ECE137A, Lab Project #2

You must purchase lead-free solder from the electronics shop. Do not purchase solder elsewhere, as it will likely be tin/lead solder, which is toxic. "Solder-sucker" desoldering tools are not permitted in the lab, as they disperse a dust of solder granules into the air and onto surrounding surfaces. If you are also foolishly using tin/lead solder, you will then poison yourself. Again, use lead-free solder from the shop, and use desoldering wick to remove solder. ***Projects assembled using lead-containing solder will receive a grade of zero***.

In this project, you will design, build, and test a small audio power amplifier to drive a loudspeaker. This will be used in conjunction with later lab projects.

The speaker is an 8 Ohm load. A differential input is required.
The circuit specifications are as follows
All testing is with an 8 Ohm load resistance.
Voltage Gain: 5, plus or minus 10%, measured at 1 kHz.
Input impedance: 1000 Ohms or more.
Variation in gain less than +/- 1 dB between 100 Hz and 10 kHz
---this sets a minimum size on bypass and coupling capacitors.
Peak-peak output swing before clipping:
at least 4 volts peak-peak.
1-10 additional points will be rewarded for signal swings between 4 Volts peak-peak and 7 Volts peak-peak.
Power supplies: Positive and negative 5 volts.
The input is to be differential, ~~with > 30 dB CMRR at 1 KHz~~.

The amplifier can only be partially AC coupled: DC blocking capacitors are allowed on the input, if desired, and an output DC blocking capacitor is also allowed but is not recommended. It is better to design for zero volts on the output.

Use of a push-pull class AB output stage is strongly suggested: these will be discussed in lecture, but are also in the notes and in the book, so you can read ahead. Beware of thermal runaway: the thermal stability factor, K, given below, must be less than 1 or the push pull circuit can spontaneously destroy itselt. Vcc is the supply voltage. Re the emitter degeneration, and the theta terms are thermal resistances.

$$k = \frac{(2.2mV/C)V_{cc}(\theta_{junction-case} + \theta_{\text{case-heatsink}} + \theta_{\text{heatsink-ambient}})}{r_e + R_e}$$

$\theta_{junction-case}$ is given on the transistor datasheet, $\theta_{\text{case-heatsink}}$ should be less than 2 C/W if you firmly attach the transistor to the heatsink with minimal air gaps, thermal conductive compound, and a thin mica insulator. $\theta_{\text{heatsink-ambient}}$ is approximately

$\theta_{\text{heatsink-ambient}} \approx 50/\sqrt{A}(C/W \cdot cm^2)$, where A is the surface area of the heat sink. Heat sink surfaces should be vertical for best thermal convection.