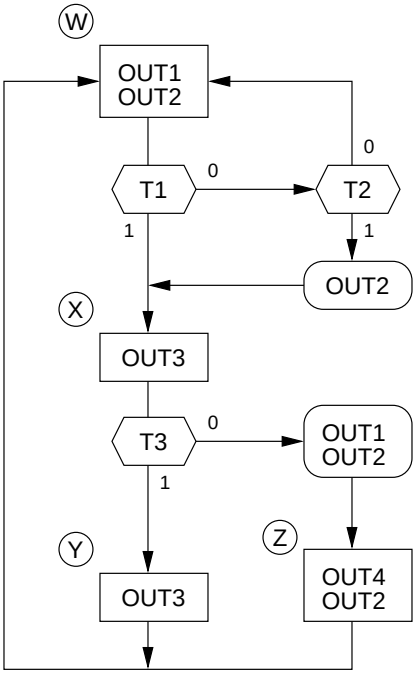
b441 – Fall 2006 – Test Two

INSTRUCTIONS: *Put your name and ID number in the upper-right of each page. Place your final answer on the test in the space provided. Scratch work is not graded, but neatness counts.*

NOTE: *For the purposes of this test, "implement" means to develop the implementation logic. You may but do not have to reduce combinational signals to gates. A boolean expression will suffice.*

Question 1. Implement this ASM using the *mux* method.



The mux method uses multiplexers to develop next-state functions and therefore requires control-state encoding. This solution encodes the states as W = *00,* X = *01,* Y = *10, and* Z = *11. The multiplexer inputs are re-labeled symbolically to reflect the encodings. Since we need to develop encoded next-state values, it may be helpful to use a truth-table or K-MAPs (but not both) to develop the terms. With practice, the terms can be read from the out-going paths of the ASM.*

Output terms can be developed the same way.

COMMENTS: *You may have noticed that the conditional output* OUT2 *in the upper portion of the chart is redundant because* OUT2 *is always asserted in state* W.
Also, looking at the next-state mux inputs it is tempting to try optimizing, based on the optimization that the inputs for states Y *and* Z *are always* 0. *Although such an optimization may be possible it is not likely to be worth the thought, except in extreme circumstances.*

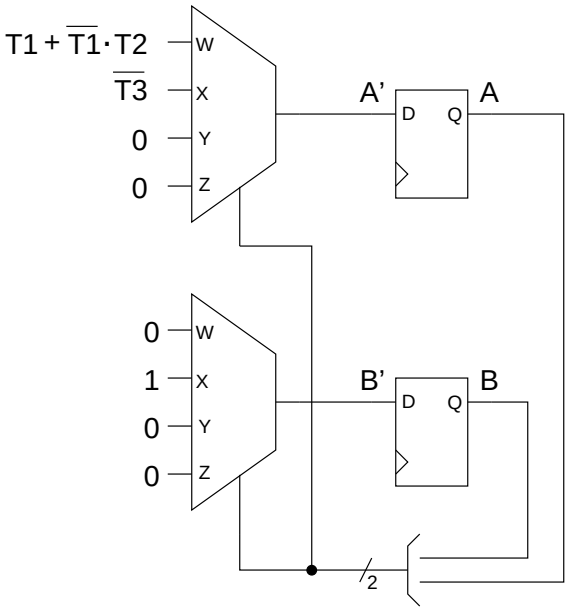
BA	T1	T2	T3	B' A'
W = 00	0	0	—	0 0 = W
	0	1	—	0 1 = X
	1	—	—	0 1 = X
X = 01	—	—	0	1 1 = Z
	—	—	1	1 0 = Y
Y = 10	—	—	—	0 0 = W
Z = 11	—	—	—	0 0 = W

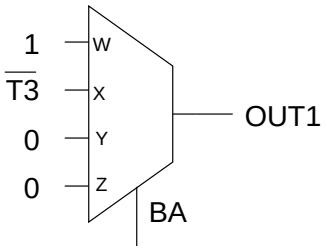
B': T1T2

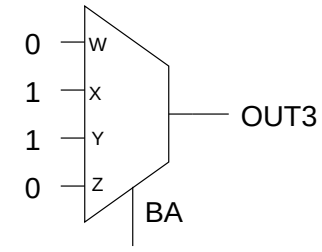
BA	00	01	11	10
W	0	0	0	0
X	1	1	1	1
Z	0	0	0	0
Y	0	0	0	0

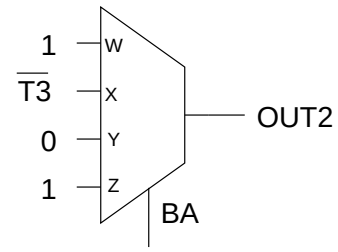
A': T1T2

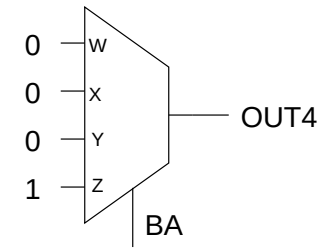
BA	00	01	11	10
W	0	1	1	1
X	$\overline{T3}$	$\overline{T3}$	$\overline{T3}$	$\overline{T3}$
Z	0	0	0	0
Y	0	0	0	0





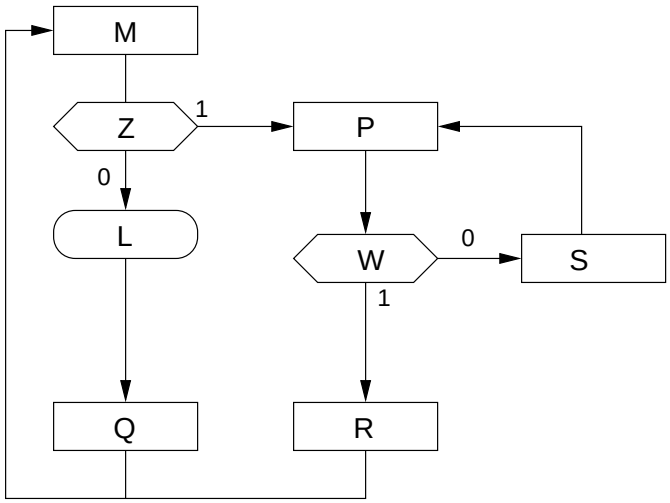


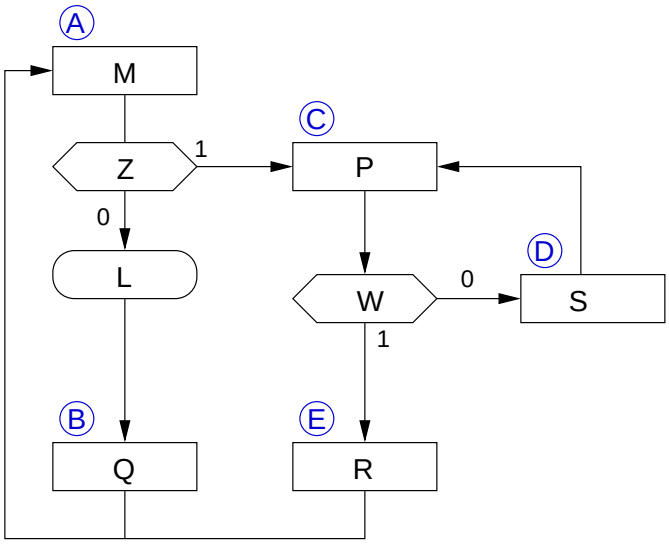


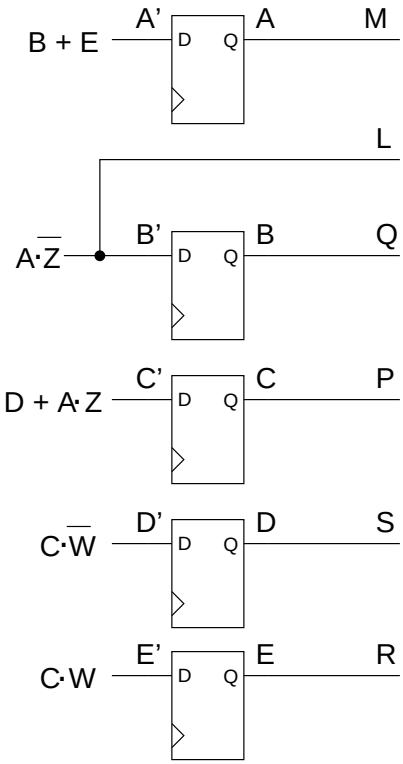


Question 2. Implement this ASM using the *one-hot* method.

The one-hot method allocates one flip-flop for each state in the ASM. In the solution below, a new name is given to each state even though, in this instance, the one-to-one correspondence between states and outputs M, P, S, W, *and* R *makes state-naming unnecessary, but in general one would do it. Next-state values for* A' *through* E' *are developed by writing out an SOP expression in which each clause describes a path leading to that state as a conjunction of the conditions which determine that path.*



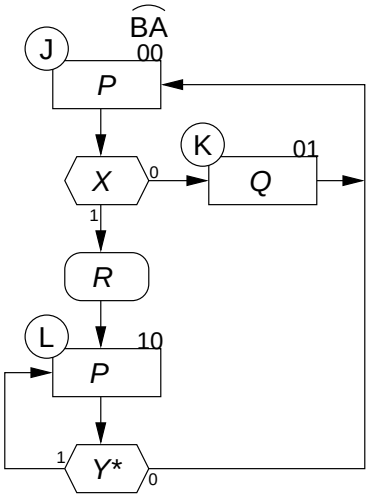




Question 3. This ASM has been labelled for an encoded-state implementation with 2-bit encoding BA.

(a) Complete the implementation.

(b) Notice that one of the decision signals, Y^*, is asynchronous. Routinely, we whould synchronize this input to avoid any possibility of a transition race. However, it happens in this case that a transition race will not occur. Explain why this is so.



The intent of the problem is to synthesize an implementation by developing boolean terms for the next-state values in the standard way. The pseudo-K-map represent in the control-state transition function, is broken down in to K-maps for each bit of the encoded state. There is no need to write down a truth-table first. Output equations are synthesized by analyzing the paths in the ASM.

The potential transition race caused by Y^* *is benign in this case because there is only one bit of difference between the encodings for states* L *and* J. *See the textbook's discussion on* unit-distance *encodings.*

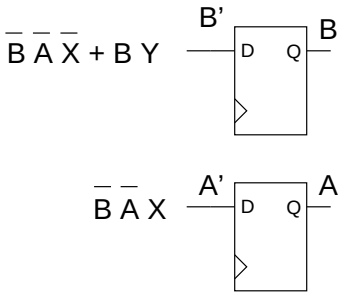
XY \ BA	J	K	--	L
00	L	J	–	J
01	L	J	–	L
11	K	J	–	L
10	K	J	–	J

B':

XY \ BA	J	K	--	L
00	1	0	–	0
01	1	0	–	1
11	0	0	–	1
10	0	0	–	0

A':

XY \ BA	J	K	--	L
00	0	0	–	0
01	0	0	–	0
11	1	0	–	0
10	1	0	–	0



$Q = \bar{B}\,A$

$R = \bar{B}\,\bar{A}\,X = A'$

$P = \bar{B}\,\bar{A} + B\,\bar{A} = \bar{A}$