

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS

MID ACADEMIC YEAR EXAMS – 2014/2015

**EEE 3131**

**DIGITAL ELECTRONICS**

<b>TIME</b>	: Three (3) hours
<b>INSTRUCTIONS</b>	: Answer any five (5) questions

## QUESTION 1

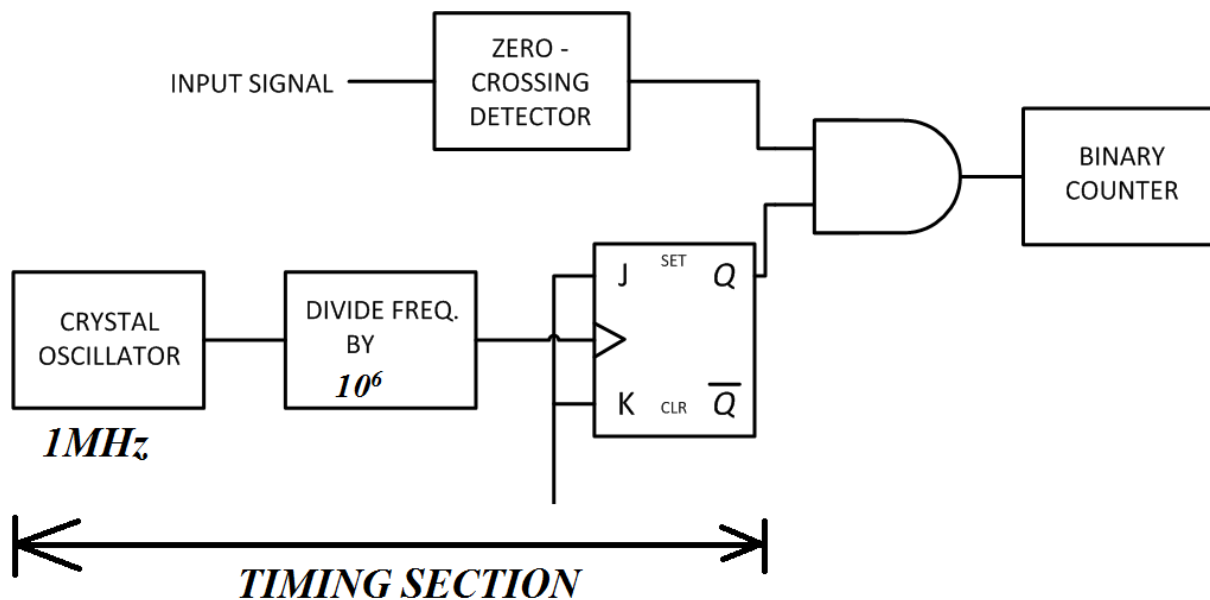
- State two advantages and two disadvantages of Emitter-Coupled Logic (ECL) in comparison with Transistor-Transistor Logic (TTL). **[4 Marks]**
- Using NAND gates, draw a JK Master-Slave flip flop and describe the advantage that it has over ordinary JK flip-flops. **[6 Marks]**
- The following four ICs are variants of a Standard Quad 2-input NOR gate implemented using TTL: 7402, 74H02, 74L02 and 74LS02.

Briefly describe the performance characteristics (speed/power) of each of the above ICs as implied by the name/designation and how the specific performance objective is implemented for each IC. **[10 Marks]**

**[Total 20 Marks]**

## QUESTION 2

- Describe the operation of the frequency measurement circuit shown in Figure Q2 below. **[10 Marks]**



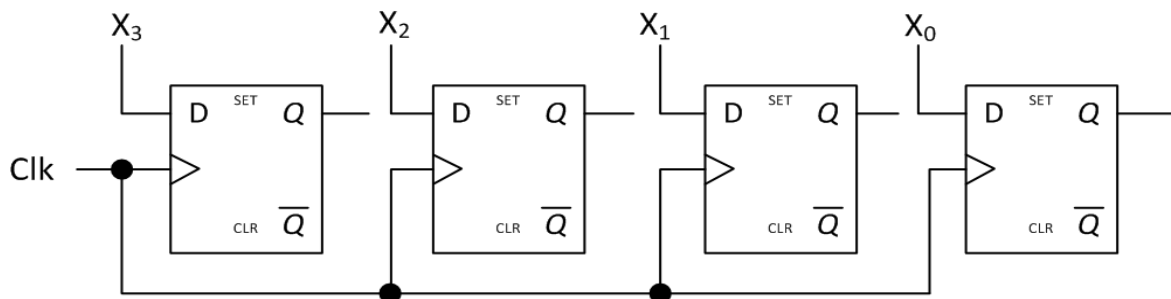
**Figure Q2**

- Consider EPROM and EEPROM:
  - What does each of the above acronyms stand for?
  - What are the main differences between the two?
  - What is the major advantage of EEPROM over EPROM?**[5 Marks]**
- Draw a NAND SR latch and its associated truth table and describe its use in switch de-bouncing. **[5 Marks]**

**[Total 20 Marks]**

### QUESTION 3

- a) What is the functional difference between a program counter and a stack pointer in an **8085** microprocessor? **[4 Marks]**
- b) Below is a simple 4-bit buffer register. Design a mechanism at its inputs that will turn it into a controlled buffer register where a LOAD signal can be used to load data when required or merely refresh the current contents when no new data is being loaded. **[8 Marks]**



**Figure Q3**

- c) List four applications of binary counters. **[2 Marks]**
- d) Draw a 1-of-4 binary decoder, its associated truth table and state an area where this is applied in real systems. **[3 Marks]**
- e) Give a step-by-step explanation of what the following assembly language code does. If we were to display the involved variable on a screen at each execution of the second instruction, what would we have on our display from start to finish of the execution of the entire program? **[3 Marks]**

*Start* : *MVI C, Fh*

*Again* : *DCR C*

*JNZ Again*

*HALT*

**[Total 20 Marks]**

### QUESTION 4

- a)
- Perform the addition  $(AF1.B3)_{16} + (FFF.E)_{16}$ . **[5 Marks]**
  - Convert the decimal number  $325.125_{10}$  to its binary equivalent. **[3 Marks]**
- b) On a Spacecraft triple sensing systems are used to increase reliability. In this system no action is taken unless at least two of the three systems call for action.
- Construct a truth table for the spacecraft triple sensing system. Take 0 to denote 'no action' and 1 to denote 'action'. **[3 Marks]**

- ii) From the truth table write the minterm (sum-of-products) Boolean expression. [2 Marks]
- iii) Simplify the above expression using the Karnaugh map method. [3 Marks]
- iv) By means of DeMorgan's theorem convert the simplified minterm expression to a Nanded product of NANDs expression. [2 Marks]
- v) Draw the logic circuit for the expression obtained in (iv). [2 Marks]

**[Total 20 Marks]**

### QUESTION 5

- a) Subtraction in binary can be performed by addition of signed 2's complement of operands.
  - i) Using signed 2's complement notation, express as 8 bit words the decimal numbers +15 and -78. [3 Marks]
  - ii) Hence, perform in 2's complement notation the arithmetic operation +15 - 78. [3 Marks]
- b) A two-input EX-OR gate has the Boolean equation  $F = \bar{A}B + A\bar{B}$ 
  - i) Apply suitable Boolean laws and theorems to modify the expression for a two-input EX-OR gate in such a way as to implement a two-input EX-OR gate by using the minimum number of two-input NAND gates only. [4 Marks]
  - ii) Draw the resultant logic circuit. [2 Marks]
- c) Given a product of sums (POS) Boolean expression in short form notation as  $f(A, B, C, D) = \prod 0, 2, 5, 7, 8, 10, 13, 15$ ,
  - i) Write the Boolean expression in its expanded form. [2 Marks]
  - ii) Draw the product of sums Karnaugh map. [4 Marks]
  - iii) Hence find the minimized Boolean expression. [2 Marks]

**[Total 20 Marks]**

### QUESTION 6

- a)
  - i) Write in 16-bit format the Excess-3 equivalent codes of  $15_{10}$  and  $671_{10}$ . [3 Marks]
  - ii) Evaluate  $(111.001)_2 \times (1.11)_2$  correct to two binary places. [2 Marks]
- b) Simplify the following three variable Boolean expressions using the Karnaugh map method and draw their respective simplified logic circuits
  - i)  $F = A\bar{B} + \bar{A}\bar{B} + ABC + \bar{A}BC$  [3 Marks]
  - ii)  $F = \bar{A}C + BC + \bar{A}B$  [3 Marks]
- c) A sum of products (SOP) Boolean expression in short form notation is given as  $f(A, B, C, D, E) = \sum 1, 5, 13, 17, 21, 25 + \sum_d 9, 26, 29$ , where the second summation over  $d$  denotes the 'don't care' conditions.
  - i) Draw the Minterm Karnaugh map for the given expression. [6 Marks]
  - ii) Using the Karnaugh map in (i) find the minimized Boolean expression. [2 Marks]
  - iii) Hence, draw the minimized logic circuit. [1 Mark]

**[Total 20 Marks]**

*Wish You Success!*

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**END OF EEE 3131 EXAMINATION**