

HWA CHONG INSTITUTION
C2 PRELIMINARY EXAMINATION 2012

COMPUTING

Higher 2

13 September 2012

Paper 1 (9754 / 01)

0815 -- 1115 hrs

Answer *ALL* questions.

Begin *EACH QUESTION* on a *FRESH SHEET* of paper.

The maximum mark for this paper is 120.

1. A computer has a number of registers which are used in the fetch-execute cycle.
 - (a) What is meant by a register? [1]
 - (b) Briefly explain the purpose of the following registers:
 - (i) Instruction register
 - (ii) Control Unit
 - (iii) Arithmetic and logic unit
 - (iv) Program counter [4]
 - (c) Explain the fetch execute cycle. [4]
 - (d) What would be the effect on the performance of the computer system of increasing the clock speed of a processor? [1]
2. The file that stores details of all the company's employees is organised as a sequential file. The file is ordered based on a 6 digit employee number.
 - (a) What is a sequential file? [1]
 - (b) How is it different from a serial file? [2]
 - (c) Describe an algorithm for adding a new employee to the file. [6]
 - (d) All orders from customers are placed in the order file.
 - (i) Describe how the order file is arranged as a random access file. [4]
 - (ii) Explain why the file designed to be random access rather than sequential access. [2]

3. Operating systems take on many roles in managing computer systems. One of the roles of the operating system is file management.
 - (a) Briefly explain the role of file management for an operating system. [1]
 - (b) Highlight and explain 2 key differences between FAT 32 and NTFS. [2]
 - (c) Virtual memory is memory management technique. Illustrate how it works with a diagram and explanations. [4]
 - (d) State what is meant by utility software. [1]
 - (e) Explain what is meant by each of the following types of utility software.
 - (i) Disk defragmenters
 - (ii) Disk partitions [2]

4. Each item offered for sale in a museum shop has information stored about it in a stock file. Each record in the file contains a number of fields.
 - (a) The description of the item is stored in a fixed length field using ASCII characters.
 - (i) Explain what is meant by the term fixed length field.
 - (ii) Describe how characters are stored in ASCII format. [3]
 - (b) The field which stores the number of items in stock is stored as a one byte binary integer.
 - (i) Explain why character and floating point representations would not be appropriate for this field. [2]
 - (ii) Describe a situation which would cause the suggested representation to fail and state how the problem could be overcome. [2]
 - (c) The personnel records for those employees who work in the shop are stored in a linked list in alphabetic order of surname.
 - (i) Using a diagram, show the list for the employees
 Smith, Wu, Arma, Hon
 (You should include reference to free space in your diagram)
 - (ii) Using a second diagram, show how Thor would be added to the list. [6]

5. An examination system requires that each candidate has a unique ID consisting of six digits. The first two digits are the school code and the next three digits are the candidate's unique number within the school. The sixth digit is a check digit.
- (a) Describe, with examples, **two** data entry errors that a check digit helps to detect. [4]
 - (b) Write an algorithm, in any appropriate form, that will calculate the correct check digit for a new candidate. Assume that the calculation uses modulus 11. [5]
 - (c) The algorithm produced in (b) is to be implemented in a program as a module.
 - (i) Justify the most appropriate type of module to use. [2]
 - (ii) State the parameter for this module. [1]
 - (d) Give an appropriate data type for the ID and justify your choice. [2]
6. The manager of a supermarket wishes to know the least number of checkouts needed at different times of the day in order that the checkout staff are kept busy, but without queues becoming unduly long. A computer simulation is being designed to show how the queue lengths are likely to vary under different conditions. At a certain time of day there are six checkouts open and the number of customers arriving during any one-minute period is equally likely to be 0, 1, 2, 3, 4, 5 or 6. Each customer joins the shortest of the six queues, and, after waiting in the queue (if there is one), is equally likely to require 1, 2, 3 or 4 minutes at the checkout point.
- (a) Design a suitable structure for the data required in this simulation, naming the essential variables and stating what each stands for. [2]
 - (b) Write, in pseudocode, a procedure, to determine which of the six queues is the shortest. [3]
 - (c) Write, in pseudocode, a segment of a program, making use of the procedure you wrote in (b) above, to run the simulation over a period of 60 minutes, and to print the length of each queue at the end of each minute. You should explain any assumptions you make, and, if you use a pseudo-random number generator, you should describe what it does. [6]
 - (d) It is later wished to change the simulation program to write out also the length of time each customer waits in the queue before being served at the checkout. Outline the effect this change will have on the choice of data structure and on the program. [3]

7. (a) In a number guessing game, John is asked to guess a number from 1 to 100. When he guesses a number, he will be told one of the three things: his guess is larger than the number, smaller than the number, or he has guessed correctly. Assume that John knows about the binary search method.
- (i) Using pseudocode, write the binary search algorithm John would use to play this number guessing game. [5]
 - (ii) What is the maximum number of guesses that he has to make before he can arrive at the correct number? [2]
 - (iii) What approximately, is the average number of times, which may need to be guessed to make the correct guess using binary search in this guessing game? [2]
- (b) A set of numeric data is held in a one-dimensional array in ascending order. Write an algorithm for a sequential search that will read a value, M, and output the position of M or output a message stating that M is not in the array. [5]
8. A hotel has 100 rooms of various sizes offering varied facilities. It receives a large number of enquiries each day about availability of accommodation. Most of these are by telephone. It also receives confirmation of bookings. These are entered onto a computer database which can be accessed by receptionists, accounts personnel, restaurant personnel and catering management.
- While a guest is resident in the hotel, any expenses incurred by the guest are entered into the database by the appropriate personnel. If guests purchase items from the bar, they have to sign a bill which is passed to a receptionist who enters the details into the database.
- When guests leave the hotel, they are given an invoice detailing all expenditure. When they pay, the database is updated and a receipt is issued.
- The database is used to keep records of all food items used in the hotel. When necessary, the catering manager places orders with suppliers. The suppliers send a delivery note with the goods and later an invoice to the hotel's accounts department.
- (a) Describe, with aid of a diagram, the data flows, processes, data stores and external links in the system. [8]
 - (b) Describe how data will be organized within this database. [6]

9. (a) Explain the difference between an iterative solution and a recursive solution to a problem. [2]

- (b) The program RADIX_CONVERT, listed below, calls a recursive procedure, OUT. The program is run, and the values 46 and 3 are input. Write down, in the correct order, all the values printed. Show your reasoning clearly. (Note that $x \text{ DIV } y$ gives the integral part of the quotient when x is divided by y , and $x \text{ MOD } y$ gives the remainder.)

```
Program RADIX_CONVERT
    declare integers a, b
    input a, b
    OUT (a, b)
    print a, b
End RADIX_CONVERT
```

```
Procedure OUT (x, y)
    declare integers a, b
    a = x DIV y
    b = x MOD y
    if a > 0 then OUT (a, y)
    print (b)
end OUT
```

[6]

- (c) Why are the values of local variables usually stored in a stack, rather than in fixed storage? [2]

- (d) Given two positive integers M and N , the function $\text{GCD}(M, N)$ is defined by

- (i) If $M < N$, swap M and N
- (ii) Divide M by N and let R be the remainder. If $R = 0$, N is the answer
- (iii) Set $M = N$, $N = R$ and go back to step (i)

Produce a recursive solution for $\text{GCD}(M, N)$ using pseudocode. You may assume the availability of the operator MOD as in part (b). [6]

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