UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BET 2023
COURSE	: DIGITAL SYSTEM
SEMESTER/SESSION	: 1-2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains **4** questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise up your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 8 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Electronic systems can be divided into two broad categories, which are digital and analog. Answer the following questions.

i. Define analog and digital signals. (2 marks)

ii. Draw the waveform of analog and digital signals. (2 marks)

b) List **TWO (2)** types of number systems used in digital signals. (2 marks)

c) Convert the following number systems to hexadecimal numbers. Write your answers up to two decimal places and show the working method.

i. 198.33_{10} (4 marks)

ii. 1001010.11001_2 (4 marks)

d) Convert the decimal number of 147_{10} to:

i. Binary number. (4 marks)

ii. Binary coded decimal (BCD). (2 marks)

QUESTION 2

a) Answer the following questions:

i. Draw the logic symbol for AND gate. (1 mark)

ii. Produce the truth table for AND gate. (2 marks)

b) Refer to Figure 1. Complete the output timing diagram Z, in Figure 2, with A and B as the input signal. (Answer this question in the given answer booklet).

(4 marks)

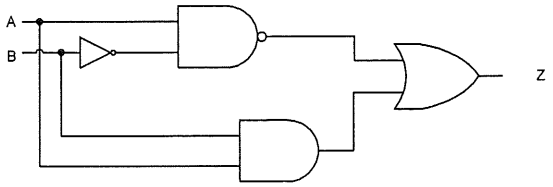

Figure 1

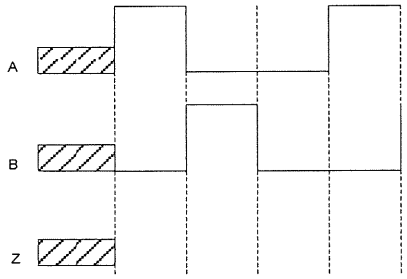

Figure 2

c) For the Boolean expression below.

$$X(D,E,F,G) = DF + \bar{D}EFG + D\bar{E}F + \bar{E}FG$$

i. Produce the standard sum-of-products (SOP) expression for output X. (4 marks)

ii. Produce the simplified output expression X using K-Map. (6 marks)

iii. Draw the logic circuit for the simplified Boolean expression obtained in question 2c)ii. (4 marks)

QUESTION 3

a) List **THREE (3)** examples of combinational logic devices. (3 marks)

b) Refer to the full adder shown in Figure 3.

i. Construct a 4-bit adder using the full adder. (4 marks)

ii. Show the logic state of each input and output if $X=1101_2$ and $Y=1110_2$ for the 4-bit adder developed in question 3b)i. (4 marks)

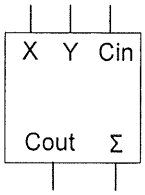

Figure 3

c) Construct the Boolean expression of $F(A,B,C)=\sum m(0,2,5,6)$ using a 4 to 1 multiplexer. (10 marks)

d) Figure 4 shows a synchronous sequential circuit. Complete the timing diagram in Figure 5 by drawing the waveform of signals Q_3, Q_2 and Q_1. (9 marks)

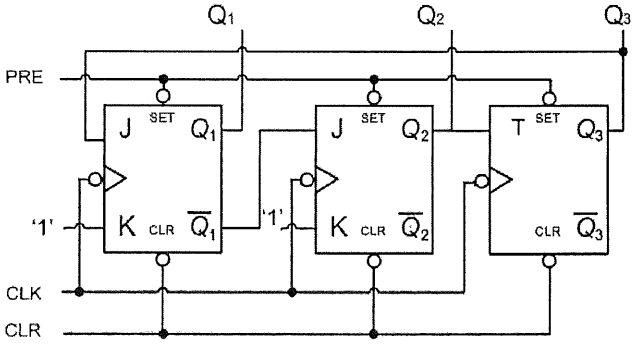

Figure 4

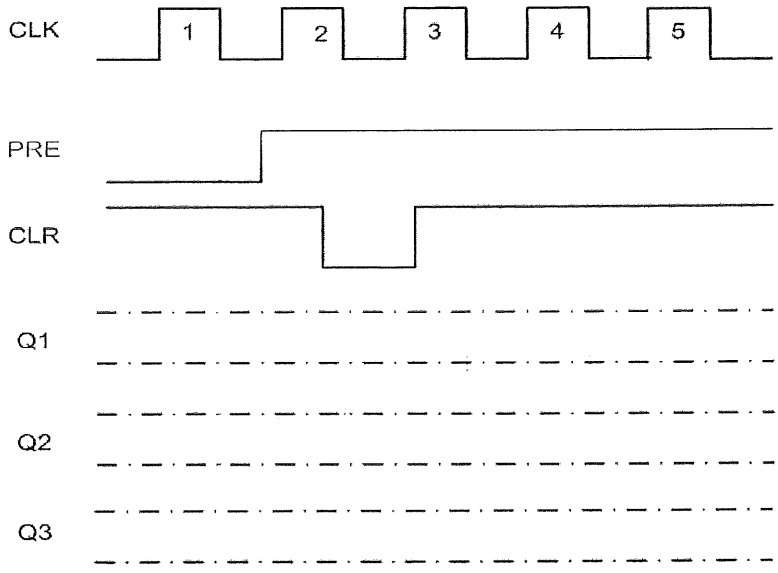

Figure 5

QUESTION 4

a) List **THREE (3)** advantages of digital systems. (3 marks)

b) List **FOUR (4)** types of shift register (4 marks)

c) Draw movement of data for serial in serial out (SISO) shift register using D Flip Flop. (3 marks)

d) Figure 6 shows a logic symbol for JK Flip Flop. Complete the timing diagram in Figure 7 by drawing the output waveform of signal Q. (5 marks)

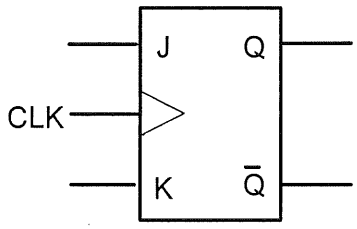

Figure 6

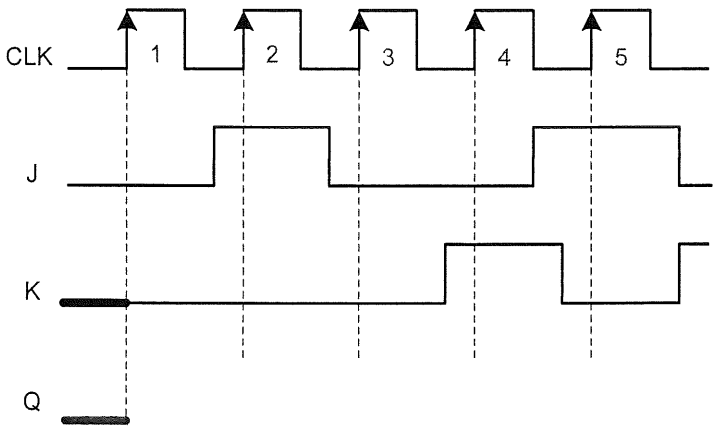

Figure 7

e) A synchronous counter with the counting sequence as shown in Figure 8 is designed by using JK flip-flops. Assume all unused states are forced to don't care condition.

i. Complete the excitation table in Table 1. (Answer this question in the given answer booklet). (4 marks)

ii. Produce the simplified Boolean equation for J_A, K_A, J_B, K_B, J_C and K_C using K-map. (6 marks)

iii. Draw the logic circuit based on the simplified Boolean expression obtained in question 4e)ii using the positive edge triggered JK flip-flop circuit with active high clock and other suitable logic gates. (4 marks)

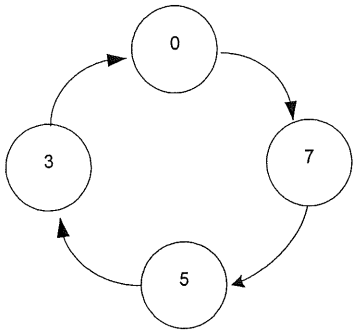

Figure 8

Table 1

PRESENT STATE	NEXT STATE	J_A	K_A	J_B	K_B	J_C	K_C
A B C	A' B' C'						
0 0 0							
0 0 1							
0 1 0							
0 1 1							
1 0 0							
1 0 1							
1 1 0							
1 1 1							

----------End of Question----------

APPENDIX 1

Table 1: Rules of Boolean Algebra

1. $A + 0 = A$	7. $A \cdot A = A$
2. $A + 1 = 1$	8. $A \cdot \overline{A} = 0$
3. $A \cdot 0 = 0$	9. $\overline{\overline{A}} = A$
4. $A \cdot 1 = A$	10. $A + AB = A$
5. $A + A = A$	11. $A + \overline{A}B = A + B$
6. $A + \overline{A} = 1$	12. $(A + B)(A + C) = A + BC$

Table 2: Excitation Table

Flip-Flop Name	Characteristic Table	Characteristic Equation	Excitation Table
SR	S R Q_{n+1} 0 0 Q 0 1 0 1 0 1 1 1 Invalid	$Q_{n+1} = S + \bar{R}Q$	Q_n Q_{n+1} S R 0 0 0 X 0 1 1 0 1 0 0 1 1 1 X 0
JK	J K Q_{n+1} 0 0 Q 0 1 0 1 0 1 1 1 $\bar{Q}$	$Q_{n+1} = J\bar{Q} + \bar{K}Q$	Q_n Q_{n+1} J K 0 0 0 X 0 1 1 X 1 0 X 1 1 1 X 0
D	D Q_{n+1} 0 0 1 1	$Q_{n+1} = D$	Q_n Q_{n+1} D 0 0 0 0 1 1 1 0 0 1 1 1
T	T Q_{n+1} 0 Q 1 $\bar{Q}$	$Q_{n+1} = T\bar{Q} + \bar{T}Q$	Q_n Q_{n+1} T 0 0 0 0 1 1 1 0 1 1 1 0