ICD HW2

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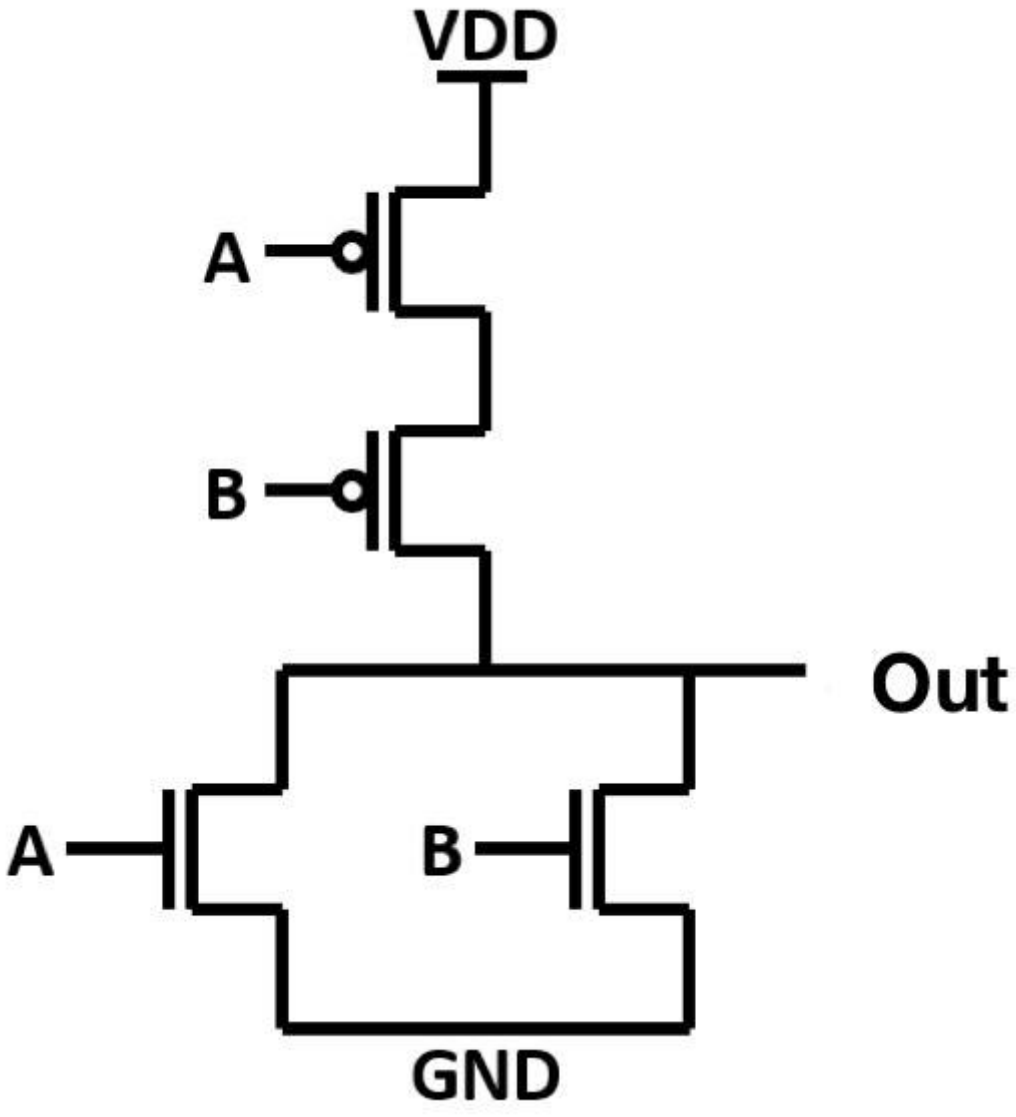
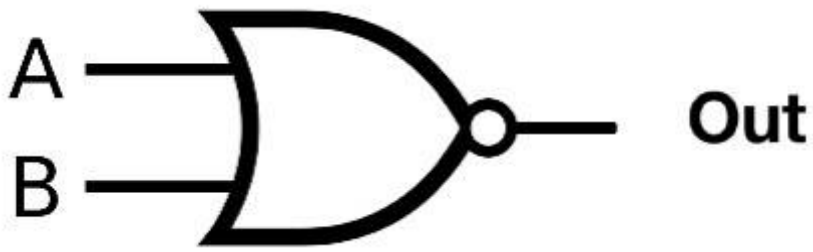
Problem1

1.NOR2:

(1)

(2).





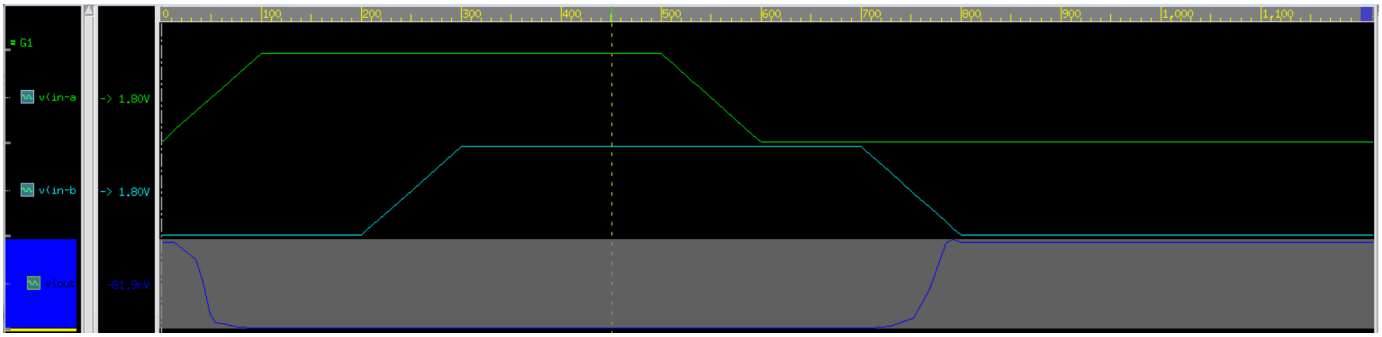
(3).

A	B	Out
0	0	1
0	1	0
1	0	0
1	1	0

(4).

```
**********************************************
.inc '90nm_bulk.l'

.SUBCKT NR2 DVDD GND In-A In-B Out
*.PININFO DVDD:I GND:I In-A:I In-B:I Out:O

MM0-A node1 In-A DVDD  DVDD  PMOS l=0.1u w=0.5u  m=1
MM0-B Out   In-B node1 node1 PMOS l=0.1u w=0.5u  m=1
MM1-A Out   In-A GND   GND   NMOS l=0.1u w=0.25u m=1
MM1-B Out   In-B GND   GND   NMOS l=0.1u w=0.25u m=1
.ENDS
**********************************************



Vdd DVDD 0 1
Vss GND  0 0
Vin1 In-A 0 pulse(0 1 3u 100n 100n 800n 2u)
Vin2 In-B 0 pulse(0 1 1u 100n 100n 800n 4u)

x1 DVDD GND In-A In-B Out NR2

.tran 10n 7u
.op
.option post
.end
```

(5).

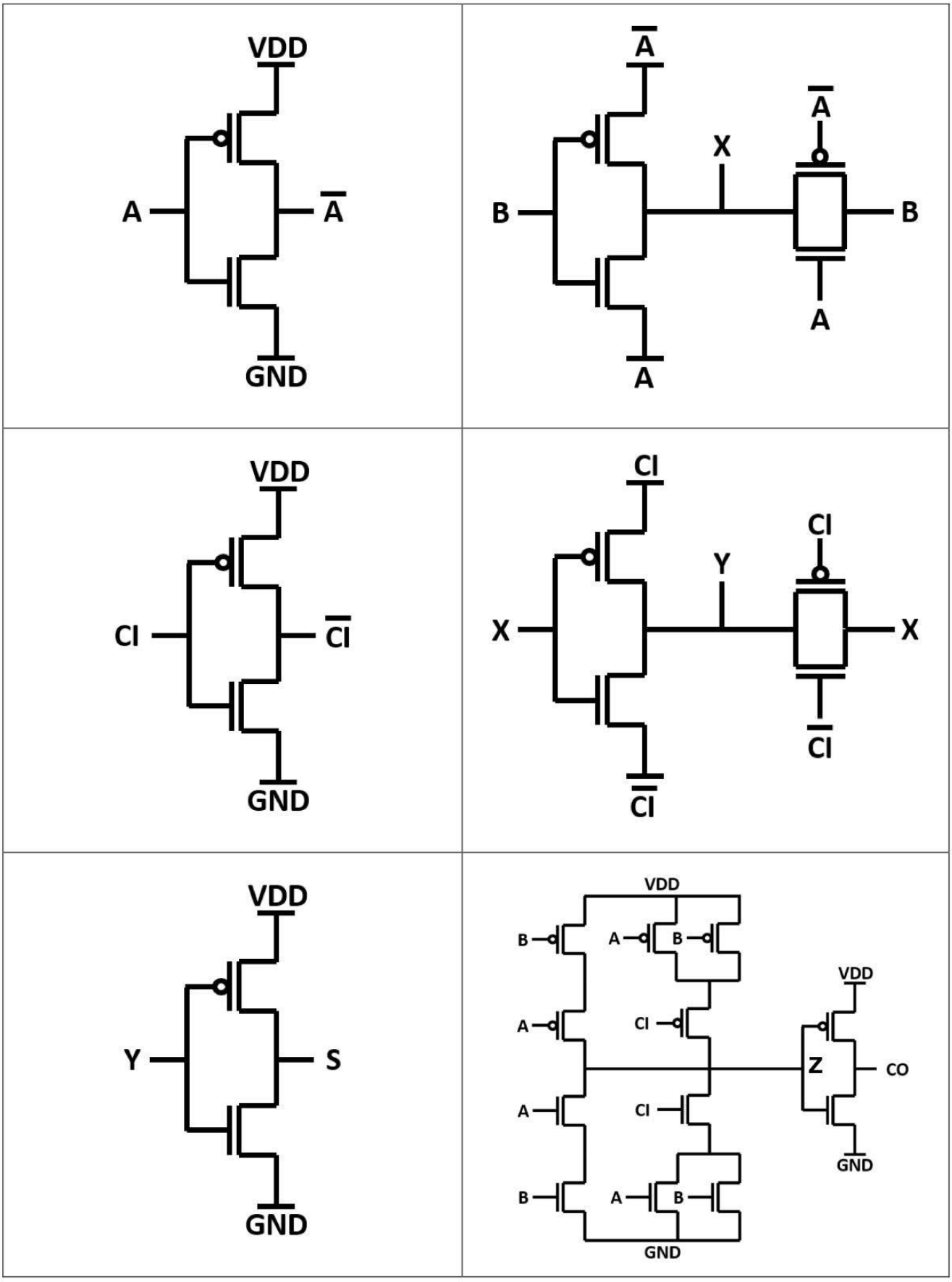


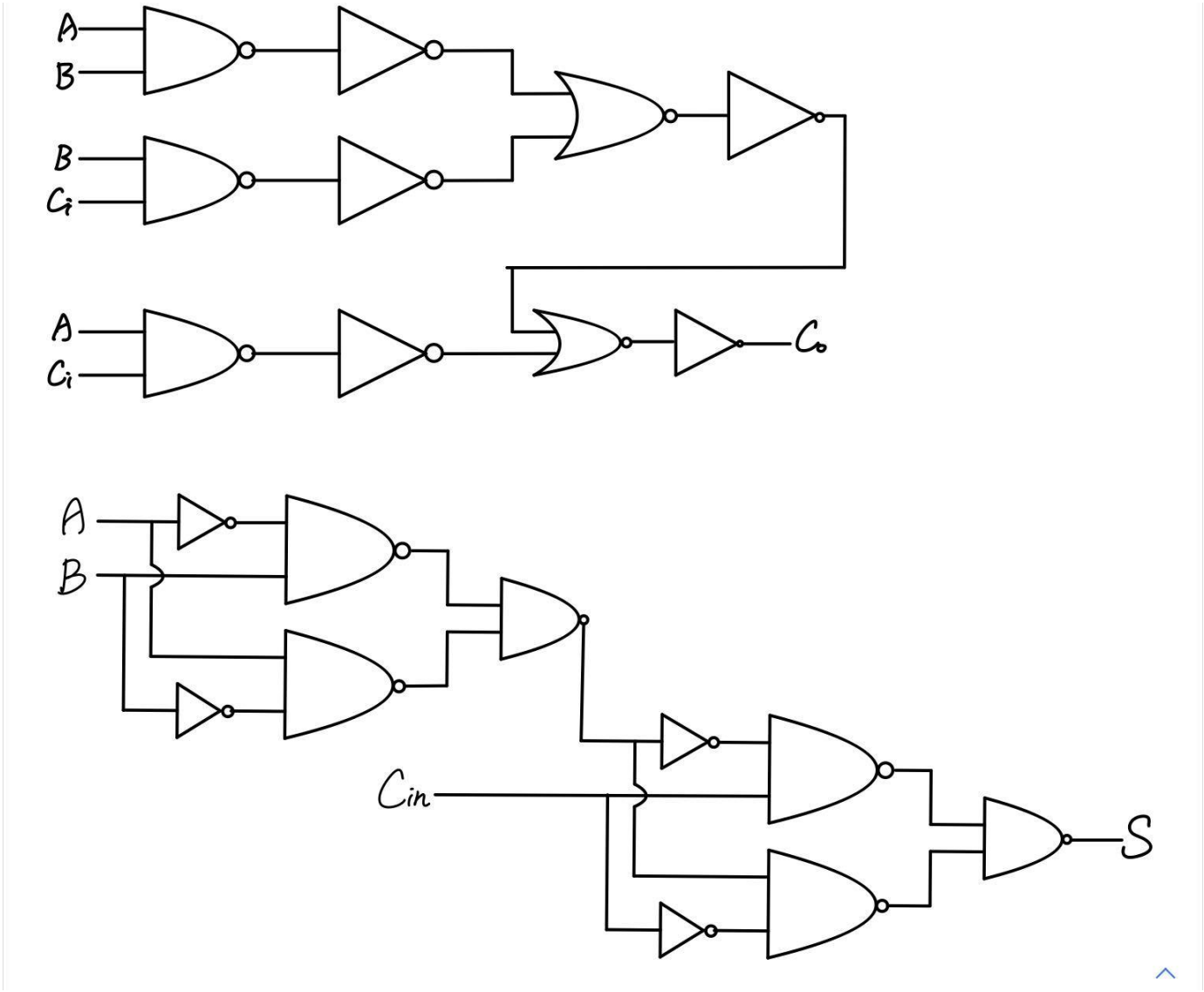
(6).

No problem.

2.Full Adder:

(1)(2).





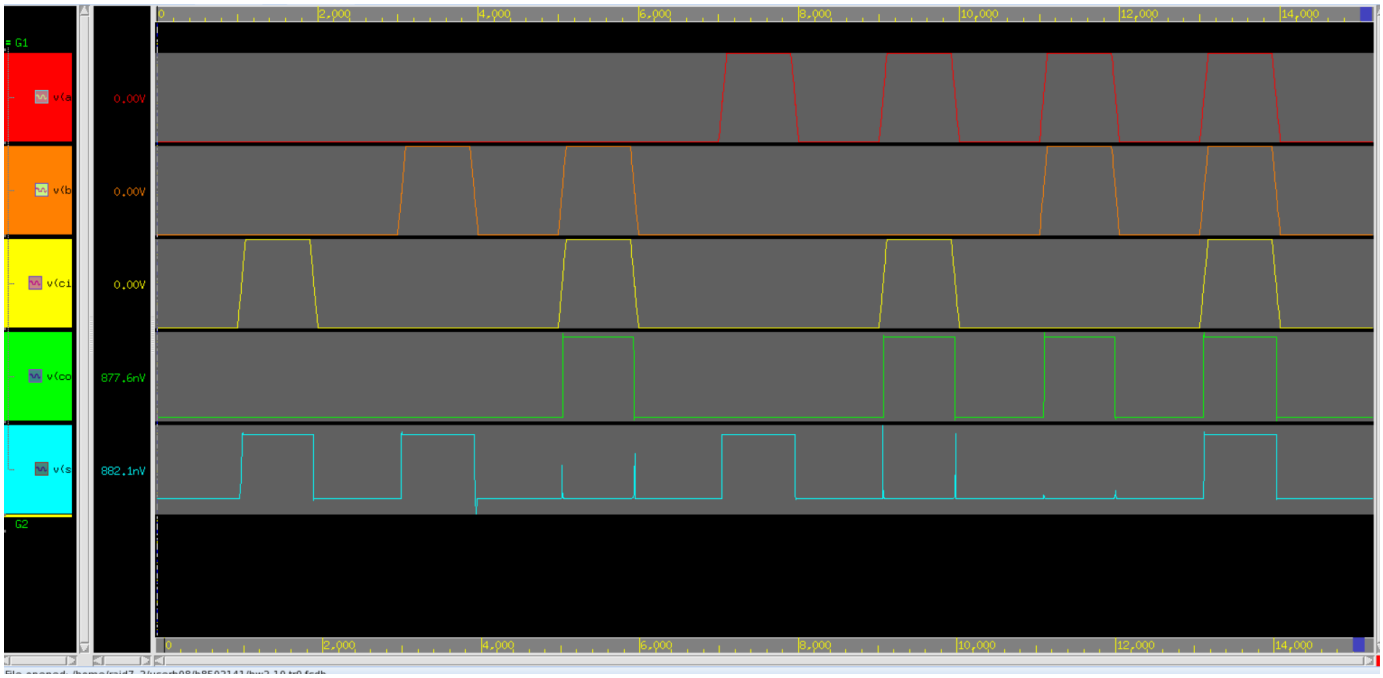
(3).

X	Y	Ci	Co	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

(4).

```
*********************************************
.inc '90nm_bulk.l'
.SUBCKT   Sum DVDD GND A B Ci Co S
MM0-A           A-bar   A      DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM1-A           A-bar   A      GND        GND       NMOS l=0.1u w=0.25u m=1

MM0-B           X       B      A-bar      A-bar     PMOS l=0.1u w=0.5u  m=1
MM1-B           X       B      A          A         NMOS l=0.1u w=0.25u m=1
MM2-B           X       A-bar  B          B         PMOS l=0.1u w=0.5u  m=1
MM3-B           X       A      B          B         NMOS l=0.1u w=0.25u m=1

MM0-Ci          Ci-bar  Ci     DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM1-Ci          Ci-bar  Ci     GND        GND       NMOS l=0.1u w=0.25u m=1

MM0-X           Y       X      Ci         Ci        PMOS l=0.1u w=0.5u  m=1
MM1-X           Y       X      Ci-bar     Ci-bar    NMOS l=0.1u w=0.25u m=1
MM2-X           Y       Ci     X          X         PMOS l=0.1u w=0.5u  m=1
MM3-X           Y       Ci-bar X          X         NMOS l=0.1u w=0.25u m=1

MM0-S           S       Y      DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM1-S           S       Y      GND        GND       NMOS l=0.1u w=0.25u m=1

MM0-B-2         n1      B       DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM1-A-2         Z       A       n1         n1        PMOS l=0.1u w=0.5u  m=1

MM2-A-2         Z       A       n4         n4        NMOS l=0.1u w=0.25u m=1
MM3-B-2         n4      B       GND        GND       NMOS l=0.1u w=0.25u m=1

MM4-A-2         n2      A       DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM5-B-2         n2      B       DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM6-Ci-2        Z       Ci      n2         n2        PMOS l=0.1u w=0.5u  m=1

MM7-Ci-2        Z       Ci      n3         n3        NMOS l=0.1u w=0.25u m=1
MM8-A-2         n3      A       GND        GND       NMOS l=0.1u w=0.25u m=1
MM9-B-2         n3      B       GND        GND       NMOS l=0.1u w=0.25u m=1

MM10-Z          Co      Z       DVDD       DVDD      PMOS l=0.1u w=0.5u  m=1
MM11-Z          Co      Z       GND        GND       NMOS l=0.1u w=0.25u m=1
.ENDS
*********************************************
Vdd     DVDD    0       1
Vss     GND     0       0
Vin1    A       0       pulse(0 1 7u 100n 100n 800n 2u)
Vin2    B       0       pwl(0n 0v 3u 0v 3.1u 1v 3.9u 1v 4u 0v 5u 0v 5.1u 1v 5.9u 1v 6u 0v 11u 0v 11.1u 1v 11.9u 1v 12u 0v 13u
 0v 13.1u 1v 13.9u 1v 14u 0v 15u 0v)
Vin3    Ci      0       pulse(0 1 1u 100n 100n 800n 4u)

x1 DVDD GND A B Ci Co S Sum

.tran 500n 15u
.op
.option post
.end
```

(5).

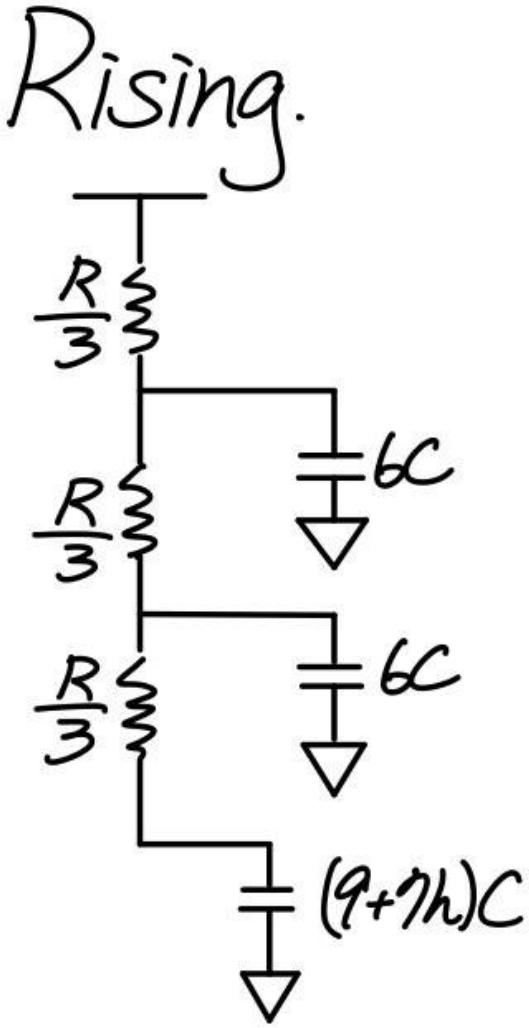


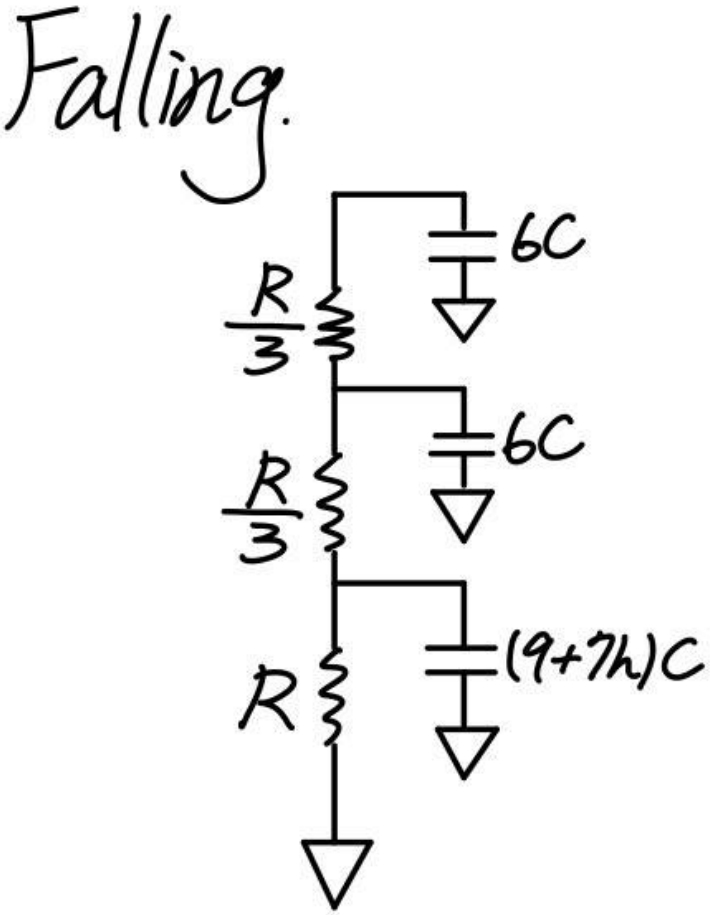
(6).

There are some sharp points in S.

Problem2

$t_{pdf} = (21 + 7h)RC$
$t_{pdr} = (15 + 7h)RC$





Problem3

A	B	C	D	n1	n2	n3	n4	Z
0	0	0	0	1	0	0	1	0
0	0	0	1	1	0	0	1	0
0	0	1	0	1	0	0	1	0
0	0	1	1	1	0	0	1	0
0	1	0	0	0	1	1	0	0
0	1	0	1	0	1	1	0	0
0	1	1	0	0	1	0	1	0
0	1	1	1	0	1	0	1	0
1	0	0	0	0	1	1	0	0
1	0	0	1	0	1	1	0	0
1	0	1	0	0	1	0	1	0
1	0	1	1	0	1	0	1	0
1	1	0	0	0	1	1	0	0
1	1	0	1	0	1	1	0	0
1	1	1	0	0	1	0	1	0
1	1	1	1	0	1	0	1	0

$P_{n1} = \frac{4}{16}$ -> $\alpha_{n1} = \frac{3}{16}$
$P_{n2} = \frac{12}{16}$ -> $\alpha_{n2} = \frac{3}{16}$
$P_{n3} = \frac{6}{16}$ -> $\alpha_{n3} = \frac{15}{64}$
$P_{n4} = \frac{10}{16}$ -> $\alpha_{n4} = \frac{15}{64}$
$P_Z = 0$ -> $\alpha_Z = 0$