

2009 Paper 2 Question 3

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]