Analysis of Truss Structures

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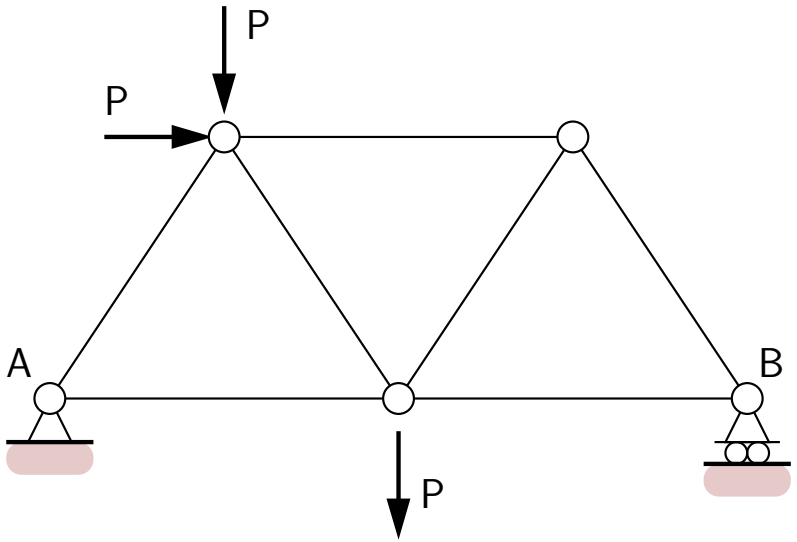
Overview

Part 2

Analysis of Truss Structure

Modeling Assumptions



- Pins offer no resistance to moment (i.e., frictionless).
- Truss elements are straight.
- Truss elements can only carry axial forces: tension (T), compression (C).
- Loads are only applied at the joints.

Zero-Force Members

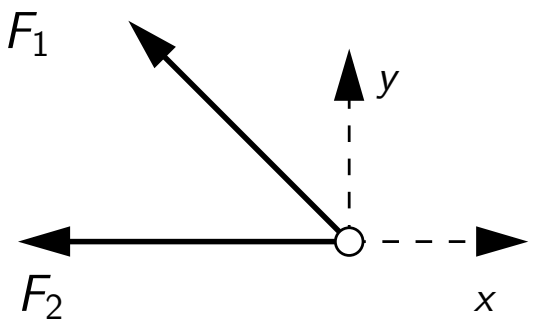
(Simplify Analysis by removing Zero-Force Members)

Zero-Force Members

Case 1. If no external load is applied to a joint connecting two bars, the force in both bars is zero.

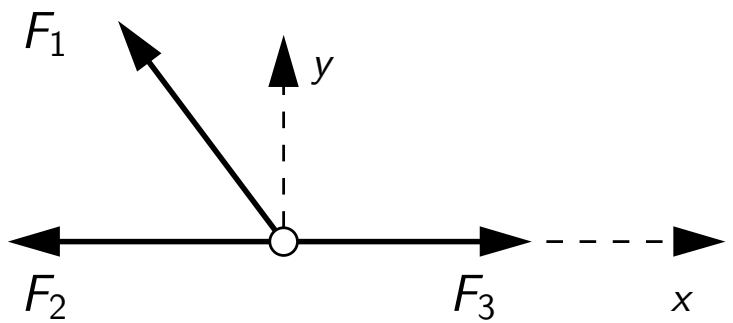
Case 2. If no external load is applied to a joint connecting three bars, two of which are colinear, then the force in the bar that is not colinear is zero.

Case 1



Zero-Force: $F_1 = F_2 = 0.0$

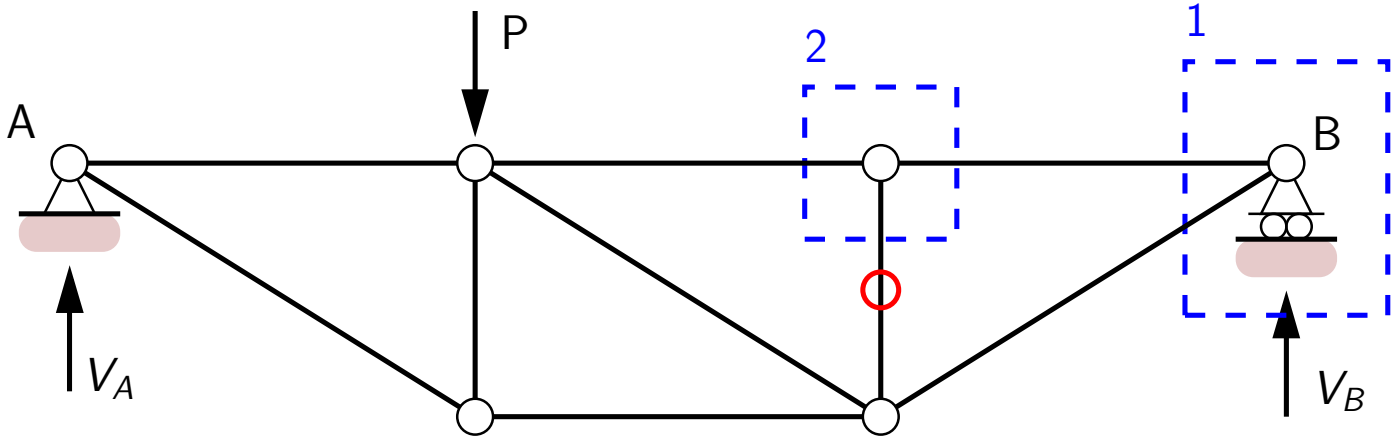
Case 2



Zero-Force: $F_1 = 0.$

Zero-Force Members

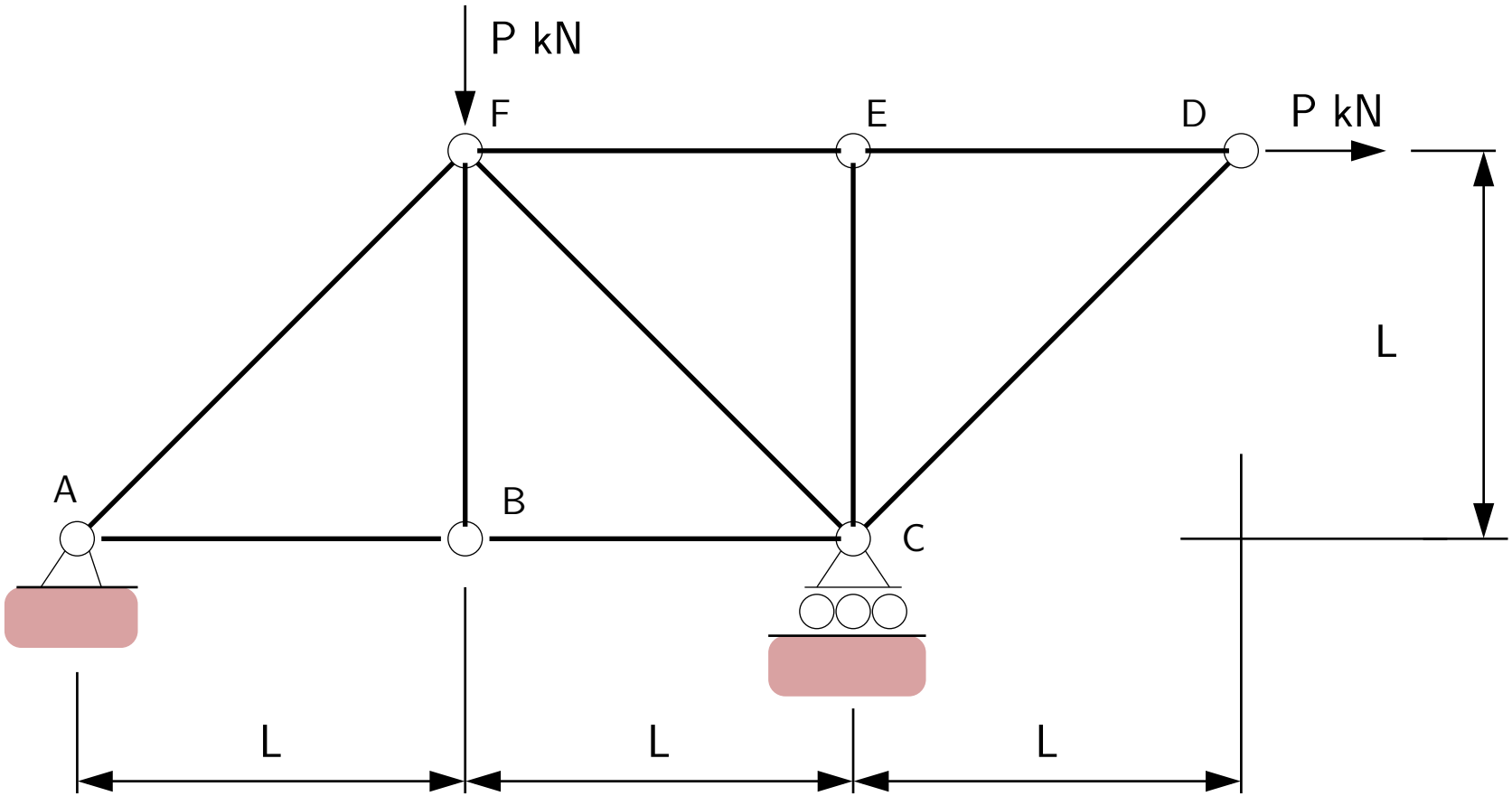
Example 1.



- At A and B [1] we have two connecting elements, but Case 1 does not apply because reaction forces V_A and $V_B \neq 0.0$.
- But at [2] the pin is connected to three elements, two are colinear, and no external forces. Case II applies.

Zero-Force Members: Midterm I, 2016

Example 2.



Zero-Force Members: Midterm I, 2016

Step-by-Step Procedure:

$$\sum M_A = 0 \rightarrow PL + PL - V_C(2L) = 0 \rightarrow V_C = P. \quad (1)$$

$$\sum F_y = 0 \rightarrow V_A + V_C = P \rightarrow V_A = 0. \quad (2)$$

At pin B:

- A-B and B-C are colinear, no external force at B. Case 2 applies.

At pin E:

- Same argument as pin B. Case 2 applies.

At pin D:

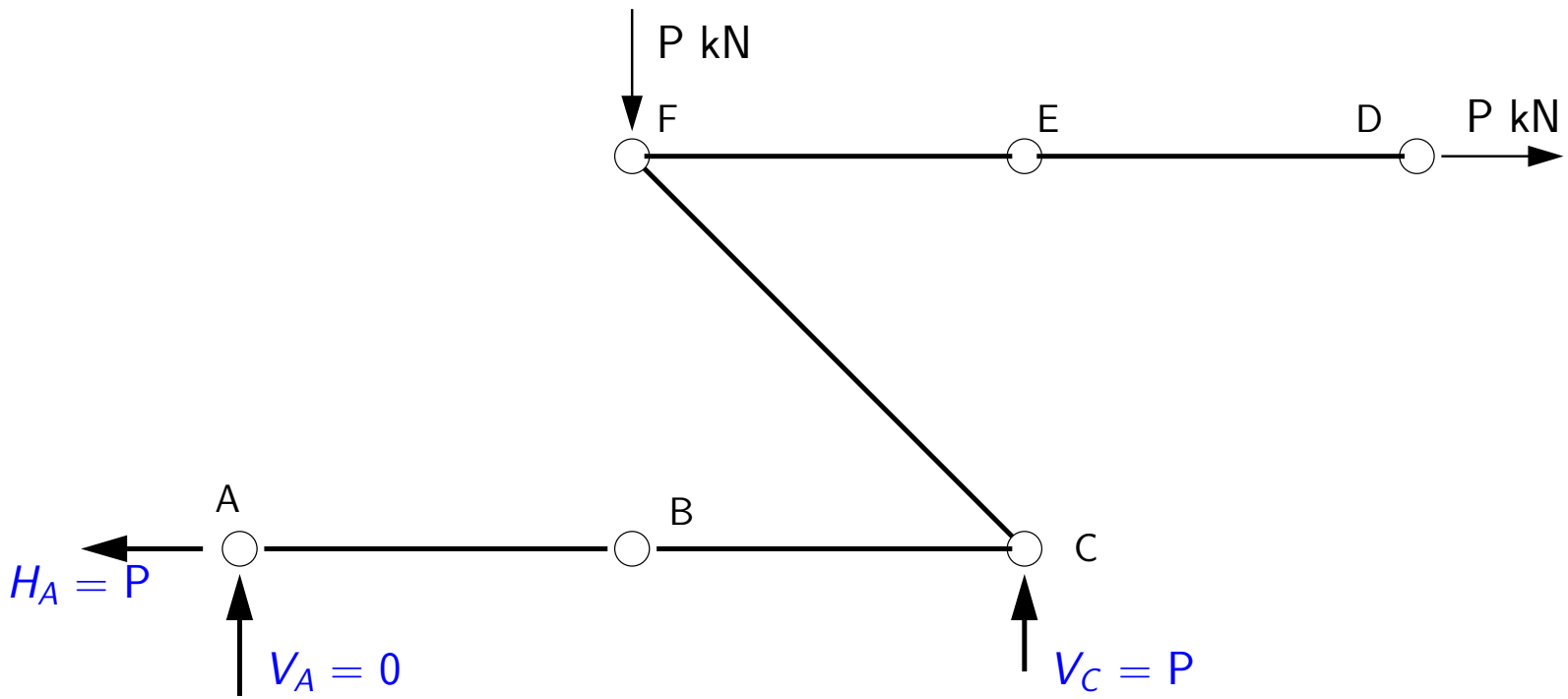
- Element D-E is colinear with applied load. Force C-D $= 0$.

Zero-Force Members: Midterm I, 2016

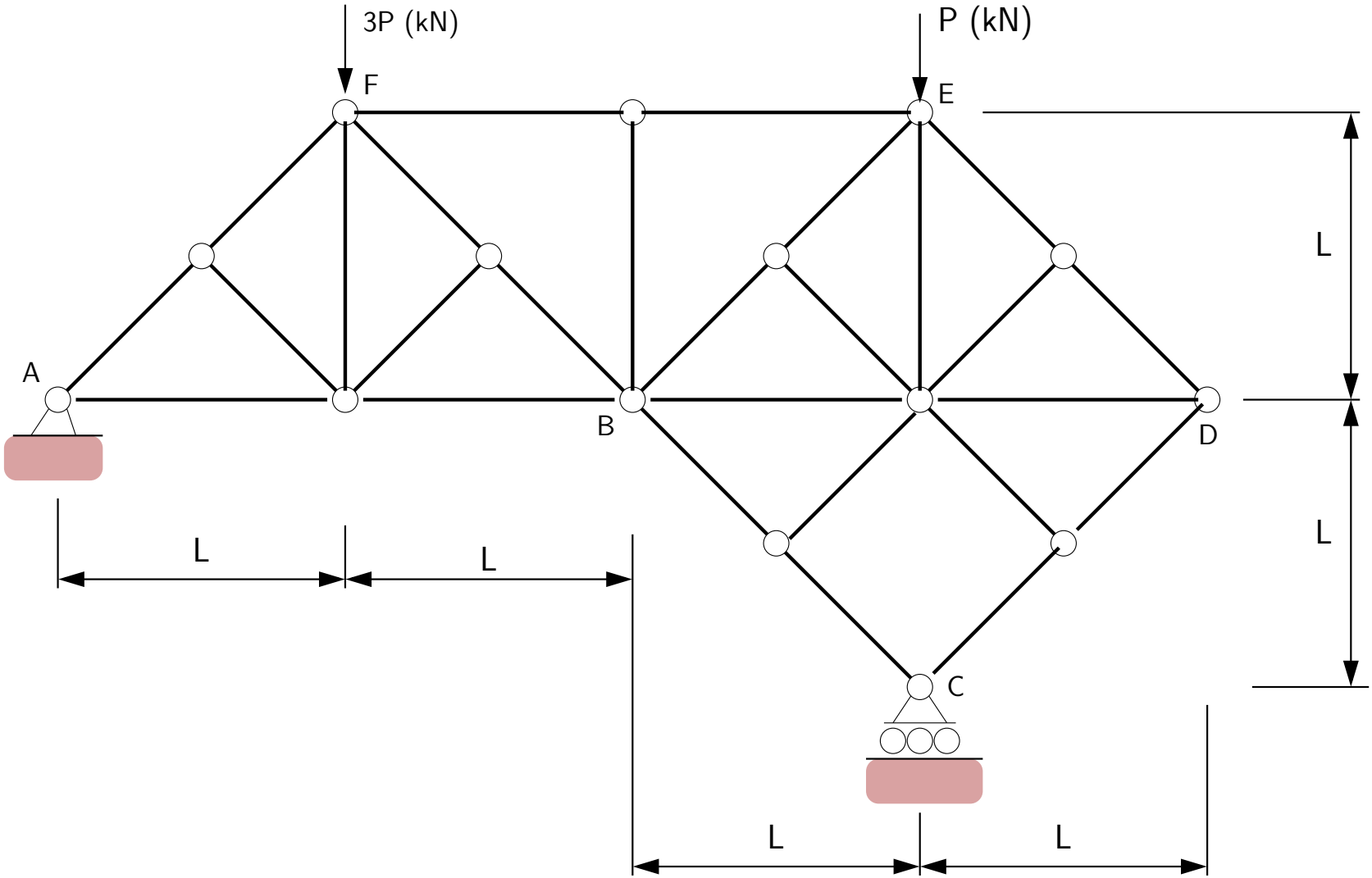
At pin A:

- $V_A = 0$. H_A is colinear with A-B and B-C.
- Element force A-F is zero.

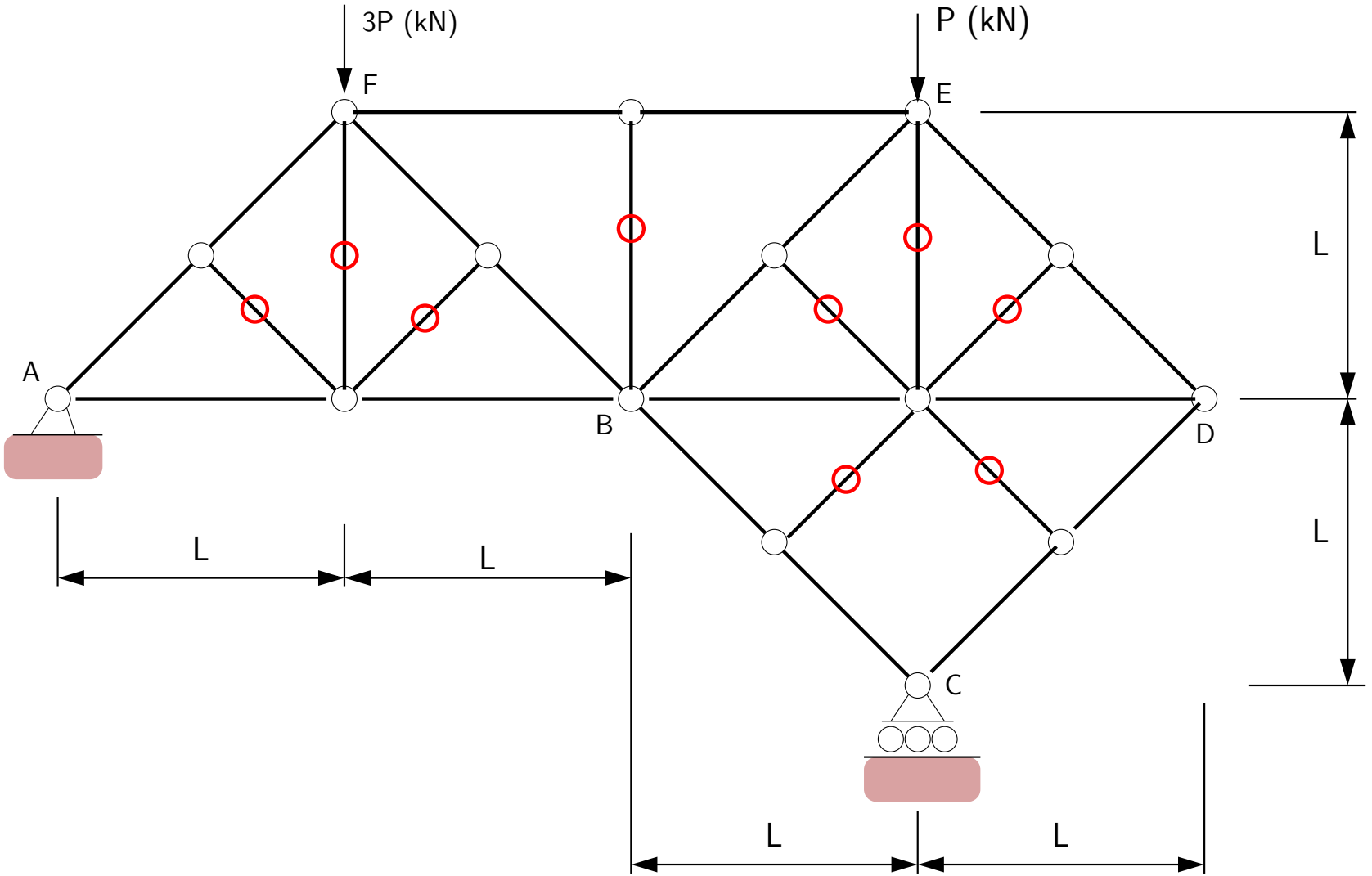
Simplified Structure (with zero-elements removed):



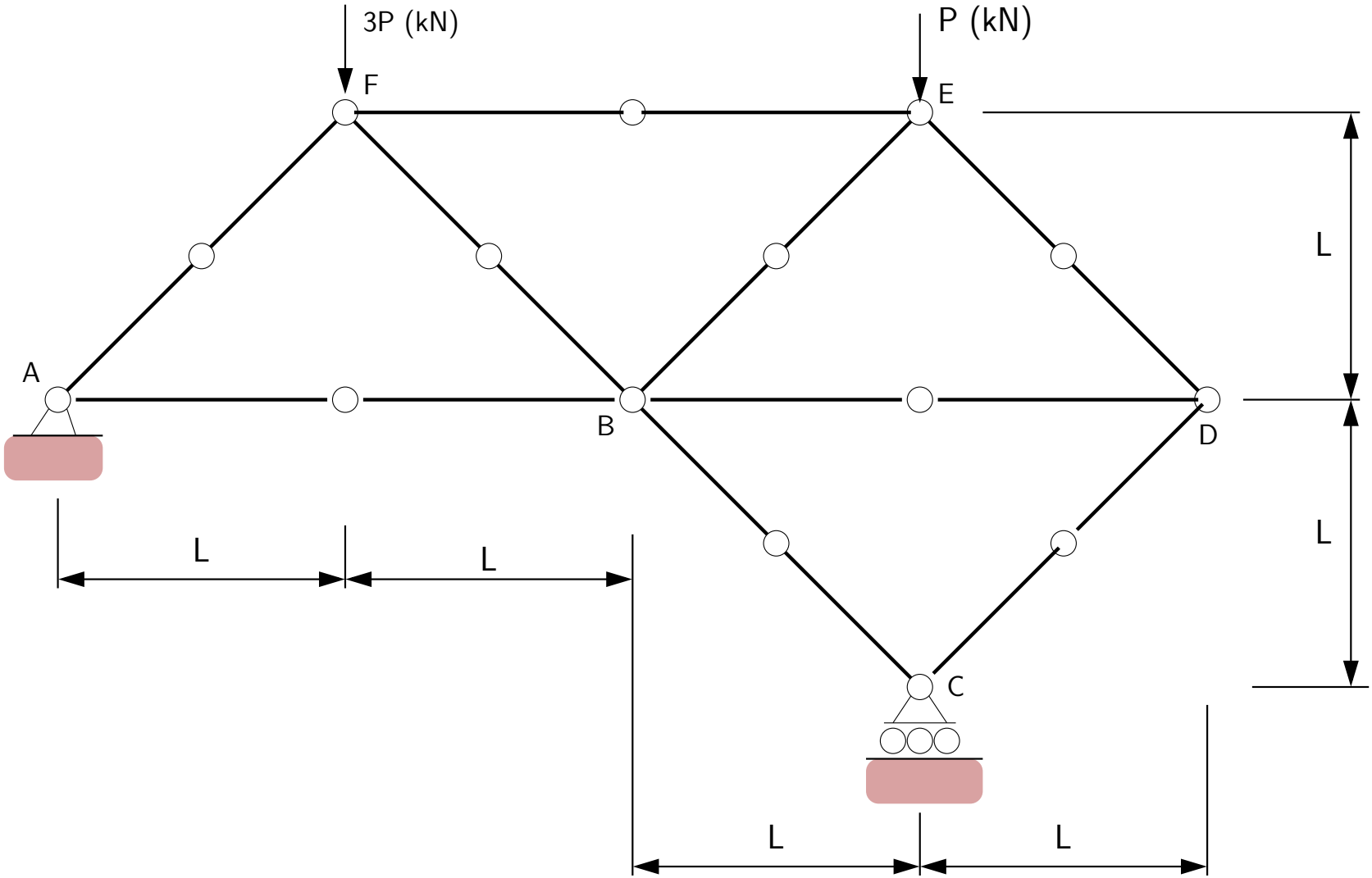
Zero-Force Members: Midterm I, 2019



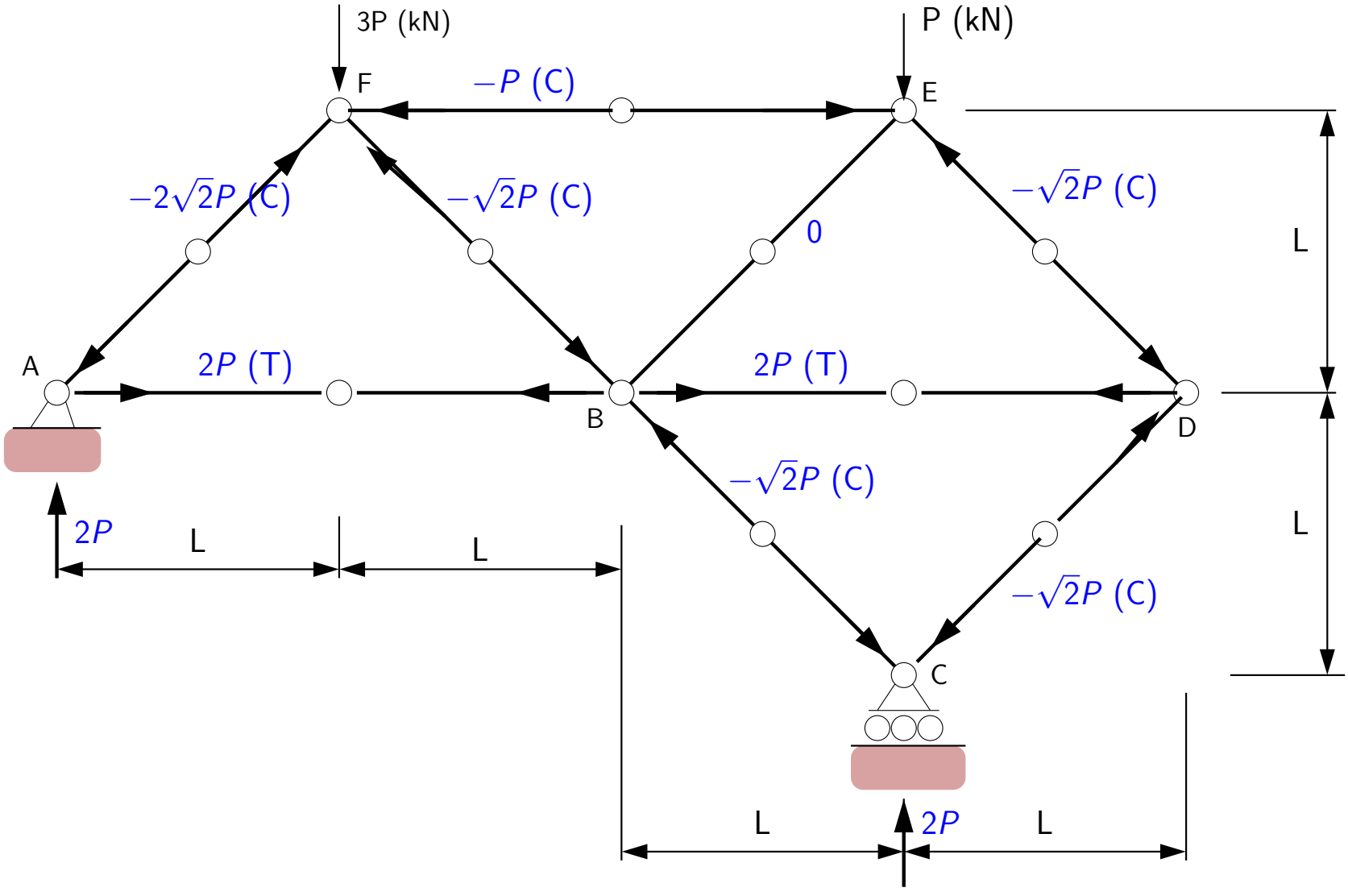
Zero-Force Members: Midterm I, 2019



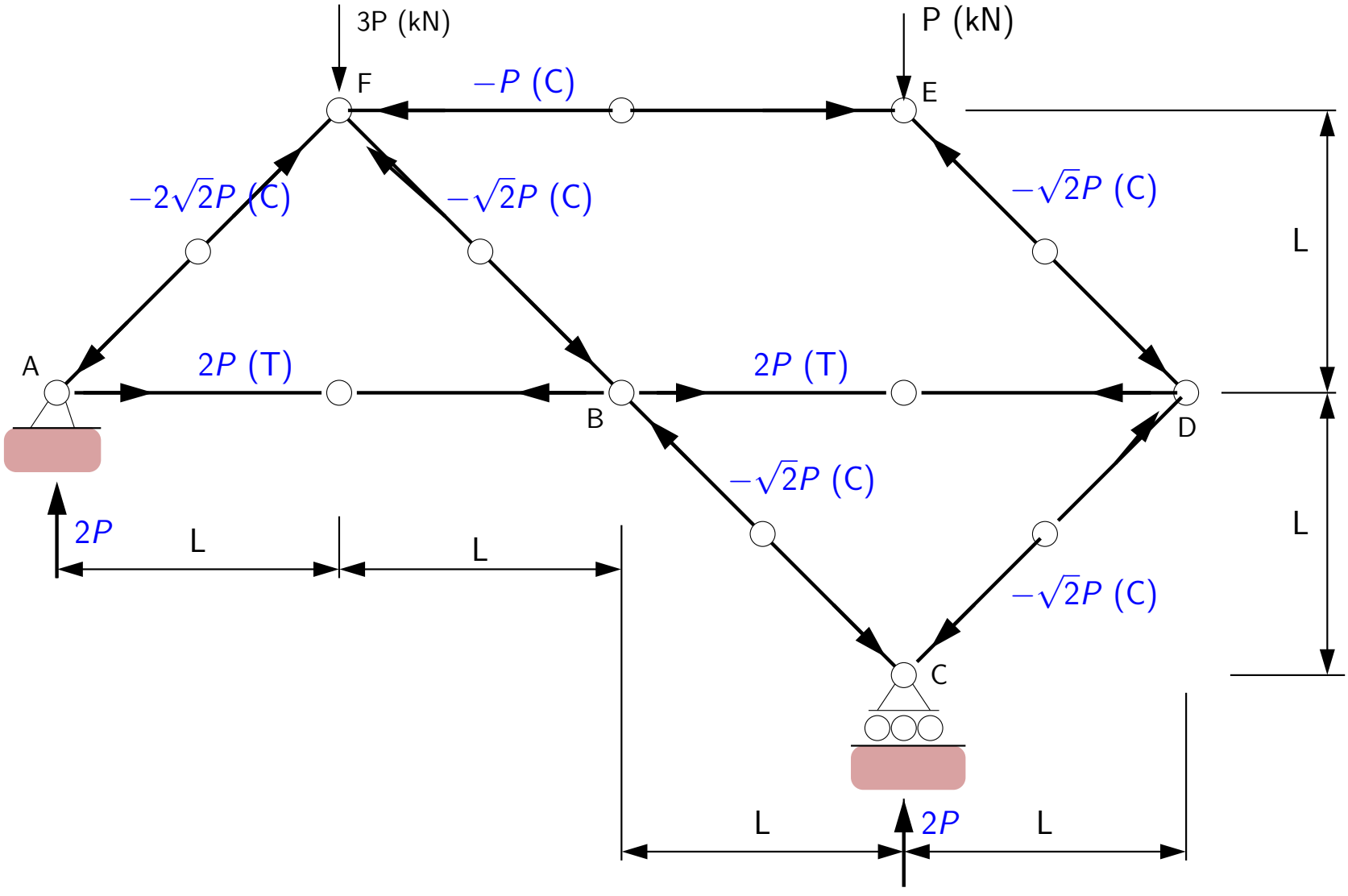
Zero-Force Members: Midterm I, 2019



Zero-Force Members: Midterm I, 2019



Zero-Force Members: Midterm I, 2019



Summary

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Method of Joints vs Method of Sections

- Use method of joints when you need to know element forces throughout the structure. Two equations of equilibrium per joint.
- Method of sections provides a short cut for solution of forces in a few specified bars.

Simplifications

- You can reduce computational effort by taking advantage of symmetries (when they exist) and removing zero-force members.