ECE 137 A Mid-Term Exam

Thursday, February 9, 2017

Do not open exam until instructed to.

Closed book: Crib sheet and 1 page personal notes permitted

There are 3 problems on this exam, and you have 75 minutes.

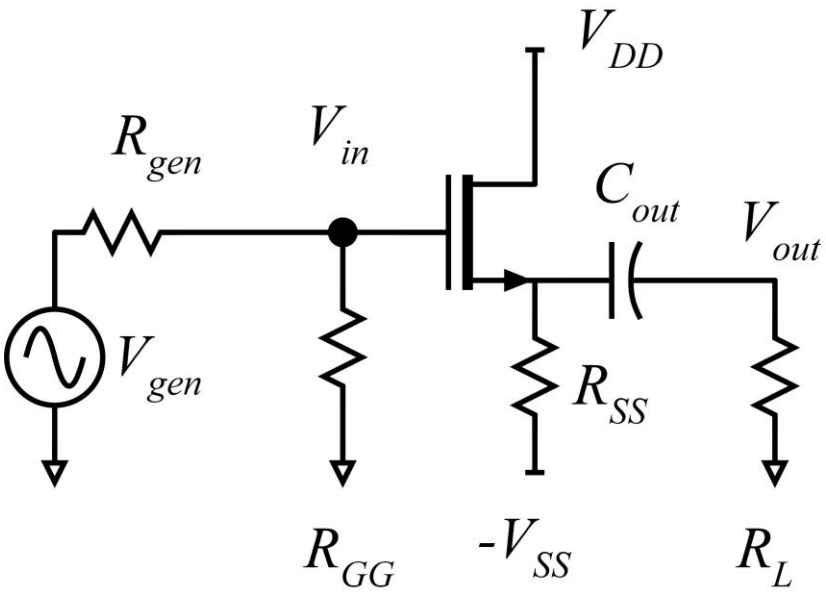
Use any and all reasonable approximations (5% accuracy is fine.) ,
AFTER STATING and approximately Justifying them.

Name: _____

Part	Points Received	Points Possible	Part	Points Received	Points Possible
1a		10	2f		15
1b		5	3a		8
1c		5	3b		8
1d		10	3c		4
1e		15			
2a		10			
2b		5			
2c		5			
2d		10			
2e		5			
TOTAL					100

Problem 1, 30 points

You will be working on the circuit below:



The transistor has

L_g=22nm, μ=180 $\mathrm{cm^2/V\text{-}s}$, $\varepsilon_{r,ox}$=3.8, T_{ox}=1nm, v_{sat}=10^7cm/s, $V_{th}=0.3\mathrm{V}$, $1/\lambda=10\mathrm{V}$,

From which we calculate:

$c_{ox}v_{sat}$=3.36 $\mathrm{mA/V/\mu m}$, $\mu c_{ox}/2L_g$=13.8 $\mathrm{mA/V^2/\mu m}$, $\Delta V = L_g v_{th}/\mu$=0.122V,

The supplies are +2V and -2 V

You are to bias the transistor at 2mA drain current, and with -0.5 V DC source voltage.

R_{GG}=10 $\mathrm{M\Omega}$, R_{gen}=100 $\mathrm{k\Omega}$, R_L=1 $\mathrm{k\Omega}$

C_{out} are is very large (AC short-circuit)

Part a, 10 points

DC bias.

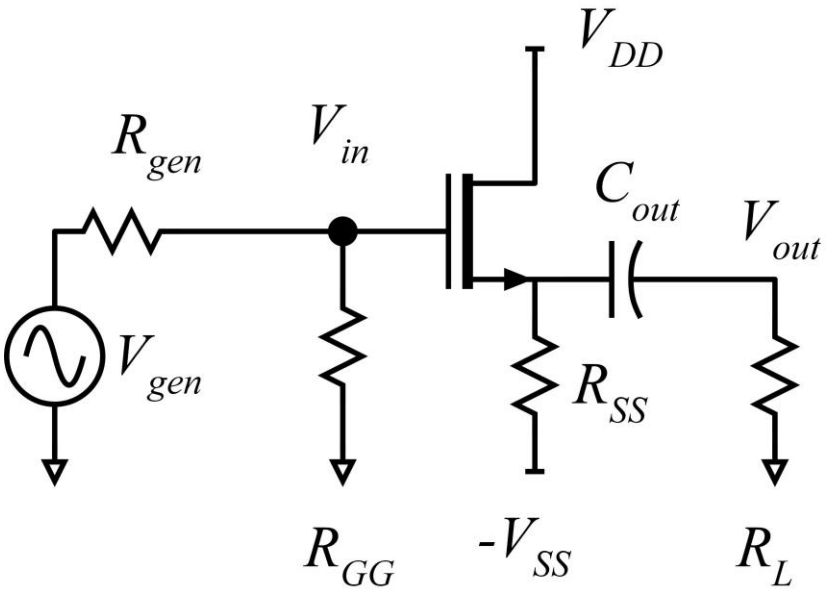
Use this approximation: Ignore (i.e. set to zero) the FET λ parameter in the DC bias calculation.

Find the following:

FET gate width Wg=_____ Rss=_____

Part b, 5 points

DC bias



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

b

Part c, 5 points

Using the actual (nonzero) FET λ parameter, find the FET small signal parameters
gm=_____ Rds=_____

Part d, 10 points.

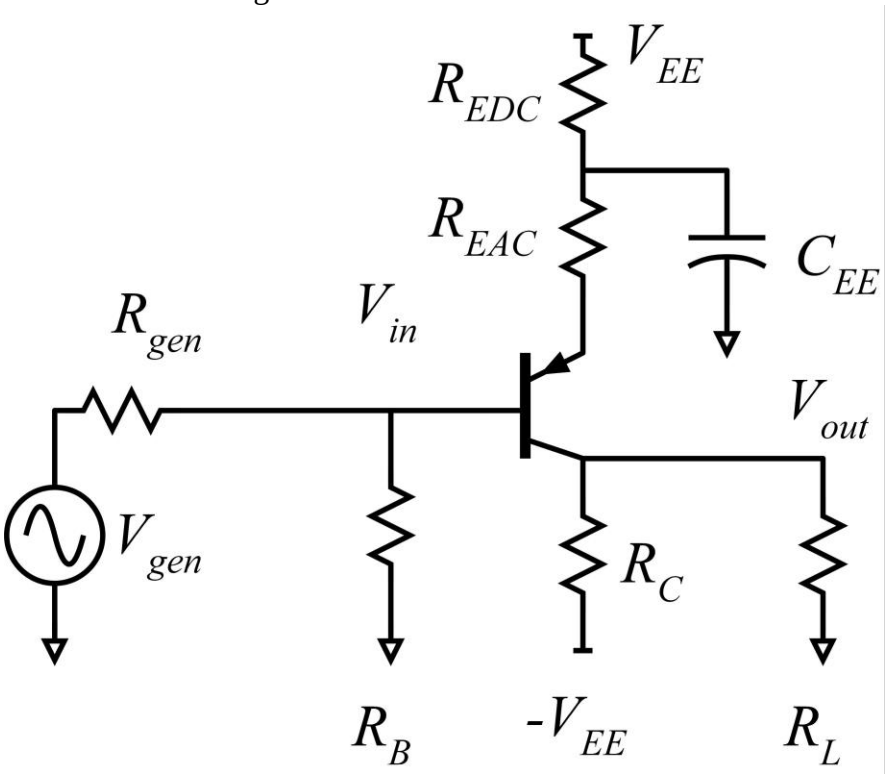
Find the small signal voltage gain Vout/Vin and the amplifier small-signal input resistance.

Vout/Vin=_____

Rin, amplfier = _____

Problem 2, 50 points

You will be working on the circuit below:



Q1: $\beta = 100$, V_A = infinity V
The supplies are +5V and -5 V.
You will bias the transistor with 10mA collector current.
The DC collector bias voltage is 0V.
R_L is 500 Ω, R_{gen} is 100 Ω, R_b is 1 kΩ, R_{EAC} is 25 Ω
C_{EE} is very large. Assume that it is an AC short-circuit.

Part a, 10 points

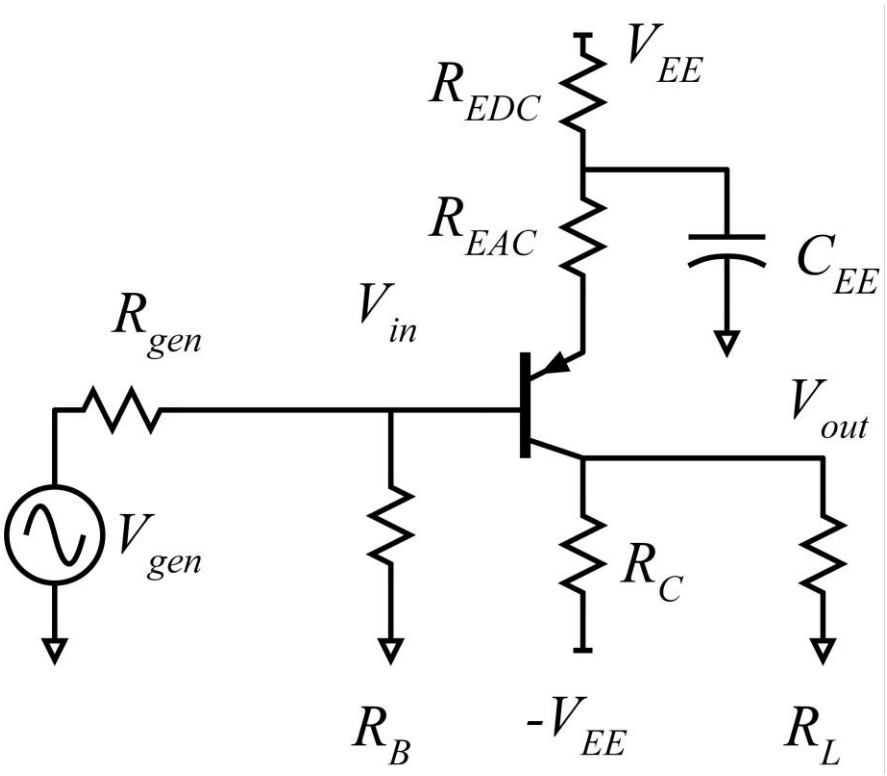
DC bias.

Find the following:

R_{EE} =_____ R_C =_____ R_{EDC} =_____

Part b, 5 points

DC bias



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

b

Part c, 5 points

Find the small signal parameters of Q1.
gm=_____ Rce=_____ Rbe=_____

Part d, 10 points.

Find the small signal voltage gain (Vout/Vin) of Q1 and the amplifier small-signal input resistance.

Vout/Vin=_____

Rin,amp= _____

Part e, 5 points

Find (Vin/Vgen) and (Vout/Vgen)

(Vin/Vgen) = _____

(Vout/Vgen) = _____

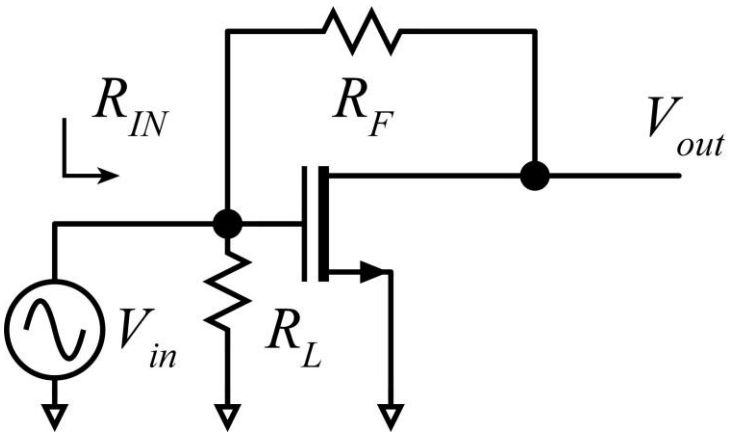
Part f, 15 points

Now you must find the maximum signal swings. Find the output voltage due to saturation and cutoff in Q2. ***Give the sign (+ or -) in your answers below.***

Cutoff of Q1; Maximum ΔVout resulting = _____

Saturation of Q1; Maximum ΔVout resulting = _____

Problem 3, 20 points
nodal analysis



You will be working on the circuit to the left.

Ignore DC bias analysis. You don't need it.

The transistor has transconductance gm.

The drain-source resistance Rds of the transistor is infinity (so you don't need to draw it!)

Part a, 8 points

Draw the small-signal equivalent circuit

Part b, 8 points

Find, by nodal analysis, a small-signal expression for Rin.

Rin= _____

Part c, 4 points

gm= 1 mS , R_L =3kOhm, $R_f = 2$ kOHm.
Give a numerical value for Rin.

Rin= _____