COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE IV IN ELECTRONICS ENGINEERING-STAGE 3

EEE412- DIGITAL ELECTRONICS 1A

FINAL EXAMINATION – PENSTER 1, 2015

DATE: 11th March, 2015 **TIME:** 09:00am – 11:10am

TIME ALLOWED: 2 HOURS

INSTRUCTIONS TO STUDENTS

1. *You are allowed 10 minutes Extra reading time during which you are NOT to write.*
2. *Begin each section on a fresh page and use both sides of the sheet.*
3. *Write your candidate-number at the top of each attached sheet.*
4. *Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string.*
5. *For all sheets of paper on which rough/draft work has been done, cross each one through and ATTACH these to your answer scripts.*
6. *Write clearly the number(s) of the question(s) attempted on the top of each sheet.*
7. *ANSWER ALL QUESTIONS.*
8. *Show all working clearly where necessary.*
9. *Programmable calculators are not allowed, especially the ones that does the conversions of number systems.*
10. ALWAYS CHECK YOUR WORK BEFORE YOU LEAVE THE ROOM!

Section A – Multiple Choice [20 marks]

Choose the appropriate answer from each question by writing the alphabet beside the question number in your answer booklet.

1. One of the advantages of digital over analog representation is that;
    A. Data can be processed and transmitted more efficiently and reliably.
    B. Digital signals typically use less bandwidth.
    C. Data cannot become corrupted.
    D. Output is not subject to quantity errors from sampling

2. A simple handheld device used for detecting HIGH, LOW, and Undefined digital logic levels is called a;
    A. Logic Analyzer
    B. Digital Oscilloscope
    C. Logic Probe
    D. Digital Multi-meter

3. The binary number 1101 is equal to the decimal number
    A. 13
    B. 49
    C. 11
    D. 3

4. The decimal number 17 is equal to the binary number
    A. 10010
    B. 11000
    C. 10001
    D. 01001

5. The binary number for $F7A9_{16}$ is
    A. 1111011110101001
    B. 1110111110101001
    C. 1111111010110001
    D. 1111011010101001

6. What is the weight of digit 6 in the decimal number 1386?
    A. 1
    B. 2
    C. 3
    D. 0

Please turn over

7. The Boolean expression for a 3-input AND gate is;
    A. A + B + C
    B. ABC
    C. AB + C
    D. A x B + C

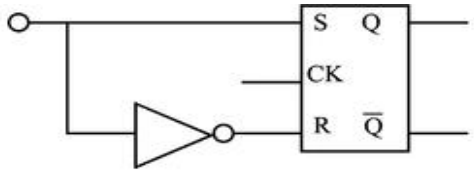
8. What is the total number of possible combinations of binary inputs to a gate having three input variables?
    A. 2
    B. 4
    C. 8
    D. 16

9. Determine the value of **C** that make the product term $A\overline{B}C\overline{D}$ equal to 1.
    A. 0
    B. 1
    C. 1010
    D. 0101

10. The output of an exclusive-OR gate is HIGH when;
    A. all inputs are LOW
    B. all inputs are HIGH
    C. the inputs are unequal
    D. none of the above

11. How is a *J-K* flip-flop made to toggle?
    A. J = 0, K = 0
    B. J = 1, K = 1
    C. J = 1, K = 0
    D. J = 0, K = 1

12. Identify the type of Flip Flop the Logic Gate circuit represents;
    A. MS Flip Flop
    B. SR Flip Flop
    C. T Flip Flop
    D. D Flip Flop



Please turn over

13. A 2-input NAND gate with its two inputs shorted will act as a;
    A. AND Gate
    B. OR Gate
    C. NOT Gate
    D. XOR Gate

14. Invalid state of an S-R latch occurs when;
    A. S = 1, R = 0
    B. S = 0, R = 1
    C. S = 1, R = 1
    D. S = 0, R = 0

15. A group of flip-flops used for data storage is called;
    A. Registers
    B. JK Flip-flop
    C. Latch
    D. Counter

16. A logic circuit with an output $X = A\overline{B}C + A\overline{C}$ consists of;
    A. Two AND gates and one OR gate
    B. Two AND gates, one OR gate, and two inverters
    C. Two OR gates, one AND gate, and two inverters
    D. Two AND gates, one OR gate, and one inverter

17. To design a 2-input NOR gate as an inverter, its inputs must be;
    A. Connected to $+V_{CC}$
    B. Added with a NOT gate
    C. Grounded
    D. Shorted

18. The Boolean expression $A + \overline{B} + C$ is a;
    A. Sum term
    B. Literal term
    C. Product term
    D. Complemented term

Please turn over

19. According to the Commutative Law of Addition,
    A. AB = BA
    B. A = A + A
    C. A + (B + C) = (A + B) + C
    D. A + B = B + A

20. A 3-variable Karnaugh map has;
    A. Eight cells
    B. Three cells
    C. Sixteen cells
    D. Four cells

Section B – True or False (10 marks)

1. For two input variables, there are four possible combinations of binary inputs to a gate.

2. The Boolean expression $X = AB + CD$ represents two AND's ORed together.

3. According to the associative law of multiplication, A + B = B + A.

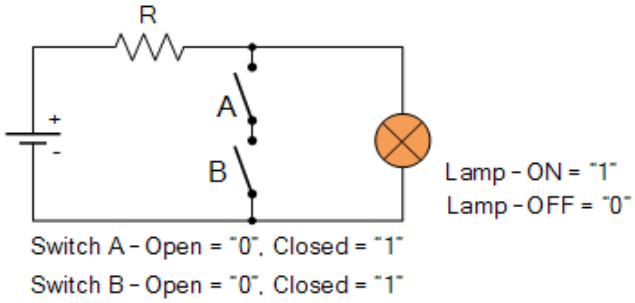
4. To measure the period of a pulse waveform, you must use an Oscilloscope.

5. A NOR output is HIGH when all inputs are HIGH.

6. The binary number 1000110101000110111 1 can be written in hexadecimal as $8D46F_{16}$.

7. All Boolean expressions can be can be implemented with NAND gates only.

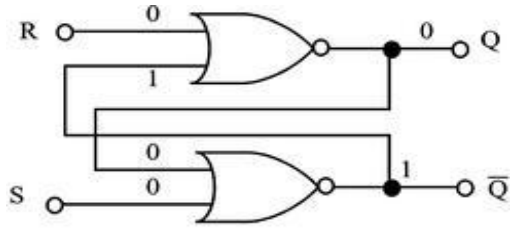
8. The switch circuit diagram shown below is the equivalent logic function of an OR gate.



Please turn over

9. If an S-R latch has a 1 on the S input and a 0 on the R input and then S input goes to 0, the latch will be SET.

10. The logic gate circuit shown below represents a S-R Flip-flop.



Cross-connected NOR Gates

Section B – Short Answers [20 marks]

1. Explain the following threshold voltage terms;
   A. V_{OH}
   B. V_{IH}
   C. V_{OL}
   D. V_{IL} (4 marks)

2. What is the difference between a CMOS and a TTL integrated circuit (IC) in terms of their operating voltages? (1 mark)

3. What is a Truth table? (1 mark)

4. State DeMorgan's theorem. (1 mark)

5. Describe the basic difference between pulse-triggered and edge-triggered flip-flops. (2 marks)

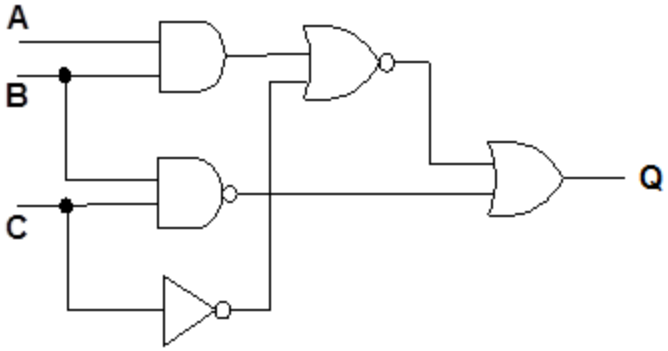
6. What is a Propagation Delay Time? Explain. (1 mark)

7. Write the output expression for the NAND gate with inputs A, B, and C. (1 mark)

8. Draw the truth table for a 3-input NOR gate. (1 mark)

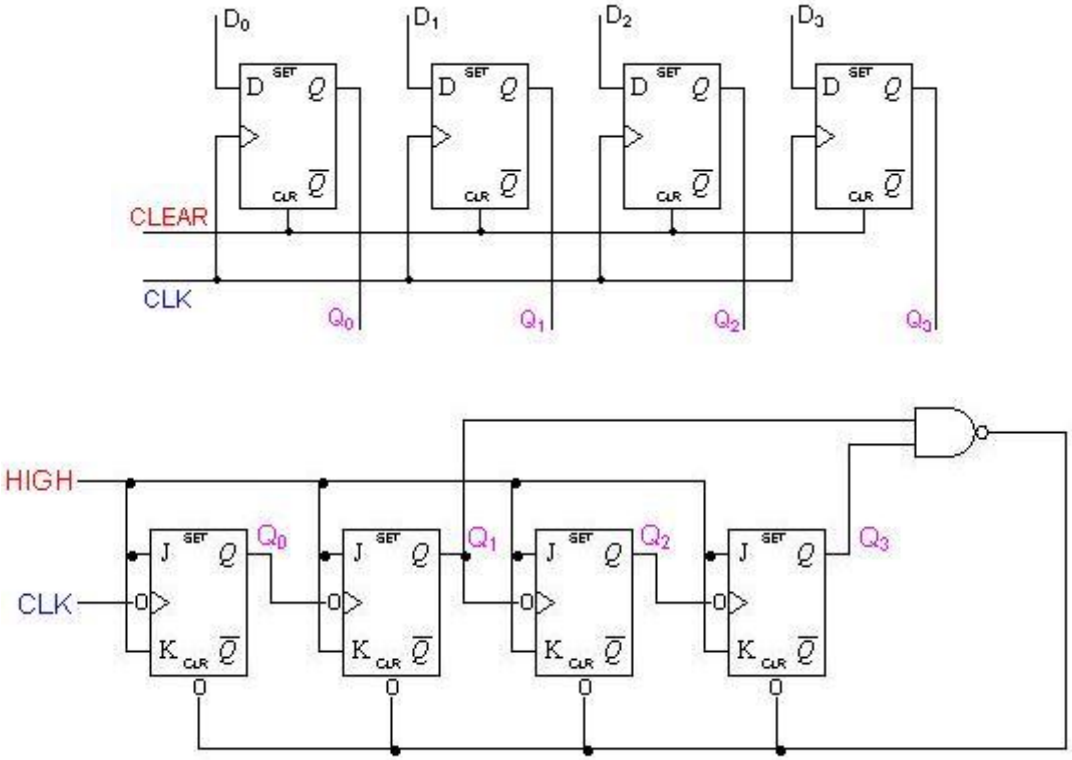
Please turn over

9. Show the behavior of the following circuit with a truth table.



(4 marks)

10. Identify the following circuits;



(4 marks)

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Section C – Calculations & Diagrams (40 marks)

Show your working clearly where necessary.

1. Draw an equivalent switch circuit for;
   A. AND Gate
   B. OR Gate (4 marks)

2. Apply DeMorgan's theorem to each expression;
   A. $\overline{(A+B+C)D}$
   B. $\overline{\overline{(A+B)}+\overline{C}}$ (4 marks)

3. Using Boolean algebra techniques, simplify this expression;
   AB + A(B + C) + B(B + C) (3 marks)

4. Convert each decimal number to binary by using the sum-of-weights method:
   A. 23
   B. 45.5 (4 marks)

5. Convert each number to binary;
   A. 5716_{16}
   B. 468_{8} (4 marks)

6. Convert the following numbers to hexadecimal;
   A. 573_{10}
   B. 110011101000_{2} (3 marks)

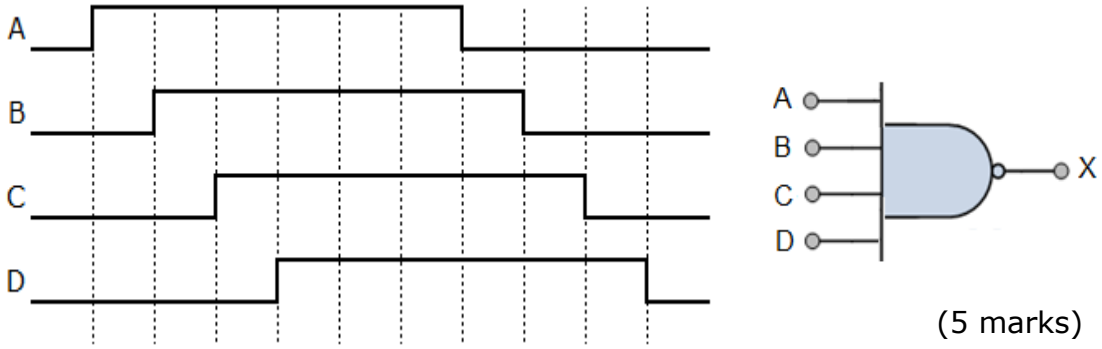
7. Convert the following numbers to decimal;
   A. $9B3_{16}$
   B. 738_{8} (4 marks)

8. Convert the following to octal;
   A. 9810_{10}
   B. 110101111_{2} (3 marks)

9. What is the largest decimal number that can be represented in binary with eight bits? (1 mark)

Please turn over

10. Determine the output waveform X for the input waveforms to a 4-input NAND gate as shown;



(5 marks)

11. Draw a mod-10 ripple counter using JK Flip-flops. (5 marks)

Section D – Application Questions (10 marks)

1. A manufacturing plant uses two tanks to store a certain liquid chemical that is required in a manufacturing process. Each tank has a sensor that detects when the chemical level drops to 25% full. The sensors produce a 5V level when the tanks are more than one-quarter full. When the volume of chemical in a tank drops to one-quarter full, the sensor puts out a 0V level.
   It is required that a single green light-emitting diode (LED) on an indicator panel show when both tanks are more than one-quarter full. Show with an aid of a diagram, and briefly explain how a NAND gate can be used to implement this function. (5 marks)

2. The supervisor of the manufacturing process as described in above (question 1) has decided that he would prefer to have a red LED display come on when at least one of the tanks fall to the quarter-full level rather than have the green LED display indicate when both are above one-quarter. Show with an aid of a diagram, how this requirement can be implemented. (5 marks)

The End

----------GOOD LUCK----------