Durham University

Examination Paper

Examination Session:	**Year**:	**Exam Code**:
May/June	2020	COMP1071-WE01

Title: **Computer Systems**

Time Allowed:	2 hours	
Additional Material provided:		
Materials Permitted:		
Calculators Permitted:	Yes	Models Permitted: Casio FX-83 GTPLUS, Casio FX-85GTPLUS, Casio FX83-GTX or Casio FX85-GTX
Visiting Students may use dictionaries: Yes		

Instructions to Candidates:	Answer ALL questions. Please answer each question in a separate answer booklet.

Revision:	

Section A Digital Electronics & Computer Architecture (Dr Eleni Akrida & Dr Ioannis Ivrissimtzis)

Question 1

Consider the following truth table:

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

(a) Express the Boolean function F, given in the truth table above, in the "sum of products" form. **[2 Marks]**

(b) Draw a Karnaugh map corresponding to the truth table above. Use it to simplify your expression for F, and present a Boolean formula for F using as few Boolean operations (AND, OR and NOT) as possible. Show your working. **[4 Marks]**

(c) Give a circuit diagram consisting only of NAND gates for F. Show your working and label the circuit so that it is clear how it corresponds to your Boolean formula for F from part (b). **[8 Marks]**

(d) Assuming that the set containing AND, OR, and NOT gates is a functionally complete set, show that NOR gates alone form a functionally complete set. **[3 Marks]**

(e) Part (e) is on Complex Instruction Set Computer (CISC) architectures.

this question is continued on the next page

i. Briefly describe the main characteristics of the CISC architectures. **[4 Marks]**

ii. Briefly discuss two disadvantages of CISC architectures. **[2 Marks]**

(f) Briefly describe what each of the following instructions does, and classify it as an R-type, I-type or J-type instruction:

i. add $s0, $t0, $t1 **[2 Marks]**

ii. jal simple **[2 Marks]**

iii. lw $t0, 0($sp) **[2 Marks]**

(g) Part (g) is on MIPS memory map.

i. Briefly describe what type of data are stored in the Text segment of the MIPS memory map and what type of data are stored in the Reserved segments. **[2 Marks]**

ii. The Text segment of the MIPS memory map consists of memory addresses up to 0x0FFFFFFC. Briefly discuss how this design decision facilitates pseudo-direct addressing with J-type instructions. **[3 Marks]**

End of Section A

continued

Section B Operating Systems (Dr Barnaby Martin)

Question 2

(a) Consider a disk with 250 cylinders (from 0 to 249). Suppose the head is on cylinder 61. It then receives requests for I/O to blocks in cylinders

150, 177, 23, 163, 80, 85, 111, 9, 220, 243.

Calculate the seek time for each of the following disk scheduling algorithms.

(i) First Come First Served (FCFS) **[2 Marks]**

(ii) Shortest Seek Time First (SSTF) **[2 Marks]**

(iii) Cyclic Scan (C-SCAN) **[2 Marks]**

(iv) Cyclic Look (C-LOOK) **[2 Marks]**

(b) Which of the four disk scheduling algorithms above might suffer from starvation? Justify your answer. **[2 Marks]**

(c) Consider the page reference string below.

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

Find the total number of page faults for each of the page replacement algorithms listed below that would occur with a three frame reference memory allocation. Assume that the frames are initially empty. Show your working.

i. First In First Out (FIFO) **[3 Marks]**

ii. Least Recently Used (LRU) **[4 Marks]**

iii. Optimal (OPT) using LRU for ties **[4 Marks]**

(d) Describe how the Second Chance page replacement algorithm works. **[4 Marks]**

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

(f) What is prepaging (also known as prefetching)? Describe its purpose and key features. **[3 Marks]**

End of Section B **continued**

Section C Databases
(Dr Boguslaw Obara)

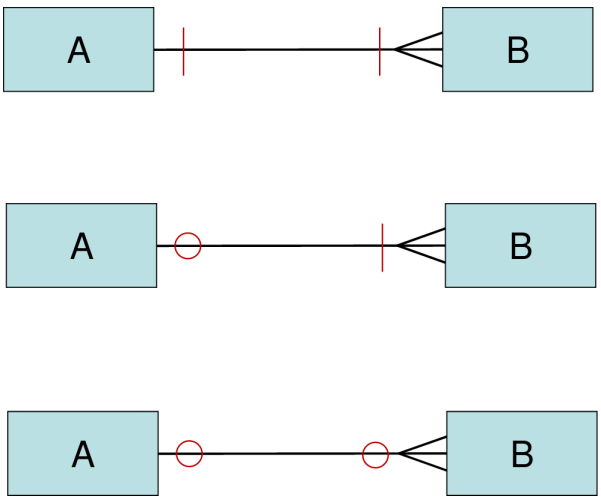
Question 3

(a) This question is about relational model:
Define the main components of the relational model.

- relation
- attribute
- domain of an attribute
- tuple
- cell
- degree

[3 Marks]

(b) This question is about cardinality:
Describe the optionality and participation presented in the ER diagrams below. **[3 Marks]**



(c) This question is about Structured Query Language (SQL) I:
Write SQL query to find all owners with the string 'Glasgow' in their address in the table below. **[5 Marks]**

ownerNo	fName	lName	address	telNo
CO87	Carol	Farrel	6 Achray St, Glasgow G32 9DX	0141-357-7419
CO40	Tina	Murphy	63 Well St, Glasgow G42	0141-943-1728
CO93	Tony	Shaw	12 Park Pl, Glasgow G4 0QR	0141-225-7025

(d) This question is about Structured Query Language (SQL) II:

For the following 'StaffBranch' table, write SQL query that for each branch, lists staff (defined by staff number and first and last name) who manage properties, including the city in which branch is located and the properties they manage in the table below. **[9 Marks]**

branchNo	city	staffNo	fName	lName	propertyNo
B003	Glasgow	SG14	David	Ford	PG16
B003	Glasgow	SG37	Ann	Beech	PG21
B003	Glasgow	SG37	Ann	Beech	PG36
B005	London	SL41	Julie	Lee	PL94

(e) This question is about cardinality:

Give three advantages and three disadvantages of distributed database management systems (DBMS). **[6 Marks]**

(f) This question is about decomposition:

The table 'StaffBranch' has redundant data (the details of a branch are repeated for every member of staff). Please decompose it into two smaller tables, 'Staff' and 'Branch'. **[7 Marks]**

Staff Branch

staffNo	sName	position	salary	branchNo	bAddress
SL21	John White	Manager	30000	B005	22 Deer Rd, London
SG37	Ann Beech	Assistant	12000	B003	163 Main St, Glasgow
SG14	David Ford	Supervisor	18000	B003	163 Main St, Glasgow
SA9	Mary Howe	Assistant	9000	B007	16 Argyll St, Aberdeen
SG5	Susan Brand	Manager	24000	B003	163 Main St, Glasgow

END OF PAPER