THE AUSTRALIAN NATIONAL UNIVERSITY

First Semester Examinations 2004

COMP1200
(Perspectives on Computing)

Writing Period: 3 hours duration
Study Period: 15 minutes duration
Maximum Marks: 100
Permitted Materials: None
Answer all questions.

Name

Student Number

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

- This paper will be marked out of 100 and consists of 6 questions. Questions are of unequal value. The value of each question is shown within square brackets. Questions that are partitioned into parts show the number of marks given to each part within square brackets. Students should attempt all questions.
- Answer *all* questions using either a **black** or **blue** pen. Use the space provided. Marks may be lost for giving information that is irrelevant. There is additional space at the end of the booklet in case the space provided is insufficient(Clearly indicate, within the question concerned, that you have used this extra space at the end of the booklet.).
- Students are permitted to have pens, pencils, rulers, and erasers. However, no other materials are permitted.
- Students are asked to check that this examination paper contains all 22 pages. Also, no pages are to be torn from this examination paper.
- This examination paper is **CONFIDENTIAL** and is not to be taken from the examination room.

Official use only:

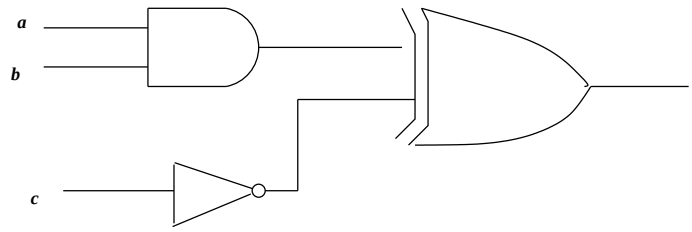
1	2	3	4	5	6	Total

QUESTION 1. [16 Marks] Computer Architecture

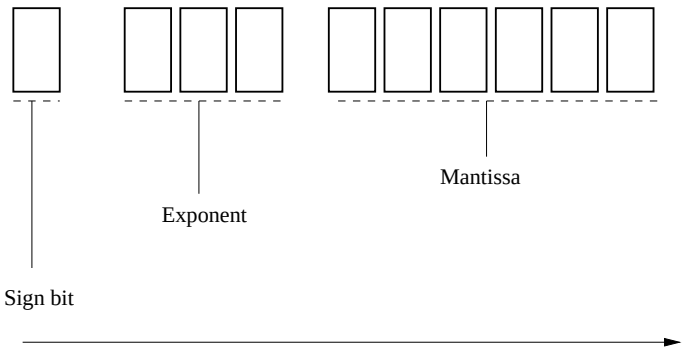
a) [4/16] Fill in the blanks in the following sentences.

- There are _____ bytes in 1MB of memory. A nibble can represent _____ different states.
- A 512MB memory would require _____ bits of address, assuming the basic unit of addressing is a byte.
- The bit pattern 10110101 in 8-bit twos-complement represents the value _____ in decimal. The binary number 110010110010 is _____ in hexadecimal.
- In the design of the CPU, ALU and MUX stand for _____ and _____ respectively.

b) [4/16] Draw the truth table and state the boolean expression for the following circuit diagram.



c) [3/16] A real number can be approximately represented by a floating point number in a computer. The components of such a representation are shown below,



where a binary pattern represents each of the components. Now, given a floating point number whose representation in binary is 0 110 100101, its value in decimal is _____ . Explain how you arrived at this result.

d) [2/16] An important factor in the performance of a computer system is the way in which information is stored. Different storage approaches form a hierarchy in terms of their attributes. Given the following storage mediums: main memory, cache, register, and hard disk, list them in increasing order in terms of access speeds.

e) [3/16] What is a finite state machine? Explain how it can be applied to the problem of controlling a traffic light at a pedestrian crossing.

QUESTION 2. [18 marks] Operating Systems and Networks

a) [6/18] Fill in the blanks in the following sentences.

- The basic unit that an OS manipulates is _____ , and its representation in computers is called a P _____ C _____ B _____ .
- The famous protocols used by the Internet are TCP/IP, where TCP and IP stand for _____ and _____ respectively.
- In most modern operating systems, _____ means that each user gets a slice of the CPU resource and is facilitated by multiprogramming, and _____ means that multiple processes may share the same code segment in main memory.
- The basic storage allocation unit for a file is called _____ . There are three major approaches to the file storage, and they are: _____ , _____ , and _____ .

b) [4/18] In operating systems, a process has 5 different states. They are: _____ , _____ , _____ , _____ , and _____ . Draw a diagram to express their relationships.

c) [4/18] Why does the information stored in a computer system need to be secured? One possible solution is the introduction of authentication. Usually an authentication is based on one of three items. Which are these three items?

d) [4/18] Draw four different network topologies, representing the connections between hosts in a network, that satisfy the following constraints: in one of the four, each host connects to at most two other hosts; in another, each host connects to exactly two other hosts; in a third, each host connects with every other host; and in the last, one host serves as the hub and every other host connects only to the hub.

QUESTION 3. [20 marks] Computation

a) [6/20] Fill in the blanks in the following sentences:

- An 8-bit color frame contains 480×720 pixels. _____ Kbs of memory is required to store the frame.
- To represent images, two graphics approaches are used. One is _____ and the other is _____ .
- In the study of algorithmic complexity, two major metrics are usually used. One is the _____ complexity and the other is the _____ complexity.

b) [4/20] State the three stages of a compiler and explain the major functions of each stage. Given an assignment statement, $x := 5x + y - 4$, provide the output of this statement after it has passed through the first stage of the compilation.

c) [4/20] The input to a compiler is called _____ and its output is called _____ . The output of an `Eiffel` compiler is _____ , which is a high-level language, while the output of the `Java` compiler is _____ , which is a language independent of any machine. Then, this language code is _____ into machine code to enable it to be executed on a machine.

d) [4/20] Consider the following program, where n is a positive integer.

```
i := 0;  j := 0
while (i < n)
      do
            j := 2 * i - 1;
            print j;
            i := i + 1;
      end.
```

1) What the total running time of the program? Assume that an addition, a subtraction, a multiplication, a comparison, an assignment and a print instruction take unit time.[2]
2) Give the output of the program when $n = 5$.[1]
3) What is the running time of the program in terms of the big-O notation.[1]

e) [2/20] Given the following sequence of running times in terms of the big-O notation, list them in increasing order of running time.

$0.3n \log n$, $\sqrt{n}$, $2^{0.0045 \log n}$, $n^{3/2} \log \log n$, 4^n.

QUESTION 4. [20 Marks] The History of Computing

A list of significant dates taken from the course web-notes is included at the end of the question paper.

a) [2/20] What, in your opinion, is the importance in studying the history of computing?

b) [4/20] Draw a diagram of the Von Neumann computer architecture. Why is the concept of the stored program significant?

c) [3/20] State what are the important differences between the second generation and the third generation of computer **hardware**.

d) [3/20] State Moore's Law. What do you think is the significance of Moore's Law?

e) [3/20] Which generation would you identify with the advent of the mainframe? Do you think that the role of the mainframe has changed with time? Briefly explain.

f) [5/20] You are employed by a government agency to help implement a $100m wireless emergency alert system using radio pagers to advise rural fire fighters when there is a fire. As an employee you are subject to direction by your boss. You realize that using SMS messages on the mobile phone network would save having to build the page network. This would save $50m and be more reliable. But the boss says no, because contracts have already been let for the network. Should you tell anyone the government is wasting money? Can you be held responsible for failure of the obsolete pager system? What should you do if you believe the failure could cause serious property damage or loss of life?

QUESTION 5. [17 Marks] Software Engineering

a) [1/17] What role did the North Atlantic Treaty Organisation (NATO) play in the early history of software engineering?

b) [2/17] What is the relationship between Software Engineers and Computer Scientists?

c) [2/17] What would you expect a code of ethics, such as that of Engineers Australia, to say about an engineers development of knowledge, skill and expertise?

d) [3/17] What is the purpose of **ISO/IEC 12207** *Software Lifecycle Processes*? What aspects of software engineering processes **are not** described by the standard?

e) [2/17] Name two of the primary lifecycle processes identified in **ISO/IEC 12207**

f) [2/17] Name two important approaches to software analysis and design.

g) [1/17] Identify one weakness of the waterfall software development lifecycle model.

h) [4/17] What is the purpose of a Capability Maturity Model (CMM)? Name the five levels of maturity defined by the software CMM. At what level of maturity are most software development organisations currently operating?

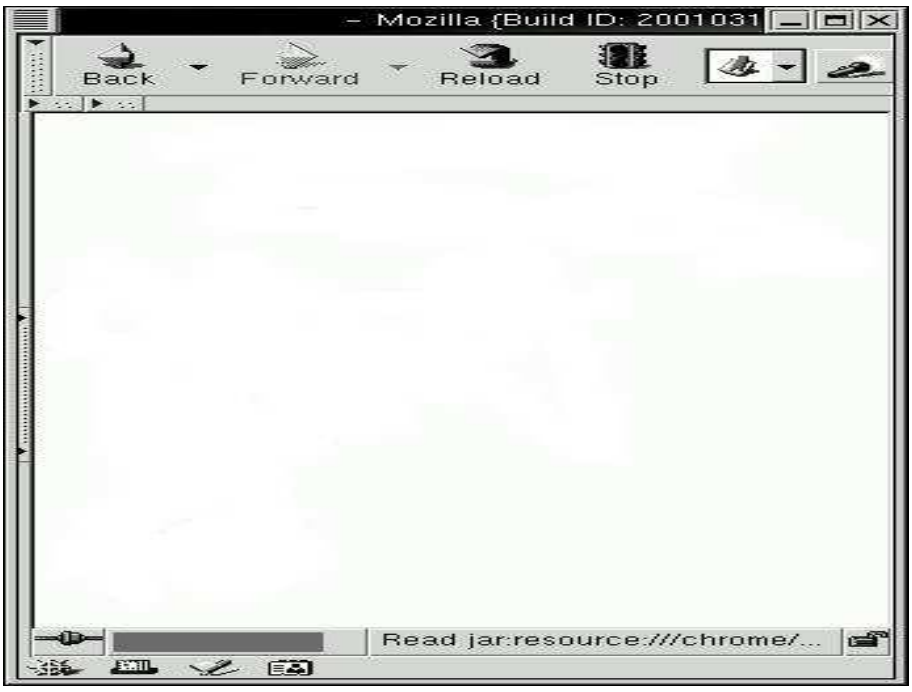
QUESTION 6. [9 Marks] HTML and AI

a) [3/9] Given the following raw HTML, show in the diagram below what this web page would look like.

```
<html> <head> <title> Peas </title>
</head> <body>
<h1 align="center"> Shelling Peas</h1>
<p align="right"> by Unknown Author </p>
<hr align="center" size="2" width="50%" noshade>
<!-- input constraints -->
<p> Obtain a basket of
    <strong>unshelled</strong>    <a href="www.peas.com">peas</a>
 and an empty
       bowl.

<!-- here's the actual algorithm -->
<p> <em>As long as there are peas in the basket, continue to
  execute the following steps</em>:
<ol> <li> Take a pea from the basket.</li> <li> Break
open the pea pod</a>. </li>
<li>Dump the peas from the pod into the bowl.
<li>Discard the pod.</li></ol>

<pre>
 ...
  <b> THE END
</b> ...
</pre> </body> </html>
```



b) [3/9] Briefly describe the three main components of a production system.

c) [3/9] What is a search tree? Why are heuristics useful, in the context of a search tree?

Additional answers to question: ___.

Additional answers to question: ___.

Additional answers to question: ___.

A brief list of dates for Perspectives on Computing

1935	IBM 601 punched card machine using relays (USA)
1937	Harvard Mark I IBM ASCC: 72 x 23 decimal digit number storage: multiply time 6 seconds
1938	Konrad Zuse: electro-mechanical computer Z1 (DE)
1939	Atanasoff and Berry: special purpose electronic computer (USA)
1941	Atanasoff and Berry: linear equation solver (USA)
1941	Konrad Zuse: Z3 programmable computer (Germany): telephone relays with mechanical storage for 64 numbers
1943	Harvard Mark I programmable computer (USA)
1943	Thomas Flowers: Colossus - the first electronic computer (UK)- 2000 vacuum tubes
1946	ENIAC fully electronic computer (USA) Eckert and Mauchly: 20 x 10-digit accumulators; 5000 operations per second
1946	Konrad Zuse's programming language Plankalkül
1946	von Neumann's paper on computer architecture: "the Von Neumann computer"
1946	Grace Hopper logs the first computer "bug" (a term previously used widely in engineering)
1947	transistor invented (Bell Labs USA)
1948	First stored-program computer (UK)
1949	CSIRAC: the first Australian-designed and built computer
1949	First use of magnetic tape (USA)
1950	Floppy disk invented (Japan)
1951	First commercially available computer (USA)
1951	symbolic assembler language invented (Grace Hopper) to improve on programming by numeric codes
1951-55	IBM 701 (scientific) and IBM 702 (commercial): 50 of each were sold
1953	Magnetic core memory
1956	television introduced in Australia
1957	(approx)languages FORTRAN(1954-7); Algol (1958-60); COBOL (1959-61); LISP (1960)
1958	FORTRAN II revision of FORTRAN language
1959	ATLAS computer designed - virtual memory invented
1959	(approx) Move from valves to transistors; Batch Operating Systems (one program at a time)
1960	COBOL common business language - commercial programming language specification
1960	(approx) portable handheld battery powered transistor radios become common
1963	FORTRAN IV revision of FORTRAN scientific calculation programming language
1964	(approx) Move from individual transistors to integrated circuits, Multiprogramming Operating System, more than 32k words of fast memory, faster than 1 microsecond (1MHz)
1964	Gordon Moore observes IC chip densities doubling regularly
1964	IBM System/360 - mainframe computer of choice - 18 000 units sold up to 1972
1965	revised COBOL 65 (became ANSI standard COBOL in 1968)
1966	FORTRAN 66 (FORTRAN IV) ANSI standard - widely implemented version of scientific calculation programming language
1968	NATO Software Conference identifies "the software crisis"
1969	ARPANET network started (USA) - start of the Internet
1970	RAM chips appear - fast cheap mass production memory
1970	(approx) pocket calculator drives out slide rule for personal scientific calculations
1971	First microprocessor appears (4004); Altair 8080 microcomputer
1971	IBM System/370 - mainframe - total of 80 000 units sold up to 1988

1971 PROLOG - programming in logic language with strong mathematical foundations
1972 e-mail invented
1972 (approx) minicomputers - 12 or 16 bit computers - mainly scientific; cheaper than peripherals: DEC PDP-8
1972 Pascal programming language: portable initially for education
1972 C programming language - structured language suited for low-level portable systems programming of minicomputers
1973 First mass-market computer game (Pong)
1974 Personal computers appear: Altair hobbyists' personal micro-computer
1974 Microsoft founded - to sell BASIC standalone programming system for Altair
1974 COBOL 1974 revision of commercial programming language
1975 UNIX operating system marketed; C language starts to become popular
1975 (approx) XEROX invents Graphical User Interface (GUI)
1977 FORTRAN 77 revision with structured programming features
1977 software error in navigation controls of F-16 aeroplane: flips upside down when crosses equator (simulator)
1979 PET & TRS-80 user-friendly micro computers: 8 bit systems; CP/M operating system common
1979 VisiCalc - first computer spreadsheet program - for Apple II

1981 IBM PC released - 16 bit personal computer for desktops; command line operating system MS-DOS word processing becomes software application for PC rather than dedicated system
1981 (approx) DEC VAX-11 32 bit extended minicomputers as small mainframes
1981 the bug heard 'round the world - first Space Shuttle launch delayed 2 days by software bug
1983 Lotus 1-2-3 spreadsheet for 16 bit personal computers becomes popular application
1984 Apple Macintosh released: popular introduction of Graphical User Interface
1985 Windows GUI introduced for IBM PC
1985 FTP (file transfer protocol) specification published; widely implemented and used
1987 first widespread computer viruses and worms spread to thousands of computer systems
1988 programming design errors discovered in THERAC-25 therapeutic radiation machine: kills 3 people
1989 World Wide Web invented
1990 FORTRAN 90 revision of scientific programming language; with vector and parallel programming features
1991 (approx) Java programming language introduced - object oriented; network aware
1994 errors discovered after widespread release in Pentium processor chip
1995 WWW traffic overtakes FTP traffic on the Internet
1997 Deep Blue chess computer beats world champion Gary Kasparov at chess
1999 widespread fear of Y2K bug triggers millions of dollars of work to fix legacy systems
2000 First 1 GHz microprocessors
2000 worldwide annual PC sales reach 133 Million (all types)