Aachen, June, 2025
SWS: V3/Ü1, ECTS: 6
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Exercise for

Embedded Systems

Summer Term 2025

Sheet 4: Real Time

Exercise 1: Basics

- Name the two requirements needed for real time.

  Solution:
  The requirements are:

  - The Computation is correct
  - The Computation finishes before its deadline

- Expain the terms

  - Hard real time

    Solution:
    The usefulness of a computation is 100% before a deadline, but drops to 0 when the deadline is passed.

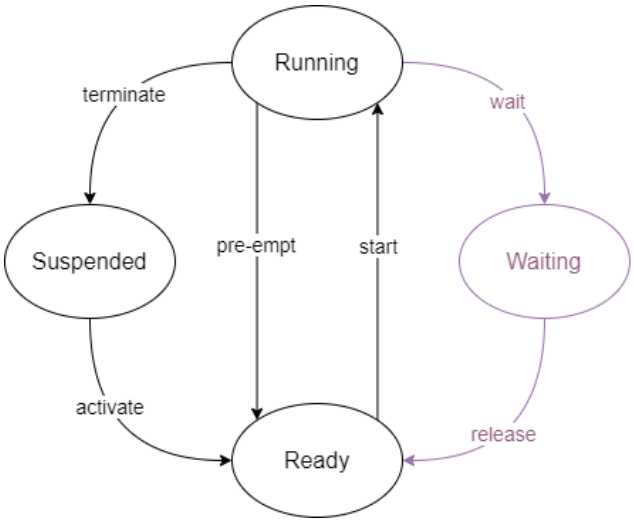
  - Soft real time

    Solution:
    The usefulness of a computation is 100% before a deadline. After the deadline the usefullness is still above 0, but reduces as more time passes.

Exercise 2: OSEK

- Sketch the extended OSEK task model

  Solution:



- How many processes and resources are needed for
  - Deadlock
    Solution:
    A Deadlock requires at least 2 Processes and 2 Resources
  - Priority Inversion
    Solution:
    Priority Inversion requires at least 3 Processes and 1 Resources

Exercise 3: Real Time and Resources
Given are four tasks that are all executed only once.

Start denotes at which point in time the task enters the ready state.

Run denotes how many time units the task whiches to run without doing any requests.

Req denotes that a tasks requests exclusive access to a system resource.

T denotes that a tasks terminates releasing all resources.

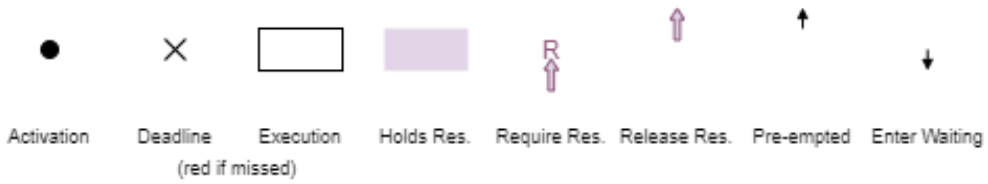
DL denotes the absolute deadline, i.e., the point in time when the computation must be finished.

Schedule these tasks (sorted by prioriy; first task has highest priority)

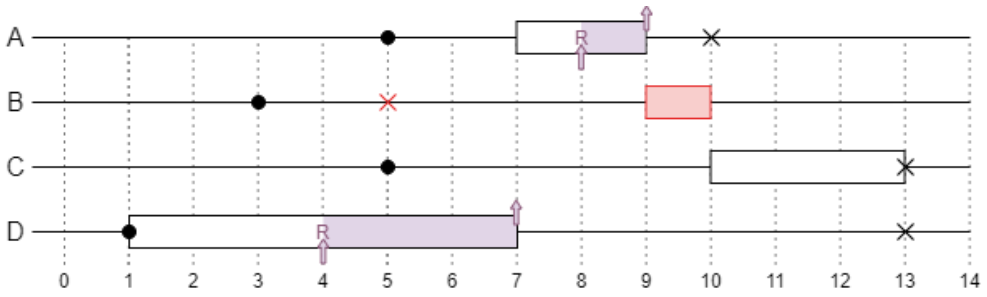
Task	**Execution**	**Deadline (absolute)**
Task A	Start @ 5 | runs 1 | Req. | runs 1 | T	DL @ 10
Task B	Start @ 3 | runs 1 | T	DL @ 5
Task C	Start @ 5 | runs 3 | T	DL @ 13
Task D	Start @ 1 | runs 3 | Req. | runs 3| T	DL @ 13

using

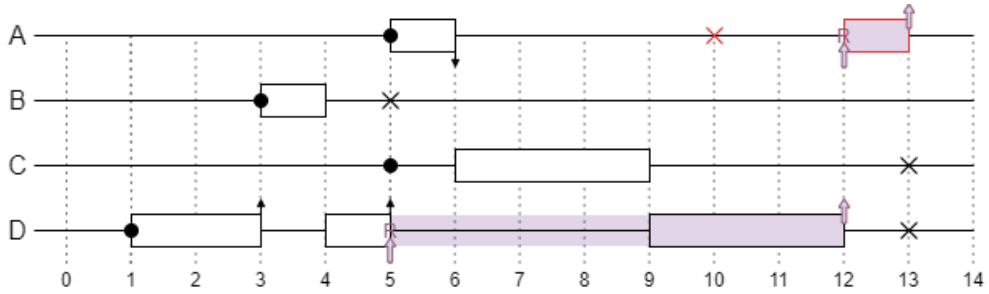
Solution Legend:



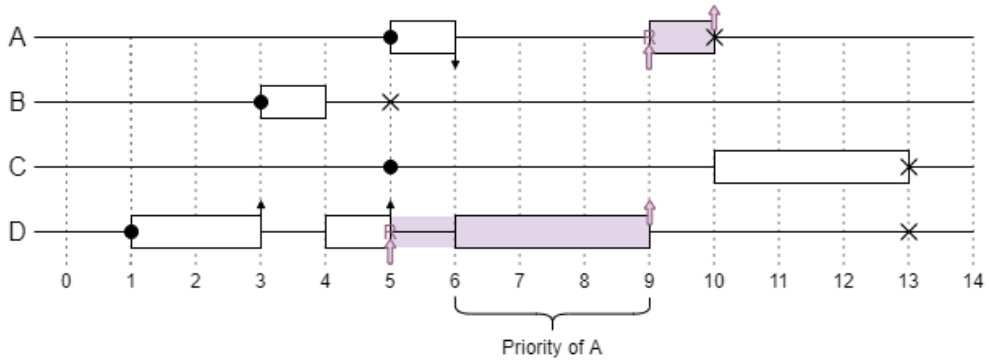
- Cooperative scheduling
  Solution:



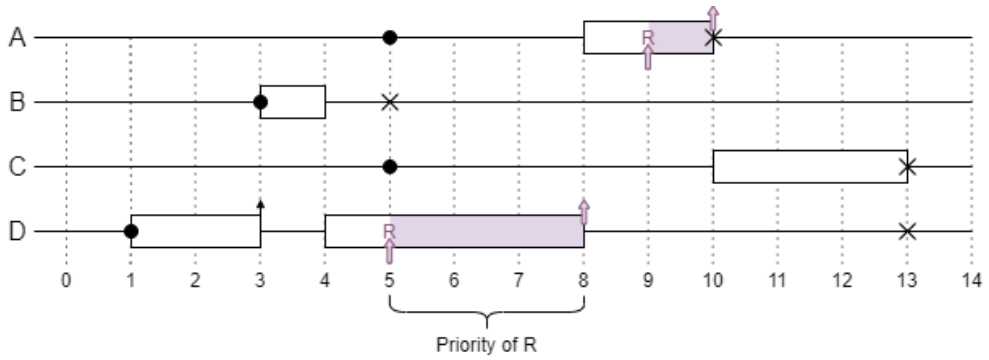
- Preemptive scheduling
  Solution:



- with priority inheritance protocol
  Solution:



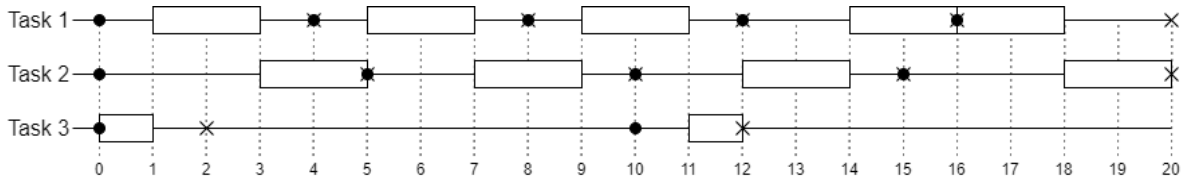
- with priority ceiling protocol
  Solution:



Exercise 4: Periodic Scheduling
Use earliest deadline first to schedule this task system:

$$(4, 2, 4), (5, 2, 5), (10, 1, 2)$$

Solution:



Why is the following task system not schedulable?

$$(3, 2, 2), (6, 2, 7), (10, 3, 10)$$

Solution:
We calculate the Utilization:
$U = \frac{2}{3} + \frac{2}{6} + \frac{3}{10} = 1.3$
Since Utilization is above 1, the task system is not schedulable.