Master of Technology in Computer Technology

First Year Second Semester

INTERNAL ASSESSMENT
16^{th} October, 2020

Subject: Advanced Operating Systems

Time: 3 Hours | Full Marks: 50

Answer Any Five Questions

1. (a) What is a Process Control Block? What are different information stored in it?
   (b) Explain the working principle of the `fork()` system call.
   (c) For the following code segment determine the output and state the number of new processes that will be created. Provide necessary justifications.

```
int i=0;
fork();
i++;
fork();
i++;
printf("i = %d\n", i);
```

   (d) What is a dispatcher?

2+3+4+1=10

2. (a) Differentiate between preemptive and non-preemptive scheduling.
   (b) Differentiate between a long term scheduler and a short term scheduler. Under which conditions a mid-term scheduler may be invoked?
   (c) What are the advantages of having different time-quantum sizes on different levels of multi-level queue scheduling?
   (d) An operating system uses Shortest Remaining Time First (SRTF) process scheduling algorithm. Consider the arrival times and execution times for the following processes:

Process	Execution Time	Arrival Time
P_1	20	0
P_2	25	15
P_3	10	30
P_4	15	45

   What is the total waiting time for process P2?

2+3+1+4=10

3. (a) Consider the following implementation of a solution to the reader-writer problem using monitors.

```
monitor readerWriter{
    int numberOfReaders = 0;
    int numberOfWriters = 0;
    boolean busy = FALSE;
```

```
public:
    startRead(){
        while(numberOfWriters != 0);
        numberOfReaders++;
    };
    finishRead(){
        numberOfReaders-;
    };
    startWrite(){
        numberOfWriters++;
        while(busy(numberOfReaders>0));
        busy = TRUE;
    };
    finishWrite(){
        numberOfWriters--;
        busy = FALSE;
    };
};
```

This solution is not deadlock free. State how a deadlock can happen? Provide proper justifications.

(b) What is a condition variable? What are the different operations allowed on a condition variable? Propose a deadlock free solution to the reader-writer problem using condition variables.

4+(2+4)=10

4. (a) What is a `TestAndSet` instruction? Describe how this instruction can be used to solve critical section problem. Explain if your solution satisfies the bounded waiting requirement. Provide justification for your answer.

(b) P_1, P_2 and P_3 are three processes executing their respective tasks. They should synchronize among themselves using semaphores such that the string "India is great" gets printed infinite times. Determine, minimum number of semaphores required and their initial values. Also identify places where operations on those semaphore should be inserted in the code of P_1, P_2 and P_3. Provide necessary justifications.

P_1
```
while(true){
    print("India");
}
```

P_2
```
while(true){
    print("is");
}
```

P_3
```
while(true){
    print("great\n");
}
```

(1+2+2)+5=10

5. (a) Differentiate between soft and hard real time systems with suitable examples.

(b) Describe the unbounded priority inversion problem using a suitable example.

(c) Multi-threading (i) increases responsiveness of applications, (ii) increases processor utilization in multi-processor architecture. Substantiate the two assertions using suitable examples.

(d) "A user-level thread performing a blocking system call causes the entire process to block" - explain why?

2+4+2+2=10

6. (a) Briefly describe the volume structure of a typical Unix file system.

(b) How does Linux Virtual File System provides a single uniform interface to user processes

(c) Describe the structure of an i-node in an Unix file system.

(d) In a particular Unix OS, each disk block is of size 2048 bytes, each i-node has 8 direct addresses to data blocks and three additional addresses: one for single indirect block, one for double indirect block and one for triple indirect block. Size of each disk block address is 8 bytes. Determine the approximate maximum size of a file.

2+2+2+4=10

7. (a) Describe the different steps that client module performs when it tries to read a file stored in Google File System.

(b) What are the advantages of having large chunk size in Google File System?

(c) Describe how Google File System withstands failure of the Master node.

(d) What are chekpoint region and inode map in a log structured file systems (LFS)?

3+3+2+2=10