1. Use: ignore \( r_o \), \(|V_{BE}| = 0.7\), \( \beta = 100\)

\( V_t = 1V \)
\( k_n' (W/L) = 10mA/V^2 \)
\( \lambda = 0 \)
\( V_{DO} = 0.8V \)
\( V_{IN} = 5 + 0.001\sin(20t) \)

For DC analysis, assume that the capacitors are open.

(a) Solve for the DC currents:
   a. \( I_D \)
   b. \( I_S \)
   c. \( I_B \)
   d. \( I_E \)
   e. \( I_C \)

(b) Solve for the DC voltages:
   a. \( V_G \)
   b. \( V_S \)
   c. \( V_D \)
   d. \( V_B \)
   e. \( V_E \)

(c) Verify that the MosFet transistor, M1 is saturated. Verify that the BJT transistor, Q2 is active.

2. Create a rough sketch of the total waveforms seen at \( V_O \) and \( V_{O1} \) given \( V_{IN} \) stated above, \( V_B/V_{IN} = -3V/V \), and \( V_{O}/V_B = -27V/V \). Make sure to label all relevant y-axis values (maximum, minimum, etc.). First draw \( V_{O1} \) and then draw \( V_O \). There should be 2 sketches.

3. Use the circuit on the next page: ignore \( r_o \) and \( \lambda \), \(|V_{BE}| = 0.7\), \( \beta = 100\), \( n = 1\), \( V_t = 25mV\), \( V_t(\text{threshold voltage}) = 1V\), \( k_n' (W/L) = 10mA/V^2\), \( V_{sig} = 0.02\sin(20t)\), \( I_{E3} = 4mA\), \( I_{DIODE} = 2mA\), \( I_D = 20mA\)

For the following hybrid-\( \pi \) equivalent circuit below, find the following values:
(a) Find \( r_d \), \( r_{\pi3} \), \( g_m2 \), and \( g_m3 \) values.
(b) \( R_{in} \) (input resistance –ignore only the input source, \( V_{sig} \); include all resistors seen above \( V_{sig} \))
(c) \( R_{out} \) (output resistance-include all resistors at node \{no load is connected\})
(d) Midband gain, \( \frac{V_O}{V_{sig}} \)
4. (a) Explain why or why not this is a good amplifier for voltage amplification, $V_o/V_{sig}$.
(b) Explain why or why not this is a good amplifier for current amplification, $I_{out}/I_{in}$. 
5. For the circuit shown below:

**Draw** the AC small-signal equivalent circuit (use hybrid-π or model T). Make sure that everything is labeled in terms of the transistor number. (e.g. $g_m1$, $v_{π2}$, etc.). **Include** $r_o$ for all transistors. $v_{sig} = 0.001\sin(10t)$ AC.


6. $|V_{BE}| = 0.7$, $β = 100$, ignore $r_o$, $V4 = (0.1\sin(ωt))$ Volts. Assume that the applied signal frequency is adequate to keep the circuit operating in the flat midband region. Assume that the capacitors act as an open for DC operation and a short for AC operation. The following DC values were measured: $I_D = 1.3m$, $V_D = 9V$, $V_G = 6V$, $V_S = 3.1V$, $I_E = 12mA$, $V_E = 2.3V$, $V_B = 3V$, $V_C = 10V$.

The AC gain was measured to be $V_{o1}/V_4 = 83V/V$, $V_{o2}/V_{o1} = 1V/V$, $r_π = 200Ω$, $g_m_{MOSFET} = 5mA/V$.

- Does this circuit operate as a **linear** AC amplifier with the applied shown voltage? If so, what is the gain, $\frac{V_o}{V_{sig}}$, of the following circuit? If not, explain why.

7. Assume that C2 and C6 contribute pole values less than 1rad/sec. Calculate the pole contributions of C2 and C4. What is $f_L$ (in rad/sec)?