CSC 258 midterm solutions

27 February 2002, 11:00

1. a) What function does the following logic gate diagram compute?
[not shown here; see the test paper]

Answer: $x(xy \oplus xyz)$

b) Simplify this formula (using any appropriate technique).

Answer:

$x(xy \oplus xyz)$
$= x(\overline{(xy)}xyz + xy\overline{(xyz)})$
$= x((\bar{x} + \bar{y})xyz + xy(\bar{x} + \bar{y} + \bar{z}))$
$= x\bar{x}xyz + x\bar{y}xyz + xxy\bar{x} + xxy\bar{y} + xxy\bar{z}$
(you may prefer to expand to that in two or three steps, but it does all multiply through)
$= 0 + 0 + 0 + 0 + xy\bar{z}$
$= xy\bar{z}$

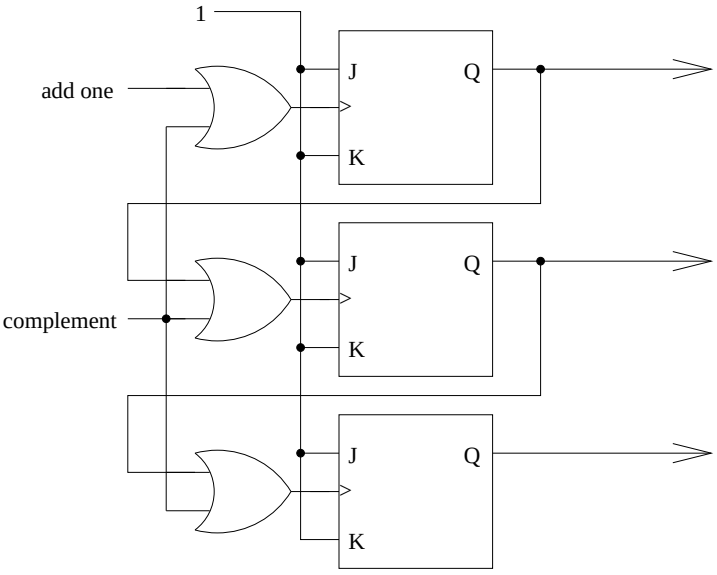
c) Draw a logic gate diagram for your simplified formula.

[answer not shown here]

2. Here is a three-bit ripple counter.
[standard ripple counter picture went here, similar to the answer below]

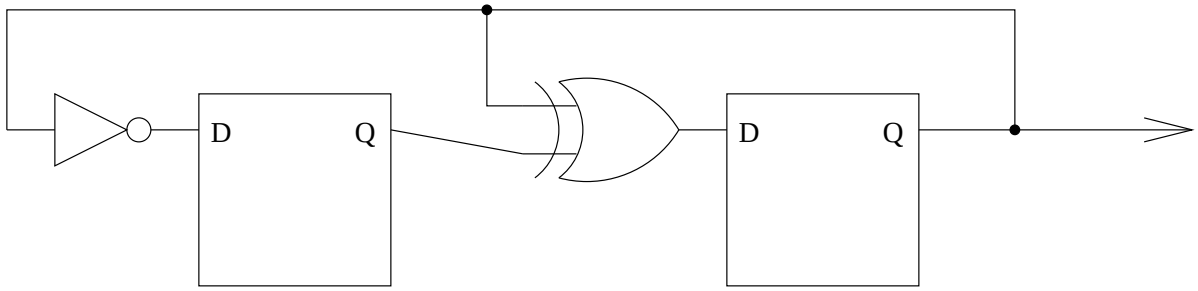
Draw a three-bit counter with *two* inputs: an ‘‘add one’’ input such as above, and a ‘‘complement’’ input which toggles all three bits (e.g. 010 will become 101).

You can assume that these two inputs will never be 1 at the same time.



(over)

3. What is the output sequence of the following "counter", after it gets established in its cycle?



Answer: either 0,0,1,0,0,1,0,0,1,... or staying at 1, depending upon initial state.

4. a) Here are some four-bit addition problems, some of which will overflow. Complete the addition operation and state the base-ten value of the operands and the result.

Question and answers combined:

0001 +0010 ----- 0011	0111 +0010 ----- 1001	0100 +0011 ----- 0111	0101 +0011 ----- 1000	1000 +1000 ----- 0000	0001 +1011 ----- 1100
$1+2=3$	$7+2=-7$	$4+3=7$	$5+3=-8$	$-8+-8=0$	$1+-5=-4$

b) Show that overflow is *not* the same as carry out (from the entire addition, i.e. c_n) by using one of the examples above.

Answer: Either $7+2=-7$ or $5+3=-8$ would do; in both of these examples, overflow = 1 and carry-out = 0.