EEE 3307 Homework Set 2

Problem 1.
For all the transistors in the following, $\beta = 75$. The results of some measurements are indicated on the following figures. Find the values of the other labeled currents, voltages, and/or resistor values.

![Figure](image)

Problem 2.
For circuits shown in the following figures, the values of measured parameters are shown. Determine $\beta, \alpha$ and the other labeled currents and voltages. Sketch the DC load line and plot the Q-point.

![Figure](image)
**Problem 3.**

Consider the circuit shown in the following figure. The measured value of the emitter voltage is $V_E = 2\, \text{V}$. Determine $I_E$, $I_C$, $\beta$, $\alpha$ and $V_{EC}$. Sketch the DC load line and plot the Q-point.

![Circuit Diagram](image1)

**Problem 4.**

For the circuit shown in the following figure, if $\beta = 200$ for each transistor, determine:

$I_{E1}$, $I_{E2}$, $V_{C1}$ and $V_{C2}$

![Circuit Diagram](image2)
Problem 5.
Consider the circuit shown in the following figure. Determine $I_{BQ}$, $I_{CQ}$, and $V_{CEQ}$ for $\beta = 75$ and $\beta = 150$.

Problem 6.
Using the circuit in the following figure, design a bias stable amplifier such that the Q-point is in the center of the load line. Let $\beta = 125$. Determine $I_{CQ}$, $V_{CEQ}$, $R_1$ and $R_2$. 
Problem 7.

The DC load line and Q-point of the circuit in Figure (a) are shown in Figure (b). For the transistor, $\beta = 120$. Find $R_E$, $R_1$, and $R_2$ such that the circuit is bias stable.

![Circuit Diagram](image1)

**Problem 8.**

For each transistor in the circuit in the following, $\beta = 120$. Determine the quiescent base, collector, and emitter currents in $Q_1$ and $Q_2$. Also determine $V_{CEQ1}$ and $V_{CEQ2}$.

![Circuit Diagram](image2)
Problem 9.

The transistor parameters are $\beta = 125$ and $V_A = 200\,\text{V}$. A value of $g_m = 200\,\text{mA/V}$ is desired. Determine the collector current required, and then find $r_n$ and $r_0$.

Problem 10.

The parameters of the transistor in the circuit in the following figure are $\beta = 150$ and $V_A = \infty$. (a) Determine $R_1$ and $R_2$ to obtain a bias stable circuit with the Q-point in the center of the load line. (b) Determine the small signal voltage gain $A_v = \frac{v_0}{v_s}$.

![Circuit Diagram]

Problem 11.

Consider the circuit shown in the following figure, where $v_s = 4\sin\omega t\,\text{mV}$. Assume $\beta = 80$. Determine $v_o(t)$ and $i_o(t)$. What are the small signal voltage and current gains?

![Circuit Diagram]
Problem 12.

The parameters of the transistor in the following circuit are $\beta = 100$ and $V_A = 100\, \text{V}$.
(a) Find the DC voltages at the base and emitter terminals.
(b) Find $R_C$ such that $V_{CEQ} = 3.5\, \text{V}$.
(c) Assuming $C_C$ and $C_E$ act as short circuits, determine the small signal voltage gain $A_V = v_0 / v_s$.
(d) Repeat part (c) if a 500Ω source resistor is in series with the $v_s$ signal source.

Problem 13.

For the circuit in the following figure, let $\beta = 100$, $V_A = \infty$, $R_E = 12.9\, \text{k}\Omega$, and $R_C = 6\, \text{k}\Omega$.
Determine the maximum undistorted swing in the output voltage if the total instantaneous C-E voltage is to remain in the range $1 \leq v_{CE} \leq 9\, \text{V}$ and if the total instantaneous collector current is to remain greater or equal to 50μA.

![Diagrams for Problem 12 and Problem 13]
Problem 14.

The transistor parameters for the circuit are \( \beta = 180 \) and \( V_t = \infty \).

(1) Find \( I_{CQ} \) and \( V_{CEQ} \).
(2) Plot the DC and AC load lines.
(3) Calculate the small signal voltage gain.
(4) Determine the input and output resistances \( R_{ib} \) and \( R_o \).

![Circuit Diagram](image)

Problem 15.

For the circuit in the figure, the transistor current gain is \( \beta = 80 \), \( R_E = 0.5 \text{ k}\Omega \), and \( R_L = 0.5 \text{ k}\Omega \). Design the circuit to obtain a small-signal current gain of \( A_i = i_0/i_s = 8 \). Let \( V_{CC} = 10 \text{ V} \), and the quiescent point Q is in the center of DC load line. (1) Find \( R_1, R_2, \) and the output resistance \( R_o \). (2) What is the current gain if \( R_L = 2 \text{ k}\Omega \).

![Circuit Diagram](image)
Problem 16.

For the circuit shown in the following figure, the transistor parameters are $\beta = 100$ and $V_A = \infty$.

(1) Determine the DC voltages at the collector, base and emitter terminals
(2) Find the input resistance $R_i$
(3) Determine the small signal voltage gain $A_v = v_o / v_s$

Problem 17.

The parameters for each transistor in the circuit shown in the following figure are $\beta = 100$ and $V_A = \infty$. Find:

(1) the small signal parameters $r_h$ and $r_0$ for both transistors through DC analysis;
(2) the small- signal voltage gain $A_{v1} = v_{o1} / v_s$, assuming $v_{o1}$ is connected to an open circuit, and determine the gain $A_{v2} = v_o / v_{o1}$;
(3) the overall small signal voltage gain $A_v = v_o / v_s$. Compare the overall gain with the product $A_{v1} \times A_{v2}$, using the values calculated in part (2).
Problem 18.

For the circuit shown in the following figure, assume transistor parameters of $\beta=100$ and $V_A = \infty$. Find:

(1) the DC collector current in each transistor;
(2) the small signal voltage gain $A_v = v_o / v_s$;
(3) the input and output resistances $R_{ib}$ and $R_o$. 

![Circuit Diagram](image_url)