Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2018					

HIT235 – Digital Systems and Computer Architecture	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has one section.
Note that questions ARE NOT of equal value.
Read ALL questions carefully.
Answer ALL questions.
Total marks for this examination: 100

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1 (5 marks)

An automated cyclone warning system is required. The cyclone risk on any given day depends on several variables of which the barometric pressure, sea-surface temperature and wind speed are the main ones. When the barometric pressure is high, a green light should be on, indicating a low risk of cyclone development. If the barometric pressure is low but the sea-surface temperature and wind speed are also low, there is a moderate risk and an orange light should be on. If the barometric pressure is low and the sea-surface temperature is high there is a high risk of a cyclone developing and a red light should be on. The red light should also be on if the barometric pressure is low and the wind speed is high. If the barometric pressure is low and both the sea-surface temperature and the wind speed are high the cyclone risk is extreme and a "cyclone warning" sign should be switched on. Design the logic circuit for this system. Clearly label all inputs and outputs for your circuit.

Question 2 (3 marks)

a) What is the difference between Gray code and binary code? (1 mark)
b) Is Gray code a weighted number system? (1 mark)
c) Suggest an application where Gray code may be used. (1 mark)

Question 3 (4 marks)

a) Give the truth table for a half adder. (2 marks)
b) How many half adders do you need to make a 3 bit binary adder? Explain your answer. (2 marks)

Question 4 (4 marks)

With the aid of timing diagrams, explain the difference between the hold time and set up time of a flip-flop?

Question 5 (4 marks)

Each of the eight full-adders in an 8-bit parallel ripple carry adder exhibits the following propagation delays:

A to Sum (Σ) and $Carry_{out}$	40 ns
B to Sum (Σ) and $Carry_{out}$	40 ns
$Carry_{in}$ to Sum (Σ)	35 ns
$Carry_{in}$ to $Carry_{out}$	25 ns

Determine the maximum total time for the addition of two 8-bit numbers.

Question 6 (4 marks)

A NAND gate is often described as a universal gate.

a) Draw the symbol of a NAND gate. (1 mark)
b) Draw a diagram showing how NAND gates can be used to make an AND gate. (1 mark)
c) Draw a diagram showing how NAND gates can be used to make an OR gate. (2 marks)

Question 7 (3 marks)

For the cascade counter shown in Figure 1, the input is a periodic pulse waveform with a frequency of 240 kHz. Determine the frequency of the waveform at each point indicated by a circled number.

Figure 1

Question 8 (3 marks)

Explain how subtraction of binary numbers can be done.

Question 9 (4 marks)

a) Explain the difference between the two elements shown in Figure 2. (3 marks)
b) Suggest a practical application for this type of device. (1 mark)

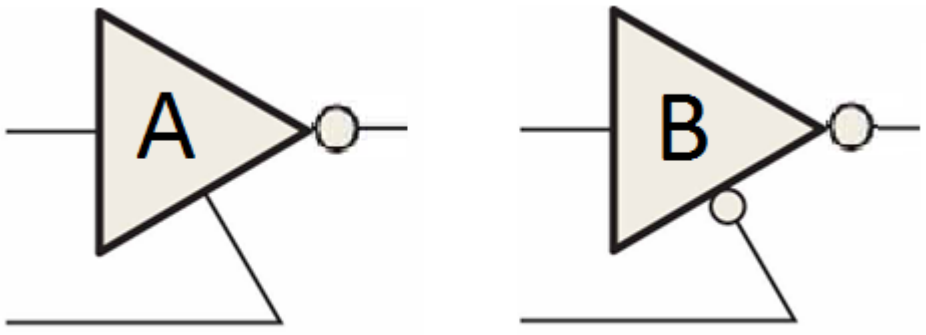

Figure 2

Question 10 (5 marks)

A combinational logic circuit is shown in Figure 3 along with a timing diagram.

a) The output waveform (X) shown in the timing diagram is not correct for the circuit shown. Draw the correct waveform. (2 marks)

b) The output waveform shown is the result of incorrect implementation of the circuit. One of the gates has been replaced by another type of gate. Which gate has been replaced and what is the replacement gate? Explain your answer. (3 marks)

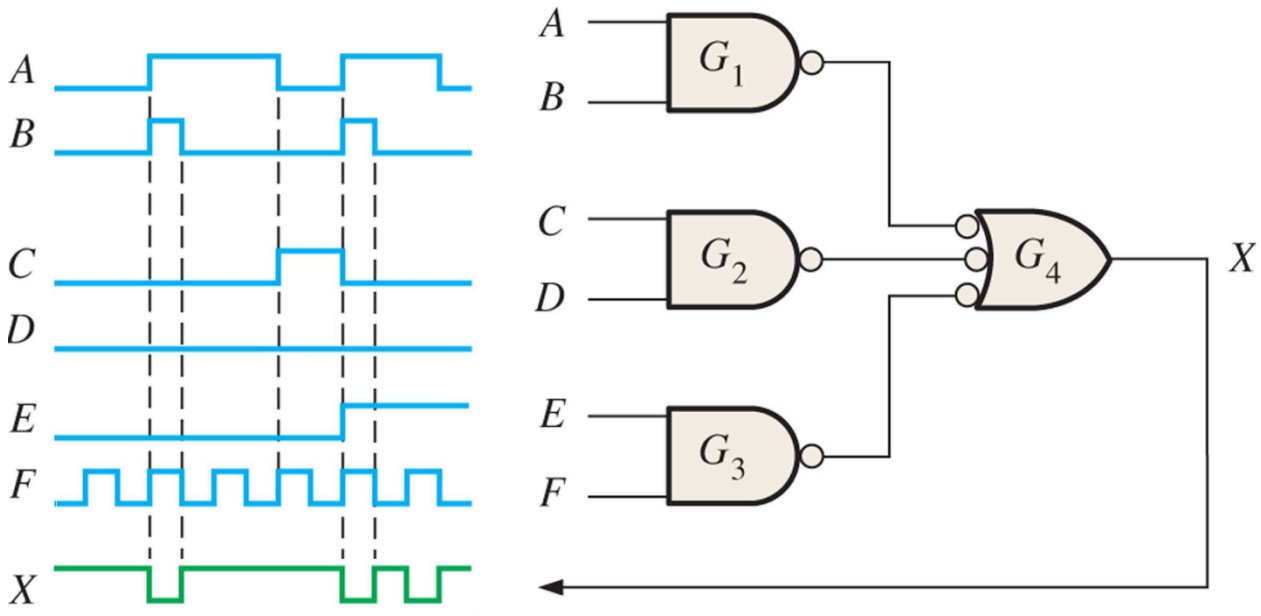

Figure 3

Question 11 (3 marks)

a) Explain the difference between weighted and unweighted number systems. (1 mark)

b) Give two examples of weighted number systems. (2 marks)

Question 12 (2 marks)

Form the 2's complement of the following 8-bit binary numbers.

a) 11011010 (1 mark)

b) 10001101 (1 mark)

Question 13 (4 marks)

Draw the circuit diagram of a circuit that gives a LOW output when 2 bit number *A* is larger or equal than 2 bit number *B*.

Question 14 (4 marks)

Apply DeMorgan's theorems to simplify the following Boolean expressions:

a) $\overline{\overline{(ABC)}\,\overline{(ABD)}}\,\overline{(ABC)}$ (2 marks)

b) $\overline{(A+B)}\,\overline{(A+C)}\,\overline{(A+D)}\overline{\overline{(A+B)}}$ (2 marks)

Question 15 (4 marks)

a) Write the output expression for X in the circuit shown in Figure 4. (2 marks)
b) Is it possible to implement the circuit using fewer gates? If yes, draw the circuit. (2 marks)

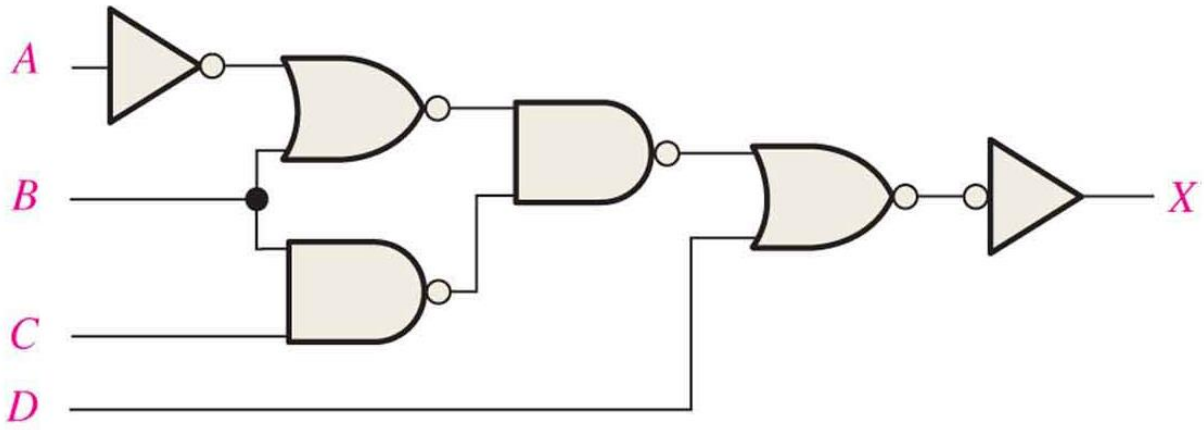

Figure 4

Question 16 (3 marks)

A light switch alarm for a car should be on when the headlights are on, the ignition is switched off and the door is open. It should be off at all other times.

a) Determine the truth table for this system. (1 mark)
b) Draw a digital circuit that implements the required logic for this system. (2 marks)

Question 17 (4 marks)

a) What is the function of a decoder? (1 mark)
b) How many inputs and how many outputs does a decimal to *BCD* decoder have? Explain your answer. (3 marks)

Question 18 (3 marks)

Explain how the circuit shown in Figure 5 would need to be modified to create a D flip-flop and draw the new circuit including these modifications.

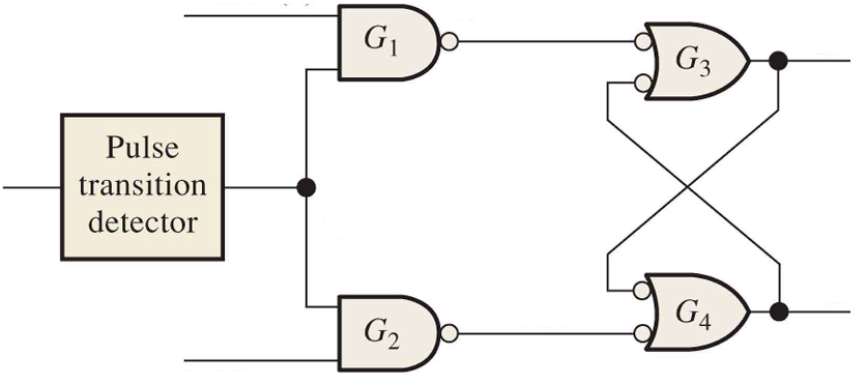

Figure 5

Question 19 (4 marks)

A combinational logic circuit is shown in Figure 6.

a) What is this circuit called? (1 mark)

b) Explain how this circuit works. (3 marks)

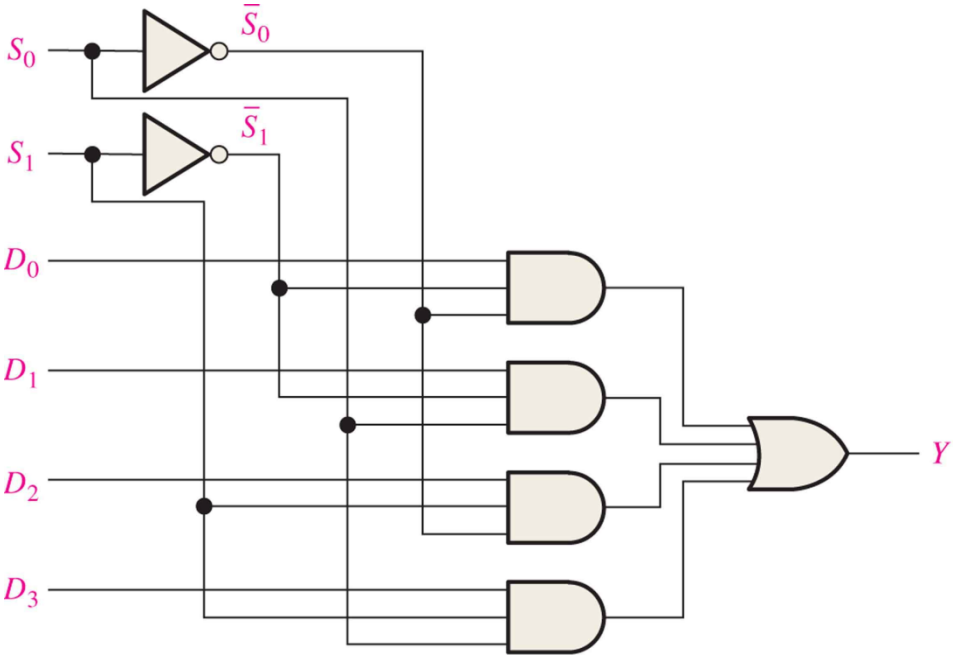

Figure 6

Question 20 (5 marks)

For the truth table shown below in Table 1,

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Table 1

a) Derive the standard Sum Of Product (SOP) expression (1 mark)

b) Derive the standard Product Of Sums (POS) expression. (1 mark)

c) Use a Karnaugh map to find the minimum SOP expression. (3 marks)

Question 21 (4 marks)

The prototype digital circuit shown in Figure 7 is being tested using an oscilloscope and function generator. The engineer conducting the test notices short pulses at the output of U2D which are not desirable as they may cause incorrect operation of the system this circuit is part of. Suggest a reason for these pulses and describe how the circuit may be modified to prevent them from occurring.

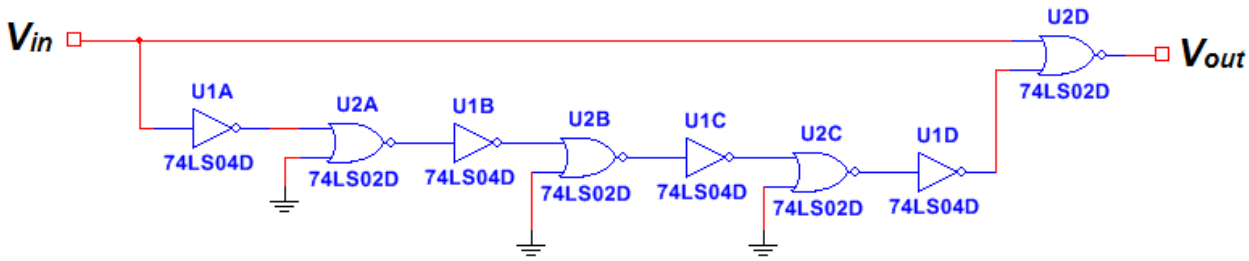

Figure 7

Question 22 (2 marks)

In a computer system, explain the function of:

a) The ALU (1 mark)
b) The Data Bus (1 mark)

Question 23 (3 marks)

A combinational logic circuit is shown in Figure 8.

a) What is this circuit called? (1 mark)

b) What is the function of this circuit? (1 mark)

c) What advantage does this circuit have over other circuits which perform the same function? (1 mark)

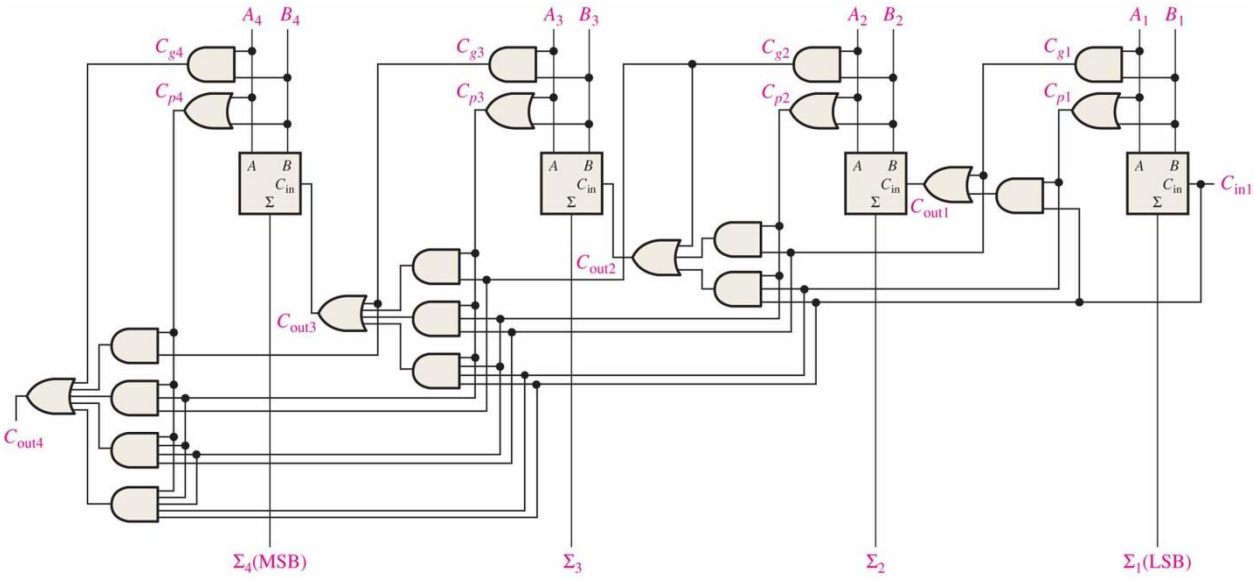

Figure 8

Question 24 (3 marks)

Please answer yes or no for each of the following.

Is a dual core processor required for:

a) Pipelining (1 mark)
b) Multitasking (1 mark)
c) Multithreading (1 mark)

Question 25 (4 marks)

a) What is the difference between an astable multivibrator and a bistable multivibrator? (2 marks)
b) Give an application for each of them. (2 marks)

Question 26 (3 marks)

For the inputs and the circuit shown in Figure 9, determine the output at Q and draw the timing diagram. Assume the *Q* output is initially high.

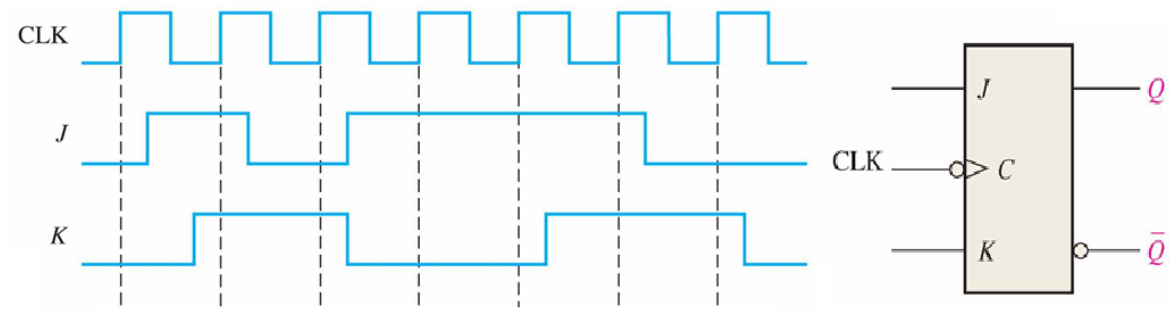

Figure 9

Question 27 (3 marks)

What is the advantage of using a Johnson counter instead of a ring counter?

Question 28 (3 marks)

Is it possible to build a circuit that performs the same function as the circuit shown in Figure 10 using only JK flip-flops? Explain your answer.

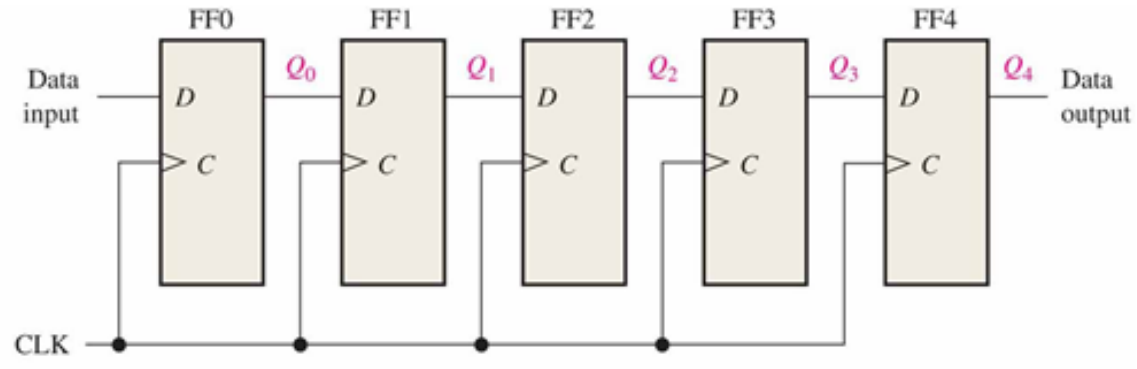

Figure 10