

1.

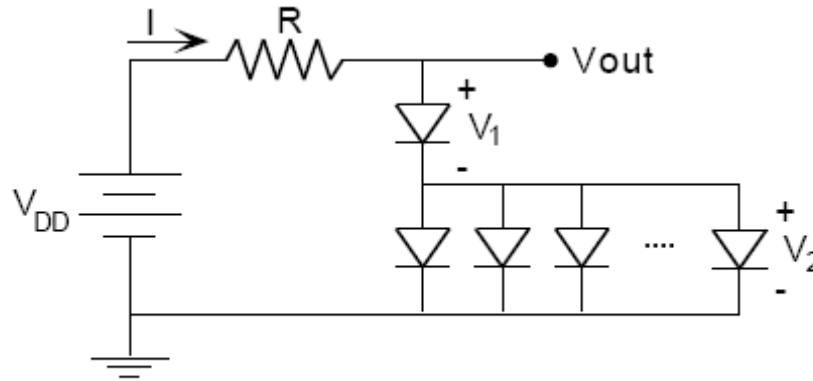


Figure 1

$I_s = 10^{-15} \text{ A}$ and $n = 1.25$ for all diodes. $V_{DD} = 5 \text{ V}$ and $R = 1.67 \text{ K}\Omega$.

$$V_{out} = 1.657 \text{ V} \Rightarrow I = \frac{5 - 1.657}{1.67 \text{ K}} = 2 \text{ mA}$$

$$V_1 = nV_T \ln\left(\frac{I}{I_s}\right) = 1.25 \times 0.025 \times \ln\left(\frac{0.002}{10^{-15}}\right) = 0.885 \text{ V}$$

$$\Rightarrow V_2 = 1.657 - 0.885 = 0.772 \text{ V}$$

$$I_2 = \frac{I}{M}$$

$$\Rightarrow \frac{I}{M} = \frac{2 \text{ mA}}{M} = I_s e^{\frac{V_2}{nV_T}} = 10^{-15} e^{\frac{0.772}{1.25 \times 0.025}} = 53.56 \mu\text{A}$$

$$\Rightarrow M = 37.3 \text{ (or 38)}$$