Exercise:
In the program below, how many times will the message “Hello World” be printed? Will the pid numbers printed be different each time? Explain.

```c
int main(void)
{
    int pid = fork();
    if(pid == 0)
        pid = fork();

    pid = fork();
    if(pid !=0)
        printf("(ID: %d) Hello World\n", pid);

    return(0);
}
```
Lecture 3: “Time”

• Time – some concepts and definitions
  • Absolute vs. Relative
    (w.r.t. real world time) (w.r.t. some reference)
  • Interval vs. Duration
    (start time, stop time) stop time – start time
    T1: _________
    T2: _________
    T3: _________

  All with same duration
  T1 & T2 with same interval

• Reactive system vs. Time Based system
  Initiated by int/ext events
  Typically asynchronous
  Controlled by time
  Generally synchronous

• Periodic vs. Aperiodic

• Jitter vs. Delay
  variation in time
time between req. and action.
L3: “Time”

- Task activity – Periodic time-based

**Figure 12.1** Task Activity in a Periodic Time-Based System
L3: “Time”

• Task activity – Aperiodic Foreground-background

Foreground-Background: Two groups of tasks
F: Initiated by Interrupt or real time constraint; higher priority levels
B: Non-interrupt, non real time tasks; lower priorities

Figure 12.2  Task Activity in an Aperiodic Foreground/Background Design
L3: “Time”

- Hard (deadline): when an action must occur by a specified time. Missed deadline ➔ partial or total system failure.
- Hard Real Time system: contains one or more tasks with hard constraints.
- Soft Real Time system: relaxed constraints. May meet deadlines on average.

<table>
<thead>
<tr>
<th>Property</th>
<th>Nonreal-time</th>
<th>Soft Real-time</th>
<th>Hard Real-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic</td>
<td>No</td>
<td>Possibly</td>
<td>Yes</td>
</tr>
<tr>
<td>Predictable</td>
<td>No</td>
<td>Possibly</td>
<td>Yes</td>
</tr>
<tr>
<td>Consequences of late computation</td>
<td>No effect</td>
<td>Degraded performance</td>
<td>Failure</td>
</tr>
<tr>
<td>Critical reliability</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Response dictated by external events</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Timing analysis possible</td>
<td>No</td>
<td>Analytic (sometimes)</td>
<td>Analytic, stochastic simulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>stochastic simulation</td>
<td></td>
</tr>
</tbody>
</table>
Assignment

• Read sections 12.0 – 12.2.3