Department of Computer Science, National Chengchi University

Digital Systems Final Examination, 6/18/2003

1. True or false (20%)

(a) Synchronous counters are also known as parallel counters.

(b) The principal advantage of MOS ICs over TTL ICs is their faster operating speed..

(c) The resolution of a DAC depends *only* on the number of bits.

(d) A certain TTL has a fan-out of 20. Simply stated, this series is capable of driving a total of 20 input devices of any series.

(e) A dynamic memory will hold its data as long as electrical power is applied.

(f) Successive-approximation ADC is also known as counter-type ADC.

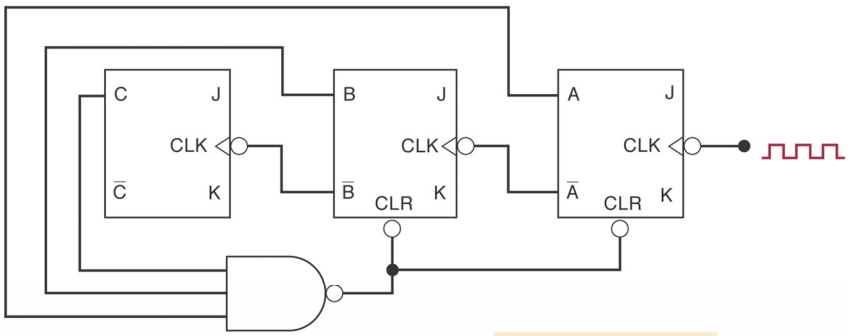
(g) The MOD number of a Johnson counter will always be equal to one-half of the number of flip-flops in the counter.

(h) Multiplexer is also know as data selector.

(i) EEPROM can be erased and re-programmed in circuit.

(j) A TTL output acts as a current sink in the LOW state..

2. **[Asynchronous counter design]** (a) Draw the diagram for a MOD-8 *down* counter using J-K flip-flops. (5%) (b) Analyze the circuit shown in the following figure. What is its function? Determine the actual sequence it counts through. (5%)



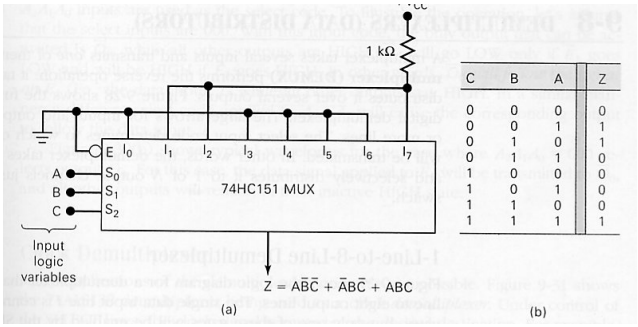
3. **[Johnson counter]** (a) Design a MOD-8 Johnson counter and draw its state diagram. (5%) (b) Show the corresponding the decoding logic.(5%]

4. **[Synchronous counter design]** (a) Fill in the blanks in the following J-K excitation table. (4%)

Transition at Output	Present State	Next State	J	K
0→0	0	0		
0→1	0	1		
1→0	1	0		
1→1	1	1		

(b) Use the above table to design a synchronous counter with the following counting sequence: 000,011,101,010, and repeat. You should write down the complete design procedure and draw the final implementation using J-K flip-flops. (11%)

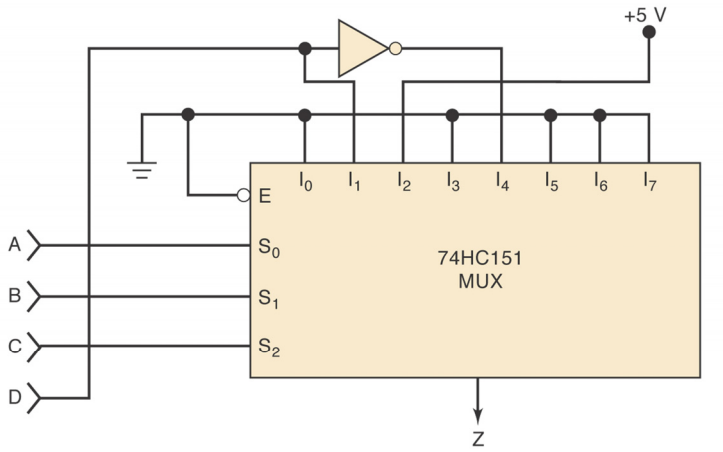
5. **[Multiplexer]** The following figure shows how to use 74HC151 MUX to implement the logic function: Z=AB'C'+A'BC'+ABC.



C	B	A	Z
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(a) Show how a 74151 can be used to generate the function Z=A'B+B'C+AC'. (4%)

(b) The following figure shows how a 8 input MUX can be used to generate a four variable logic function even though the MUX has only three SELECT inputs. What is the output Z ? (6%)



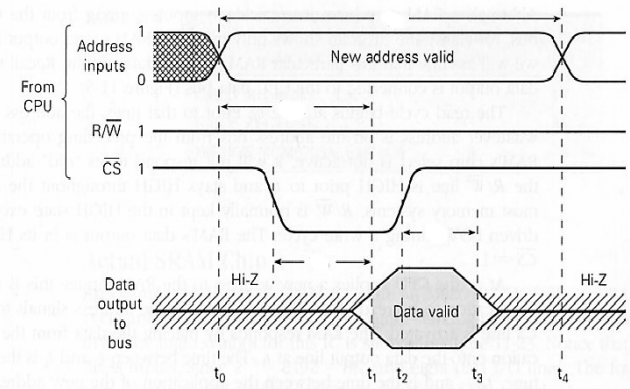
6. **[Analog to digital converter]** (a) Illustrate how a 4-bit successive-approximation ADC converter works assuming that the analog input V_A is 11V and the step size is 1V. (8%) (b) Compute and compare the maximum conversion times of a 8-bit digital-ramp ADC and a 8-bit successive-approximation ADC if both utilize a 400KHz clock frequency. (2%)

7. **[Digital IC families]** Refer to the following table. (a) Which TTL series has the optimal speed-power product? (3%) (b) Which TTL series has the best noise margin? (3%) (c) Compute the fan-out of a 74AS20 NAND chip given that I_{OH}(max)=2mA, I_{OL}(max)=20mA, I_{IH}(max)=20 uA, I_{IL}(max)=0.5 mA. (4%)

TABLE 8-6 Typical TTL series characteristics.

	74	74S	74LS	74AS	74ALS	74F
Performance ratings						
Propagation delay (ns)	9	3	9.5	1.7	4	3
Power dissipation (mW)	10	20	2	8	1.2	6
Speed–power product (pJ)						
Max. clock rate (MHz)	35	125	45	200	70	100
Fan-out (same series)	10	20	20	40	20	33
Voltage parameters						
V_{OH}(min)	2.4	2.7	2.7	2.5	2.5	2.5
V_{OL}(max)	0.4	0.5	0.5	0.5	0.5	0.5
V_{IH}(min)	2.0	2.0	2.0	2.0	2.0	2.0
V_{IL}(max)	0.8	0.8	0.8	0.8	0.8	0.8

8. **[Memory devices]** In the following timing diagram for static RAM read cycle, identify and explain the times: t_{ACC},t_{RC}, t_{CO}, and t_{OD}. (5%)

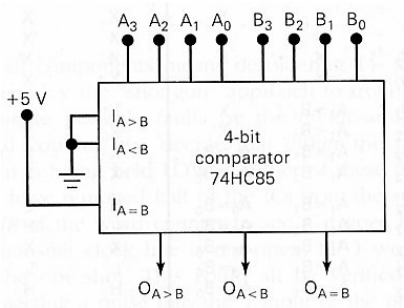


(b) Regarding flash memory, where does the word *flash* come from? (2%)

(c) List 3 applications of ROM. (3%)

9. **[Comparator, priority encoder]**

(a) Explain how a decimal-to-BCD priority encoder works by constructing its truth table. (5%) (b) How do you connect two 74HC85 4-bit comparators to perform 8-bit comparison? (3%) (Note: indicate high-order bits and low-order bits) Describe the operation of the 8-bit comparison arrangement when $A_7A_6A_5A_4A_3A_2A_1A_0$=10101111 and $B_7B_6B_5B_4B_3B_2B_1B_0$ = 10101001. (2%)



10. **[Applications]** Analyze and explain how the following circuit works.(5%)