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		
C	В	\boldsymbol{A}
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 $001\underline{0}01\underline{0}$ 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.

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