CSE350

Digital Electronics and Pulse Techniques

Lab Report

Experiment No: 04

Analysis of the binary weighted and R/2R ladder D/A converters

Submitted by:

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Section - 04

Department - CSE

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BRAC UNIVERSITY

Objective:

The objective of this experiment is to construct two different D/A converter and to verify that digital signal is converted into proportional analog signal.

Equipment:

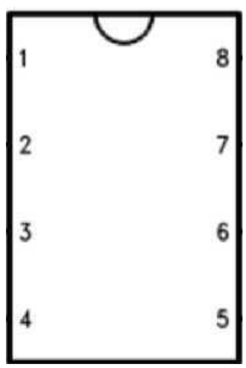
Resistance = 10K, 20K, 5K, 2.5K, 1.25K

Dc source

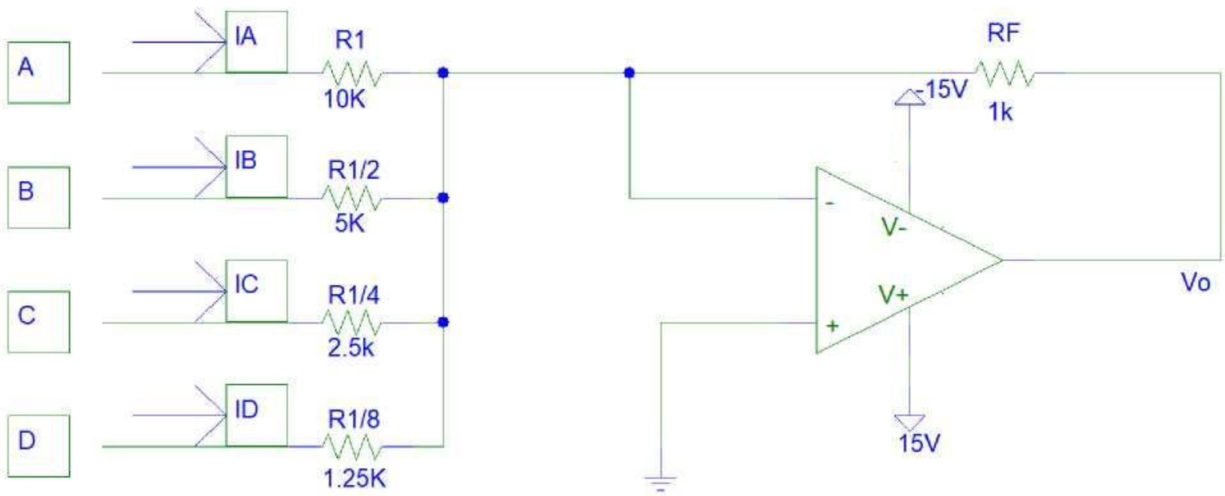
Operational Amplifier

Multimeter

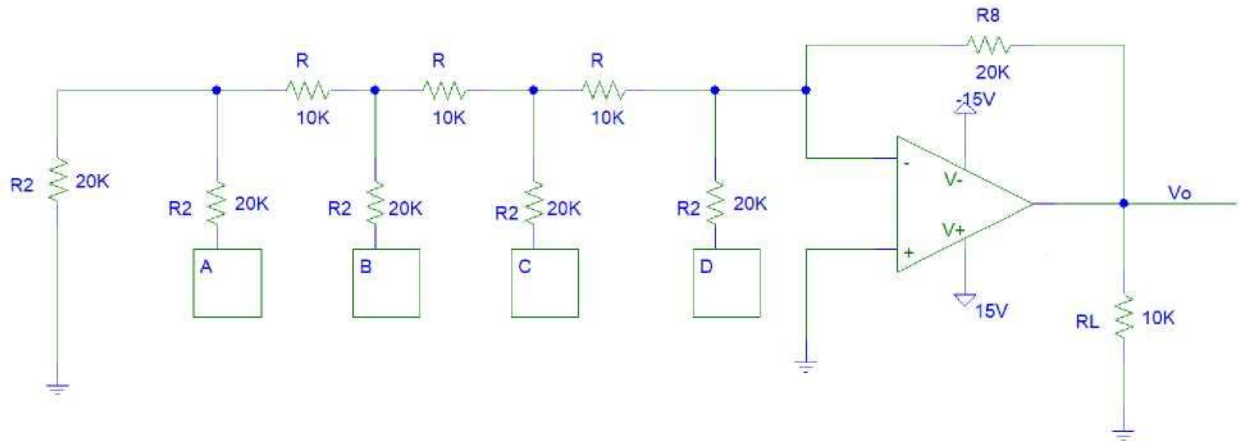
Circuit Diagram:

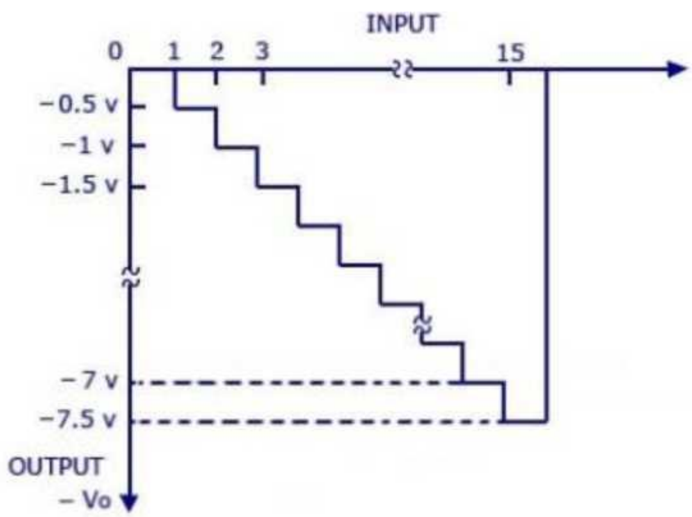


Circuit Diagram 01
Digital to Analog Converter using Binary-Weighted Resistors



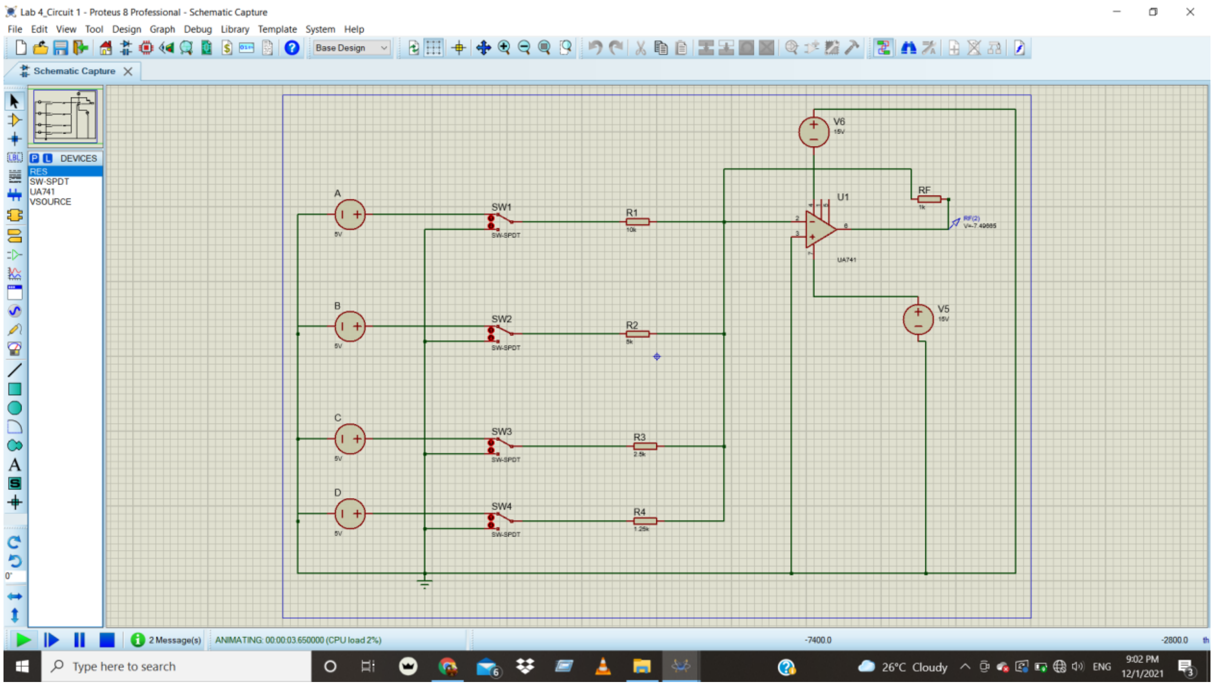
Circuit Diagram 02
Digital to Analog Converter with R and 2R Resistors



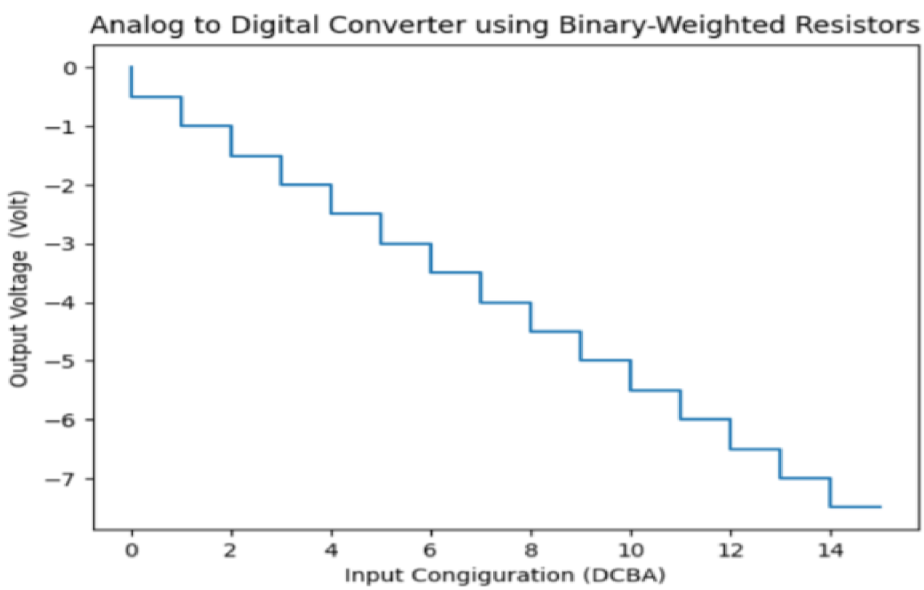


Circuits:

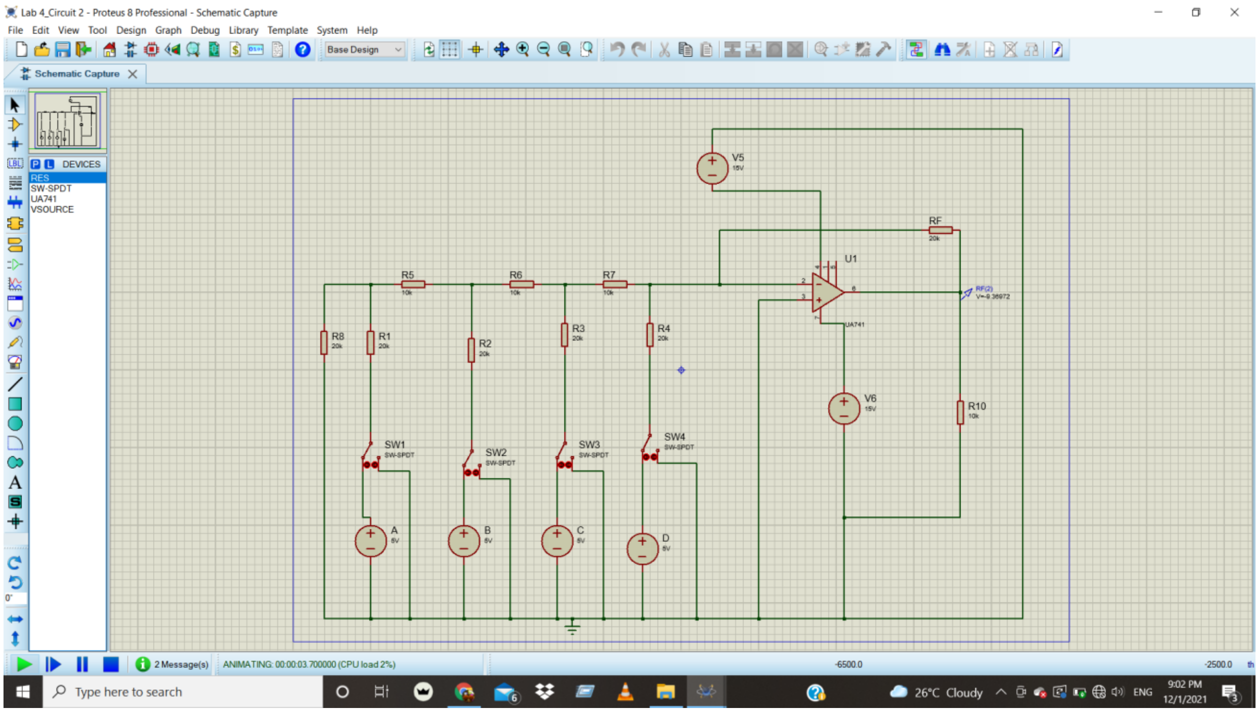
Circuit 01



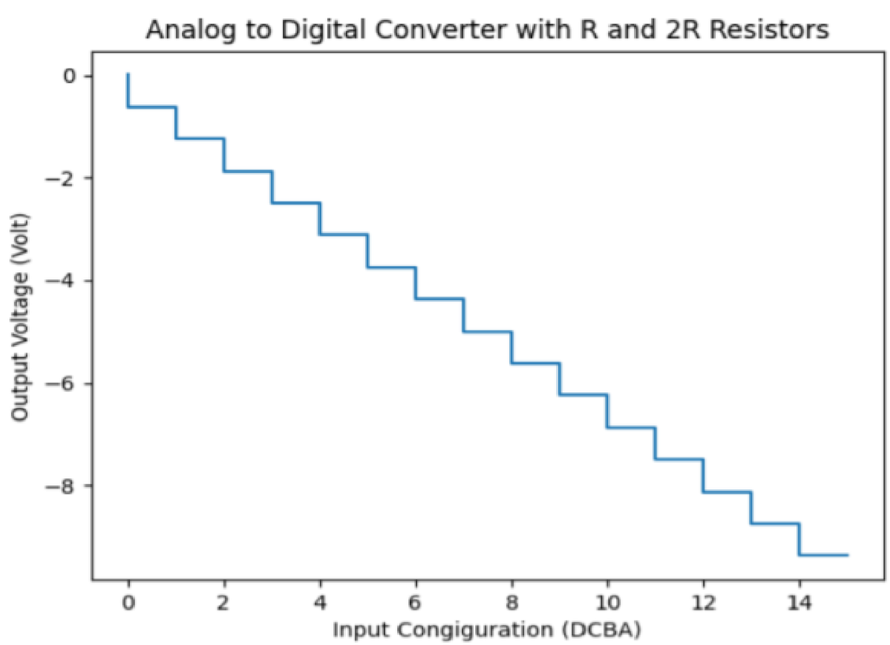
Graph For Circuit 1:



Circuit 02



Graph For Circuit 2:



Data table: Circuit-1:

Input Configuration	D	C	B	A	Output voltage, Vo (V)
1	0	0	0	0	0.00272
2	0	0	0	1	-0.497259
3	0	0	1	0	-0.99723
4	0	0	1	1	-1.4972
5	0	1	0	0	-1.99714
6	0	1	0	1	-2.49712
7	0	1	1	0	-2.9971
8	0	1	1	1	-3.49708
9	1	0	0	0	-3.99685
10	1	0	0	1	-4.49683
11	1	0	1	0	-4.9968
12	1	0	1	1	-5.49678
13	1	1	0	0	-5.99672
14	1	1	0	1	-6.4967
15	1	1	1	0	-6.99667
16	1	1	1	1	-7.49665

Circuit-2

Input Configuration	D	C	B	A	Output voltage, Vo (V)
1	0	0	0	0	0.00495
2	0	0	0	1	-0.620026
3	0	0	1	0	-1.24501
4	0	0	1	1	-1.86999
5	0	1	0	0	-2.49996
6	0	1	0	1	-3.11994
7	0	1	1	0	-3.77492
8	0	1	1	1	-4.3699
9	1	0	0	0	-4.99487
10	1	0	0	1	-5.67985
11	1	0	1	0	-6.24983
12	1	0	1	1	-6.86981
13	1	1	0	0	-7.49478
14	1	1	0	1	-8.11976
15	1	1	1	0	-8.74479
16	1	1	1	1	-9.36972

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Answer to the Question No-1 : By Changing the value of R_F we can change the value of the step size. But there's only one condition and that is we need to set the step value in such a way that for any input our analog value must be less than (±15 V), meaning output voltage should exceed saturation levels of the op amp? So, it is not possible to get higher than 15 V in D2A converter.

Answer to the Question No-2:

We know, full step output = Reference voltage × Vo (LSB)

For, Binary weighted D2A, resolution ~~value~~ $= 1 - .4971 = .497$

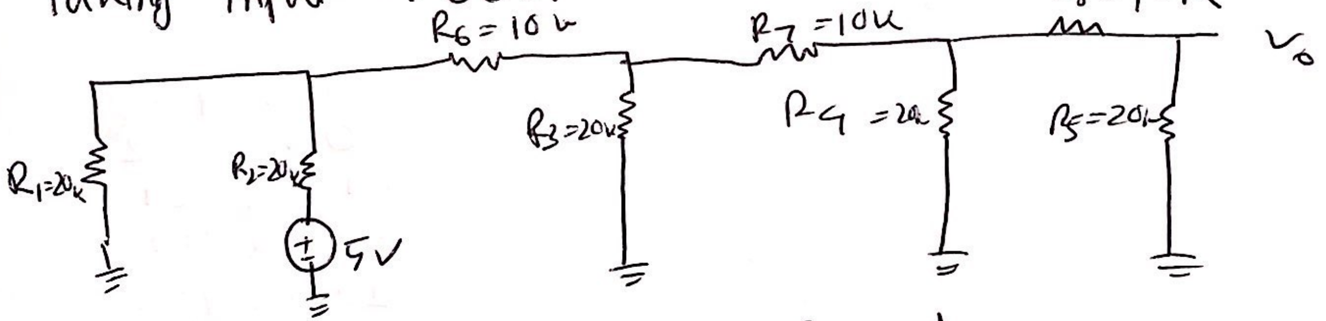
$\therefore$ full step output $= 15 \times .497 = 7.455$ volt

For, R and 2R R2A, resolution ~~value~~ $= 1.6201 = .620$

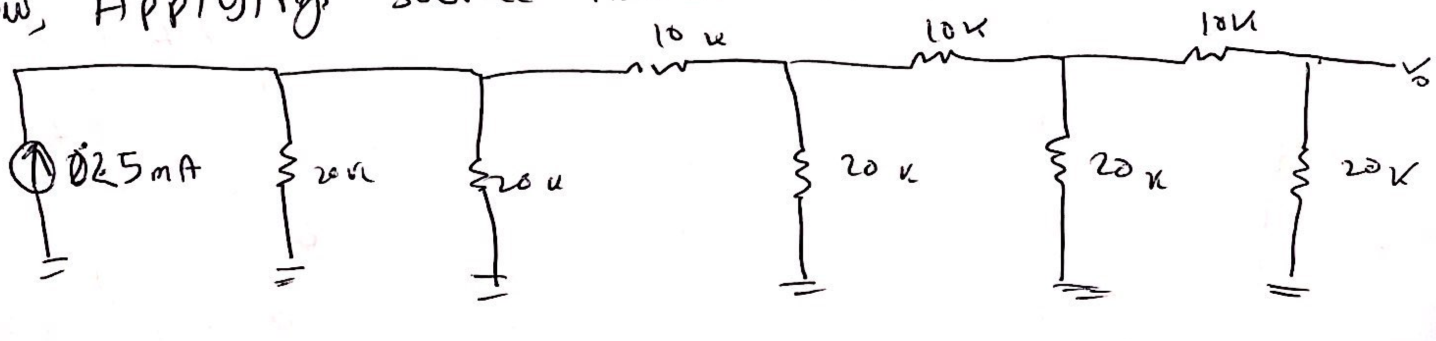
$\therefore$ full step output $= 15 \times .620 = 9.3$ Volt

Answer to the Question No-3 :-

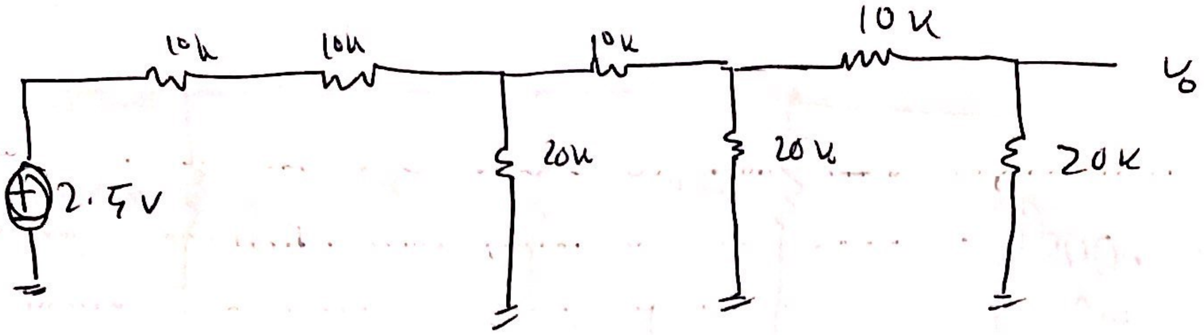
Taking input → 0001

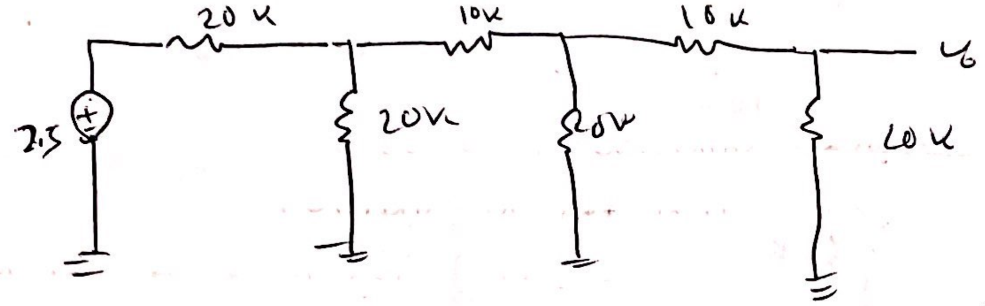


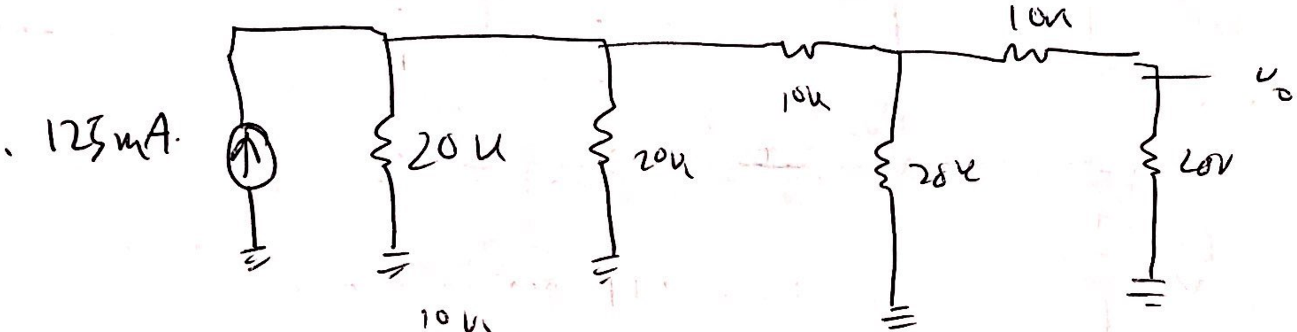
Now, Applying source transformation :

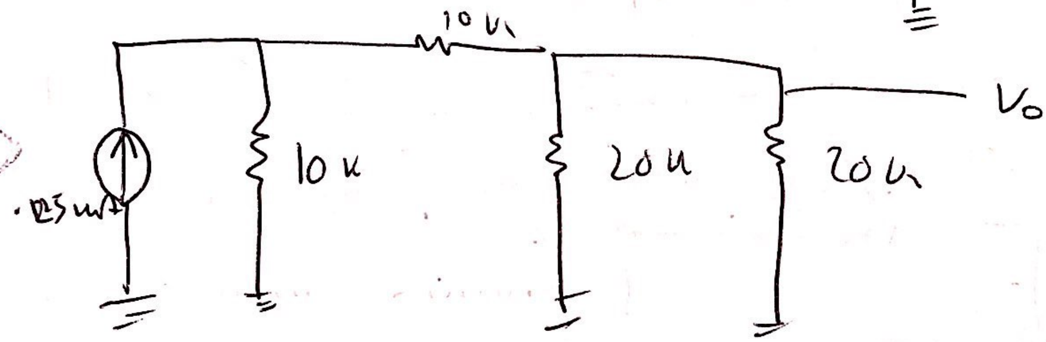


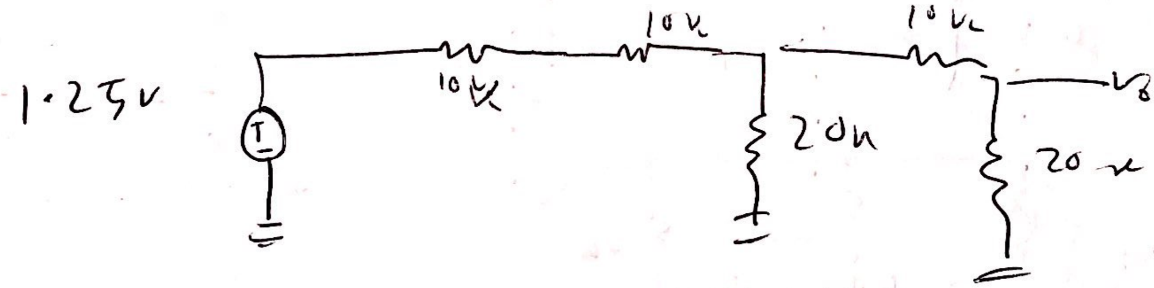
Scanned with CamScanner

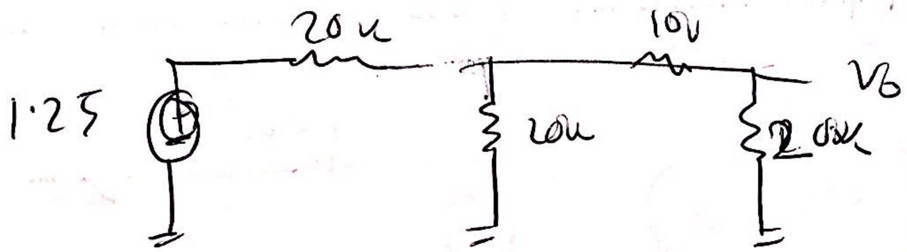
⇒ 
10k
10k
10k
10k
20k
20k
20K
2.5V
V_o

⇒ 
20K
10K
10K
2.5
20K
20K
20K
V_o

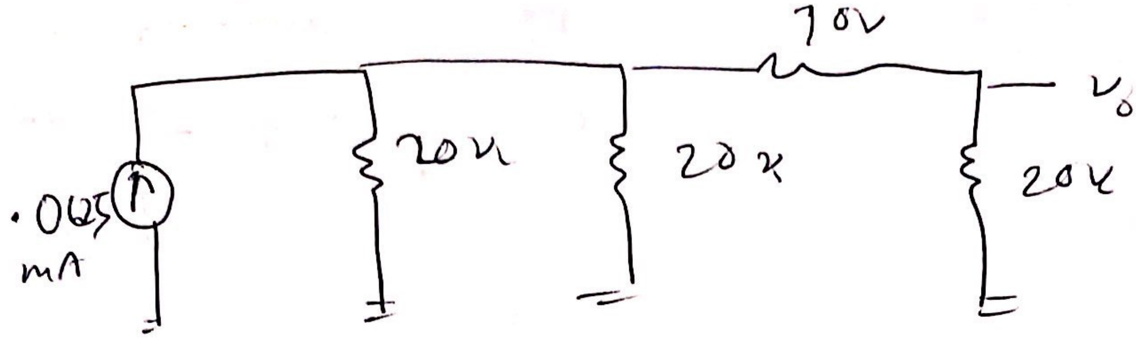
⇒ 
.125mA.
20K
20K
10K
10K
20K
20K
V_o

⇒ 
.125mA
10K
10K
20K
20K
V_o

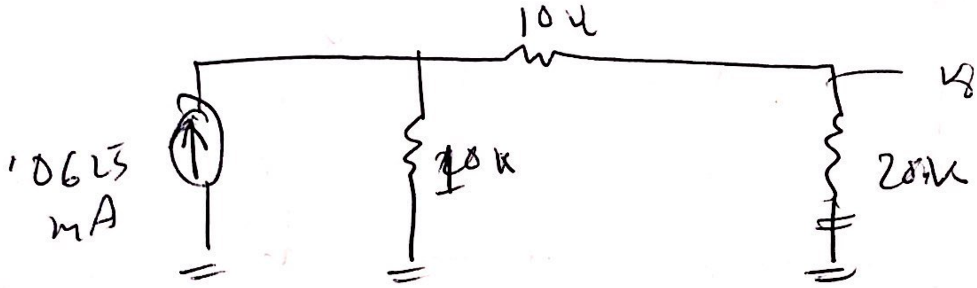
⇒ 
1.25V
10K
10K
10K
20K
20K
V_o

⇒ 
1.25
20K
10K
20K
20K
V_o

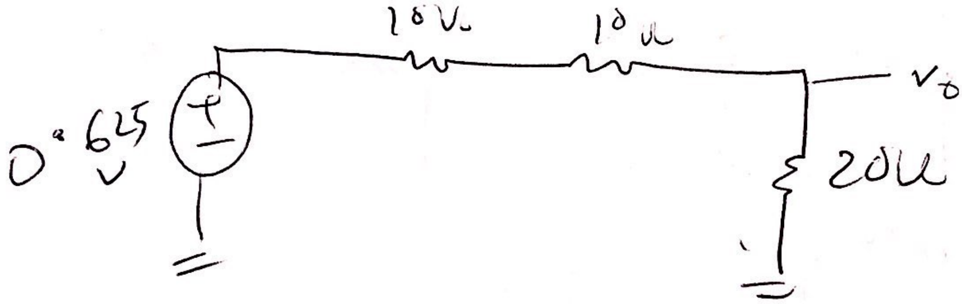
⇒


10k
20k
20k
20k
v_0
.0625
mA

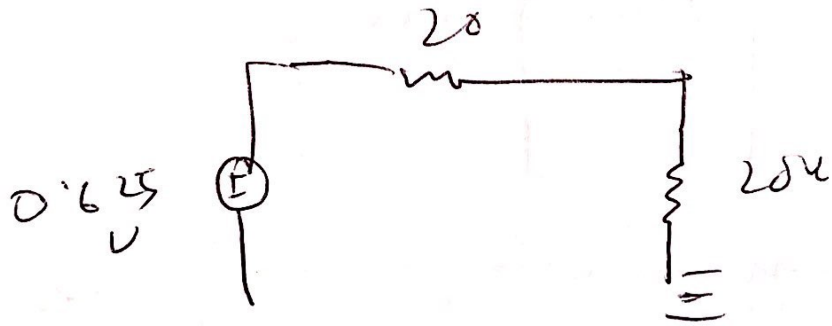
⇒


10k
.0625
mA
10k
20k
v_0

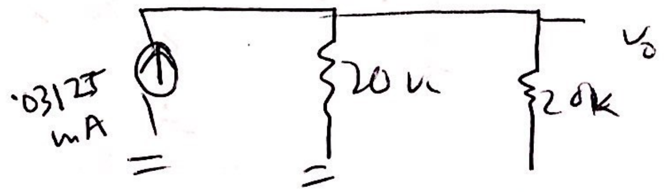
⇒


10k
10k
0.625
V
20k
v_0

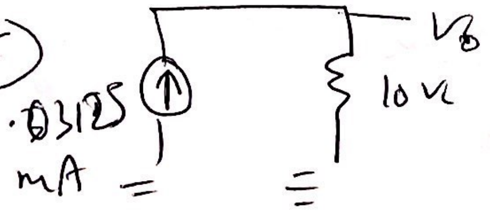
⇒


20
0.625
V
20k

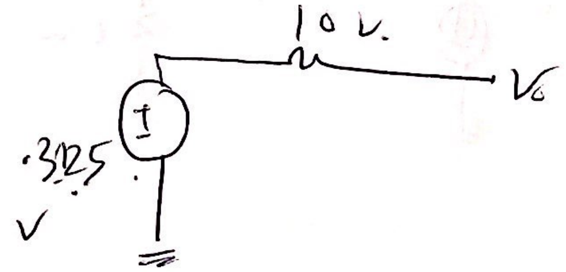
⇒


.03125
mA
20k
20k
v_0

⇒


.03125
mA
10k
v_0

⇒


10k
.3125
V
v_0

The closed loop voltage gain of an inverting amplifier is:

$$\frac{V_{out}}{V_{in}} = \frac{-R_f}{R_{in}}$$

$$\Rightarrow V_{out} = \frac{-20}{10} \times (.3125)$$

$$= -0.625\,v$$

Answer to the Question No- 4 :

ID- 19101038 ∴ $V_A = V_B = V_C = V_D = 3 + 8 = 11\,v$

Input configuration	D	C	B	A	Output Voltage
1	0	0	0	0	0.0027228
2	0	0	0	1	-1.09729
3	0	0	1	0	-2.19717
4	0	0	1	1	-3.29713
5	0	1	0	0	-4.39698
6	0	1	0	1	-5.49694
7	0	1	1	0	-6.59688
8	0	1	1	1	-7.69684
9	1	0	0	0	-8.79634
10	1	0	0	1	-9.8963
11	1	0	1	0	-10.9962
12	1	0	1	1	-12.0962
13	1	1	0	0	-13.196
14	1	1	0	1	-13.4965
15	1	1	1	0	-13.4959
16	1	1	1	1	-13.4953

Answer to the Q. 5 :

We know, Step size = $\left(\frac{R_F}{R_{in}}\right) V_{HIGH}$

From this formula, it can be said that, by changing the value of R_F, R_i and V_{HIGH}, we can control the step size. It is seen that, the relationship between R_F and step size is proportional. That means If we increase R_F, the step size will increase too. and if we decrease the R_F and step size will decrease as well, but when the value of R_i and V_{HIGH} is unchanged.