COS126: General Computer Science **Spring 1996**

Exercise # 8

Handed out:April. 26, 1996

These exercises are meant to guide class discussion. *Do not* turn them in.

1 Suppose you have a memory array with 4 address bits into the decoder and 16 bits stored as shown in page 6 of Lecture 20 Notes.

1a Give the sequence of values needed for each of the address bits, `write` and `in` to store alternating values 0 and 1 in the array (i.e. bit 0 should get value 0, bit 1 should get value 1, bit 2 should get value 0, etc.). What are the values of `out` during this sequence of inputs?

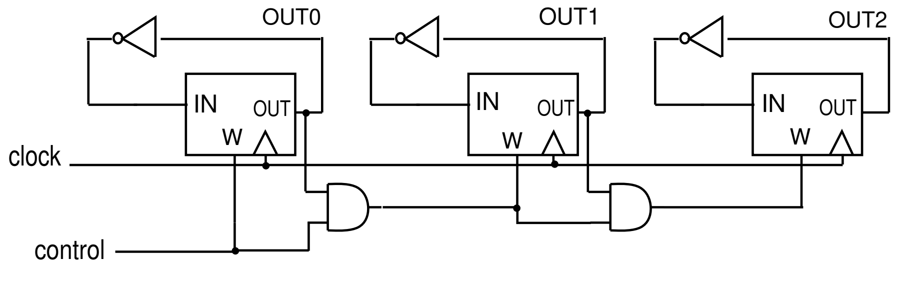
1b Give the sequence of values for each of the address bits, `write` and `in` to read the values of bits 4 through 7 in order. What are the values of `out` during this sequence of inputs?

2 A JK flip-flop has inputs J and K and output Q. Its output value is determined according to the following table:

```
J K | new Q
----|------
0 0 | previous Q  (hold state)
0 1 | 0           (reset)
1 0 | 1           (set)
1 1 | complement of previous Q  (i.e. \bar{Q})  (toggle state)
```

Implement a JK flip-flop using a master-slave flip-flop (shown on page 2 of Lecture 22 Notes).

3 Consider this circuit build using master-slave flip-flops:



3a Suppose `OUT0`, `OUT1`, and `OUT2` initially have value 0. What are their values after `control` alternates values 1 and 0 three times, i.e. 101010?

3b In general terms, what does this circuit do?

4 **4a** Give a finite state machine representation of a 2-bit counter.

4b Give Boolean equations for a combinational circuit that could be used in implementing the finite state machine of (4a) in the manner shown on page 7 of the Lecture 22 Notes.

5 The accumulator register, labeled `accum`, on page 6 of the Lecture 22 Notes requires a reset input, labeled `rst`; when `rst = 1`, all bits stored in the register become 0. Modify the circuit for the master-slave flip-flop of page 2 to have such a reset input. Note that in the diagram for the multiplier circuit on page 6, no `clock` inputs are shown, they are implicitly there for all the registers, including `accum`.