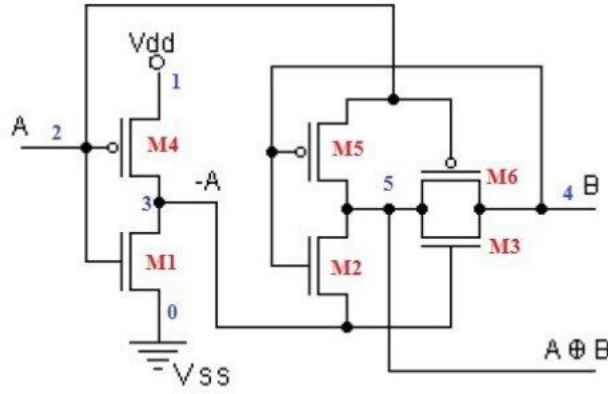


1)



XOR		
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

$$Q = A \oplus B$$



Şekil 1 – Pass Transistör XOR Kapısı

Doğruluk tablosu değerlerine göre Source ve Drain uçları değişmektedir! Kodlarda bu uçlar belirtildi. Bu soruda transistör numaraları yukarıdaki gibidir.

M6 ve M3 transistörlerinin bağlantı şekline göre B girişinden girilen değere göre çeşitli çıktı durumları elde ediliyor. B girişinden 0 veya 1 verdiğimizde source-drain-bulk uçları değişiyor ve bu sayede 4 farklı durum elde ediliyor.

A=0 ve B=0 için;

```
.MODEL MOSN NMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=5.36726E+15 VTO=0.743469 KP=8.00059E-05 GAMMA=0.543
+ PHI=0.6 U0=655.881 UEXP=0.157282 UCRIT=31443.8
+ DELTA=2.39824 VMAX=55260.9 XJ=0.25U LAMBDA=0.0367072
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=1.0 RSH=70.00
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0003 MJ=0.6585
+ CJSW=8.0E-10 MJSW=0.2402 PB=0.58
```

```
.MODEL MOSP PMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=4.3318E+15 VTO=-0.738861 KP=2.70E-05 GAMMA=0.58
+ PHI=0.6 U0=261.977 UEXP=0.323932 UCRIT=65719.8
+ DELTA=1.79192 VMAX=25694 XJ=0.25U LAMBDA=0.0612279
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=-1.0 RSH=120.6
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0005 MJ=0.5052
+ CJSW=1.349E-10 MJSW=0.2417 PB=0.64
```

*** D G S B**

```
M1 3 2 0 0 MOSN W=1.8u L=1.2u
M2 3 4 5 5 MOSN W=1.8u L=1.2u
M3 5 3 4 4 MOSN W=1.8u L=1.2u
M4 3 2 1 1 MOSP W=3.6u L=1.2u
M5 2 4 5 5 MOSP W=3.6u L=1.2u
M6 4 2 5 5 MOSP W=3.6u L=1.2u
```

```
vdd 1 0 5V
```

```
v2 2 0 0v
```

```
v4 4 0 0v
```

```
*Vin1 2 0 pulse(0V 5V 0 0ns 0ns 100ns 200ns)
```

```
*Vin2 4 0 pulse(0V 5V 0 0ns 0ns 200ns 400ns)
```

```
.control
```

```
tran 0.05n 500n
plot v(2) v(4) v(5)
.endc
.end
```

A=0 ve B=1 için;

```
.MODEL MOSN NMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=5.36726E+15 VTO=0.743469 KP=8.00059E-05 GAMMA=0.543
+ PHI=0.6 U0=655.881 UEXP=0.157282 UCRIT=31443.8
+ DELTA=2.39824 VMAX=55260.9 XJ=0.25U LAMBDA=0.0367072
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=1.0 RSH=70.00
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0003 MJ=0.6585
+ CJSW=8.0E-10 MJSW=0.2402 PB=0.58
```

```
.MODEL MOSP PMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=4.3318E+15 VTO=-0.738861 KP=2.70E-05 GAMMA=0.58
+ PHI=0.6 U0=261.977 UEXP=0.323932 UCRIT=65719.8
+ DELTA=1.79192 VMAX=25694 XJ=0.25U LAMBDA=0.0612279
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=-1.0 RSH=120.6
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0005 MJ=0.5052
+ CJSW=1.349E-10 MJSW=0.2417 PB=0.64
```

*** D G S B**

```
M1 3 2 0 0 MOSN W=1.8u L=1.2u
M2 3 4 5 5 MOSN W=1.8u L=1.2u
M3 4 3 5 5 MOSN W=1.8u L=1.2u
M4 3 2 1 1 MOSP W=3.6u L=1.2u
M5 2 4 5 5 MOSP W=3.6u L=1.2u
M6 5 2 4 4 MOSP W=3.6u L=1.2u
```

```
vdd 1 0 5V
v2 2 0 0v
v4 4 0 5v
```

```
*Vin1 2 0 pulse(0V 5V 0 0ns 0ns 100ns 200ns)
*Vin2 4 0 pulse(0V 5V 0 0ns 0ns 200ns 400ns)
```

```
.control
tran 0.05n 500n
plot v(2) v(4) v(5)+0.1
.endc
.end
```

A=1 ve B=0 için;

```
.MODEL MOSN NMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=5.36726E+15 VTO=0.743469 KP=8.00059E-05 GAMMA=0.543
+ PHI=0.6 U0=655.881 UEXP=0.157282 UCRIT=31443.8
+ DELTA=2.39824 VMAX=55260.9 XJ=0.25U LAMBDA=0.0367072
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=1.0 RSH=70.00
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0003 MJ=0.6585
+ CJSW=8.0E-10 MJSW=0.2402 PB=0.58
```

```
.MODEL MOSP PMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=4.3318E+15 VTO=-0.738861 KP=2.70E-05 GAMMA=0.58
+ PHI=0.6 U0=261.977 UEXP=0.323932 UCRIT=65719.8
+ DELTA=1.79192 VMAX=25694 XJ=0.25U LAMBDA=0.0612279
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=-1.0 RSH=120.6
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0005 MJ=0.5052
+ CJSW=1.349E-10 MJSW=0.2417 PB=0.64
```

*** D G S B**

```
M1 3 2 0 0 MOSN W=1.8u L=1.2u
M2 5 4 3 3 MOSN W=1.8u L=1.2u
M3 5 3 4 4 MOSN W=1.8u L=1.2u
M4 3 2 1 1 MOSP W=3.6u L=1.2u
M5 2 4 5 5 MOSP W=3.6u L=1.2u
M6 4 2 5 5 MOSP W=3.6u L=1.2u
```

```
vdd 1 0 5V
v2 2 0 5v
v4 4 0 0v
```

```
*Vin1 2 0 pulse(0V 5V 0 0ns 0ns 100ns 200ns)
*Vin2 4 0 pulse(0V 5V 0 0ns 0ns 200ns 400ns)
```

```
.control
tran 0.05n 500n
plot v(2) v(4) v(5)+0.1
```

```
.endc
.end
```

A=1 ve B=1 için;

```
.MODEL MOSN NMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=5.36726E+15 VTO=0.743469 KP=8.00059E-05 GAMMA=0.543
+ PHI=0.6 U0=655.881 UEXP=0.157282 UCRIT=31443.8
+ DELTA=2.39824 VMAX=55260.9 XJ=0.25U LAMBDA=0.0367072
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=1.0 RSH=70.00
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0003 MJ=0.6585
+ CJSW=8.0E-10 MJSW=0.2402 PB=0.58
```

```
.MODEL MOSP PMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=4.3318E+15 VTO=-0.738861 KP=2.70E-05 GAMMA=0.58
+ PHI=0.6 U0=261.977 UEXP=0.323932 UCRIT=65719.8
+ DELTA=1.79192 VMAX=25694 XJ=0.25U LAMBDA=0.0612279
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=-1.0 RSH=120.6
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0005 MJ=0.5052
+ CJSW=1.349E-10 MJSW=0.2417 PB=0.64
```

* D G S B

```
M1 3 2 0 0 MOSN W=1.8u L=1.2u
M2 3 4 5 5 MOSN W=1.8u L=1.2u
M3 4 3 5 5 MOSN W=1.8u L=1.2u
M4 3 2 1 1 MOSP W=3.6u L=1.2u
M5 5 4 2 2 MOSP W=3.6u L=1.2u
M6 5 2 4 4 MOSP W=3.6u L=1.2u
```

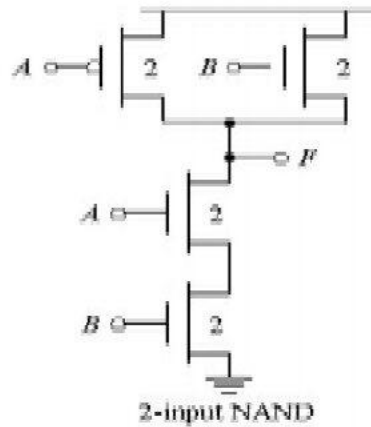
```
vdd 1 0 5V
v2 2 0 5v
v4 4 0 5v
```

```
*Vin1 2 0 pulse(0V 5V 0 0ns 0ns 100ns 200ns)
*Vin2 4 0 pulse(0V 5V 0 0ns 0ns 200ns 400ns)
```

```
.control
tran 0.05n 500n
plot v(2)+0.1 v(4)
plot v(5)
```

```
.endc
.end
```

2)



NAND		
A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

$$Q = \neg(A \wedge B)$$



```
.MODEL MOSN NMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=5.36726E+15 VTO=0.743469 KP=8.00059E-05 GAMMA=0.543
+ PHI=0.6 U0=655.881 UEXP=0.157282 UCRIT=31443.8
+ DELTA=2.39824 VMAX=55260.9 XJ=0.25U LAMBDA=0.0367072
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=1.0 RSH=70.00
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0003 MJ=0.6585
+ CJSW=8.0E-10 MJSW=0.2402 PB=0.58
```

```
.MODEL MOSP PMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=4.3318E+15 VTO=-0.738861 KP=2.70E-05 GAMMA=0.58
+ PHI=0.6 U0=261.977 UEXP=0.323932 UCRIT=65719.8
+ DELTA=1.79192 VMAX=25694 XJ=0.25U LAMBDA=0.0612279
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=-1.0 RSH=120.6
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0005 MJ=0.5052
+ CJSW=1.349E-10 MJSW=0.2417 PB=0.64
```

```
M1 2 5 3 3 MOSN W=1.8u L=1.2u
M2 3 4 0 0 MOSN W=1.8u L=1.2u
M3 2 4 1 1 MOSP W=5.4u L=1.2u
M4 2 5 1 1 MOSP W=5.4u L=1.2u
```

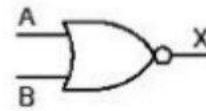
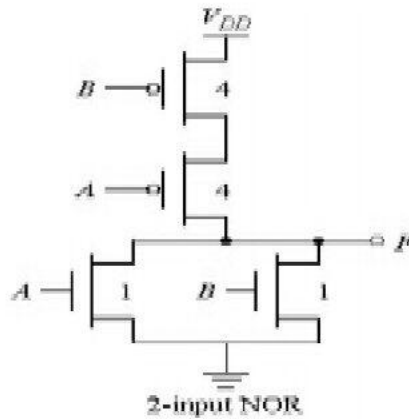
```
vdd 1 0 5V
Vin 4 0 pulse(5V 0V 0 1ns 1ns 100ns 200ns)
Vin1 5 0 pulse(5V 0V 0 1ns 1ns 200ns 400ns)
```

```
c1 5 0 1fF
```

```
.control
tran 0.05n 200n
plot v(2) v(4)+0.1 v(5)+0.2
```

```
.endc
.end
```

3)



A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

```
.MODEL MOSN NMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=5.36726E+15 VTO=0.743469 KP=8.00059E-05 GAMMA=0.543
+ PHI=0.6 U0=655.881 UEXP=0.157282 UCRIT=31443.8
+ DELTA=2.39824 VMAX=55260.9 XJ=0.25U LAMBDA=0.0367072
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=1.0 RSH=70.00
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0003 MJ=0.6585
+ CJSW=8.0E-10 MJSW=0.2402 PB=0.58
```

```
.MODEL MOSP PMOS LEVEL=2 LD=0.15U TOX=200.0E-10
+ NSUB=4.3318E+15 VTO=-0.738861 KP=2.70E-05 GAMMA=0.58
+ PHI=0.6 U0=261.977 UEXP=0.323932 UCRIT=65719.8
+ DELTA=1.79192 VMAX=25694 XJ=0.25U LAMBDA=0.0612279
+ NFS=1E+12 NEFF=1.001 NSS=1E+11 TPG=-1.0 RSH=120.6
+ CGDO=4.3E-10 CGSO=4.3E-10 CJ=0.0005 MJ=0.5052
+ CJSW=1.349E-10 MJSW=0.2417 PB=0.64
```

```
M1 5 2 0 0 MOSN W=1.8u L=1.2u
M2 5 4 0 0 MOSN W=1.8u L=1.2u
M3 3 2 1 1 MOSP W=5.4u L=1.2u
M4 5 4 3 3 MOSP W=5.4u L=1.2u
```

```
vdd 1 0 5V
Vin 2 0 pulse(5V 0V 0 1ns 1ns 100ns 200ns)
Vin1 4 0 pulse(5v 0V 0 1ns 1ns 200ns 400ns)
```

```
c1 5 0 1fF
```

```
.control
tran 0.05n 400n
plot v(5) v(2)+0.1 v(4)+0.2
```

```
.endc
.end
```