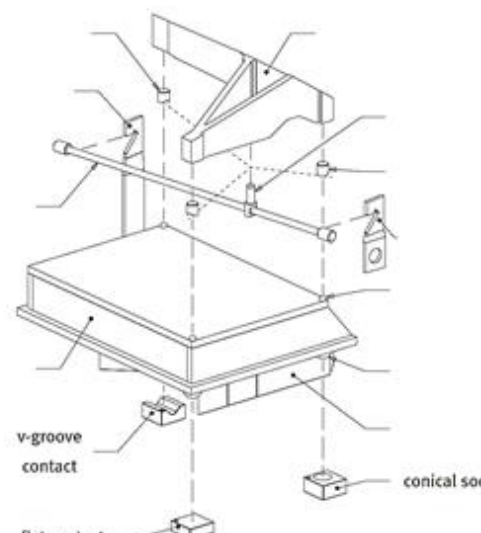
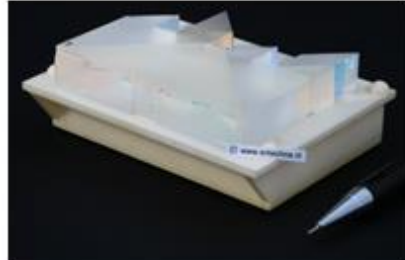
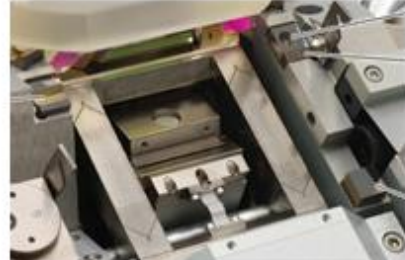


Design Principles for Precision Engineering

Kinematic mount: example

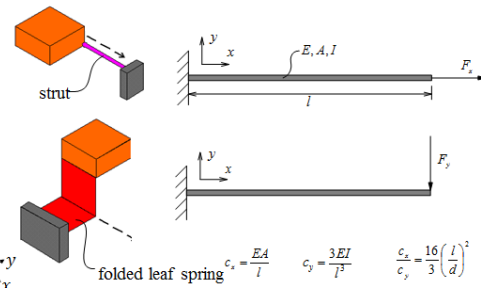
v-groove contact

flat contact

conical socket

Figure 5.23 - p. 93

Constrain one translation



strut

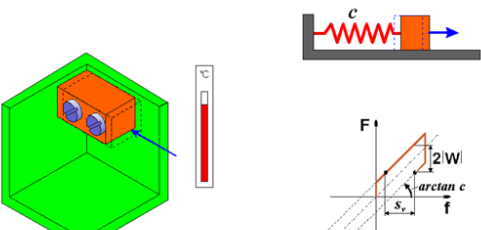
folded leaf spring

$$c_x = \frac{EA}{l}$$

$$c_y = \frac{3EI}{l^3}$$

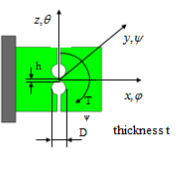
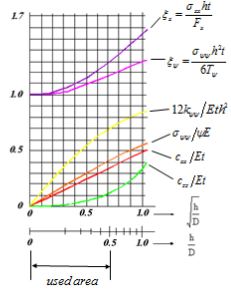
$$c_z = \frac{16}{3} \left(\frac{l}{d} \right)^2$$

hysteresis



$$s_r = \frac{2|W|}{c}$$

Dimensioning hole hinges

thickness

used area

$$\epsilon_x = \frac{\sigma_{xx} h t}{F_x}$$

$$\epsilon_y = \frac{\sigma_{yy} h^2 t}{6 I_y}$$

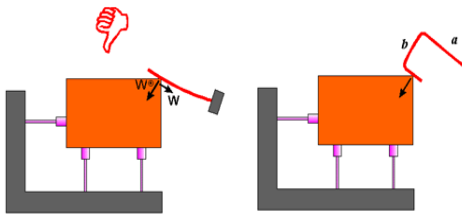
$$12 K_{xy} / Et h^2$$

$$\sigma_{xy} / \nu E$$

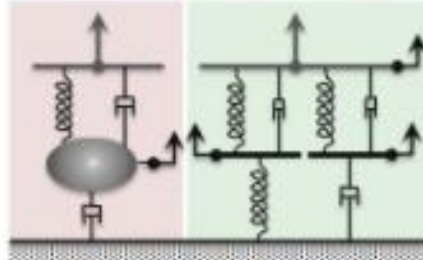
$$c_m / Et$$

$$c_n / Et$$

Preload spring



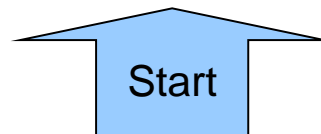
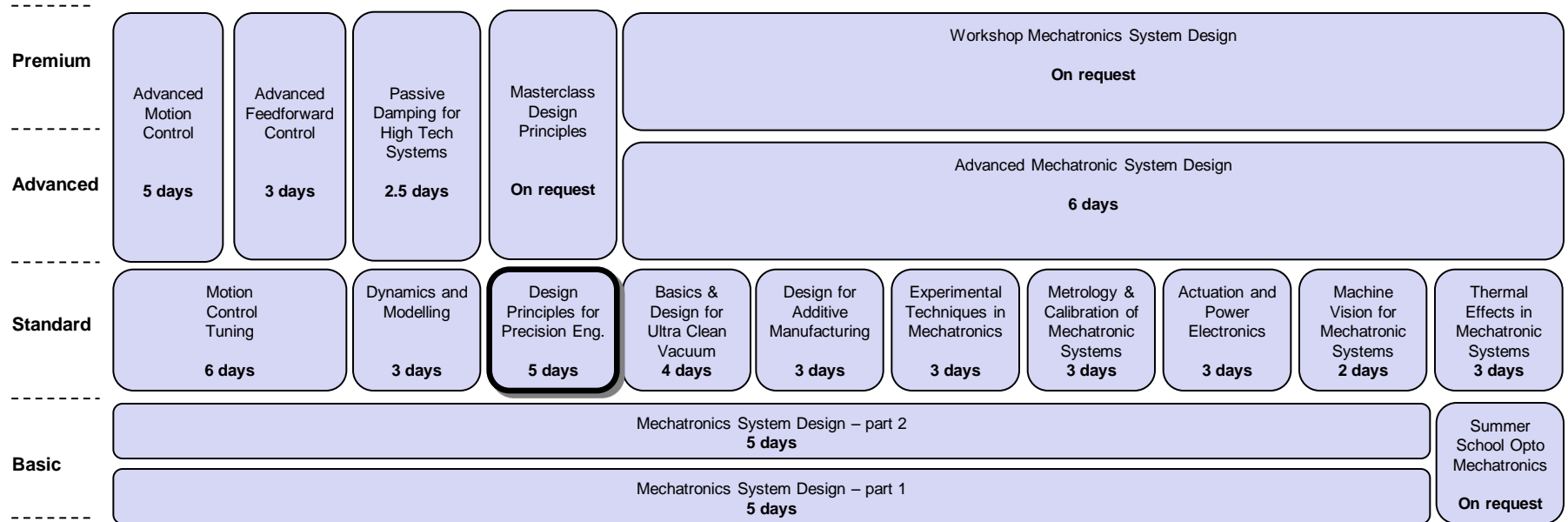
Hydromount Damping



Contents

- Mechatronics Academy & Mechatronics Curriculum
- Details *Design Principles for Precision Engineering*

Mechatronics Training Curriculum



Relevant partner trainings:
 Applied Optics, Electronics for non-electrical engineers, System Architecture, Soft skills for technology professionals, ...

www.mechatronics-academy.nl

Mechatronics Academy

- In the past, many trainings were developed within Philips to train own staff, but the training center CTT stopped.
- **Mechatronics Academy B.V.** has been setup to provide continuity of the existing trainings and develop new trainings in the field of precision mechatronics. It is founded and run by:
 - Prof. Maarten Steinbuch
 - Prof. Jan van Eijk
 - Dr. Adrian Rankers
- We cooperate in the **High Tech Institute** consortium that provides sales, marketing and back office functions.

Design Principles for Precision Engineering

Trainers / Course Director(s)

Teachers

- ir. Huub Janssen (Janssen Precision Engineering)
- Dr.ir. Roger Hamelinck & Dr.ir. Chris Werner (Entechna)
- Prof.Dr.ir. Dannis Brouwer (University Twente)
- Dr.ir. Kees Verbaan (NTS Group)

Course Director(s)

- Ir. Huub Janssen (Janssen Precision Engineering)
- Dr.ir. Adrian Rankers (Mechatronics Academy)

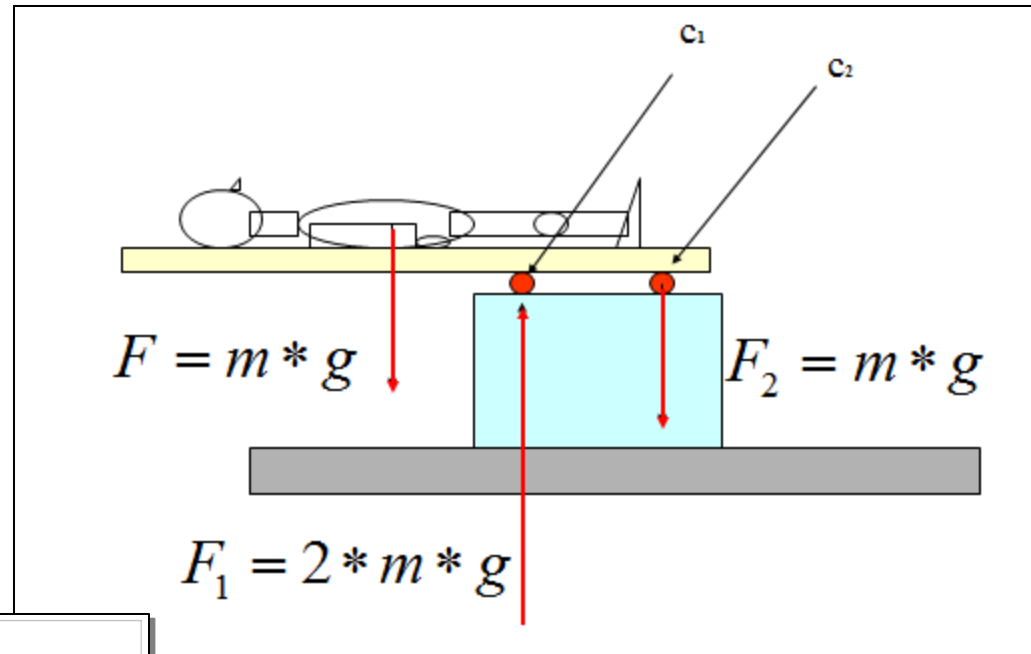
Program

Day	Topic	Presenter
Mon	Mechatronic Context Design for Stiffness	Huub Janssen
Tue	Controlling Degrees of Freedom	Chris Werner and Roger Hamelinck
Wed	Elastic Elements, Advanced Flexures Energy Compensation Techniques	Dannis Brouwer
Thu	Friction, Hysteresis, Stick-Slip, ... Damping (Rubbers, Constraint Layers, Eddy Current ...)	Huub Janssen Kees Verbaan
Fri	Case Capita Selecta (guestspeakers)	Huub Janssen

Day 1



- Mechatronic Context
- Design for Stiffness

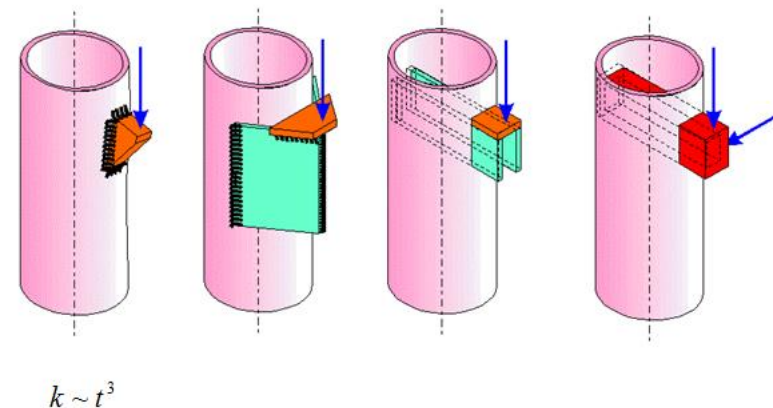


Comparison torsional stiffness of tubes
with different cross sections
and equal perimeter $O = 4b$ and wall thickness t

Cross section					
I^*	1	0.59	0.56	0.04	1.6

Torsional stiffness $k = \frac{G \cdot I^*}{l}$ Polar moment of inertia: $I^* = \frac{4A_{om}^2 t}{O}$

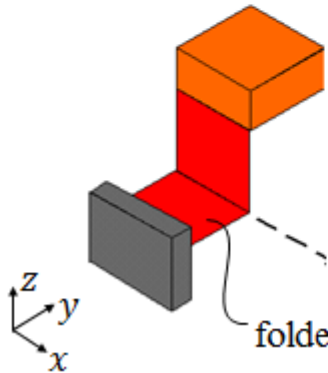
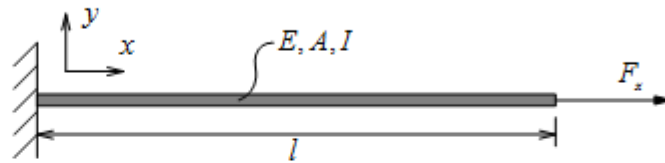
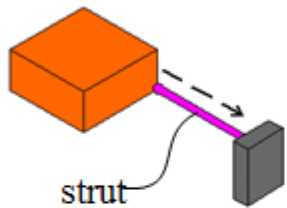
Applying forces to a tube-like column



Day 2

Controlling Degrees of Freedom

Constrain *one* translation



folded leaf spring $c_x = \frac{EA}{l}$ $c_y = \frac{3EI}{l^3}$ $\frac{c_x}{c_y} = \frac{16}{3} \left(\frac{l}{d} \right)^2$

Kinematic mount: example

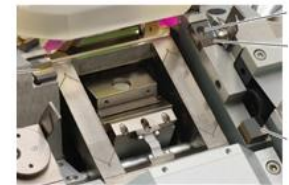
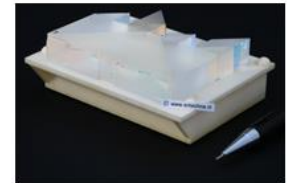
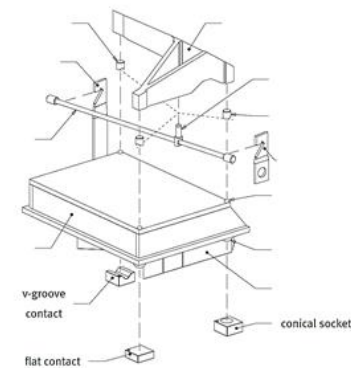
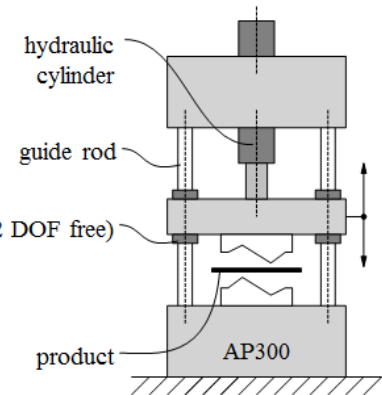


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Four-column press

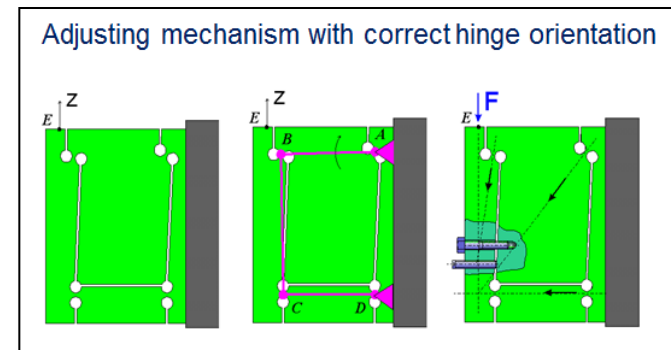
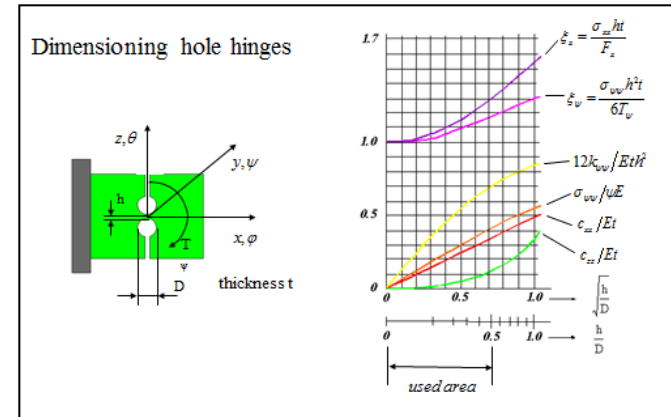
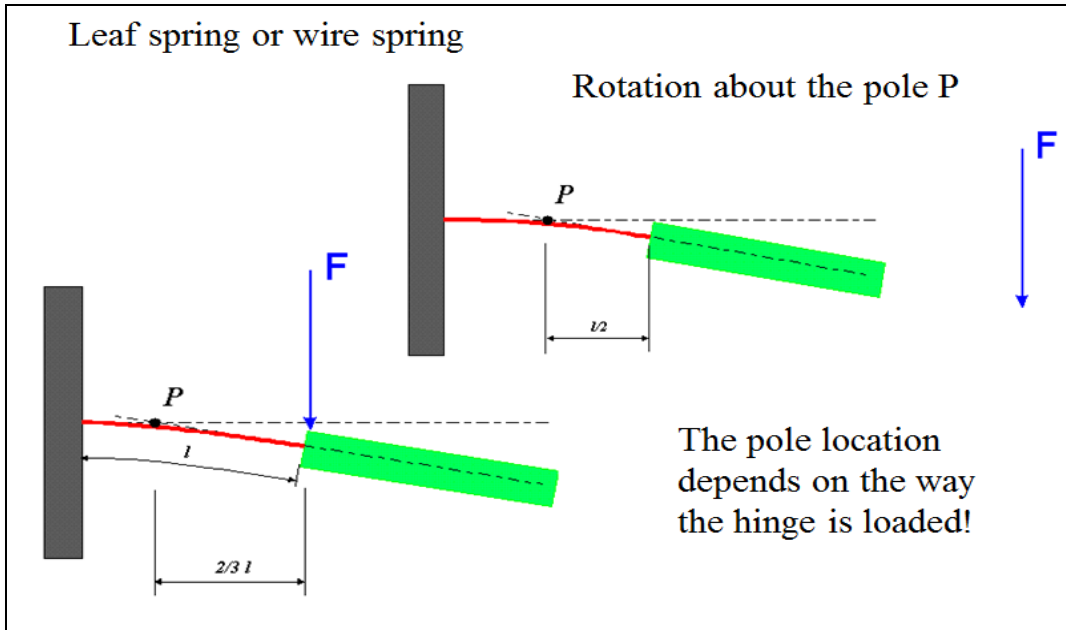
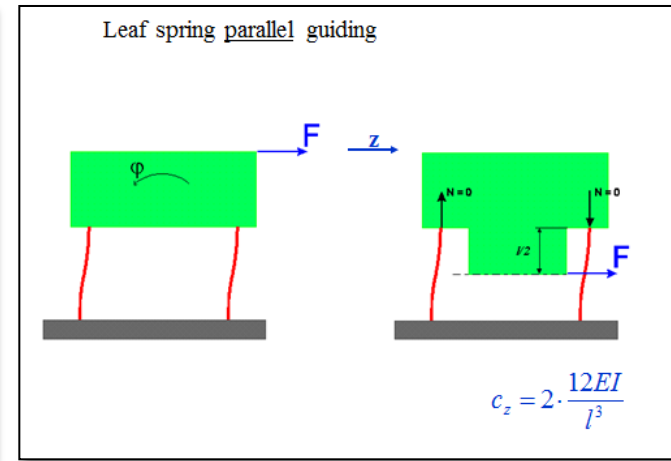
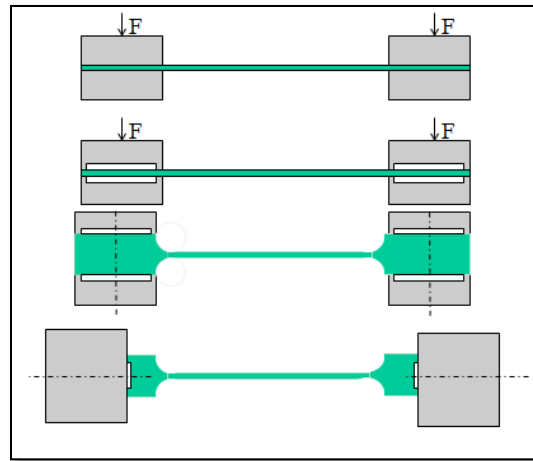
Over-determined
How many times?

Required: 5
 Constrained: 16 bush (2 DOF free)
 Overconstrained: 11



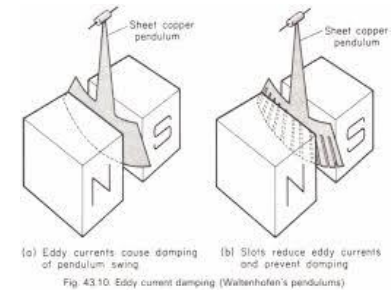
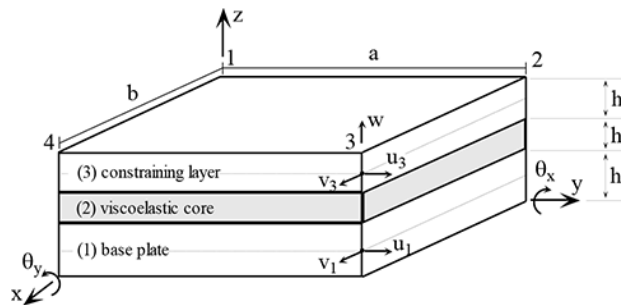
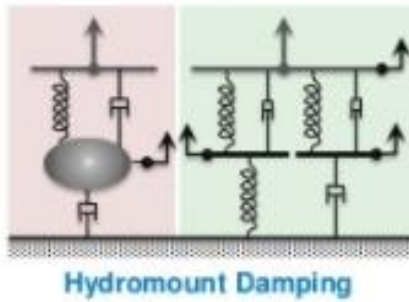
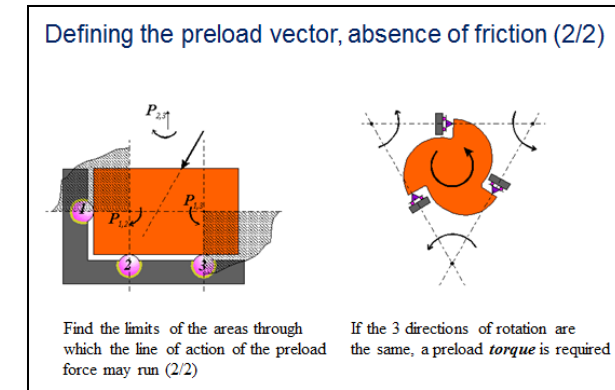
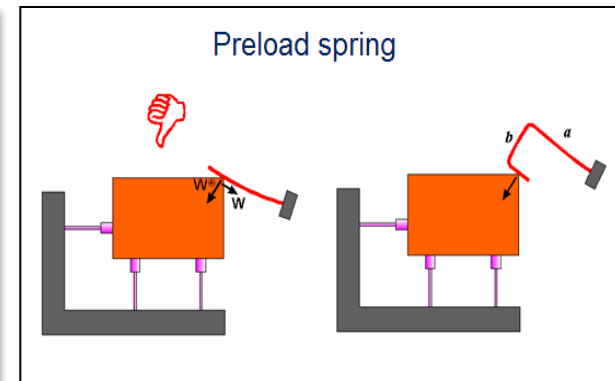
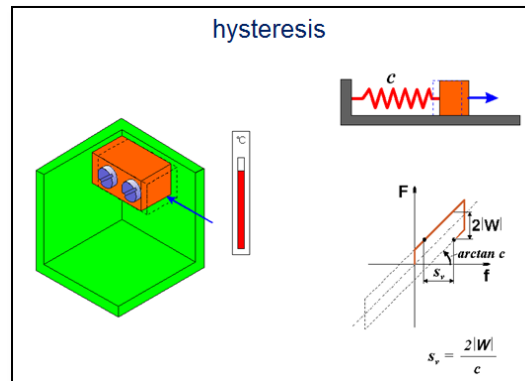
Day 3

- Elastic Elements
- Advanced Flexures
- Energy Compensation Techniques



Day 4

- Friction & Hysteresis
- Damping
 - Rubbers
 - Tuned Mass Dampers
 - Constrained Layer Damping
 - Eddy Current Damping



Day 5

- Case Study
- Capita Selecta
- Guest Speakers academia/industry

Sign-up for this training

Via the website of our partner
High Tech Institute