1. Consider the given circuit, $\beta = \beta_0 = 100$, $I_{CQ1}$ is 1 ma, $V_{CQ1} = 5.7V$, $V_{CC}$ is 15V, and $-V_{CC}$ is -15.7V.

   a) (10) What is $V_{BQ1}$?

   b) (10) What is $I_{CQ2}$?

   c) (10) What is the voltage gain of the circuit in dB if $V_1 = -V_2$ and $R_1 = 2K$ and $R_2 = R_3 = 5K$? Note that bias values will differ from what has already been given above.

   d) (10) What is the CMRR for these resistor values?

   e) (10) Suppose that this circuit was modified without your knowledge and you are given the circuit in a sealed box. After making some measurements, you find that the only significant change in performance is that the common-mode gain is lower by about 40 dB. Briefly describe how the circuit might have been modified for this to occur.
2. You are to design a 4 W Class B public address amplifier with one .5 V inputs that will operate off of a single battery of 10 Volts. Assume that available op amps have a gain-bandwidth product of 1 mHz and can come within .3V of the rail voltage.

a) (10) Draw your circuit showing component values and biasing. Note that sufficient gain must be provided to obtain maximum power output.

b) (10) If the lower frequency limit is to be 50 Hz, identify the circuit components that affect low frequency response and give cost-effective values for them.

c) (10) What is the maximum impedance of the speaker (load) that still meets the power requirement?

d) (10) Given that class B amplifiers have distortion, explain how your circuit minimizes the problem. Class AB operation is not an option here.

3. (10) Using 3 PMOS and 3 NMOS transistors, draw a schematic diagram for a CMOS OR gate.