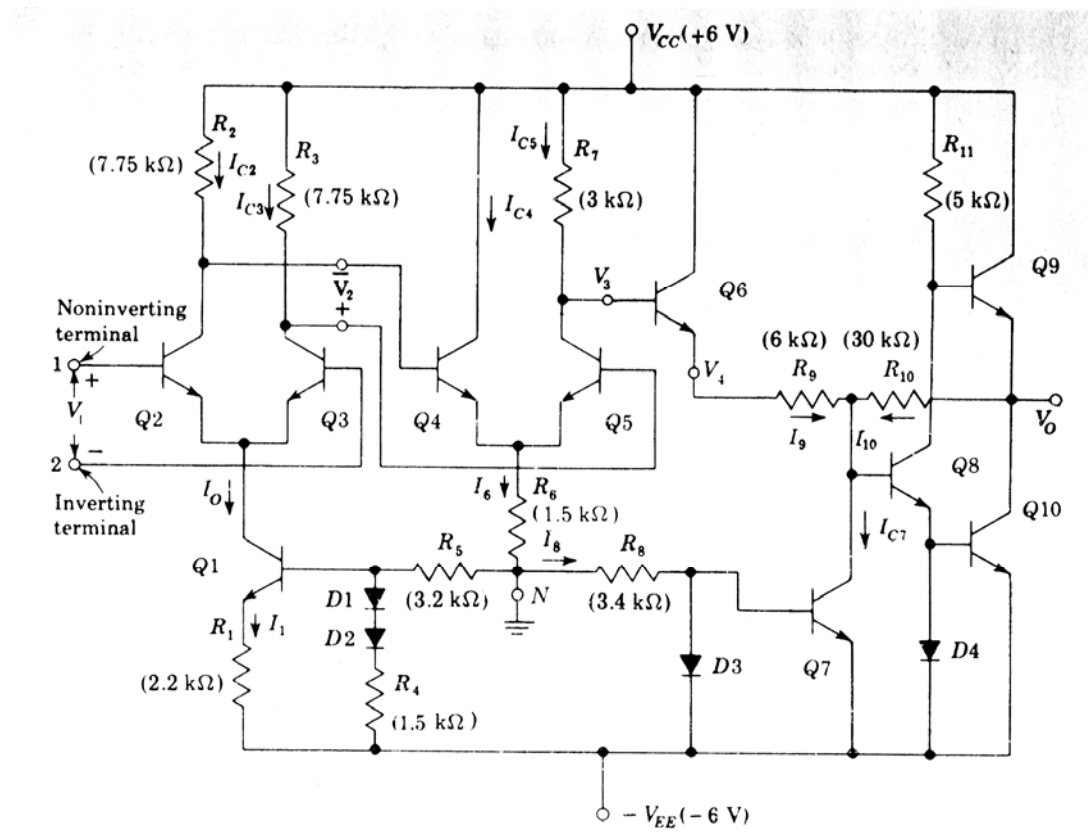# ELEC271: Case study of a commercial op-amp.

Exercise: The figure below shows an early operational amplifier (Motorola MC1530). All transistors are out of saturation, therefore base currents can be neglected. Note also that the diodes D_1 - D_4 are formed by transistors with the base and collector terminals connected together.

I. Identify the circuit building blocks that make up the amplifier.

II. Calculate the following <u>d.c. currents and voltages</u> (applied a.c. voltages at inputs 1 and 2 are both zero).

(i) Voltage at the base of Q_1, (ii) hence I_1, I_O and $I_{C2} = I_{C3}$, (iii) voltage at base of Q_4, (iv) $I_{C4} = I_{C5}$, (v) V_3, V_4, (vi) I_8 hence I_{C7} (Hint: what is the circuit configuration formed by R_8, D_3 and Q_7?), (vii) voltage at base of Q_8, (viii) I_9, (ix) I_{10}, (x) V_O

III. Assuming $\beta_o = 100$ for all transistors:

(xi) calculate the gain of the first stage $A_{V1} = v_2 /v_1$ (Load is 7.75k in parallel with the input resistance of Diff. Amp. formed by Q_4,Q_5 : r_{be4}).

(xii) find the gain of the second stage, $A_{V2} = v_3/v_2$

(xiii)   hence find the overall gain of the amplifier, $A_V = v_o/v_1$. (Hint: the gain of the final stage is set by the ratio of resistors R_{10}, R_9)