I. (25 pts): Consider the common-emitter configuration shown on the circuit diagram below used to amplify the source signal $V_s$ with source resistance $R_s$.

The $\beta$ of the transistor is 100. The DC analysis has been carried out and the following values were found:

$I_E = 0.97 \text{ mA}$ and $I_C = 0.96 \text{ mA}$.

\[ g_m = \frac{I_C}{V_T} \]

\[ V_T = 26 \text{ mV} \]

\[ I_E = (\beta + 1) I_B \]

\[ I_C = \beta I_B \]

\[ R_H = \frac{V_T}{I_B} \]

\[ R_H = \frac{\beta}{g_m} \]
For all questions below, neglect the base resistance $r_x$ and the resistance $r_o$ in the hybrid-$\pi$ model of the BJT and assume that the internal capacitances of the BJT are equal to $C_\pi = 2$ pF and $C_\mu = 10$ pF.

- Draw the small AC signal equivalent circuit of this amplifier configuration using the hybrid-$\pi$ model and including all capacitances, i.e., the coupling and bypassing capacitors plus internal capacitances as well as the effect of $r_x$. 
• Using the Gray-Searle technique, give an analytical expression of the low frequency pole due to the bypassing capacitor $C_E$.

• Calculate the numerical value of the low frequency pole found above in rad/s using the values of the resistors on the circuit diagram of the amplifier and the small signal parameters of the hybrid-$\pi$ model.
II. (25 pts): Consider the amplifier below.

- (5 pts) What type of amplifier is it? (circle your answer) Common Emitter, Common Base, or Common Collector?
- (15 pts) Draw the small AC equivalent circuit of the amplifier. Neglect the effects of the base resistance $r_s$ and the output resistance $r_0$ in the circuit diagram.
- (20 pts) Use the low frequency Gray-Searles procedure to determine the angular frequency $\omega_2$ of the pole associated to the coupling capacitor $C_2$ shown in the circuit diagram. Since no numerical values are given for the components of the circuit, all you need to derive is an analytical expression for $\omega_2$. 