EE381: Exp-1

Design and Implementation of a BJT Operational Amplifier

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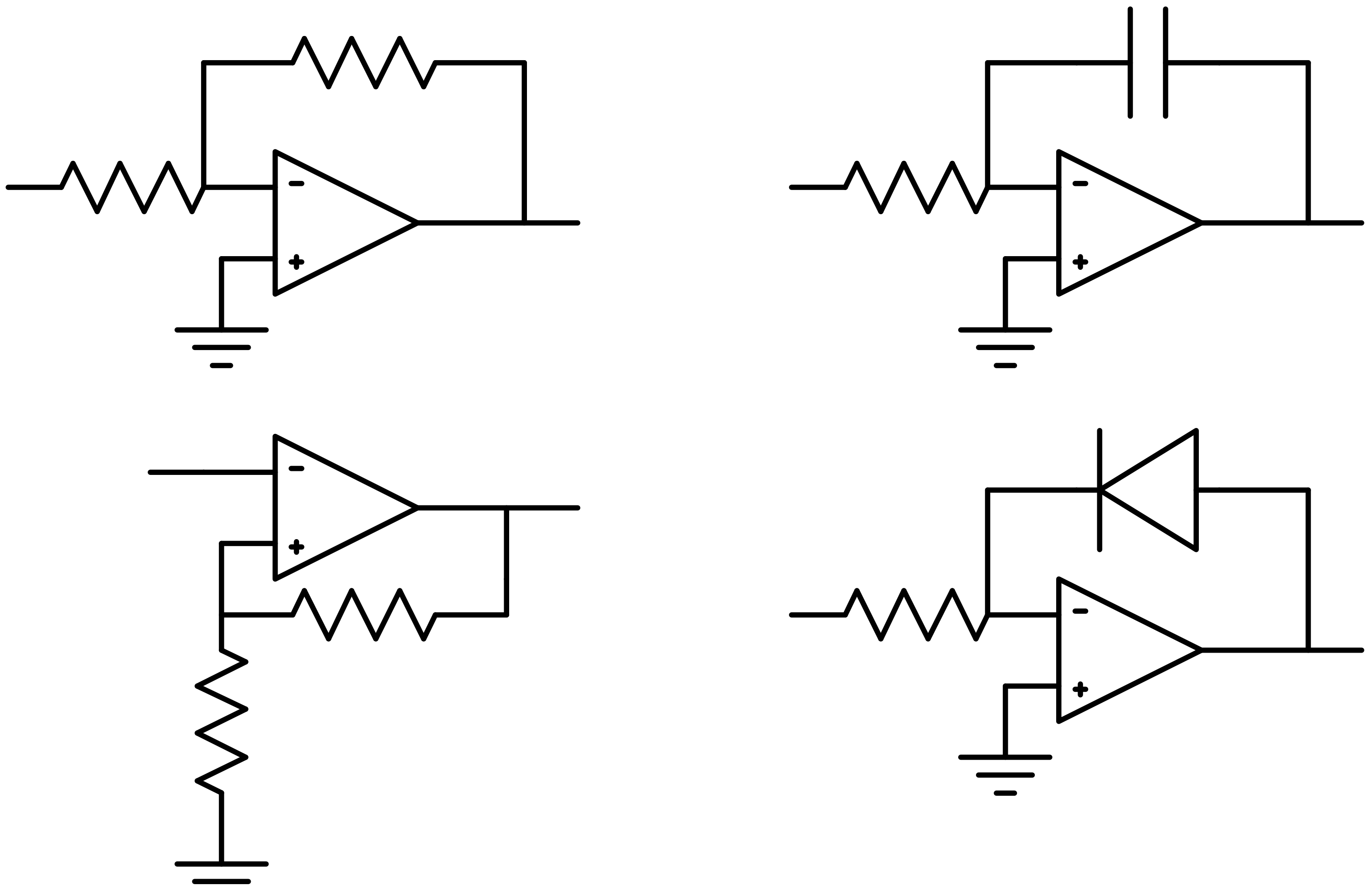
How do we decide the specs. Of the opamp?



Specifications of the opamp

$$A_V \geq 10^3$$

$$R_{in} \geq 10^5\Omega$$

$$R_O \leq 10^2\Omega$$

$$V_{CC} \pm 12V$$

- These are only the baseline specs. You are free to choose specs. better than these.

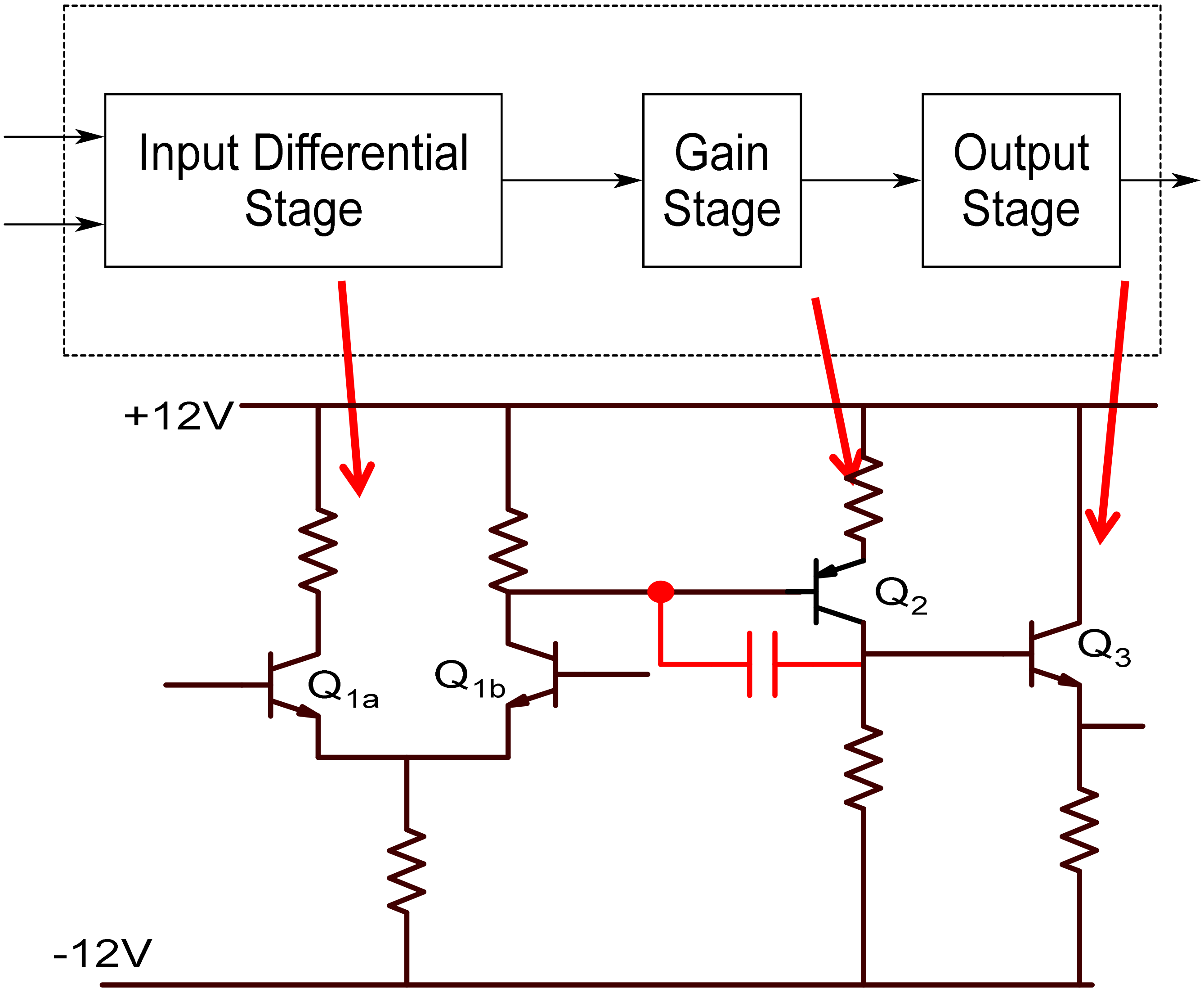
Design is a decision making process

1. Choice of Technology

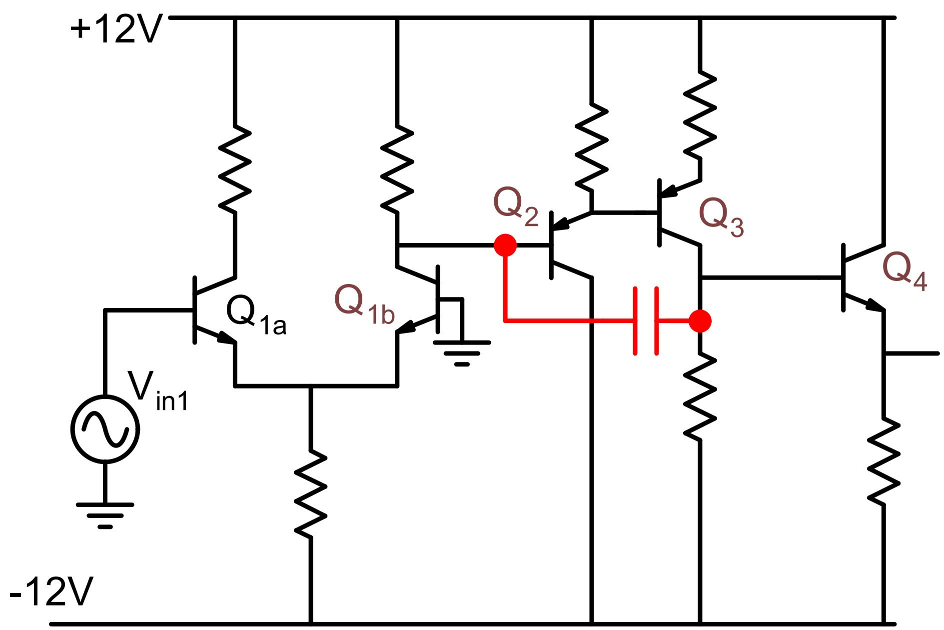
Discrete implementation using BJT

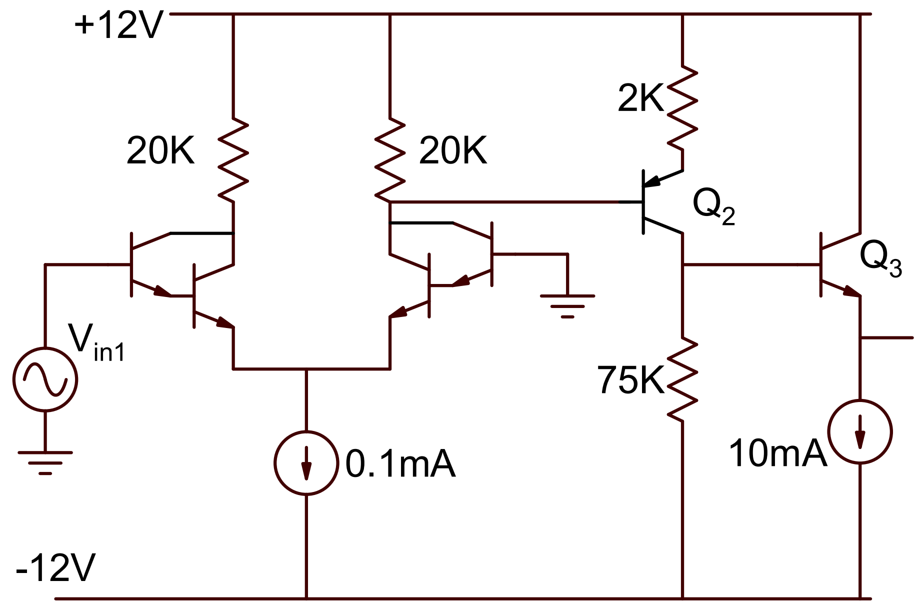
NPN transistor : BC547
PNP transistor : BC 557.

2. Architecture of the system

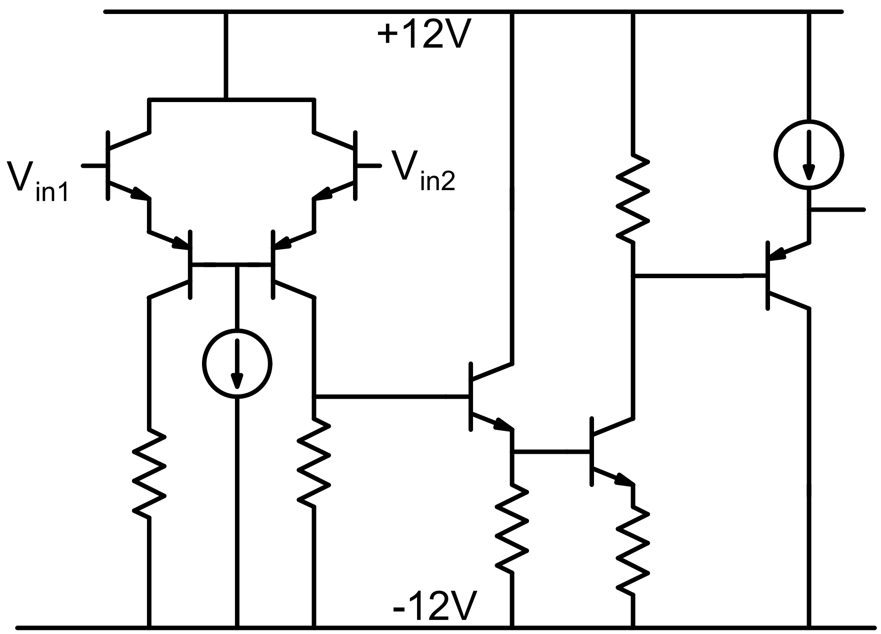


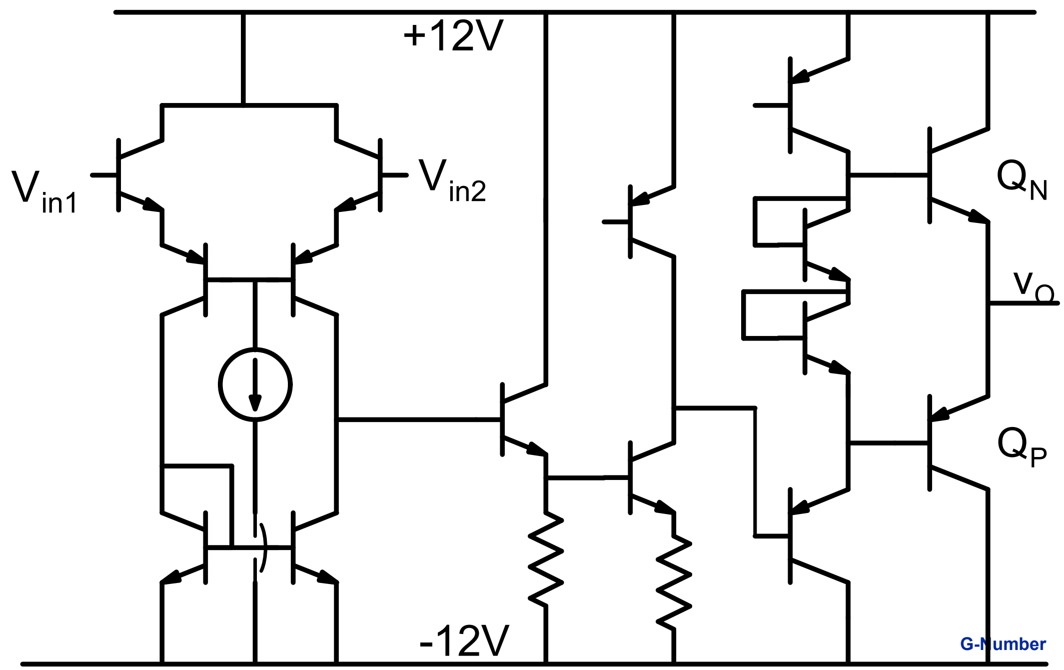
There are often many alternative choices



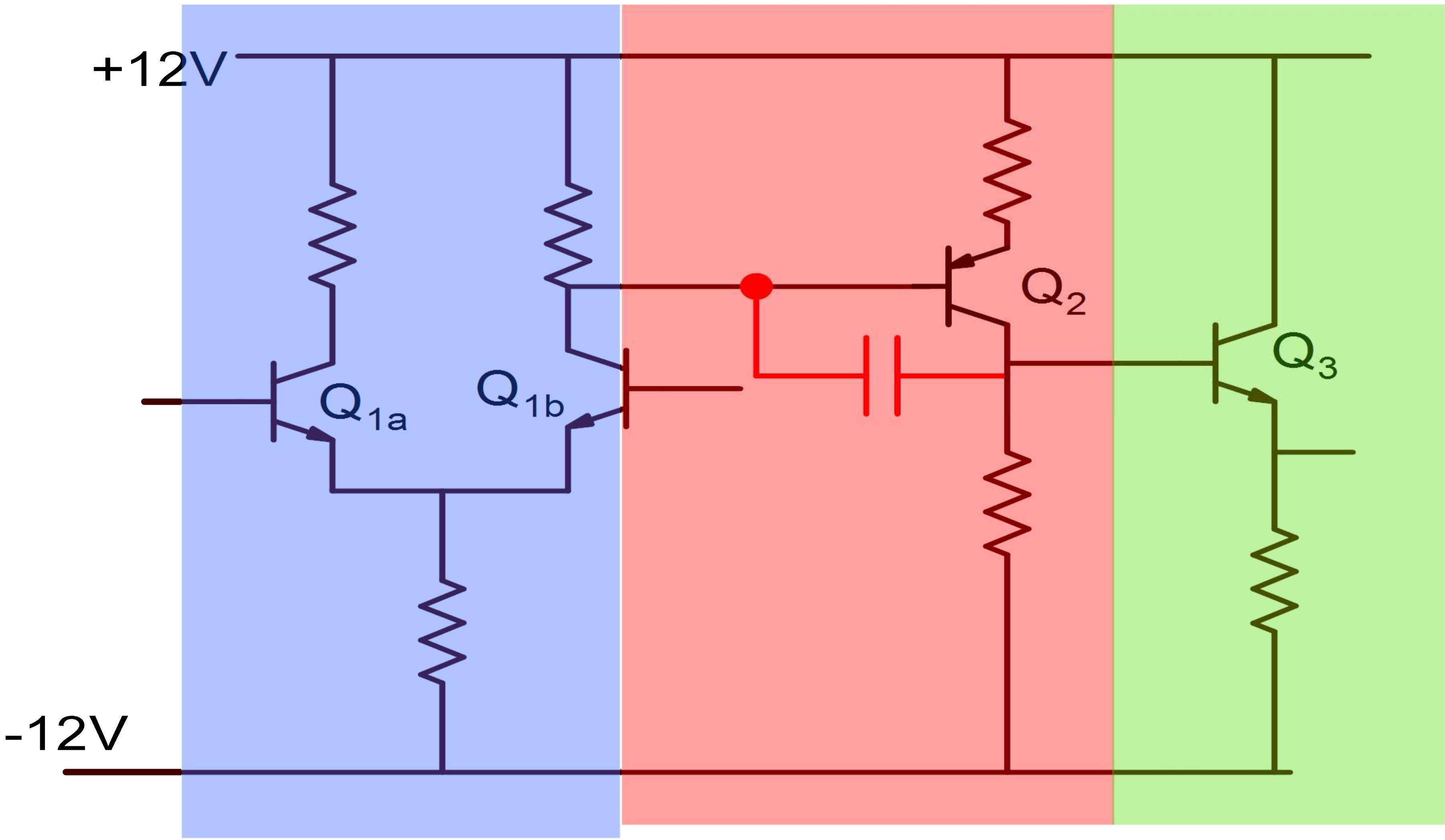


Design is an iterative process





3. Determine specs of the sub-systems from the overall specs



4. Design each of the individual blocks

The E12 Range

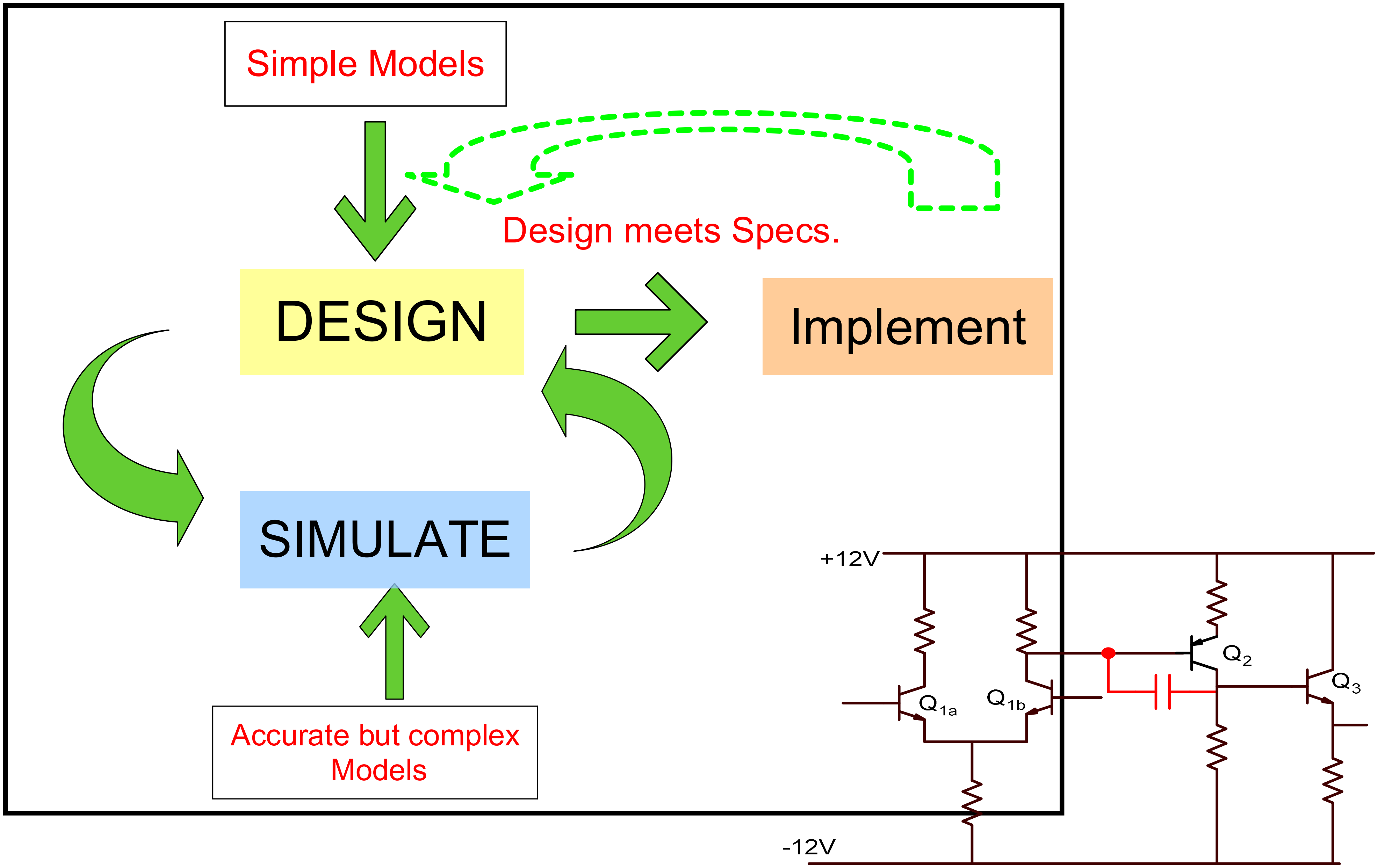
These identify a range of resistors that are know as "preferred values". In the E12 range there are 12 "preferred" or "basic" resistor values, and all of the others are simply decades of these values:
1.0, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8 and 8.2

The table below lists every resistor value of the E12 range of preferred values. You will notice that there are 12 rows containing the basic resistor values, and the columns list the decade values thereof. This range most commonly covers standard carbon film resistors, which are not readily available in values above 10 Megohms - 10M.

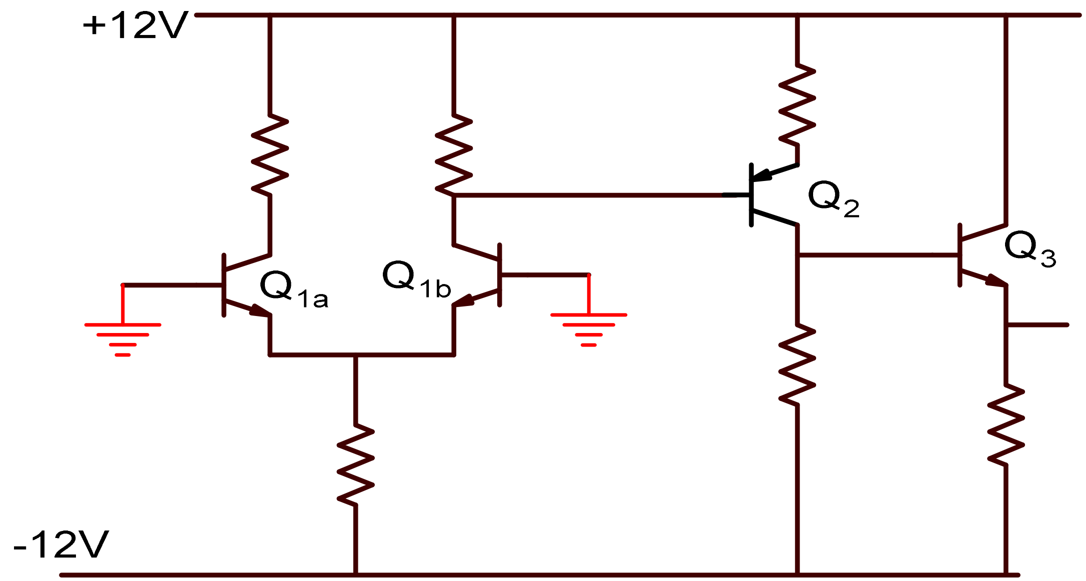
1R0	10R	100R	1K0	10K	100K	1M0	10M
1R2	12R	120R	1K2	12K	120K	1M2	n/a
1R5	15R	150R	1K5	15K	150K	1M5	n/a
1R8	18R	180R	1K8	18K	180K	1M8	n/a
2R2	22R	220R	2K2	22K	220K	2M2	n/a
2R7	27R	270R	2K7	27K	270K	2M7	n/a
3R3	33R	330R	3K3	33K	330K	3M3	n/a
3R9	39R	390R	3K9	39K	390K	3M9	n/a
4R7	47R	470R	4K7	47K	470K	4M7	n/a
5R6	56R	560R	5K6	56K	560K	5M6	n/a
6R8	68R	680R	6K8	68K	680K	6M8	n/a
8R2	82R	820R	8K2	82K	820K	8M2	n/a

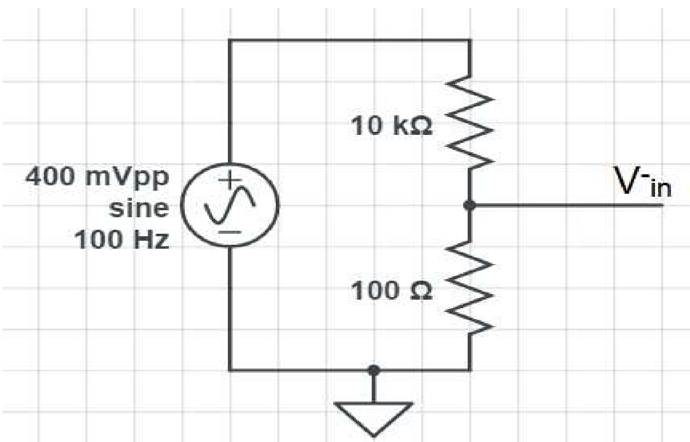
R denotes zero. K, R, M are used in place of decimal point

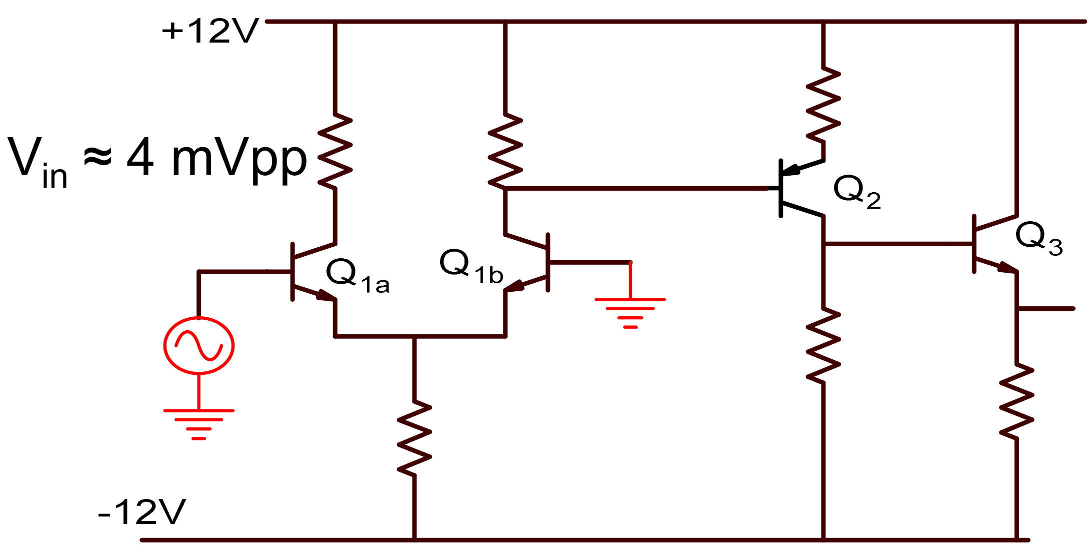
5. Simulate the complete system and modify design if necessary to achieve the specs. with sufficient safety margin.

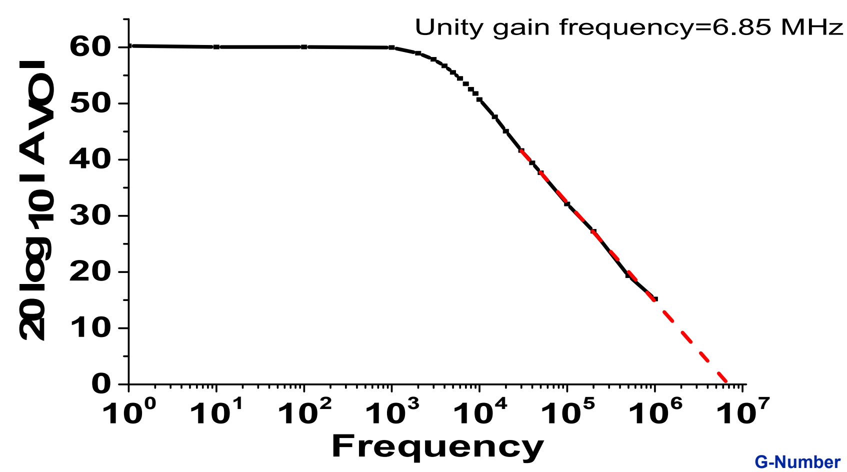


6. Breadboard the circuit. Measure the dc bias points and small signal gain,….

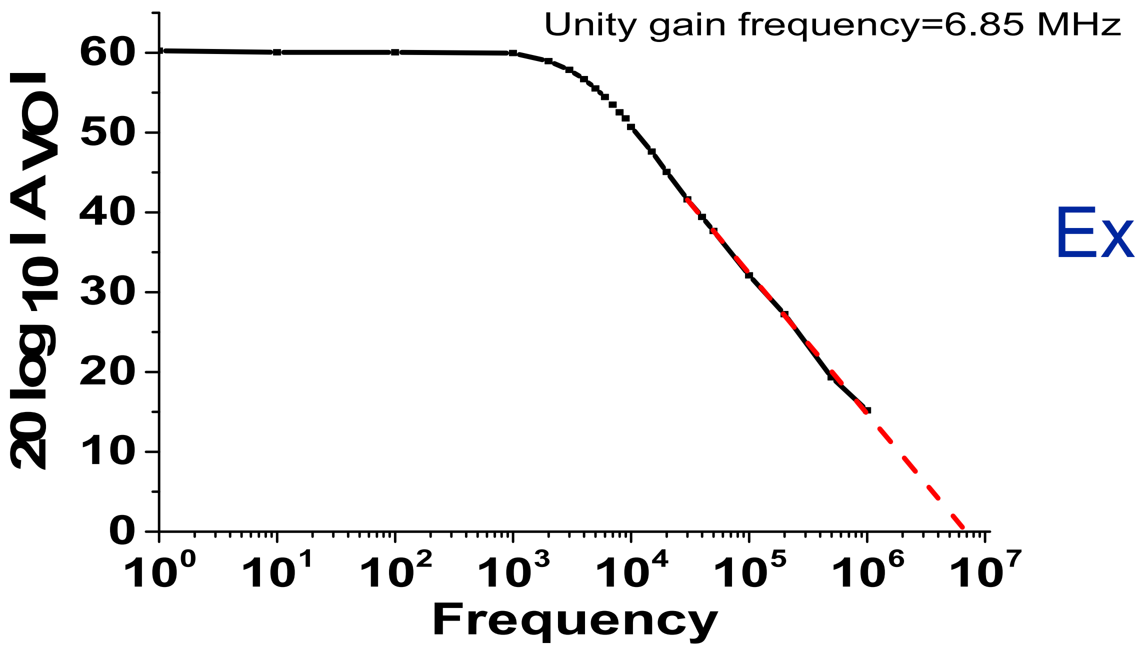




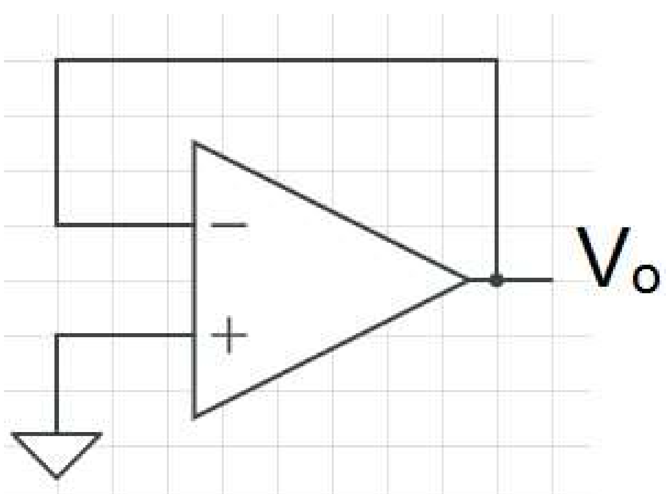


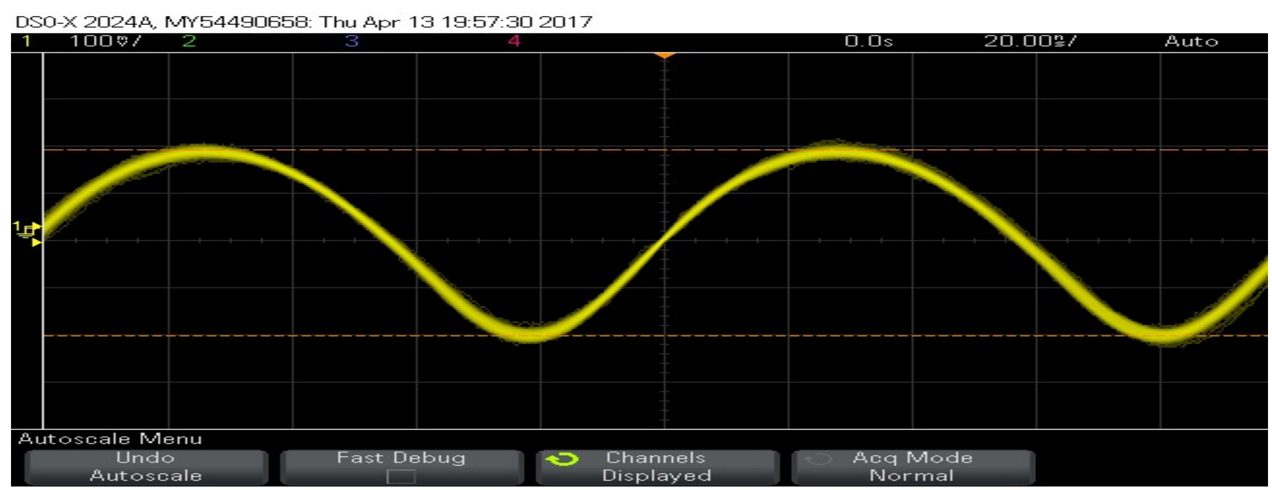


7. Measure the Gain and Phase response and add compensation

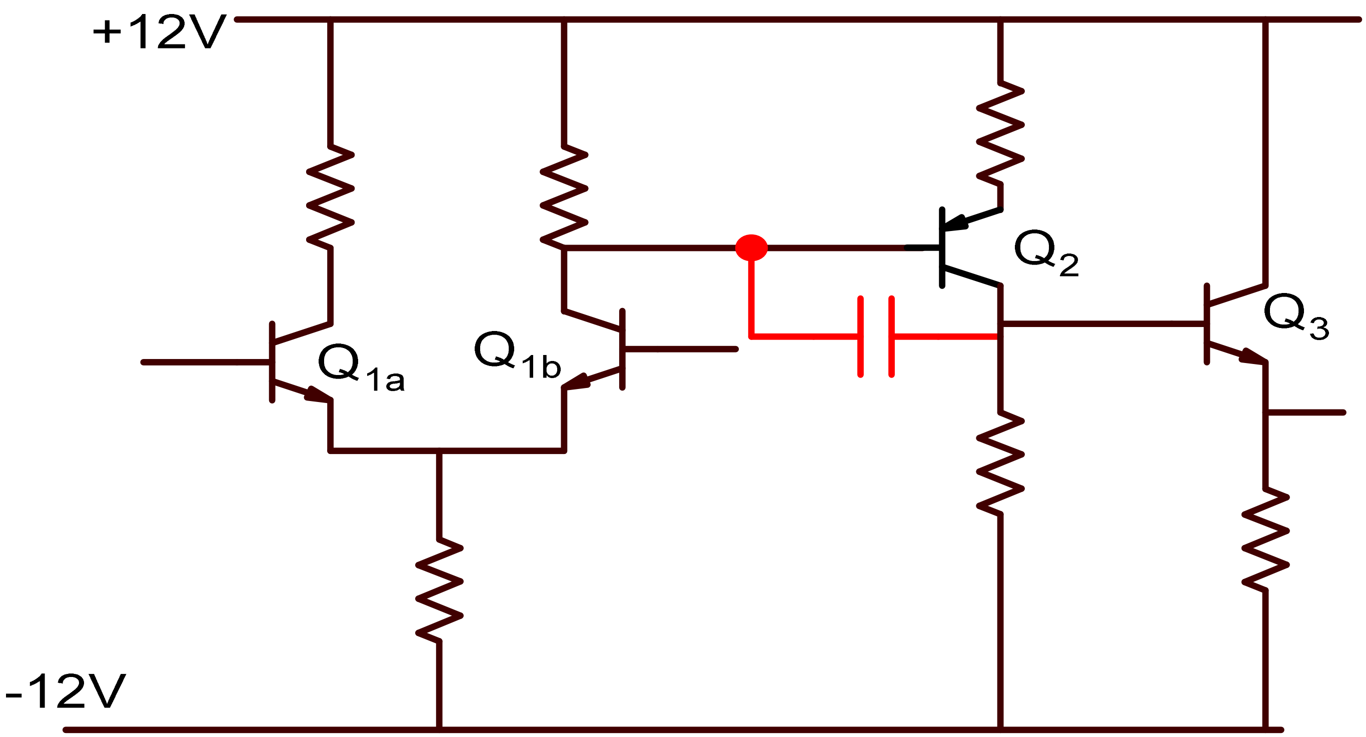


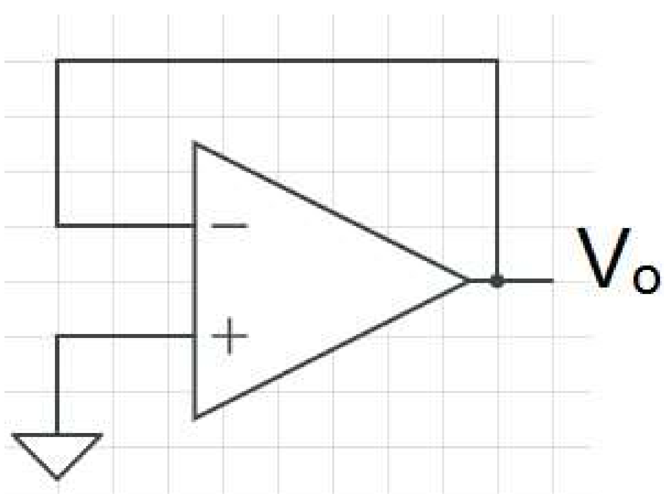
Expected phase margin ?

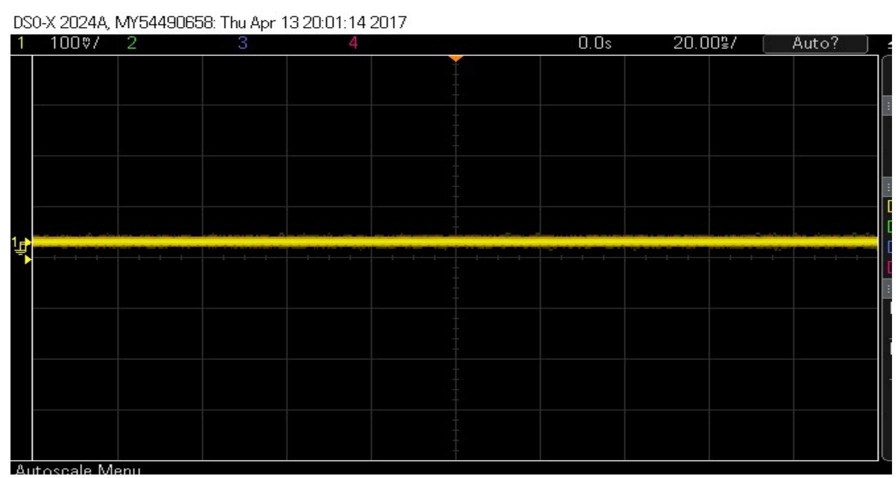




Add a compensation capacitor to get phase margin of at least 75°

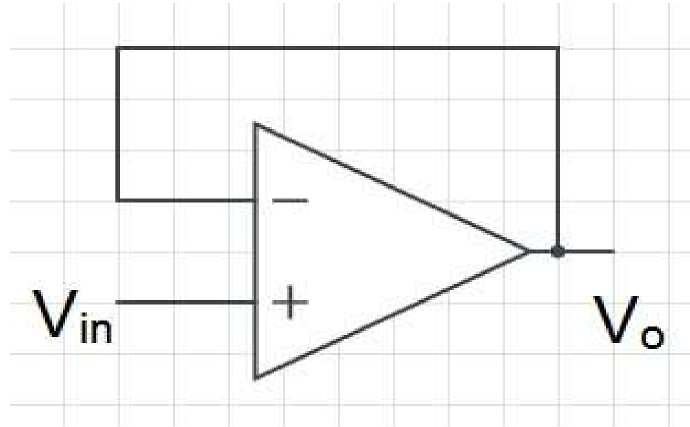


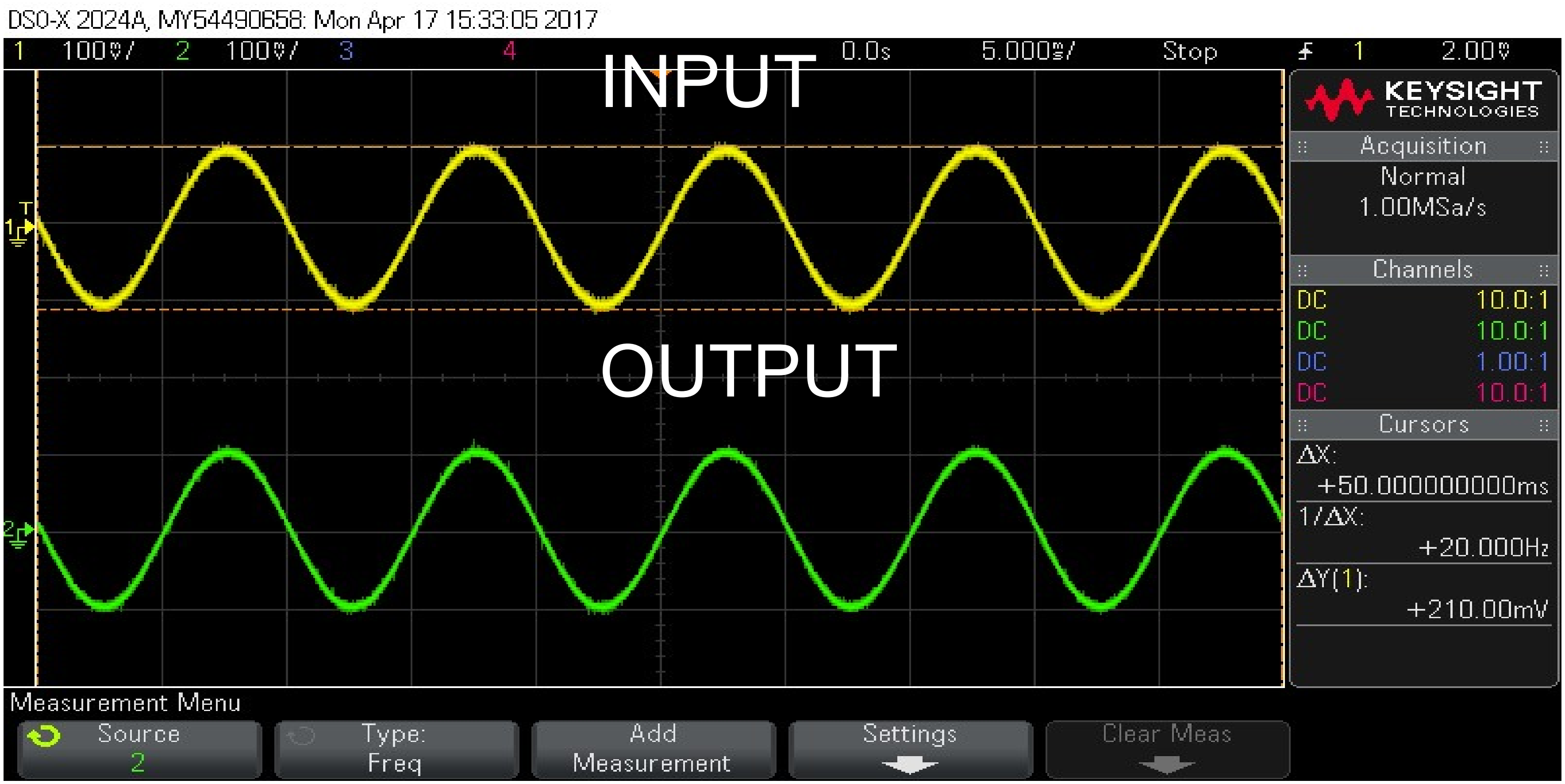




Voltage follower

V_{in} = 200mVpp, 100 Hz



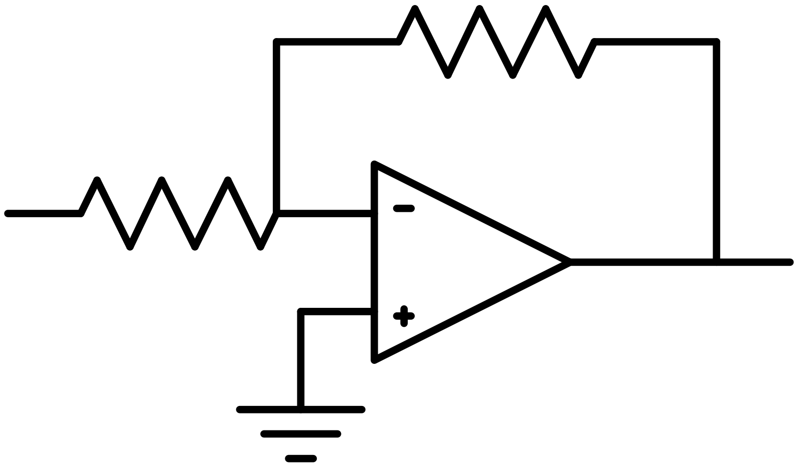


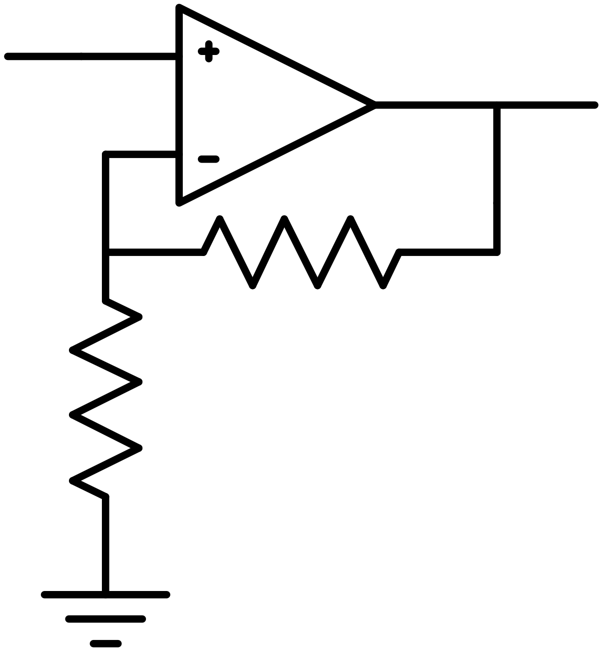
G-Number

8. Characterize the opamp.

1. Open loop gain
2. Input resistance
3. Output resistance
4. Unity gain frequency and phase margin
5. Offset voltage
6. Slew rate
7. ….

9. Make inverting and non-inverting amplifiers with your opamp to highlight its usefulness





10. Document the design and results (Lab. Report)

1. Each student has to prepare a separate lab report, a hard copy of which has to be submitted at the end of the experiment.

2. Lab report should include all relevant details including the design methodology, simulation and experimental results.

3. Lab. report should include a discussion of experimental results vis-a-vis results expected from analytical calculations or simulation results

4. All significant experimental results should be shown to the TA and recorded by the TA as well.

Lectures :opamp-1
https://youtu.be/ehekdOHOIZ0
Opamp-2 : https://youtu.be/3vMPtSVc20s