This is a difficult assignment to mark, so please write and label everything clearly. Up to 20% will be deducted for messy work.

For all of the transistor amplifier circuits in this assignment, assume that $\beta = 100$, $V_{BE} = 0.7\text{V}$ and $V_T = 25\text{mV}$.

1. For the following three amplifier circuits assume that $R_1 = 0\Omega$ and all capacitors are short circuits at operating frequencies. Answer the following questions for all three amplifier configurations.

   (a) What is the name of this transistor amplifier configuration.

   (b) Draw and label the DC equivalent circuit.

   (c) Calculate the DC currents I_B, I_C, I_E and DC voltages V_B, V_C, V_E.

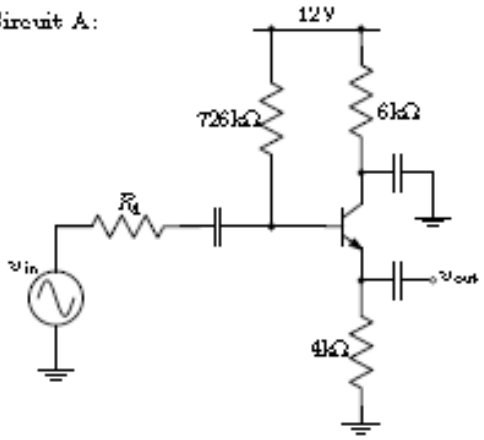
   (d) Draw and label the AC equivalent circuit (Assume all capacitors are short circuits at operating frequencies).

   (e) Draw and label the T model and the Hybid-π model for the transistor.

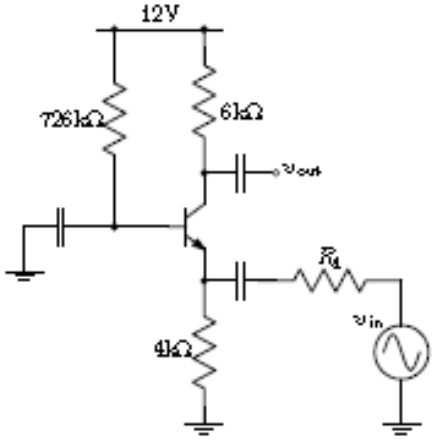
   (f) Using the Hybrid-π model for the transistor, draw and label the Small Signal Equivalent Circuit.

   (g) Calculate the voltage gain v_0/v_i.

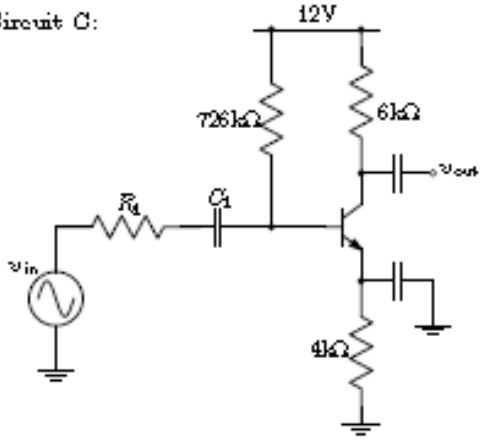
Circuit A:



Circuit B:



Circuit C:



2. For Circuit C from question 1, assume that the input coupling capacitor C_1 is $4\mu F$ and R_4 is still 0Ω.

   (a) Write an expression for v_{be} in terms of v_{in}. (Hint: Work form the small signal equivalent model developed in question 1f)

   (b) Calculate the Cutoff frequency ω_L for the input stage of the amplifier.

   (c) Calculate the gain of the transistor circuit at the following frequencies: 1kHz, 10kHz, 100kHz, 1MHz and 10MHz.

3. For the three amplifier circuits from question 1, let $R_4 = 500\Omega$. Note that R_4 does not affect the DC currents and voltages, and thus does not affect the T model or the Hybrid-π model of the transistor. Assume again that all capacitors are short circuits at operating frequencies.

   (a) Draw and label the T model and the Hybid-π model for the transistor.

   (b) Using the Hybrid-π model for the transistor, draw and label the Small Signal Equivalent Circuit.

   (c) Calculate the voltage gain v_o/v_s.

   (d) How has R_4 affected the voltage gain of the transistor?

4. Calculate the voltage gain of the transistor amplifier below. Notice that this amplifier is made up of two stages, the output of stage 1 is connected to the input of stage 2. DC analysis can be performed on the two stages independently. (Hint: follow the same steps as in question 1).