Data Tables

In all the data tables, write the input combinations in ascending order.

SL	$V_D(V)$	$V_C(V)$	$V_B(V)$	$V_A(V)$	$V_Y(V)$	
0	0	0	0	0	0	0.5
1	0	0	0	5	-0.5	0.6
2	0	0	5	0	-1.1	0.5
3	0	0	5	5	-1.57	0.3
4	0	5	0	0	-1.89	0.5
5	0	5	0	5	-2.39	0.3
6	0	5	5	0	-2.97	0.5
7	0	5	5	5	-3.48	0.4
8	5	0	0	0	-4.22	0.7
9	5	0	0	5	-4.72	0.5
10	5	0	5	0	-5.30	0.6
11	5	0	5	5	-5.80	0.5
12	5	5	0	0	-6.11	0.3
13	5	5	0	5	-6.60	0.5
14	5	5	5	0	-7.03	0.4
15	5	5	5	5	-7.31	0.3

Table 1: Table for binary-weighted D/A converter

SL	$V_D(V)$	$V_C(V)$	$V_B(V)$	$V_A(V)$	$V_Y(V)$	
0	0	0	0	0	0	
1	0	0	0	5	−0.89	0.89
2	0	0	5	0	−1.72	0.8~~8~~
3	0	0	5	5	−2.62	0.9
4	0	5	0	0	−2.77	0.2
5	0	5	0	5	−3.22	0.5
6	0	5	5	0	−3.86	0.6
7	0	5	5	5	−4.54	0.7
8	5	0	0	0	−4.98	0.4
9	5	0	0	5	−5.87	0.9
10	5	0	5	0	−6.72	0.9
11	5	0	5	5	−7.21	0.5
12	5	5	0	0	−7.48	0.3
13	5	5	0	5	−7.88	0.4
14	5	5	5	0	−7.94	0.1
15	5	5	5	5	−7.99	0.01

Table 2: Table for R/2R ladder D/A converter

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Report

Please answer the following questions briefly in the given space.

1. Find the resolution of both D/A converters.

Ans.

For binary D/A converter:

Resolution = 0 − (−0.5) = 0.5

For, R/2R ladder D/A converter:

Resolution = 0 − (−0.89) = 0.89 ≈ 0.9

2. For any one of the converters, change the value of R_F (feedback resistance) to $0.5\times R_F$ and then to $2\times R_F$. For each case, measure output voltage for any two consecutive input combinations and calculate the step sizes. Does the effect on step size match with the theory?

Ans. Using R/2R ladder D/A converter:-

For 0.5 R_F,

$$V_o = (-0.5R_F)\left(\frac{V_A}{R_1} + \frac{V_B}{R_2} + \frac{V_C}{R_3} + \frac{V_D}{R_4}\right)$$

for $V_A = V_B = V_C = V_D = 0\,V$

$V_o = 0$

for $V_A = V_B = V_C = 0\,V$, $V_D = 5\,V$

$V_o = (-0.5 * 20)\left(\frac{5}{20}\right) = -2.5\,V$

For 2 R_F

$$V_o = (-2R_F)\left(\frac{V_A}{R_1} + \frac{V_B}{R_2} + \frac{V_C}{R_3} + \frac{V_D}{R_4}\right)$$

for $V_A = V_B = V_C = V_D = 0\,V$

$V_o = 0\,V$

for $V_A = V_B = V_C = 0\,V$, $V_D = 5\,V$

$V_o = (-2 * 20)\left(\frac{5}{20}\right) = -10\,V$

Theoritically, $V_o \propto -R_f \Rightarrow \underbrace{\Delta V_o}_{\text{step size}} \propto \Delta R_f$

R_f	V_A	V_B	V_C	V_D	V_o	
0.5 R_f	0	0	0	0	0	step size = 2.5 V
	0	0	0	5	−2.5	
2 R_f	0	0	0	0	0	step size = 10 V
	0	0	0	5	−10	

For 0.5 R_f,

$\Delta V_o = 0 - (-2.5) = 2.5\,V$

step size = 2.5

For 2 R_f,

$\Delta V_o = 0 - (-10) = 10\,V$

step size = 10

∴ The effect of step size matches with the theory.

3. How can you get output lower than -15 V in the above D/A converters?
Ans.

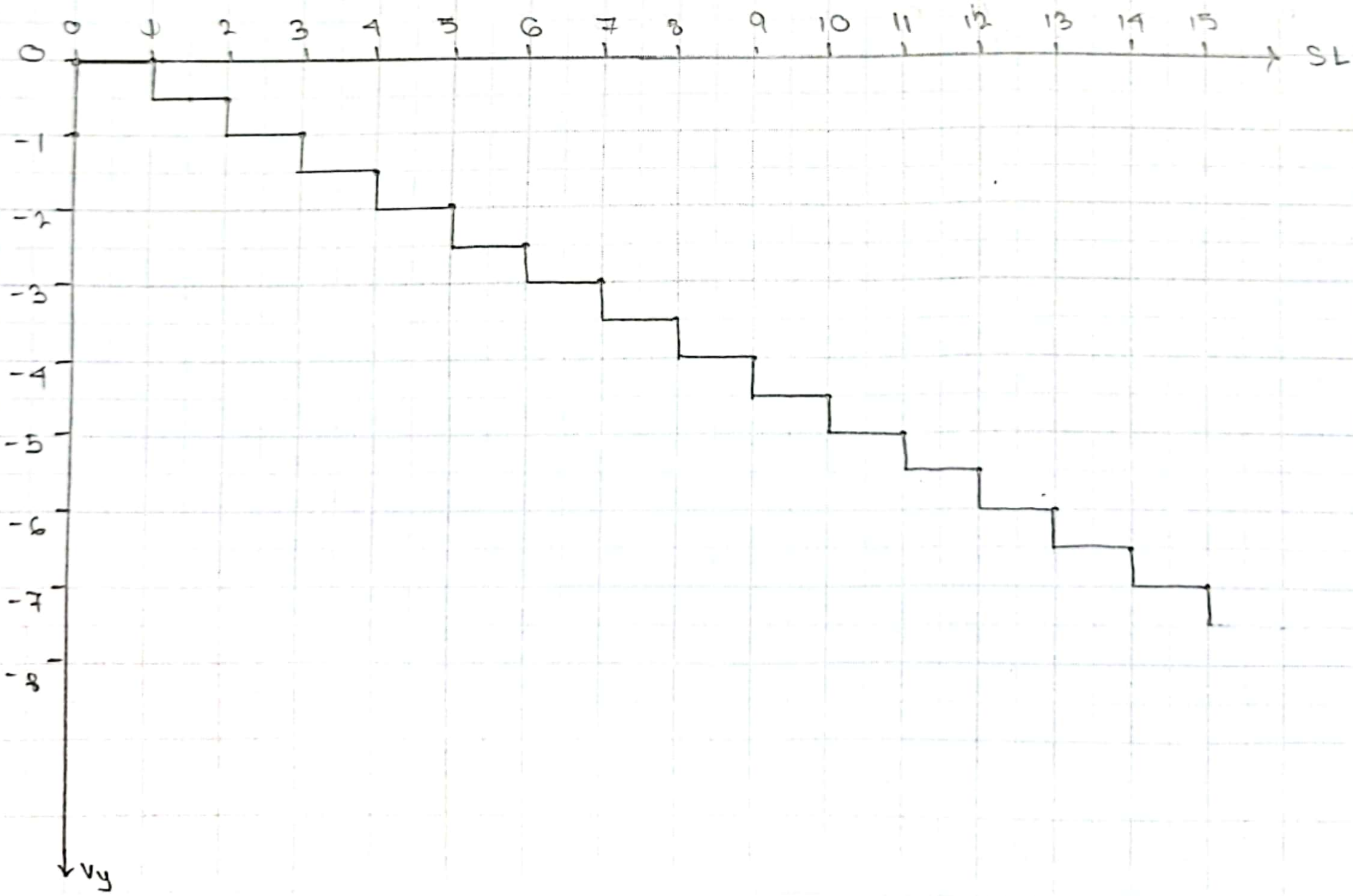
Since we connect the $-V_s$ pin of the op-amp to the -ve terminal of the trainer board voltage supply, we can move the knob and change the voltage lower than -15V and check the voltage change with multimeter for accuracy.

If we lower $-V_s$ to less than -15V, then we can get output lower than -15V.

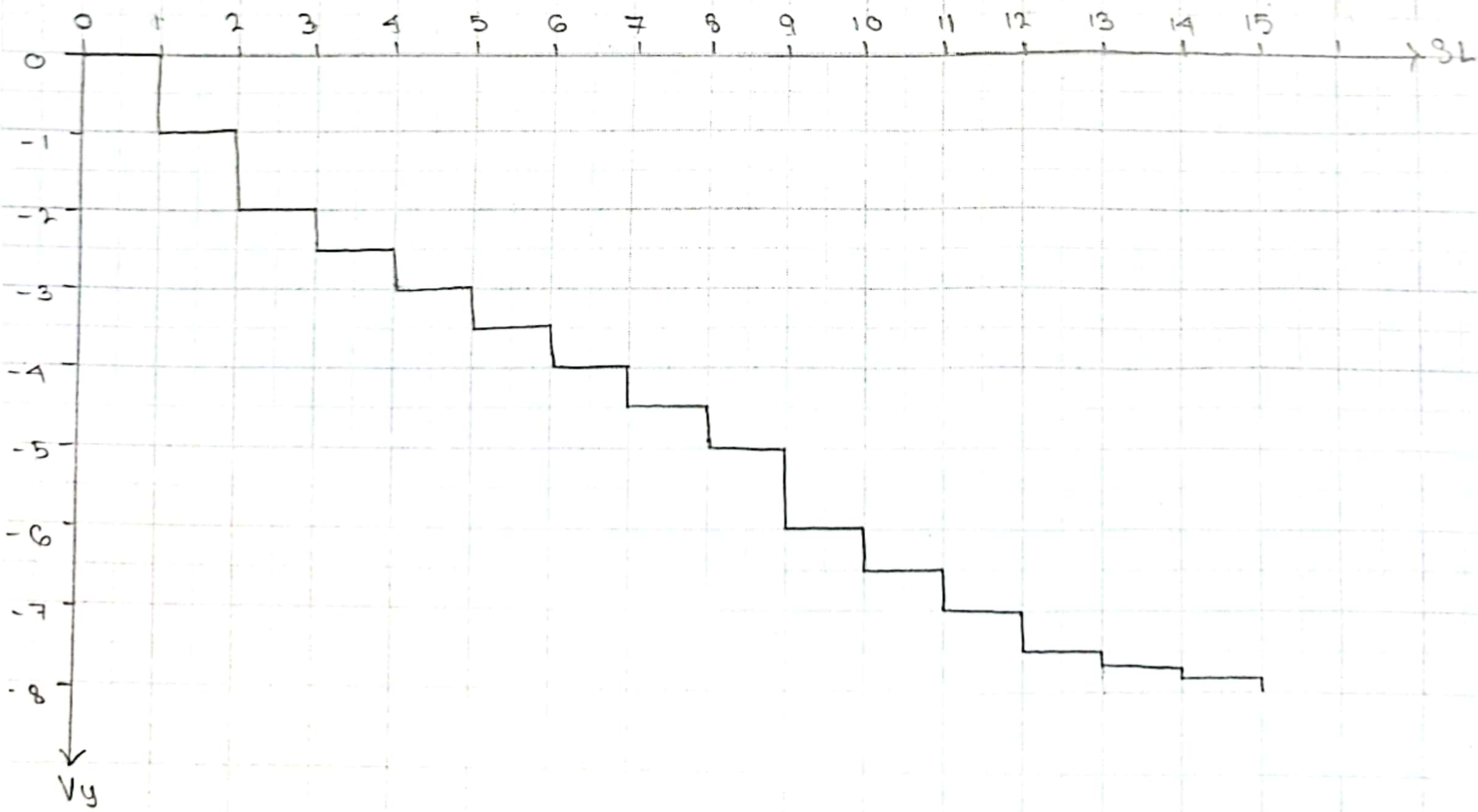
4. Plot the results obtained in table 1 and table 2 in the given graph paper. Keep the serial no of inputs in the horizontal axis and the output voltages in the vertical axis.

5. Briefly discuss which of the two converters is better in a practical scenario.

R/2R Ladder D/A converter is better than binary D/A converter because R/2R ladder uses only 2 resistors of known resistance, whereas binary D/A converter uses $\frac{R_1}{2}, \frac{R_1}{4}, \frac{R_1}{8}$ of only R1 resistor of known resistance (R_1). It is quite difficult to find out exact-valued resistors for $\frac{R_1}{2}, \frac{R_1}{4}, \frac{R_1}{8}$ resistances which makes the result of the output less reliable for D/A converter. Using R/2R ladder, the problem of finding out exact valued resistances is resolved.



Graph paper for table 1



Graph paper for table 2