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I.D.Number: _____ Printed Name: _____

McGill University
Department of Electrical and Computer Engineering

Course ECSE-322B -- Computer Engineering

MidTerm Test

Friday 22 February 2013

PLEASE NOTE CAREFULLY:

Sign this paper, fill in your student ID number and print your name at the top of the first page and on the mark sense sheets - if you do not do this the exam may not be marked. **Initial each page of the exam paper in case the sheets should get separated**. Make sure the signed paper in its entirety is handed in at the end of the examination.

INSTRUCTIONS:

- *This exam consists of two parts; part 1 consists of a set of 16 multiple choice questions, part 2 consists of a set of 2 questions with short answers -* ***YOU SHOULD CHOOSE ONE OF THE TWO QUESTIONS IN PART 2****. The answers to the questions in Part 1 (the first 16 questions) should be entered on the computer marked sheets, the answers to Part 2 should be written on this question paper in the space provided.* ***DO NOT USE ANY OTHER EXAM BOOKS FOR ANSWERS TO BE MARKED.***
- *Unless otherwise stated on the exam paper, the scoring method for this examination will assign 1 mark for each correct answer, 0 marks for a blank or wrong answer. All multiple choice questions will be weighted equally in scoring.*
- *This is a closed book exam. However, the candidates are allowed to bring in one sheet of letter size paper which may have handwritten notes on both sides.*
- ***Student answers in the multiple choice section will be subject to analysis by the McGill Exam Security Computer Monitoring Program in order to identify unusually similar answer patterns****.*

Please sign this paper at the top of this page, write your name legibly, and read the important notice above.

ENTER THE NUMBER OF THE SHORT ANSWER QUESTION IN PART 2 TO BE MARKED HERE:

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TEST QUESTIONS

PART 1 - This part consists of 16 multiple choice questions. Indicate the correct answer to each question on the computer readable sheets provided.

1. Which of the following is NOT an example of an asynchronous system?

a) A phone call
b) The posting of information on My Courses
c) A reservation for dinner in a restaurant
d) Using a taxi to get home
e) Organizing a meeting with a group of friends

2. The number of additions needed to find an element in a vectored four dimensional array is?

a) 1
b) 2
c) 3
d) 4
e) None.

3. To prevent a queue from migrating in memory, it is necessary to

a) Lock one end to a specific memory location
b) Ensure that data is inserted and removed from the same point
c) Implement it in a fixed array
d) Use “wrap-around indexing” to make it circular
e) Use hardware memory protection to keep it in place.

4. The main advantage of a *Programmed Input-Output* system is that

a) the processor keeps checking the status of the device and responds as soon as the device is ready
b) the system avoids the overhead of an interrupt
c) device service routines are not needed
d) devices are only checked when a processor wants to use them
e) it is simple to program

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5. Which of the following sequences can represent the elements of an ordered array that are visited by a binary search:

a) 50 80 90 78 79
b) 50 29 22 27 28
c) 50 27 29 25 22
d) All of the above.
e) None of the above.

6. A timing problem exists between a printer and the cpu because:

a) The interface has no information on the actions of the printer
b) The cpu cannot send characters to the printer if it is executing another program
c) The mechanics of the printer mean it prints characters more slowly than the cpu generates them
d) A serial line can limit the character transmission speed
e) The interrupt process on the bus slows down the rate at which characters can be sent to the printer..

7. Which of the following is NOT normally provided on a bus?

a) Address
b) Data
c) Control
d) Power
e) They are all provided

8. In order to achieve $log_2(n)$ performance in a *searching algorithm*, it is necessary that

a) The data not be already ordered
b) The data has been stored using a hashing algorithm based on a key
c) The data are sorted on a key in ascending or descending order
d) The data are all of the same type
e) The key chosen for searching is part of the data set

9. A *sparse vector* is a data structure in which

a) Many of the data elements are equal to zero or do not exist.
b) The addressing polynomial has several terms with zero coefficients.
c) A multi-dimensional array cannot be vectored.
d) Not all the elements are of the same type.
e) A hashing function is used for storage address computation..

10. Data are usually stored in a well defined structure so that

a) The best use is made of the available space
b) Hashing functions are not needed
c) Memory needs are minimized
d) The existence of a particular item can be verified in minimum time
e) Collisions can be avoided

11. Sorting data is always slower than searching for data because

a) Data are obtained randomly
b) Most data are already sorted
c) Sorting requires looking at every piece of data, searching does not
d) Binary searches are very efficient
e) Sorting is not always slower than searching.

12. An *insertion sort* to place N items in a linked list has a complexity of

a) O(constant)
b) $O(N^2)$
c) $O(N\log_2 N)$
d) O(N)
e) $O(\log_2 N)$.

13. The *Device Status Register* on an interface is used to

a) Place a vectored interrupt address on the bus
b) Move data between the bus and the interface circuits
c) Move control information to and from the interface
d) Decode the address on the bus to provide control signals to the interface
e) Provide information to the device connected to the interface

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14. In enabling an RS-232 link to use a Start/Stop protocol, which of the following connections must be made?

a) Connect DTR, DSR to Ground and RTS, CTS to a rail
b) Connect DTR to CTS and DSR to RTS
c) Connect DTR to RTS and DSR to CTS
d) Connect DTR to DSR and RTS to CTS
e) Leave all control signals disconnected and just use the Send and Receive lines for transmission

15. In transferring information between two devices or systems, which of the following requirements is not necessary?

a) Minimize the errors
b) Identify and correct the errors
c) Minimize the time to move the data
d) Ensure that both ends of the link are synchronized
e) Minimize the cost

16. A *computer* is a device which is intended to

a) Provide high speed computations
b) Provide a method of accessing information
c) Provide information processing, storage and transmission capabilities
d) Connect to the internet
e) Provide a platform for entertainment systems.

PART 2 of this exam starts on the next page. Please turn over the page and begin Part 2 NOW!

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PART 2 - This part consists of 2 short answer questions. YOU SHOULD ANSWER ONLY ONE OF THE QUESTIONS - IF YOU ANSWER BOTH, ONLY ONE WILL BE MARKED. The question is worth 10 marks (Each question consists of 5 sections). Write your answers to the question in the space provided on this exam paper. Do not use extra paper - any answers written outside of the allowed space will not be marked.

17. (a) In designing and evaluating any algorithm, two properties are of interest. What are they? (2 marks)

(i) Property 1: _____

(ii) Property 2: _____

(b) Express the following polynomial in nested product form and explain why this form is computationally useful.

$$P(x) = -4 + 2.1x^2 + 5x^3 + 7x^4 + 3.2x^6$$

(i) Nested Product Form: (1 mark)

(ii) It is useful because: (1 mark)

(c) (i)Describe what is meant by a “collision” when using a hashed from of data storage and explain how it can be dealt with. (1 mark)

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(ii) Give an example of a situation in which a hashed storage scheme would be an appropriate solution to the data structure problem (1 mark)

(d) It is desired to sort a randomly ordered data set (consisting of numbers only) using a binary tree (a Tree Sort).

(i) Describe the algorithm for doing this (either as a flow chart or a set of steps) (1 mark)

(ii) What would the time complexity of this process be? (0.5 marks)

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(iii)For the problem described, what is the ratio of memory needed for the Tree Sort compared to a Quicksort? (0.5 marks) (assume that all the data elements are integers)

(e) A large data set represents the students at McGill University. It is required to access the data set frequently. If each student is to be accessed M times, derive an expression for M in terms of the total number of students, N, if it is to be worth sorting the data set before searching for a student. (2 marks)

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18. (a) Explain the roles of the following components of an interface:

(i) Device Data Register (1 mark): _____

_____

(ii) Data Address Register (1 mark): _____

_____

(b) In a vectored interrupt system, the CPU transmits an *Interrupt Acknowledge* signal to the interrupting device when it receives an *Interrupt* signal. If several devices have interrupted it is important that only one accepts the Interrupt Acknowledge signal. This is the first interrupting device that is encountered on the Interrupt Acknowledge line. This device blocks the Interrupt Acknowledge signal, i.e. if Interrupt Acknowledge is a "1"coming in to the interface, it should be set to "0" on exiting the interface. The two signals involved in this are the *Interrupt Set* and the *Interrupt Acknowledge*.

(i) Complete the truth table below (with signal names and logic values) for the logic that will generate the outgoing Interrupt Acknowledge signal (1 mark).

		Interrupt Acknowledge (Out)

(ii) Draw the circuit that will implement the truth table in (i) (1 mark)

(c) A particular system takes (on the average) 40 microseconds to get to the pertinent ISR after the interrupt is received and the FETCH and EXECUTE cycle is broken. The overhead of the ISR (i.e. the time taken up with restoring the contents of the CPU registers, etc.) takes 15 microseconds.

(i) If 25 % of the total interrupt time (from the break in CPU execution cycle) is associated with the overhead, determine how much ISR execution time it takes to actually service the I/O device on average. (1 mark)

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(ii) Measurements on a real system suggest that only 22% of the CPU time is spent on interrupts. What is the average number of interrupts received by the CPU each second? (1 mark)

(d) A computer is equipped with a character based display employing a 90 by 48 screen format (i.e. 90 characters by 48 rows). After examining a (screen) page, we have the option of requesting a hard copy, which is printed while examining the next page.

(i) Assume the printer has a single character buffer, i.e. it prints characters as soon as they arrive. After a character is printed, the printer interface interrupts the CPU. If it takes an average of 51.8 seconds to print a page, and the printer can print 125 characters per second, calculate the time taken by the interrupt routine (2 marks)

(e) (i) Describe the steps necessary to move data from the CPU to a printer through the printer interface there is no interrupt capability. (1.5 marks) (describe all the operations and data flow through all the registers)

(ii)This process is known as (0.5 marks):