CSCI 3753: Operating Systems
Problem Set Two

Please write your answers in the space provided.

Due date: Tuesday, March 12 in class. No extensions will be given, except at the instructor's discretion in documented cases of extreme hardship or emergencies.

Problem 1. [20 Points] What is a process context switch? When does it occur? Describe the steps involved in implementing a process context switch

Problem 2. [10 Points] What is the key advantage of threads over processes?

Problem 3. [40 Points] Unisex bathroom problem: CU wants to show off how politically correct it is by applying the U.S. Supreme Court's "Separate but equal is inherently unequal" doctrine to gender as well as race, ending its long-standing practice of gender-segregated bathrooms on campus. However, as a concession to tradition, it decrees that when a woman is in the bathroom, other women may enter, but no men, and vice versa. A child may enter the bathroom only if there is at least one adult present in the bathroom. Finally, at most N (N > 1) individuals may use the bathroom at any time.

You task is to write three functions: man_use_bathroom( ), woman_use_bathroom( ), and child_use_bathroom( ). Provide a monitor-based solution that manages access to the bathroom. Your solution should be fair, starvation free and deadlock free.

```
void man_use_bathroom ( )          void child_use_bathroom ( )        void woman_use_bathroom ( )
{                                  {                                  {
 unisex_bathroom.                   unisex_bathroom.                   unisex_bathroom.
    enter_bathroom_man ( );            enter_bathroom_child( );           enter_bathroom_woman( );
    Use restroom                       Use restroom                       Use restroom
 unisex_bathroom.                   unisex_bathroom.                   unisex_bathroom.
    exit_bathroom_man ( );             exit_bathroom_child( );            exit_bathroom_woman ( );
}                                  }                                  }
```

```
monitor unisex_bathroom {
    int mc, mcw, fc, fcw, cc, ccw, total;
    condition m_cond, f_cond, c_cond;

    void enter_bathroom_man
    {
      if (fc == 0 && fcw == 0 && (cc+mc) < N) mc++;
      else {
        mcw++;
        while (!(fc == 0 && fcw == 0 && (cc+mc) < N)) m_cond.wait( );
        mcw--; mc++;
      }
    }

    void enter_bathroom_woman  is similar to enter_bathroom_man( )

    void enter_bathroom_child
    {
      if ((mc > 0 && (mc+cc) < N) || (fc > 0 && (fc+cc) < N)) cc++;
      else {
        ccw++;
        while (!(((mc > 0 && (mc+cc) < N) || (fc > 0 && (fc+cc) < N))) c_cond.wait( );
        ccw--; cc++;
      }
    }
```

```
void exit_bathroom_female
{
    fc--;
    if (mcw == 0) {
        if (fcw > 0 && (fc == 0 || ccw == 0) f_cond.signal( );
        else if (fc > 0 && fcw == 0 && ccw > 0) c_cond.signal( );
        else if (fc > 0 && fcw > 0 && ccw > 0) {
            //choose a number m = 0 or 1 at random
            if (m == 0) f_cond.signal( );
            else c_cond.signal( );
        }
    }
    else {
        if (fc > 0 && ccw > 0) c_cond.signal( );
        else if (fc == 0) {
            int x = N – cc; x1 = ccw; x2 = mcw;
            if (x1 == 0) {
                if (x2 < x) for (int i=0; i<x2; i++) m_cond.signal( );
                else for (int i=0; i<x; i++) m_cond.signal( );
            }
            else {
                if (x > x1+x2) x = x1+x2;
                m_cond.signal( );
                x--; x2--;
                while (x != 0) {
                    if (x1 == 0) {
                        m_cond.signal( );
                        x2--; x--;
                    }
                    else if (x2 == 0)
                    {
                        c_cond.signal( );
                        x1--; x--;
                    }
                    else {
                        //choose a number m = 0 or 1 at random
                        if (m == 0) {m_cond.signal( ); x2--;}
                        else {c_cond.signal( ); x1--;}
                        x--;
                    }
                }
            }
        }
    }
}

void exit_bathroom_man  is similar to enter_bathroom_woman( )
```

```
void exit_bathroom_child( )
{
    cc--;
    if (fc > 0) {
      if (mcw > 0 && ccw > 0) c_cond.signal( );
      else if (fcw == 0 && ccw > 0) c_cond.signal( );
      else if (fcw > 0 && mcw == 0 && ccw == 0) f_cond.signal( );
      else if (fcw > 0 && mcw == 0 && ccw > 0) {
          //choose a number m = 0 or 1 at random
          if (m == 0) f_cond.signal( );
          else c_cond.signal( );
      }
    }
    else if (mc > 0) {
      //This code is similar to the code in the above if statement
    }
}

init_code( )
{
    mc = fc = cc = mcw = fcw = ccw = 0;
}
}
```