Copy your answers to **Question 1** here.

1	2	3	4	5	6
D	A	A	B	C	A
7	**8**	**9**	**10**	**11**	**12**
C	A	A/C	A	A	B

Copy your answers for **Question 2** here.

2.1.1	2.1.2	2.1.3	2.1.4	2.1.5	2.1.6
T	F	F	T	F	F
2.2.1	**2.2.2**	**2.2.3**	**2.2.4**	**2.2.5**	**2.2.6**
D	C	B	A	D	A

Copy your answers to **Question 3** here.

1	2	3	4	5	6
C	A	C	A	C	B
7	**8**	**9**	**10**	**11**	**12**
A	C	A	A	A	C

Copy your answers for **Question 4** here.

4.A.1	4.A.2	4.A.3	4.A.4	4.A.5	4.A.6	4.B.1	4.B.2
False	False	False	True	True	False	3	4

Copy your answers for **Question 5** here.

5.1) ***Each two correct answers get 0.5 points***

Process	Turnaround Time	Waiting Time
P1	14	8
P2	9	5
P3	25	15
P4	7	5
P5	17	11

5.2) ***Each two correct answers get 0.5 points***

Process	Turnaround Time	Waiting Time
P1	6	0
P2	9	5
P3	17	7
P4	17	15
P5	21	15

5.3) ***Each get 0.5 points***

Question	Total Context Switching Overhead
a) RR (q=0)	= 13* 5 = 65 ms
b) FCFS	= 4 * 5 = 20 ms

Question 1

1) Which of the following is NOT a goal of an operating system?
a) Execute user programs and make solving user problems easier
b) Make the computer system convenient to use
c) Use the computer hardware in an efficient manner
d) Run a single program at a time

2) What are two important design considerations for cache management?
a) Cache size and replacement policy
b) Cache location and access speed
c) Cache consistency and durability
d) Cache optimization and configuration

3) What is the purpose of deferring interrupt handling?
a) To prevent interrupts from interfering with critical processing
b) To allow the CPU to handle multiple interrupts simultaneously
c) To prioritize interrupts based on their urgency
d) To reduce the overhead of interrupt handling

4) Which type of multiprocessing system is characterized by a boss-worker relationship?
a) Symmetric multiprocessing (SMP)
b) Asymmetric multiprocessing (AMP)
c) Single-processor system
d) Multithreaded system

5) What is the role of a virtual machine manager (VMM) in terms of dual-mode operation?
a) It operates in user mode only.
b) It operates in kernel mode only.
c) It operates in a separate mode with privileges between user and kernel modes.
d) It does not use dual-mode operation.

6) What resources does a process need to accomplish its task?
a) CPU, memory, I/O devices, and files
b) Operating system, compiler, and linker
c) User input, output devices, and storage
d) None of the above

7) What is the fundamental requirement for executing a program?
a) The entire program must be loaded into memory at once.
b) All the program's data must be available in memory simultaneously.
c) At least a portion of the program's instructions and data must reside in memory.
d) The program must be compiled into machine code before execution.

8) In a multitasking environment, why is it crucial to use the most recent value of data?
a) To ensure data consistency and prevent inconsistencies between multiple processes accessing the same data.
b) To optimize performance and avoid unnecessary data reloads from slower storage levels.
c) To maintain system stability and prevent crashes due to outdated data usage.
d) All of the above

9) What is the primary difference between protection and security in an operating system?
a) Protection controls access to resources within the system, while security protects the system from external threats.
b) Protection is enforced by the operating system kernel, while security is implemented using user-level applications.
c) Protection is concerned with preventing accidental or unauthorized access to resources, while security is focused on defending against malicious attacks.
d) Protection is only applicable to hardware resources, while security extends to software resources as well.

10) Which of the following technology reduces the overhead for bulk data movement?
a) Direct Memory Access (DMA)
b) Non-uniform Memory Access (NUMA)
c) Symmetric Multiprocessing (SMP)
d) Storage Area Network (SAN)

11) What is the main concept behind cloud computing?
a) Providing computing resources, such as storage and applications, as services over the internet.
b) Running multiple operating systems on a single computer.
c) Translating instructions from one CPU type to another.
d) Protecting computer systems from malware and viruses.

12) Which of the following statements accurately describes the purpose of virtualization software like VMware Player and VirtualBox?
a) Virtualization software allows users to physically install multiple operating systems on a single computer.
b) Virtualization software provides a secure environment for experimenting with different operating systems without affecting the host system.
c) Virtualization software improves the performance of resource-intensive applications by distributing their workload across multiple virtual machines.
d) Virtualization software enables users to access operating systems remotely from any device with an internet connection.

Question 2 [6 Marks]

2.1) True or False (no explanation needed). Copy your answers (T for True or F for False) for 2.1.1 to 2.1.6 in the table given on the first page. [3 Marks]

2.1.1	Layered approach simplifies debugging, but layers need to be carefully defined.
2.1.2	Accounting service is provided by the OS to allocate resources to each process concurrently.
2.1.3	Message passing model is useful for exchanging large amounts of data.
2.1.4	MS-DOS is a single-tasking OS.
2.1.5	SYSGEN program allows selection of kernel from multiple disks, versions, kernel options
2.1.6	The monolithic structure of UNIX is easy to implement and maintain.

2.2) Select the most correct answer. Copy your answers (A, B, C, or D) for 2.2.1 to 2.2.6 in the table given on the first page. [3 Marks]

2.2.1	System calls can be mostly accessed through
A.	User-defined scripts
B.	System program
C.	IPC
D.	API

2.2.2	Methods of passing parameters to OS that do not limit the number or length parameters being passed are
A.	Registers and block/table
B.	Registers and stack
C.	Block/table and stack
D.	Registers

2.2.3	Policy ____.
A.	Determines how to do something
B.	Determines what will be done
C.	Is not likely to change across places
D.	Is not likely to change over time

2.2.4	The caller needs to know nothing about how the …. is implemented and just needs to obey …. and understand what OS will do as a result call
A.	System call , API
B.	API , system call
C.	System call, system program
D.	System program, system call

2.2.5	Which of the following is a limitation of microkernel design approach?
A.	Security
B.	Making sure each layer is easily converted to modules
C.	Difficulty in debugging
D.	Overhead of user space to kernel space communication

2.2.6	The kernel provides core services while other services are implemented dynamically, as the kernel is running.
A.	Modules structure
B.	Layered structure
C.	Monolithic structure
D.	Simple structure

Question 3

1) Which one of the following is not shared by threads?
a) Program counter
b) Stack
c) Both program counter and stack.
d) None of the above.

2) A thread shares its code section, data section with
a) All threads belonging to the same process.
b) Few threads belonging to the same process.
c) Does not share at all.
d) None of the above.

3) A process can be _____
a) Single threaded.
b) Multithreaded.
c) Both single threaded and multithreaded.
d) None of the above.

4) A thread is also called _____
a) Light Weight Process(LWP)
b) Heavy Weight Process(HWP)
c) Process
d) None of the above

5) Which of the following in not a multicore programming challenge
a) Data dependency
b) Dividing activities
c) Scalability
d) None of the above.

6) What is the speed up if application is 75% parallel and 25% serial, moving from 1 to 2 cores.
a) 1
b) 1.6
c) 2
d) 1.5

7) In the Many to One model, if a thread makes a blocking system call _____
a) The entire process will be blocked
b) A part of the process will stay blocked, with the rest running
c) The entire process will run
d) None of the above.

8) Which multithreading model has the best concurrency?
a) One-to-many
b) Many-to-one
c) One-to-one
d) Many-to-many

9) User threads management is done by
a) User-level threads library.
b) Kernel threads
c) Both user and kernel thread
d) None of the above

10) Which of the following cancelation approaches allow the target thread to periodically check if it should be cancelled:
a) Deferred cancellation
b) Asynchronous cancellation
c) Synchronous cancellation
d) Periodical cancellation

11) Which of the following is true?
a) A single-threaded process can run on only one processor, regardless how many are available.
b) A single-threaded process can run on multiple processors.
c) A single threaded process can run on multiple systems.
d) None of the above.

12) Thread cancellation is _____
a) The task of destroying the thread once its work is done.
b) The task of removing a thread once its work is done.
c) The task of terminating a thread before it has completed.
d) None of the above.

Question 4

(Part A)

For each of the following sentences, select whether the sentence is True or False (no explanation is needed). Copy your answer to the table on page 2. [4.5 marks]:

4.A.1) A process is a passive entity and it is a program in execution.

4.A.2) A process stack contains the memory dynamically allocated to the process during run time.

4.A.3) A process can move directly from waiting state to running state.

4.A.4) A process can create one or more children through the **`fork()`** operation.

4.A.5) Long-term scheduler selects which processes should be brought into the ready queue.

4.A.6) In message passing, the communication is under the control of the users processes not the operating system.

(Part B)

Consider the following C program [1.5 marks]:

```
#include<stdio.h>
#include<unistd.h>

int main() {
   if (fork()==0) {
     printf("A \n");
   } else {
        printf("B \n");
        fork();
        printf("C \n");
   }
          }
```

Assuming fork will never fail, answer the following questions:

4.B.1) The total number of processes running (including the main process) is …….

4.B.2) The total number of executed print statements is …….

Question 5

Consider the following set of processes which are assumed to have arrived in the order P1, P2, P3, P4, P5.

Process	Arrival Time	Burst Time
P1	0	6
P2	1	4
P3	5	7
P4	7	2
P5	11	12

5.1**) [2.5 points]** Calculate the turnaround time and waiting time for each process using **Round Robin** scheduling algorithm, given the time quantum **q=3**. (please fill the table in the answer sheet)

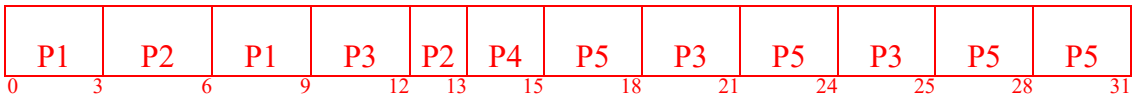
5.2) **[2.5 points]** Calculate the turnaround time and waiting time for each process using non-preemptive **SJF** algorithm.

5.3) **[1 point]** Assuming the context switching overhead is **5 milliseconds,** and *no overhead* for loading the first process:

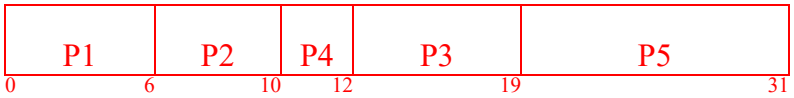
a) How much is the total context switching overhead when using Round Robin scheduling with q=3?
b) How much is the total context switching overhead when using SJF scheduling?

Answer sheet:

RR (q=3)



SJF



5.1) ***Each two correct answers get 0.5 points***

Process	Turnaround Time	Waiting Time
P1	9	3
P2	12	8
P3	20	13
P4	8	6
P5	20	8

5.2) ***Each two correct answers get 0.5 points***

Process	Turnaround Time	Waiting Time
P1	6	0
P2	9	5
P3	14	7
P4	5	3
P5	20	8

5.3) ***Each get 0.5 points***

Question	Total Context Switching Overhead
c) RR (q=0)	= 10* 5 = 50 ms
d) FCFS	= 4 * 5 = 20 ms