Midterm Examination

Electronic Circuits I - 304-330A
November 15th 2001, 10:05 AM – 11:25 AM
Professor David Plant

Pertinent Information:

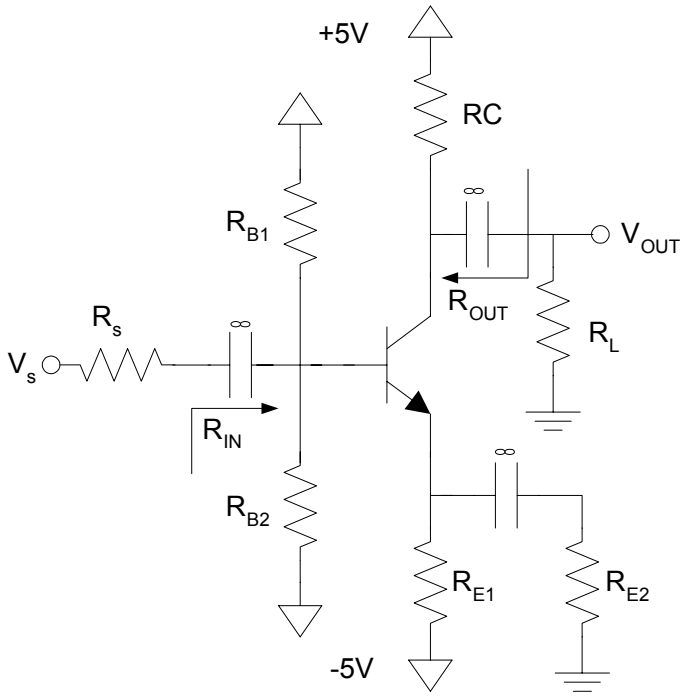
1) This is a closed-book examination, no notes permitted.

2) The examination consists of 3 problems; 36 total possible points.

3) Only the Faculty Standard Calculator is permitted.

Question #1 [10 pts]:

Consider the following circuit.



$R_{B1} = 40k\Omega$
$R_{B2} = 20k\Omega$
$R_C = 1k\Omega$
$R_{E1} = 2.5k\Omega$
$R_{E2} = 1k\Omega$
$R_L = 2k\Omega$
$R_s = 50k\Omega$
$\beta = 99$

a) [2 pts] Calculate the DC emitter current, I_E, and the DC collector voltage, V_C. You can neglect the Early Voltage effect ($V_A = \infty$)

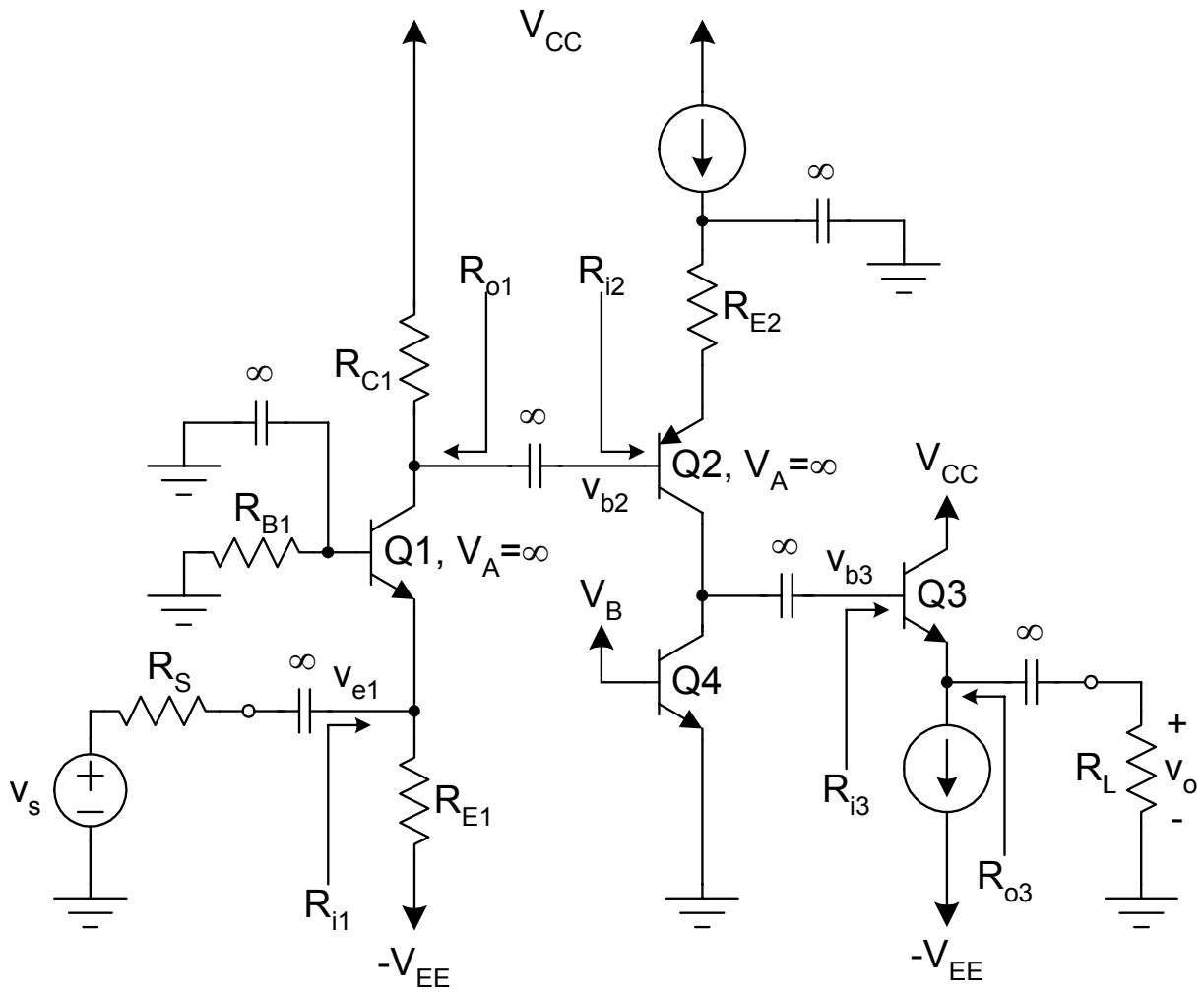
For parts (b) through (e), assume $I_E = 1$ mA (you can neglect the Early Voltage effect: $V_A = \infty$).

b) [2 pts] Calculate the input resistance, R_{IN}.
c) [2 pts] Calculate the output resistance, R_{OUT}.
d) [2 pts] Calculate the gain, V_{OUT}/V_S.
e) [2 pts] Calculate the largest allowable input signal magnitude, $|V_S|$, for which the small signal model holds.

Question #2 [21 pts]:

Consider the following circuit. You can assume that all transistors are in active mode and that they have the same β. For Q3 and Q4, DO NOT assume that $V_A = \infty$. You can assume that $V_A=\infty$ for the Q1 and Q2.

Give your answers in terms of β, R_s, R_{E1}, R_{B1}, R_{C1}, R_{E2}, R_L and the small signal parameters (for example, use g_{m1}, r_{e1} and r_{o1} for the small signal parameters of Q1). You can leave your answers for parts 3), 5), 6) and 9) in terms of the input and output resistances (e.g. R_{i1}, R_{o1}, etc.). If two transistors appear in parallel (say R_1 and R_2), use the notation R1//R2 in your answers instead of expanding R_{eq} to $(R_1 \times R_2)/(R_1+R_2)$. Please circle the final expression that you find for each question.



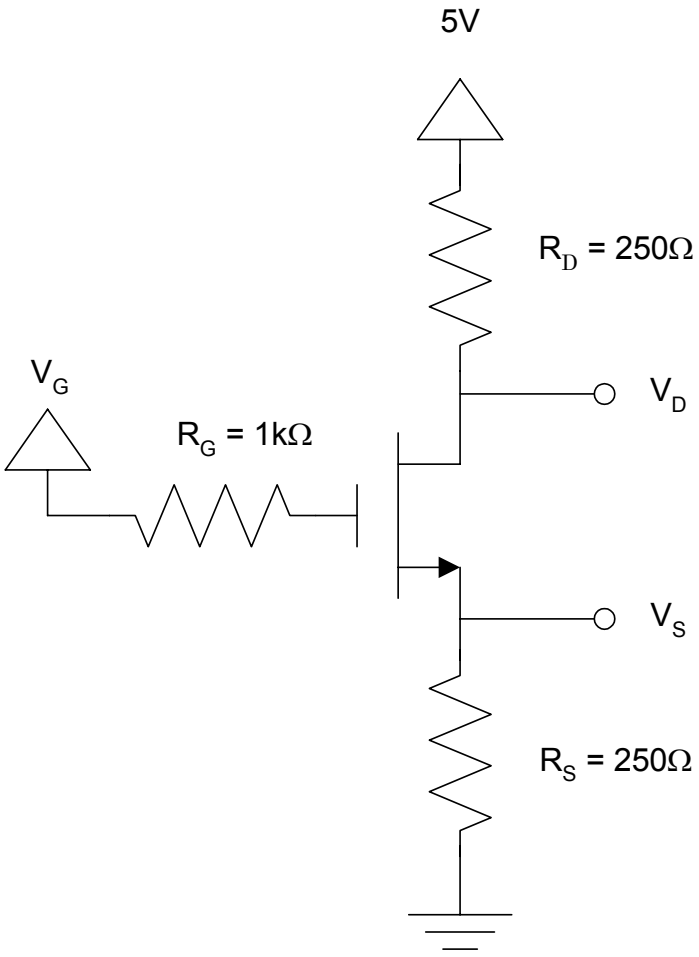
a) [2 pts] Find R_{i3} with the load R_L connected.
b) [3 pts] Find R_{o3}.
c) [2 pts] Find v_o/v_{b3}.
d) [2 pts] Find R_{i2}.

Question #2 continued:

e) [3 pts] Find v_{b3}/v_{b2}.
f) [3 pts] Find v_{b2}/v_{e1}.
g) [2 pts] Find R_{i1}.
h) [1 pts] Find R_{o1}.
i) [1 pts] Find v_{e1}/v_s.
j) [2 pts] Can you say why Q4 was preferred over a resistor at the collector of Q2? (You answer should have no more than two lines. Answers longer that two lines will NOT be corrected).

Question #3 [5 pts]:

Consider the following circuit The NMOS transistor has the following characteristics: $k_n' = 100\ \mu A/V^2$; $W/L = 20$, $V_t = 1.0V$ and $V_A=\infty$. You can neglect the Body Effect for this problem.



a) [3 pts] Assuming $V_S = 1.0$ V, calculate V_D, V_G and I_D. What mode of operation is the transistor in?

b) [2 pts] For $V_G = 3V$ and $I_D = 2$ mA, find the new value of R_D which puts the NMOS FET at the saturation/triode boundary assuming R_S and R_G remain unchanged.