#50DAYS CHALLENGE

DAY 4

HALF SUBTRACTOR

a)Design Code

Data Flow Modelling

```
module half_subtractor(input a,b,output difference,borrow);
assign difference=a^b;
assign borrow=(!a)&(b);
endmodule
```

Behavioral Modelling

```
module half_subtractor(a,b,difference,borrow);
input a,b;
output reg difference,borrow;
always@(*)
begin
difference=a^b;
borrow=(!a)&(b);
end
endmodule
```

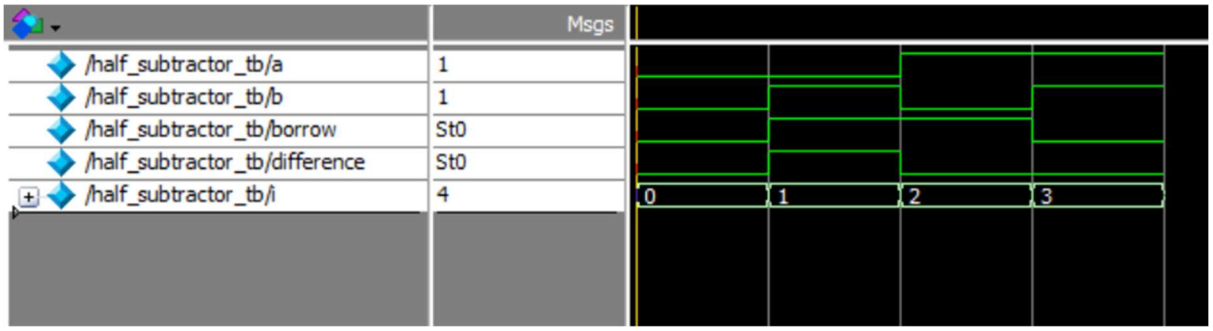
Gate Level Modelling

```
module half_subtractor(input a,b,output difference,borrow);
wire w1;
xor x1(difference,a,b);
not n1(w1,a);
and a1(borrow,w1,b);
endmodule
```

b)Testbench

```
module half_subtractor_tb();
reg a,b;
wire borrow,difference;
integer i;
half_subtractor dut(a,b,borrow,difference);

initial
begin
for(i=0;i<4;i=i+1)
begin
{a,b}=i;
#10;
$display("Time=%t |a=%b |b=%b | difference=%b |borrow=%b ",$time,a,b,difference,borrow);
end
$finish();
end
endmodule
```

c))Waveform



d)Console Output

```
VSIM 3> run -all
# Time=                    10 |a=0 |b=0 | difference=0 |borrow=0
# Time=                    20 |a=0 |b=1 | difference=1 |borrow=1
# Time=                    30 |a=1 |b=0 | difference=0 |borrow=1
# Time=                    40 |a=1 |b=1 | difference=0 |borrow=0
```

FULL SUBTRACTOR

a)Design Code

Data Flow Modelling

```
module full_subtractor(a,b,bin,borrow,difference);
input a,b,bin;
output borrow,difference;
assign borrow=a^b^bin;
assign difference=(!a&b)|(!a&bin)|(b&bin);
endmodule
```

Behavioral Modelling

```
module full_subtractor(a,b,bin,borrow,difference);
input a,b,bin;
output reg borrow,difference;
always@(*)
begin
borrow=a^b^bin;
difference=(!a&b)|(!a&bin)|(b&bin);
end
endmodule
```

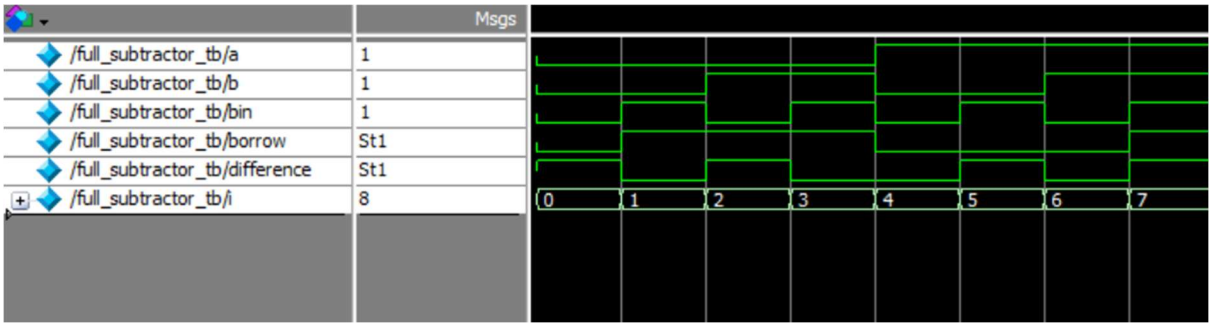
Gate Level Modelling

```
module full_subtractor(a,b,bin,borrow,difference);
input a,b,bin;
output borrow,difference;
wire w1,w2,w3,w4,w5;
xor x1(w2,a,b);
xor x2(difference,w1,bin);
not n1(w1,a);
not n2(w4,w2);
and a1(w3,w1,b);
and a2(w5,w4,bin);
or o1(borrow,w5,w3);
endmodule
```

b)Testbench

```
module full_subtractor_tb();
reg a,b,bin;
wire borrow,difference;
integer i;
full_subtractor dut(a,b,bin,borrow,difference);

initial
begin
for(i=0;i<8;i=i+1)
begin
{a,b,bin}=i;
#10;
$display("Time=%t |a=%b |b=%b | bin=%b | difference=%b |borrow=%b ",$time,a,b,bin,difference,borrow);
end
$finish();
end
endmodule
```

c) Waveform



d)Console Output

```
# Time=                10 |a=0 |b=0 | bin=0 | difference=1 |borrow=0
# Time=                20 |a=0 |b=0 | bin=1 | difference=0 |borrow=1
# Time=                30 |a=0 |b=1 | bin=0 | difference=1 |borrow=1
# Time=                40 |a=0 |b=1 | bin=1 | difference=0 |borrow=1
# Time=                50 |a=1 |b=0 | bin=0 | difference=0 |borrow=0
# Time=                60 |a=1 |b=0 | bin=1 | difference=1 |borrow=0
# Time=                70 |a=1 |b=1 | bin=0 | difference=0 |borrow=0
# Time=                80 |a=1 |b=1 | bin=1 | difference=1 |borrow=1
```

FULL SUBTRACTOR USING HALF SUBTRACTOR

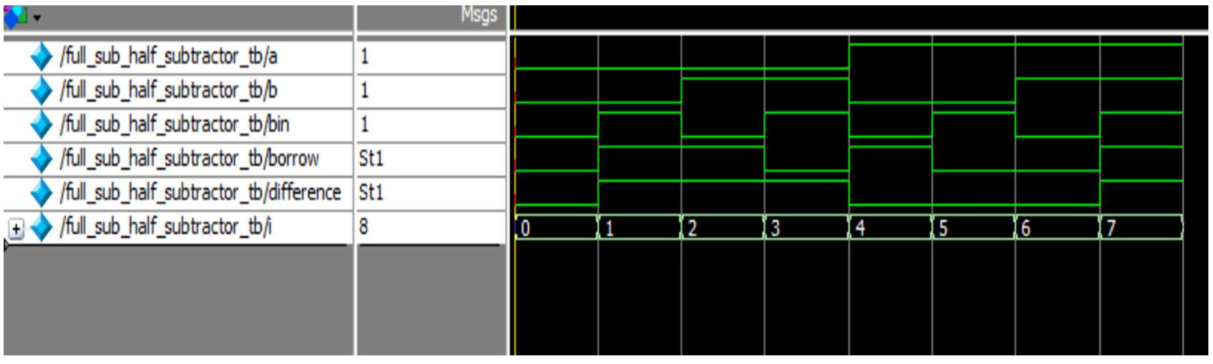
a)Design Code

```
module half_subtractor(input a,b,output difference,borrow);
assign difference=a^b;
assign borrow=(!a)&(b);
endmodule

module full_sub_half_subtractor(input a,b, bin,output difference,borrow);
wire w1,w2,w3;
half_subtractor h1(a,b,w1,w2);
half_subtractor h2(w1,bin,difference,w3);
assign borrow=w2|w3;
endmodule
```

b)Testbench

```
module full_sub_half_subtractor_tb();
reg a,b,bin;
wire borrow,difference;
integer i;
full_sub_half_subtractor dut(a,b,bin,borrow,difference);

initial
begin
for(i=0;i<8;i=i+1)
begin
{a,b,bin}=i;
#10;
$display("Time=%t |a=%b |b=%b | bin=%b | difference=%b |borrow=%b ",$time,a,b,bin,difference,borrow);
end
$finish();
end
endmodule
```

c)Waveform



d)Console Output

```
# Time=                    10 |a=0 |b=0 | bin=0 | difference=0 |borrow=0
# Time=                    20 |a=0 |b=0 | bin=1 | difference=1 |borrow=1
# Time=                    30 |a=0 |b=1 | bin=0 | difference=1 |borrow=1
# Time=                    40 |a=0 |b=1 | bin=1 | difference=1 |borrow=0
# Time=                    50 |a=1 |b=0 | bin=0 | difference=0 |borrow=1
# Time=                    60 |a=1 |b=0 | bin=1 | difference=0 |borrow=0
# Time=                    70 |a=1 |b=1 | bin=0 | difference=0 |borrow=0
# Time=                    80 |a=1 |b=1 | bin=1 | difference=1 |borrow=1
```