

**King Fahd University of Petroleum and Minerals**  
**Electrical Engineering Department**

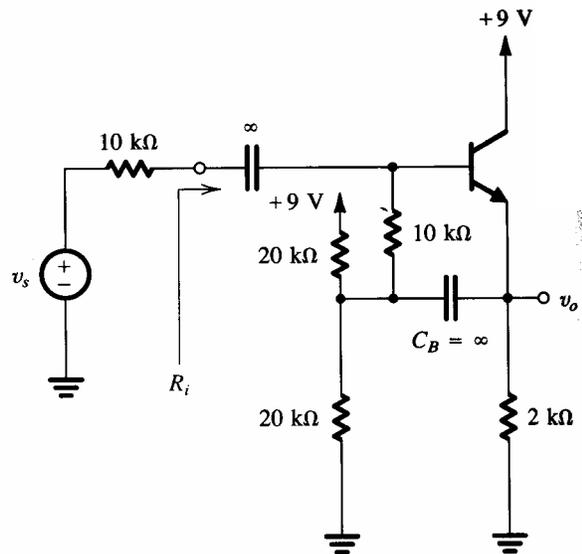
**EE203 Electronics I**  
**Final Exam** ( $2\frac{1}{2}$  Hours)

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|-------|------|-------|
| Name: | I.D# | Sec.# |
|-------|------|-------|

**Question #1**

The BJT in the circuit shown has  $\beta=100$ .

- (a) Perform DC analysis to check that the transistor is working in active region (Do not neglect the base current).
- (b) Replace the transistor by its hybrid- $\pi$  model, draw the small-signal equivalent circuit of the amplifier. Analyze the resulting circuit to determine the voltage gain?



### Question # 2

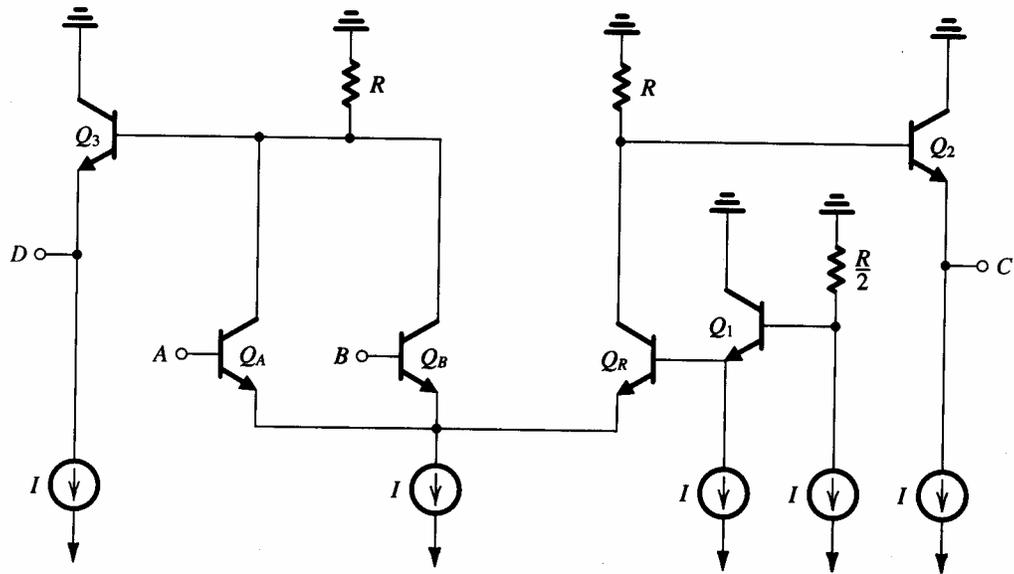
For the basic ECL logic gate shown, assume all transistors are in active and neglect the base currents. If  $I=1\text{mA}$ ,  $R=1\text{k}\Omega$ ,

(a) Calculate  $V_{E1}$

(b) Calculate  $V_C$  and  $V_D$  for the following cases:

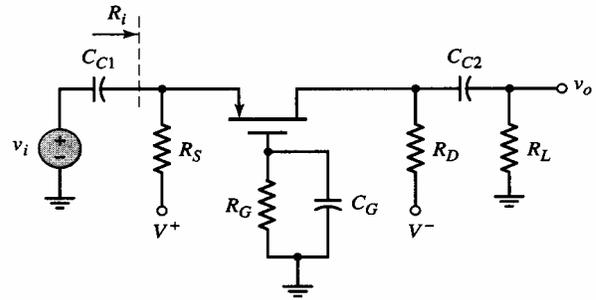
(i)  $A=B=-1.7\text{V}$

(ii)  $A=B=-0.7\text{V}$



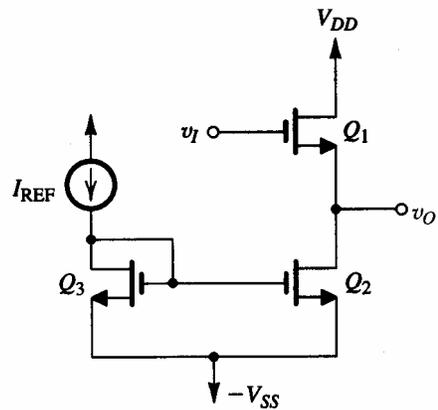
**Question # 3**

(a) Replace the transistor with its hybrid- $\pi$  model and draw the amplifier small signal equivalent circuit?



(a)

(b) Prove that Q1 and Q2 in the circuit shown below work in pinch off region for  $I_{REF}=100\mu A$ .  $V_{DD}=-V_{SS}=5V$ ,  $W/L=100\mu m/1.6\mu m$  for all transistors,  $\mu C_{ox}W/L = 90\mu A/V^2$  and  $V_t=1V$ . (Hint  $v_t$  is ground from DC point of view),



**Question # 4**

(a) Sketch a CMOS logic circuit using minimum number of transistors that realize the function:  $Y = \overline{A.(B + C.D) + E}$

Find the minimum width for each transistor such that the delay is not worse than the reference inverter.

Assume that the reference inverter is symmetrical with  $(W/L)_n=1$  and  $(W/L)_p=3$ . Take  $L=0.5\mu\text{m}$  for all the transistors.

(b) Design pass-transistor logic (transmission gate) circuit to realize a two-to-one multiplexer with the following Boolean function:  $M = CA + \overline{CB}$ ? **(Draw complete transistor circuit)**

**Question # 5**

For the differential amplifier shown, neglect the effect of  $r_o$  and assume transistors are identical.

- (i) Drive an expression for the differential mode gain.
- (ii) Drive an expression for the common mode gain.
- (iii) Express  $V_o$  in terms of  $V_{i1}$  and  $V_{i2}$ .

