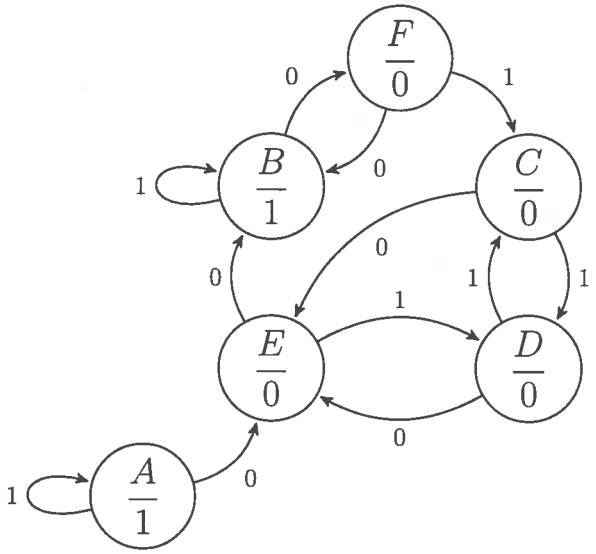
Name: SOLUTIONS

Read each question carefully before answering. Answer all parts. Show all work, calculations, and/or reasoning, otherwise no points will be awarded. Properly labeled loops must be shown on K-maps. Point values are as indicated.

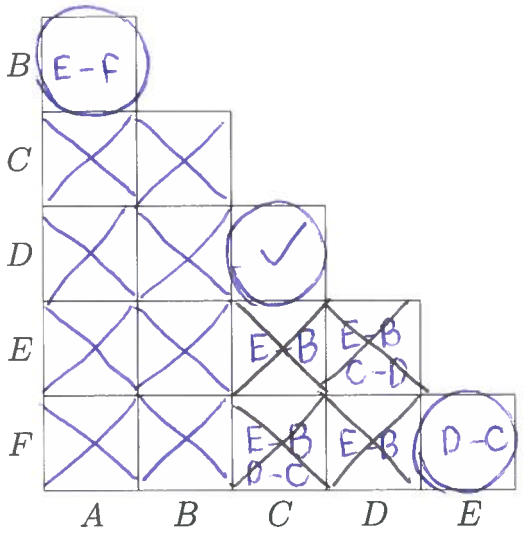
1. Your buddy (who may or may not be any good at digital systems) shows you the following state diagram...



(a) (10 points) Fill out the corresponding state table.

Current State	Next State		Output
	$X = 0$	$X = 1$	
A	E	A	1
B	F	B	1
C	E	D	0
D	E	C	0
E	B	D	0
F	B	C	0

(b) (10 points) Use an implication table to reduce the number of states. Indicate which (if any) states are equivalent.



A ≡ B
C ≡ D
E ≡ F

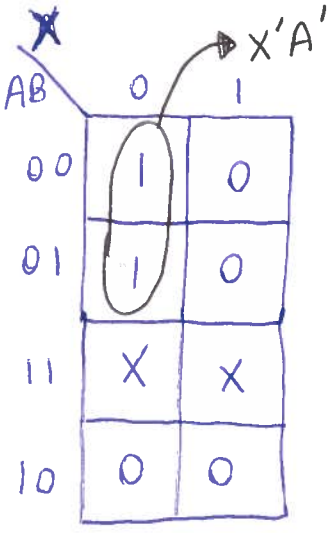
(c) (10 points) Fill out a new state table.

Current State	Next State		Output
	$X = 0$	$X = 1$	
A	E	A	1
C	E	C	0
E	A	C	0

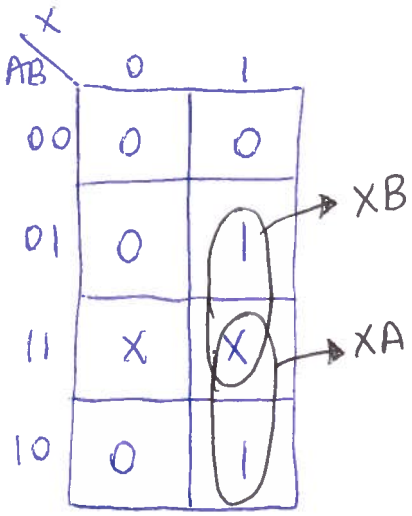
(d) (10 points) Create state assignments for the states (indicate what they are) and fill out the corresponding transition table.

Current State	Next State		Output
	$X = 0$	$X = 1$	
A 00	10	00	1
C 01	10	01	0
11	XX	XX	X
E 10	00	01	0

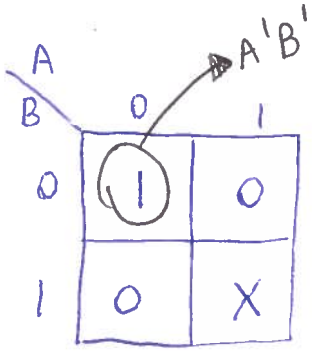
(e) (10 points) Use K-maps, Boolean algebra or Quine-McCluskey to derive next-state equations for each flip-flop, as well as an equation for the output, Z.



$A^+ = X'A'$

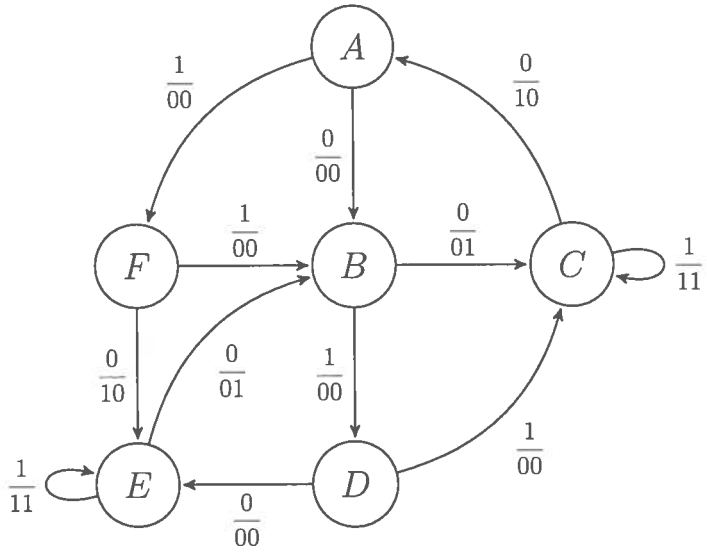


$B^+ = X(A+B)$



$Z = A'B'$

2. The following is a fully reduced state diagram and state table for a Mealy machine with two outputs, Y and Z.



Current State	Next State		Outputs (YZ)	
	$X = 0$	$X = 1$	$X = 0$	$X = 1$
010 A	B	F	00	00
111 B	C	D	01	00
011 C	A	C	10	11
001 D	E	C	00	00
110 E	B	E	01	11
101 F	E	B	10	00

(a) (10 points) Use the guidelines for state assignment to find reduced binary representations for each state.

Guideline 1:

AE ✓
DF ✓
CD ✓

Guideline 2:

BF ✓
CD ✓
AC ✓
EC
BE x2 ✓

Guideline 3:

AD
BE ✓
CF

ABDF
CE

(b) (10 points) Use a K-map to determine state assignments for each state. Indicate the binary values for each state.

	A	
BC	0	1
00	X	X
01	D	F
11	C	B
10	A	E

A = 010
B = 111
C = 011
D = 001
E = 110
F = 101

(c) (10 points) Fill out the corresponding transition table.

Current State	Next State		Outputs (YZ)	
	$X = 0$	$X = 1$	$X = 0$	$X = 1$
000	XXX	XXX	XX	XX
D 001	110	011	00	00
C 011	010	011	10	11
A 010	111	101	00	00
100	XXX	XXX	XX	XX
F 101	110	111	10	00
B 111	011	001	01	00
E 110	111	110	01	11

(d) (10 points) Derive an equation for each output variable.

y

BC \ XA	00	01	11	10
00	X	X	X	X
01	0	1	0	0
11	1	0	0	1
10	0	0	1	0

X'AB' A'BC XAC'

$y = A'BC + A(X'B' + XC')$

z

BC \ XA	00	01	11	10
00	X	X	X	X
01	0	0	0	0
11	0	1	0	1
10	0	1	1	0

XA'BC X'AB ABC'

$z = AB(X' + C') + XA'BC$

(e) (20 points) Using D flip-flops, derive an equation for each flip-flop.

A^+

BC \ XA	00	01	11	10
00	X	X	X	X
01	1	1	1	0
11	0	0	0	0
10	1	1	1	1

$X'B'$, AB', C'

$A^+ = C' + B'(X' + A)$

B^+

BC \ XA	00	01	11	10
00	X	X	X	X
01	1	1	1	1
11	1	1	0	1
10	1	1	1	0

B', $A'C$, X', AC'

$B^+ = X' + B' + A \oplus C$

C^+

BC \ XA	00	01	11	10
00	X	X	X	X
01	0	0	1	1
11	0	1	1	1
10	1	1	0	1

NO!

XC, $A'C'$, $X'AB$

$C^+ = XC + A'C' + X'AB$