

ECE 3042

Homework Assignment No. 1 Fall 2009 Homework Problem Set for Exp. No. 1 Due Week of August 31

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 7.3. For the design calculations assume the the base-to-emitter dc voltage drop is 0.65 V, that the current in R_{B1} is $10I_B$, $\beta = 416$, the base spreading resistance is $0\ \Omega$, and the Early voltage is infinity. Assume that $R_{E1} = 5.1\ \text{k}\Omega$, $R_C = 22\ \text{k}\Omega$, and $R_L = 10\ \text{k}\Omega$. Also assume that $C_1 = C_2 = 22\ \mu\text{F}$ and $C_E = 330\ \mu\text{F}$. Compute the values of R_{E2} , R_{B1} , and R_{B2} to satisfy the design criteria. The dc power supply voltage is $V^+ = 30\ \text{V}$.

2. For the circuit parameters indicated in the diagram, use either Cadence and 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 flowing 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 0.1 Hz to 100 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 a sine wave with a frequency of 1 kHz and a peak value 0.7 V.
- 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 0.7 V. Plot the output voltage on a log scale.

Assume that the SPICE parameters for the 2N3904 NPN BJT are: saturation current, 6.734 f A; forward beta, 416; Early voltage, 74.03 V, zero-bias base collector capacitance, 3.638 pF; forward transit time, 301.2 ps, and base spreading resistance, 10 Ω . (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.

