Bond Graphs practice

A graphical language for the analysis of multiphysical systems

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Slide deck 2: practice

Course outline

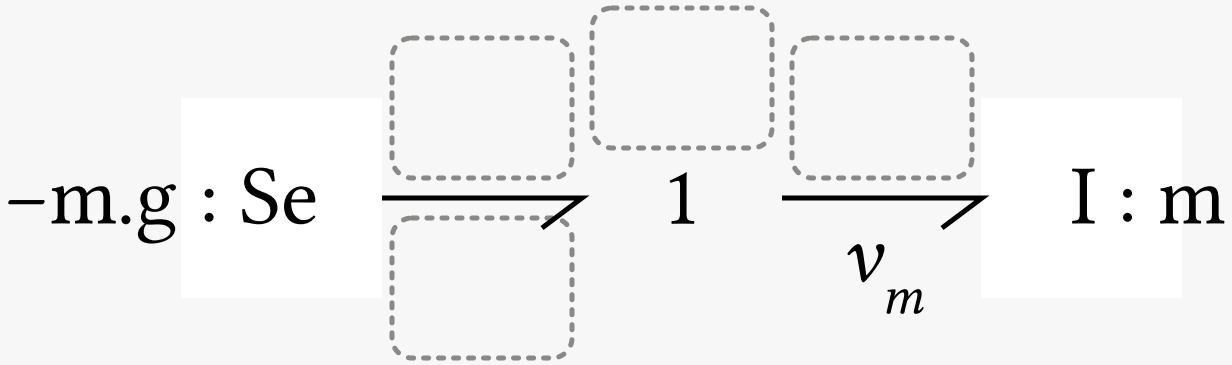
- Bond graph objectives
- The bond graph language
  - Bonds and power variables: the physical analogy
  - Elements
- **Practice: reading & creating bond graphs**
- Causality and derivation of mathematical models

Practice 🔨

Objectives: being able to

1. **Read** BGs
    - recognize classical structure
2. **Create** BGs from network diagrams (electrical, mechanical)

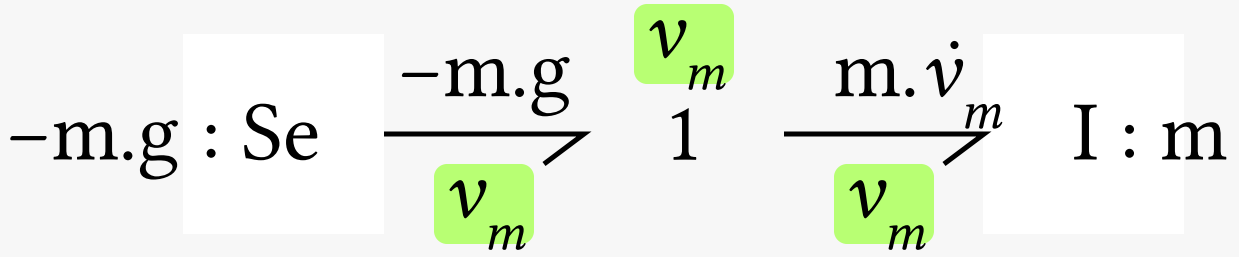
M1: 1 junctions represent “velocity points”

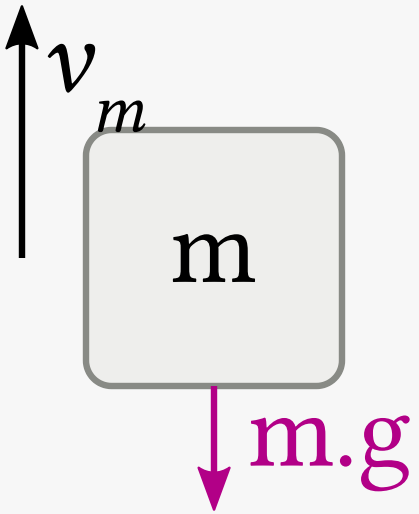


Questions:

- Fill the blanks on the BG
- Represent the physical system
- Derive the overall mechanical equation of the system

M1: 1 junctions represent “velocity points” (S)

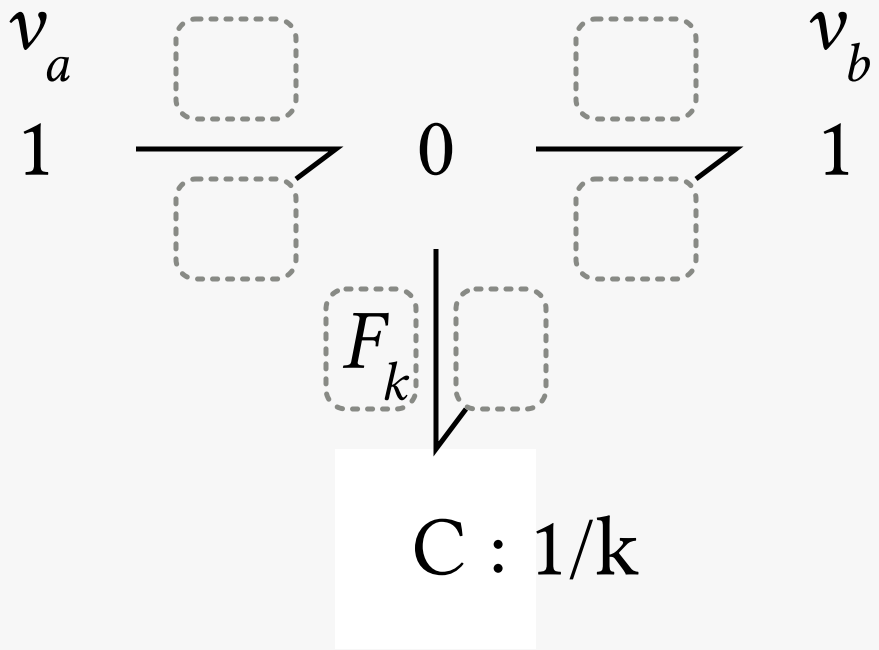




This BG represents the **free fall** of a mass m with equation:

$$m.\frac{dv_m}{dt} = -m.g$$

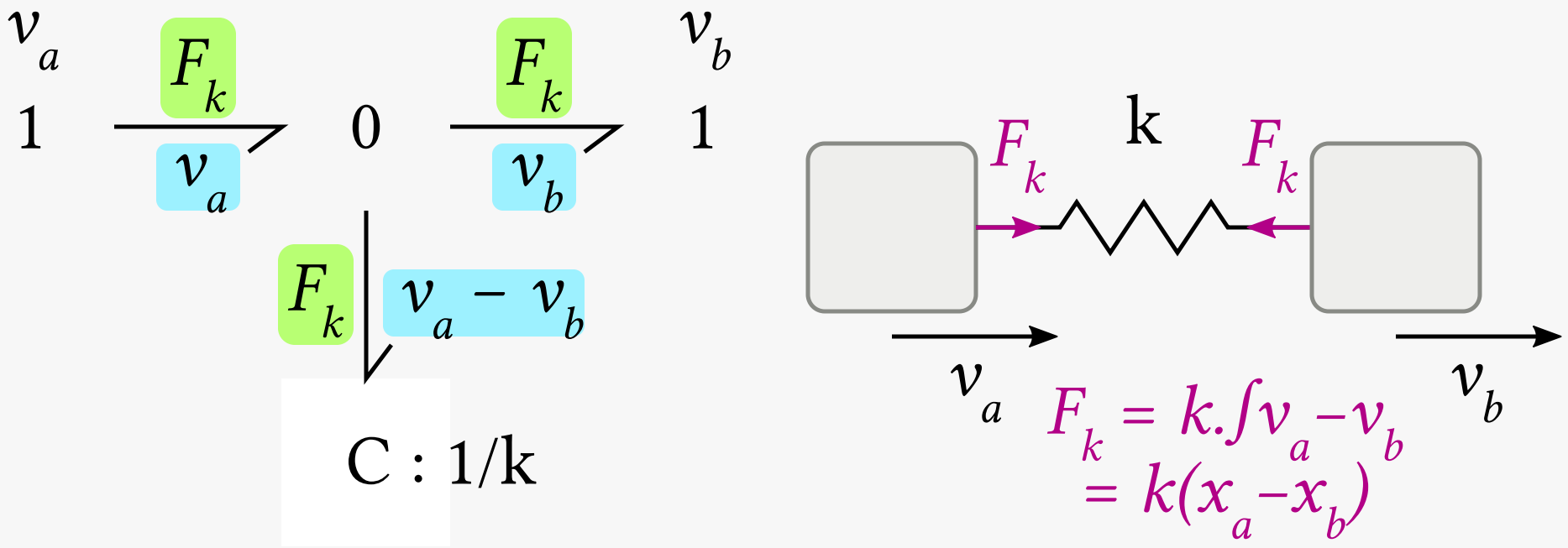
M2: Springs and dampers typically on 0 junctions



Questions:

- Fill the blanks on the BG
- Represent the physical system
- Give the expression of F_k

M2: Springs and dampers typically on 0 junctions (Sol.)



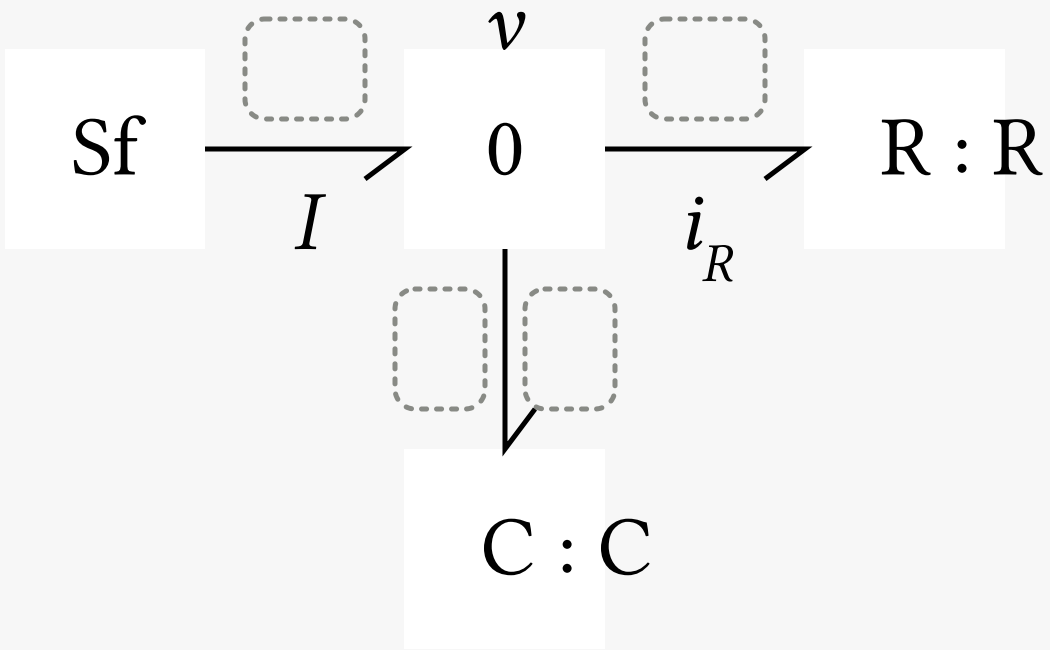
This BG represents a spring of stiffness k between two points A and B.

$$F_k = k \int (v_a - v_b).dt = k(x_a - x_b)$$

Mechanical BGs: main structures

- velocity points represented by 1 junctions
  - an Inertia can attach directly to its corresponding 1 junction
- components which reacts on a velocity/position differences (spring and dampers) are typically connected to a *0 junction placed between two 1 junctions*

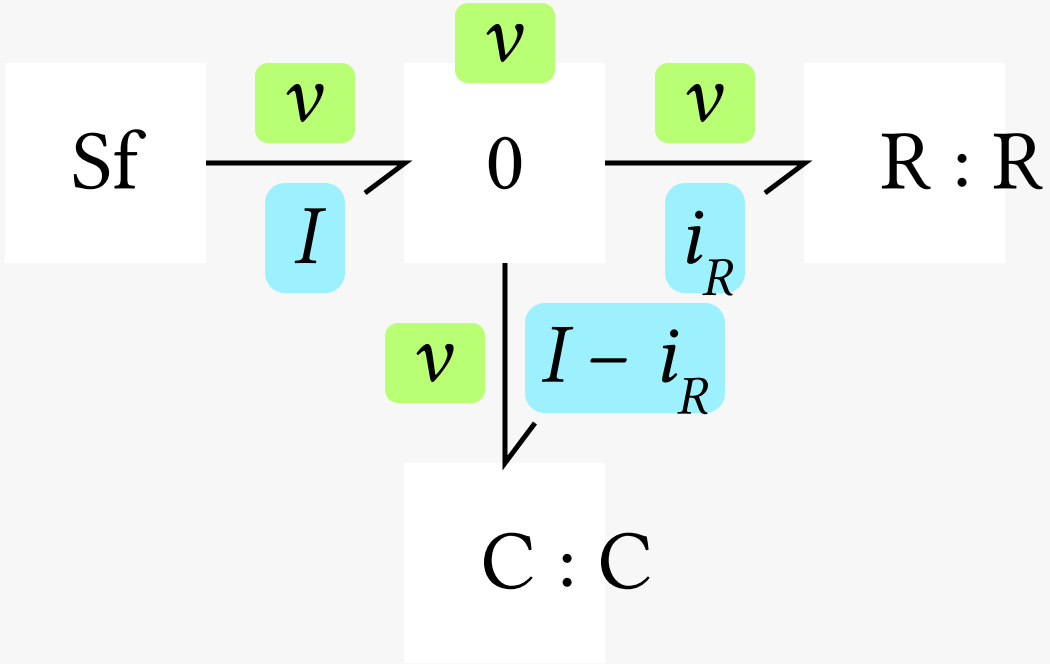
E1: 0 junctions represent voltage nodes

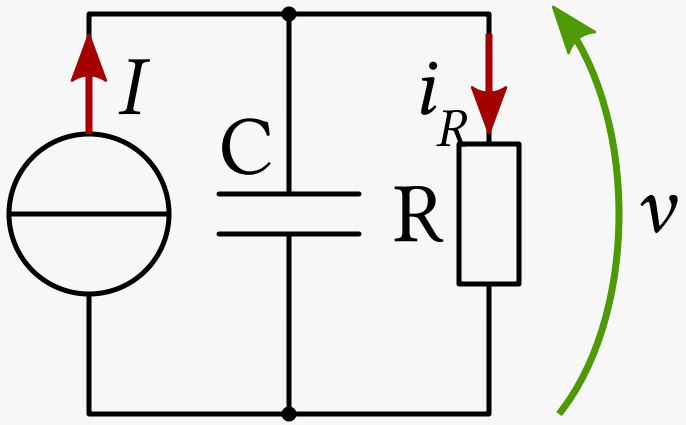


Questions:

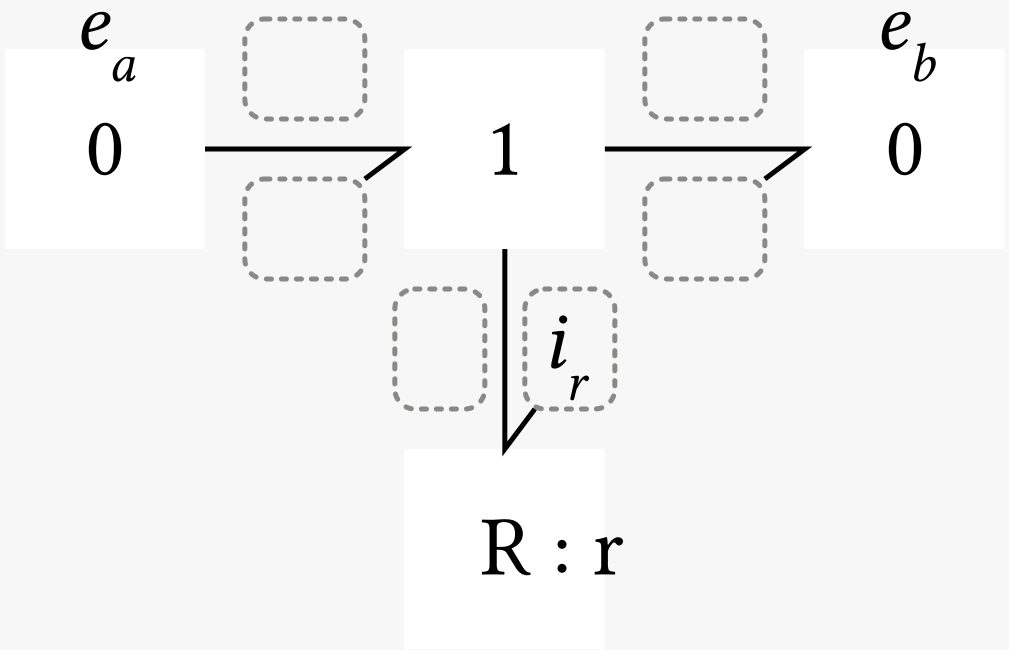
- Fill the blanks on the BG
- Represent the physical system

E1: 0 junctions represent voltage nodes (Sol.)





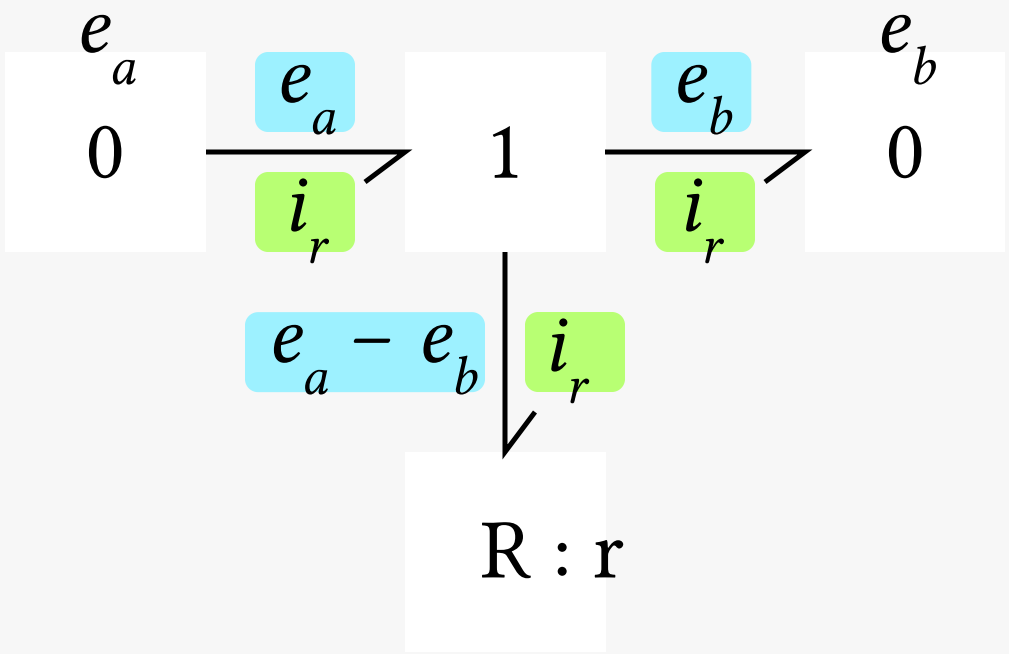
E2: 1 junction for voltage drop on a RLC component

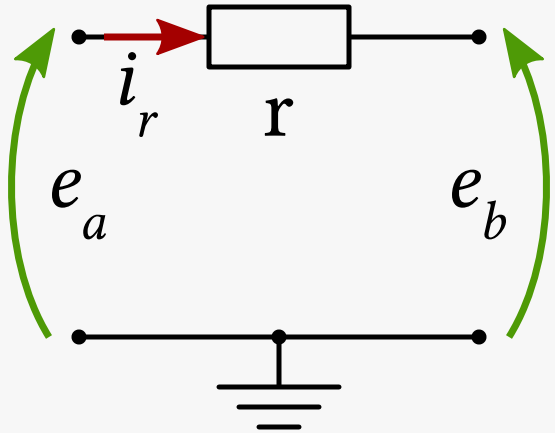


Questions:

- Fill the blanks on the BG
- Represent the physical system
- Compute i_r

E2: 1 junction for voltage drop on a RLC component (Sol.)





$i_r = (e_a - e_b)/r$

$$i_r = (e_a - e_b)/r$$

E3: Voltage source

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