**Studio 10**

1. **Names of the people:** Sayali Patil
2. **Review of the kernel thread interface:**

Kthread.h is a kernel threads macro that explains how kernel threads can be implemented using different in-built functions defined inside the macro to use kernel threads in our programs/modules. It explains the structures of kernel thread struct to be used correctly while declaring pointers of type thread struct and how these pointers can be used inside the kernel thread functions chosen according to the application we want to implement.

1. **Code snippet:**

**A screenshot of a computer screen

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1. A) Why the value should be 4000000?

If there are no data races every thread will run the for loop for 1000000 iterations while executing its own loop so the value of shared\_data will be 1000000 when the first thread finishes its execution, 2000000 when the second finishes, 3000000 when the third finishes, and 4000000 when the fourth thread finishes its execution.

b) Why a data race might cause a different value to be printed?

If data race happens between two threads, then the second thread might not wait for the first thread to finish execution and write the value of shared\_data variable at the end of its execution to be used by the next thread. Second thread may just pick some intermediate value of shared\_data variable and will start updating the value, that might cause a different value to be printed.

1. **Output of original\_km:**
2. First run:

[   98.936028] Module initialization started

[   98.936197] Kernel function is running on CPU: 0

[   98.937598] Kernel function is running on CPU: 2

[   98.939998] Kernel function is running on CPU: 1

[   98.947453] Kernel function is running on CPU: 3

[  107.059539] Module exit process started

[  107.059571] Kernel function finished execution on CPU: 0

[  107.059627] Kernel function finished execution on CPU: 1

[  107.059658] Kernel function finished execution on CPU: 2

[  107.059711] Kernel function finished execution on CPU: 3

[  107.059730] shared\_data value is: 2910033

1. Second run:

[  173.339170] Module initialization started

[  173.341761] Kernel function is running on CPU: 0

[  173.341806] Kernel function is running on CPU: 1

[  173.351971] Kernel function is running on CPU: 2

[  173.352004] Kernel function is running on CPU: 3

[  176.306445] Module exit process started

[  176.306505] Kernel function finished execution on CPU: 0

[  176.306579] Kernel function finished execution on CPU: 1

[  176.306668] Kernel function finished execution on CPU: 2

[  176.306727] Kernel function finished execution on CPU: 3

[  176.306762] shared\_data value is: 2546993

1. Third run:

[  229.800622] Module initialization started

[  229.811057] Kernel function is running on CPU: 0

[  229.811448] Kernel function is running on CPU: 3

[  229.811657] Kernel function is running on CPU: 2

[  229.812104] Kernel function is running on CPU: 1

[  231.846808] Module exit process started

[  231.846899] Kernel function finished execution on CPU: 0

[  231.847894] Kernel function finished execution on CPU: 1

[  231.851758] Kernel function finished execution on CPU: 2

[  231.851833] Kernel function finished execution on CPU: 3

[  231.851901] shared\_data value is: 1180486

1. **Code snippet for atomic\_km:**

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A screenshot of a computer screen

Description automatically generated

1. **Output for atomic\_km:**
2. First run:

[  287.651765] Module initialization started

[  287.655786] Kernel function is running on CPU: 0

[  287.679319] Kernel function is running on CPU: 2

[  287.681704] Kernel function is running on CPU: 1

[  287.686664] Kernel function is running on CPU: 3

[  296.294918] Module exit process started

[  296.294958] Kernel function finished execution on CPU: 0

[  296.295055] Kernel function finished execution on CPU: 1

[  296.296614] Kernel function finished execution on CPU: 2

[  296.296653] Kernel function finished execution on CPU: 3

[  296.296696] shared\_data value is: 4000000

1. Second run:

[  332.712546] Module initialization started

[  332.715009] Kernel function is running on CPU: 1

[  332.720933] Kernel function is running on CPU: 0

[  332.723830] Kernel function is running on CPU: 2

[  332.736032] Kernel function is running on CPU: 3

[  334.327600] Module exit process started

[  334.327667] Kernel function finished execution on CPU: 0

[  334.327769] Kernel function finished execution on CPU: 1

[  334.327822] Kernel function finished execution on CPU: 2

[  334.327926] Kernel function finished execution on CPU: 3

[  334.327964] shared\_data value is: 4000000

1. Third run:

[  356.529499] Module initialization started

[  356.533214] Kernel function is running on CPU: 2

[  356.533300] Kernel function is running on CPU: 1

[  356.538474] Kernel function is running on CPU: 0

[  356.541036] Kernel function is running on CPU: 3

[  358.218677] Module exit process started

[  358.218769] Kernel function finished execution on CPU: 0

[  358.218874] Kernel function finished execution on CPU: 1

[  358.218932] Kernel function finished execution on CPU: 2

[  358.219031] Kernel function finished execution on CPU: 3

[  358.219072] shared\_data value is: 4000000

1. **Time taken by threads to complete their loop (for the third run):**
2. Thread 1: 1.680203
3. Thread 2: 1.685574
4. Thread 3: 1.685718
5. Thread 4: 1.677995