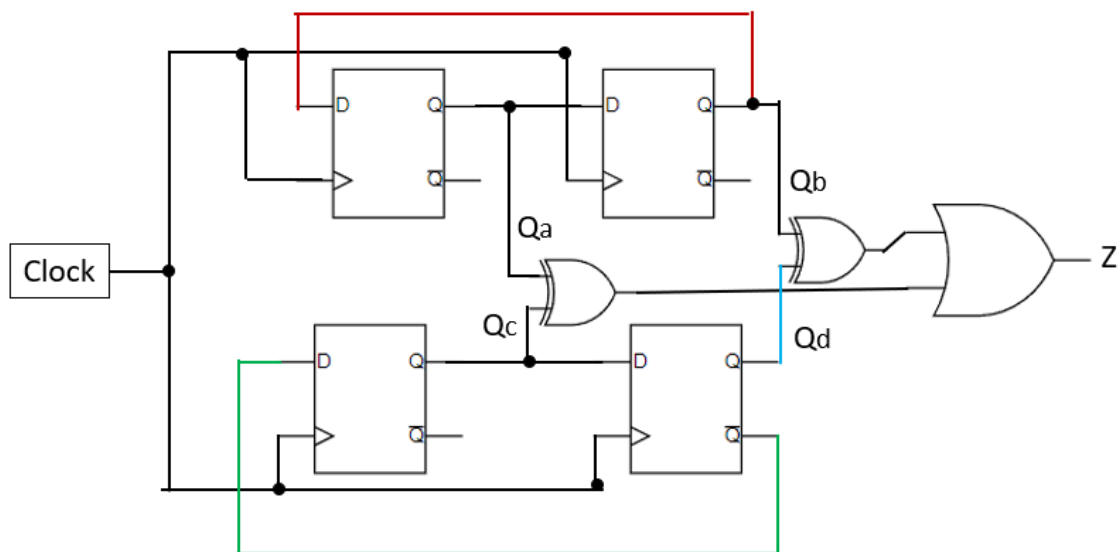# EC 2.101 - Digital Systems and Microcontrollers

Practice Sheet 4

Q1. For the synchronous sequential circuit shown below the output Z is zero for the initial conditions $Qa=Qc=0$ and $Qb=Qd=1$. The minimum number of clock cycles after which the output Z would again become zero is

Q2. Design a counter with T flip-flops that goes through the following binary repeated sequence: 0, 1, 3, 7, 6, 4. Show that when binary states 010 and 101 are considered as don't care conditions, the counter may not operate properly. Find a way to correct the design.

Q3. A 12-bit Hamming code word containing 8 bits of data and 4 parity bits is read from memory. What was the original 8-bit data word that was written into memory if the 12-bit word read out is as follows :

        (a) 000011101010

        (b) 101110000110

        (c) 101111110100

Q4. A digital system has a clock generator that produces pulses at a frequency of 80 MHz. Design a circuit that provides a clock with a cycle time of 50 ns.

Q5. It is necessary to formulate the Hamming code for four data bits D3, D5, D6 and D7 together with three parity bits P1, P2 and P4.

(a) Evaluate the 7-bits composite code word for the data word 0010.

(b) Evaluate three check bits, C4 C2, and C1, assuming no error.

(c) Assume an error in bit D5 during writing into memory. Show how the error in the bit is detected and corrected.

(d) Add parity bit P8 to include double error detection in the code. Assume the error occurred in bits P2 and D5. Show how the double error is detected.

Q6. (a) How many 32K x 8 RAM chips are needed to provide a memory capacity of 256K bytes?

(b) How many lines of the address must be used to access 256K bytes? How many of these lines are connected to the address inputs of all chip?

(c) How many lines must be decoded for the chip select inputs? Specify the size of decoder.

Q7. Show the memory cycle timing waveforms for the write and read operations. Assume a CPU clock of 100 MHz and a memory cycle time of 25 ns.

Q8. Obtain the 15-bit Hamming code for the 11-bit data word 11001001010.