Linear Electronics Class B Work

For the circuit below determine: A) The value of R1 for proper bias. B) The maximum load power assuming that the output stage clips before the first stage. C) Ratings of P_{D-MAX}, BV_{CEO}, and I_{C-MAX} for transistors Q2 through Q4. D) The real compliance of the entire circuit. NOTE: You may assume that the betas for Q3 and Q5 are 50 each, and that beta is 100 each for Q1, Q2 and Q4.
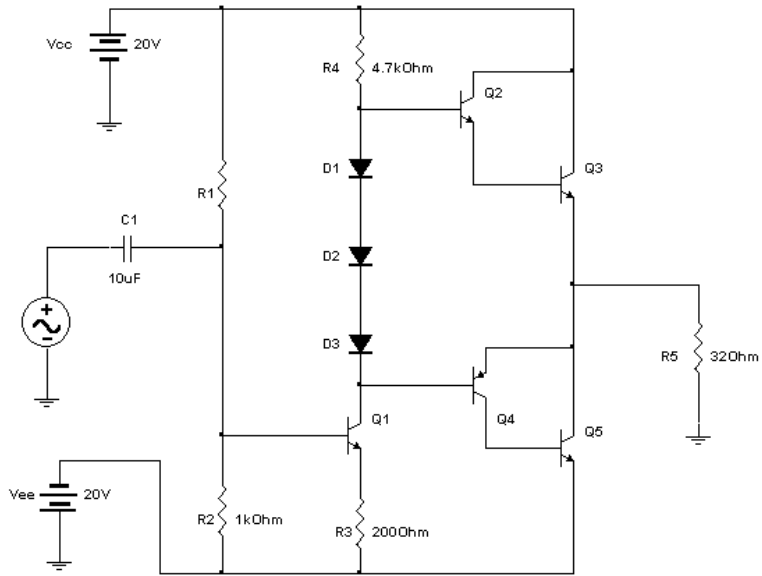
Solutions

A) The value of R1 for proper bias.

In order to achieve 0VDC at the load, the base of Q2 needs to be at 1.4V and therefore 20-1.4 or 18.6 volts drops across the 4.7k. This results in 18.6/4.7k=3.96 mA. This same current flows down through Q1 producing 3.96 mA*200 = .79 volts across the 200 ohm emitter resistor. This means that .7 + .79 = 1.49 volts must be dropped across the 1k voltage divider resistor which results in 1.49 mA. This same current flows through R1. The voltage across R1 is 40-1.49=38.51 volts. Therefore R1=38.51 v / 1.49 mA = 25.8 k.

B) The maximum load power assuming that the output stage clips before the first stage.

Assuming that the output stage clips first, the power supplies set the limit at +/- 20 volts, or 40 volts peak-peak or 14.1 volts RMS. Pload-max is 14.1^2 / 32 = 6.2 watts.

C) Ratings of P_{D-MAX}, BV_{CEO}, and I_{C-MAX} for transistors Q2 through Q5.

The breakdown is the max power supply differential for all devices or 40 volts. The P_{D-MAX} is the max load power divided by 5 or 1.24 watts for Q3 and Q5. Q2 and Q4 require beta less current and therefore beta less power or about 24.8 mW. The max load current for Q3 and Q5 would be 20 volts / 32 ohms = .625 amps, and .625 / 50 = 12.5 mA for Q2 and Q4.

D) The real compliance of the entire circuit.

A closer inspection of part B will show that the driver stage actually clips before the output stage. An AC load line for the driver reveals that it will clip around 18.1 volts peak or 12.8 volts RMS, yielding 5.1 watts.

The max swing for the class A driver is the smaller of V_{CEQ} and $I_{CQ}(r_C+r_E)$. The voltage portion is 20-.7=19.3v. The current was found in part A to be 3.96 mA. The collector resistance of 4.7 k is in parallel with the class B input impedance of 50*100*32 ohms for 4.57 k. 3.97 mA * 4.77 k = 18.9 volts, which is the smaller of the two. There is a voltage divider between the load and the swamping resistor so the actual output is slightly less at 18.1 volts peak.