**Problem 1**

Will this circuit work as an amplifier? Why or why not?

Use $|V_{BE}|=0.7$, $\beta=100$, $V_T=25\,\text{mV}$, $V_{DO}=0.7$, $V_i=1\,\text{V}$ $k_n'(W/L)=30\mu\text{A/V}^2$, ignore $r_o$ and $\lambda$. $V_{IN}=2V+(2m)\sin\omega t$. 

**Diagram:**

- Circuit diagram showing various components and connections.
- Labels for $V_{IN}$, $I_{DIODE}$, $V_{o1}$, $V_{G4}$, $R_{in}$, $R_{out}$, and other terminals and values.
- Resistors, capacitors, and diodes depicted with their specifications.

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Problem 2

\[
\left( \frac{W}{L} \right)_1 = \left( \frac{W}{L} \right)_2 = \left( \frac{W}{L} \right)_4 = 5
\]

Use:
\[
\left( \frac{W}{L} \right)_3 = 200
\]

- \( V_i = 1 \text{V} \)
- \( k_n = 40 \mu \text{A/V}^2 \)
- \( \lambda_{1,2,3,4} = 0 \)
- \( V_{D0} = 0.6 \)
- \( n = 1 \)
- \( V_I = 25 \text{mV} \)
- Ignore \( V_A \)
- \( V_{BE} = 0.7 \)
- \( \beta = 150 \)
- \( V_{in} = 8 + 1 \text{msin} \theta \)

1. Find the following DC values:
   (a) \( I_{DIODE} \)
   (b) \( V_{G3} \)
   (c) \( V_{o1} \)
   (d) \( V_{out} \)

2. Draw the AC small-signal circuit

3. Find the AC values:
   (a) Find \( R_{in} \).
   (b) Find \( R_{out} \).
   (c) Find the overall gain, \( V_{o}/V_{IN} \). State value as a numeric value.

4. What is the maximum value that the resistor \( R_C = 4k \) at the collector of transistor Q5 be changed to and still keep the transistor active? Explain in detail how this resistor changes the overall gain?
Problem 3

Use: \( V_i = 1V \), \( k_n^* = 30\mu A/V^2 \)
\[ \lambda = 0 \]
\[ \left( \frac{W}{L} \right) = 10 \]
\[ \left( \frac{W}{L} \right) = 100 \]
\[ V_{D0} = 0.6 \]
\[ n = 2 \]
\[ V_T = 25mV \]
ignore \( V_A \)
\[ V_{BE} = 0.7 \]
\[ \beta = 150 \]
\[ V_{in} = 5 + 2\sin\omega t \]

1. Find the following DC values:
   (e) \( I_{DIODE} \)
   (f) \( V_{G4} \)
   (g) \( V_{o1} \)
   (h) \( V_{out} \)

2. Draw the AC small-signal circuit

3. Find the AC parameters:
   (a) \( r_\pi \)
   (b) \( g_m \) for transistor Q4
   (c) \( g_m \) for transistor Q5
   (d) \( r_d \) for the diodes

4. Find the values for \( R_n \) and \( R_{out} \).

5. Find the gain: \( \frac{V_{o1}}{V_{IN}} \)

6. Find the gain: \( \frac{V_{out}}{V_{IN}} \)

7. Find the total instantaneous output voltage \( V_{out} \). Draw the input, \( V_i \), and the total output (DC and AC) on the same graph vs time for 2 periods. Mark the maximum and minimum peak values.

8. What is the maximum value that the resistor \( R_C = 1k \) at the collector of transistor Q5 be changed to and still keep the transistor in saturation? Explain in detail how this resistor changes the overall gain?
Problem 4

Solve the circuit when $n=1$, $V_t=25\text{mV}$, $V_i=+1\text{V}$, $k'(W/L)=2\text{mA/V}^2$, $\beta=100$, ignore $V_A$, $\lambda=0$, $V_{BE}=0.7\text{V}$

a. DC Values:
   i. $I_{B1}$, $I_{C1}$, $I_{E1}$
   ii. $I_{D2}$, $I_{G2}$, $I_{S2}$
   iii. $I_{B3}$, $I_{C3}$, $I_{E3}$
   iv. $V_{B1}$, $V_{E1}$, $V_{C1}$
   v. $V_{G2}$, $V_{S2}$, $V_{D2}$
   vi. $V_{B3}$, $V_{E3}$, $V_{C3}$

b. AC Values:
   i. $R_{in}$ (do not include 100k)
   ii. $R_{out}$ (do not include RL)
   iii. Gain: $V_{out}/V_s$