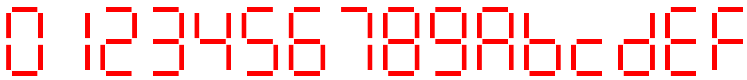
1. Example Paper 3: All questions

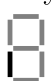
2. Seven-segment displays are frequently used to display numeric digits and certain letters. You have been asked to design a display that continuously cycles through the first 8 numbers in the Fibonacci sequence in base 16 (i.e., 0, 1, 1, 2, 3, 5, 8, D) using the following number/letter shapes below:



   (a) Compare the advantages of designing using one-hot state encoding versus sequential state encoding.

   (b) Suppose you elect to solve this problem using one-hot state encoding. Describe your state encoding. In particular, explain how many state bits are required.

   (c) Provide an identifier for each state bit in your assignment scheme. What is the combinational logic required for the output driving the bottom left segment of the display (i.e, the one highlighted in black below) in terms of your state bit identifiers?



3. Consider a computer architecture using the following 8-bit instruction format for a left-shift-by-one operation.

00101	rrr

   where the five most-significant bits indicate the left-shift operation and the three least-significant bits (i.e., "rrr") specifies the register to apply the shift to. The left-shift-by-one instruction shifts the contents of the specified register to the left by one bit and writes the result back into that same register.

   (a) What does the instruction `0x2A` do?

   (b) Sketch a circuit that implements a left-shift-by-one for an 8-bit number if an input L is asserted. If L is not asserted then the circuit's output should match the input. Feel free to use any of the logic elements covered in the lecture notes.

(c) Is this particular computer's architecture limited to a maximum of 8 registers? Justify your answer.

4. The lecture notes show an example of a CMOS NAND gate with two inputs. However, many of the boolean functions discussed in lecture and in the assignments require logic gates with 3 inputs.

   (a) Draw a CMOS NAND gate with three inputs.

   (b) Draw a NMOS logic NOR gate with three inputs.