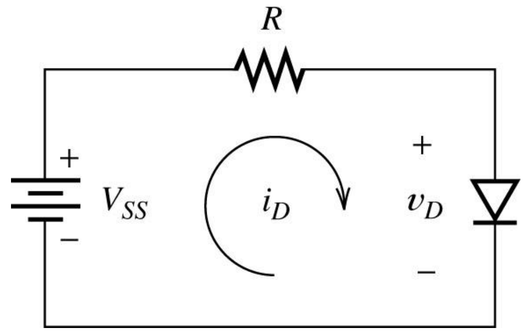
University of Texas at Arlington EE 2403 Fall 2015 Quiz 3A ID:

LAST NAME **FIRST NAME**

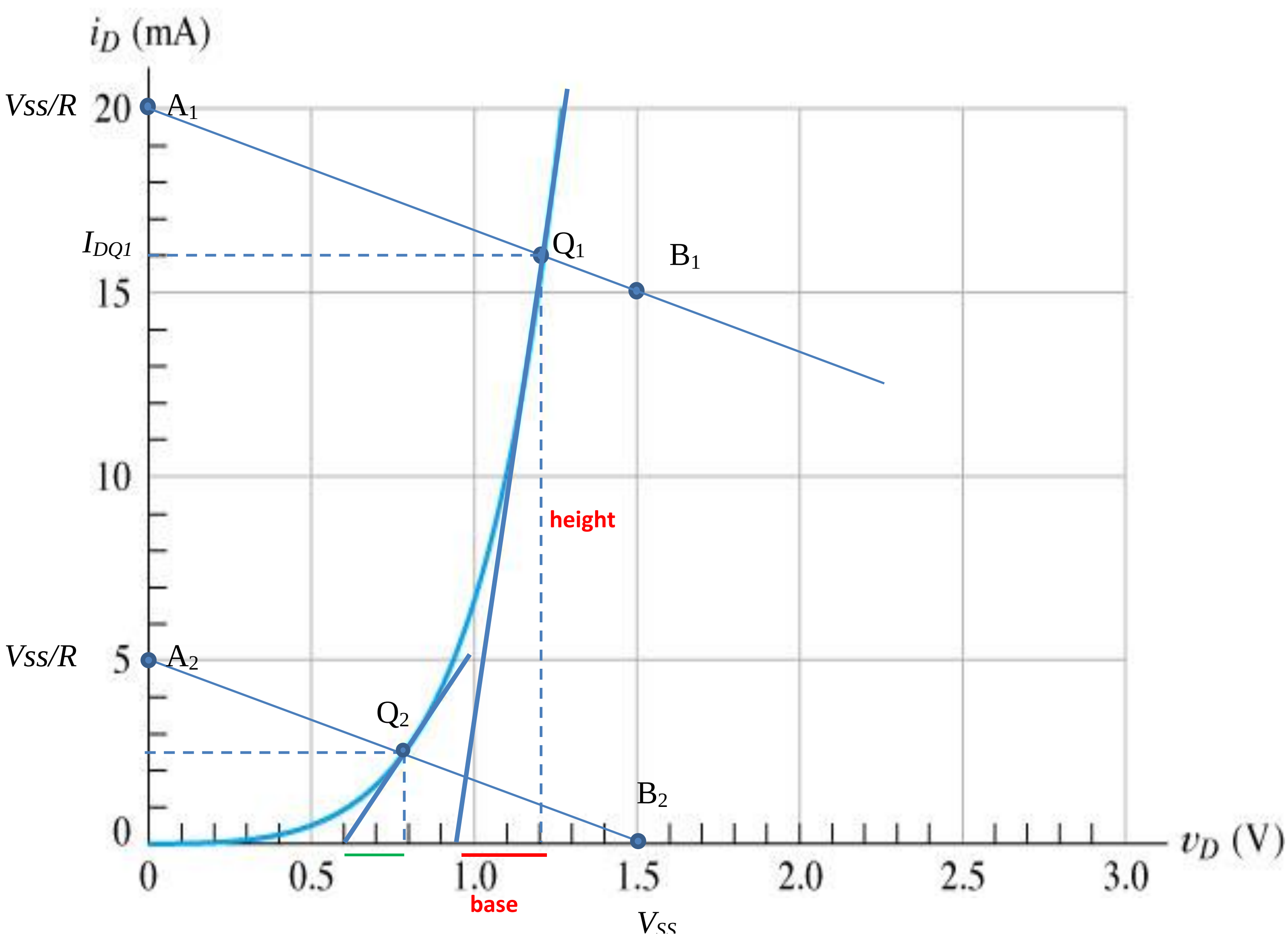
Problem 1



A) Given R=300 Ω & V_{ss}= 6.0 V Draw the DC load line.
B) Use graphical method to obtain the Q point and write down the approximate values for I_Q and V_Q.
C) Use graphical method to obtain the value of r_d at the Q point.
D) Repeat A), B), and C) for V_{ss}= 1.5V.

ANSWERS (draw tangents as accurately as possible)

V_{ss} (V)	V_{DQ} (V)	I_{DQ} (mA)	r_{dQ} (Ω)
6.0	1.2	16.0	15.6
1.5	0.8	2.5	80.0



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Problem 1 continued

Unit convention: $[R] = k\Omega$ $[i] = mA$ $[v] = V$

Load Lines:

$KVL \Rightarrow v_D = V_{SS} - Ri_D$ This represents a straight line in the $v_D - i_D$ space (*load line*)

Drawing Load Lines:

Find two points on the line by choosing two values of i_D and the corresponding v_D values.

$Case\,1$: $V_{SS} = 6V$: $v_D = 6 - 0.3i_D$.

For example A_1: $choose\ i_D = 20 \Rightarrow v_D = 0$ B_1: $choose\ i_D = 15 \Rightarrow v_D = 1.5$

$Case\,2$: $V_{SS} = 1.5V$: $v_D = 1.5 - 0.3i_D$.

For example A_2: $choose\ i_D = 0 \Rightarrow v_D = 1.5$ B_2: $choose\ v_D = 0 \Rightarrow i_D = 5$

Q-point: Interception of load line with Diode IV curve

Dynamic Resistance: $r_{dQ} = \dfrac{1}{slope\ of\ tangent} = \dfrac{triangle\ base}{triangle\ height}$

$Case\ 1$: $r_{dQ} = \dfrac{0.25\ V}{16\,mA} = 15.6\,\Omega$ $Case\ 2$: $r_{dQ} = \dfrac{0.2\ V}{2.5\,mA} = 80\,\Omega$

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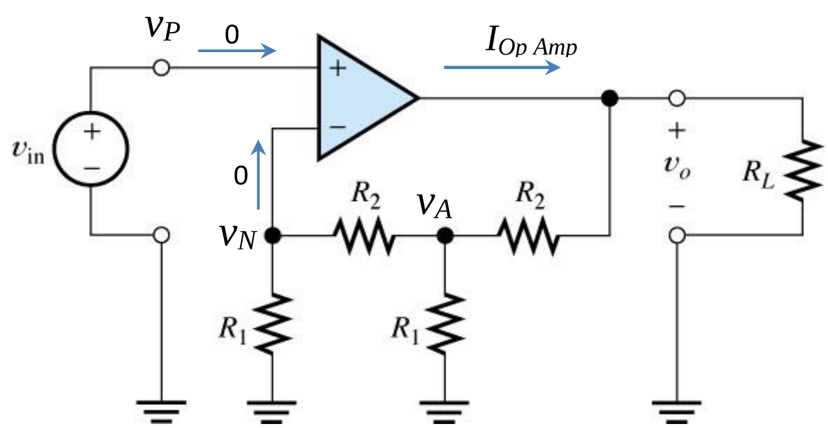
Problem 2

Op Amp input resistance is ∞, output resistance is 0, and open loop gain is ∞ and the power supplies are at +10 and -10 V. R_1=4 kΩ , R_2=2 kΩ, and R_L=2 kΩ. v_{in} =2 V. Find v_o.



Solution:

Assume Op Amp is operating in Linear Region *then* $v_N = v_P$

$$\therefore v_N = 2V$$

Node Voltage Equations

$$\begin{cases} \dfrac{v_N}{R_1} + \dfrac{v_N - v_A}{R_2} = 0 & \Rightarrow \dfrac{2}{4} + \dfrac{2 - v_A}{2} = 0 \Rightarrow 2 + 4 - 2v_A = 0 \Rightarrow v_A = 3V \\ \dfrac{v_A}{R_1} + \dfrac{v_A - v_N}{R_2} + \dfrac{v_A - v_0}{R_2} = 0 & \Rightarrow \dfrac{3}{4} + \dfrac{3-2}{2} + \dfrac{3 - v_0}{2} = 0 \Rightarrow 3 + 2 + 6 - 2v_0 = 0 \Rightarrow v_0 = 5.5\ V \end{cases}$$

Note that $-10 < 5.5 < +10 \Rightarrow -10 < v_0 < +10 \Rightarrow$ **Original Assumption IS valid.**

$$I_{Op\,Amp} = \frac{v_0 - v_A}{R_2} + \frac{v_0}{R_L} \quad \Rightarrow \quad I_{Op\,Amp} = \frac{5.5 - 3}{2} + \frac{5.5}{2} = 4\,A$$