FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

School of Electrical & Electronics Engineering

Bachelor of Engineering (Honours) (Electrical & Electronics Engineering)

EEB603 – Digital Electronics

FINAL EXAMINATION

Semester 1, 2019

Date: As per Exam Time Table

Time: As per Exam Time Table (3 hours)

Venue: As per Exam Timetable

Instructions to Students

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Attempt ALL questions in this examination booklet
3. Write your answers in the answer booklet provided.
4. Write your Student ID number on each page used.
5. Begin each Section on a fresh page and use both sides of the answer sheet.
6. You may use calculators provided they are non-programmable.
7. Clearly number the questions in your answer paper in their correct sequence and write legibly. Show all working.
8. Attach any extra sheets used to your answer booklet securely with the string provided.

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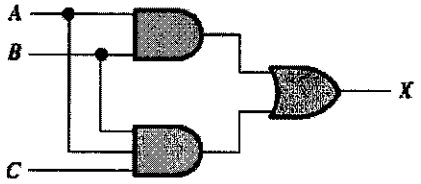
Section A: Short Answers (2 marks each) [20 marks]

1) Show the truth table of a 2-input NOR gate.
2) Represent 32 as an 8-bit signed magnitude number.
3) Convert the binary number 101011.011 to decimal.
4) Convert the decimal number 138 to 8421 BCD.
5) Convert the hexadecimal number $2B4_{16}$ to decimal.
6) Binary data are transferred to a USB at the rate of 24 million bits per second (24 Mbps), how long will it take to transfer 64 bits if 8-bit parallel channel of communication is used?
7) Derive the Boolean expression for the logic circuit shown below:



8) State 2 advantages of digital systems.
9) If a logic gate operates on a dc supply voltage of 5 V and draws an average current of 4 mA, what is its power dissipation?
10) In a certain automated manufacturing process, electrical components are automatically inserted in a PCB. Before the insertion tool is activated, the PCB must be properly positioned (P), and the component to be inserted must be in the chamber (C). Each of these prerequisite conditions is indicated by a HIGH voltage. The insertion tool (I) requires a LOW voltage to activate it. Show the truth table for this problem.

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Section B: Concepts and Designing [80 marks]

Question 1: Number Systems [14 marks]

a) Convert the decimal number 27.265 to binary. [4 marks]

b) Convert the decimal number 564 to octal. [3 marks]

c) Convert the octal number 4175 to its equivalent hexadecimal number. [3 marks]

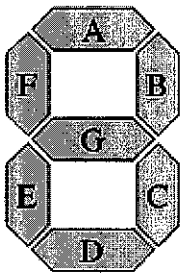
d) Express the decimal number -24 in 1's and 2's complement form. [4 marks]

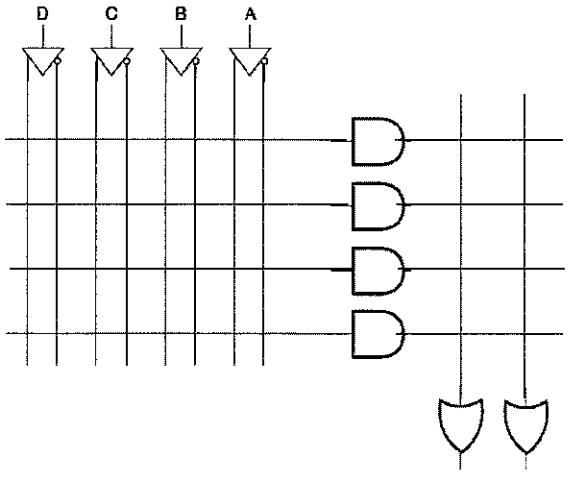
Question 2: Logic Gates and Boolean Algebra [32 marks]

a) Using Boolean algebra techniques and DeMorgan's theorems, simplify the expression

$\overline{\overline{A}BC} + \overline{A + B + \overline{C}} + \overline{ABC}$ [3 marks]

b) Suppose you are working on a project that is due in a day's time and your BCD to 7-segment display driver that is part of your project burns out. Upon enquiring you find out that there is no replacement available locally. You decide to design your own BCD to 7-segment display driver using the available PLD. Show the design of your BCD to 7-segment display for controlling segment g of the 7-segment display. Also show the implementation of the design using the PLA given below. (Use D as MSB and A as LSB) [9 marks]





c) Draw the output waveform for the four input system shown on the next page with its proper time relationship to the inputs. (*Answer in the solution sheet showing all working*) [5 marks]

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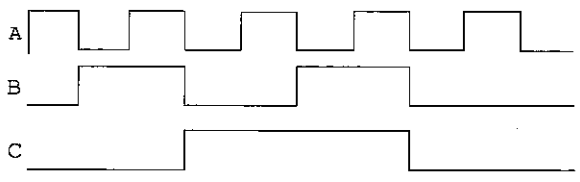
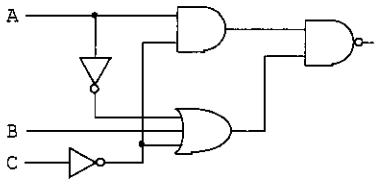




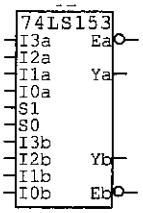
d) Given $f(A,B,C,D) = \sum_m (0,2,3,6,9,11,12)$, determine the minimum SOP expression using Quine-McClusky method. [10 marks]

e) Realize the function $X = AB[C(\overline{DE} + \overline{AB})]$ as stated using NAND gates only. [5 marks]

Question 3: Functions of Combinational Logic, MUX and DEMUX [10 marks]

a) Show how full adders can be used to add the binary numbers 1101 and 1001. Show all input and output values. [4 marks]

b) Realize the function $f(A,B,C) = \sum_m (1,2,4,7)$ using the 74LS153 multiplexer. [6 marks]



Question 4: Flip-flops and Counters [24 marks]

a) Water supply is a major problem for people living in remote areas. They tend to use water from the stream or well. As a design engineer, you have been assigned the task to design an automatic system for pumping water from the well (that is located down the hill about 1 km away from the village) to the tank located in the village in order to assist the villagers. The requirements are as follows. Two level sensors are to be placed in the tank, one to indicate low water level (T_L) and another to indicate that the tank is full (T_F). Two level sensors are also to be placed in the well for monitoring the level of water in the well. One level sensor needs to be placed at the bottom of the well (W_L), while another level sensor (W_S) needs to be placed at an appropriate place in the well in order to indicate that there is enough water in the well to fill at least one third of the tank.

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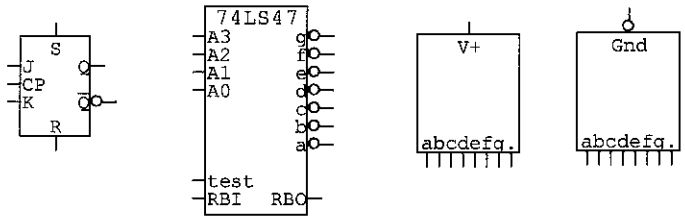
The system should automatically start pumping water to the tank when the water level in the tank goes low. However, the pump should be started if the level of water in the well is above sensor W_L. On the other hand, once the pump is started, it should not be switched off until the tank is full unless the water level in the well goes below the lower level sensor (W_L). In this case, the pump should restart once the water level in the tank reaches sensor W_S. Note, rain water is also collected by the tank. Assume that the level sensor will produce a HIGH when the water is at or above the level sensor and a HIGH is required to switch on the motor. Show a fully labelled state diagram for this system.

[9 marks]

b) Given the following components, design a synchronous counter using JK flip flops (shown below) and logic gates that counts in the sequence: 6, 1, 4, 0, 2. The counter is to be self-starting and restart counting at 6 after 2. The final prototype must be a completely functional circuit which utilizes the 74LS47 BCD to 7 segment decoder/driver. Select the correct 7 segment display to be used from the two given. [15 marks]



THE END

ALL THE BEST FOR THE EXAMINATION