Concordia UNIVERSITY

Course	Number	Section
Electronics II	ELEC 312	U and W

Examination	Date	Time	# of pages
Final	April 1996	3 Hours	6

Instructor(s)

Drs. M.B. Gawargy and H.R. Mehrvar

Materials allowed: ☐ No ☒ Yes (Please specify)

Calculators allowed: ☐ No ☒ Yes

Students are allowed to use pocket-sized electronic calculators only.
Students are allowed one double-sided, 8-1/2" x 11" crib sheet.

Special Instructions:

Attempt all six (6) questions. All questions carry equal weight.
Students are required to return question paper with exam booklet(s).
Your answers must be logical, reasoned, concise, and neatly organized.

1. For the MOS transistors shown in Figure 1, $|v_t| = 1$ v, $k = 0.5$ mA/v^2 and $\lambda = 0$.

   (a) Find v_1, v_2, and v_3 and modes of operations of Q_1 and Q_2.

   (b) Find g_{m1} and g_{m2}.

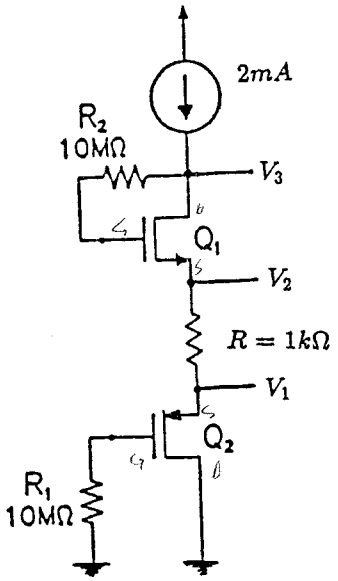

Figure 1

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2. Consider the circuit shown in Figure 2.

(a) Draw the small signal equivalent circuit.
(b) Find v_o/v_i in terms of circuit parameters, g_{m1}, g_{m2}, ro_1, and ro_2.

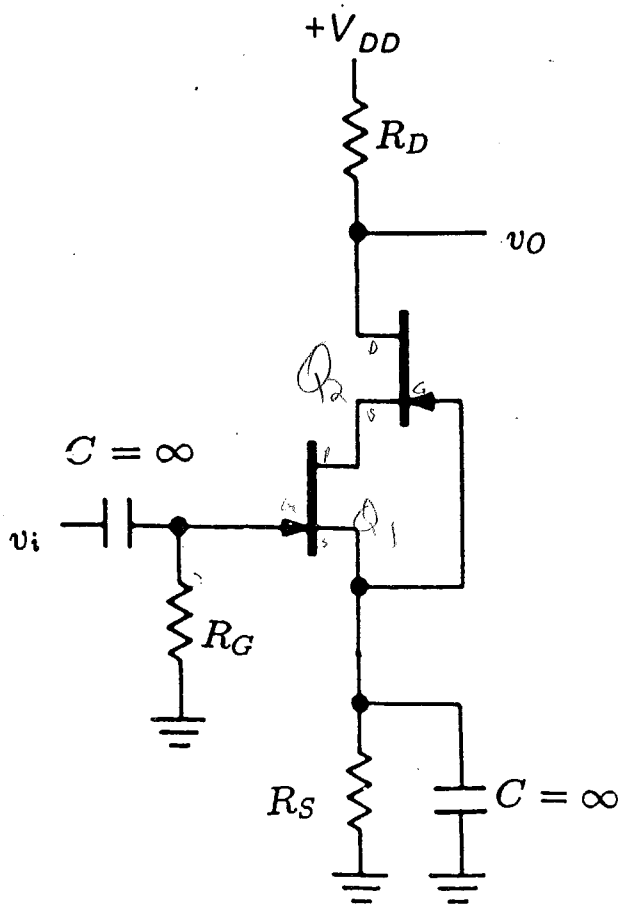

Figure 2

3. BJTs in the differential amplifier shown in Figure 3 have ß = 100, V_{BE} = 0.7 ~~V~~ and $r_o = \infty$. Find

(a) The current in the current source (I).
(b) r_{e1} and r_{e2}.
(c) The differential gain v_o/v_d.
(d) The input resistance R_{id}.
(e) The range of allowable common mode input.

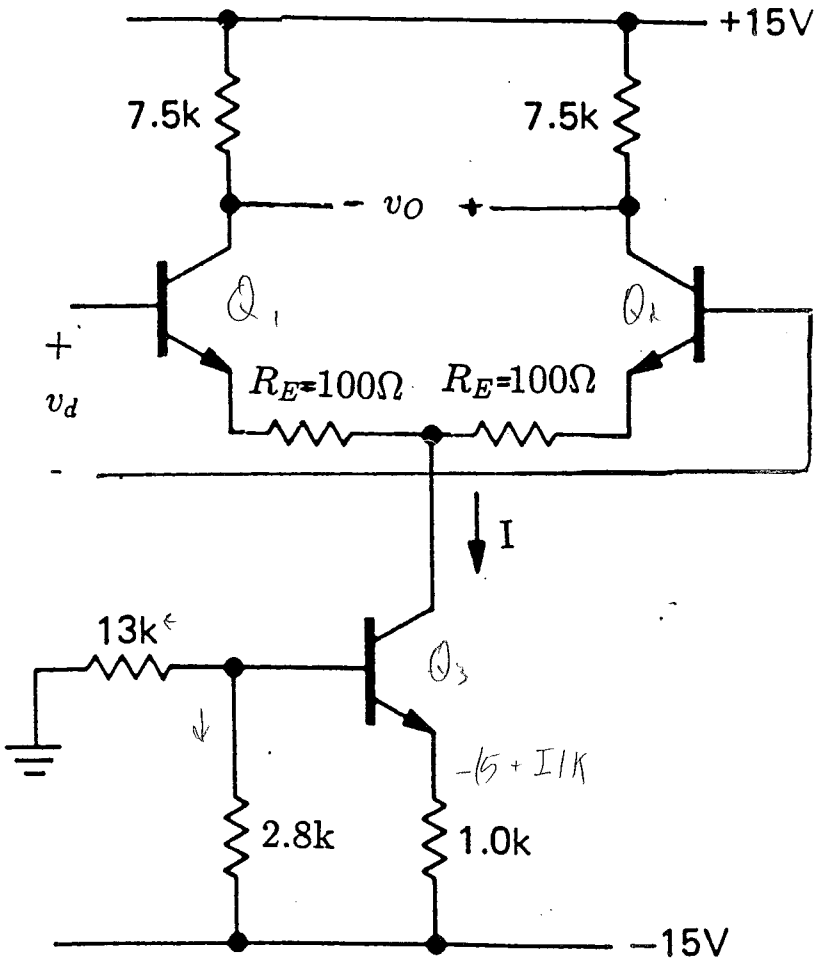

Figure 3

4. Figure 4 shows a Wilson current mirror which uses identical transistors Q_1, Q_2 and Q_3. Assume ß = 100 and I_{E1} = 0.25mA, V_A = 100 volts.

   (a) Calculate r_e, r_o and g_m.

   (b) Draw the equivalent circuit for the current mirror. Use the hybrid π models for Q_2 and Q_3 and replace Q_1 with its incremental resistance r_e.

   (c) Calculate the output resistance of the current mirror seen from the collector of Q_3.

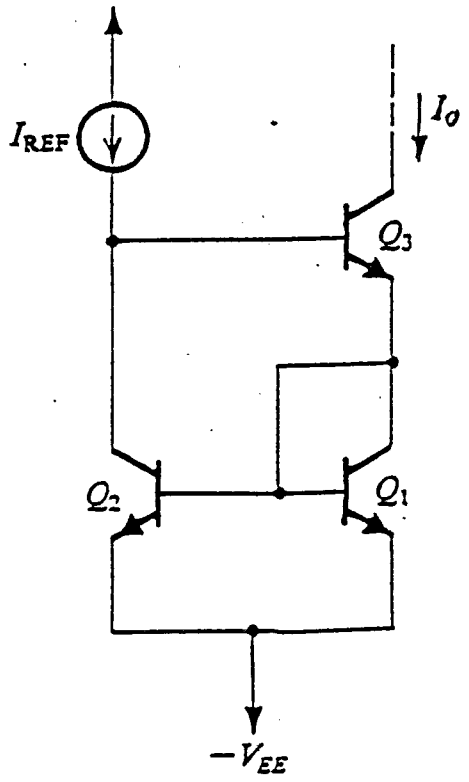

Figure 4

5. Figure 5 shows the high-frequency equivalent circuit of a FET amplifier.

(a) Derive an expression for the mid-frequency voltage gain (set C_{gs} and C_{gd} to zero).

(b) Use open circuit time constant method to derive expressions for R_{gs} and R_{gd}.

(c) Let R = 100kΩ, g_m = 4mA/V, R_L = 5kΩ, R_S = 100Ω, and $C_{gd} = C_{gs}$ = 1pF. Find the mid-frequency gain and the upper 3-dB w_H.

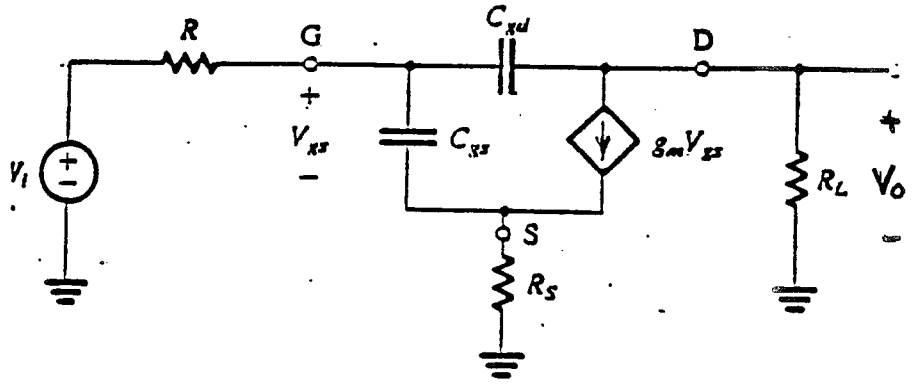

Figure 5

6. Assume that in the circuit of Figure 6 the BJT is operating in the active mode.

(a) State the type of feedback topology that has been employed in this circuit. Draw the feedback circuit, the A circuit, and the ß circuit with all their components expressed in terms of those of the given circuit.

(b) Derive expresions for A, R_i, R_o, and ß.

(c) Derive expressions for $A_f = v_o/v_s$, R_{if}, and R_{of}.

(d) Derive expressions for R_{in} and R_{out}, using feedback method.

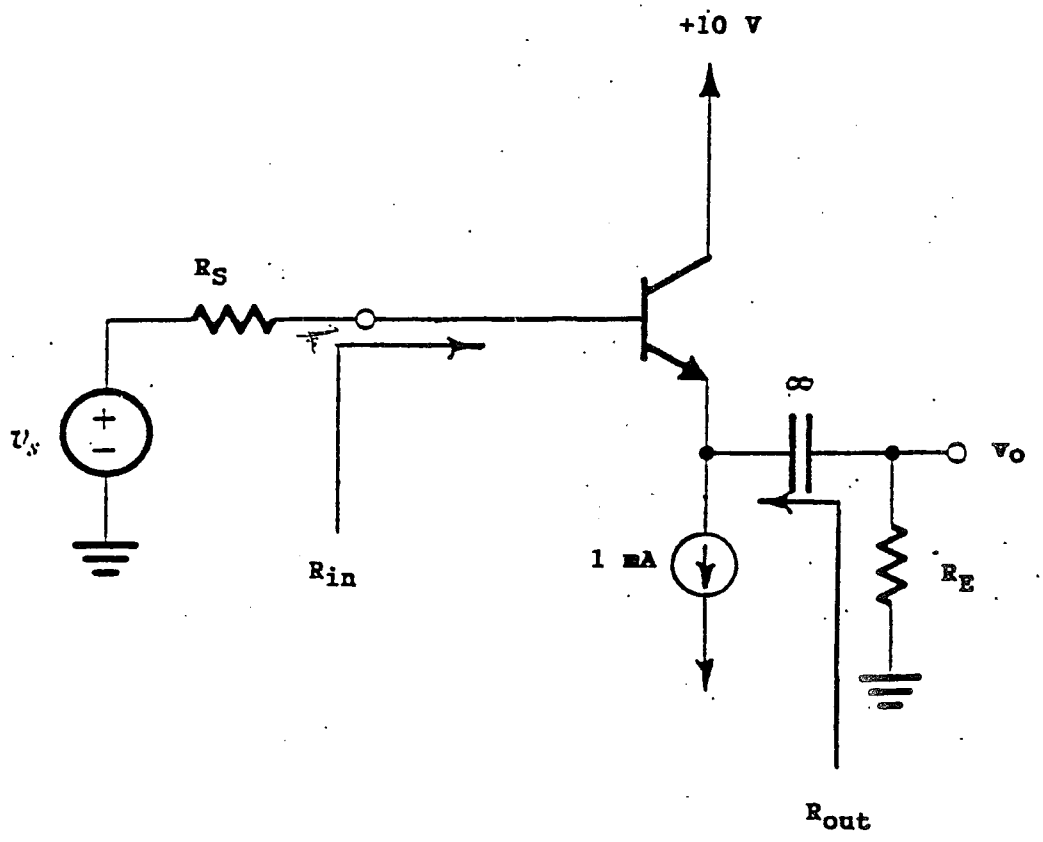

Figure 6

CONCORDIA UNIVERSITY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
MIDTERM EXAMINATION
ELECTRONICS II (ELEC 312/4)

Date: Friday, February 21, 1992 **Section U:** Dr. M.O. Ahmad

Time: 11:45 a.m. - 1:00 p.m. **Section W:** Dr. B.B. Bhattacharyya

Note:
(i) This is a closed-book examination
(ii) Electronic calculators are allowed
(iii) Attempt all four (4) questions
(iv) All questions carry equal weight

Question 1

The NMOS device shown in Figure 1 has the following parameters: $\lambda = 0$, $K = 1\ mA/V^2$, and $V_t = 2\ V$. The resistor $R_{G1} = 4\ k\Omega$ and the supply voltage $V_{DD} = +5\ V$. Design the circuit to establish a saturation – region dc operating point of $V_D = 2\ V$ and $I_D = 1\ mA$.

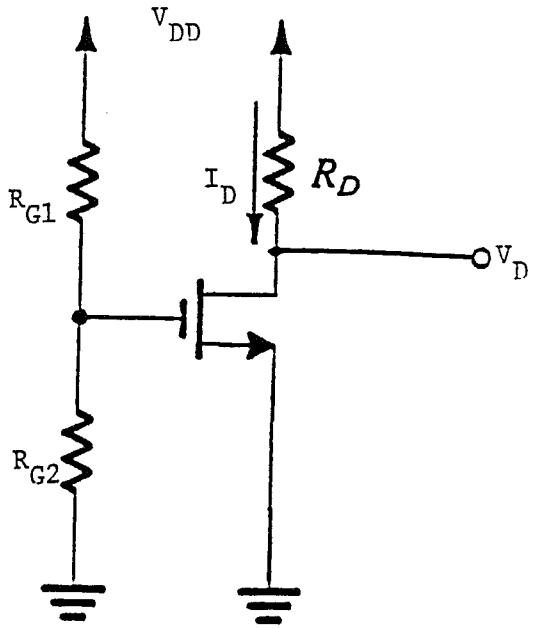

Figure 1

Question 2

The PMOS transistor in the circuit of Figure 2 has $V_t = -1\,V$, $\mu_p C_{ox} = 5\ \mu A/V^2$, $L = 10\,\mu m$, and $\lambda = 0$. Find the values of R and the gate width W in order to establish a drain current of 1 mA and a voltage $V_D = 2\ V$.

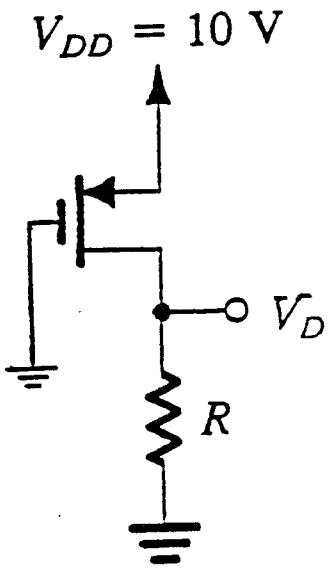

Figure 2

Question 3

For the amplifier circuit shown in Figure 3, assume that the MOSFET is operating in the saturation region and that $\lambda = 0$.

(a) Derive the expressions for the voltage gains v_{o1}/v_i and v_{o2}/v_i in terms of the circuit components and the FET's small-signal parameters.

(b) Establish the condition for $v_{o1} = -v_{o2}$.

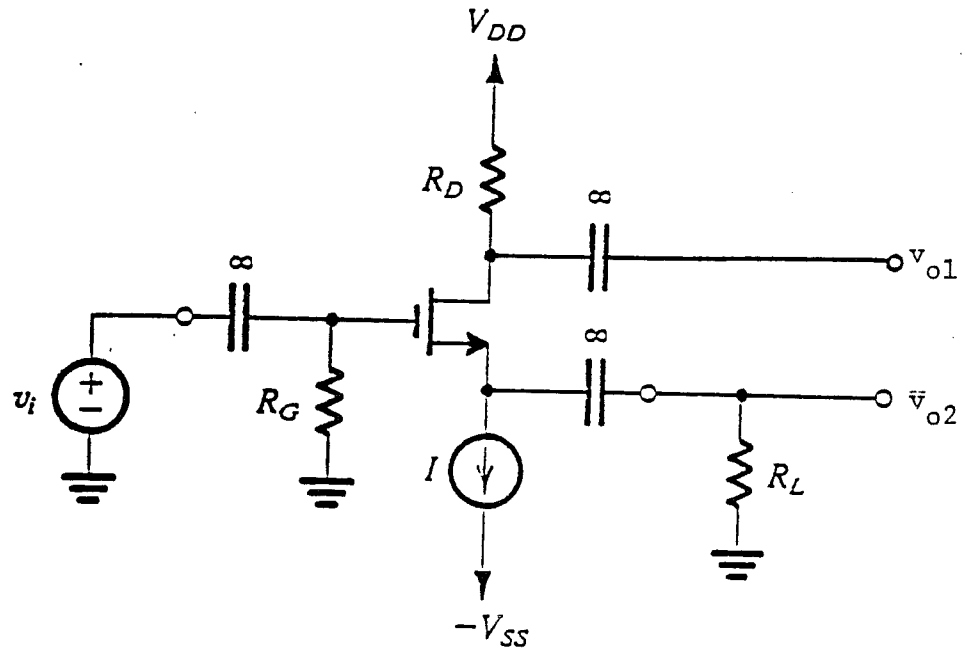

Figure 3

Question 4

The BJTs of the differential amplifier circuit shown in Figure 4 are operating in the active region and have $V_A = \infty$.

(a) Derive expressions for the dc voltages V_{C1} and V_{C2} and the emitter resistances r_{e1} and r_{e2}.

(b) Derive expressions for the voltage gain v_o/v_i in terms of the circuit components and the BJTs' small-signal parameters.

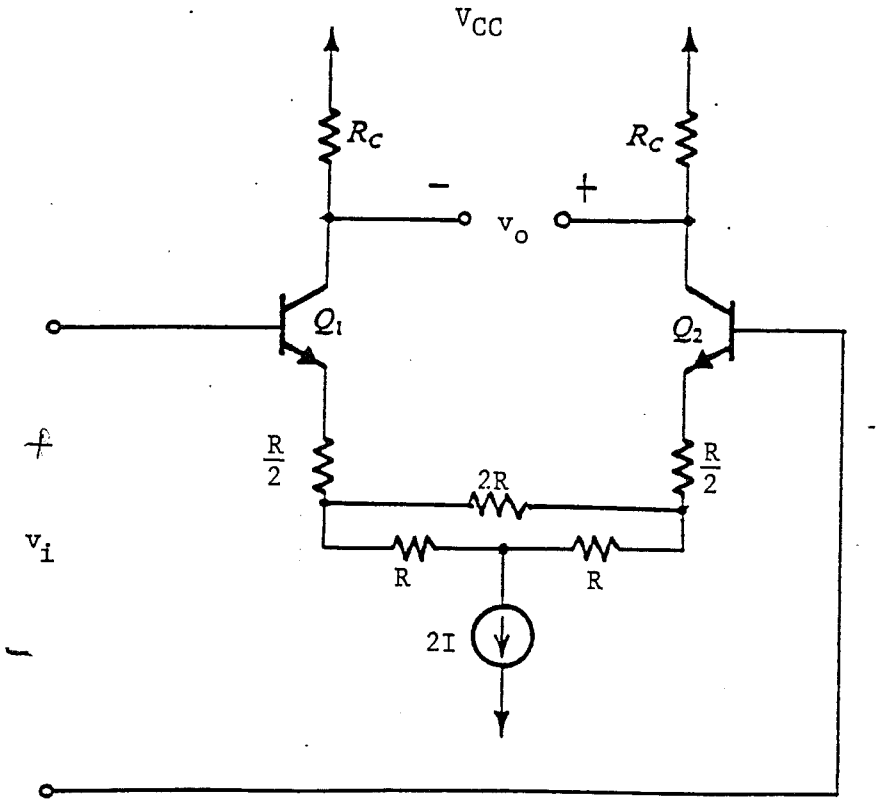

Figure 4