1. Shown below are two single stage common emitter amplifiers using a NPN BJT $Q_1$ as the active amplifying device. Circuit 1 is biased with an ideal current source while circuit two is biased with a two transistor current source. The dc power supply voltages are $V^+ = 15 \text{ V}$ and $V^- = -15 \text{ V}$. It is given that $C_1 = 10 \mu\text{F}$, $C_2 = 22 \mu\text{F}$, $C_E = 330 \mu\text{F}$, $R_L = 12 \text{ k}\Omega$, $R_B = 51 \text{ k}\Omega$, and $R_C = 5.1 \text{ k}\Omega$. For Circuit 1 $I_E = 2 \text{ mA}$. Design Circuit 1 so that the magnitude of the midband voltage gain is 10. Design Circuit 2 so that $I_E = 2 \text{ mA}$ and the magnitude of the midband voltage gain is 10. In selecting $R_1$, $R_{E2}$, and $R_{E3}$ assume that the $\beta$ for transistors $Q_3$ and $Q_4$ are $\infty$.

2. For each circuit, use SPICE to determine:
   - the dc operating point of the circuit, viz. the dc voltage at each terminal of the transistor and the current flowing into the collector and base leads and out of the emitter. (DC Operating Point or OP analysis)
   - the small signal ac voltage gain, viz. a plot of the gain, $A_v$ versus frequency where the frequency range is from 10 Hz to 100 MHz. (AC Analysis)
   - plot of the output voltage versus time for 2 cycles of the input for an input signal a sine wave with a frequency of 1 kHz and a peak values for significantly clipped (hard clipping). (Transient Analysis)
   - plot of the output voltage versus frequency for a frequency span from dc to 10 kHz, viz. the spectra of the output with an input signal a sine wave with a frequency of 1 kHz and a peak value of 1 V which will cause the output to clip. Plot the output voltage on a log scale. Determine the THD (Fourier Analysis)
   - plot the noise spectral density at the output (noise analysis). Also determine the total noise at the output.
   
   Assume that the SPICE parameters for the NPN BJT are: saturation current, $6.734 \text{ fA}$; forward beta, 100; Early voltage, 170 V, zero-bias base collector capacitance, $3.638 \text{ pF}$; forward transit time, 301.2 ps, and base spreading resistance, $10 \text{ k}\Omega$.

3. Verify the SPICE solution for the above with a hand calculation using the parameters given for the SPICE simulation. Calculate the dc operating point, mid-band small signal voltage gain, and positive and negative clipping levels.