

Name (Please print legibly): **FINAL KEY** Net ID: _____

Do not forget to copy the Form Number onto the Scantron sheet.

FORM NUMBER 1:

Please work on this exam independently. Please answer on scantron sheet.

Mark the BEST answer to each of the questions below

1. **POSIX** is ...
 - a) An operating system that implements a standard set of system calls and system behaviors.
 - b) A specification for *how* an operating system must implement a standard set of system calls and system behaviors.
 - c) A specification for a programming language and library that provide a standard set of system calls and system behaviors.
 - d) **A specification for a standard set of system calls and system behaviors that can be implemented in different ways by operating systems.**

2. Which of the following is a *correct* use of **formatted I/O**?
 - a) `printf("%s%d\n", 'h', 5);`
 - b) **`printf("%lf\n", x);` */* assume float x; */***
 - c) `scanf("%d\n", m);` */* assume int m; */*
 - d) **`scanf("%d\n", &m);` */* assume int m; */***

3. A difference between **system calls** and **function calls** is that:
 - a) Only function calls preserve the stack frame; system calls do not.
 - b) Function calls can be called from a signal handler but system calls cannot.
 - c) **System calls require a change of privilege level but function calls do not.**
 - d) System calls can pass arguments on the stack; function calls cannot.

4. In POSIX-compatible systems, the **file descriptor object** is:
 - a) **Created and returned by the open system call.**
 - b) Created by the fopen C library call (without a system call) and managed by the program.
 - c) **Created by the open system call, stored within the OS, and a pointer to it is returned.**
 - d) Exists permanently in the operating system and a pointer to it is returned by the open system call.
 - e) Exists permanently on disk and read in by the operating system when requested, and a pointer to it is returned by the open system call.

5. The **fork** system call:
 - a) Runs a new program in a child process.
 - b) Provides an exact copy of the current process's address space to an existing child process.
 - c) **Creates a new child process and gives it an exact copy of the current process's address space.**
 - d) Creates a new child thread and gives it an exact copy of the current process's address space.

6. A process is said to **terminate abnormally** if it exits because:
 - a) It calls exit with a non-zero argument.
 - b) It encounters a fatal error, e.g., an illegal memory access exception (SEGV).
 - c) It receives a SIGKILL signal.
 - d) **Any of the above happens.**
 - e) **Either b) or c) happens, but not a).**

7. For a process that **terminates normally**, which of the following is *incorrect*?
 - a) Its address space is reclaimed by the operating system.
 - b) All output file descriptor buffers are flushed and all file descriptors are closed.
 - c) **Output file descriptor buffers are not flushed but all file descriptors are closed.**
 - d) The parent process is notified via a signal.

8. Which of the following kinds of data are **automatically visible** (i.e., a pointer does not have to be passed explicitly) to all POSIX threads in a multithreaded program:

- a) Global and stack variables and heap objects
- b) **Global variables and heap objects only**
- c) Global and stack variables only
- d) **Global variables only**
- e) Heap objects only

9. Which of the following causes a POSIX **process** (not just the calling thread) to **exit**:

- a) A call to `pthread_exit` by a child thread but not the main thread.
- b) A call to `pthread_exit` by the main thread.
- c) A call to `pthread_join` by the main thread that returns after a child thread (not necessarily the last one) has exited.
- d) A call to `pthread_join` by the main thread that returns after the last child thread has exited.
- e) **None of the above.**

10. Which of the following X values is NOT possible after both threads complete execution? (X is a global variable and initially X = 0.)

```
Thread 1:
for (i = 0; i < 2; i++) {
    int c = X;
    c++;
    X = c;
}
```

```
Thread 2:
for (i = 0; i < 2; i++) {
    int c = X;
    c++;
    X = c;
}
```

- a) 4
- b) 3
- c) 2
- d) **1**

11. Which scheduling algorithm gives the smallest average wait time?

- a) First Come First Served.
- b) Round Robin.
- c) **Shortest Job First.**
- d) Priority

12. Consider the following program snippets:

Snippet i: char *foo(char *ptr) { return ptr; }	Snippet ii: char *foo(char *ptr) { char a[100]; ptr = a; return ptr; }	Snippet iii: char *foo(char *ptr) { char a[100]; strcpy(a, ptr); return a; }
Snippet iv: char *foo(char *ptr) { char a[100]; strncpy(a, ptr, 10); a[10] = '\0'; return a; }	Snippet v: char *foo(char *ptr) { char *a = (char *)malloc(strlen(ptr) + 1); strcpy(a, ptr); return a; }	

Which of the above snippets are correct (in terms of memory usage):

- a) (i) only
- b) (ii) only
- c) (iii) only
- d) (i) and (iv)
- e) (i) and (v)

13. What is the output of the following code?

```
char str[] = "I start from NULL and end at 0, but do I stop at \0 or NULL?";  
printf("%s", str);
```

- a) I start from
- b) I start from NULL and end at
- c) I start from NULL and end at 0, but do I stop at
- d) I start from NULL and end at 0, but do I stop at \0 or
- e) I start from NULL and end at 0, but do I stop at \0 or NULL?

14. What would be the output of the following code?

```
void *print_thread(void *ptr) {  
    int i;  
    for(i = 0; i < 10000 ; i++) {  
        printf("%d\n", i);  
    }  
}  
  
int main() {  
    pthread_t p;  
    pthread_create(&p, NULL, print_thread, NULL);  
    pthread_exit(NULL);  
    return 0;  
}
```

- a) No output
- b) It is not possible to write 'pthread_exit' within main()
- c) 0 through 9999
- d) Different output in different runs
- e) None of the above

15. Which of the following is NOT true for a system call?

- a) The OS handles the system calls.
- b) System calls are more heavyweight than normal function calls.
- c) In a system call, caller and callee are at the same address space.
- d) The state of the hardware (CPU) has to be saved before a system call is handled.
- e) None of the above.

16. Threads belonging to the same process **share**

- a) stack
- b) data section
- c) register set
- d) thread ID

17. Consider the following scheduling policies: (i) First In, First Out (FIFO), (ii) Round Robin with a small quantum, (iii): Round Robin with a large quantum, (iv): Preemptive Shortest Job First (SJF), (v): Preemptive Priority Scheduling (PPRI). Which of these policies can lead to starvation of processes?

- a) (i), (iii), and (iv) only
- b) (iv) and (v) only
- c) (i) and (iii) only
- d) (iii), (iv), and (v) only
- e) (i), (ii), (iii), (iv), and (v)

18. Which of the following systems may never exhibit a “hold-and-wait” situation (“hold and wait” is one of the preconditions of deadlock)? You may assume that the only blocking in these systems occurs on mutexes.

- a) Systems that ensure that all resources needed for an application are locked in a single atomic operation that either succeeds and locks all requested resources or fails and locks none.
- b) Systems with only one mutex.
- c) Systems where all mutexes are numbered. A user cannot lock a mutex with a lower number, X , after they have locked a mutex with a larger number, $Y > X$.
- d) Systems of type (a) and (b) only
- e) Systems of type (a), (b) and (c)

19. A database system allows process A to kill process B if the latter holds a resource that the former needs. The resource is then released and given to A. Process B is rolled back to a previous state in which it was before it acquired the resource, and is allowed to retry later. What is this mechanism an example of?

- a) An example of allowing preemption
- b) An example of a hold-and-wait condition
- c) An example of allowing circular wait
- d) An example of deadlock
- e) An example of disallowing mutually exclusive access to resources

20. Which of the following lock request sequences results in a deadlock? Assume that no locks are released in each of the sequences below. Assume no resources were locked at the beginning of each sequence. Assume that a request for a lock succeeds in acquiring the lock if it has not already been acquired by a previous request in the sequence. A request for locked resource blocks. Each sequence is a different case, independent from the other sequences. Processes are denoted by letters A, B, C, ... and locks are denoted by letters R1, R2, R3, ...

- a) A requests R1. B requests R1. C requests R1
- b) A requests R1. B requests R2. C requests R3. D requests R1
- c) A requests R1. B requests R2. A requests R2. B requests R1. C requests R3
- d) A requests R1. A requests R2. B requests R2. C requests R1
- e) None of the above deadlocks

Good luck!