

IA – Digital Electronics

Examples Paper 2 – Sequential Logic

1. The input to the first stage of a five-stage shift register is obtained from the exclusive-OR function of the outputs of the 3rd and 5th stages. Consider at the start that all 5 stages have a 1 output that shifts to the right on the application of each clock pulse. What is the output sequence expressed as a decimal number, taking the right (5th) stage as the least significant bit? After how many clock pulses does it repeat?

What happens if all 5 stages have 0 set on them at the start?

2. The six states of a divide-by-six counter using 3 D-Type FFs are given in the following table and use the natural binary count. Determine the next state logic for the 3 FF inputs.

FF outputs		
<i>C</i>	<i>B</i>	<i>A</i>
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1

3. Design a divide-by-four synchronous counter that will count up (natural binary, i.e., 00, 01, 10, 11, etc.) when an input $Z = 0$, and that will count down (natural binary) when $Z = 1$. Use two D-type FFs.

4. (a) Draw the state diagram only (Moore form) for a system with a single input Y , connected to a line carrying serial digital data on which it is desired to detect a sequence $Y = 0010$. The sequence 0010010 should give an output twice at the instants underlined.

(b) Write down the state table for the state diagram in part (a). Now apply row matching to remove a redundant state. What problem arises in the state table if you do so?

(c) Show how the problem present in the state diagram in part (b) can be overcome by representing the corresponding state diagram in a Mealy form.

5. Gray codes have a sequence where only one bit changes at any one time. A two-bit Gray code is 00, 01, 11, 10, 00, Design a machine using D-Type FFs to generate this Gray code sequence.

6. Use the two-bit Gray code machine you designed in question 18 as the basis for generating the traffic light sequence, Red, Red and Amber, Green, Amber, Red...

Relevant IA Paper 2 Tripos questions include: Q2-2023, Q2-2022, Q2-2020, Q2-2019, Q2-2018.