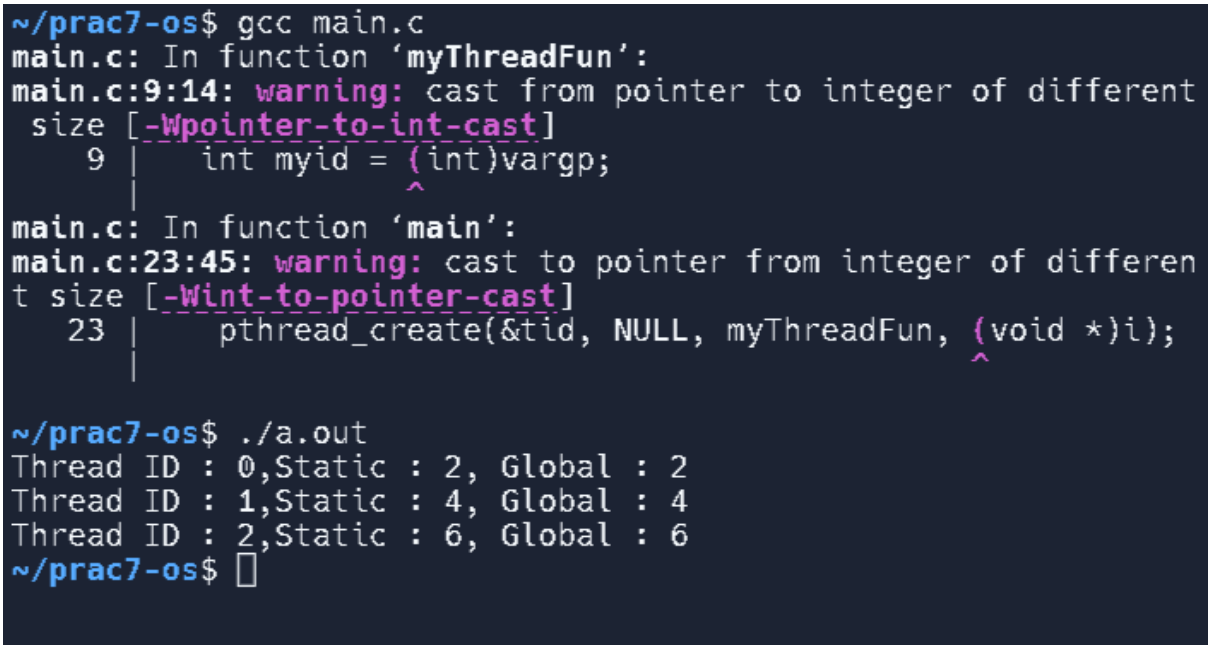
Name:Mohammad Abubakr Khanooni
Cse a roll no 27
Practical 7 operating system

Aim:
Write C programs to implement threads and semaphores for process synchronisation.

Prac 7a-threads:
1.A simple C program to demonstrate use of pthread basic functions and to implement multiple threads with global and static variables
Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
// Let us create a global variable to change it in threads
int g = 0;
// The function to be executed by all threads
void *myThreadFun(void *vargp) {
  // Store the value argument passed to this thread
  int myid = (int)vargp;
  // Let us create a static variable to observe its changes
  static int s = 0;
  // Change static and global variables
  ++s;
  ++g;
  // Print the argument, static and global variables
  printf("Thread ID : %d,Static : %d, Global : %d\n", myid, ++s, ++g);
}
int main() {
  int i;
  pthread_t tid;
  // Let us create 3 Threads
  for (i = 0; i < 3; i++)
    pthread_create(&tid, NULL, myThreadFun, (void *)i);
  pthread_exit(NULL);
  return 0;
}
```

o/p:

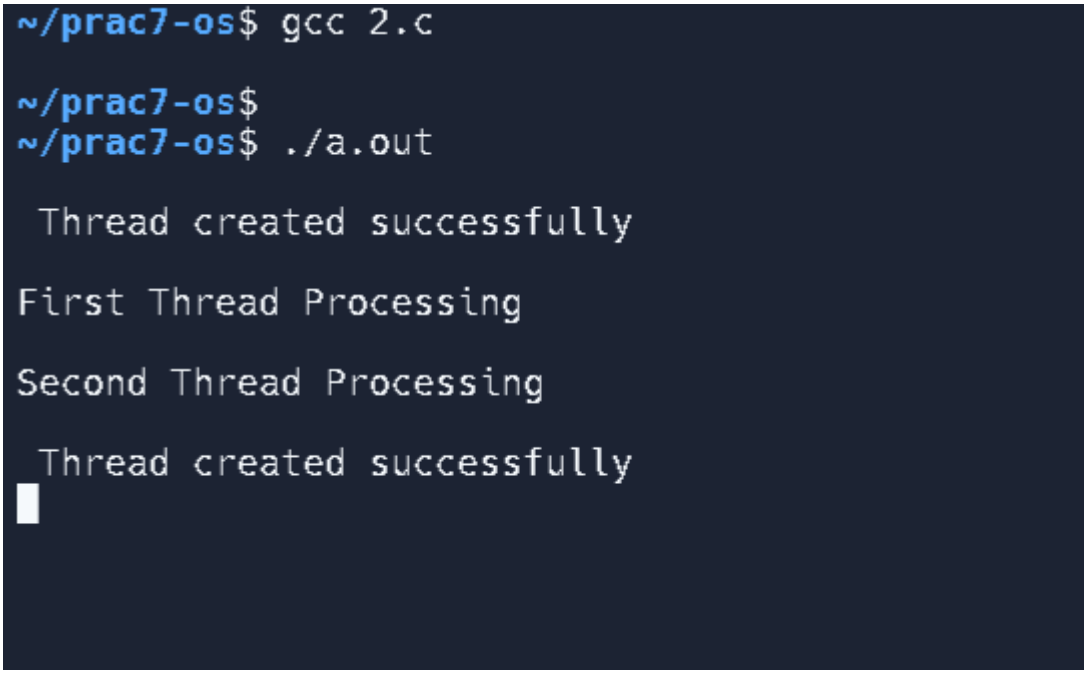


2.To demonstrate thread system calls
Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
pthread_t tid[2];
void *doSomeThing(void *arg) {
  unsigned long i = 0;
  pthread_t id = pthread_self();
  if (pthread_equal(id, tid[0]))
    printf("\nFirst Thread Processing \n");
  else
    printf("\nSecond Thread Processing \n");
  for (i = 0; i < (0xFFFFFFFF); i++)
    ;
  return NULL;
}
int main(void) {
  int i = 0;
  int err;
  while (i < 2) {
    err = pthread_create(&tid[i], NULL, &doSomeThing, NULL);
    if (err != 0)
      printf("\nCan't create Thread : [%s]", strerror(err));
    else
      printf("\n Thread created successfully\n");
    i++;
```

```
  }
  sleep(5);
  return 0;
}
```

o/p:



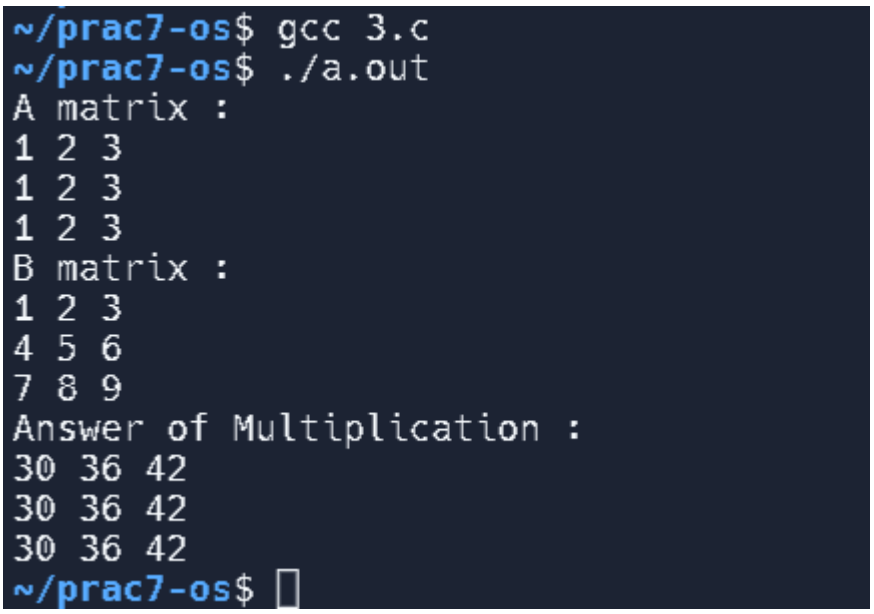
3.Matrix Multiplication using Threads

Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#define size 3
int A[size][size] = {{1, 2, 3}, {1, 2, 3}, {1, 2, 3}};
int B[size][size] = {{1, 2, 3}, {4, 5, 6}, {7, 8, 9}};
int C[size][size];
typedef struct {
  int row;
  int col;
} m;
void *mult(void *args) {
  m *index = (m *)args;
  int r = index->row;
  int c = index->col;
  for (int i = 0; i < size; i++) {
    C[r][c] += A[r][i] * B[i][c];
  }
}
int main() {
```

```
  pthread_t t[size][size];
  printf("A matrix :\n");
  for (int i = 0; i < size; i++) {
    for (int j = 0; j < size; j++) {
      printf("%d ", A[i][j]);
    }
    printf("\n");
  }
  printf("B matrix :\n");
  for (int i = 0; i < size; i++) {
    for (int j = 0; j < size; j++) {
      printf("%d ", B[i][j]);
    }
    printf("\n");
  }
  for (int i = 0; i < size; i++) {
    for (int j = 0; j < size; j++) {
      m *index = (m *)malloc(sizeof(m));
      index->row = i;
      index->col = j;
      pthread_create(&t[i][j], NULL, mult, (void *)index);
    }
  }
  for (int i = 0; i < size; i++) {
    for (int j = 0; j < size; j++) {
      pthread_join(t[i][j], NULL);
    }
  }
  printf("Answer of Multiplication :\n");
  for (int i = 0; i < size; i++) {
    for (int j = 0; j < size; j++) {
      printf("%d ", C[i][j]);
    }
    printf("\n");
  }
}
```

o/p:



4.Linear search using Multi-threading (use n number of threads)

Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#define max 20
#define thread_max 4
int a[max] = {1,  2,  3,  4,  5,  6,  7,  8,  9,  10,
           11, 12, 13, 14, 15, 16, 17, 18, 19, 20};
int key = 15;
int flag = 0, i;
int current_thread = 0;
void *LinearSearch(void *args) {
  int num = current_thread++;
  for (num *(max / 4); i < ((num + 1) * (max / 4)); i++) {
    if (a[i] == key)
      flag = 1;
  }
}
int main() {
  pthread_t thread[thread_max];
  for (int i = 0; i < thread_max; i++)
    pthread_create(&thread[i], NULL, LinearSearch, (void *)NULL);
  for (int i = 0; i < thread_max; i++)
    pthread_join(thread[i], NULL);
  if (flag == 1)
    printf("Element found (%d)\n", key);
  else
    printf("Element not present(%d)\n", key);
}
```

o/p:

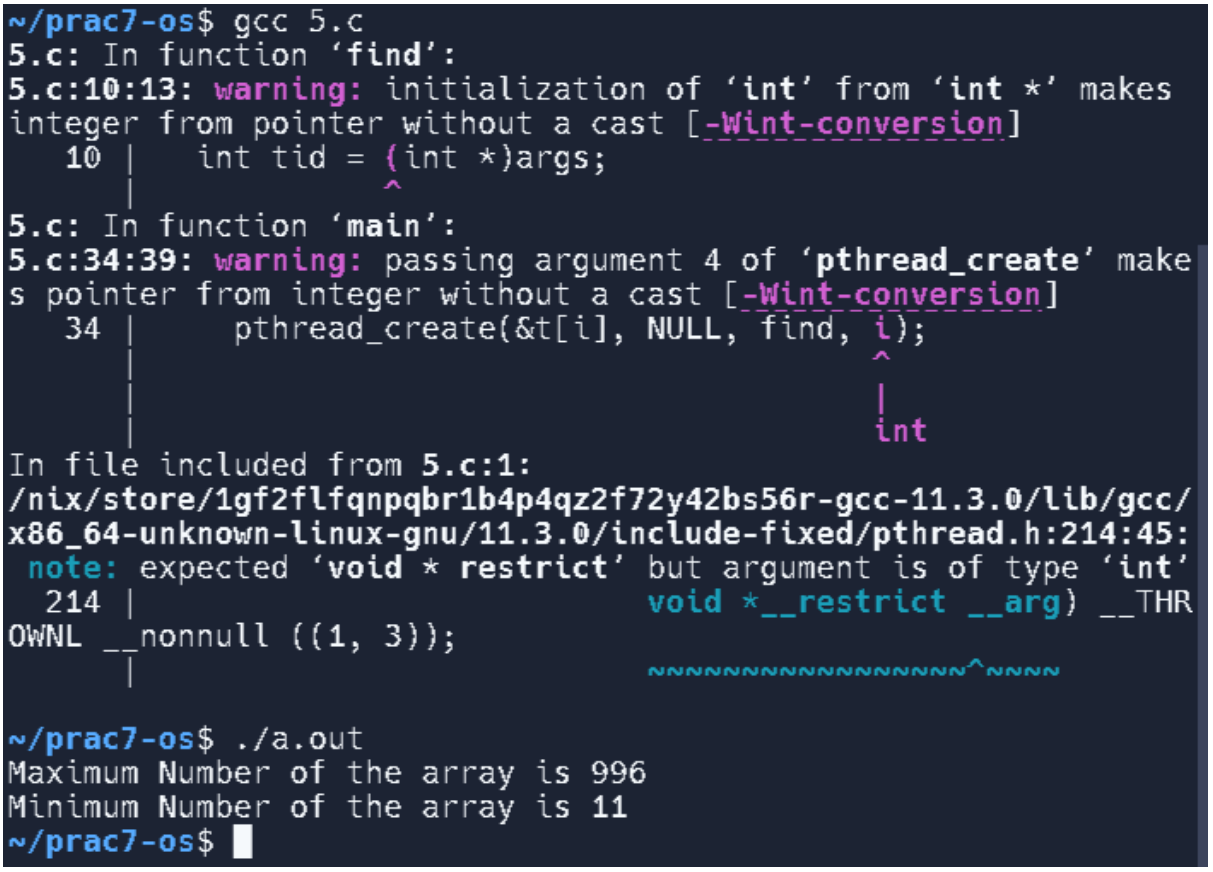
5.To find the maximum and minimum element in an array using Multithreading (for 100 to 200 numbers or more and create 10 or more threads)

Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#define size 100
#define thread_max 10
int a[size];
int max = -9999;
int min = 9999;
void *find(void *args) {
  int tid = (int *)args;
  int subarray_size = size / thread_max;
  int s_index = tid * subarray_size;
  int e_index = s_index + subarray_size;
  int MAX = -9999;
  int MIN = 9999;
  for (int i = s_index; i < e_index; i++) {
    if (a[i] > MAX)
      MAX = a[i];
    else if (a[i] < MIN)
      MIN = a[i];
  }
  if (MAX > max)
    max = MAX;
  if (MIN < min)
    min = MIN;
  pthread_exit(NULL);
}
int main() {
  pthread_t t[thread_max];
  for (int i = 0; i < size; i++) {
    a[i] = rand() % 1000;
  }
  for (int i = 0; i < thread_max; i++) {
    pthread_create(&t[i], NULL, find, i);
  }
```

```
  for (int i = 0; i < thread_max; i++) {
    pthread_join(t[i], NULL);
  }
  printf("Maximum Number of the array is %d\n", max);
  printf("Minimum Number of the array is %d\n", min);
}
```

o/p:



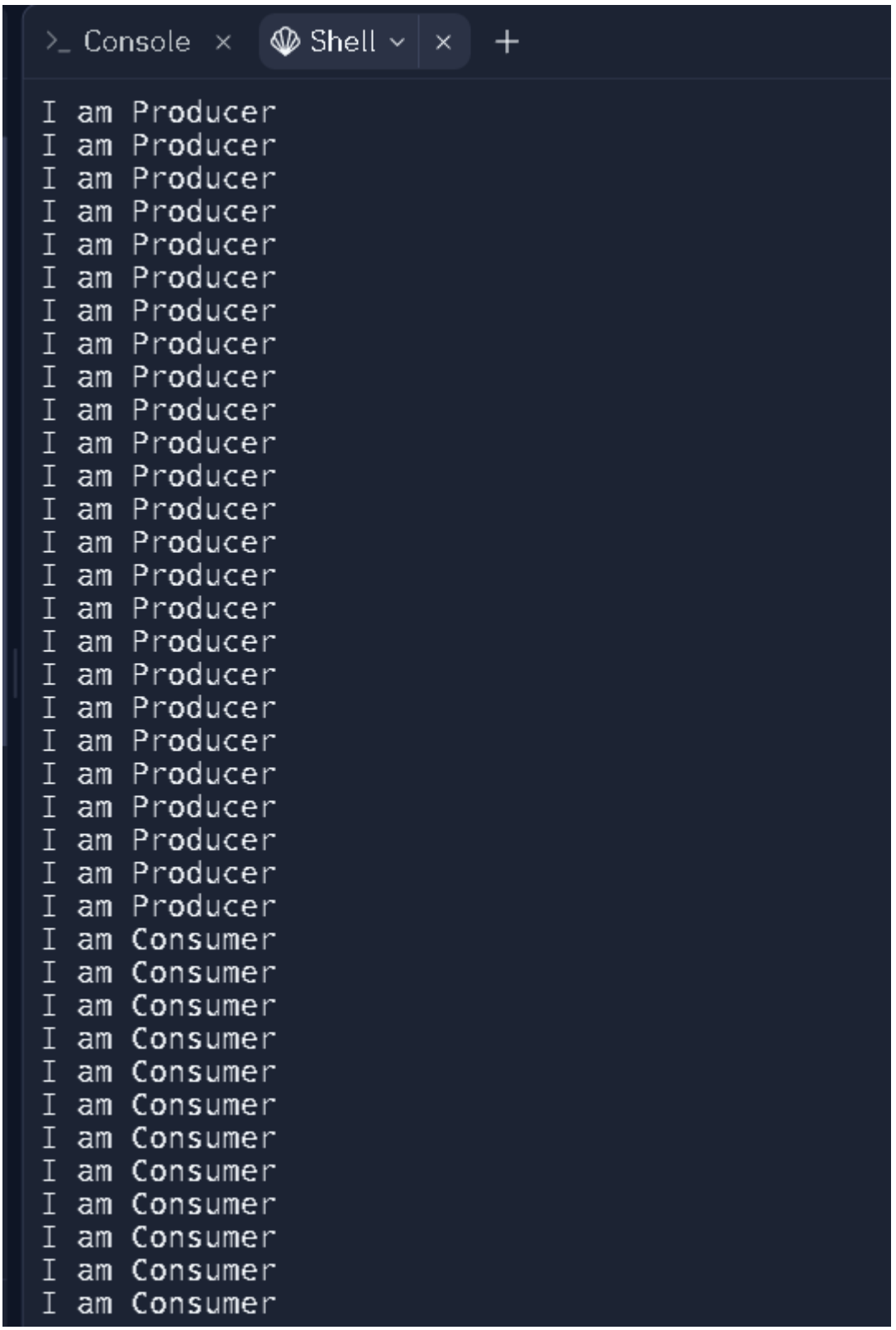
6.Example without synchronization FOR PRODUCER CONSUMER PROBLEM

Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
void *producer(); // the thread
void *consumer(); // the thread
int main() {
  pthread_t ptid, ctid; // Thread Id for Producer &
  Consumer pthread_create(&ptid, NULL, producer, NULL); // Producer
  pthread_create(&ctid, NULL, consumer, NULL);          // Consumer
  pthread_join(ptid, NULL);
  pthread_join(ctid, NULL);
}
```

```
// The thread will begin control in this function
void *producer(void *param) {
  do {
    printf("I am Producer\n");
  } while (1);
  pthread_exit(0);
}
// The thread will begin control in this function
void *consumer(void *param) {
  do {
    printf("I am Consumer\n");
  } while (1);
  pthread_exit(0);
}
```

o/p:



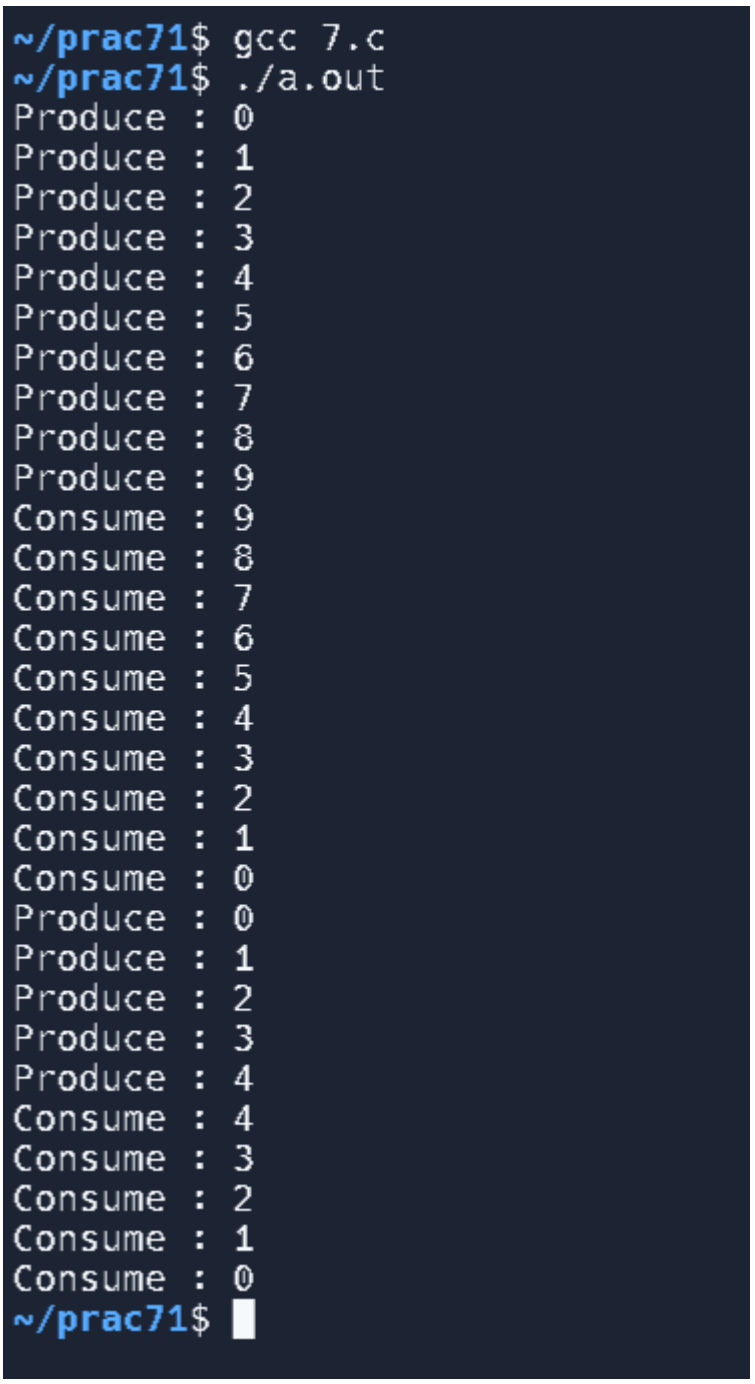
Will run infinite loop for producer consumer

7.Example with synchronization : using mutex & condition variable FOR PRODUCER CONSUMER PROBLEM

Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#define BufferSize 10
void *Producer();
void *Consumer();
int BufferIndex = -1;
char BUFFER[10];
pthread_cond_t Buffer_Empty = PTHREAD_COND_INITIALIZER;
pthread_cond_t Buffer_Full = PTHREAD_COND_INITIALIZER;
pthread_mutex_t mVar = PTHREAD_MUTEX_INITIALIZER;
int main() {
  pthread_t ptid, ctid;
  pthread_create(&ptid, NULL, Producer, NULL);
  pthread_create(&ctid, NULL, Consumer, NULL);
  pthread_join(ptid, NULL);
  pthread_join(ctid, NULL);
  return 0;
}
void *Producer() {
  int i;
  for (i = 0; i < 15; i++) {
    pthread_mutex_lock(&mVar);
    if (BufferIndex == BufferSize - 1)
      pthread_cond_wait(&Buffer_Empty, &mVar);
    BUFFER[++BufferIndex] = '#';
    printf("Produce : %d \n", BufferIndex);
    pthread_mutex_unlock(&mVar);
    pthread_cond_signal(&Buffer_Full);
  }
}
void *Consumer() {
  int i;
  for (i = 0; i < 15; i++) {
    pthread_mutex_lock(&mVar);
    if (BufferIndex == -1) {
      pthread_cond_wait(&Buffer_Full, &mVar);
    }
    printf("Consume : %d \n", BufferIndex--);
    pthread_mutex_unlock(&mVar);
    pthread_cond_signal(&Buffer_Empty);
  }
}
```

o/p:



8.Readers Writers Problem solved with mutex and pthread.
Code:

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#define readers 5
#define writers 2
int sharedResource = 0;
pthread_mutex_t resourceLock = PTHREAD_MUTEX_INITIALIZER;
pthread_mutex_t readerCountLock = PTHREAD_MUTEX_INITIALIZER;
```

```
int readerCount = 0;
void *reader(void *arg) {
  int readerId = *(int *)arg;
  pthread_mutex_lock(&readerCountLock);
  readerCount++;
  if (readerCount == 1) {
    pthread_mutex_lock(&resourceLock);
  }
  pthread_mutex_unlock(&readerCountLock);
  printf("Reader %d reads shared resource: %d\n", readerId, sharedResource);
  pthread_mutex_lock(&readerCountLock);
  readerCount--;
  if (readerCount == 0) {
    pthread_mutex_unlock(&resourceLock);
  }
  pthread_mutex_unlock(&readerCountLock);
  pthread_exit(NULL);
}
void *writer(void *arg) {
  int writerId = *(int *)arg;
  pthread_mutex_lock(&resourceLock);
  sharedResource = writerId;
  printf("Writer %d writes shared resource: %d\n", writerId, sharedResource);
  pthread_mutex_unlock(&resourceLock);
  pthread_exit(NULL);
}
int main() {
  pthread_t readerThreads[readers];
  pthread_t writerThreads[writers];
  int readerIds[readers];
  int writerIds[writers];
  for (int i = 0; i < writers; i++) {
    writerIds[i] = i + 1;
    pthread_create(&writerThreads[i], NULL, writer, &writerIds[i]);
  }
  for (int i = 0; i < readers; i++) {
    readerIds[i] = i + 1;
    pthread_create(&readerThreads[i], NULL, reader, &readerIds[i]);
  }
  for (int i = 0; i < readers; i++) {
    pthread_join(readerThreads[i], NULL);
  }
  for (int i = 0; i < writers; i++) {
    pthread_join(writerThreads[i], NULL);
  }
  return 0;
}
```

o/p:

```
~/prac71$ gcc 8.c
~/prac71$ ./a.out
Reader 3 reads shared resource: 0
Writer 1 writes shared resource: 1
Reader 4 reads shared resource: 1
Reader 5 reads shared resource: 1
Reader 2 reads shared resource: 1
Writer 2 writes shared resource: 2
Reader 1 reads shared resource: 2
~/prac71$
```

Result:
Programs for c in linux using threads has been executed .
Thank you!