

Last Name (Print): \_\_\_\_\_

First Name (Print): \_\_\_\_\_

ID number (Last 4 digits): \_\_\_\_\_

Section: \_\_\_\_\_

Submission deadlines:

- Turn in the written solutions for problems 5 through 8 by 4:00 pm Tuesday January 28 in the homework slot outside 121 EE East.

Problem	Weight	Score
5	25	
6	25	
7	25	
8	25	
Total	100	

**Problem 5:** (25 points)

Figure 1 shows the the state diagram for a Moore machine with one input  $x$  and one output  $y$ .

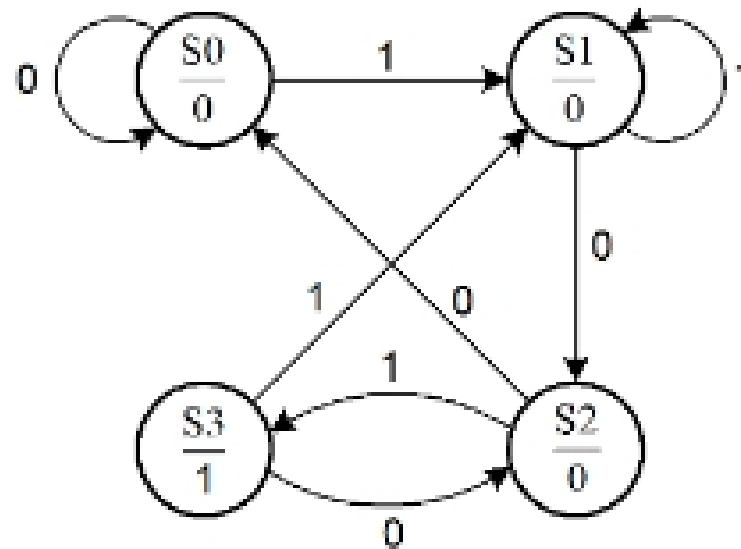


Figure 1: State diagram.

- (3 points) As with an example in Lecture 2, this Moore finite state machine produces an output  $y = 1$  when a desired sequence of zeros and ones occurs in the serial bit stream appearing on the input  $x$ . What sequence of zeros and ones will produce an output  $y = 1$  coincident with the last one in the sequence?
- (5 points) Determine the state table using the state assignments in Table 1.

State	$Q_A$	$Q_B$
S0	0	0
S1	0	1
S2	1	0
S3	1	1

Table 1: Assignment of states to flip-flop outputs  $Q_A$  and  $Q_B$ .

- (9 points) Given that the state machine is realized using D-type flip-flops, obtain logic equations in terms of  $x$ ,  $Q_A$ , and  $Q_B$  for the flip-flop inputs  $D_A$  and  $D_B$ , and the circuit output  $y$ . For each signal,  $D_A$ ,  $D_B$ , and  $y$ , include with your solution a three-variable Karnaugh map, shown in Figure 2, that shows how you derived the logic expression.

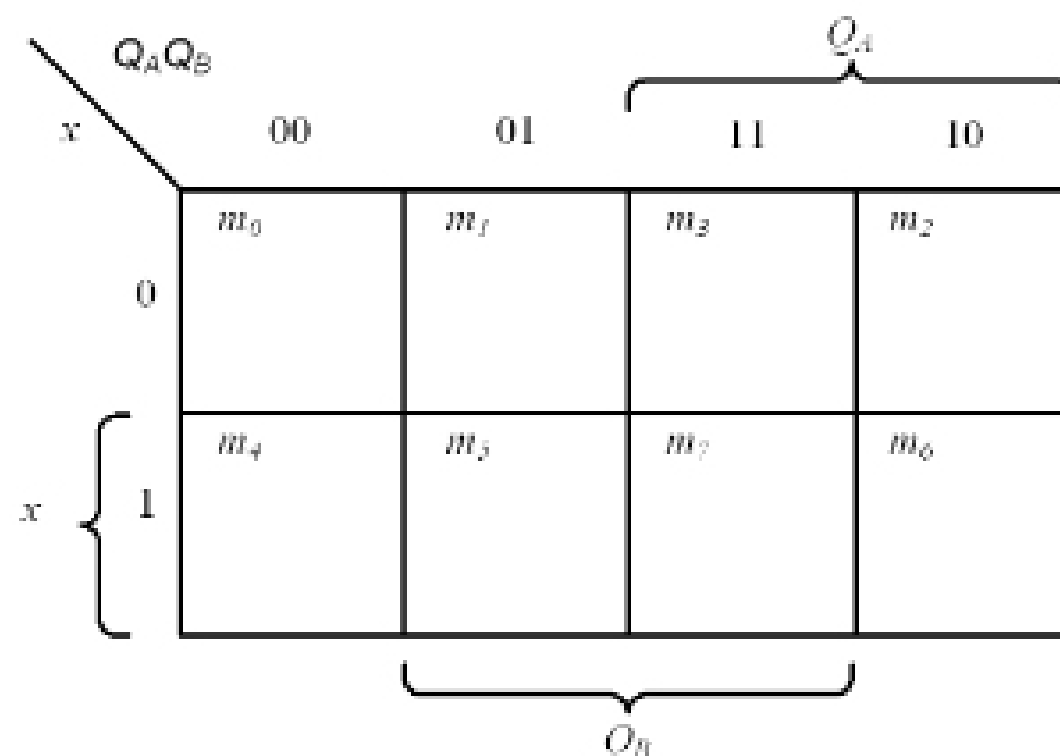


Figure 2: Three-variable Karnaugh map.

4. (8 points) Draw the logic circuit that realizes the finite state machine using D-type flip-flops and NAND gates.

**Problem 6:** (25 points)

The passive network in Figure 3 implements a filter network with input voltage  $f(t)$  and output voltage  $y(t)$ .

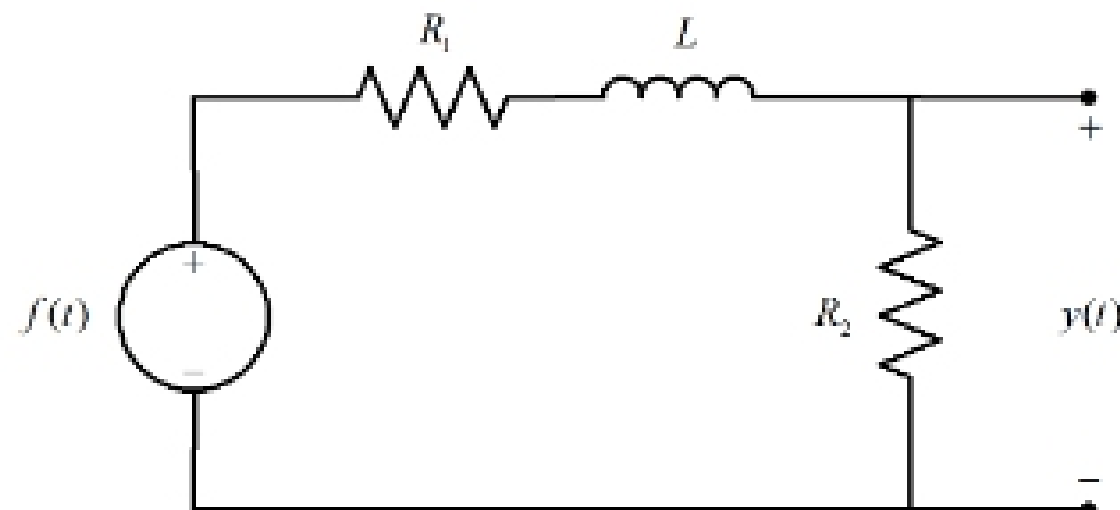


Figure 3: Passive filter network.

1. (10 points) Show that the phasor representations  $\bar{Y}$  and  $\bar{F}$ , of the output and input respectively, satisfy

$$\bar{Y} = K \frac{1}{j\omega/\omega_c + 1} \bar{F}.$$

Express the parameters  $K$  and  $\omega_c$  in terms of  $R_1$ ,  $R_2$ , and  $L$ .

2. (10 points) The frequency response function of a network is the ratio of the output and input phasors. The frequency response function for the network in Figure 3 is

$$H(j\omega) = \frac{\bar{Y}}{\bar{F}} = K \frac{1}{j\omega/\omega_c + 1}.$$

The DC gain of the network is the value of the frequency response function when input the frequency  $\omega$  is set to zero, while the high frequency gain of the network is the magnitude of the frequency response function in the limit as the input frequency approaches infinity.

- (2 points) Determine the DC gain of the filter network in Figure 3.
  - (2 points) Determine the high frequency gain of the filter network in Figure 3.
  - (4 points) Determine the frequency at which the magnitude of the frequency response function is equivalent to the DC gain divided by  $\sqrt{2}$ .
  - (2 points) Does this network realize a low-pass or high-pass filter? Justify your answer in one or two sentences.
3. (10 points) Assuming that  $K = 1/4$ , determine the sinusoidal steady-state response  $y(t)$  of the circuit in Figure 3 for the input

$$f(t) = 8 + 4\sqrt{2} \cos(\omega_c t + 75^\circ) + 100 \cos(10\omega_c t + 90^\circ).$$