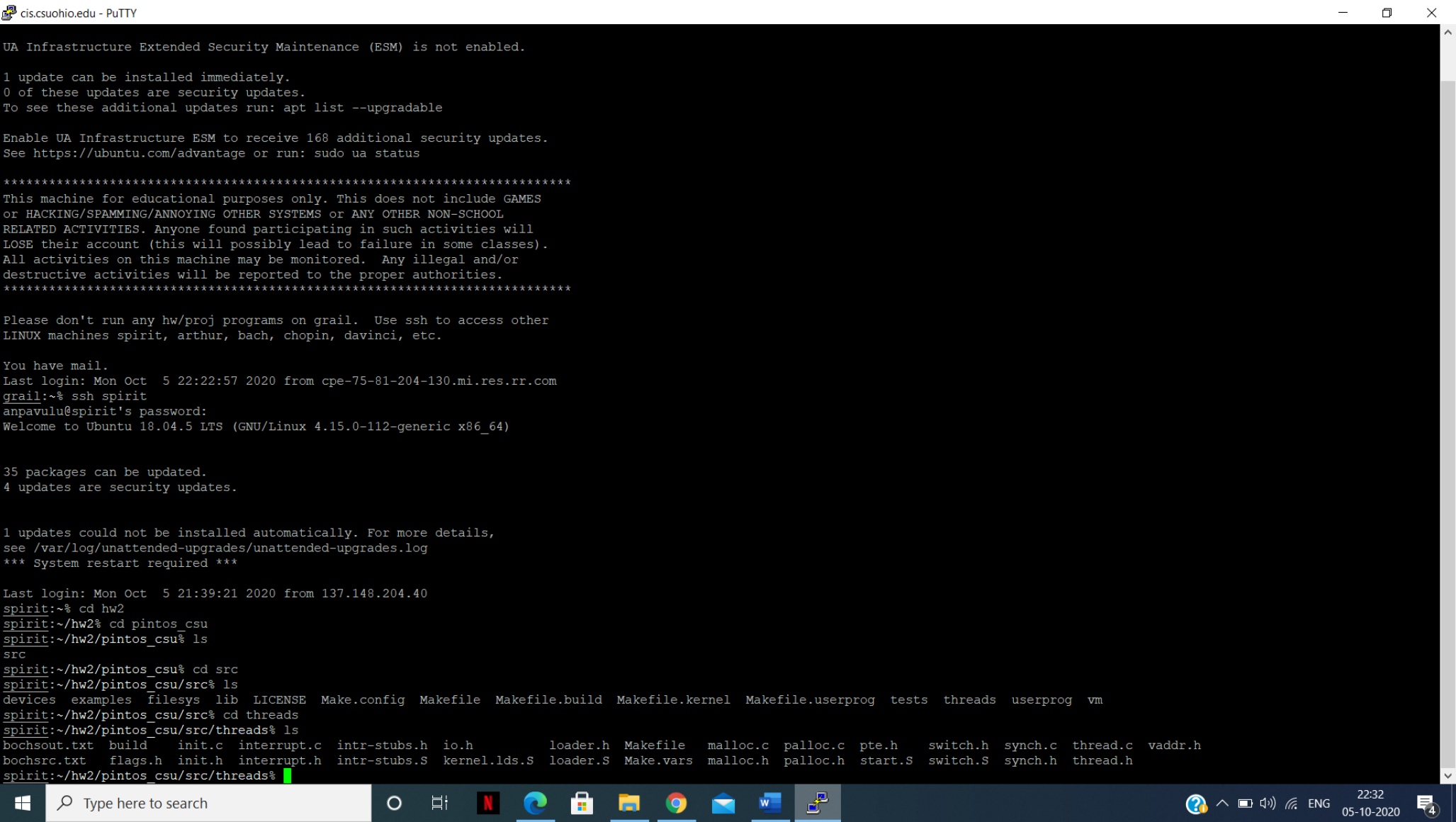**Name: Hemal Paneliya, Anil Pavuluru**

Login id: anpavulu

Task-1:

-Firstly, we have make a directory called hw2 and under this directory we have extracted the
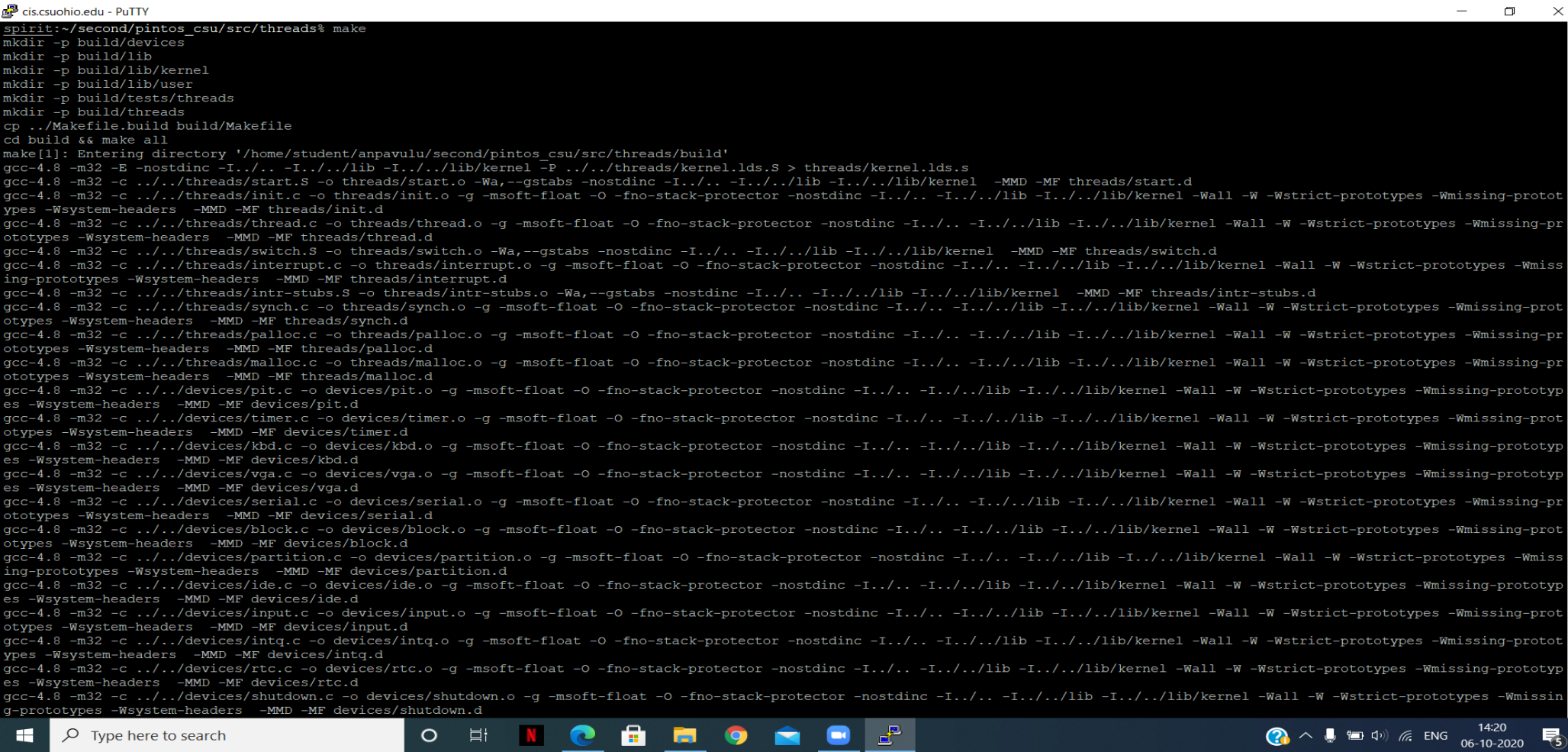
tar xvfz ~cis345s/pub/pintos csu.tar.gz

-Mostly for hw2 we are going to work under pintos_csu/src/threads and for the test cases we are going to follow pintos_csu/src/tests/threads

-For the first part we navigate to pintos_csu/src/threads and execute the make command to compile and build the kernel kernel.bin

-Screenshot after make command implementation

-After compiling the test case alarm-single we are running it using

pintos -v -- run alarm-single

-Screenshot of the output for the test case alarm-single

Task-2:

-In this task we have to add a produce/consumer program as a new test case

-Firstly, I have copied the producer/consumer program from ~cis345s/pub/prd-cns.c to the directory pintos_csu/src/tests/threads/ using command

cp ~cis345s/pub/prd-cns.c pintos_csu/src/tests/threads/

-Secondly, we have to modify prd-cns.c file as below to make it work for pintos version

-Replacing headers of prd-cns.c with alarm-wait.c

-Replacing static sem_t with struct semaphore

-Replacing PTHREAD_MUTEX_INITIALIZER with struct lock

-Remove pointer from both functions(producer, consumer) and added UNUSED with its argument to remove the warnings

-Replacing sem_wait and sem_post with sem_down and sem_up

-Replacing lock with lock_acquire and unlock with lock_release

-Replacing main method name to test_prd_cns

-Removed statement pthread_t prodid, custid

-Changed sem_init parameters from 3 parameters to 2 parameters(removed the middle 0)

-Replacing pthread_create to thread_create and replaced the first two parameters putting "producer"/"consumer" as the first parameter and PRTY_DEFAULT as the second parameter

```
  GNU nano 2.9.3                                          prd-cns.c

/* Replacing headers with alarm-wait.c */
#include <stdio.h>
#include "tests/threads/tests.h"
#include "threads/init.h"
#include "threads/malloc.h"
#include "threads/synch.h"
#include "threads/thread.h"
#include "devices/timer.h"
#define N 10
#define BUFSIZE 3
static int buffer[BUFSIZE];
static int bufin = 0, bufout = 0;

/* Replacing static sem_t with struct sempahore */
struct semaphore  empty, full;

/* Replacing PTHREAD_Mutex_Intitializer with struct lock */
struct lock buffer_lock;

static void producer(void *arg1 UNUSED) {//Remove pointer from the function and used UNUSED with the parameter to remove the warning
   int i, item;

   for (i = 0; i < N; i++) {
      sem_down(&empty);//Replacing sem_wait to sem_down
      item = i*i*i*i;
      lock_acquire(&buffer_lock);//Replacing lock to lock_acquire
      buffer[bufin] = item;
      bufin = (bufin + 1) % BUFSIZE;
      lock_release(&buffer_lock);//Replacing unlock to lock_release
      printf("p: put item %d\n", item);
      sem_up(&full);//Replacing sem_post to sem_up
   }
   // return NULL;
}

static void consumer(void *arg2 UNUSED) {//Remove pointer from function and used UNUSED with the argument to remove the warning
   int i, item;

   for (i = 0; i < N; i++) {
      sem_down(&full);//Replacing sem_wait to sem_down
      lock_acquire(&buffer_lock);//Replacing lock to lock_acquire
      item = buffer[bufout];
      bufout = (bufout + 1) % BUFSIZE;
      lock_release(&buffer_lock);//Replacing unlock to lock_release
      printf("c: get item %d\n",item);

                              [ Read 59 lines ]
^G Get Help     ^O Write Out    ^W Where Is     ^K Cut Text     ^J Justify      ^C Cur Pos      M-U Undo        M-A Mark Text   M-] To Bracket  M-◄ Previous    ^B Back
^X Exit         ^R Read File    ^\ Replace      ^U Uncut Text   ^T To Spell     ^_ Go To Line   M-E Redo        M-6 Copy Text   M-W WhereIs Next M-► Next       ^F Forward
```

```
  GNU nano 2.9.3                                          prd-cns.c

      sem_down(&empty);//Replacing sem_wait to sem_down
      item = i*i*i*i;
      lock_acquire(&buffer_lock);//Replacing lock to lock_acquire
      buffer[bufin] = item;
      bufin = (bufin + 1) % BUFSIZE;
      lock_release(&buffer_lock);//Replacing unlock to lock_release
      printf("p: put item %d\n", item);
      sem_up(&full);//Replacing sem_post to sem_up
   }
   // return NULL;
}

static void consumer(void *arg2 UNUSED) {//Remove pointer from function and used UNUSED with the argument to remove the warning
   int i, item;

   for (i = 0; i < N; i++) {
      sem_down(&full);//Replacing sem_wait to sem_down
      lock_acquire(&buffer_lock);//Replacing lock to lock_acquire
      item = buffer[bufout];
      bufout = (bufout + 1) % BUFSIZE;
      lock_release(&buffer_lock);//Replacing unlock to lock_release
      printf("c: get item %d\n",item);
      sem_up(&empty);//Replacing sem_post to sem_up
   }
   // return NULL;
}

void test_prd_cns(void) {//Replacing main method name to test_prd_cns
   lock_init(&buffer_lock);//lock intialization
   sem_init(&full, 0);//Relacing sem_init with only two parameters
   sem_init(&empty, BUFSIZE);//Replacing sem_init with only two parameters
   thread_create("producer", PRTY_DEFAULT, producer, NULL);//Replacing pthread_create to thread_create and also replacing the first two parameters
   thread_create("consumer", PRTY_DEFAULT, consumer, NULL);//Replacing pthread_create to thread_create and also replacing the first two parameters
   // thread_exit(0);
}

^G Get Help     ^O Write Out    ^W Where Is     ^K Cut Text     ^J Justify      ^C Cur Pos      M-U Undo        M-A Mark Text   M-] To Bracket  M-◄ Previous    ^B Back
^X Exit         ^R Read File    ^\ Replace      ^U Uncut Text   ^T To Spell     ^_ Go To Line   M-E Redo        M-6 Copy Text   M-W WhereIs Next M-► Next       ^F Forward
```

-Thirdly, we have added a pair {"prd-cns", test_prd_cns}

```
#include "tests/threads/tests.h"
#include <debug.h>
#include <string.h>
#include <stdio.h>

struct test
  {
    const char *name;
    test_func *function;
  };

static const struct test tests[] =
  {
    {"alarm-single", test_alarm_single},
    {"alarm-multiple", test_alarm_multiple},
    {"alarm-simultaneous", test_alarm_simultaneous},
    {"alarm-priority", test_alarm_priority},
    {"alarm-zero", test_alarm_zero},
    {"alarm-negative", test_alarm_negative},
    {"priority-change", test_priority_change},
    {"priority-fifo", test_priority_fifo},
    {"priority-preempt", test_priority_preempt},
    {"priority-sema", test_priority_sema},
    {"prd-cns", test_prd_cns},//Added pair
  };

static const char *test_name;

/* Runs the test named NAME. */
void
run_test (const char *name)
{
  const struct test *t;

  for (t = tests; t < tests + sizeof tests / sizeof *tests; t++)
    if (!strcmp (name, t->name))
      {
        test_name = name;
        msg ("begin");
        t->function ();
        msg ("end");
        return;
      }
  PANIC ("no test named \"%s\"", name);
}
```

```
[ Read 86 lines ]
^G Get Help    ^O Write Out   ^W Where Is    ^K Cut Text    ^J Justify     ^C Cur Pos     M-U Undo    M-A Mark Text   M-] To Bracket   M-^ Previous   ^B Back
^X Exit        ^R Read File   ^\ Replace     ^U Uncut Text  ^T To Spell    ^_ Go To Line  M-E Redo    M-6 Copy Text   M-W WhereIs Next M-v Next       ^F Forward
```

-fourthly, we have added an extern test_func test_prd_cns in tests.h

```
#ifndef TESTS_THREADS_TESTS_H
#define TESTS_THREADS_TESTS_H

void run_test (const char *);

typedef void test_func (void);

extern test_func test_alarm_single;
extern test_func test_alarm_multiple;
extern test_func test_alarm_simultaneous;
extern test_func test_alarm_priority;
extern test_func test_alarm_zero;
extern test_func test_alarm_negative;
extern test_func test_priority_change;
extern test_func test_priority_fifo;
extern test_func test_priority_preempt;
extern test_func test_priority_sema;
extern test_func test_prd_cns;//added extern

void msg (const char *, ...);
void fail (const char *, ...);
void pass (void);

#endif /* tests/threads/tests.h */
```

```
[ Read 25 lines ]
^G Get Help    ^O Write Out   ^W Where Is    ^K Cut Text    ^J Justify     ^C Cur Pos     M-U Undo    M-A Mark Text   M-] To Bracket   M-^ Previous   ^B Back
^X Exit        ^R Read File   ^\ Replace     ^U Uncut Text  ^T To Spell    ^_ Go To Line  M-E Redo    M-6 Copy Text   M-W WhereIs Next M-v Next       ^F Forward
```

-Fifthly, we have added a source tests/threads/prd-cns.c to Make.tests

GNU nano 2.9.3   Make.tests

```
-*- makefile -*-

# CSU-version S19: Test names.
tests/threads_TESTS = $(addprefix tests/threads/,alarm-single          \
alarm-multiple alarm-simultaneous alarm-priority alarm-zero            \
alarm-negative priority-change                                        \
priority-fifo priority-preempt priority-sema)

# Sources for tests.
tests/threads_SRC  = tests/threads/tests.c
tests/threads_SRC += tests/threads/alarm-wait.c
tests/threads_SRC += tests/threads/alarm-simultaneous.c
tests/threads_SRC += tests/threads/alarm-priority.c
tests/threads_SRC += tests/threads/alarm-zero.c
tests/threads_SRC += tests/threads/alarm-negative.c
tests/threads_SRC += tests/threads/priority-change.c
tests/threads_SRC += tests/threads/priority-fifo.c
tests/threads_SRC += tests/threads/priority-preempt.c
tests/threads_SRC += tests/threads/priority-sema.c
tests/threads_SRC += tests/threads/prd-cns.c
```

[Read 21 lines]

| ^G Get Help | ^O Write Out | ^W Where Is | ^K Cut Text | ^J Justify | ^C Cur Pos | M-U Undo | M-A Mark Text | M-] To Bracket | M-◄ Previous | ^B Back |
| ^X Exit | ^R Read File | ^\ Replace | ^U Uncut Text | ^T To Spell | ^_ Go To Line | M-E Redo | M-6 Copy Text | M-W WhereIs Next | M-► Next | ^F Forward |

-Lastly, we navigated to pintos csu/src/threads and executed make command to rebuild the kernel to include the new test case of producer/consumer and run it using

pintos -v -- run prd-cns


```
Use "fg" to return to nano.

Suspended (signal)
spirit:~/hw2/pintos_csu/src/tests/threads% nano tests.h
Use "fg" to return to nano.

Suspended (signal)
spirit:~/hw2/pintos_csu/src/tests/threads% nano Make.tests
Use "fg" to return to nano.

Suspended (signal)
spirit:~/hw2/pintos_csu/src/tests/threads% cd ../../threads
spirit:~/hw2/pintos_csu/src/threads% ls
bochsout.txt  build    init.c   interrupt.c  intr-stubs.h  io.h        loader.h  Makefile   malloc.c  palloc.c  pte.h    switch.h  synch.c  thread.c  vaddr.h
bochsrc.txt   flags.h  init.h   interrupt.h  intr-stubs.S  kernel.lds.S  loader.S  Make.vars  malloc.h  palloc.h  start.S  switch.S  synch.h  thread.h
spirit:~/hw2/pintos_csu/src/threads% make
cd build && make all
make[1]: Entering directory '/home/student/anpavulu/hw2/pintos_csu/src/threads/build'
gcc-4.8 -m32 -c ../../threads/init.c -o threads/init.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstrict-prototypes -Wmissing-protot
ypes -Wsystem-headers  -MMD -MF threads/init.d
gcc-4.8 -m32 -c ../../tests/threads/tests.c -o tests/threads/tests.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstrict-prototypes -W
missing-prototypes -Wsystem-headers  -MMD -MF tests/threads/tests.d
gcc-4.8 -m32 -c ../../tests/threads/alarm-wait.c -o tests/threads/alarm-wait.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstrict-pro
totypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/alarm-wait.d
gcc-4.8 -m32 -c ../../tests/threads/alarm-simultaneous.c -o tests/threads/alarm-simultaneous.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall
 -W -Wstrict-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/alarm-simultaneous.d
gcc-4.8 -m32 -c ../../tests/threads/alarm-priority.c -o tests/threads/alarm-priority.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wst
rict-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/alarm-priority.d
gcc-4.8 -m32 -c ../../tests/threads/alarm-zero.c -o tests/threads/alarm-zero.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstrict-pro
totypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/alarm-zero.d
gcc-4.8 -m32 -c ../../tests/threads/alarm-negative.c -o tests/threads/alarm-negative.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wst
rict-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/alarm-negative.d
gcc-4.8 -m32 -c ../../tests/threads/priority-change.c -o tests/threads/priority-change.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -W
strict-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/priority-change.d
gcc-4.8 -m32 -c ../../tests/threads/priority-fifo.c -o tests/threads/priority-fifo.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstri
ct-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/priority-fifo.d
gcc-4.8 -m32 -c ../../tests/threads/priority-preempt.c -o tests/threads/priority-preempt.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W
-Wstrict-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/priority-preempt.d
gcc-4.8 -m32 -c ../../tests/threads/priority-sema.c -o tests/threads/priority-sema.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstri
ct-prototypes -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/priority-sema.d
gcc-4.8 -m32 -c ../../tests/threads/prd-cns.c -o tests/threads/prd-cns.o -g -msoft-float -O -fno-stack-protector -nostdinc -I../.. -I../../lib -I../../lib/kernel -Wall -W -Wstrict-prototype
s -Wmissing-prototypes -Wsystem-headers  -MMD -MF tests/threads/prd-cns.d
ld -melf_i386 -T threads/kernel.lds.s -o kernel.o threads/start.o threads/init.o threads/thread.o threads/switch.o threads/interrupt.o threads/intr-stubs.o threads/synch.o threads/palloc.o
threads/malloc.o devices/pit.o devices/timer.o devices/kbd.o devices/vga.o devices/serial.o devices/block.o devices/partition.o devices/ide.o devices/input.o devices/intq.o devices/rtc.o de
vices/shutdown.o devices/speaker.o lib/debug.o lib/random.o lib/stdio.o lib/stdlib.o lib/string.o lib/arithmetic.o lib/ustar.o lib/kernel/debug.o lib/kernel/list.o lib/kernel/bitmap.o lib/k
ernel/hash.o lib/kernel/console.o tests/tests.o tests/threads/alarm-wait.o tests/threads/alarm-simultaneous.o tests/threads/alarm-priority.o tests/threads/alarm-zero.o tests/threads
/alarm-negative.o tests/threads/priority-change.o tests/threads/priority-fifo.o tests/threads/priority-preempt.o tests/threads/priority-sema.o tests/threads/prd-cns.o
objcopy -R .note -R .comment -S kernel.o kernel.bin
make[1]: Leaving directory '/home/student/anpavulu/hw2/pintos_csu/src/threads/build'
spirit:~/hw2/pintos_csu/src/threads%
```

-Final Output

```
threads/malloc.o devices/pit.o devices/timer.o devices/kbd.o devices/vga.o devices/serial.o devices/block.o devices/partition.o devices/ide.o devices/input.o devices/intq.o devices/rtc.o de
vices/shutdown.o devices/speaker.o lib/debug.o lib/random.o lib/stdio.o lib/stdlib.o lib/string.o lib/arithmetic.o lib/ustar.o lib/kernel/debug.o lib/kernel/list.o lib/kernel/bitmap.o lib/k
ernel/hash.o lib/kernel/console.o tests/threads/tests.o tests/threads/alarm-wait.o tests/threads/alarm-simultaneous.o tests/threads/alarm-priority.o tests/threads/alarm-zero.o tests/threads
/alarm-negative.o tests/threads/priority-change.o tests/threads/priority-fifo.o tests/threads/priority-preempt.o tests/threads/priority-sema.o tests/threads/prd-cns.o
objcopy -R .note -R .comment -S kernel.o kernel.bin
make[1]: Leaving directory '/home/student/anpavulu/hw2/pintos_csu/src/threads/build'
spirit:~/hw2/pintos_csu/src/threads% pintos -v -- run prd-cns
squish-pty bochs -q
00000000000i[      ] BXSHARE not set. using compile time default '/usr/local/share/bochs'
========================================================================
                    Bochs x86 Emulator 2.6.9
              Built from SVN snapshot on April 9, 2017
                  Compiled on Jan 10 2019 at 16:23:58
========================================================================
00000000000i[      ] reading configuration from bochsrc.txt
00000000000i[      ] installing nogui module as the Bochs GUI
00000000000i[      ] using log file bochsout.txt
PiLo hda1
Loading........
Kernel command line: run prd-cns
Pintos booting with 4,096 kB RAM...
383 pages available in kernel pool.
383 pages available in user pool.
Calibrating timer...  204,600 loops/s.
Boot complete.
Executing 'prd-cns':
(prd-cns) begin
(prd-cns) end
Execution of 'prd-cns' complete.
p: put item 0
p: put item 1
p: put item 16
c: get item 0
c: get item 1
c: get item 16
p: put item 81
p: put item 256
p: put item 625
c: get item 81
c: get item 256
c: get item 625
p: put item 1296
p: put item 2401
p: put item 4096
c: get item 1296
c: get item 2401
c: get item 4096
p: put item 6561
c: get item 6561
```