PROBLEM 1

For the differential pair shown below, plot the $I_{C1}, I_{C2}$ vs $V_{ID}$ ($V_{ID} = V_{IP} - V_{IM}$).

Show the range of $V_{ID}$ for which $I_{C1}, I_{C2}$ vs $V_{ID}$ is linear.

Assume, $\beta = 100$

$Q_1, Q_2$ are identical.

PROBLEM 2

For the differential pair shown below,

Find the voltages $V_{C1}, V_{C2}$ & $V_e$

$\beta = 100$

$V_{BEQ} = 0.7$

$V_{IP} = -2V$

$1mA$

$Q_1, Q_2$ are identical.
**PROBLEM: 3**

For Problem 2 find $V_{c1}, V_{c2}$ & $V_e$ when $V_{ip} = +1V$ & $V_{im} = -2V$.

**PROBLEM: 4**

Find the **differential** input impedance of the differential pair shown below.

![Differential Pair Diagram]

$Q_1, Q_2$ are identical

**PROBLEM: 5**

Find the DC currents $I_{c1}$ & $I_{c2}$ for the differential pair shown below.

Assume $\beta = \infty$

$V_{ip} = (-2V + 10mV)$

$V_{im} = (-2V - 10mV)$

$Q_1, Q_2$ are identical.
Problem 6
Repeat Problem 5 for \( V_{ip} = -2V + 50mV \) and \( V_{im} = -2V - 50mV \).

Problem 7
Find the DC current \( I_{out} \) for the differential pair with the active load shown below:

\[ \text{Assume: } B = 60, \quad V_A = 60 \]
\[ Q_1 \text{ and } Q_2 \text{ are identical} \]
\[ Q_3 \text{ and } Q_4 \text{ are identical} \]

Also assume all the transistors are in forward active region.
**Problem 8**

Find the small-signal gain $\frac{V_{o}(s)}{V_{in}}$ for the differential pair shown below.

Find the d.c. gain & the pole frequency.

Assume:

$\beta = 60$ & $V_A = 45$ ($r_o = 80$)

Assume all transistors are in forward active.

$Q_1, Q_2$ are identical

$Q_3, Q_4$ are identical.

$R_L = 10k\Omega$

$C_L = 10pF$
**Problem #9**

A common emitter amplifier with active load is shown in the figure.

(a) Plot the approximate large-signal transfer function $\frac{V_o}{V_i}$ clearly marking the plot where each transistor is transitioning between active & saturation.

(b) Draw the low-frequency small-signal model of the amplifier and find the gain for $\beta = 100 \quad & \quad V_A = 75 \text{V}$. For both PNP & NPN.

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**Problem #10**

Draw the low-frequency small-signal model (Do not neglect $r_o$) of the Wilson's current mirror and find the expression for the output impedance.