

ELL/EEL 201 Digital Electronics Minor2 Exam

20 March 2015

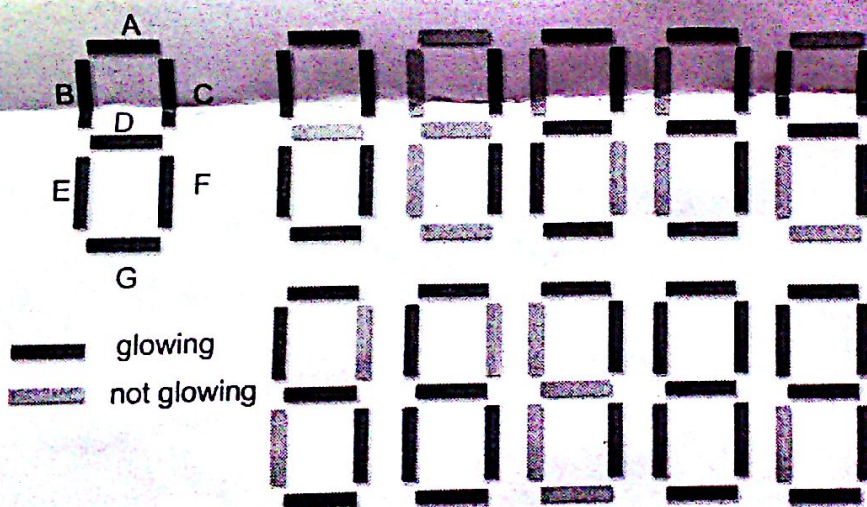
Max. Marks: 20

This is a closed book exam. No books, notes or digital resources are permitted during the exam. Read the instructions below before you start.

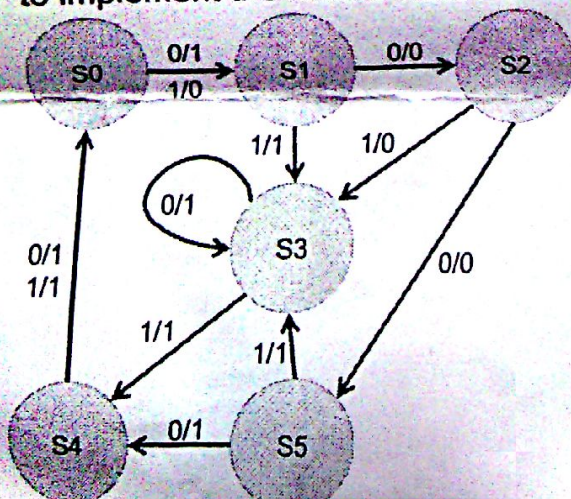
Important instructions

- A. Attempt **all four** questions.
- B. Please begin your **answer to each question on a new page**.
- C. **All parts** of a question must be answered **together**.
- D. Adoption of **unfair means** will lead to 'F' grade in the course.

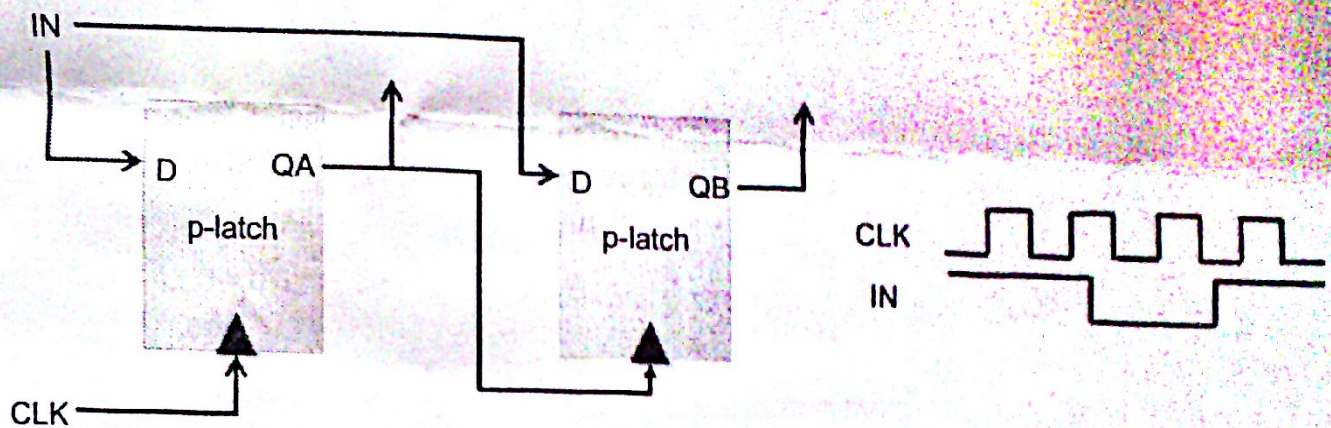
1. [9 marks] Design a stopwatch that can measure from 0 to 999 milliseconds, and display the time on a display panel (while running as well). It should have a start, stop and reset input (not necessarily separate). The display panel will be able to show any three-digit number using 7 sets of LEDs for each digit (marked A to G) as shown below. Each set of LEDs glows when the input to that set is high (e.g., '0' is displayed when $A=B=C=E=F=G=1$ and $D=0$). You are given a 1 MHz clock source. (Hint: You can reuse a sub-component of your design, if needed.)



2. [2 + 1 = 3 marks] Convert the following Mealy machine to a Moore machine and draw the state diagram. How many additional D-flip flops do you require to implement the Moore machine?



3. [3 marks] Assume that the p-latches (positive level sensitive latch) shown below have a small but finite setup time that is larger than their clock-to-Q/D-to-Q delay but less than half the period of CLK. There is no clock skew. Given the input signals CLK and IN, draw the timing diagrams (with respect to CLK and IN) of QA and QB.



4. [2 + 3 = 5 marks]

- a) Various kinds of cyclic Gray-codes can be generated by walking through a Karnaugh Map. Design a counter, using T-flip flops, which implements the Cyclic K-Map Walk as shown below.
- b) Given that the setup time is 3 ns, hold time is 1.5 ns, clock-to-Q delay is 2 ns, gate delays are 2 ns for NAND/NOR, 1 ns for NOT and 3 ns for XOR, and the clock skew between each of the flip flops is 0.25 ns, and is applicable in the direction: ~~LSB flop → MSB flop~~, what is the fastest frequency at which you can clock the circuit?

