THE UNIVERSITY
of LIVERPOOL

SUMMER 2001 EXAMINATIONS

Bachelor of Arts : Year 2
Bachelor of Engineering : Year 2
Bachelor of Science : Year 2

COMPUTER SYSTEMS AND THEIR IMPLEMENTATION

TIME ALLOWED : Two Hours

INSTRUCTIONS TO CANDIDATES

Answer **FOUR** questions

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).

Answer **four** questions

1.
(a) Three users each execute the Unix command 'ls –l' simultaneously.
    (i) How many *programs* are involved? Explain your answer.   (2 marks)
    (ii) How many *processes* are involved? Explain your answer.   (2 marks)

(b) With the aid of a suitable transition diagram, describe the various states that a process may be in, and explain what may cause it to shift from one state to another.   (11 marks)

(c) A process P1 issues a call to read from the keyboard. To what state should P1 be moved, and why? How might buffering affect your answer?   (5 marks)

(d) A Unix process P2 executes a fork() system call. What is the effect of this call, and what process state changes take place?   (5 marks)

2.
(a) In a certain producer-consumer situation, all of the producers and consumers communicate via a shared buffer, capable of holding a single, integer-valued item. Below is an attempt at representing this buffer in Java. Explain why this is not a good way of implementing the buffer.
    (9 marks)

```
class Buffer {
private int v;

  public void insert(int x) {
    v = x;
  }

  public int remove() {
    return(v);
  }
}
```

(b) Explain how the buffer code given in (a) could be improved to solve the problems you have outlined. (Note: it is not sufficient simply to present Java code without explanation).
    (16 marks)

3.

(a) Describe what is meant by the Principle of Locality. What is the explanation for this phenomenon?

Explain how the Principle extends to the notion of the working set W(T,s). Give the formula for estimating the working set at a future time interval.   (7 marks)

(b) In an operating system that makes use of paging, page references are made in the following sequence (assume references are made at unit time intervals):

```
page  |A|B|C|B|B|B|A|C|C|B|
time   0 1 2 3 4 5 6 7 8 9 10
```

What are the values of the following (explain your answers):
   (i) W(0,4)
   (ii) W(3,3)
By using the formula you gave in part (a), predict the working set W(10,3)   (9 marks)

(c) Using the same sequence given in part (b), assume that page D is now accessed at time 10, and that one of the pages A,B,C must be discarded to make room.
For each of the page replacement policies below, say which page must be replaced and give your explanation.
   (i)   LRU
   (ii) FIFO
   (iii) LFU

                                                                (9 marks)

4.

A compiler is given the following expression as its input:

```
a*(b+c)^2-d
```

(a) Briefly describe the actions performed by the lexical analyser in processing this expression.
                                                                (5 marks)

(b) Show how you could develop a parsing algorithm to convert expressions to postfix notation. Apply your algorithm to the above expression and show the resulting postfix string.
                                                                (13 marks)

(c) Explain how your postfix string could be converted to machine code for a simple stack-based computer.   (7 marks)

5.

(a) Explain what is meant by a *client-server* system. Give two examples of well-known servers.
                                                                (5 marks)

(b) With the aid of suitable diagrams, describe the steps that a server and its clients must perform when communicating via sockets.   (15 marks)

(c) Explain how it is possible for a single server to communicate simultaneously with several clients all making different requests.   (5 marks)