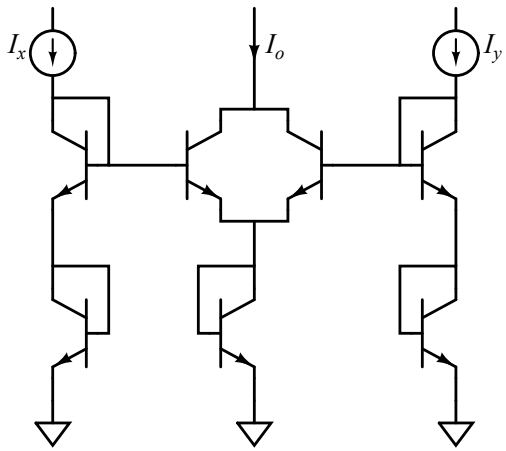
(e)



We know the current through Q5 (the transistor connected to the emitters of the diff pair) is I_o, but we don't know the currents through the diff pair transistors, I_6 and I_7. From the left side loop:

$$I_x^2 = I_6 I_o$$
$$I_6 = \frac{I_x^2}{I_o}$$

From the right side Gilbert loop we can similarly write that $I_7 = I_y^2 \triangleleft I_o$. Put them together:

$$I_o = I_6 + I_7$$
$$= \frac{I_x^2}{I_o} + \frac{I_y^2}{I_o}$$
$$I_o^2 = I_x^2 + I_y^2$$