Electrical and Computer Engineering Department

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ECE 2200L:

Experiment Number 13 & 14

MOSFET Self Biasing

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Background Information:

The metal-oxide-semiconductor field-effect transistor (MOSFET) is a type of field-effect transistor (FET) that is typically produced through the controlled oxidation of silicon. It features an insulated gate, with its voltage controlling the device's conductivity. MOSFETs are widely employed in various amplifiers and logic gates.

Objective:

To experiment on design, construction, and analysis of the biasing circuit for a MOS field effect transistor common source amplifier & to experiment on design and analysis of common source amplifier.

Pre-Lab:

1. The circuit shown in Figure 1 is for a Common Source MOSFET Amplifier. By hand calculation, find RD, RS, R1, and R2 such that the MOSFET has a Q-point of:

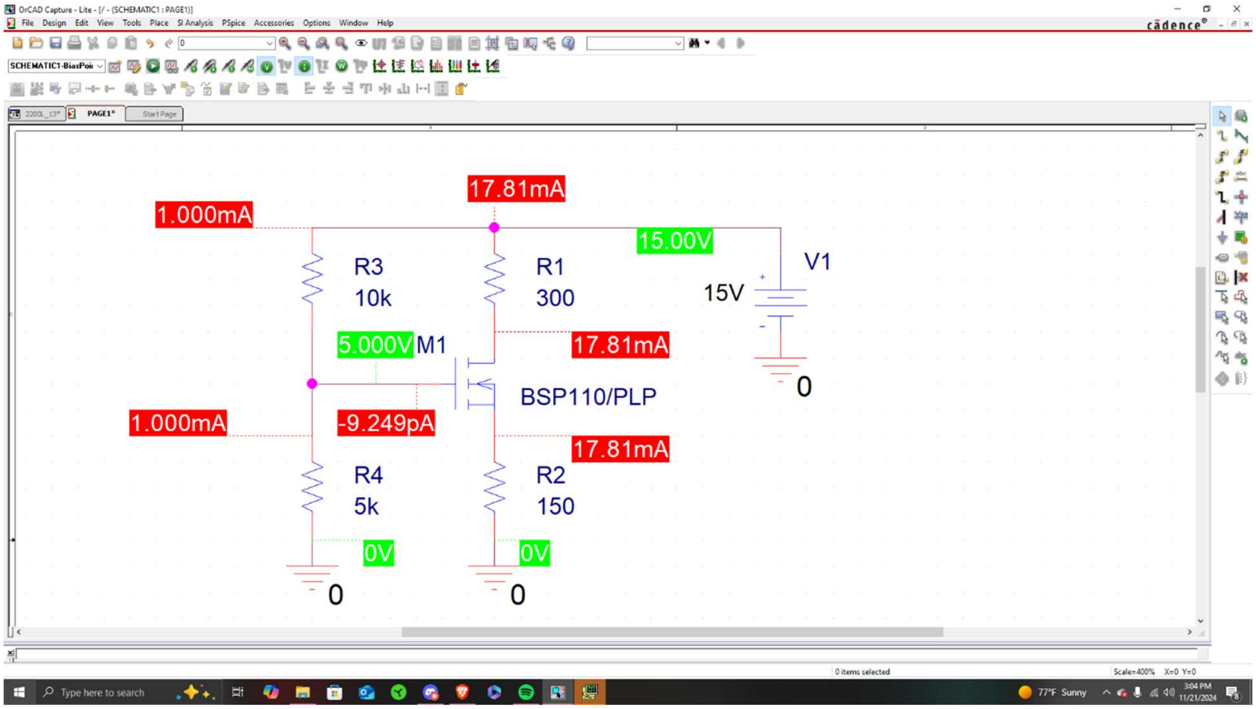
ID = 5mA

VDS = 5 V

Power supply voltage is VDD = 10 V.

(For K and Vth use the values from experiment 10)

2. Capture circuit A (Self-Biased Circuit, given in the lecture notes) in PSpice. Run Bias Point simulation to find all voltages and currents.



DC analysis *Given Vt = 1.7V n Kn = 0.12

10-5 / Rd + R5 = Id → Rd + R5 = 1K Ohms → 500 Ohms each (Rd n R5)

Vgs – 1.7 = sqrt(0.005 * 2/0.12) – 1.99 Volts → Vgs = Vg – Vs = 1.99 – 2.5 =~ 4.5 Volts

-(Ir2 * R2) + Vgs + Id+R5 = 0

10 / R1+R2 = 0.0005 → R1+R2 = 20k

4.5 = 1- * R2/20k → R2 = 9k → R1 = 11k

Thus, R between 50k – 100k

R1 = 55k Ohms & R2 = 45k Ohms

Lab Report #13:

1. ***Figure 1:***

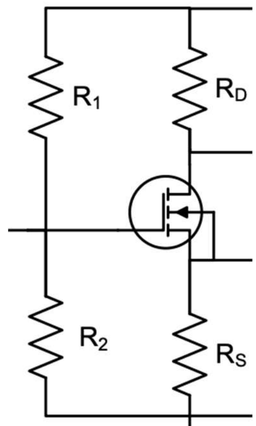
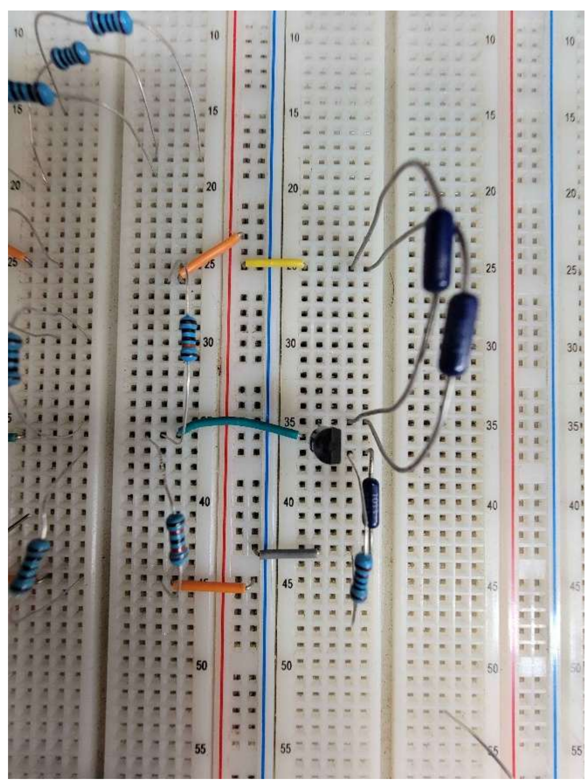


Figure 1

Part 1:

Hand Calculations:



$V_{DD} = 10V$

$I_D = 5mA$

$V_S = 1.98V$

$V_{DS} = 5V$

$R_S = 400\Omega$

$R_D = 600\Omega$

$R_1 = 100k\Omega$

R2 = 66k Ohms

Measured Values:

$V_S = 2.2V$

$V_{DS} = 5.22V$

$V_{GS} = 2.11V$

$I_D = \frac{V_{RD}}{R_D} = 0.00478A$

Part 2:

Hand Calculations:

$R_1 = 10k\Omega$

$R_2 = 5k\Omega$

$R_D = 300\Omega$

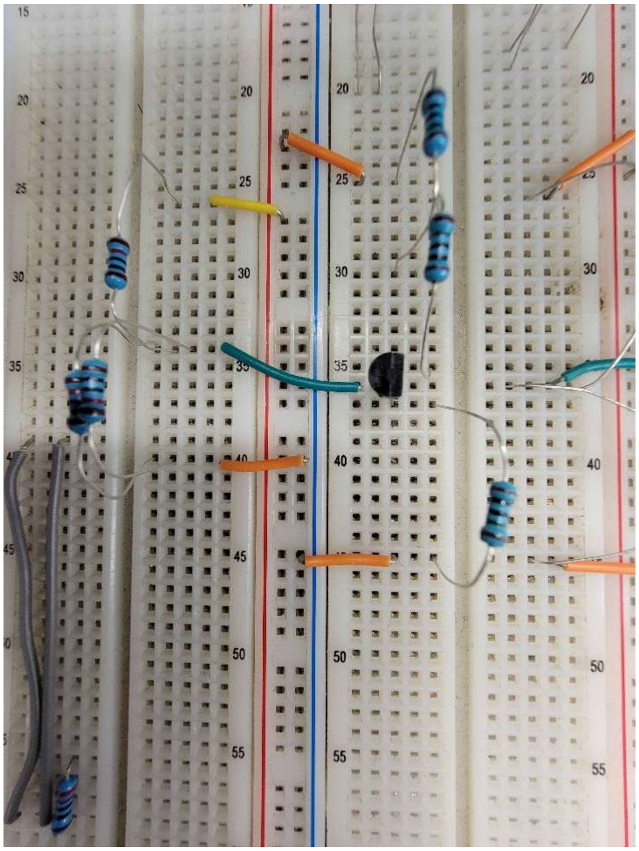
$R_s = 150\Omega$

$V_{DD} = 15V$

$V_{DS} = 6V$

$V_{GS} = 1.98V$

$I_D = \frac{V_{RD}}{R_D} = 0.02A$



Calculations:

- Calculating K Value:

$$Part\ 2: K = \frac{2I_D}{(V_{GS} - V_{TH})^2} = 0.69$$

Measured values (PSpice)

$$V_{DS} = 6.9855V$$

$$V_{GS} = 2.3286V$$

$$I_D = \frac{V_{RD}}{R_D} = 0.01781A$$

Data Analysis:

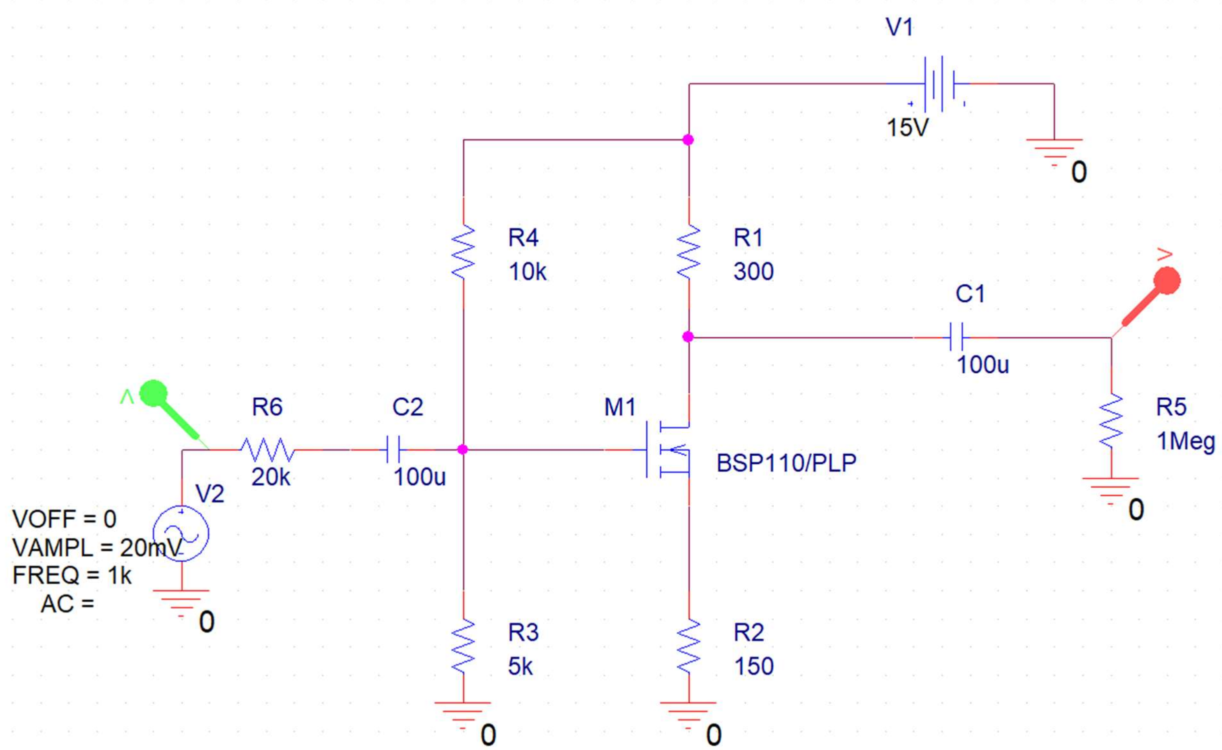
	Vgs	Vds	Id
Measured	2.11	5.22	0.00478
Hand Calc	1.98	5	0.005
Deviation	6.356968	4.305284	4.498978

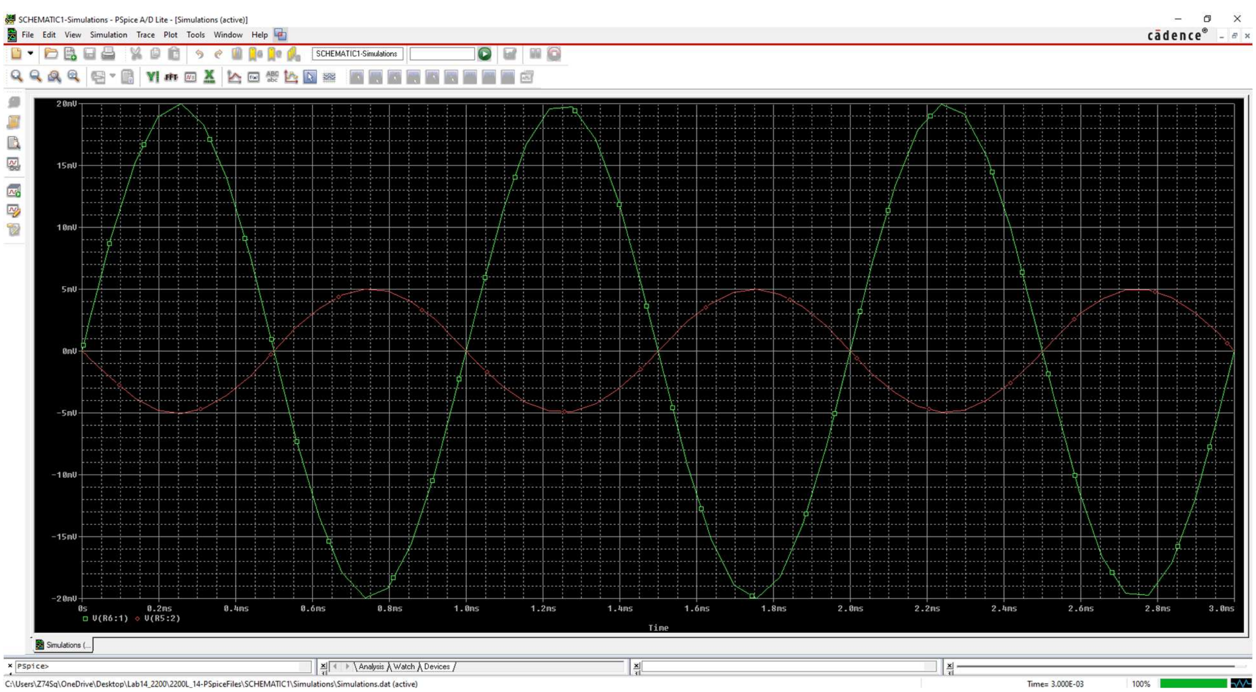
	Vgs	Vds	Id
Measured	1.98	6	0.02
PSpice	2.3285	6.9855	0.01781
Deviation	16.17732	15.17847	11.58424

Where deviation is in %

Lab Report #14:

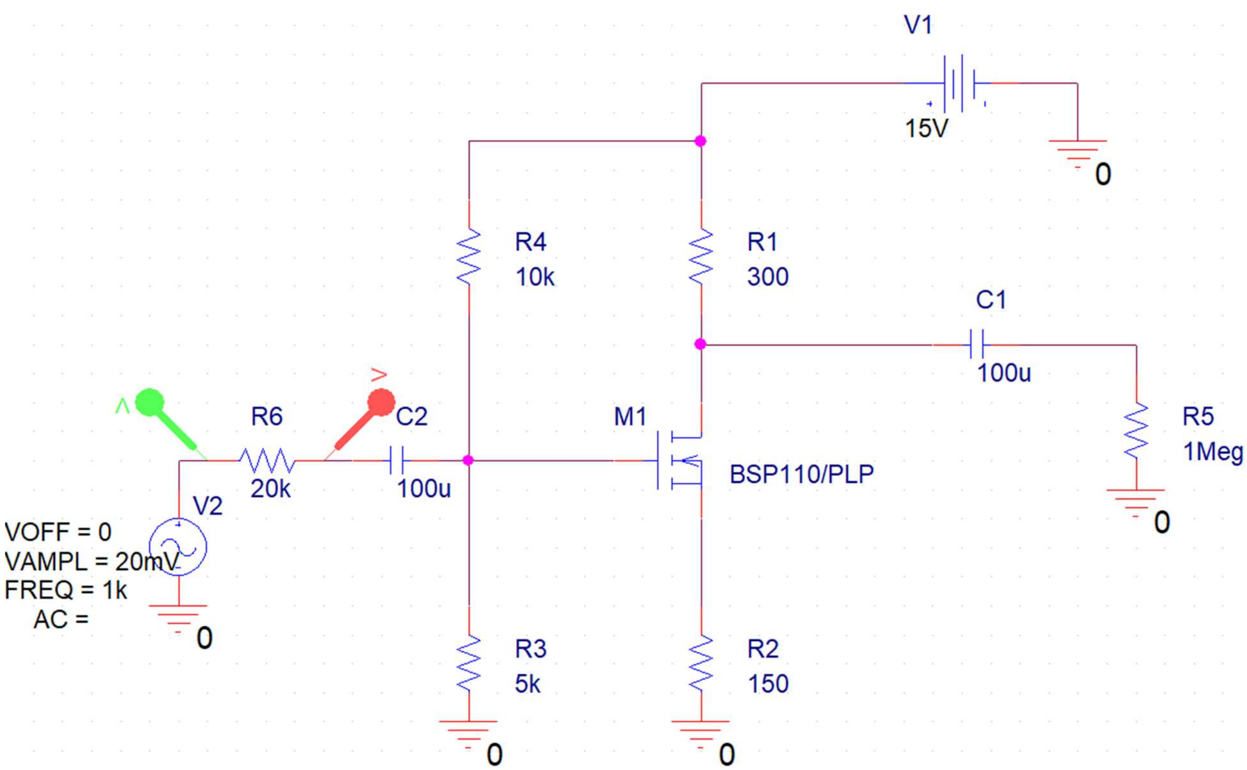
Part 1:

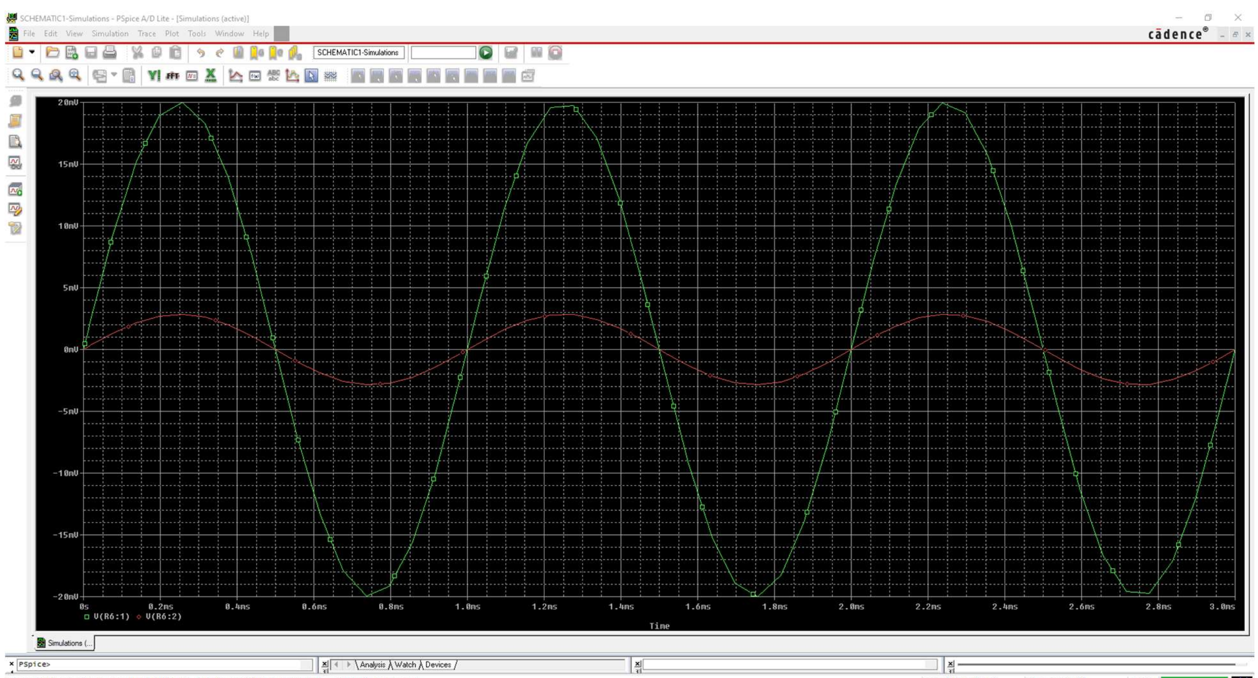




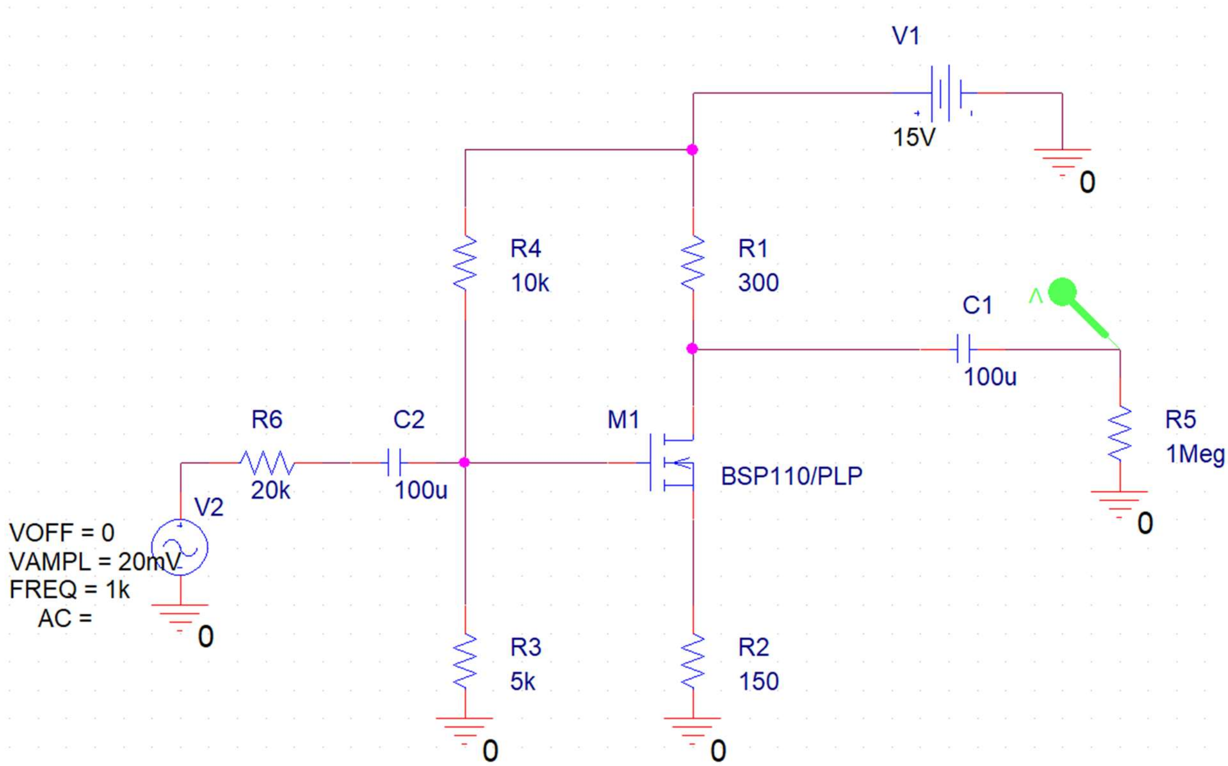
Gain = 0.5

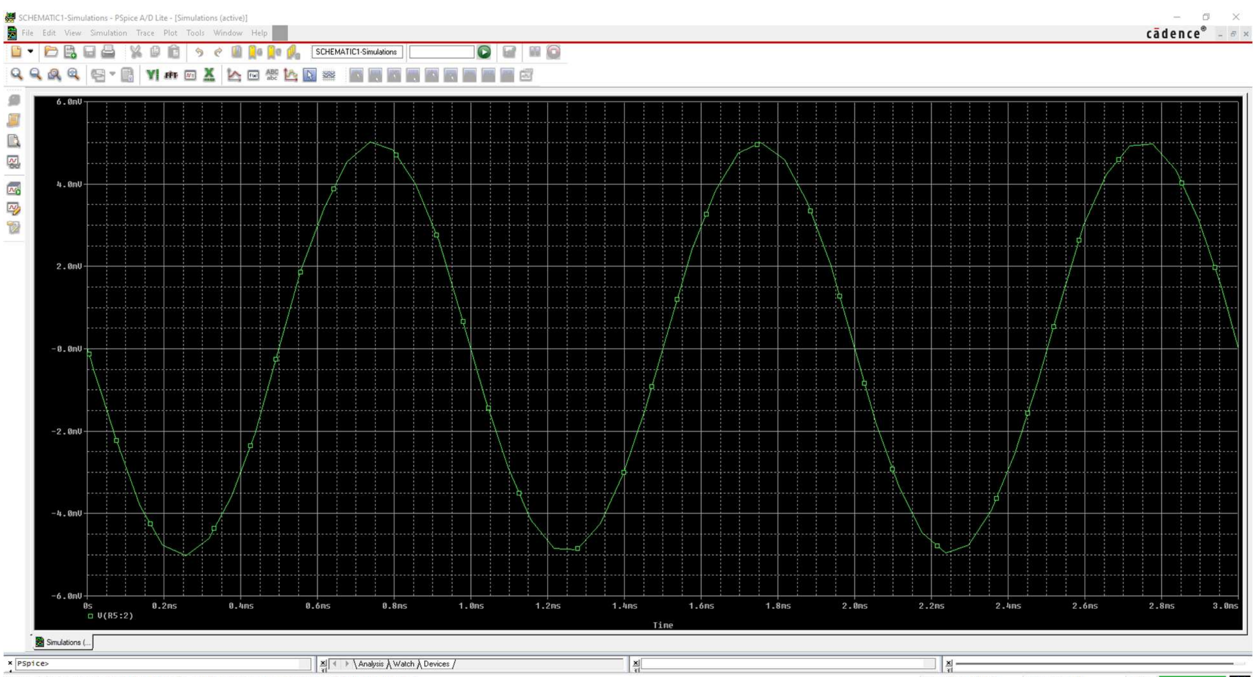
Part 2:


V1
15V
0
R4
10k
R1
300
C1
100u
R6
C2
M1
R5
20k
100u
BSP110/PLP
1Meg
V2
VOFF = 0
VAMPL = 20mV
FREQ = 1k
AC =
R3
5k
R2
150



Part 3:


V1
15V
0
R4
10k
R1
300
C1
100u
R6
20k
C2
100u
M1
BSP110/PLP
R5
1Meg
V2
VOFF = 0
VAMPL = 20mV
FREQ = 1k
AC =
R3
5k
R2
150


SCHEMATIC1-Simulations - PSpice A/D Lite - [Simulations (active)]
cādence
V(R5:2)
Time

Calculations:

Vs = 20mV   Vi = 19.711 mV   Rin = 20kOhms

Ri = Vi*Rin / Vs-Vi   where Vs – Vi = 0.000289   → Ri = 394.22/0.00289 = 1.36M Ohms

Vo’ = Vo * RL / RL+Ro   → Ro = 600 * (466.779 – 233.664 / 233.664)

→ Ro = 600 * 0.9977 = 598.22 Ohms

Av = Vpp(Vo) / Vpp(Vi) = 884.779/39.847 = 22.2

Conclusion:

In this experiment, we successfully explored the design, construction, and analysis of a MOSFET self-biasing circuit and its application in a common source amplifier. By performing both hand calculations and simulations in PSpice, we gained a deeper understanding of how the biasing point is influenced by resistor values, input voltage, and circuit parameters. These insights are crucial for designing stable amplifiers with desired characteristics. The experimental results, compared to theoretical values, highlighted the practical considerations and potential deviations inherent in real-world implementations. This foundational knowledge will be instrumental in designing and optimizing amplifiers in future applications.