1. (6 points)
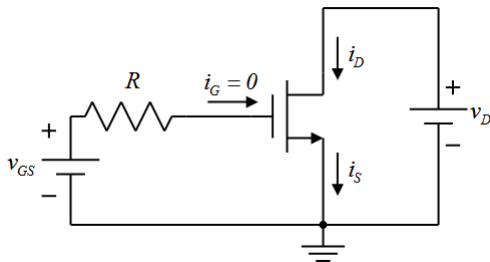
For the MOSFET in the circuit below $k'_n=\mu_n C_{ox}=25\frac{\mu A}{V^2}$, W=50$\mu m$, L=5$\mu m$, and V_t=3V. Also R=1$M\Omega$ and v_{GS}=4V.

   a. Calculate i_D if v_D=0.5V.
   b. Calculate i_D if v_D=8.7V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

(a) i_D : ___ μA

(b) i_D : ___ μA

Correct Answers:

   • 93.75
   • 125

2. (6 points)

An N-MOSFET having V_t=1V is operated in the triode region with v_{DS} small. With v_{GS}=2.4V is found to have a resistance r_{DS}=970Ω.

   a. What value of V_{GS} is required to obtain r_{DS}=190Ω.
   b. With the previously computed value of V_{GS}, compute the resistance r_{DS} if the device W is doubled. .

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

(a) V_{GS} : ___ V

(b) r_{DS} : ___ Ω

Correct Answers:

   • 8.14737
   • 95

3. (6 points)

An N-MOSFET having V_t=1V and $k'_n(W/L)$=0.17$\frac{mA}{V^2}$ is operated in the saturation region.

   a. If i_D is to be 0.3mA find the required V_{GS} in volts.
   b. For the computed value of part a) find the minimum required v_{DS} in volts.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

(a) v_{GS} : ___ V

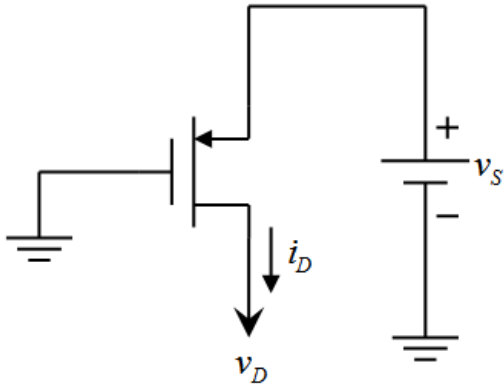**(b)** v_{DS} : ___ V

Correct Answers:

   • 2.87867
   • 1.87867

4. (6 points)

For the MOSFET in the circuit below $k'_p(W/L)$=80$\frac{\mu A}{V^2}$, V_t=-1.5V, and λ=-0.02V^{-1}. Also v_S=5V.

   a. Calculate i_D if v_D=4.5V.
   b. Calculate i_D if v_D=-2.4V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

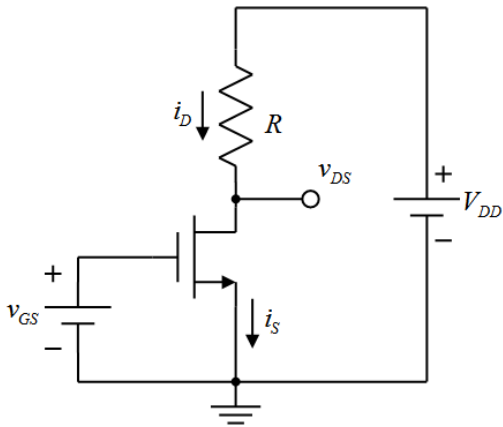**(a)** i_D : ____ μA

(b) i_D : ____ μA

Correct Answers:

- 130
- 562.52

5. (6 points)

The MOSFET in the circuit shown is known to have a threshold voltage $0.9V \leq V_t \leq 3.1V$. Also V_{DD}=15V and R=710Ω. When v_{GS}=4.1V, v_{DS}=14.89V. When v_{GS}=10V, v_{DS}=12.92V. Find V_t. For this MOSFET $V_A = \infty$.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)
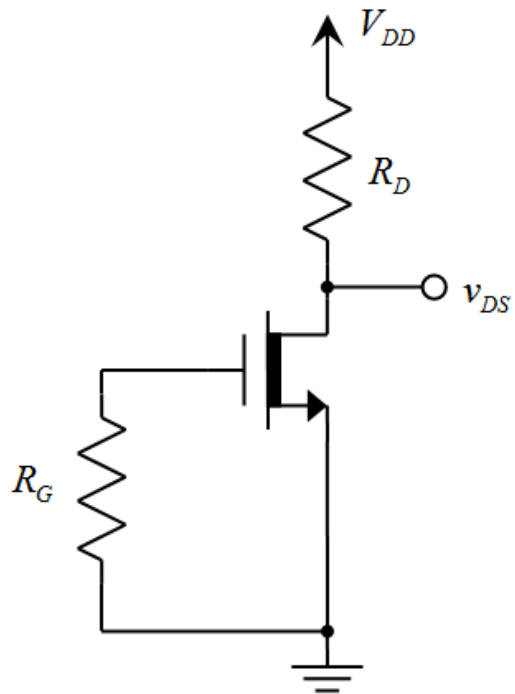

V_t : ____ V

Correct Answers:

- 2.338

6. (10 points)

The MOSFET in the circuit shown is known to have a threshold voltage V_t=-2V and $k'_n(W/L)$=0.0001$\frac{A}{V^2}$. Also V_{DD}=10V.

    a. Compute i_D when R_D=26300Ω in μA.
    b. Compute v_{DS} when R_D=26300Ω in V.
    c. Compute i_D when R_D=52000Ω in μA.
    d. Compute v_{DS} when R_D=52000Ω in V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

a) i_D : ____ μA

b) v_{DS} : ____ V

c) i_D : ____ μA
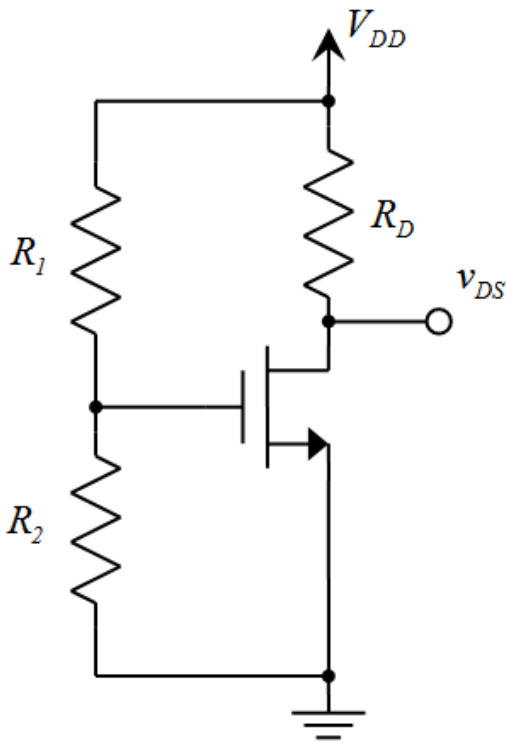
d) v_{DS} : ____ V

Correct Answers:

- 200
- 4.74
- 168.991
- 1.21248

7. (10 points)

The MOSFET in the circuit shown is known to have a threshold voltage V_t=3V, $k'_n(W/L)$=0.1$\frac{mA}{V^2}$, and $V_A = \infty$. Also V_{DD}=12V, R_D=11600Ω, R_1=2MΩ, and R_2=4MΩ.

a. Compute i_D in mA.
b. Compute v_{DS} in V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

a) i_D : ____ mA
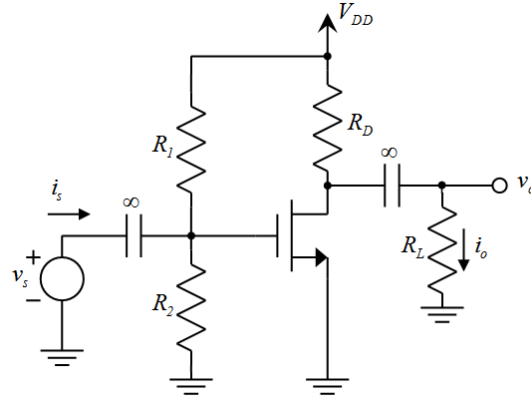
b) v_{DS} : ____ V

Correct Answers:

- 0.847913
- 2.16421

---

8. (12 points)

The MOSFET in the circuit shown is known to have a threshold voltage V_t=2.5V, $k'_n(W/L)$=1$\frac{mA}{V^2}$, and $V_A = \infty$. Also V_{DD}=15V, R_D=12080Ω, R_L=14300Ω, R_1=3.1MΩ, and R_2=1MΩ.

a. Compute I_D in μA.
b. Compute V_{DS} in V.
c. Compute the voltage gain v_o/v_s

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

a) I_D : ____ μA

b) V_{DS} : ____ V

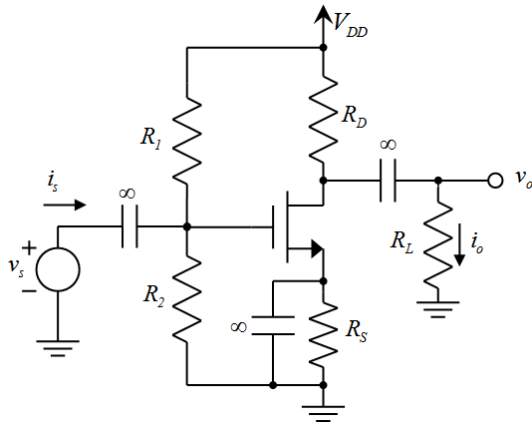**c)** v_o/v_s : ____ V/V

Correct Answers:

- 671.104
- 6.89307
- -7.58644

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9. (12 points)

The MOSFET in the circuit shown is known to have a threshold voltage V_t=1V, $k'_n(W/L)$=2$\frac{mA}{V^2}$, and $V_A = \infty$. Also V_{DD}=15V, R_D=7360Ω, R_S=3480Ω, R_L=10000Ω, R_1=10MΩ, and R_2=5MΩ.

a. Compute I_D in μA.
b. Compute V_{DS} in V.
c. Compute the voltage gain v_o/v_s

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

a) I_D : _____ μA

b) V_{DS} : _____ V

c) v_o/v_s : _____ V/V

Correct Answers:

- 879.88
- 5.46211
- -7.95371

a) I_D : _____ μA

b) V_{DS} : _____ V

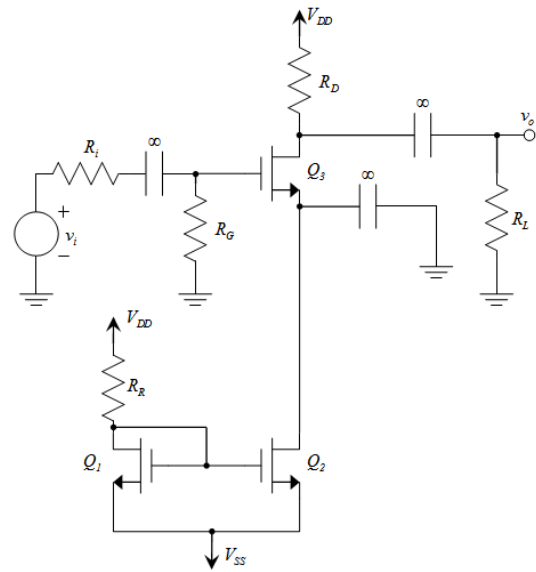**c)** v_o/v_i : _____ V/V

Correct Answers:

- 532.956
- 10.1447
- -6.1938

10. (16 points)

The MOSFETs in the circuit shown are all identical with a threshold voltage V_t=2V, $k_n'(W/L)$=1$\frac{mA}{V^2}$, and V_A=100V. Also V_{DD}=15V, V_{SS}=-15V, R_R=50600Ω, R_D=14800Ω, R_i=10000Ω, R_L=10700Ω, and R_G=5$M\Omega$.

   a. Compute I_D in μA for Q3.
   b. Compute V_{DS} in V for Q3.
   c. Compute the voltage gain v_o/v_i

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)
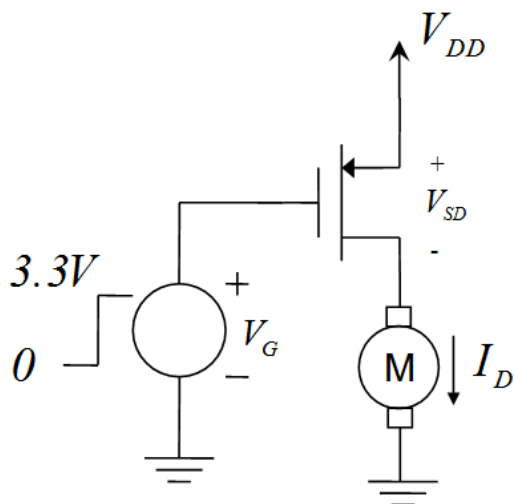
11. (5 points)

The MOSFET in the circuit shown has threshold voltage V_t=2V and $r_{SD(on)}$=0.27Ω. The motor can be represented in DC as a resistance R_M=4.3Ω and V_{DD}=3.6V.

   a. Compute I_D in mA when the MOSFET is "on".
   b. Compute V_{SD} in V when the MOSFET is "on".
   c. Compute the smallest possible motor resistance that will keep the MOSFET in the triode region in Ω.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

a) I_D : _____ mA

b) V_{SD} : _____ V

c) R_M : _____ Ω

Correct Answers:

- 787.746
- 0.212691
- 0.3375

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12. (5 points)

The N-MOSFETs in the circuit shown have threshold voltage V_t=2V and $r_{DS(on)}$=0.22Ω. The P-MOSFETs in the circuit shown have threshold voltage V_t=3V and $r_{SD(on)}$=0.25Ω. The motor can be represented in DC as a resistance R_M=8.5Ω and V_{DD}=5.2V.

a. Compute the current motor in mA when it is turned on.
b. Compute the maximun power disipated by the N-MOSFETs in mW.
c. Compute the maximun power disipated by the P-MOSFETs in mW.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)
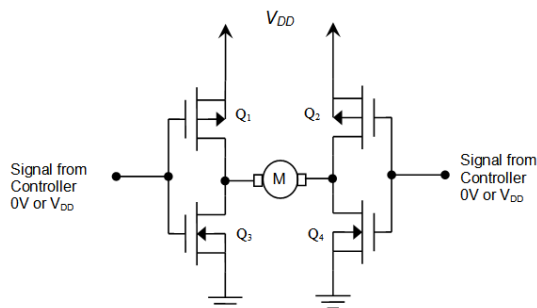
a) I_D : _____ mA

b) P_N : _____ mW

c) P_P : _____ mW

Correct Answers:

- 579.71
- 73.934
- 84.016