1. **(20 points)** Characterize the 2N3904 NPN-BJT in Multisim. Obtain the values for $\beta_{\text{DC}}$, $\beta_{\text{AC}}$, $r_\pi$, $g_m$, and $r_o$ at $I_C=0.5$ mA.
   - In order to obtain these values, 4 plots must be generated. For more details, refer to Dr. Silva’s notes posted on the website: [http://www.ece.tamu.edu/~spalermo/ecen325/Chapter%20Va.pdf](http://www.ece.tamu.edu/~spalermo/ecen325/Chapter%20Va.pdf)
   - 2 input characteristic plots ($I_C$ vs $V_{BE}$ & $I_B$ vs $V_{BE}$) with the collector-emitter voltage fixed around 1.5 V. From the above notes, examples on how to extract $g_m$ and $g_\pi=1/r_\pi$ are shown on pages 21 and 23, respectively.
   - 2 output characteristic plots ($I_C$ vs $V_{CE}$ & $I_C$ vs $I_B$) with the base-emitter voltage fixed such that the $I_C$ is within 100$\mu$A-4mA. For $\beta_{\text{DC}}$ and $\beta_{\text{AC}}$, an example is shown on page 24. For $g_o=1/r_o$, an example is shown on pages 22 (bottom) and 23 (top).

2. **(20 points)** For the following circuit, bias your transistor such that $g_m R_C=10$ (gain of -10V/V); $R_C$ is the resistance connected at the collector of the transistor. Fix the collector-emitter voltage such that the transistor operates in the active region.
   a) Simulate in Multisim and show the bias currents and voltages
   b) Simulate the circuit for AC analysis. Plot the frequency response of the circuit from 0.1Hz up to 10 MHz.
3. (15 points – 10pts calc., 5pts Multisim) BJT DC Operating Points and AC small signal parameters.  
   a) For the BJT circuit below, calculate the DC values for $V_C$, $V_B$, $V_E$, $I_C$, $I_B$, and $I_E$. Compute the AC 
      small signal parameters $g_m$, $r_\pi$, $r_e$. Assume the transistor $\beta=150$, $V_{BE}=0.7V$, and $V_{th}=25.9mV$.  
   b) Verify the DC operating points in Multisim.

![BJT Circuit Diagram]

   a) For the common emitter amplifier below, calculate the small signal gain $A_v=v_o/v_i$ (from the transistor 
      base to the output node), the input resistance $R_{in}$, the output resistance $R_{out}$, and the overall voltage gain 
      $G_v=v_o/v_s$ (from the voltage source to the output node). Assume that the capacitors act as AC shorts and 
      that the transistor's $r_o$ is infinite (can be neglected). Note, you can use the small signal parameters that 
      you solved for in Problem 3.  
   b) Simulate in Multisim. Plot the magnitude in dB (or $db\Omega$) of $A_v$, $G_v$, $R_{in}$, and $R_{out}$ versus frequency 
      from 10Hz to 10MHz.

![Common Emitter Amplifier Diagram]
Repeat parts a) and b) from Problem 4 for the common collector amplifier.

Repeat parts a) and b) from Problem 4 for the common base amplifier.