

Calculators not allowed. **Show your work for any possible partial credit or in some cases for any credit at all** (5 pages plus a diagram page and a blank k map page, 100 possible points).

1) State Machine State Diagram:

a) (10 points) Draw the state diagram for the following speed control system for a Metz to Paris TGV train. There is one input, the train engineer has one switch which she may place in either the faster = 1 or slower = 0 position. (There is no stay at the same speed input switch position). The train has four speeds: not moving, moving forward, moving forward fast, moving forward very fast. There is one output, there is a danger light which is on when the train is in the moving very fast "state".

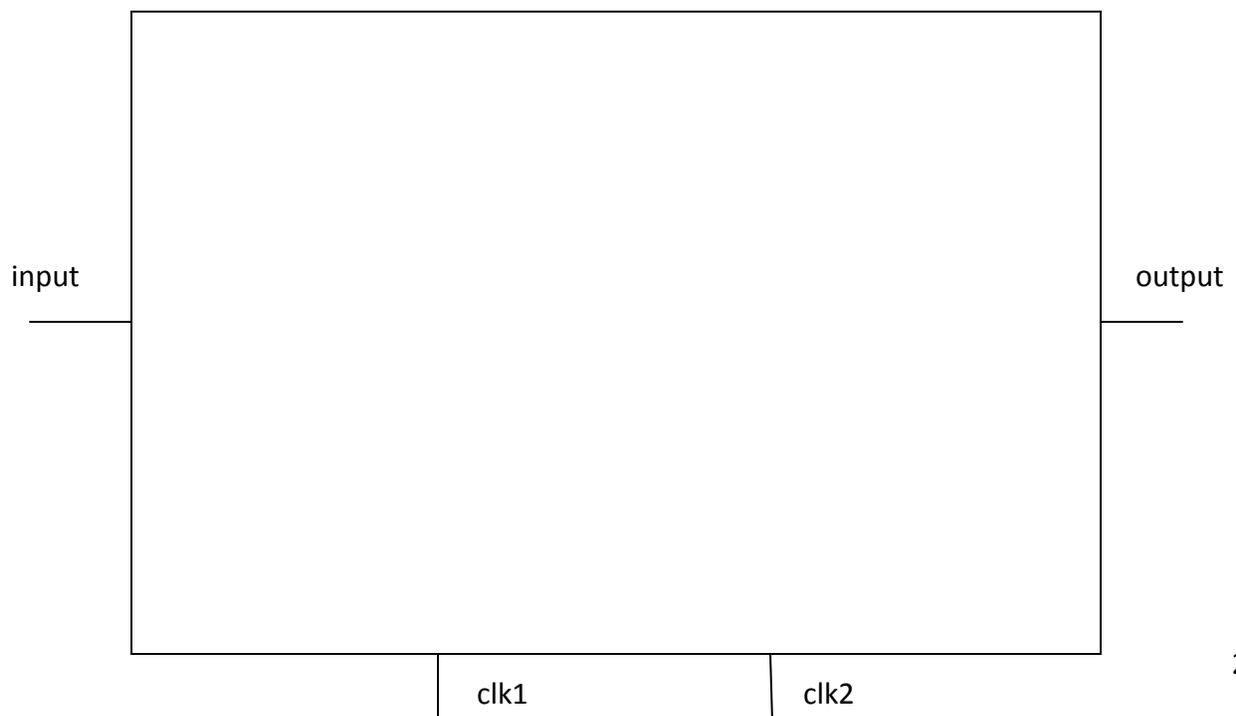
b) (10 points) Show the state table for the system described above.

2) State machine hardware

a) (10 points) Show the k maps and the resulting Boolean equations to implement the following state table. (Note blank k maps on attached page)

input	S0	NS0	output
0	0	1	1
0	1	0	0
1	0	0	1
1	1	1	1

b) (10 points) Show all the hardware needed in the box below to implement this state machine. Be sure to include any registers you need.



3) (15 points) SIMM Memory Systems

Using SIMMs that are 1 GBytes (one billion addresses by eight bit words):

Part A Suppose that these SIMMS are used to build a 4 billion address memory system with 32 bit words. Answer the following questions about this memory system:

How many address lines does each SIMM require? \_\_\_\_\_

How many address lines does the entire memory system require? \_\_\_\_\_

How many SIMMS are require for the entire memory system? \_\_\_\_\_

What kind of address decoder is required? \_\_\_\_\_

How many memory banks are needed? \_\_\_\_\_

4) (15 points) Suppose the following inputs (in hexadecimal) are applied to the 32-bit shift unit used in the single cycle data path shown in the diagram on the last page of the exam. Determine the output of the shift unit (in hexadecimal). You may assume the "su en" is a one to allow the shift unit to output a result.

Shift Type (st)	Input Value	Shift Amount (count)	Output
rotate	0x9B4CEF10	0x00000016	
arithmetic	0x97D3AB2F	0x00010000	
logical	0xFFFFFFFF	0xFFFFFFFF	

Show your work here:

5) Using the datapath we have been discussing in class and shown on the last page of the exam (you may tear off that last page) write the microcode fragments to accomplish the following procedures. Use an “X” when a value is a don’t care. You may assume register 0 contains all zeros. For full credit complete the description field. **Less registers used and less steps in your answers earn more credit.** Add more step #s if you need more than is drawn below.

a) (10 points) Write a microcode fragment (1 or more microinstructions) that puts the numerical value of the lower 16 bits of register 5 into register 7.

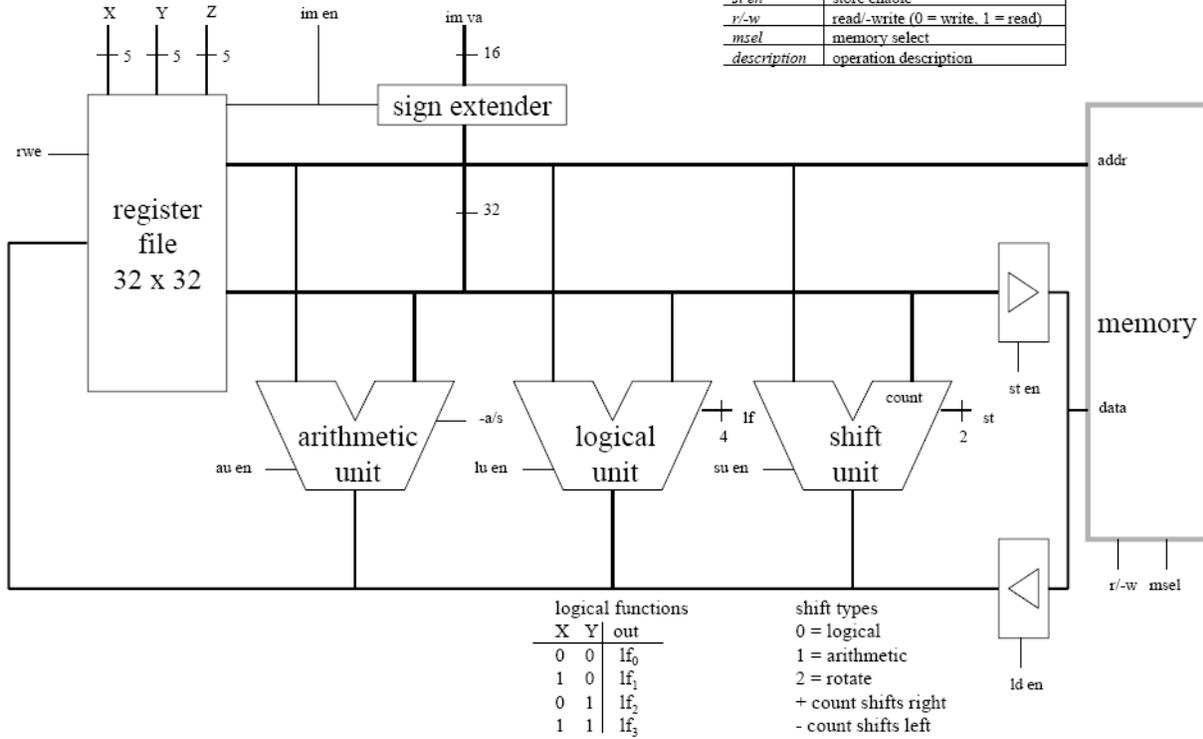
#	X	Y	Z	rwe	im en	im va	au en	-a/s	lu en	lf	su en	st	st en	ld en	r/-w	mselect	description
1																	
2																	
3																	
4																	
5																	

b) (20 points) Write a microcode fragment (1 or more microinstructions) that Exclusive ORs memory location 5,233 with memory location 5,500 and puts the result in memory location 6,500

#	X	Y	Z	rwe	im en	im va	au en	-a/s	lu en	lf	su en	st	st en	ld en	r/-w	mselect	description
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	

<i>cycle</i>	cycle number
<i>X</i>	register driven onto X bus
<i>Y</i>	register driven onto Y bus
<i>Z</i>	register written from Z bus
<i>rwe</i>	register write enable
<i>im en</i>	immediate enable on Y bus
<i>im va</i>	immediate value

<i>au en</i>	arithmetic unit enable
<i>-a/s</i>	-add / sub (0 = add, 1 = subtract)
<i>lu en</i>	logical unit enable
<i>lf</i>	logical function
<i>su en</i>	shift unit enable
<i>st</i>	shift type
<i>ld en</i>	load enable
<i>st en</i>	store enable
<i>r/-w</i>	read/-write (0 = write, 1 = read)
<i>m sel</i>	memory select
<i>description</i>	operation description



K MAPS:

