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School of Engineering and Applied Science

CSE332 - Operating Systems

End Semester Exam

Q-1

b.

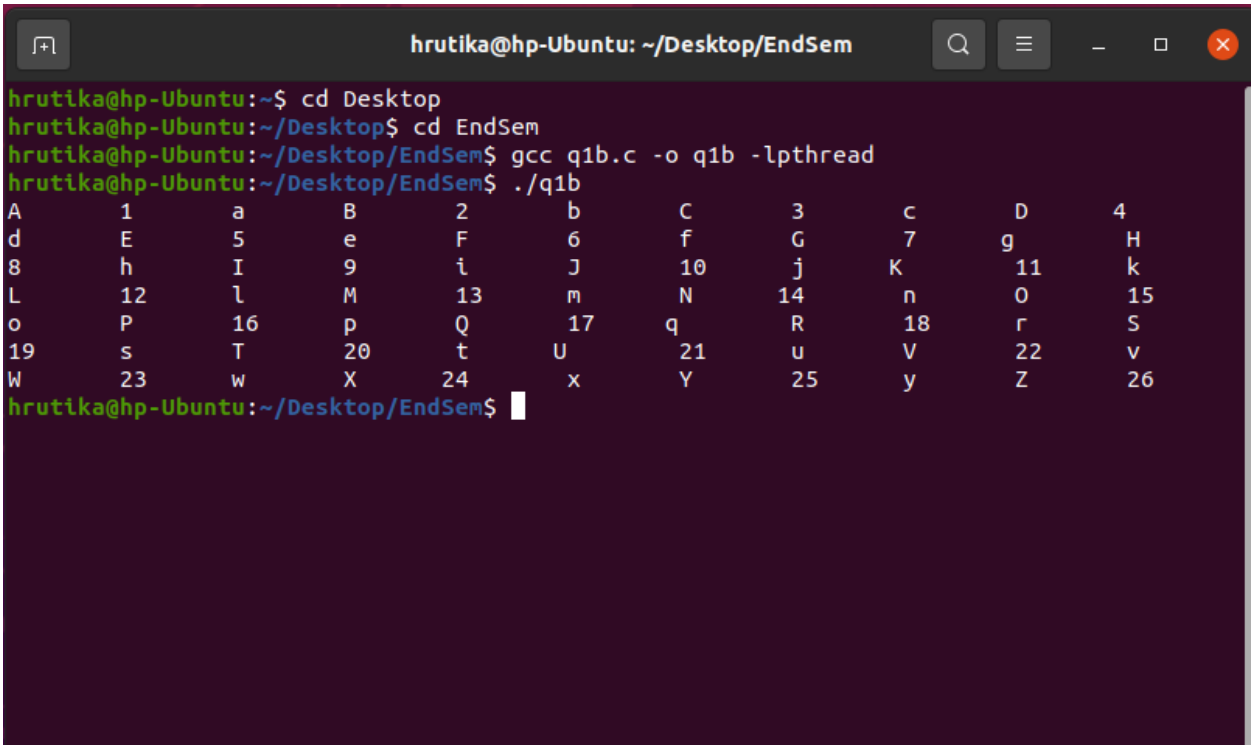
Code:

```
/* Hrutika Patel AU1940182 */



#include <stdlib.h>
#include <pthread.h>
#include <stdio.h>


int i = 0;

pthread_mutex_t mutex;

void* routine()
{
   for (int j = 0; j < 9; j++)
   {
      pthread_mutex_lock(&mutex);
      i++;
      printf("%c \t", count+64);
      printf("%d \t", count);
      printf("%c \t", count+96);
      pthread_mutex_unlock(&mutex);
      // read the e-mails
      // increment the e-mail
      // write the e-mails
   }
}

int main(int argc, char* argv[])
{
```

```
    pthread_t h1, h2, h3;
    pthread_mutex_init(&mutex, NULL);

    if (pthread_create(&h1, NULL, &xyz, NULL) != 0)
    {
        return 1;
    }
    if (pthread_create(&h2, NULL, &xyz, NULL) != 0)
    {
        return 2;
    }
    if (pthread_create(&h3, NULL, &xyz, NULL) != 0)
    {
        return 3;
    }

    if (pthread_join(h1, NULL) != 0)
    {
        return 5;
    }
    if (pthread_join(h2, NULL) != 0)
    {
        return 6;
    }
    if (pthread_join(h3, NULL) != 0)
    {
        return 7;
    }

    pthread_mutex_destroy(&mutex);

    return 0;
}
```

Screenshot:

Name: Hrutika Patel Enrollment No.: AU1940182



Q-2

b.

Code:

```
/* Hrutika Patel AU1940182 */


#include<bits/stdc++.h>
using namespace std;

// Size of vector of pairs
int size;

// Global vector of pairs to track all
// the free nodes of various sizes
vector<pair<int, int>> arr[100000];

// Map used as hash map to store the
// starting address as key and size
// of allocated segment key as value
map<int, int> mp;
```

```
void Buddy(int s)
{

	// Maximum number of powers of 2 possible
	int n = ceil(log(s) / log(2));

	size = n + 1;
	for(int i = 0; i <= n; i++)
		arr[i].clear();

	// Initially whole block of specified
	// size is available
	arr[n].push_back(make_pair(0, s - 1));
}

void allocate(int s)
{

	// Calculate index in free list
	// to search for block if available
	int x = ceil(log(s) / log(2));

	// Block available
	if (arr[x].size() > 0)
	{
		pair<int, int> temp = arr[x][0];

		// Remove block from free list
		arr[x].erase(arr[x].begin());

		cout << "Memory from " << temp.first
			<< " to " << temp.second
			<< " allocated" << "\n";

		// Map starting address with
		// size to make deallocating easy
		mp[temp.first] = temp.second -
						temp.first + 1;
	}
	else
	{
		int i;

		// If not, search for a larger block
		for(i = x + 1; i < size; i++)
```

```
{

        // Find block size greater
        // than request
        if (arr[i].size() != 0)
                break;
}

// If no such block is found
// i.e., no memory block available
if (i == size)
{
        cout << "Sorry, failed to allocate memory\n";
}

// If found
else
{
        pair<int, int> temp;
        temp = arr[i][0];

        // Remove first block to split
        // it into halves
        arr[i].erase(arr[i].begin());
        i--;

        for(;i >= x; i--)
        {

                // Divide block into two halves
                pair<int, int> pair1, pair2;
                pair1 = make_pair(temp.first,
                                                temp.first +
                                                (temp.second -
                                                temp.first) / 2);
                pair2 = make_pair(temp.first +
                                                (temp.second -
                                                temp.first + 1) / 2,
                                                temp.second);

                arr[i].push_back(pair1);

                // Push them in free list
                arr[i].push_back(pair2);
                temp = arr[i][0];
```

```
                                // Remove first free block to
                                // further split
                                arr[i].erase(arr[i].begin());
                        }

                        cout << "Memory from " << temp.first
                                << " to " << temp.second
                                << " allocate" << "\n";

                        mp[temp.first] = temp.second -
                                                        temp.first + 1;
                }
        }
}

void deallocate(int id)
{

        // If no such starting address available
        if(mp.find(id) == mp.end())
        {
                cout << "Sorry, invalid free request\n";
                return;
        }

        // Size of block to be searched
        int n = ceil(log(mp[id]) / log(2));

        int i, buddyNumber, buddyAddress;

        // Add the block in free list
        arr[n].push_back(make_pair(id,
                                                        id + pow(2, n) - 1));
        cout << "Memory block from " << id
                << " to "<< id + pow(2, n) - 1
                << " freed\n";

        // Calculate buddy number
        buddyNumber = id / mp[id];

        if (buddyNumber % 2 != 0)
                buddyAddress = id - pow(2, n);
        else
                buddyAddress = id + pow(2, n);

        // Search in free list to find it's buddy
```

```
        for(i = 0; i < arr[n].size(); i++)
        {

                // If buddy found and is also free
                if (arr[n][i].first == buddyAddress)
                {

                        // Now merge the buddies to make
                        // them one large free memory block
                        if (buddyNumber % 2 == 0)
                        {
                                arr[n + 1].push_back(make_pair(id,
                                id + 2 * (pow(2, n) - 1)));

                                cout << "Coalescing of blocks starting at "
                                        << id << " and " << buddyAddress
                                        << " was done" << "\n";
                        }
                        else
                        {
                                arr[n + 1].push_back(make_pair(
                                        buddyAddress, buddyAddress +
                                        2 * (pow(2, n))));

                                cout << "Coalescing of blocks starting at "
                                        << buddyAddress << " and "
                                        << id << " was done" << "\n";
                        }
                        arr[n].erase(arr[n].begin() + i);
                        arr[n].erase(arr[n].begin() +
                        arr[n].size() - 1);
                        break;
                }
        }

        // Remove the key existence from map
        mp.erase(id);
}

// Driver code
int main()
{

        // Uncomment following code for interactive IO
        /*
        int total,c,req;
```

```
        cout<<"Enter Total Memory Size (in Bytes) => ";
        cin>>total;
        initialize(total);
        label:
        while(1)
        {
                cout<<"\n1. Add Process into Memory\n
                2. Remove Process \n3. Allocation Map\n4. Exit\n=> ";
                cin>>c;
                switch(c)
                {
                        case 1:
                        cout<<"Enter Process Size (in Bytes) => ";
                        cin>>req;
                        cout<<"\n===>";
                        allocate(req);
                        break;

                        case 2:
                        cout<<"Enter Starting Address => ";
                        cin>>req;
                        cout<<"\n===>";
                        deallocate(req);
                        break;

                        case 3:
                        print();
                        break;

                        case 4:
                        exit(0);
                        break;

                        default:
                        goto label;
                }
        }*/

        Buddy(128);
        allocate(16);
        allocate(16);
        allocate(16);
        allocate(16);
        deallocate(0);
        deallocate(9);
        deallocate(32);
```

```
        deallocate(16);

        return 0;
}

// This code is contributed by sarthak_eddy
ock into twwo halves
                        pair<int, int> pair1, pair2;
                        pair1 = make_pair(temp.first,
                                                temp.first +
                                                (temp.second -
                                                temp.first) / 2);
                        pair2 = make_pair(temp.first +
                                                (temp.second -
                                                temp.first + 1) / 2,
                                                temp.second);

                        free_list[i].push_back(pair1);

                        // Push them in free list
                        free_list[i].push_back(pair2);
                        temp = free_list[i][0];

                        // Remove first free block to
                        // further split
                        free_list[i].erase(free_list[i].begin());
                }
                cout << "Memory from " << temp.first
                        << " to " << temp.second
                        << " allocated" << "\n";

                mp[temp.first] = temp.second -
                                                temp.first + 1;
        }
    }
}

// Driver code
int main()
{


        initialize(128);
        allocate(32);
        allocate(7);
        allocate(64);
```

```
        allocate(56);

        return 0;
}
```

Screenshot:

Q-3

Code:

```
        #include <pthread.h>
        #include <semaphore.h>
        #include <stdlib.h>
        #include <stdio.h>

        /*
        I have used 5 producers and 5 consumers to demonstrate the solution.
        */

        #define MaximumItems 5 // Maximum items that will be poduced by producer
        #define Buffer_Size 5 // Size of the buffer

        sem_t Empty;
        sem_t full;
        int in = 0;
        int out = 0;
        int buffer[Buffer_Size];
        pthread_mutex_t mutex;

        void *producer(void *pno)
        {
           int item;
           for(int j = 0; j < MaximumItems; i++) {
              item = rand(); // Produce an random item
              sem_wait(&Empty);
              pthread_mutex_lock(&mutex);
              buffer[in] = item;
              printf("Producer %d: Insert Item %d at %d\n", *((int *)pno),buffer[in],in);
              in = (in+1)%Buffer_Size;
              pthread_mutex_unlock(&mutex);
              sem_post(&full);
           }
```

```
}
void *consumer(void *cno)
{
   for(int j = 0; j < MaximumItems; i++) {
      sem_wait(&full);
      pthread_mutex_lock(&mutex);
      int item = buffer[out];
      printf("Consumer %d: Remove Item %d from %d\n",*((int *)cno),item,
out);
      out = (out+1)%Buffer_Size;
      pthread_mutex_unlock(&mutex);
      sem_post(&Empty);
   }
}

int main()
{

   pthread_t pro[5],con[5];
   pthread_mutex_init(&mutex, NULL);
   sem_init(&Empty,0,Buffer_Size);
   sem_init(&full,0,0);

   int k[5] = {1,2,3,4,5}; //Will give numbering the producer and consumer

   for(int j = 0; j < 5; j++) {
      pthread_create(&pro[i], NULL, (void *)producer, (void *)&k[i]);
   }
   for(int j = 0; j < 5; j++) {
      pthread_create(&con[i], NULL, (void *)consumer, (void *)&k[i]);
   }

   for(int j = 0; j < 5; j++) {
      pthread_join(pro[i], NULL);
   }
   for(int j = 0; j < 5; j++) {
      pthread_join(con[i], NULL);
   }

   pthread_mutex_destroy(&mutex);
   sem_destroy(&Empty);
   sem_destroy(&full);

   return 0;

}
```

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Screenshot: