American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics

Quiz 2 – December 9, 2011

Closed Book – *No Programmable Calculators*

90 minutes

Penalty is 5 to 1

(1 to 4 wrong answers do not result in a penalty; 5 to 9 wrong answers cancel one correct answer; 10 to 14 wrong answers cancel two correct answers; and so on)

All questions are equally graded.

Name: _____ ID number: _____

1. An amplifier has an open-circuit voltage gain of 10 V/V, an input resistance of 12 kΩ, and an output resistance of 10 kΩ. Find the amplifier short-circuit transconductance G (in mA/V).

a) 1.5 b) 2.0 c) 2.5 d) 0.5 e) 1.0

---

2. A transconductance amplifier has an input resistance of 9 kΩ, an output resistance of 1 kΩ, and a short-circuit transconductance of 50 mA/V. If two of these transconductance amplifiers are cascaded, find the voltage gain (in V/V), from input of first stage to load, when a 4 kΩ load is connected across the output terminals.

a) 1800 b) 1152 c) 72 d) 288 e) 648

---

3. A particular MOSFET operating in the saturation region has an output resistance (r_o) of 50 kΩ at I_D = 1 mA and V_{DS} = 3 V. Find the Early voltage V_A (in V) of this MOSFET.

a) 57 b) 37 c) 42 d) 47 e) 52

The drain current of an enhancement N-channel MOSFET is measured at several values of V_{GS} and V_{DS}, as shown in the table below. For this MOSFET, V_t = 1 V.

V_{GS} (V)	V_{DS} (V)	I_D (mA)
3	3	0.8960
3	4	0.9280
Vx	0.2	0.2320

4. Find the value of λ (in V^{-1}).

a) 0.05 b) 0.04 c) 0.03 d) 0.02 e) 0.01

5. Find the value of $k_n'(W/L)$ in mA/V^2.

a) 0.56 b) 0.32 c) 0.64 d) 0.40 e) 0.48

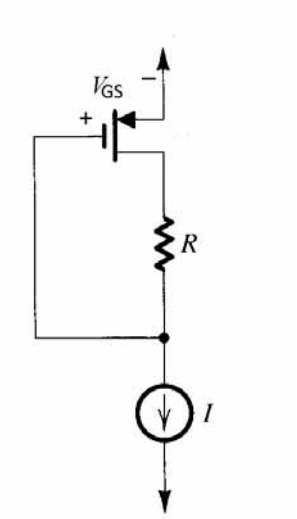
6. Find Vx (in V).

a) 5.5 b) 4.5 c) 5.0 d) 3.5 e) 4.0

---

7. For the PMOS transistor in the circuit shown in the figure below, $k_p' = 80\ \mu\text{A}/\text{V}^2$, $W/L = 2.5$, $\lambda = 0$, and $V_t = -1.4$ V. Find the voltage V_{GS} (in V) for $I = 100\ \mu\text{A}$ and $R = 8\ \text{k}\Omega$.

a) –2.8 b) –2.4 c) –2.0 d) –2.2 e) –2.6



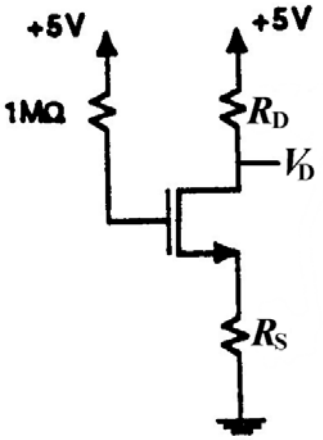
---

8. The N-channel enhancement MOSFET has V_t = 1.1 V, $\lambda = 0$, and $k_n'(W/L) = 1\ m\text{A}/\text{V}^2$. If R_D = 1.5 kΩ and the MOSFET operates at the *boundary* between the triode and saturation regions, find V_D (in V).

a) 3.6 b) 3.7 c) 3.8 d) 3.9 e) 4.0

9. Find the value of R_S (in kΩ) in the previous problem.

a) 6.39 b) 8.35 c) 2.59 d) 5.88 e) 3.67

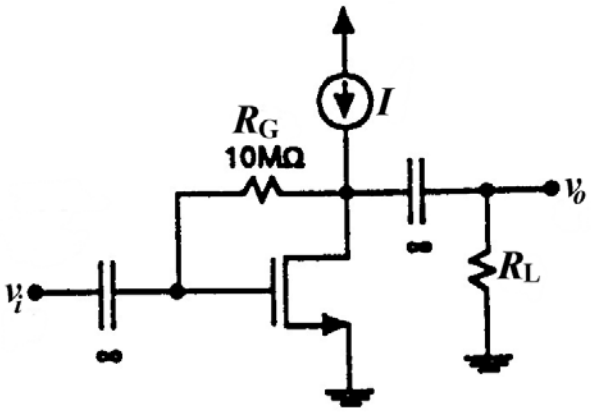


---

10. An N-channel enhancement MOSFET having $k_n'(W/L) = 1\ m\text{A}/\text{V}^2$ is used for small signals as a linear resistance between drain and source whose value is 2 kΩ when V_{GS} is 1 V. If V_{GS} is increased to 3.5 V, what would the value of this resistance become (in Ω)?

a) 333.3 b) 1000 c) 666.7 d) 500 e) 400

In the circuit shown below, R_G = 10 MΩ, the capacitors are very large, and $\lambda = 0$. The transistor is biased in the saturation region such that the gate to source overdrive voltage V_{OV} is 1.8 V.

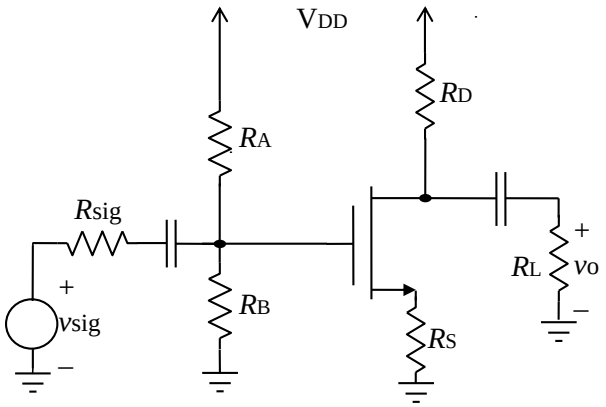


11. Find the value of the MOSFET transconductance g_m (in mA/V) if the current source carries I = 1 mA.
a) 0.91 b) 1.43 c) 1.25 d) 1.11 e) 1.67

12. If the MOSFET transconductance g_m = 1 mA/V and the input resistance of the amplifier v_i/i_i was measured to be 1.0 MΩ, find the value of the load resistance R_L (in kΩ).
a) 8.1 b) 11.5 c) 10.1 d) 9.0 e) 7.3

13. Assume that the DC component of v_{GS} is V_{GS} = 2.8 V and that the small-signal voltage gain v_o/v_i of –8 V/V. Neglecting distortion, find the largest input signal amplitude $v_{gs(max)}$ (in mV) such that the MOSFET remains in saturation.
a) 166.7 b) 142.8 c) 125.0 d) 111.1 e) 100.0

In the circuit shown below, the transistor is biased in the saturation region.
The capacitors are very large, $\lambda = 0$, $k_n'(W/L) = 0.5\ mA/V^2$,
R_A = R_B = 380 kΩ, Rsig = 10 kΩ, R_D = 8 kΩ, R_L = 12 kΩ,
and R_S = 1.4 kΩ.



14. Find the value of the MOSFET transconductance g_m (in mA/V) if the transistor is biased such that I_D = 1.4 mA.
a) 1.304 b) 1.183 c) 0.707 d) 0.894 e) 1.05

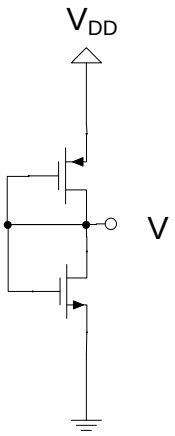
15. If the MOSFET transconductance g_m = 1 mA/V and $\boldsymbol{v}_{\mathbf{sig}}$ is a 0.2 V peak-to-peak sinusoid, find the peak-to-peak variation of v_{gs} (in mV).
a) 79.2 b) 73.08 c) 86.36 d) 118.75 e) 105.55

16. Assume now that a *large capacitor is connected in parallel with* R_S and that the MOSFET is biased such that g_m = 0.9 mA/V and r_o = 25 kΩ. Find the small-signal current gain i_o/i_i (in A/A). Note that i_o flows in R_L, and i_i flows in R_{sig}.
a) –31.9 b) –38.3 c) –44.6 d) –51.0 e) –57.4

---

17. A MOSFET is biased at V_{OV} = 1 V, V_{DS} = 5 V, with I_D = 0.2 mA. Find the resistance value (in kΩ) that appears between gate and source in the small-signal ***T*-model**.
a) 2.5 b) 2.0 c) 1.7 d) 5.0 e) 3.3

In the circuit shown below, the N-channel MOSFET is characterized by $k'_n(W/L)$ = 4 mA/V^2, V_{tn} = 1 V and λ = 0. The PMOS transistor is characterized by $k'_p(W/L)$ = 2 mA/V^2, V_{tp} = –1 V and λ = 0.



18. If V_{DD} is large enough for the MOSFETs to conduct, in what region would the MOSFETs be operating?
a) N is TRIODE, P is TRIODE
b) N is SAT, P is TRIODE
c) N is SAT, P is SAT
d) N is TRIODE, P is SAT
e) N is OFF, P is OFF; the MOSFETs cannot conduct for any value of V_{DD}.

19. Given that the voltage V is 4 V, what is the value of I_D (in mA)?
a) 2 b) 18 c) 8 d) 50 e) 32

20. If V_{DD} = 6 V, what is the voltage V (in V) at the connected gates?
a) 3.49 b) 3.90 c) 4.31 d) 3.07 e) 2.66