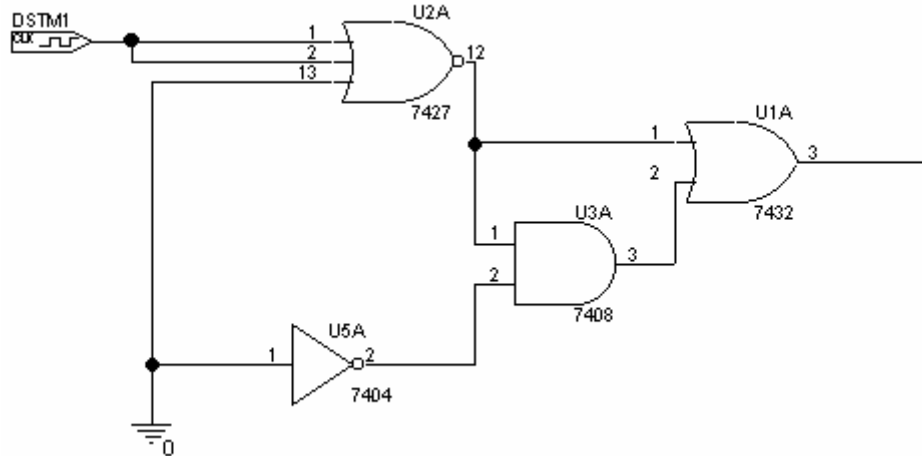## 1) Logic Gates (20 points)

You should recognize the digital gates in the following circuit as the ones introduced in the lab and/or in class.
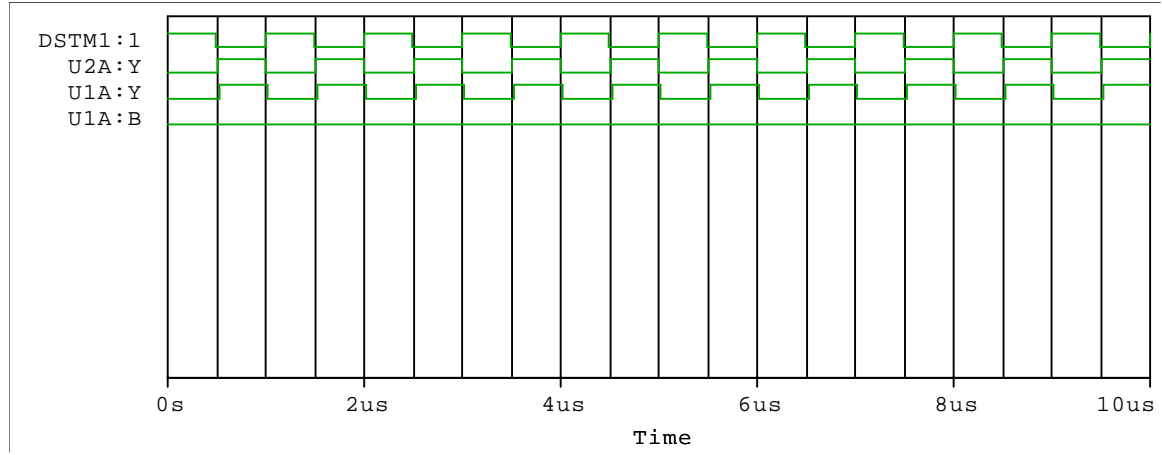

a) What kind of gate is U2A? (2 points)

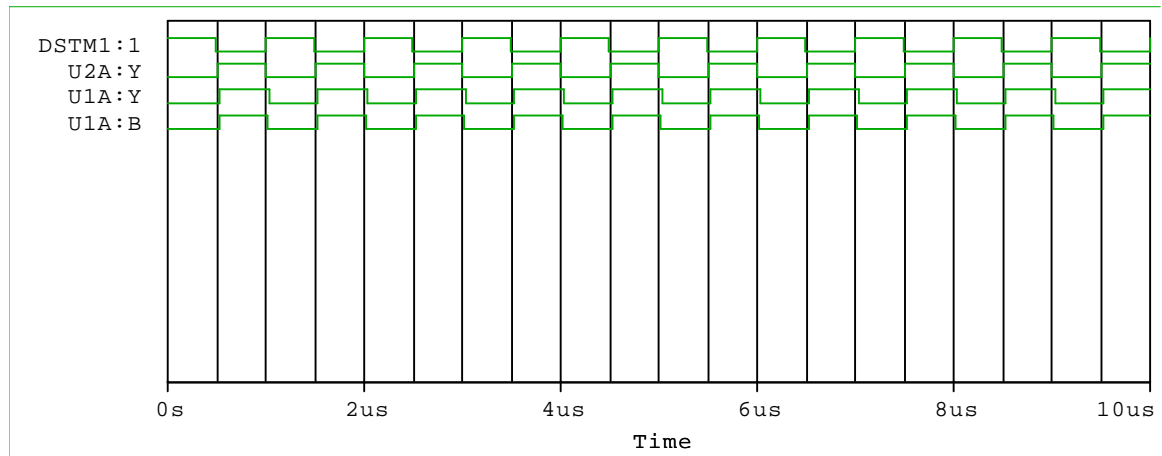b) What is the truth table for gate U2A? (6 points)

c) Indicate which of the three plots on the following page represents the output of the circuit. Show any work below for partial credit. (12 points)
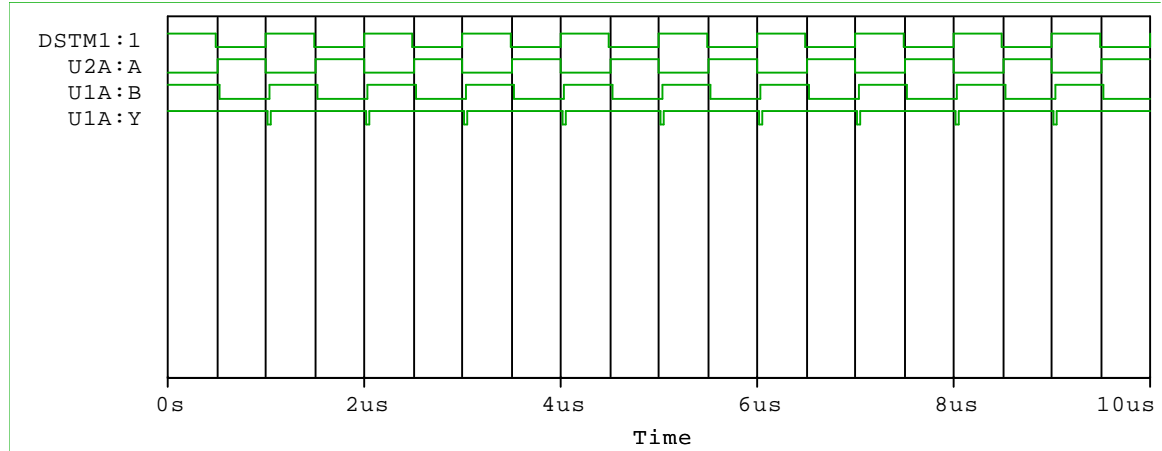
Circuits for question 1 part c).

A.


```
DSTM1:1
 U2A:Y
 U1A:Y
 U1A:B
```

0s   2us   4us   6us   8us   10us

Time

B.


```
DSTM1:1
 U2A:Y
 U1A:Y
 U1A:B
```

0s   2us   4us   6us   8us   10us

Time

C.


```
DSTM1:1
 U2A:A
 U1A:B
 U1A:Y
```

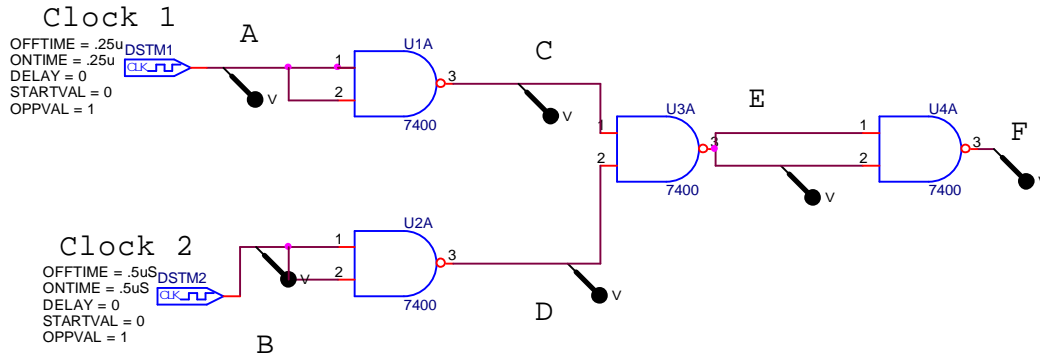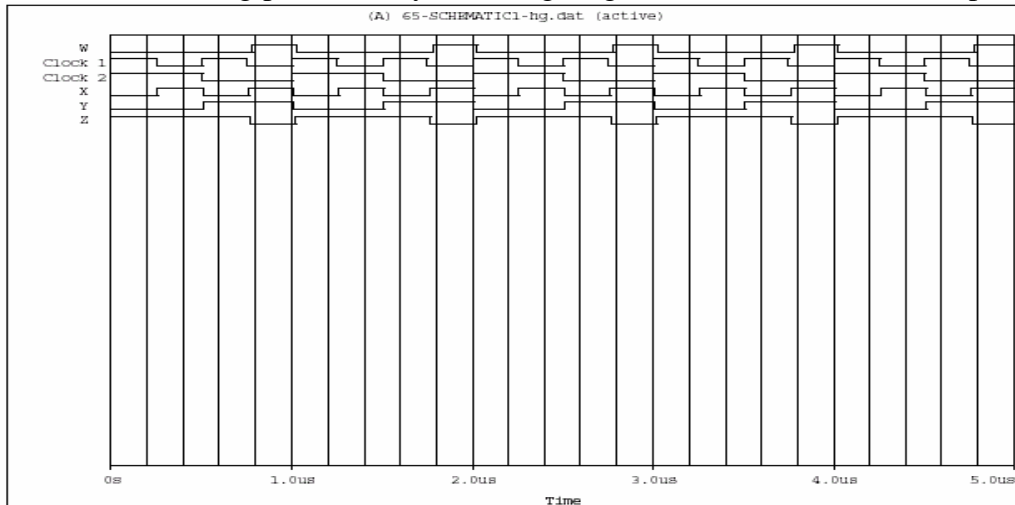0s   2us   4us   6us   8us   10us

Time

2) NAND Gate Circuits (20 points)

It is possible to configure all standard gates using just NAND gates. The figure below show one such combination of NANDS.

a. On the following plot, identify which signal goes with which location (6 points).

b. Draw a truth table for the circuit, showing the inputs, the output and as many steps in between as you need to determine how it works (10 points).

c. Which single type of gate is this circuit equivalent to (4 points)?

3) Combinational Logic (20 points)

Draw the truth table for the circuit above:

A	B	C	D	E	F	G	H	I	Q

4) Digital-to-Analog Converter (20 points)

a) In figure below, R5 = 20K? , R6 = 1K? and R7 = 5K? . This configuration of op-
    amps and resistors can produce an analog output voltage equal to the binary word
    ABCD input at the left. Assume that you are working with TTL devices, so the
    voltage levels for ones and zeros are TTL levels (0V and 5V). Select values for R1,
    R2, R3, and R4 so that the output voltage will be the decimal equivalent of ABCD.
    For example if ABCD=1010, or equivalently VA=VC=5v, VB=VD=0v, Vout = 10v.
    The circuit should work for **all** possible ABCD combinations. (12 points)

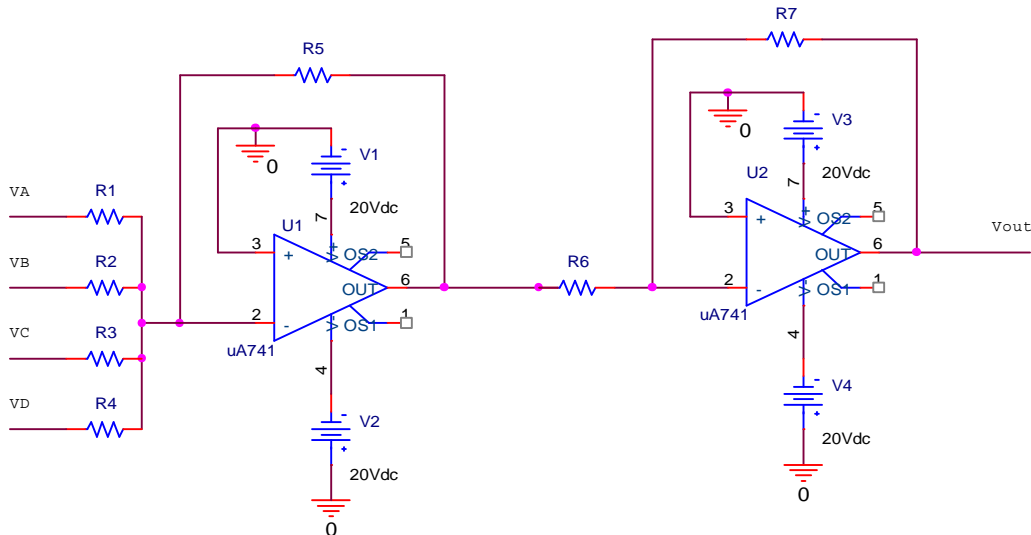R1 =   R2 =   R3 =   R4 =

b) Your choices of resistors should work for any number, but specifically show that your
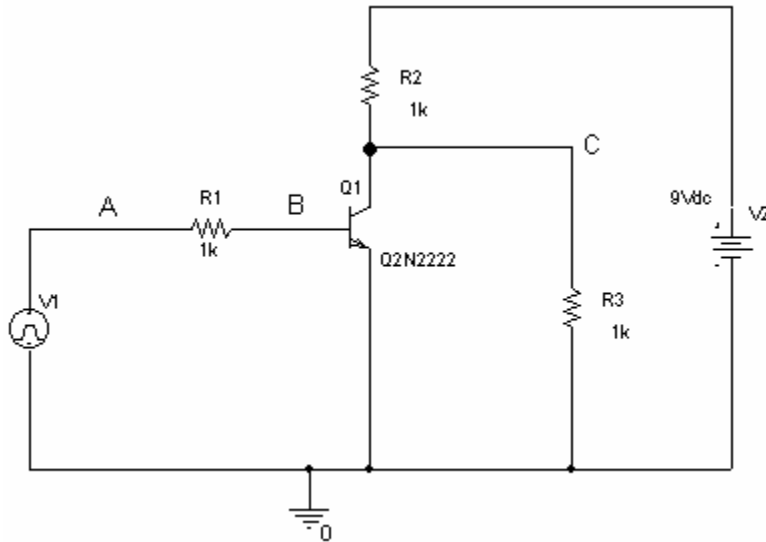values work for the two binary numbers ABCD =0010 and ABCD = 1011. (8 points)

(Show your work here for question 4.)
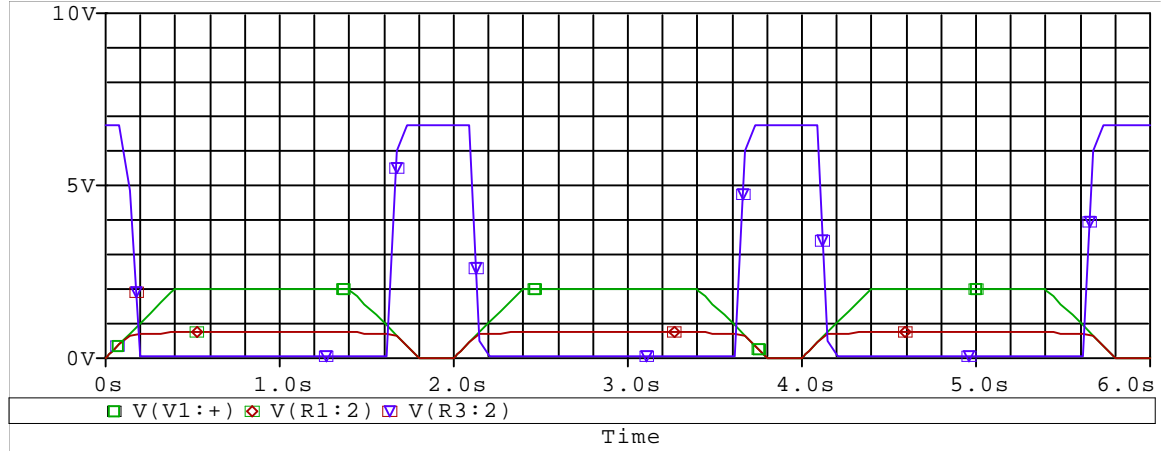
5) Transistor Circuit (20 points)

a) Redraw the circuit when the diode in the transistor is "off". Show the transistor as a switch in the appropriate position. What is the value of the voltage at point C? (6 points)

b) Redraw the circuit when the diode in the transistor is "on". Show the transistor as a switch in the appropriate position. What is the value of the voltage at point C? (6 points)
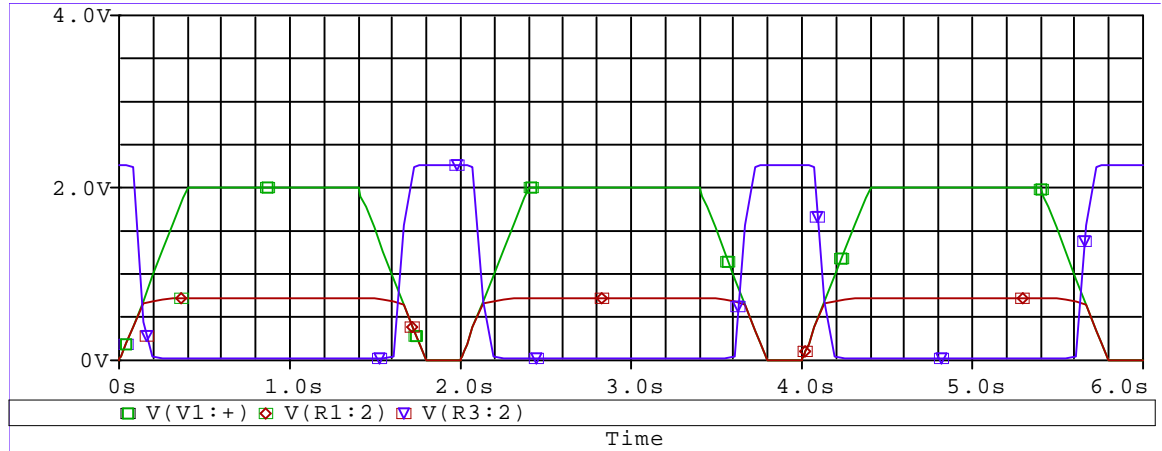
c) Indicate which of the three plots on the following page corresponds to the circuit above AND indicate on the chosen plot, which signal corresponds to which of the above points (A, B, C, D) on the circuit. (8 points)

Plots for question 5.

A

B.

C.