Submission Notes:

- This project can be done in groups of max 6 students and min 4.

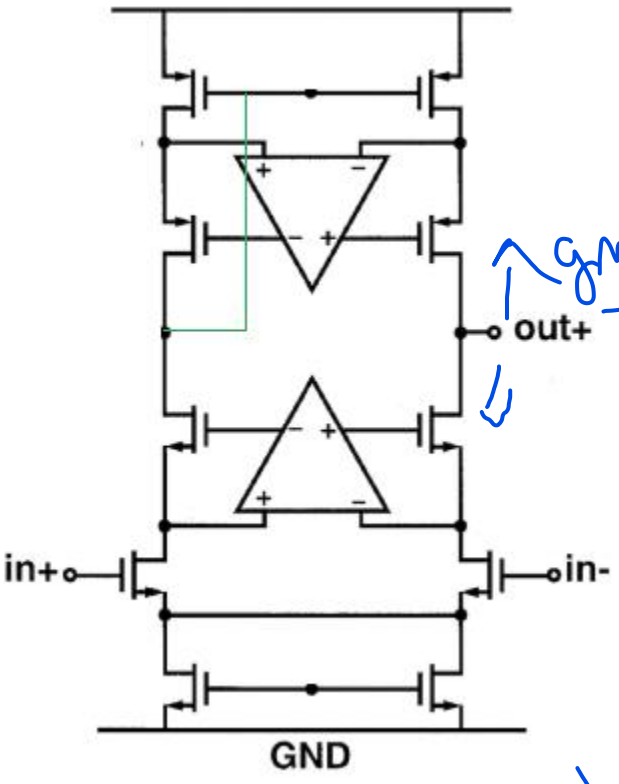
-Any copied reports will be given Zero, as well as a zero for anyone who will not participate in the project.

- You should provide the required simulations using CADENCE, and make sure they are ready in our meeting at the end of the term.

- The cover page must contain the group names in Arabic and their ID's.

- All graphs and figures should be clear with readable axes and traces, and all schematics of the operating points and sizing should be included.

Q1.Using the Vm of 65nm tsmc technology, design the following amplifier to achieve the following specs:



1-Gain_min= 80dB
2-Open loop bandwidth for 500fF load = 1Mhz
3-Optimize the used current and area.

Design hints:

1-Follow the tutorial

Requirements:

1-The open loop gain of the main amplifier
2-The dissipated power
3-The operating point of all transistors(vgs, vds, vth, Ids, gm, rout), and the sizing.

$BW = \frac{1}{2\pi R_{out} C_{out}} = 1M$

$GBW = \frac{g_m R_{out}}{2\pi R_{out}^2 C_{out}} = 100M$

$g_m = 100 \times 2\pi \times C_{out} = 628\mu$

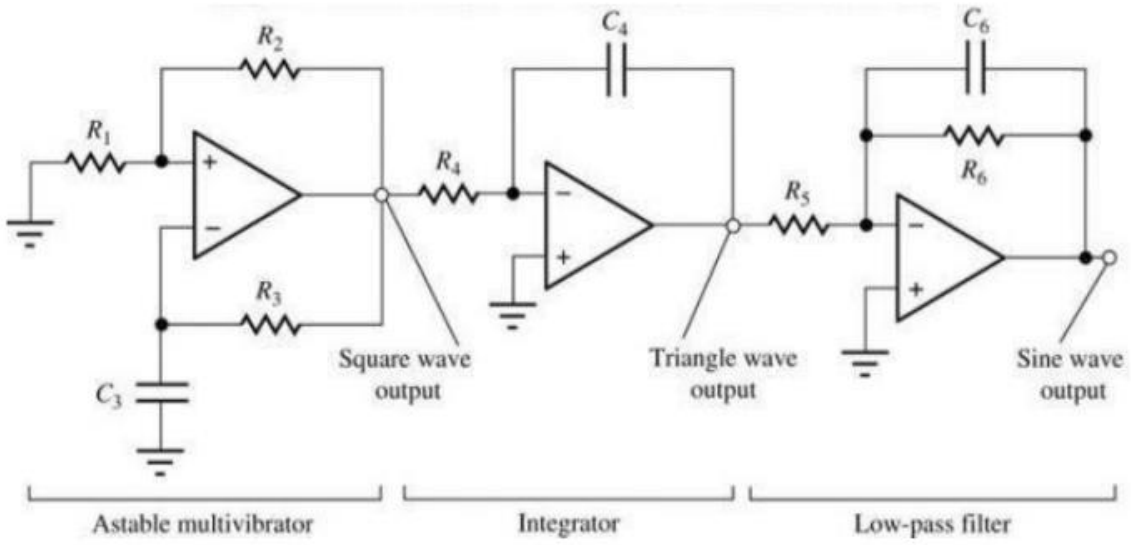
$I = 3m$

Q2.

Analog Function Generator:

You are required to simulate a simple function generator using the astable multi-vibrator to generate the square wave. The function generator should be able to generate square, triangular, and sine waveforms with a frequency range from 100kHz to 10MHz.

Analog Function Generator Functional Block Diagram:



Circuit Description:

The above circuit consists of three stages:

o Astable Multi-vibrator:

▪ Uses positive and negative feedback to generate square wave output.

▪ Frequency is varied by changing R3 and/or C3.

o Lossless Integrator

▪ Driven by the output of the astable multi-vibrator to produce a triangular waveform.

o Low-pass Filter

▪ The output of the integrator is then passed through a low-pass filter to produce a low-distortion sine wave.

Requirements:

1. Determine the values of the passive elements (resistors and capacitors) to generate output frequencies from 100kHz up to 10MHz. (show your analysis and design choices)
2. Simulate the schematic of the function generator using a model for the op-amps to have a gain and BW (you can use voltage controlled voltage source with gain=10,000 and a first order RC network to set the BW=100MHz).
3. Plot the output waveforms from the three stages showing the minimum and maximum frequencies.
4. Show the purity of the output sine wave using Discrete Fourier Transform (DFT) and total harmonic distortion (THD) in dB.
    - o Show clearly the definition of THD and how to get the value of THD from the DFT.
5. Change the gain of the ideal operational amplifiers (to be 1000 & 100) and show the effect on #3 & #4.
6. Change the BW of the ideal operational amplifiers (to be 1MHz & 1KHz) and show the effect on #3 & #4.
7. (1 bonus point) if you used the designed opamp of Q1 in this circuit and just obtained the square,sine, and triangle waves.
8. Discuss your results.