All questions are single answer. Space has been provided after each question for you to state assumptions and/or justify for you answers. This is optional.

1. For each of the following definitions, enter the term (from the list below) that is best fits the definition. Enter your selection in the space provided. Each correct answer is worth 0.5 marks.

   a) A system call that can be used to create either a process or a thread on Linux is: _____

   b) An interrupt that occurs when a program accesses a portion of the address space that is not currently loaded into physical memory is called a: _____

   c) A mechanism by which a kernel can notify a run-time system if it knows a thread is blocked is referred to as: _____

   d) An entity within an OS that defines the environment in which a thread can execute is a: _____

clock interrupt	page fault	sharing_flags
clone	pop-up thread	task
CPU bound	process	thread
create_thread	process table	thread table
fork	Pthread	trapping to the kernel
kernel stack	resource grouping	upcall
kernel-space thread	run-time system	user-space thread
multithreading	scheduler activation	wrapper

2. In which one of the following scenarios would a multi-threaded implementation be likely to out-perform a single-threaded implementation of the same program?
   a) when the program is IO-bound
   b) when the program is CPU-bound
   c) when the program is being developed for a single-core CPU
   d) when the program is being developed for a multi-core CPU
   e) never; a single-threaded implementation will always out-perform a multi-threaded implementation

   Justification (optional): _____

3. Which one of the following is an advantage that threads have over processes?
   a) do not trap to the kernel to make blocking IO calls
   b) faster context switching
   c) faster thread creation
   d) increased pseudo-parallelism
   e) all of the above are advantages that threads have over processes

   Justification (optional): _____

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
void *bye (void *id) {
   printf ("I am about to die ... %d\n", id);
   pthread_exit(0);
}
int main (int argc, char *argv[])
{
   int i;
   int rc;
   pthread_t threads[10];
   for (i=0; i<3; i++) {
      rc=pthread_create(&threads[i], 0, bye, (void *)i);
   }
   exit(0);
}
```

4. Assume that you compile and run the program shown above on a multi-threaded OS. How many threads are created?
   a) zero
   b) one
   c) two
   d) three
   e) four

   Justification (optional): _____

   _____

5. Which one of the following Pthread library calls would you make if you want a thread to terminate without affecting other threads in the process?
   f) Pthread_block()
   g) Pthread_exit()
   h) Pthread_kill()
   i) Pthread_stop()
   j) Pthread_wait()
   k) none of the above

   Justification (optional): _____

   _____

6. Assume that a thread is running on a system that has only user space threads. What state will be stored in the ***process table*** when the thread blocks on IO?
   a) BLOCKED
   b) READY
   c) RUNNING
   d) none of the above, the process table does not maintain state information

   Justification (optional): _____

   _____

7. Which one of the following is an advantage that user space threads have over kernel space threads?
   a) superior performance for IO bound applications
   b) fast thread switching
   c) the kernel can schedule the individual threads
   d) blocking system calls do not affect other threads in the same process

   Justification (optional): _____

   _____

8. A multi-threaded Java program is executing on an older Unix system that support multi-threading via the Pthreads library.

   True or false: The threads in your program will be managed by the JVM, which will map them onto Pthreads in the kernel.
   a) TRUE
   b) FALSE

   Justification (optional): _____

   _____

9. What does it mean if the CLONE_FILES flag is *cleared* when you are making a clone() system call on Linux?
   a) copy the file descriptors
   b) create new uninitialized files descriptors
   c) do not copy, clone, or share file descriptors
   d) share the file descriptors
   e) none of the above

   Justification (optional): _____

   _____