ECE 2C Mid-Term Exam

May 6, 2010

Do not open exam until instructed to.

Closed book: Crib sheet and 1 page personal notes permitted

There are xx problems on this exam, and your have 50 minutes.

Use any and all reasonable approximations (5% accuracy is fine.) , ***AFTER STATING and approximately Justifying them.***

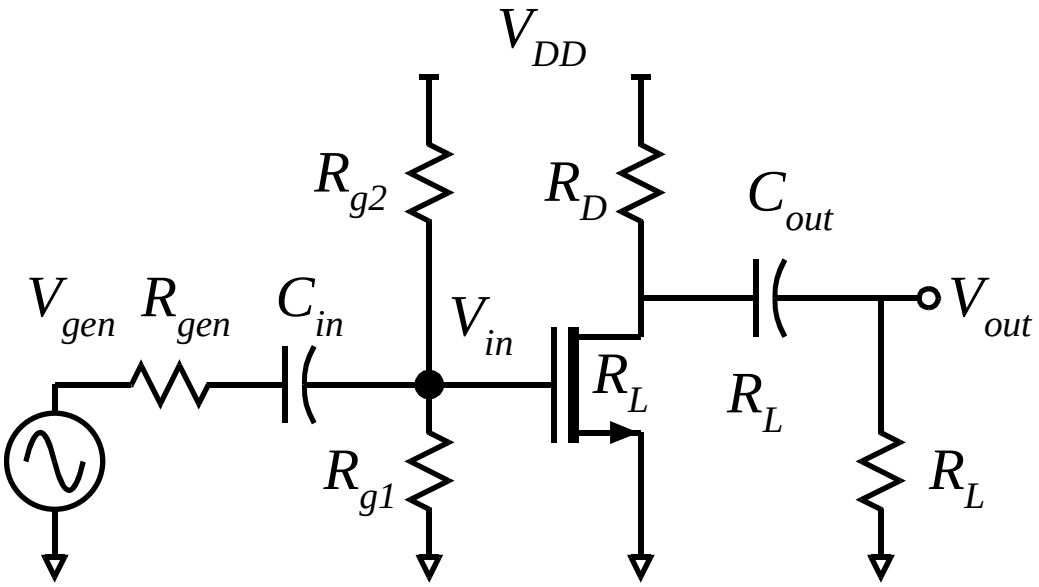
Name: _____

Problem	Points Received	Points Possible
1a		10
1b		10
1c		10
1d		15
1e		10
1f		10
1g		15
2		20
total		100

a

Problem 1, 85 points

You will be working on the circuit below:



Q1 is a mobility-limited FET, ie. $I_d = (\mu C_{ox} W_g / 2L_g)(V_{gs} - V_{th})^2 (1 + \lambda V_{ds})$ where $(\mu C_{ox} W_g / 2L_g)$=4 mA/V^2, $\lambda = 0.1\,\mathrm{V}^{-1}$, and V_{th}=0.3 V.

+Vcc= +3.0 volts.
Cin1 and Cout are very big and have negligible AC impedance.
RL=10 kOhm
Rgen=100kOhm

Part a, 10 points

DC bias.

Q1 is to be biased with 1 mA drain current.

The drain of Q1 is to be biased at 1.0 Volts

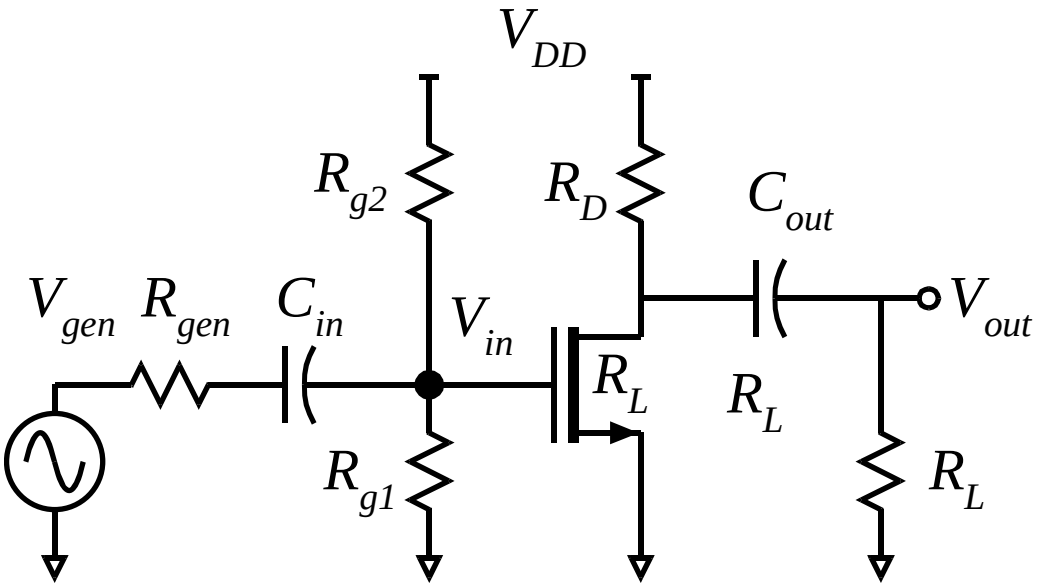
The DC current in Rg1 is 1 μA

Ignore λ while solving this part.

Find: Rg1=_____ Rg2=_____ Rd=_____

Part b, 10 points

DC bias



On the circuit diagram above, label the DC voltages at **ALL nodes** and the DC currents through **ALL resistors**

Part c, 10 points

Find the small signal parameters of Q1. Use the constant-mobility model.

gm=_____
Rds=_____

Part d, 15 points

Replacing the transistor with its small-signal model, draw a small-signal equivalent circuit diagram for the amplifier. Give values for all elements on the diagram.

Part e, 10 points.

Find the small signal voltage gain (Vout/Vin) of Q1.

Vout/Vin=_____

Part f, 10 points

Find the *** amplifier *** input resistance, Vin/Vgen, and Vout/Vgen

Rin,amplifier =_____

Vin/Vgen= _____

(Vout/Vgen) = _____

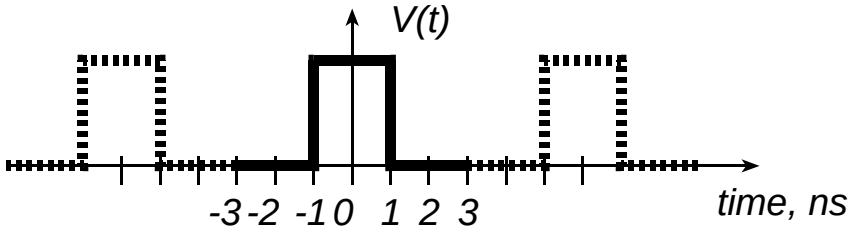
Part g, 15 points

Now you must find the maximum signal swings. Find the output voltage due to the knee voltage and due to cutoff in Q1.

Cutoff of Q1; Maximum ΔVout resulting = _____

Kneed voltage of Q1; Maximum ΔVout resulting = _____

Problem 2, 20 points
Fourier series



The waveform repeats with a period of 6 ns. The peak value is 1 volt.

V(t) can be written as a Fourier series like so:

$$V(t) = V_{dc} + a_1 \cdot \sqrt{2} \cdot \cos(2\pi f_0 t) + a_2 \cdot \sqrt{2} \cdot \cos(2 * 2\pi f_0 t) + a_3 \cdot \sqrt{2} \cdot \cos(3 * 2\pi f_0 t) + ...$$
$$+ b_1 \cdot \sqrt{2} \cdot \sin(2\pi f_0 t) + b_2 \cdot \sqrt{2} \cdot \sin(2 * 2\pi f_0 t) + b_3 \cdot \sqrt{2} \cdot \sin(3 * 2\pi f_0 t) + ...$$

where $f_0 = (1/6\text{ns})$

Write an integral which gives the value for for a3, and find its numerical value (10 points each)

integral equation for a3=_____

numerical value for a3=_____