Operating Systems

(a) Operating systems typically provide each process with a virtual address space.

(i) Give three advantages of this. [3 marks]

(ii) In which circumstances does external fragmentation occur? How can it be managed? [2 marks]

(iii) In which circumstances does internal fragmentation occur? [1 mark]

(iv) Design a multi-level page table for a computer with a 48-bit virtual address space, 48-bit physical address space, and a 4K page size. You should explain its operation, and justify your design decisions. [6 marks]

(b) In the context of the UNIX operating system:

(i) What is a pipe? What is it used for? How does it operate? Use a diagram to illustrate your answer. [4 marks]

(ii) What is the shell? Describe its operation in pseudo-code, giving special emphasis to any system calls invoked. [4 marks]