

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING



THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Analog IC Design

Experiment-7

Submitted by

PRATIBHA SINGH

602162015

M.Tech (VLSI Design)

Experiment-7

Aim:

To design a differential amplifier with active load for a gain 100 and analyse its transient characteristics.

Tool Used:

LTspice tool

Theory:

Differential amplifiers amplify the difference between two voltages making this type of operational amplifier circuit a Subtractor unlike a summing amplifier which adds or sums together the input voltages.

For a Level NMOS let's assume

$$V_{DD} = 1.8V$$

$$V_T = 0.4V$$

$$K_n = 120\mu A/V^2,$$

For a Level PMOS let's assume

$$V_{DD} = 1.8V$$

$$V_T = -0.4V$$

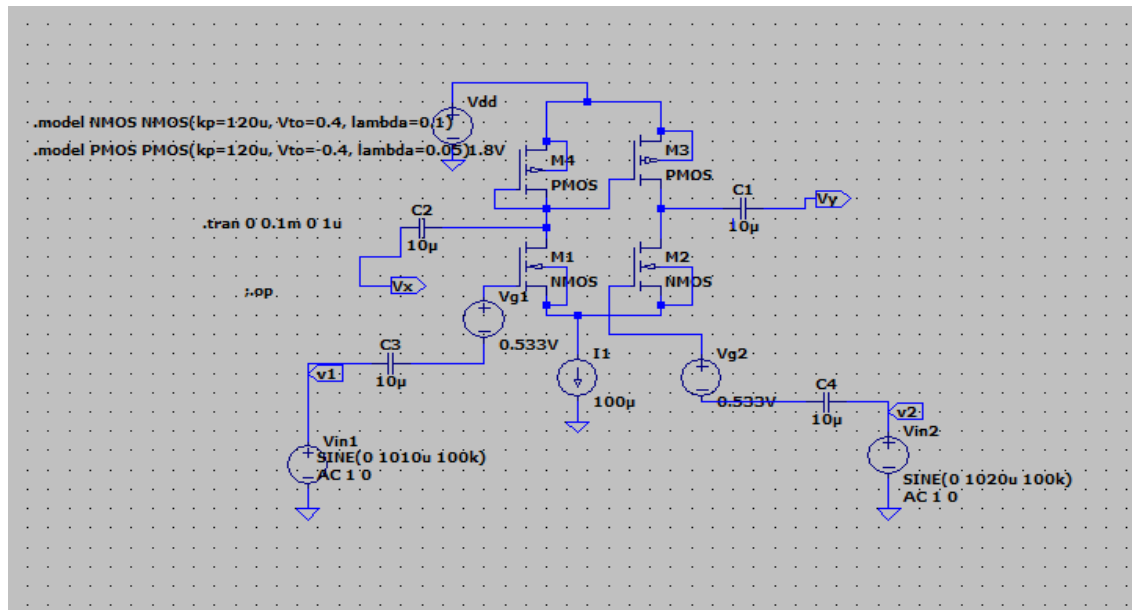
$$K_p = 120\mu A/V^2,$$

Which gives a value of $(W/L) = (46.8)$ for 1mA ID.

The value of V_{DS} should be maintained above $(V_{GS} - V_T = 0.6 - 0.4 = 0.2V)$ for the transistor to stay in saturation region.

As for M2 and M1, the width is taken as 468 μm and the length is taken as 10 μm and for M3 and M4, the width is taken as 10 μm and the length is taken as 10 μm .

Circuit Schematic:



DC Operating Point



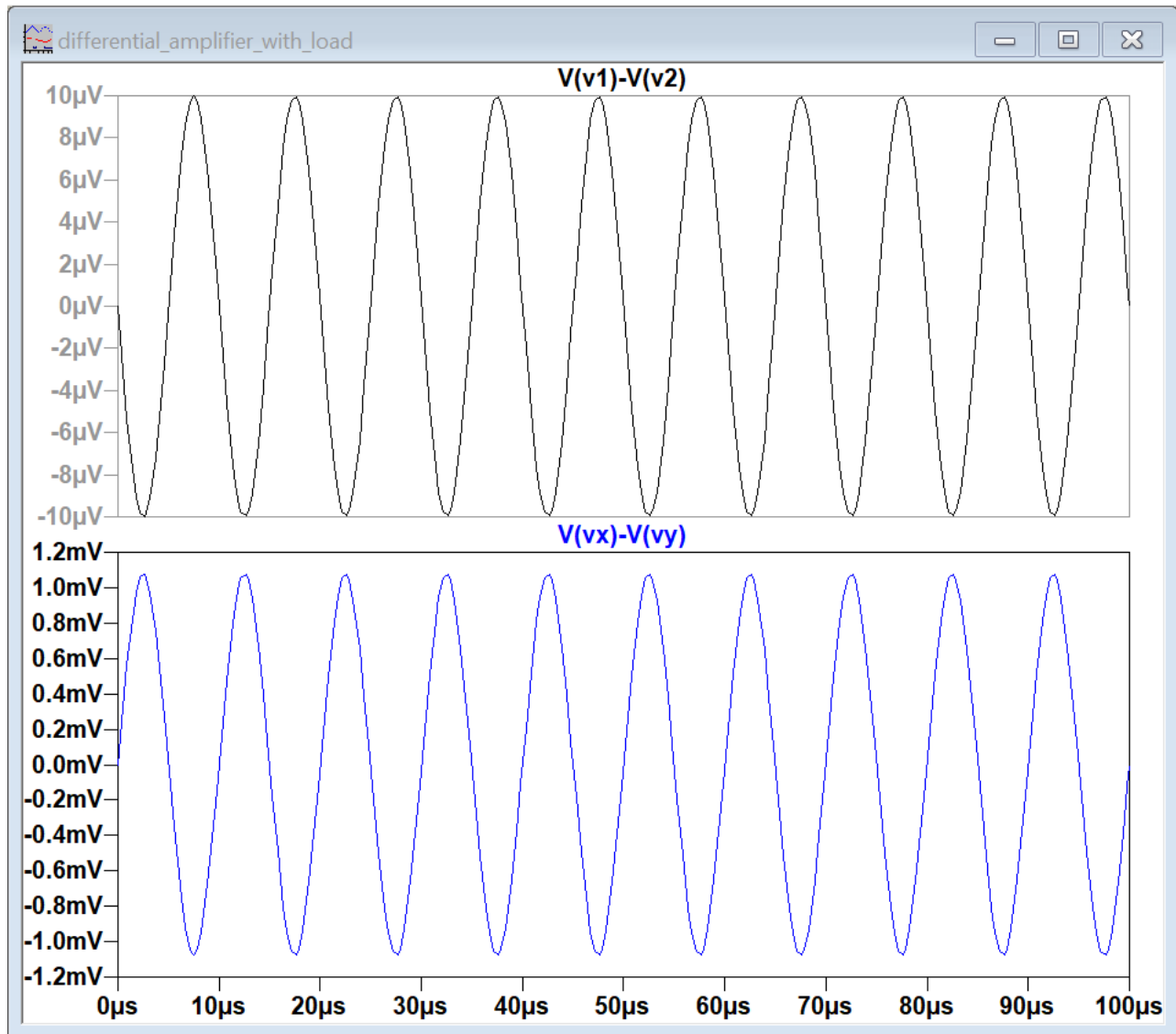
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--- Operating Point ---

V(n003):	0.515111	voltage
V(n007):	0.533	voltage
V(n005):	0.00285173	voltage
V(n002):	0.515111	voltage
V(n006):	0.533	voltage
V(n001):	1.8	voltage
V(vy):	5.15106e-006	voltage
V(v2):	0	voltage
V(v1):	0	voltage
V(n009):	0	voltage
V(n008):	0	voltage
V(vx):	5.15106e-006	voltage
Id(M4):	5e-005	device_current
Ig(M4):	-0	device_current
Ib(M4):	1.29489e-012	device_current
Is(M4):	-5e-005	device_current
Id(M3):	5e-005	device_current
Ig(M3):	-0	device_current
Ib(M3):	1.29489e-012	device_current
Is(M3):	-5e-005	device_current
Id(M1):	5e-005	device_current
Ig(M1):	0	device_current
Ib(M1):	-5.2226e-013	device_current
Is(M1):	-5e-005	device_current
Id(M2):	5e-005	device_current
Ig(M2):	0	device_current
Ib(M2):	-5.2226e-013	device_current
Is(M2):	-5e-005	device_current
I(C4):	0	device_current
I(C3):	0	device_current
I(C2):	5.15106e-018	device_current
I(C1):	-5.15106e-018	device_current
I(I1):	0.0001	device_current
I(Vg1):	0	device_current
I(Vg2):	0	device_current
I(Vdd):	-0.0001	device_current
I(Vin1):	0	device_current
I(Vin2):	0	device_current

Output Waveforms:

Transient Response:



Result:

The circuit is designed for a gain of 100 and the output is verified to be correct.