

Lastname, Name:_____

ID:_____

EEE 102: Digital Systems Design

Midterm Exam 2

April 27, 2015

Duration: 90 min

Q	1	2	3	4	Total
Pts	25	25	25	25	100
Score					

This is a closed-book and closed-notes exam.

NO CREDIT will be given to answers without clear, formal and
clean

JUSTIFICATION.

1. **[25 pts]** Implement a JK flip-flop using a T flip-flop and minimal number of AND and OR gates. Complements of the J and K variables and logic levels 0 and 1 are not available. Complement of the T flip-flop output Q is available.

2. [25 pts] Design a sequential circuit with serial input X and serial outputs Z_1 and Z_2 which performs the following operation. Whenever the circuit receives a sequence 1100 on input it should output $Z_1 = 1$ and $Z_2 = 0$. Whenever the circuit receives a sequence 0101 on input it should output $Z_1 = 0$ and $Z_2 = 1$. Otherwise it should output $Z_1 = 0$ and $Z_2 = 0$. An example of input output sequence is shown below:

X	:	0	0	1	0	1	0	1	0	0	1	1	0	0	0
Z_1	:	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Z_2	:	0	0	0	0	1	0	1	0	0	0	0	0	0	0

Write down the state diagram and the state table using minimum number of states.

3. [25 pts]

Design a sequential circuit that outputs 1 when it receives a three consecutive number of 0's on the input (including the current input) As an example,

x	1	1	1	0	0	0	0	1	...
y	0	0	0	0	0	1	1	0	...

where x is the input and y is the output.

You can only use PR-type flip-flop, where an PR-type flip-flop is defined as follows:

P	R	Q(t+1)
0	0	0
0	1	1
1	0	$\bar{Q}(t)$
1	1	Q(t)

and a minimum number of NOR gates.

4. [25 pts]

Design a sequential circuit that counts up or counts down depending on the input x . If the $x = 0$, then the circuit counts down from 2 to 0 in a circular manner. Else if $x = 1$, then the circuit counts up from 0 to 2 in a circular manner. As an example,

x	1	1	1	1	1	1	0	0	0	0	1	0	...
y	0	1	2	0	1	2	1	0	2	1	2	1	...

where x is the input and y is the output.

You can only use T-type flip-flops and a minimum number of NAND gates.

