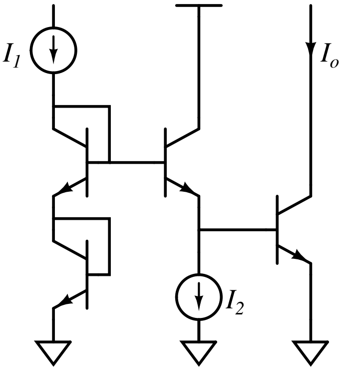
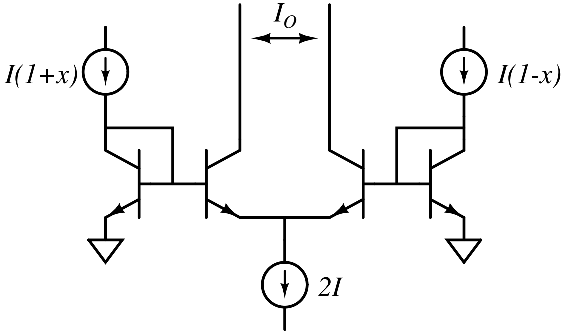
(a)



$$I_1 I_1 = I_2 I_o \longrightarrow I_o = \frac{I_1^2}{I_2}$$

(b)



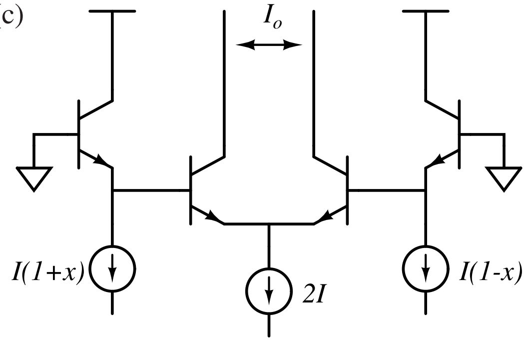
Write I_o as $I(1+y)$ and $I(1-y)$. Then,

$$I(1+x)I(1-y) = I(1+y)I(1-x)$$
$$1 - y + x - xy = 1 + y - x - xy$$
$$x = y$$

The output currents are $I(1+x)$ and $I(1-x)$ so

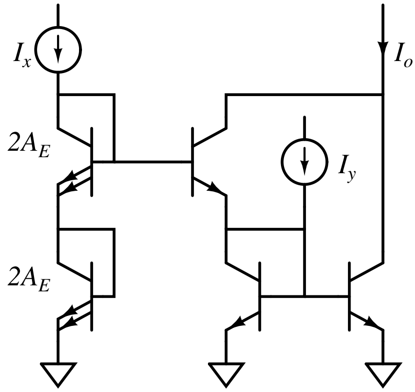
$$I_o = I(1+x) - I(1-x)$$
$$I_o = 2x$$

(c)



$$I(1+x)I(1+y) = I(1-y)I(1-x)$$
$$1 + x + y + xy = 1 - x - y + xy$$
$$2x = -2y$$
$$x = -y$$
$$I_o = I(1-x) - I(1+x) = -2x$$

(d)



First find I_3 in terms of I_o and I_y:

$$I_3 = I_o - I_y\text{, and}$$
$$I_3 = I_o - I_3 - I_y$$
$$2I_3 = I_o - I_y$$
$$I_3 = \frac{I_o - I_y}{2}$$

From the Gilbert loop in the left four transistors, we know that

$$\frac{I_x^2}{4} = I_3(I_3 + I_y)$$
$$\frac{I_x^2}{4} = \frac{I_o - I_y}{2} \qquad \frac{I_o + I_y}{2}$$
$$\frac{I_x^2}{4} = \frac{I_o^2 - I_y^2}{4}$$
$$I_o^2 = I_x^2 + I_y^2$$