

# Real-Time Programming

Summer Semester 09

## Assignment #4

Homepage: [http://www.iste.uni-stuttgart.de/ps/Lehre/SS2009/V\\_RTP/](http://www.iste.uni-stuttgart.de/ps/Lehre/SS2009/V_RTP/)

Discussion of Solutions: June 24, 2009

### 1 Cyclic Executive

The following task set is given:

Task	$T$	$C$
A	200	10
B	100	10
C	200	20
D	100	10
E	100	5
F	200	20

In the table,  $T$  denotes the minimum time between process releases (process period) and  $C$  denotes the worst-case computation time (WCET) of the process.

1. Given the above task set, find a cyclic executive that schedules the tasks appropriately. What are the minor and major cycles?
2. The following task is added:

Task	$T$	$C$
G	40	5

How does the schedule change?

3. Yet another task is added:

Task	$T$	$C$
H	200	50

This task exceeds the minor cycle. What can you do to still schedule this task?

4. Finally, the following task is added:

Task	$T$	$C$
I	400	10

How does the schedule change?

5. Implement the cyclic executive schedule of 1.4 as a sequential Ada program. A general framework is provided at

[http://www.iste.uni-stuttgart.de/ps/Lehre/SS2009/V\\_RTP/a4](http://www.iste.uni-stuttgart.de/ps/Lehre/SS2009/V_RTP/a4)

## 2 Scheduling

The following process set is given:

Process	$T$	$C$	Importance
P	100	30	most
Q	6	1	second most
S	25	5	least

1. Show the timeline for the process set assuming that priority is based on importance.
2. What is the process utilization of the processes?
3. Is there a scheduling strategy that allows these processes to meet their deadlines? If so, name the strategy and show the timeline.
4. To the above process set is added a fourth process R. Failure of this process will not lead to safety being undermined. R has a period of 50, but has a processing requirement that is data dependent and varies from 5 to 25 milliseconds. Discuss how this process should be integrated with P, Q, and S.

## 3 Schedulability

The following process set is given:

Process	$T$	$C$
P	50	10
Q	40	10
S	30	9

1. Using the utilization-based schedulability test, determine if it is possible to schedule the process set.
2. Using response time analysis for rate-monotonic priority assignment, determine if it is possible to schedule the process set.

## 4 Processes and Threads

1. How many processes are created when the following program is executed assuming POSIX fork semantics?

```
int main (void) {
    int i;
    for (i=0 ; i<=10 ; i++) {
        fork();
    }
}
```

2. If a multi-thread process executes a POSIX-like `fork` system call, how many threads will the created process contain?

3. Contrast

- POSIX's `fork` and `wait`
- Pthread's `pthread_create` and `pthread_join`
- Ada tasks

according to the following criteria:

- Execution environment
- Communication and Synchronization
- Control flow
- Scheduling