Calvin Passmore

A02107892

ECE 5420

Basic Mosfets

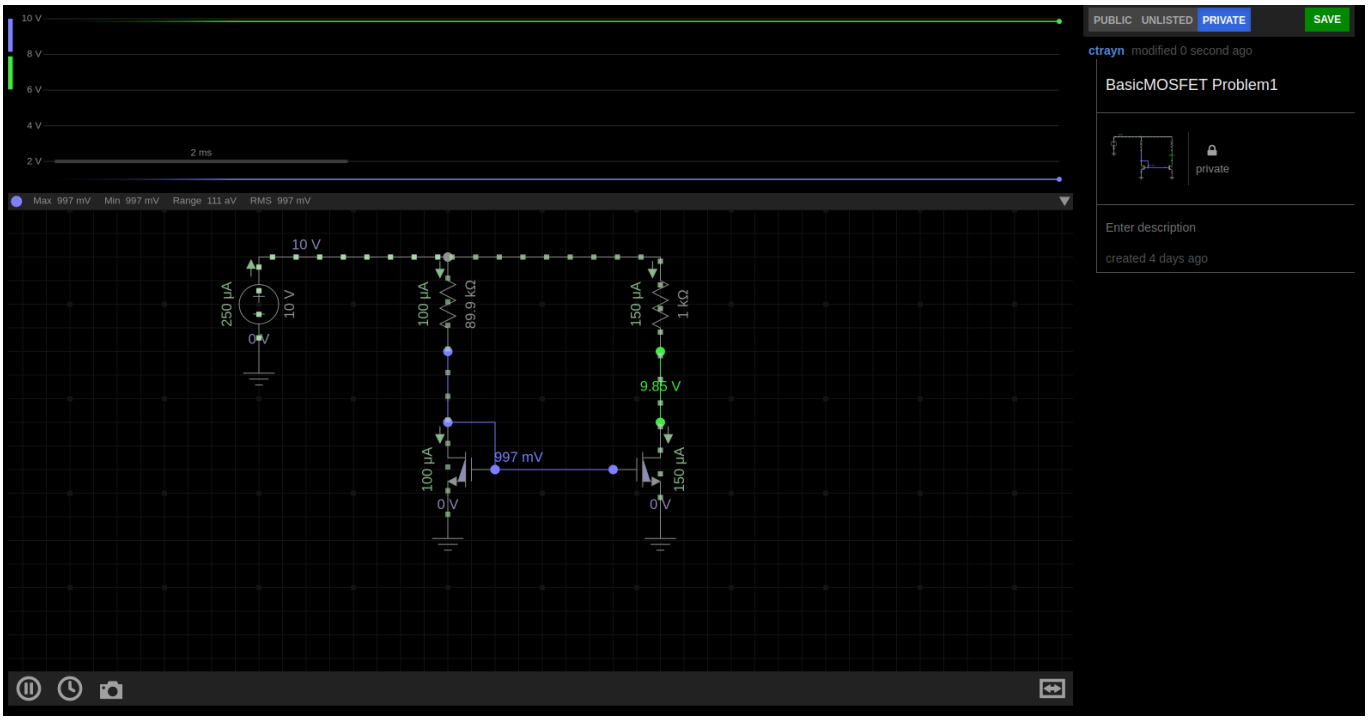
I worked out all the math in python to facilitate changes my answers more easily. Please see the attached python files and corresponding output.

Problem1

Source Code

```
from math import sqrt
from constants import *

V_DBias = sqrt(2 * IB / K_N) + V_THN
print(f"V_DBias: {V_DBias}")

R_Bias = (VDD - V_DBias) / IB
print(f"R_Bias: {R_Bias}")

Vov = V_DBias - V_THN
print(f"Vov: {Vov}")

RL = 1e3

IL = 0.5 * K_N * (Vov**2)
print(f"IL: {IL}")

VDL = IL*RL+VDD
print(f"VDL: {VDL}")
```

Screenshot



Answers

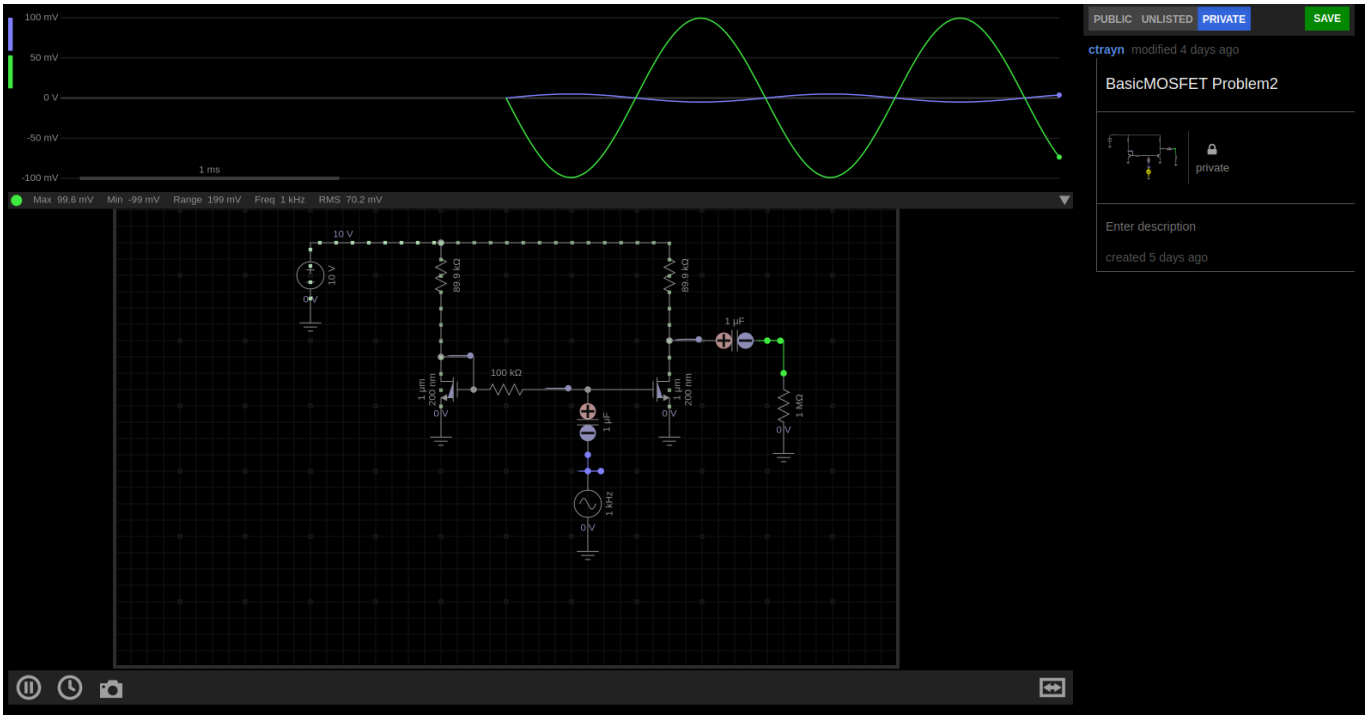
	Calculations	Simulations
R	89 kOhm	89 kOhm
VG	1.01 v	997 mV
IL	100 uA	150 uA
VD	10.1 v	9.85 v

Problem2

Source Code

```
from math import sqrt
from constants import *

R = 89.88e3

AV = -sqrt(2 * K_N * (VDD - V_THN) * R)
print(f"AV: {AV}")

ID = (VDD - V_THN)/R
print(f"ID: {ID}")

gm = sqrt(2 * K_N * ID)
r0 = 1/(LAMBDA_N * ID)
print(f"gm: {gm}")
print(f"r0: {r0}")
```

Screenshot



Answers

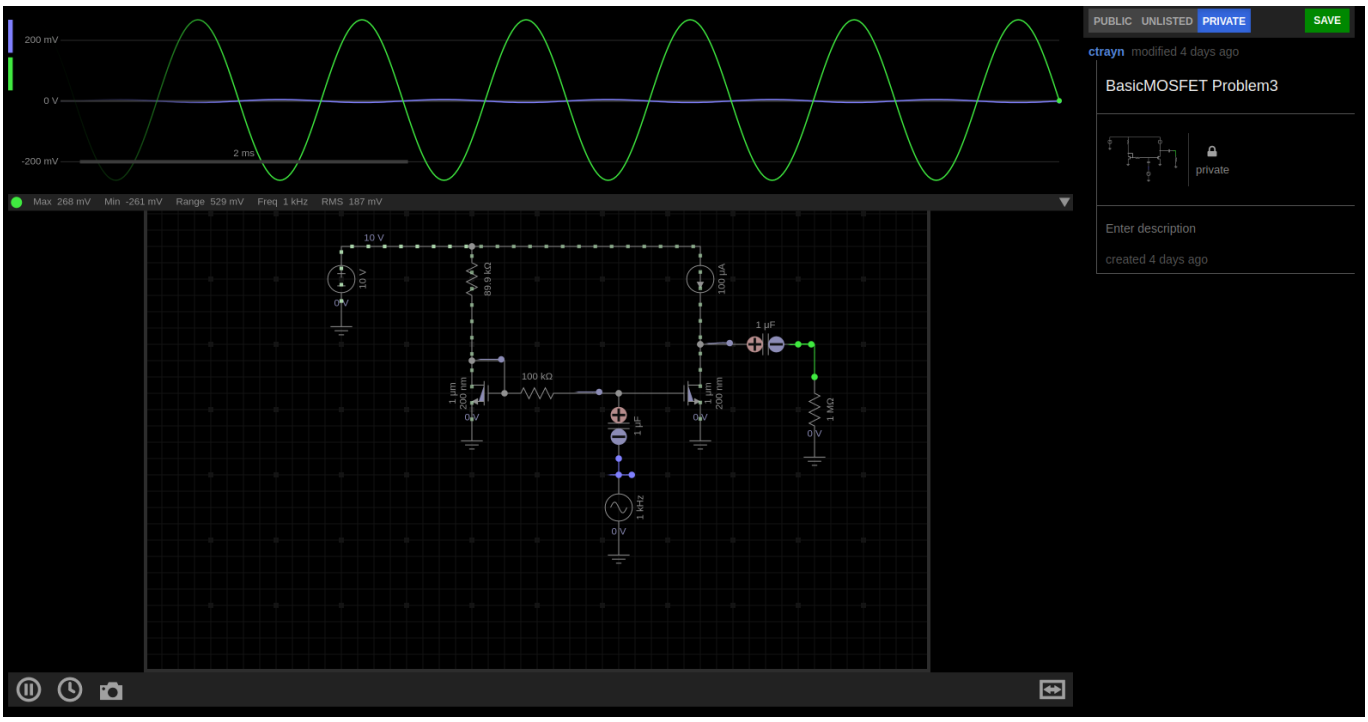
	Calculation	Simulation
gmn	354 uA/V	X
r0n	156.5 kOhm	X
Av	-31.85	19.5

Problem3

Source Code

```
from cmath import sqrt
from cmd import IDENTCHARS
from constants import *

VG = V_THN + sqrt(2 * IB / K_N)

gm = sqrt(2 * K_N * IB)
r0 = 1 / (LAMBDA_N * IB)

Av = -gm * r0

print(f"Av: {Av}")
print(f"gm: {gm}")
print(f"r0: {r0}")
```

Screenshot



Answers

	Calculation	Simulation
gmn	343.5	X
r0n	166.6 kOhm	X
Av	-57.25	52.9

Problem4

Source Code

```
from math import sqrt
from constants import *

Vov = sqrt(2 * IB / K_P)
VGS = -1 * (Vov + V_THP - VDD)
VG = VDD - VGS
R = VG / IB

RL = 1e3
IL = 0.5 * K_P * (Vov**2)
VDL = IL * RL

print(f"R : {R}")
```

```
print(f"VG: {VG}")
print(f"IL: {IL}")
print(f"VDL: {VDL}")
```

Screenshot

Answers

	Calculations	Simulations
R	10.6 kOhm	10.6 kOhm
VG	1.06	7.95
IL	1.0 uA	750uA
VD	0.01	7.95

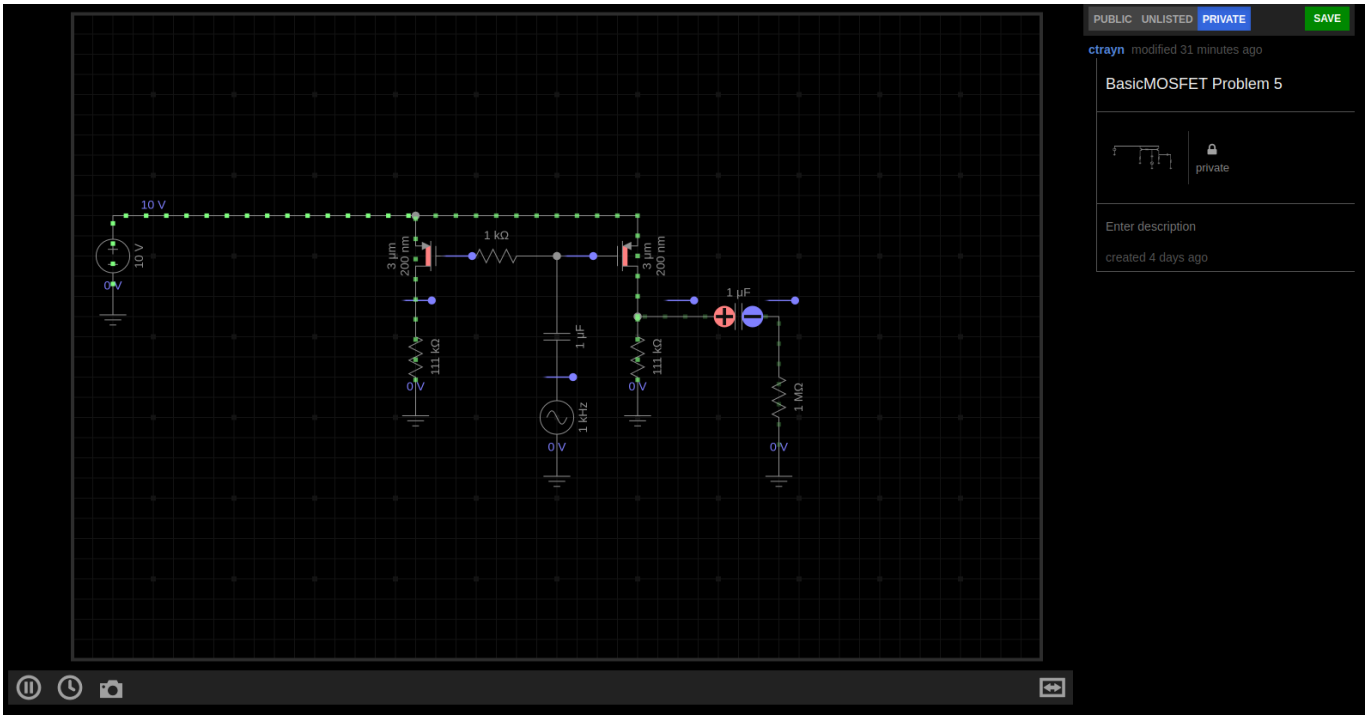
Problem5

Source Code

```
from cmath import sqrt
from constants import *
from Problem4 import R

Vg = 0
Vov = Vg - VDD - V_THP
VD = R/2 * K_P * (Vov**2)
IL = 0.5 * K_P * (Vov**2)
r0 = 1 / (LAMBDA_P * IL)
```

```
gm = sqrt(2 * K_P * IL)
Av = (gm*r0)/(gm + r0)

print(f"R: {R}")
print(f"gm: {gm}")
print(f"r0: {r0}")
print(f"Av: {Av}")
```

Screenshot



Answers

	Calculation	Simulation
gmn	4.73 mA/V	X
r0n	406.9 Ohm	X
Av	4.73 mV/V	Everycircuit says it's close to 0

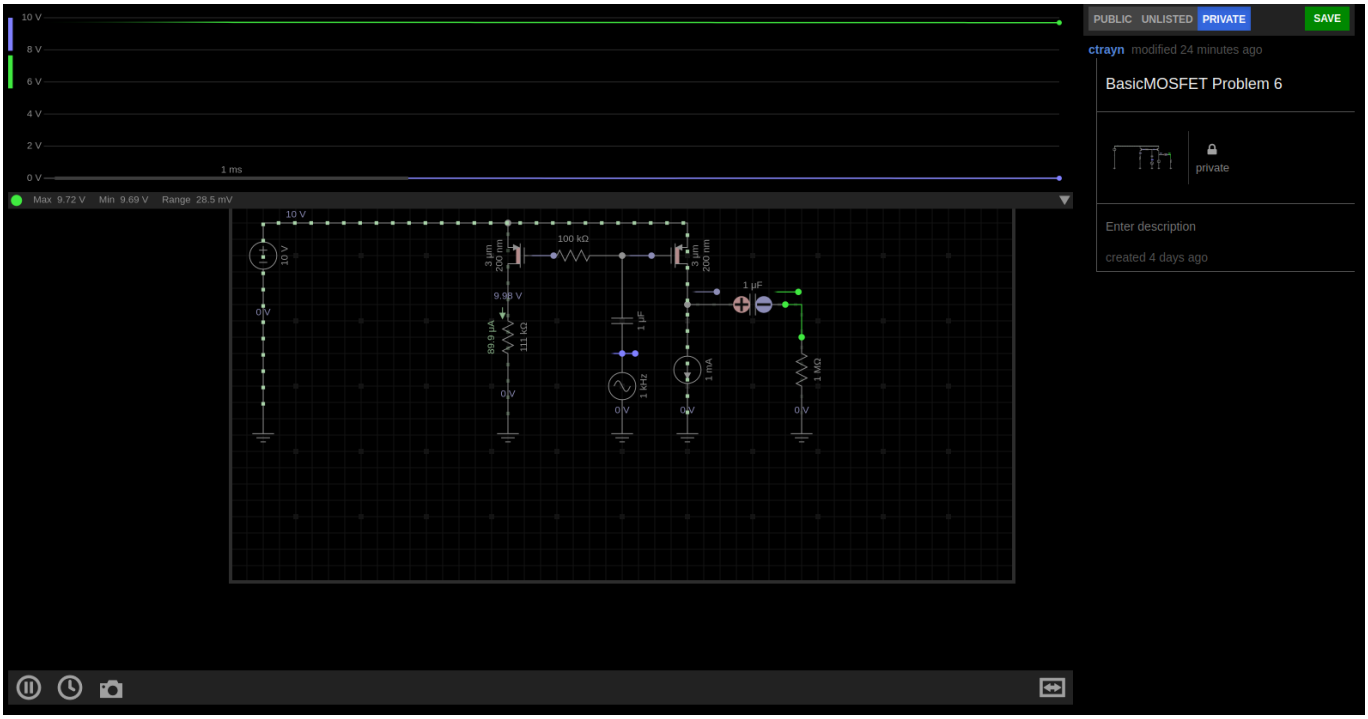
Problem6

Source Code

```
from constants import *
from math import sqrt

Vov = sqrt(2 * IB / K_P)
Vg = Vov + VDD + V_THP
R = Vg / IB
```

```
gm = sqrt(2 * K_P * IB)
r0 = 1/(LAMBDA_P * IB)
Av = -1 * gm * r0


print(f"R: {R}")
print(f"gm: {gm}")
print(f"r0: {r0}")
print(f"Av: {Av}")
```

Screenshot



Answers

	Calculation	Simulation
gmn	301 uA/V	X
r0n	100 kOhm	X
Av	-30.15	Everycircuit says it's close to 0

Problem7

Source Code

```
from constants import *
from Problem6 import R, gm, r0
```

Screenshot

Answers

	Calculation	Simulation
Av	-30.15	23.19