Consider the current source circuit shown in Fig. P3.11 (page 178) of the Text. The device parameters are: $V_{th} = 1\text{V}, \mu_n C_{ox} = 90\mu\text{A}/\text{V}^2, W/L = 1, \lambda = 0.01 \text{ }1/\text{V}, \gamma \approx 0$.

a) Find $V_{ref}$ so that the output current of the current source is $I_o = 50\mu\text{A}$. State your assumptions.

b) For $V_{ref}$ found in (a), find the minimum voltage (i.e. the minimum voltage at the drain of Q1) such that both devices operate in the active/saturation mode. Find the output resistance of the current source assuming the output voltage is greater than the minimum.

c) Using one DC voltage supply $V_{DD} = 5\text{V}$, one resistor and as many NMOS devices as you need, construct the voltage source $V_{ref}$. Find the resistance value so that $V_{ref}$ is as found in (a). Specify all device sizes. Sketch the complete circuit of the current source.

d) Sketch PMOS version of the current source designed in part (c).