ECE 3042
Spring 2013 Homework No. 1 for Exp. No. 1
Due Week of January 21

1. Shown below is a single stage common emitter amplifier using an 2N3904 NPN BJT as the active device. Design the circuit so that it clips symmetrically, viz. pick R_{B1} and R_{B2} so that the collector current is that which yields symmetric clipping. The design specification for the magnitude of the small signal midband voltage gain is 33. For the design calculations assume the the base-to-emitter dc voltage drop is $0.65\,\mathrm{V}$, that the current in R_{B1} is $10I_B$, $\beta = 200$, the base spreading resistance is $10\,\Omega$, and the Early voltage is infinity.

2. For the circuit parameters indicated in the diagram, use National Instruments SPICE to determine:

- the dc operating point of the circuit, viz. the dc voltage at each terminal of the transistor and the current owing into the collector and base leads and out of the emitter.

- the small signal ac voltage gain, viz. a plot of the gain, A_v versus frequency where the frequency range is from $10\,\mathrm{Hz}$ to $100\,\mathrm{MHz}$.

- the positive and negative clipping levels, viz. the maximum and minimum possible values of the output voltage, v_o.

- plot of the output voltage versus time for 2 cycles of the input for an input signal with a frequency of $1\,\mathrm{kHz}$ and a peak value 0.1, 0.3, and $1\,\mathrm{V}$.

- plot of the output voltage versus frequency for a frequency span from dc to $10\,\mathrm{kHz}$, viz. a spectral analysis. Plot the output voltage on a log scale for each of the three input levels used in the previous step. Compute the THD for each.

Assume that the SPICE parameters for the 2N3904 NPN BJT are: saturation current, $10\,\mathrm{fA}$; forward beta, 200; Early voltage, $170\,\mathrm{V}$, zero-bias base collector capacitance, $3.6\,\mathrm{pF}$; forward transit time, $0.3\,\mathrm{ns}$, and base spreading resistance, $10\,\Omega$. (These are the values given in the model statement on page 7 of Experiment 1.)

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.