ECE 137 A Mid-Term Exam

Thursday, February 8, 2019

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.

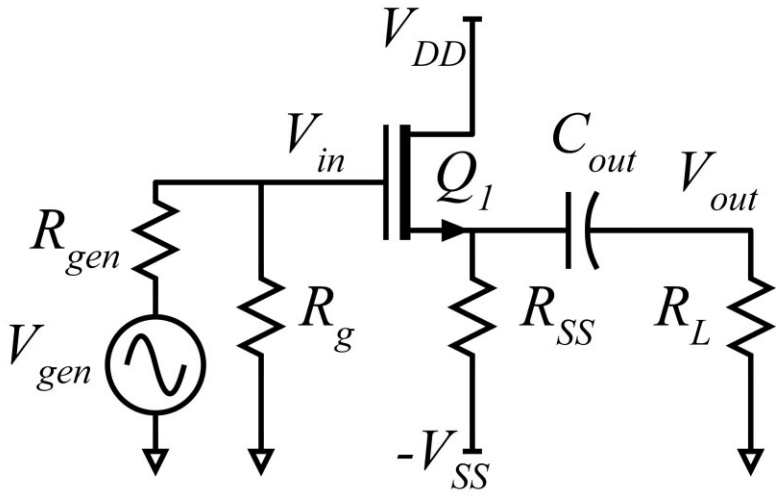
Use any and all reasonable approximations (5% accuracy is fine.) ,
AFTER STATING and approximately Justifying them.

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

$K_\mu = \mu c_{gs} W_g / 2L_g = 0.55\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$

$K_v = c_{gs} v_{inj} W_g = 0.69\text{mA/V} \cdot (W_g / 1\mu\text{m})$

$\Delta V = v_{inj} L_g / \mu = 0.625\text{V}$, $V_{th} = 0.3\text{V}$, $1/\lambda = 20\text{V}$

The supplies are +2V and -2 V

You are to bias the transistor at 10mA drain current, and with -0.5 V DC source voltage.

R_g =1 MΩ, R_{gen}=30 kΩ, R_L=500 Ω

C_{out} is very large (AC short-circuit at the signal frequency)

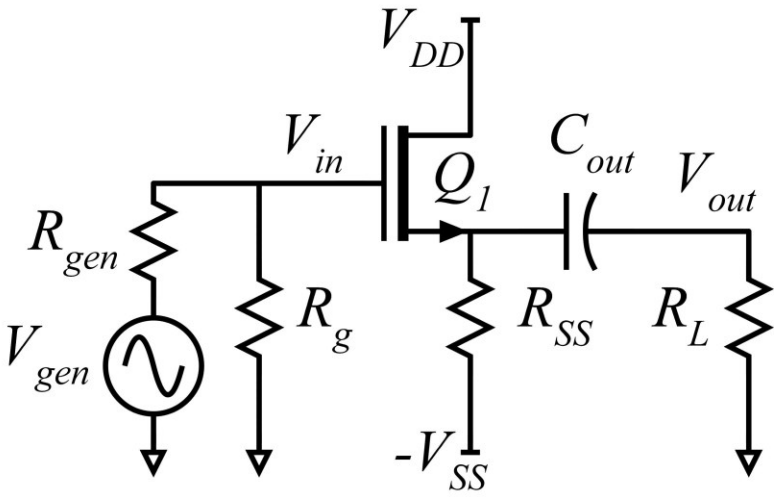
Part a, 10 points
DC bias.

Find the following:
FET gate width Wg=_____ Rss=_____

a

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,** give **all resistor values**, and give the **FET width**.

Part c, 5 points

Find the FET small signal parameters
gm=_____ Rds=_____

Part d, 10 points.

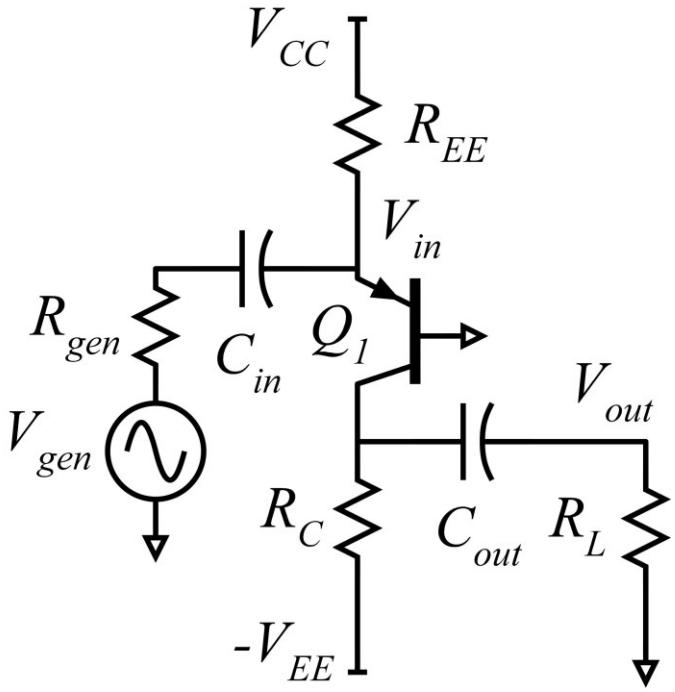
Find the small signal voltage gain Vout/Vin and the amplifier small-signal input resistance.

Vout/Vin=_____

Rin, amplfier = _____

Problem 2, 50 points

You will be working on the circuit below:



Q1: $\beta = 100$, V_A = infinity V, Vce,sat=0.5V
The supplies are +10V and -10 V.
You will bias the transistor with 1mA collector current.
The DC collector bias voltage is -5V.
R_L is 1 kΩ, R_{gen} is 100 Ω,
C_{out} and C_{in} are very large (AC short-circuit at the signal frequency)

Part a, 10 points

DC bias.

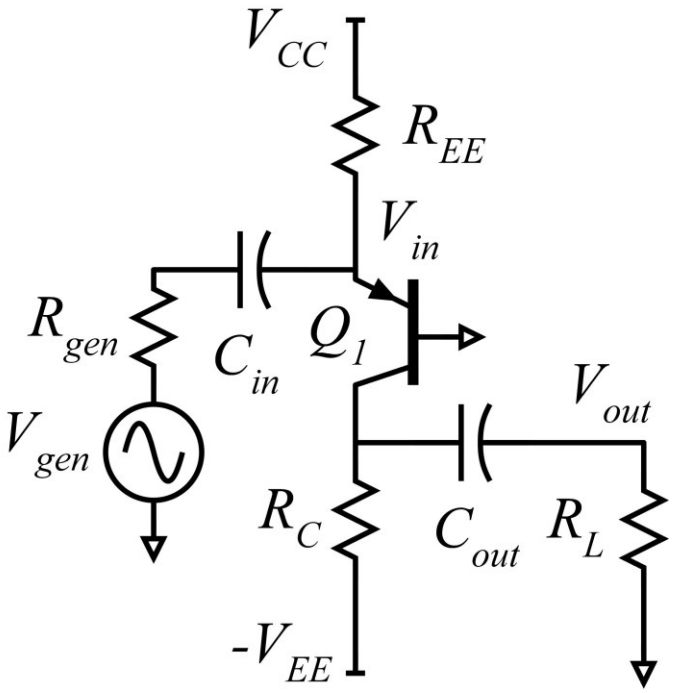
Find the following:

R_{EE} =_____ R_C =_____

a

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,** and give **all resistor values**,

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) = _____

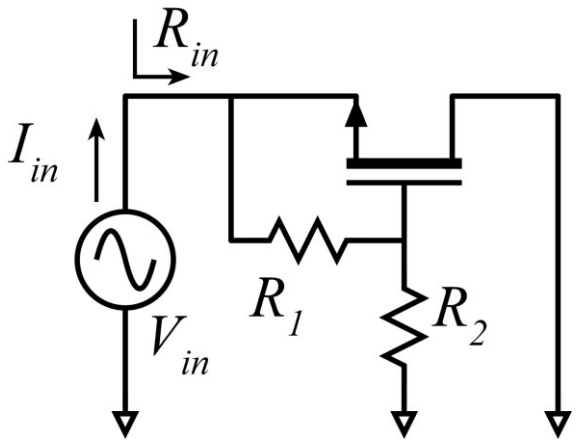
Part f, 15 points

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=Vin/Iin.

Rin= _____

Part c, 4 points

gm= 1 mS , R1=10 kOhm, R2= 500 Ohm.
Give a numerical value for Rin.

Rin= _____