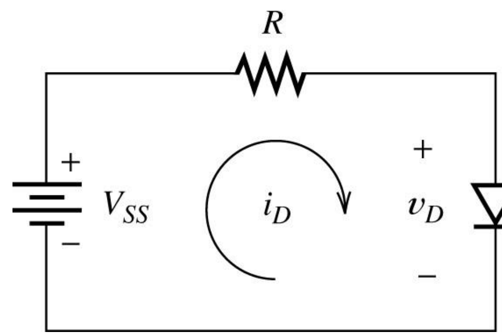
University of Texas at Arlington EE 2403 Fall 2015 Quiz 3B   ID:

LAST NAME   **FIRST NAME**

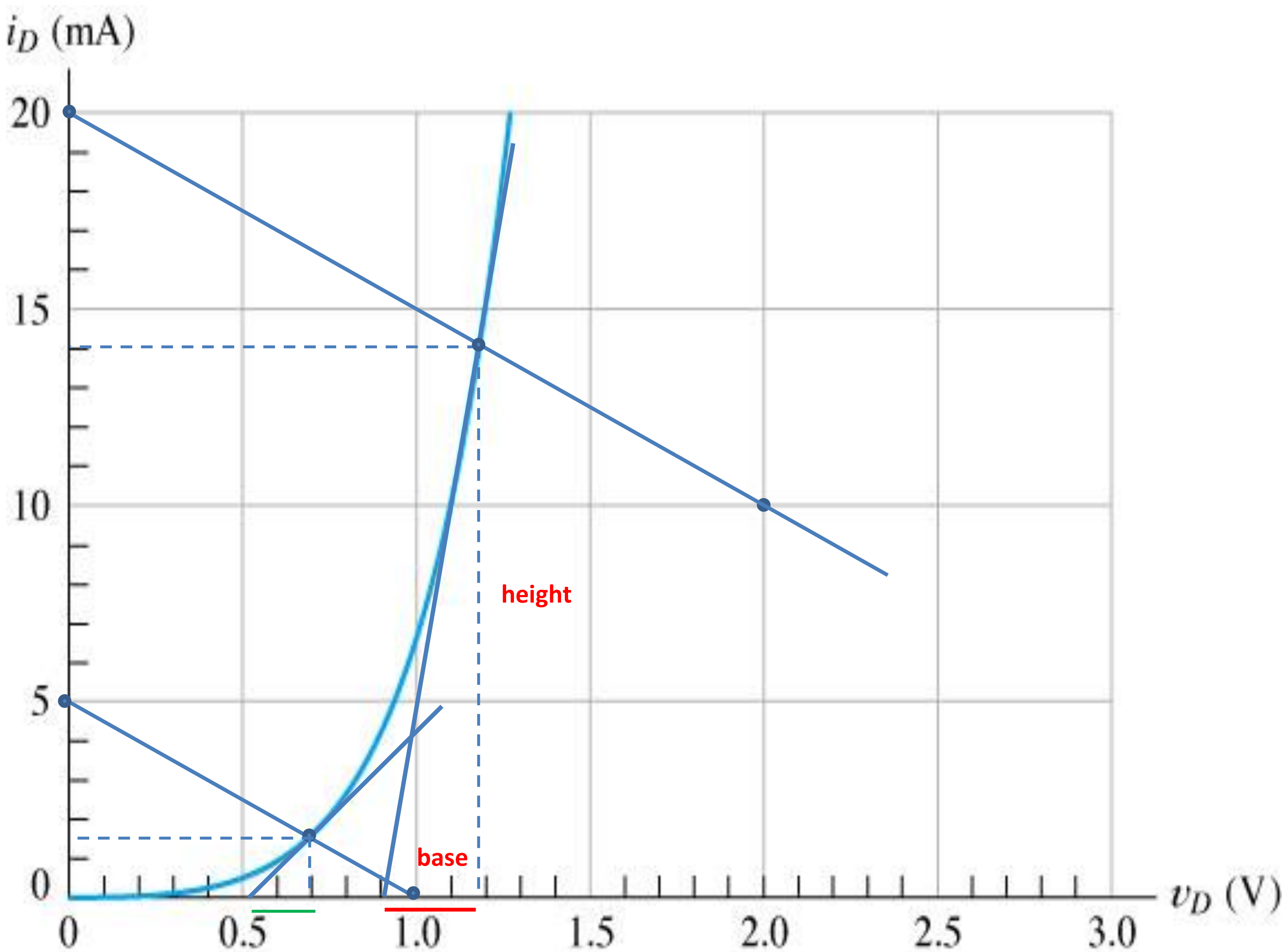
Problem 1

A) Given R=200 Ω & V_{ss}= 4.0 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 V.



ANSWERS (draw tangents as accurately as possible)

V_{ss} (V)	V_{DQ} (V)	I_{DQ} (mA)	r_{dQ} (Ω)
4.0	1.18	14.0	12.1
1.0	0.7	1.5	68



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Problem 1 continued

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

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.

$Case\,1:\; V_{SS} = 4V:\; v_D = 4 - 0.2i_D.$

For example A_1: $choose\; i_D = 20 \;\Rightarrow v_D = 0$ $\quad \mathrm{B}_1$: $choose\; i_D = 10 \Rightarrow v_D = 2$

$Case\,2:\; V_{SS} = 1.0V:\; v_D = 1.0 - 0.2i_D.$

For example A_2: $choose\; i_D = 0 \Rightarrow v_D = 1.0$ $\quad \mathrm{B}_2$: $choose\; v_D = 0 \Rightarrow i_D = 5$

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

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

$Case\;1:\quad r_{dQ} = \dfrac{0.17\;V}{14\,mA} = 12.1\Omega \qquad Case\;2:\quad r_{dQ} = \dfrac{0.17\;V}{2.5\,mA} = 68\;\Omega$

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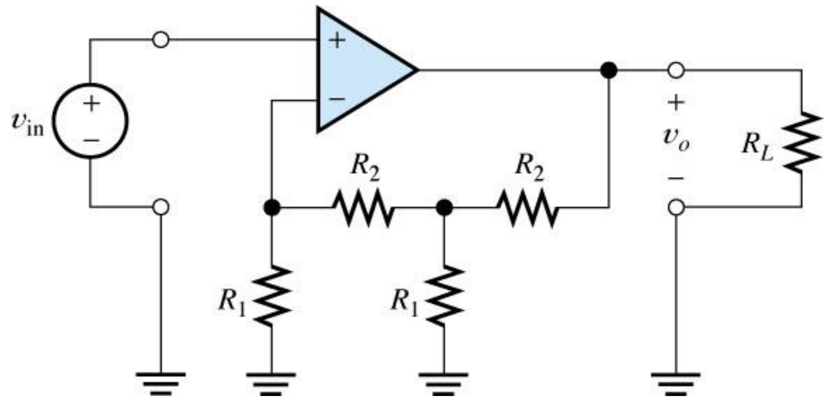
Problem 2

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=2 kΩ, , R_2=1 kΩ, and R_L=4 kΩ. v_{in}=2 V. Find v_o and current supplied by the Op Amp.



Solution:

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

$$\therefore v_N = 2V$$

Node Voltage Equations

$$\begin{cases} \dfrac{v_N}{R_1} + \dfrac{v_N - v_A}{R_2} = 0 & \Rightarrow \dfrac{2}{2} + \dfrac{2 - v_A}{1} = 0 \Rightarrow 2 + 4 - 2v_A = 0 \Rightarrow v_A = 3V \\ \dfrac{v_A}{R_1} + \dfrac{v_A - v_N}{R_2} + \dfrac{v_A - v_0}{R_2} = 0 & \Rightarrow \dfrac{3}{2} + \dfrac{3-2}{1} + \dfrac{3 - v_0}{1} = 0 \Rightarrow 3 + 2 + 6 - 2v_0 = 0 \Rightarrow v_0 = 5.5\ V \end{cases}$$

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

$$I_{Op\,Amp} = \frac{v_0 - v_A}{R_2} + \frac{v_0}{R_L} \quad \Rightarrow \quad I_{Op\,Amp} = \frac{5.5 - 3}{2} + \frac{5.5}{4} = 2.625\,A$$