Mid-Term Exam, ECE-137B
MONDAY May 14, 2007

Closed-Book Exam

There are 2 problems on this exam , and you have 50 minutes.
1) show all work. Full credit will not be given for correct answers if supporting work is not shown.
2) please write answers in provided blanks
3) Don't Panic !
4) 137a, 137b crib sheets, and 2 pages personal sheets permitted.

Do not turn over the cover page until requested to do so.

Name:

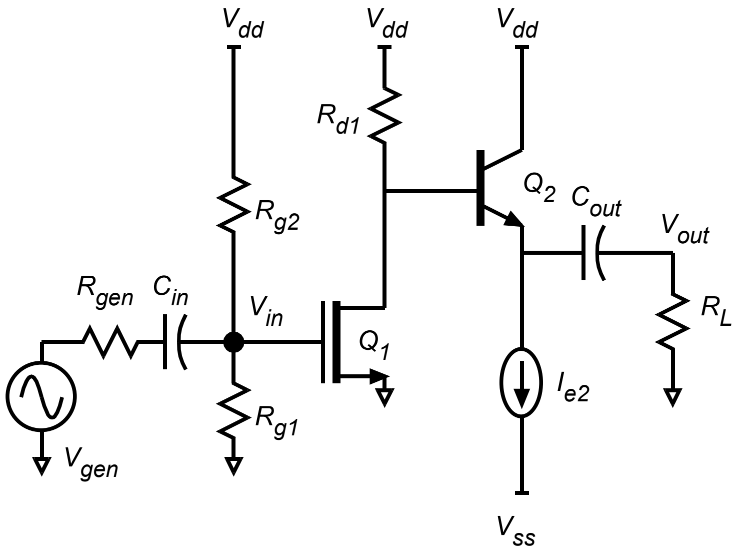
____

Use any and all reasonable approximations. 5% accuracy is fine if the method is correct.

Time function	LaPlace Transform
$\delta(t)$	1
U(t)	1/s
$e^{-\alpha t}U(t)$	$\frac{1}{s+\alpha}$
$e^{-\alpha t}\cos(\omega_d t)U(t)$	$\frac{s+\alpha}{(s+\alpha)^2+\omega_d^2}$
$e^{-\alpha t}\sin(\omega_d t)U(t)$	$\frac{\omega_d}{(s+\alpha)^2+\omega_d^2}$

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

Problem 1, 70 points

<table>
<tr><td>
</td><td>The supplies are +/- 2 Volts

Q1: $|V_{th}|$=0.3 Volt,
$v_{sat}C_{ox}W_g$=20 mA/V,
lambda=0, C_{gs}=20 fF,
C_{gd}= 0 fF

Q2: $\beta=\infty$, τ_f=1 ps,
C_{je}= 5 fF, C_{cb}=10 fF,
$V_A=\infty$ Volts

Rgen=100 kOhm.
RL=100 Ohm
Ie2=1 mA
Rg1= 1 MOhm</td></tr>
<tr><td colspan="2">The DC drain voltage of Q1 is to be 1 volts.
The DC drain current of Q1 is to be 5 mA.
Cin and Cout are AC short-circuits at all frequencies of interest---THEREFORE DO NOT TREAT THEM AS CAPACITORS in an MOTC analysis.</td></tr>
</table>

a

Part a, 10 points

Find the following

Rg2=________________ Rd1= _____________

$(C_{je} + C_{diff})$ of Q2=_________________

Part b, 10 points

Mid Band Analysis:
Find the mid-band small signal voltage gain of Q2 (the small signal voltage at the emitter of Q2 divided by the small signal voltage at the base of Q2)

Av2=_______________

Find the mid-band small signal voltage gain of Q1 (the small signal voltage at the drain of Q1 divided by the small signal voltage at the gate of Q1)

Av1=_______________

Find Vin/Vgen

Vin/Vgen=__________________

Part c: 20 points

USING MOTC, you will find the two dominant pole frequencies of the transfer function. Give the frequencies of these in Hz:

Component of a1 due to C_{gs} of transistor Q1 = ____________________ seconds.

Component of a1 due to C_{cb} of transistor Q2 = ____________________ seconds.

Component of a1 due to $(C_{je} + C_{diff})$ of transistor Q2 = _____________ seconds.

a1 = _____________ seconds.

a

Part d: 20 points

Component of a2 due to C_{gs1} and C_{cb2} = ____________________ seconds^2 .

Component of a2 due to C_{gs1} and $(C_{je} + C_{diff})$ = ____________________ seconds^2 .

Component of a2 due to C_{cb2} and $(C_{je} + C_{diff})$ = ____________________ seconds^2 .

a2 = ____________________ seconds^2

f_{p1} =_____________ , f_{p2} =________________

a

Part e: 10 points

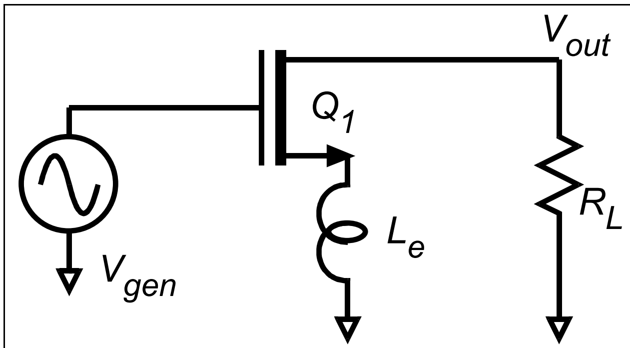
The circuit has 2 zeros its transfer function.
Give the frequencies of these in Hz:

$f_{z1} =$ ____________________

$f_{z2} =$ ____________________

<u>Problem 2, 30 points</u>

<u>Part a 10 points</u>



Small signal analysis.
Ignore the DC bias; you don't need it.

The FET has lambda=0 hence Gds=0. Also, Cgs =Cgd=0 fF

Replacing the transistor with its high frequency small-signal model, draw a small-signal equivalent circuit diagram.

Part b, 10 points

USING NODAL ANALYSIS, compute Vout(s)/Vgen(s) in ratio-of-polynomials form:

$$\frac{V_{out}(s)}{V_{gen}(s)} = \left.\frac{V_{out}}{V_{gen}}\right|_{mid-band} \times \frac{1 + b_1 s + b_2 s^2 + \,..}{1 + a_1 s + a_2 s^2 + \,..} = \rule{6cm}{0.4pt}$$

a

Part c, 10 points

gm= 100 mS.   RL=1 kOhm.   Le= 1 nH

Find the frequencies of any zeros (there may be zero, one or two present) in the transfer function:
f_{z1} =______________, f_{z2} =________________, ...

There may be either 1 or 2 poles of the transfer function.

If the poles are real, give the 1 or 2 pole frequencies in Hz:
f_{p1} =______________ , f_{p2} =_________________

If there are 2 poles, and they are complex, give $f_n = \upsilon_n / 2\pi$ and the damping factor ζ :
$f_n = \upsilon_n / 2\pi$ =________________, ζ =____________________