  
As usual, it could be described in a schematic way as:





# Tentative schedule of the course

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Day	Time		Teacher	Main topic
09-mar	10.15-13.15	Lesson	Cinquemani	Introduction + introduction test case
10-mar	14.15-17.15	Lesson	Cinquemani	Motion law 1/2
16-mar	10.15-13.15	Lesson	Cinquemani	Motion law 2/2
17-mar	14.15-17.15	Lesson	Cinquemani	Electric motors for industrial applications
23-mar	10.15-13.15	Lesson	Cinquemani	Pneumatic actuators for industrial applications
24-mar	14.15-17.15	Lesson	Cinquemani	mechanisms 1/3
30-mar	10.15-13.15	Lesson	Cinquemani	mechanisms 2/3
31-mar	14.15-17.15	Lesson	Cinquemani	mechanisms 3/3
20-apr	10.15-13.15	Lesson	Cinquemani	Cams 1/2
21-apr	14.15-17.15	Lesson	Cinquemani	Cams 2/2
27-apr	10.15-13.15	Workshop	Saccomanni	GDM
28-apr	14.15-17.15	Practice	Catelani	ADAMS intro
04-mag	10.15-13.15	Practice	Bono	Elementary motion laws
05-mag	14.15-17.15	Practice	Bono	Complex motion laws
11-mag	10.15-11.15	Practice	Bono	Synthesis of Mechanisms
12-mag	14.15-17.15	Practice	Catelani	ADAMS
18-mag	10.15-13.15	Practice	Bono	Synthesis of Mechanisms
19-mag	14.15-17.15	Visit	Maldina	IMA
25-mag	10.15-13.15	Practice	Bono	Cam Design
26-mag	14.15-17.15	Practice	Bono	Cam Design



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