Question 1: Process Management [25 marks]

One of the main services of the operating system kernel is process management.

    a. A process can create new processes by using specific system calls. Consider fork() and vfork() and analyse the differences between them.

                              [5 marks]

    b. Consider a system that is using 8 multilevel feedback queues for scheduling user processes (numbered from 0, highest priority, to 7, lowest priority). Consider three processes, A, B and C that start on level 2, 4 and 5 respectively and have the execution time 0.5 s, 0.9 s and 3 s respectively. If the time slice, denoted by q, for level 0 is 10 ms, determine the time slice for each level. Show the execution of processes A, B and C on the time axis and determine when and from which level they exit the system. We assume there is no I/O operation. The execution time slice for each level i is determined by the equation $t = 2^i q$.

                              [10 marks]

    c. What is the impact of I/O operations on the priority of processes A, B and C in 1.b? As an example, consider that process B will run for 480 ms after which it will start disk operations that will take 2 s. Follow B's execution and determine its exit queue.

                              [5 marks]

    d. Explain the concept of group scheduling.

                              [5 marks]

Question 2: Memory Management [25 marks]

Virtual memory allows programmers to ignore the physical limitations of computer system memory. The page is the main memory allocation unit.

    a. Explain the purpose of a page table and all the fields of a page entry.   [10 marks]

b. Consider that the main memory has a capacity of 512 KB and it is organized of four blocks of 4 KB, one block of 16 KB, one of 32 KB, one of 64 KB, one of 128 KB and one of 256 KB. All blocks are initially free and the following sequence of allocations and de-allocations is executed, where A means allocation and D de-allocation: A(3.8KB), A(11KB), A(15KB), D(15KB), A(4.2KB), A(2.7KB), A(3KB), A(33KB). Use the Buddy algorithm and show graphically which block is used for each operation, sequentially. Explain, using the diagram, the size of internal and external fragmentation at the end of the sequence of operations. For the same scenario, use the next fit allocation technique, show graphically the final allocation and determine the size of internal and external fragmentation in this case.

[10 marks]

c. Explain the page swapping process and when and how a page that was swapped onto the disk is brought back into the main memory.

[5 marks]

Question 3: I/O Devices Management [20 marks]

Mobile devices are equipped with a number of sensors, managed by the operating system.

.   a. Draw the Android sensor subsystem. Explain the role of the application framework and its operation.

[10 marks]

b. Explain what an Android sensor event is and how the sensor value is communicated. Describe the Android event report modes.

[10 marks]

Question 4: File System [10 marks]

    a. What is the mechanism by which Linux supports different file systems?

[5 marks]

    b. What is a superblock and what data structures does it contain?

[5 marks]