（本试卷答卷时间为 120 分钟，答案必须写在试卷上，做在草稿纸上无效，中英文均可）
NO aids (books, notes, discussion etc.) are allowed. Ask the instructor if you have any questions.

Student ID_____Name_____Score_____

Question	1	2	3	4	Sum
Score					

1. Choice（36%）

Note that there exists only ONE answer to each question.

(1) Which item below is used to support applications getting direct help from operating system kernel?

A. Utilities
B. System calls
C. Subroutines
D. Compilers

Reference answer: B

(2) Among following scheduling types, which pair are mainly used to adjust the degree of multiprogramming?

A. Long-term scheduling, and mid-term scheduling
B. Long-term scheduling, and short-term scheduling
C. Short-term scheduling, and mid-term scheduling
D. Short-term scheduling, and disk scheduling

Reference answer: A

(3) Among following statements, which one is NOT true?

A. SPN is a priority-based scheduling policy with which the shortest process has the highest priority
B. The Multi-level feedback scheduling policy takes round-robin for the lowest level queue
C. Take the time-slice to infinite, RR turns to FCFS
D. Take the time-slice to very short, RR turns to SPN

Reference answer: D

(4) Which one of the following scheduling policies is most suitable to SMP systems?

A. FCFS
B. RR
C. Gang-scheduling
D. SPN

Reference answer: C

(5) What communication paradigm is most suitable to micro-kernel operating systems

A. Subroutine call

B. Message passing

C. interrupt

D. shared memory

Reference answer: B

(6) Which of the following process state transitions is NOT reasonable?

A. RUNNIG to READY

B. READY to RUN

C. BLOCKED to RUNNING

D. BLOCKED to READY

Reference answer: C

(7) Which is a hardware-level mechanism for implementing mutual exclusion ?

A. Test and Set

B. Dekker's Algorithm

C. Semaphore

D. Monitor

Reference answer: A

(8) For time-sharing systems, the design objective of scheduling algorithm is to optimize _____.

A. CPU utilization

B. Response time

C. Turnaround time

D. Throughput

Reference answer: B

(9) If there are four periodic real-time tasks in the system, which one is given the highest priority by the rate-monotonic scheduling algorithm?

A. task 1 that occurs every 50 ms, with 10 ms processing time

B. task 2 that occurs every 40 ms, with 15 ms processing time

C. task 3 whose period is 30 ms, with 5 ms processing time.

D. task 4 whose period is 100 ms, with 10 ms processing time.

Reference answer: C

(10) Which statement is WRONG about user-level threads (ULTs)?

A. Thread switching does not require mode switch.

B. User level threads can run on any operating system.

C. When a ULT executes a blocking system call, all the other threads within the process are also blocked

D. Different ULTs within a process may be executing on different processors at the same time.

Reference answer: D

(11) Which one of the following scheduling algorithms does not suffer from starvation?

A. shortest process next

B. shortest remaining time

C. highest response ratio next

D. multilevel feedback

Reference answer: C

2. Short Answer（42%）

(1) What is the difference between multiprogramming and multiprocessing? (4 points)

Reference answer: Multiprogramming can only use concurrent execution of processes（2 points）, but multiprocessing can use parallelism and/or concurrency (2 points).

(2) Compare the cost of the switching of threads belongs to the same process and belongs to different process. Give the rationale. (4 points)

Reference answer: 同一个进程中的线程间切换开销小于不同进程的线程切换(2 points)。因为，同一进程间的线程切换不会引起进程的切换，而不同进程的线程切换会导致进程切换；线程不占有资源，因此相比进程切换，开销要小得多。(2 points)

(3) Some people said that if the wait()/signal() would not be designed as primitives, mutual exclusion might be violated. Is it true? Please give a comment on it. (4 points)

Reference answer: 有可能违反互斥要求（1 points)。设一信号量 S=1，且进程 P，Q 并发地执行 wait(S)，而 wait()不是原语，那么以下的执行序列就违反了互斥性（3 points）：

a) T0: P 判定 S=1;

b) T1: Q 判定 S=1;

c) T2: P 将 S 减 1 并进入临界段;

d) T2: Q 将 S 减 1 并进入临界段。

(4) The waiting list in a semaphore is typically implemented as a queue (FIFO). Can we use a stack (FILO) instead to implement it? Give comments to support your design and consider a steady stream of coming processes that blocked on the semaphore, what phenomenon might happen? (4 points)

Reference answer: 原则上，可以采用堆栈实现信号量中的等待表。因为只要能够记录有哪些进程在该信号量上被阻塞，而后可以在适当的时机释放进程即可。但对于持续到达且被阻塞在该信号量的进程序列，先前被阻塞的进程有可能产生饥饿。(4 points)

(5) Given a snapshot in the Banker Algorithm below: (6 points)

Available = [2, 1, 0, 0];

Process	Allocation				Claim			
	R1	R2	R3	R4	R1	R2	R3	R4
P1	0	0	0	2	0	0	1	2
P2	2	0	0	0	2	7	5	0
P3	0	0	3	4	6	6	5	6
P4	2	3	5	4	4	3	5	6
P5	0	3	3	2	0	6	5	2

Answer following questions.

A. Is the system in a safe state? Why?

B. Is the system in the deadlock status? Why?

C. What processes might be involved in a deadlock, if any.

Reference answer:

A. 系统处于不安全状态，因为没有一个进程可以顺利完成。(2 points)

B. 系统不一定处于死锁状态，因为当前状态只是不安全，并不代表死锁。(2 points)

C. 5 个进程都有可能相互等待而死锁。(2 points)

(6) What are the differences between I/O bound and CPU bound processes? Describe one typical application that is I/O bound; describe one that is CPU bound. (5 points)

An I/O bound process is constantly making system calls for I/O operations (1 point), and thus requires little CPU time on any particular time slice. A CPU–bound process makes almost constant use of the CPU. (1 point)

I/O bound example: a database management system constantly makes requests for disk and interprocess communication services.(1.5 points)

CPU bound example: simulating ocean currents requires many ˚oating point operations. (1.5 points)

(7) Describe busy waiting. Under what conditions might it be desirable and undesirable? (5 points)

Busy waiting means that a process maintains the CPU while it is waiting for some I/O op–

eration to complete (rather than giving up the CPU). This is generally undesirable because
the processor could be doing useful work otherwise. This behavior may be desirable under
conditions when we know that the process (usually a kernel process) will not be waiting for
a long time for the I/O operation to complete and that the process must respond to the
completion quickly (within a few processor instructions).

(8) If all the processes in a system get into the ready queue at the same time, it is stated that the shortest process next algorithm is the best one with the lowest average waiting time among all the nonpreemptive algorithms. Please prove this statement. (6 points)

Answer: Assume that there are *n* processes. Let these n processes be executed in the order P_1, P2, …, Pn. Then, the waiting time of process P_i is $P_1+\ldots+P_{i-1}$ which is less than or equal to the sum of the processing times of i shortest processes.

3. Calculation（14%）

(1) Consider the following set of processes with arrival times and CPU execution times given in milliseconds.

Process	Arrival time	Execution time
P1	0	3
P2	2	10
P3	3	8
P4	4	4
P5	9	6

Consider the following three scheduling algorithms:

Shortest Process Next
Shortest remaining time
Highest Response Ratio Next

Calculate the average waiting times for above scheduling algorithms.

P1→P3→P4→P5→P2 [6.4ms]

P1→P3(1ms)→P4→P3(7ms)→P5→P2 [5.8ms]

P1→P2→P4→P3→P5 [8.0ms]

4. Analysis（8%）

1 For the given pseudocode below:

```
const SIZEOFBUFFER N

semaphore s=1;
semaphore n=0;
semaphore s=N;
procedure producer()
{
    while (TRUE) {
        produce();
        wait(e);
        wait(s)
        append();
        signal(s)
        signal(n);
    }
}

produce consumer()
{
    while (TRUE) {
        wait(n);
        wait(s)
        take();
        signal(s)
        signal(e);
        consume();
    }
}

main()
{
    parbegin(producer, consumer);
}
```

What will happen by change the order of:

A. wait(e); wait(s);
B. signal(s); signal(n);
C. wait(n); wait(s);
D. signal(s); signal(e);

(8 points)

Reference answer:

A. 交换这两个语句可能导致系统死锁：生产者进入临界段时，如果已没有存储空间，就会阻塞在 wait(e)；而消费者因为 s 被锁定，不能进入其临界段 (2.5 points)。
B. 交换这两个语句不会导致任何不正确的结果 (1.5 points)。
C. 交换这两个语句可能导致系统死锁：消费者进入临界段时，如果缓冲区中没有物品，就会阻塞在 wait(n)；而生产者因为 s 被锁定，不能进入其临界段 (2.5 points)。
D. 交换这两个语句不会导致任何不正确的结果 (1.5 points)。