LAB 2

Anirudh Pal (pal5)

Part 3.1: Modifications can be found in *system/clkhandler.c*

Correctness was tested by running computation and system call and then seeing the granularity of clktimemilli compared to clktime.

Output:

```
Testing clktimemilli.
CLKTIME: 2 s
CLKTIMEMILLI: 2008 ms
```

Part 3.2: Modifications can be found in *system/create.c, system/clkhandler.c, system/resched.c* and *include/process.h.*

The correctness is tested by having 2 CPU bound processes and 2 IO bound processes and seeing the dynamics of CPU time usage compared to the total system time.

The CPU bound processes will have large gross time and IO bound process will not. The CPU bound processes will have approximately half of the time since their start.

Output:

```
Testing CPU Gross Time.
PID: 4, proctype: 0, CLKTIMEMILLI: 1052ms, CPU Gross Time: 23ms, CPU Wait Time: 429ms, CPU Wait Count: 1
PID: 6, proctype: 0, CLKTIMEMILLI: 1058ms, CPU Gross Time: 23ms, CPU Wait Time: 580ms, CPU Wait Count: 1
PID: 5, proctype: 1, CLKTIMEMILLI: 21029ms, CPU Gross Time: 0ms, CPU Wait Time: 16ms, CPU Wait Count: 10001
PID: 7, proctype: 1, CLKTIMEMILLI: 21032ms, CPU Gross Time: 0ms, CPU Wait Time: 13ms, CPU Wait Count: 10001
```

Part 3.3: Modifications can be found in *system/create.c, system/ready.c, system/resched.c* and *include/process.h.*

The correctness is tested by having 2 CPU Bound processes with one having a lower priority.

The lower priority process will starve and have a wait time similar to the gross cpu time of the one which is higher priority.

Also from previous test, we can see that IO Bound processes have small wait times and large wait counts due to becoming ready multiple times.

Output:

```
Testing CPU Wait Time.
PID: 9, proctype: 0, CLKTIMEMILLI: 26046ms, CPU Gross Time: 23ms, CPU Wait Time: 2ms, CPU Wait Count: 1
PID: 8, proctype: 0, CLKTIMEMILLI: 26070ms, CPU Gross Time: 23ms, CPU Wait Time: 24ms, CPU Wait Count: 1
```

Part 4: Modifications can be found in *system/initialize.c, system/sysdisp.c and system/igetpid.c.*

Correctness is tested by having 4 processes call igetpid() and compare the results to the actual PID.

Also, if anything other than 3 is used for the syscall number, the syscall dispatcher triggers trap().

Output:

```
Testing igetpid().
currpid: 10, getpid(): 10, igetpid(): 10
currpid: 11, getpid(): 11, igetpid(): 11
currpid: 12, getpid(): 12, igetpid(): 12
currpid: 13, getpid(): 13, igetpid(): 13
```

Part 5: Modifications can be found in *system/create.c, system/clkhandler.c, system/sleep.c* and *include/process.h.*

For the first one, the gross time was same and wait moderately increased as more processes where running.

For the second one, the gross time was same and wait slowly increased as more processes where running.

For the third one, the gross time and waits were larger for CPU Bound processes when compared to IO Bound processes.

I also tested the priority changes. And they worked as expected. The debugging prints can be enabled by uncommenting print statements in *system/clkhandler.c* and *system/sleep.c.*

Output:

```
Testing R3 with 8 CPU Bound Procs.
PID: 14, proctype: 0, CLKTIMEMILLI: 37155ms, CPU Gross
Time: 23ms, CPU Wait Time: 552ms, CPU Wait Count: 1
PID: 15, proctype: 0, CLKTIMEMILLI: 37171ms, CPU Gross
Time: 23ms, CPU Wait Time: 686ms, CPU Wait Count: 1
PID: 16, proctype: 0, CLKTIMEMILLI: 37185ms, CPU Gross
Time: 23ms, CPU Wait Time: 806ms, CPU Wait Count: 1
PID: 17, proctype: 0, CLKTIMEMILLI: 37197ms, CPU Gross
Time: 23ms, CPU Wait Time: 908ms, CPU Wait Count: 1
PID: 18, proctype: 0, CLKTIMEMILLI: 37207ms, CPU Gross
Time: 23ms, CPU Wait Time: 988ms, CPU Wait Count: 1
PID: 19, proctype: 0, CLKTIMEMILLI: 37215ms, CPU Gross
Time: 23ms, CPU Wait Time: 1042ms, CPU Wait Count: 1
PID: 20, proctype: 0, CLKTIMEMILLI: 37221ms, CPU Gross
Time: 23ms, CPU Wait Time: 1066ms, CPU Wait Count: 1
PID: 21, proctype: 0, CLKTIMEMILLI: 37226ms, CPU Gross
Time: 24ms, CPU Wait Time: 1056ms, CPU Wait Count: 1
```

```
Testing R3 with 8 I/O Bound Procs.
PID: 22, proctype: 1, CLKTIMEMILLI: 62109ms, CPU Gross
Time: 0ms, CPU Wait Time: 0ms, CPU Wait Count: 10001
PID: 23, proctype: 1, CLKTIMEMILLI: 62110ms, CPU Gross
Time: 0ms, CPU Wait Time: 1ms, CPU Wait Count: 10001
PID: 24, proctype: 1, CLKTIMEMILLI: 62111ms, CPU Gross
Time: 0ms, CPU Wait Time: 2ms, CPU Wait Count: 10001
PID: 25, proctype: 1, CLKTIMEMILLI: 62112ms, CPU Gross
Time: 0ms, CPU Wait Time: 3ms, CPU Wait Count: 10001
PID: 26, proctype: 1, CLKTIMEMILLI: 62113ms, CPU Gross
Time: 0ms, CPU Wait Time: 4ms, CPU Wait Count: 10001
PID: 27, proctype: 1, CLKTIMEMILLI: 62114ms, CPU Gross
Time: 0ms, CPU Wait Time: 5ms, CPU Wait Count: 10001
PID: 28, proctype: 1, CLKTIMEMILLI: 62115ms, CPU Gross
Time: 0ms, CPU Wait Time: 6ms, CPU Wait Count: 10001
PID: 29, proctype: 1, CLKTIMEMILLI: 62116ms, CPU Gross
Time: 0ms, CPU Wait Time: 7ms, CPU Wait Count: 10001

Testing R3 with 4 CPU Bound and 4 I/O Bound Procs.
PID: 30, proctype: 0, CLKTIMEMILLI: 67180ms, CPU Gross
Time: 23ms, CPU Wait Time: 593ms, CPU Wait Count: 1
PID: 32, proctype: 0, CLKTIMEMILLI: 67199ms, CPU Gross
Time: 23ms, CPU Wait Time: 990ms, CPU Wait Count: 1
PID: 34, proctype: 0, CLKTIMEMILLI: 67208ms, CPU Gross
Time: 24ms, CPU Wait Time: 1206ms, CPU Wait Count: 1
PID: 36, proctype: 0, CLKTIMEMILLI: 67210ms, CPU Gross
Time: 24ms, CPU Wait Time: 1139ms, CPU Wait Count: 1
PID: 31, proctype: 1, CLKTIMEMILLI: 87168ms, CPU Gross
Time: 0ms, CPU Wait Time: 53ms, CPU Wait Count: 10001
PID: 33, proctype: 1, CLKTIMEMILLI: 87171ms, CPU Gross
Time: 0ms, CPU Wait Time: 50ms, CPU Wait Count: 10001
```

```
PID: 35, proctype: 1, CLKTIMEMILLI: 87175ms, CPU Gross
Time: 0ms, CPU Wait Time: 48ms, CPU Wait Count: 10001
PID: 37, proctype: 1, CLKTIMEMILLI: 87178ms, CPU Gross
Time: 0ms, CPU Wait Time: 43ms, CPU Wait Count: 10001
```