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Warning

CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2016

FINAL EXAMINATION	**DURATION**
HIT235 – Digital Systems and Computer Architecture	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.

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 RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

Hard copy, unannotated English translation dictionary only

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 (4 marks)

An exhaust gas detection system for an engine is required. When the CO and NOx concentrations are both within the acceptable limits a green light should be on. If the CO concentration is below the acceptable limit but the NOx concentration is too high, an orange light should be on. If both the CO concentration and the NOx concentration are too high a blinking red light must be on. CO is dangerous, so if the CO concentration exceeds its acceptable value a warning sound should go off immediately. Design the logic circuit for this system.

Question 2 (2 marks)

What is the advantage of using BCD code instead of binary code?

Question 3 (4 marks)

a) Give the truth table for a half adder. (1 mark)
b) How many half adders do you need to make a 3 bit binary adder? Explain your answer. (3 marks)

Question 4 (3 marks)

What is 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 $Carry_{out}$	20 ns
B to Sum (Σ) and $Carry_{out}$	20 ns
$Carry_{in}$ to Sum (Σ)	30 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) Give the truth table of an XNOR gate (1 mark)
b) Is it possible to implement an XNOR gate, using only NAND gates? If no, explain why not. If yes, draw the circuit. (3 marks)

Question 7 (3 marks)

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

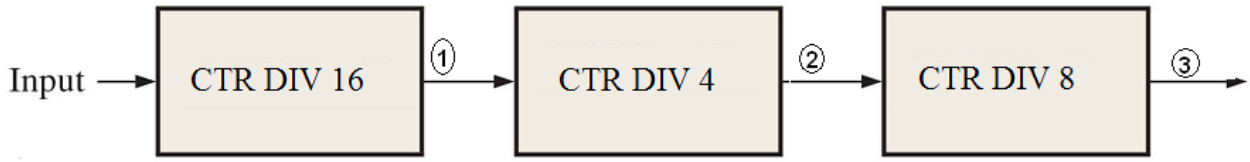

Figure 1

Question 8 (3 marks)

Explain how subtraction of binary numbers can be done.

Question 9 (4 marks)

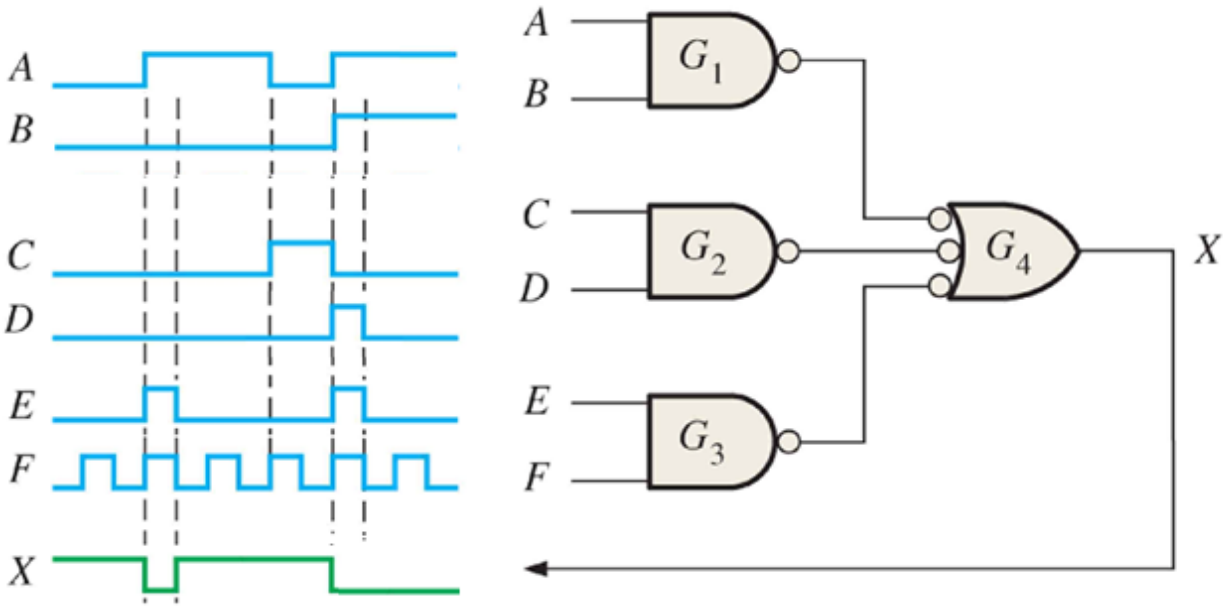

Figure 2

a) The output waveform shown above is not correct. Draw the correct waveform. (2 marks)
b) The output waveform 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. (2 marks)

Question 10 (4 marks)

Apply De Morgan's theorems to simplify the following expressions:

a) $\overline{\overline{AB}(\overline{CD}+\overline{EF})(\overline{\overline{AB}+B\overline{CD}})}$ (2 marks)

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

Question 11 (6 marks)

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

For the truth table shown above,
a) Derive the standard Sum Of Product (SOP) and the standard Product Of Sums (POS) expression. (3 marks)
b) Use a Karnaugh map to find the minimum SOP expression. (3 marks)

Question 12 (4 marks)

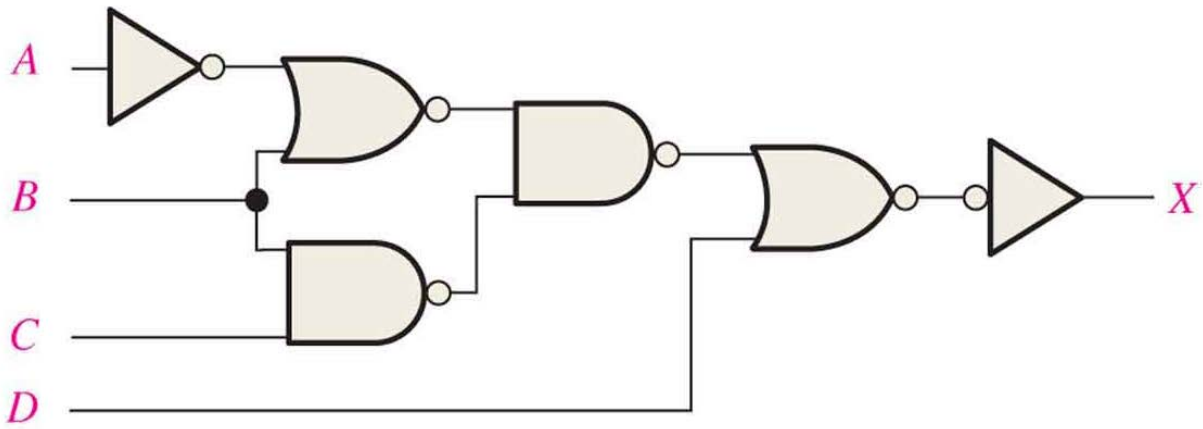

Figure 3

For the circuit shown in Figure 3, determine the output equation. Is it possible to implement the circuit using fewer gates? If yes, draw the circuit.

Question 13 (3 marks)

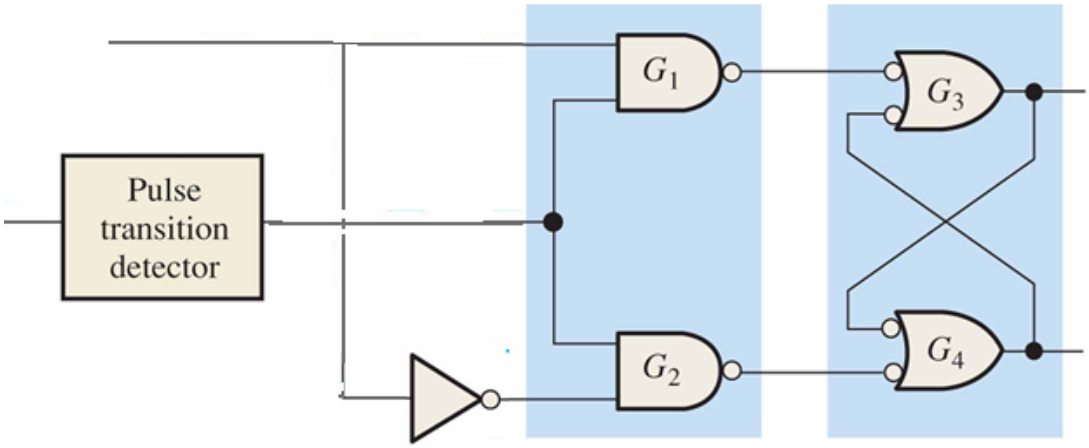

Figure 4

In what way would the circuit in Figure 4 have to be modified to create a JK flip-flop?

Question 14 (3 marks)

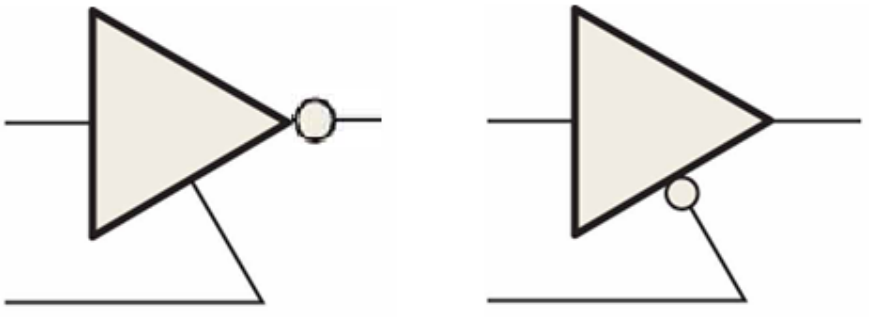

Figure 5

Explain the function of each of the two elements shown in Figure 5.

Question 15 (4 marks)

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

Question 16 (4 marks)

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

Question 17 (6 marks)

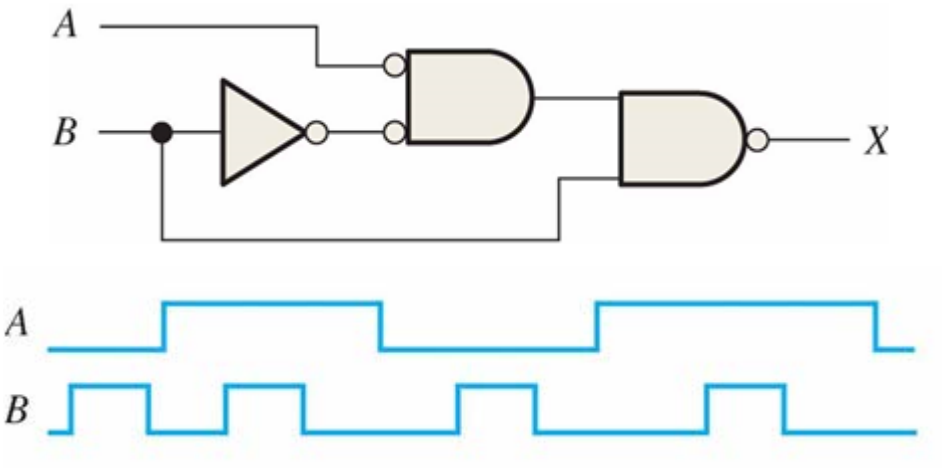

Figure 6

a) Determine the output expression for the circuit shown in Figure 6. (3 marks)
b) Draw a timing diagram for the circuit shown in Figure 6, showing the output in the proper relationship with the input signals. (3 marks)

Question 18 (3 marks)

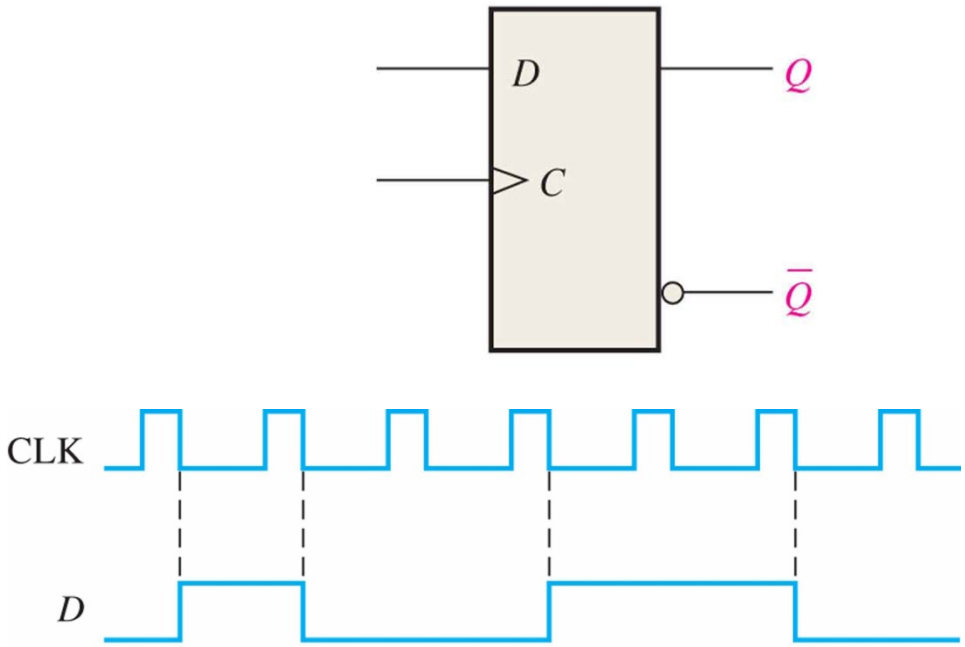

Figure 7

For the inputs and the circuit shown in Figure 7, determine the $\overline{Q}$ output. Assume the Q output is initially high.

Question 19 (3 marks)

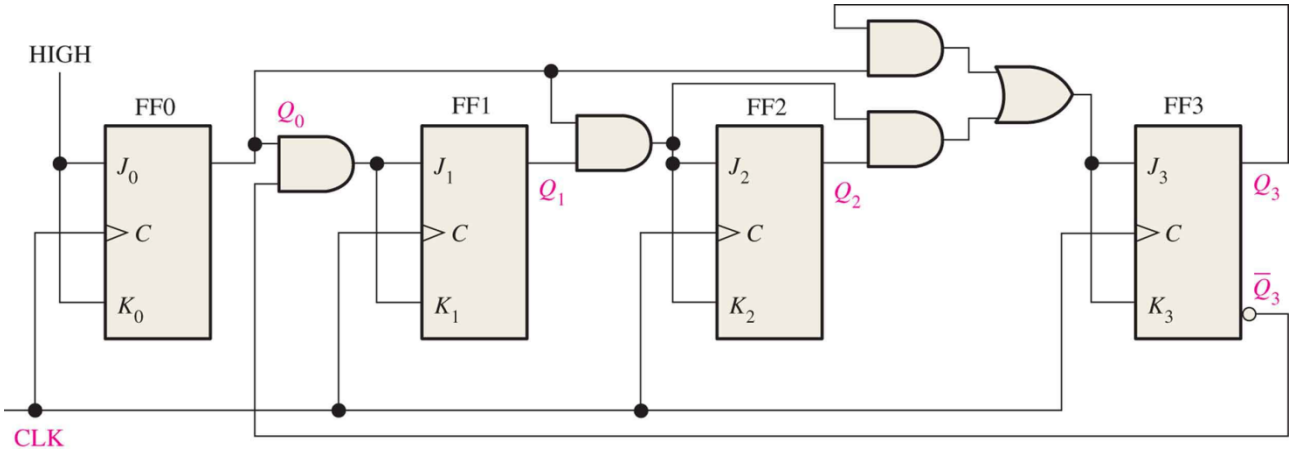

Figure 8

Explain how the circuit shown in Figure 8 works.

Question 20 (2 marks)

Is Gray code a weighted number system? Explain your answer.

Question 21 (3 marks)

Is the element shown in Figure 9 an adder? Explain your answer.

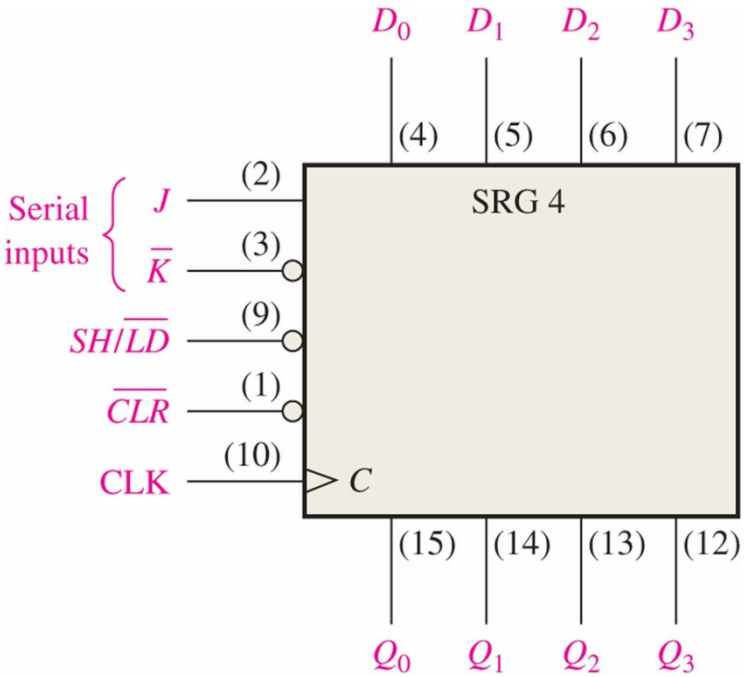

Figure 9

Question 22 (3 marks)

What is the function of a multiplexor? Give a practical application of a multiplexor.

Question 23 (3 marks)

Is a dual core processor required for
a) Pipelining (1 mark)
b) Multitasking (1 mark)
c) Multithreading (1 mark)

Question 24 (3 marks)

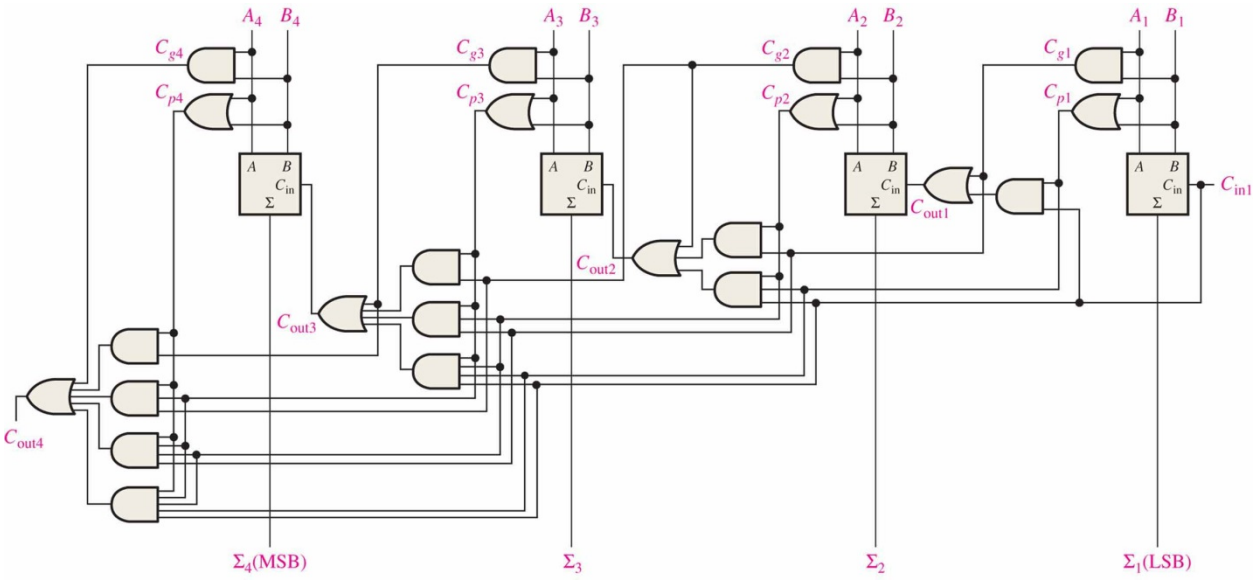

Figure 10

What is the circuit shown in Figure 10 called and what is its function?

Question 25 (4 marks)

Form the 2's complement of the following numbers:

a) 10011011 (2 marks)
b) 10101101 (2 marks)

Question 26(3 marks)

Should glitches be avoided in digital circuits? Explain your answer.

Question 27 (2 marks)

What is the function of:

a) the ALU (1 mark)
b) the Instruction Decoder (1 mark)

Question 28 (3 marks)

Explain how a ring counter works.

Question 29 (3 marks)

Is it possible to build a circuit that performs the same function as the circuit shown in Figure 11 using only SR flip-flops? Explain your answer.

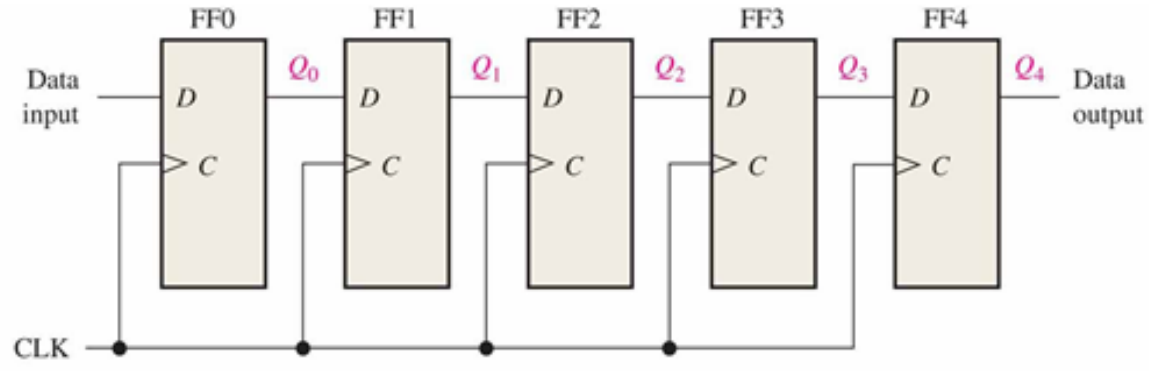

Figure 11