UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG (HONS) ELECTRICAL & ELECTRONICS ENGINEERING

SEMESTER TWO EXAMINATIONS 2021/2022

INTRODUCTORY DIGITAL ELECTRONICS

MODULE NO: EEE4013

Date: Tuesday 17th May 2022   Time: 10:00 – 12:00

INSTRUCTIONS TO CANDIDATES:

There are **SIX** questions.

You should answer **ANY FOUR** questions.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

Electronic calculators may be used provided that data and program storage memory is cleared prior to the In-Class Assessment.

CANDIDATES REQUIRE:

Calculator.

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Question 1

a) Convert 532_{10} to binary numbers. **[10 Marks]**

b) Determine the positional values of 5, 3 and 2 in 532_{10}. **[6 Marks]**

c) Convert $(10110)_2$ to Gray code. **[9 Marks]**

Total 25 marks

Question 2

a) What is main advantage of K-map? **[5 marks]**

b) State the major disadvantage of K-map. **[5 marks]**

c) A digital electronic design engineer is set to build an electronic circuit based on the following model $X = ABCD + A\bar{B}CD + AB\bar{C}D + ABC\bar{D}$, using K-mapping, determine the equivalent energy-efficient circuit. **[10 marks]**

d) Explain why the resulting circuit in 2c becomes an energy-efficient circuit.

[5 marks]

Total 25 marks

Question 3

BAE Systems is a multinational engineering company and designs digital electronic systems. Recently, you have been employed as a digital electronic intern in the company. Your first assignment was to design a four-bit parallel adder.

a) Using a fully labelled diagram, draw a four-bit parallel adder. **[14 marks]**

b) Using the 4-bit parallel adder and the truth table, determine the sum and carry out bit for the addition of 1100 and 1100. **[11 marks]**
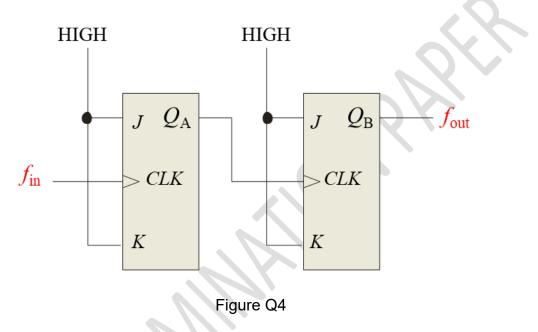
Total 25 marks

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Question 4

a) What is a flip flop? **[5 marks]**

b) Flip flops can be used for frequency division. Considering the JK flip-flop depicted in Figure Q4. If $f_{in} = 440$ kHz, determine the output frequency of the system.

Figure Q4

[5 marks]

c) Using suitable waveforms, demonstrate the input and all the output stages waveforms of the system in Figure Q4. **[10 marks]**

d) State the major disadvantage of the system when used for frequency division.

[5 marks]

Total 25 marks

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Question 5

a) Differentiate between synchronous and asynchronous counters.   **[5 Marks]**

b) Explain the disadvantages of asynchronous counters over synchronous counters.   **[5 Marks]**

c) Consider the following 3-bit synchronous counter as shown in Figure Q5, show how to decode State 5 with an active Low output by
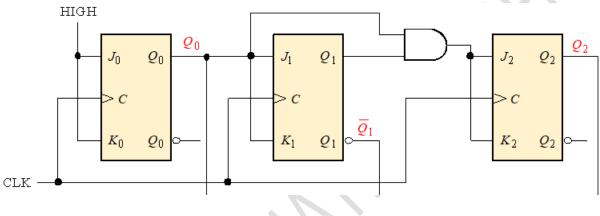

Figure Q5

i) Redrawing the resulting circuit diagram   **[10 Marks]**

ii) Expressing the output Boolean expression of the circuit   **[5 Marks]**

Total 25 Marks

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Question 6

a) Some binary coding systems appeal, more suitably than others, to specific engineering applications. Assuming that you have been recruited by the European Space Agency (ESA) as a digital electronic engineer to participate in finalising the design and launching of the Innovative Mars Rover robotic systems that would explore the Red Planet's surface. Known as ExoMars, the robotic systems will collect and send information gleaned about the Red Planet's surface to the Earth.

   i.   Identify any three different types of digital coding system.   **[6 Marks]**

   ii. With suitable example, describe the type of digital coding system that would befit the digital electronic part of the ExoMars to obtain high precision signals and reliability for the space mission.   **[10 marks]**

b) Arduino boards and other similarly systems are equipped with microcontrollers. This implies that data management is a critical factor in the use of such systems in proposing, building and implementing engineering projects.

   i.   Identify any four different number systems.   **[4 marks]**

   ii. Explain which number system should be used in microcontrollers to ensure efficient use of resources.   **[5 marks]**

   Total 25 Marks

END OF PAPER