Examination Session:	Year:	Exam Code:
May/June	2017	COMP1071-WE01

Title: Computer Systems

Time Allowed:	2 hours	
Additional Material provided:		
Materials Permitted:		
Calculators Permitted:	Yes	Models Permitted: Casio FX-83 GTPLUS or Casio FX-85GTPLUS
Visiting Students may use dictionaries:		

Instructions to Candidates:	Answer FOUR questions. (TWO from Section A and ONE from Section B and ONE from Section C)
	Revision:

Computer Systems (COMP1071/WE01)

Section A   Machine Architecture and Digital Electronics
(Dr M. Bordewich)

Question 1

(a) Explain what a decoder is and sketch a 4-to-1 decoder circuit using AND, OR and NOT gates.   **[3 Marks]**

(b) Explain what a multiplexor is and sketch a 2-to-1 multiplexor circuit using AND, OR and NOT gates.   **[3 Marks]**

(c) Explain what a tristate gate is, and sketch a 2-to-1 multiplexor circuit using tristate gates.   **[4 Marks]**

(d) Explain what two's-complement representation is, how it is formed and give the 8-bit two's-complement representation of -38.   **[3 Marks]**

(e) Design a simple ALU that can do addition, subtraction, bitwise AND and bitwise OR. You may use logic gates, decoders, multiplexors, adders and other components that you define. Sketch and label your design. Explain carefully how the control lines function.   **[12 Marks]**

Question 2

Consider the following linear truth table, in which three of the outputs are unknown (represented as ?):

Input A	Input B	Input C	Input D	Output F(A,B,C,D)
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	?
0	1	1	0	?
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	?
1	1	1	1	0

(a) Use a Karnaugh map to obtain a simple Boolean expression for F, assuming that unknown outputs should be set to 0. **[7 Marks]**

(b) Use a Karnaugh map to obtain a simple Boolean expression for F, assuming that unknown outputs can be freely set to either 0 or 1. **[4 Marks]**

(c) Explain what it means to say "NOR gates alone form a functionally complete set". **[2 Marks]**

(d) Give a circuit diagram consisting only of NOR gates for F (assuming that unknown outputs can be freely set to either 0 or 1). Show your working and label the circuit so that it is clear how it corresponds to your Boolean formula for F from part (b). **[12 Marks]**

Question 3

(a) Explain what is meant by the architecture, micro-architecture and state of a CPU. **[6 Marks]**

(b) List the state elements of the MIPS CPU. **[3 Marks]**

(c) Explain precisely what the MIPS "save word" instruction `sw $t1, 4($sp)` does. **[3 Marks]**

(d) The machine code for the instruction in (c) is `AFA90004`, in hexadecimal representation. The first 6 bits give the op-code, the next 5 bits identify the register containing the base address, the next five identify the register containing the data word to be saved and the last 16 bits give the immediate value to be offset to the base address. Give the op-code, the two register numbers and the immediate data value in binary, and also the op-code in decimal. **[5 Marks]**

(e) Sketch the state elements of the MIPS CPU and circuitry connecting them that would realise the `sw` instruction. **[8 Marks]**

End of Section A

Section B   Operating Systems (Dr S. Doswell)

Question 4

(a) Using the page reference string below, show the total page faults for each of the replacement algorithms listed in i to iii that would occur with a three-frame reference memory allocation. Assume that the frames are initially empty.

Page reference string: 0, 1, 2, 3, 0, 1, 4, 0, 1, 2, 2, 2

   i. First In First Out (FIFO)

   ii. Least Recently Used (LRU)

   iii. Optimal (OPT)

Show your working.   **[9 Marks]**

(b) Briefly describe Belady's anomaly. Which of the three algorithms in part (a) suffer from Belady's anomaly?   **[2 Marks]**

(c) Describe how the Second Chance page replacement algorithm works.

                                                          [4 Marks]

(d) Define the term thrashing, and explain how a page fault frequency scheme can be used to control thrashing.   **[5 Marks]**

(e) What is prepaging (also known as prefetching)? Describe its purpose, key features and potential drawback(s).   **[5 Marks]**

Question 5

(a) Briefly describe the five possible process states.   **[5 Marks]**

(b) Assume a set of processes A to E arrive at different times in the ready queue. The table below shows the burst time, the priority (smallest priority number implies the highest priority), and the arrival time for each of the processes.

Process	Priority	Arrival Time	Burst Time
A	1	3	7
B	3	6	3
C	5	0	5
D	2	5	4
E	4	4	1

Draw a Gantt chart illustrating the execution of the processes for each of the following CPU scheduling algorithms.

    i. First-Come, First-Served (FCFS)

   ii. Shortest Job First (SJF)

  iii. Round Robin (RR) with a time slice of 2 units

[9 Marks]

(c) For each of the algorithms in part (b) give the average waiting time.

[3 Marks]

(d) What is meant by the term pre-empting? What is the pre-emptive version of the Shortest Job First (SJF) CPU scheduling algorithm called and how does it work?   **[4 Marks]**

(e) In CPU scheduling, what is meant by the term process starvation? Describe how process starvation could be managed when CPU scheduling.

[4 Marks]

Section C   Databases (Dr S. Jaf)

Question 6

(a) Briefly define what is meant by the terms: Modification anomaly; Primary key; 1st Normal Form (1NF). **[3 Marks]**

Consider the following tables.

Tickets			
parkCode	ticketNo	ticketType	ticketPrice
SP4533	11001	Adult	24.99
SP4533	11002	Child	14.99
SP4533	11003	Senior	8.50
FR1001	13601	Child	18.99
FR1001	13603	Senior	20.99
FR1001	13604	Child	9.65
UK2622	21366	Adult	28.49
UK3452	888567	Senior	22.50
UK3452	888568	Child	12.12
UK3452	888569	Adult	42.10

ThemePark			
parkCode	parkName	city	country
FR1001	Disney	Paris	France
UK2622	GoldTown	Windsor	UK
UK3452	Legoland	London	UK
SA1342	Adventure	Rome	Italy
SP4533	Miniland	Madrid	Spain

(b) Suppose that the manager wanted to increase the ticket price for all tickets that are £10.00 or less, by 10%. Write an SQL query that will make this modification. **[3 Marks]**

(c) Write a query to return the ticket price, park code and ticket type for all tickets that have park code starting with the string "UK" and have ticket price between £10.00 and £40.00. **[4 Marks]**

(d) Give an SQL left outer join statement that will return all the park codes, park names, cities, ticket numbers, and ticket types from the tickets and theme park tables. **[4 Marks]**

Consider the following schema for the relation WorkPlace which stores information about the projects, the employees who work on those projects along with the departments that manage projects and emplyees.

WorkPlace {<u>projectName</u>, projectManager, <u>employeeId</u>, employeeName, projectBudget, projectStartDate, employeeSalary, departmentName, departmentManager}

(e) Generate a suitable second Normal Form (2NF) schema from the schema above, and state the primary key and foreign key(s) for each schema you produce. **[5 Marks]**

(f) Generate a suitable third Normal Form (3NF) schema from the schema above, and state the primary key and foreign key(s) for each schema you produce. **[6 Marks]**

Question 7

(a) Briefly define the following terms: Deletion anomaly; Foreign key; Candidate key. **[3 Marks]**

(b) For the following scenario draw the Entity-Relationship (ER) diagram using crow's foot notation, clearly showing the entities, their relationships and the cardinalities of these relationships.

> A factory produces many items, while every item is produced by exactly one factory. Each factory exclusively employs several workers. Each employee packages many items, while each item is being packaged by exactly one employee. On the other hand, each customer may place many orders, or no order at all. Each order contains at least one item and each item sold is contained in a unique order.

[10 Marks]

Suppose you have the following two tables in a database: one table is called 'Fruits' and one called 'Colours'. Each record in the colours table is tied to a particular fruit by the fruit ID.

Fruits					Colours	
fruitId	fruitName	price	currentQnt		fruitId	colour
1	apple	0.89	965		1	red
2	orange	1.29	1240		2	orange
3	banana	0.65	1100		3	yellow

(c) Write an SQL statement using the inner join to list all fruit names, their colour, price and the current quantity of that fruit. **[3 Marks]**

(d) Write an SQL statement to remove 'orange' from the fruits table. **[3 Marks]**

(e) Write an SQL statement to add a new record to the fruits table for 1000 units of grapes, which cost £1.10 per unit, and use an ID of 10 for grapes. **[3 Marks]**

(f) Write an SQL statement to find all the fruit names that contain the letter 'e' . **[3 Marks]**

END OF PAPER