Université d'Ottawa
Faculté de génie

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Canada's university

University of Ottawa
Faculty of Engineering

ITI 1100

SAMPLE FINAL EXAM GIVEN in 2013
Solutions

Name:

Student Number:

Good Luck!

Question 1 (8 points)

a. The solutions to the quadratic equation $x^2 - 10x + 14 = 0$ are x = 2 and x = 6. What is the base of the numbers? Show your work.

base=8

b. Show that the dual of the exclusive-OR is equal to its complement.

Q2.24 of the book

x xor y = x'y + xy' and (x xor y)' = (x + y')(x' + y)
Dual of x'y + xy' = (x' + y)(x + y') = (x xor y)'

c. Find the complement of F = wx + yz; What is the value of FF' ?

Q2.8 of the book

F' = (wx + yz)' = (wx)'(yz)' = (w' + x')(y' + z')
FF' = wx(w' + x')(y' + z') + yz(w' + x')(y' + z') = 0
F + F' = wx + yz + (wx + yz)' = A + A' = 1 with A = wx + yz

Question 2 (8 points)

A majority circuit is a combinational circuit whose output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise.

Design a 3 input majority circuit by finding the circuit's truth table, Boolean equation and a logic diagram.

Q4.6 of the book

F = xz + yz + xy

Question 3 (11 points)

Design a combinational circuit that generates the 9's complement of a BCD digit by finding the circuit's truth table, Boolean equation and a logic diagram.

Q4.18 of the book

Inputs: **ABCD**
Outputs: **wxyz**

d(A, b, c, d) = Σ(10, 11, 12, 13, 14, 15)

w = A'B'C'
x = BC' + B'C = B xor C
y= C
z = D'

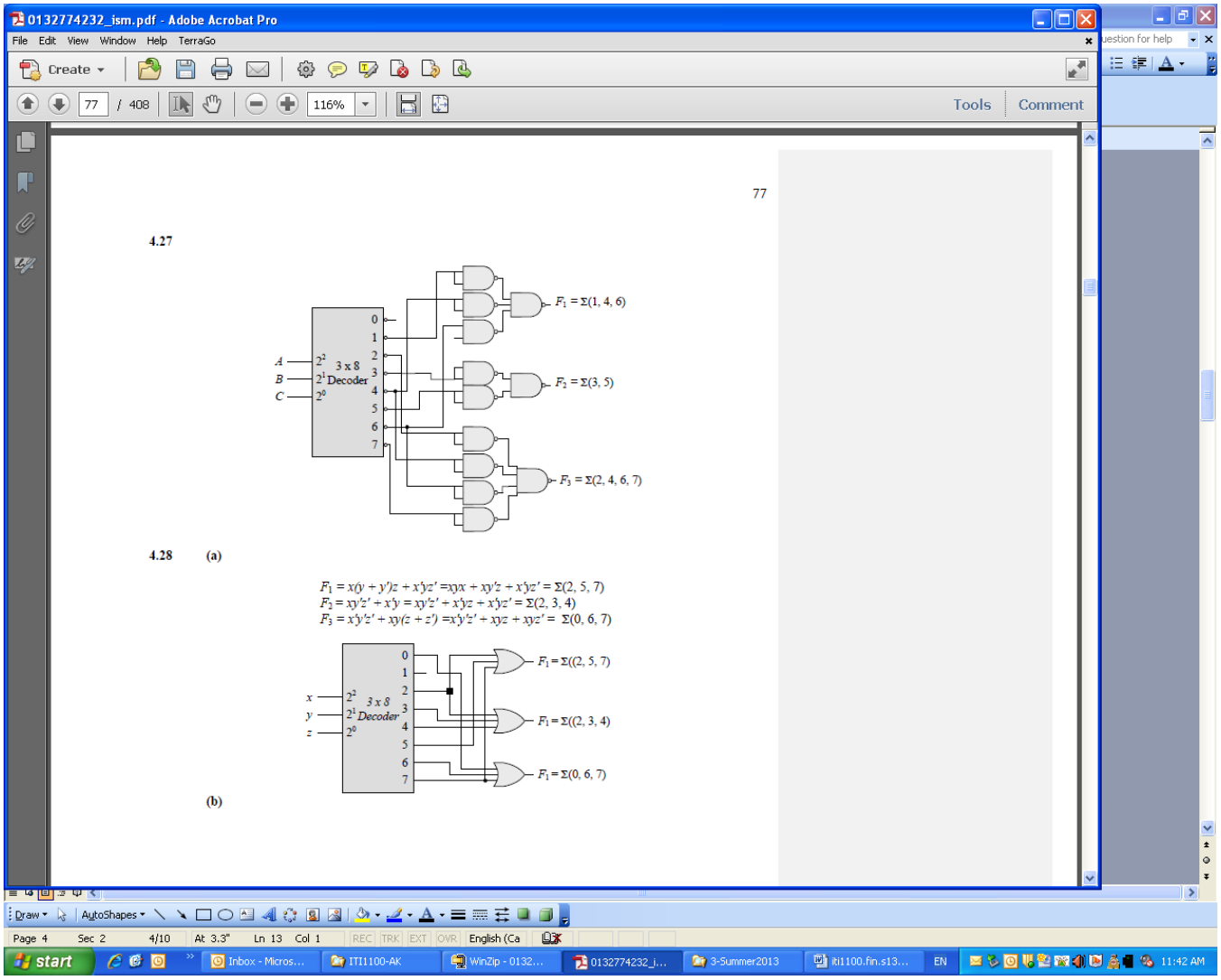
Question 4 (5 points)

A combinational circuit is specified by the following two Boolean functions:

$F_1(A,B,C) = \sum(1,4,6)$
$F_2(A,B,C) = \sum(3,5)$

Implement the circuit with a decoder. Use a block diagram for the decoder and use NAND gates for the gates connected to the decoder outputs.

Q4.27 of the book



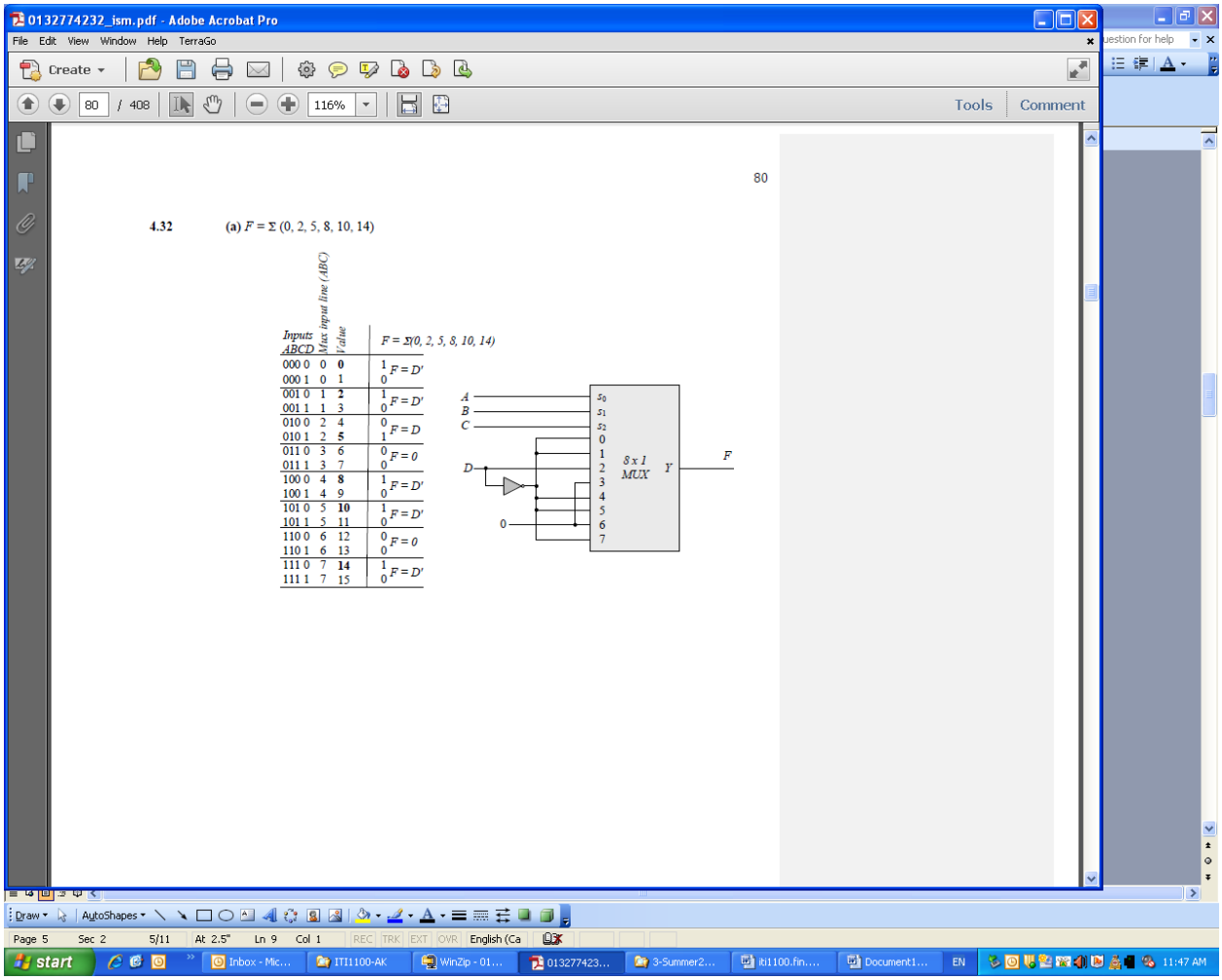
Question 5 (8 points)

Implement the following Boolean function with a multiplexer.

$F(A,B,C) = \sum(2,4,6)$

Q4.32 of the book

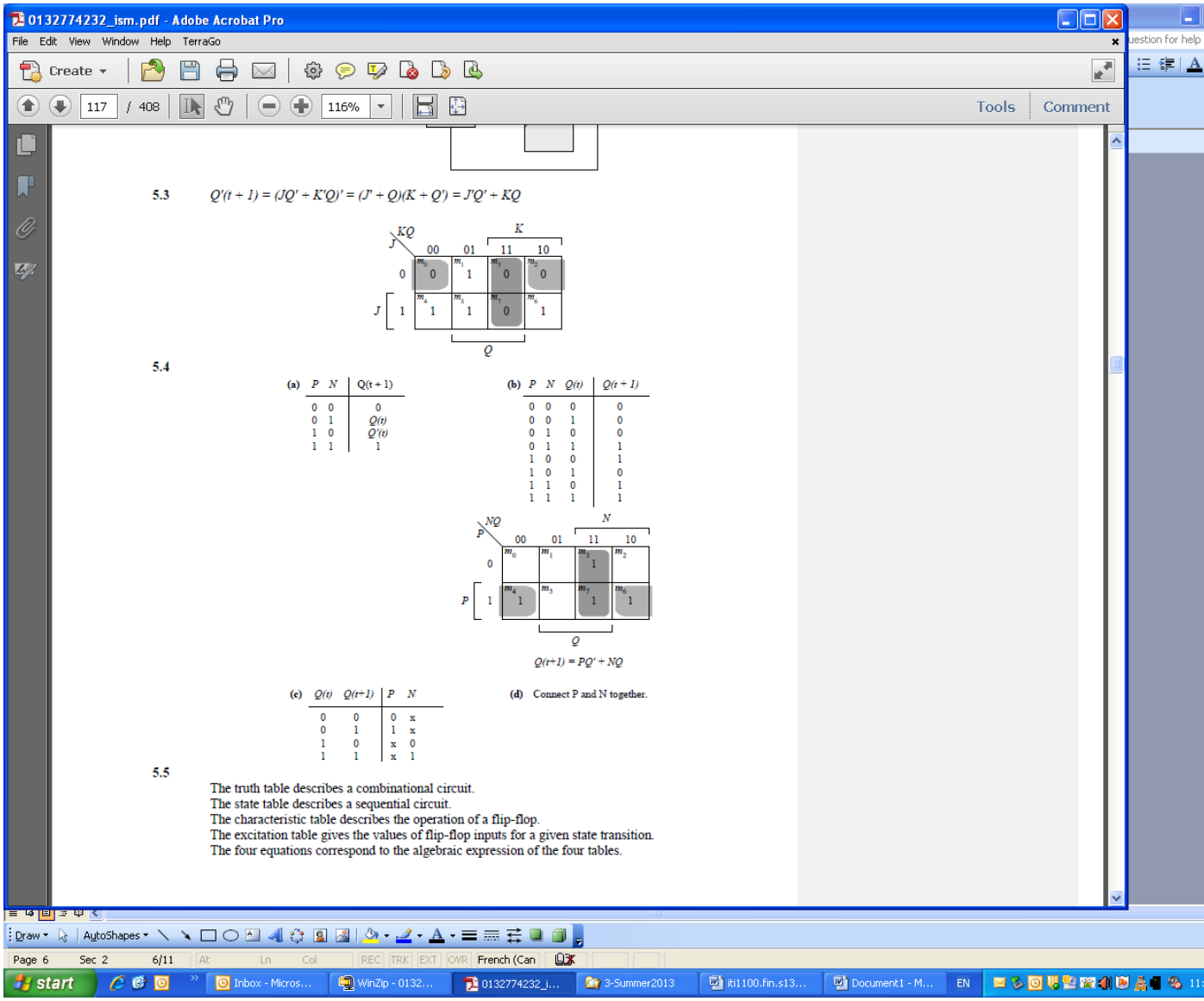
Similar to this one



Question 6 (11 points)

A PN flip-flop has four operations: clear to 0, no change, complement, and set to 1, when the inputs P and N are 00, 01, 10, and 11, respectively.

Q5.4 of the book



a. Tabulate the characteristic table.

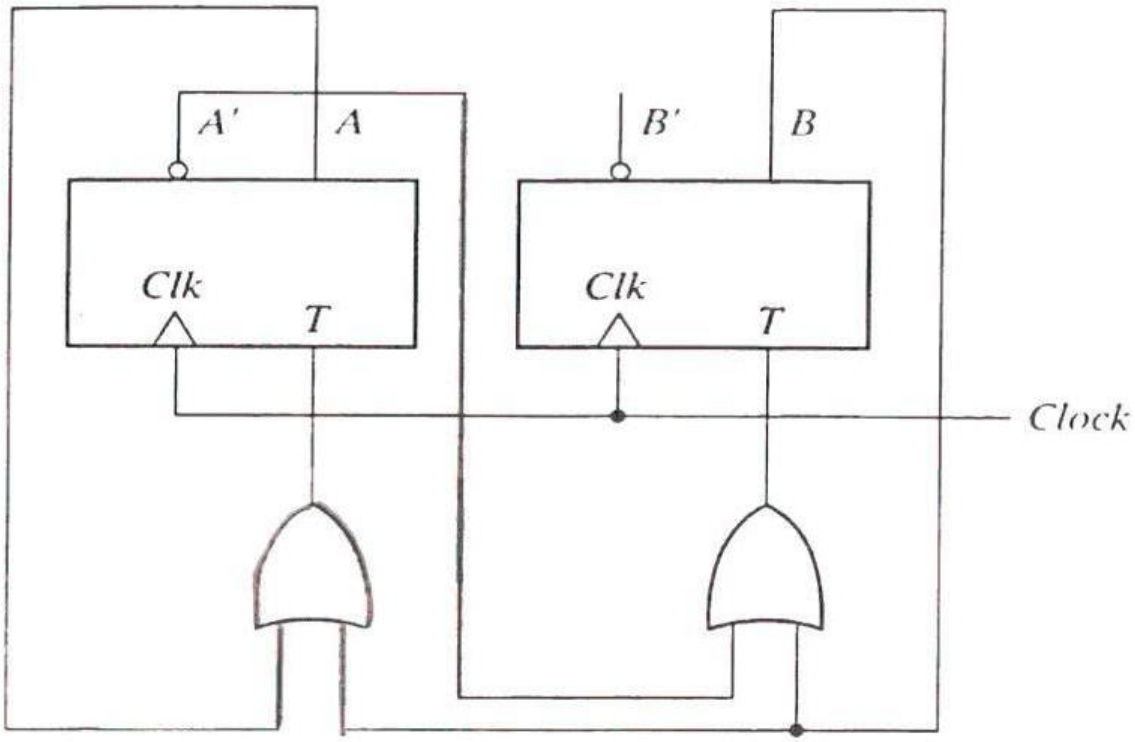
b. Derive the characteristic equation.

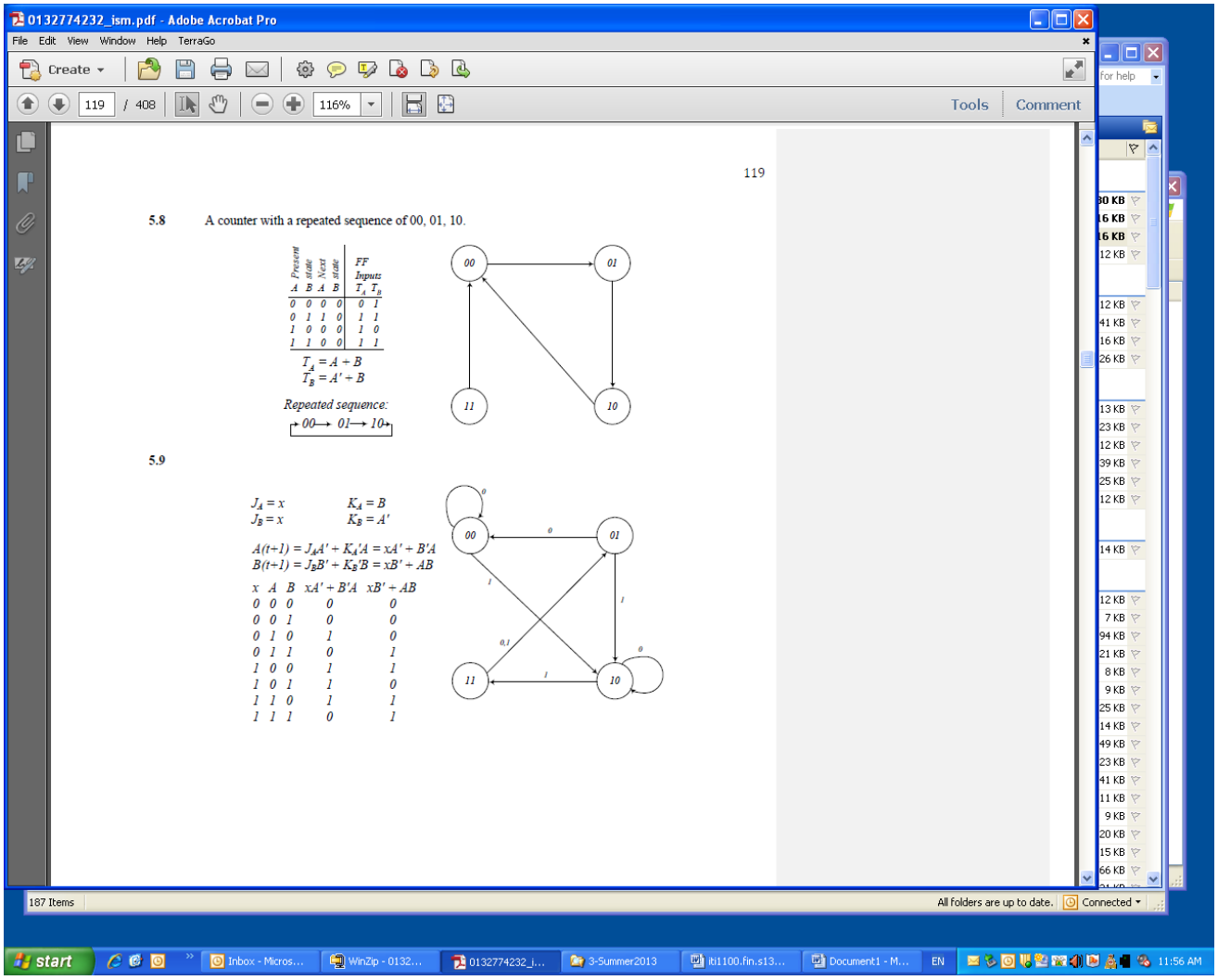
c. Tabulate the excitation table or the transition table.

Question 7 (8 points)

Derive the state table, state equations and the state diagram of the following sequential circuit:

Q5.8 of the book

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5.8
A counter with a repeated sequence of 00, 01, 10.
Present state A B
Next state A B
FF Inputs T_A T_B
0 0 0 0 0 1
0 1 1 0 1 1
1 0 0 0 1 0
1 1 0 0 1 1
$T_A = A + B$
$T_B = A' + B$
Repeated sequence:
00 → 01 → 10
00
01
11
10
5.9
$J_A = x$ $K_A = B$
$J_B = x$ $K_B = A'$
$A(t+1) = J_A A' + K_A' A = xA' + B'A$
$B(t+1) = J_B B' + K_B' B = xB' + AB$
x A B xA' + B'A xB' + AB
0 0 0 0 0
0 0 1 0 0
0 1 0 1 0
0 1 1 0 1
1 0 0 1 1
1 0 1 1 0
1 1 0 1 1
1 1 1 0 1
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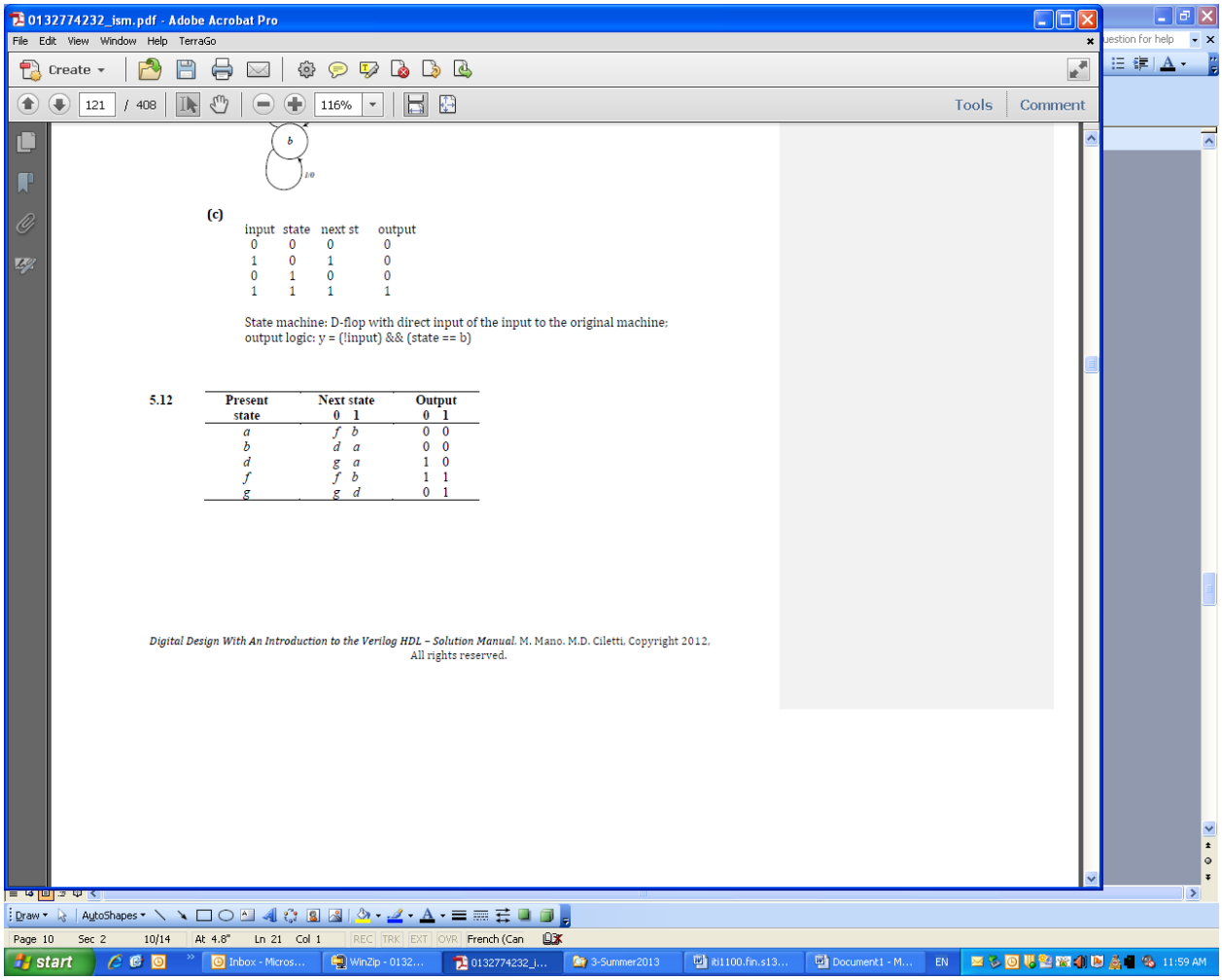
Question 8 (10 points)

For the following state table:

Present State	Next State		Output	
	x = 0	x = 1	x = 0	x = 1
a	e	d	0	0
b	d	c	0	1
c	a	e	1	0
d	a	b	1	0
e	d	c	0	1

Q5.12 and 5.13 of the book



5.13 (a) State: *a f b c e d g h g g h a*
Input: 0 1 1 1 0 0 1 0 0 1 1
Output: 0 1 0 0 0 1 1 1 0 1 0
(b) State: *a f b a b d g d g g d a*
Input: 0 1 1 1 0 0 1 0 0 1 1
Output: 0 1 0 0 0 1 1 1 0 1 0

a. Draw the corresponding state diagram.

b. Tabulate the reduced table.

c. Draw the state diagram corresponding to the reduced state table.

d. Starting from state a, and the input sequence 0111000, determine the output sequence for the above reduced state table.

Question 9 (12 points)

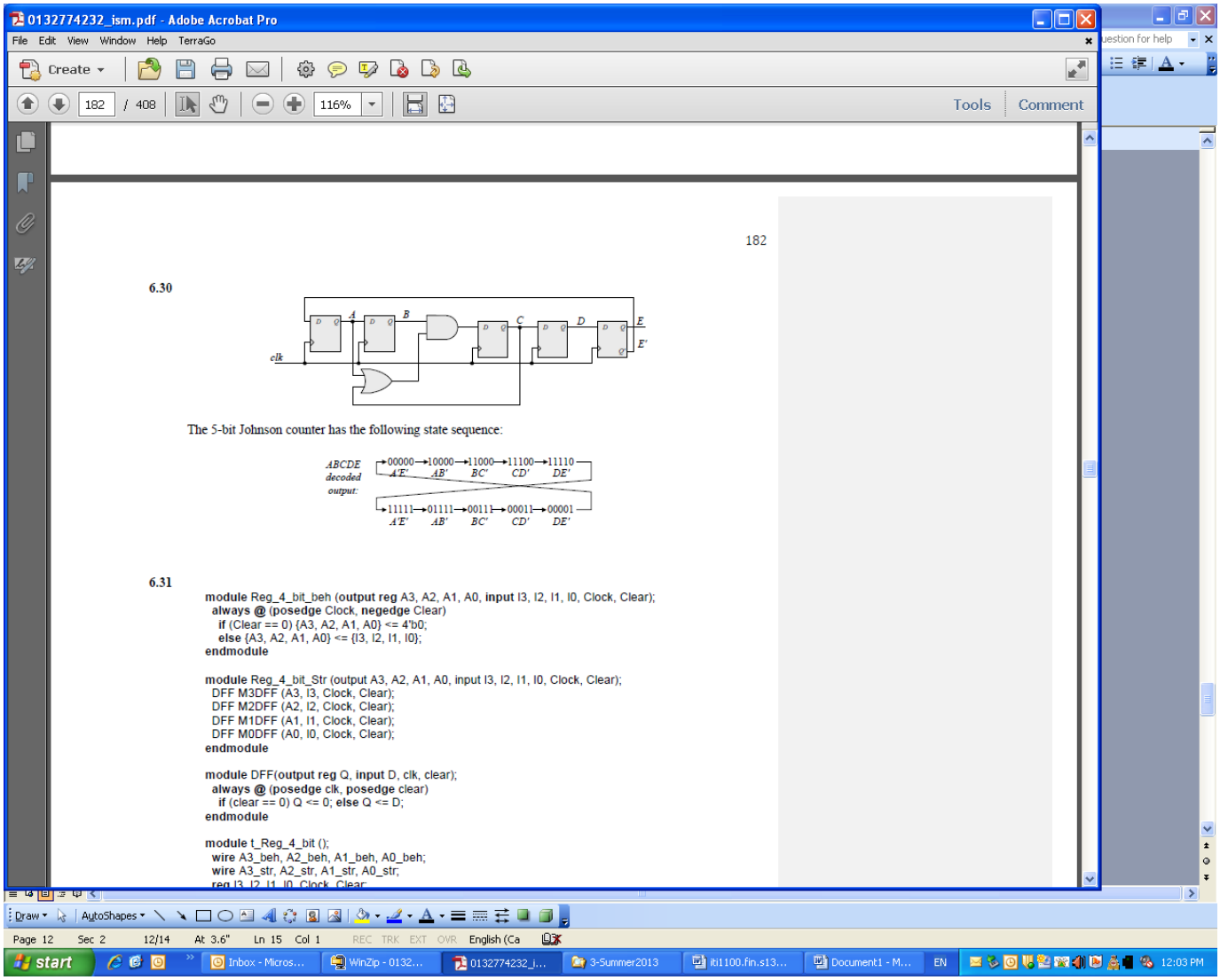
a. The contents of a four-bit register is initially 0110. The register is shifted six times to the right with the serial input being 1011100. What is the content of the register after each shift.

Q6.4 of the book

6.4 0110 => 0011, 0001, 1000, 1100, 1110, 0111, 1011

b. List the sequence of states produced with 3 and 4 flip-flops in a Johnson counter. The initial value of the register is 000 and 0000 respectively.

Q6.30 of the book



c. A Johnson counter with *n* flip-flops produces a sequence of many states?

d. What is the characteristic equation for the complement output of a JK flip-flop?

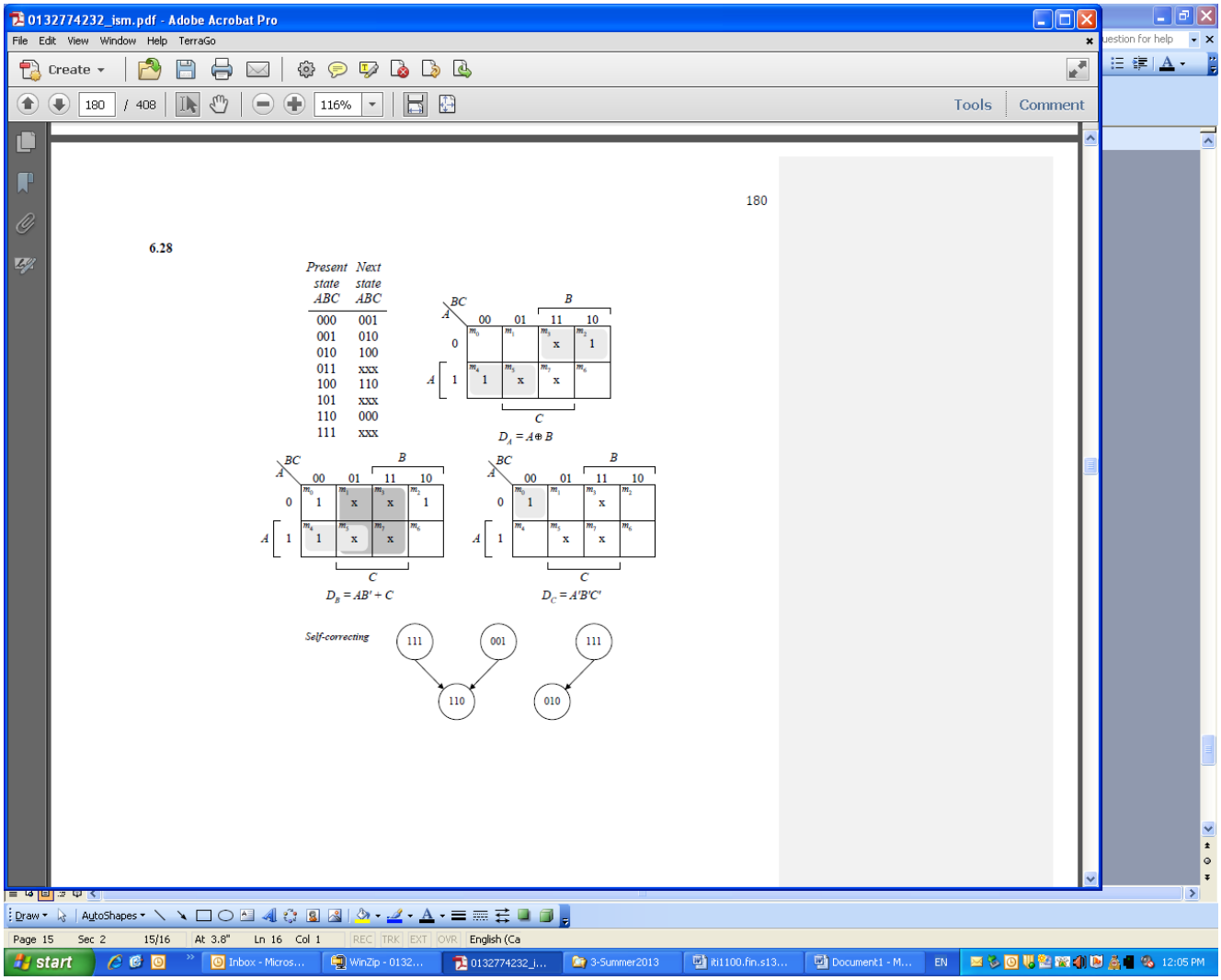
Q5.3 of the book

5.3 ***Q'(t + 1) = (JQ' + K'Q)' = (J' + Q)(K + Q') = J'Q' + KQ***

Question 10 (8 points)

Using D flip-flops,

Q6.28 of the book



a. Design a synchronous counter with the following repeated binary sequence 0, 1, 2, 4, 6.

b. Draw the logic diagram of the counter.

Question 11 (11 points)

Design a 3-bit ring counter using T Flip-flops. The initial value of the register is 100. Draw the logic diagram of the counter.

Q6.x of the book