

# Question

Consider MOS capacitor. The substrate is grounded and the flat-band condition is realized when the gate voltage is 0V.

1. Suppose the gate oxide thickness is 10nm and the substrate doping concentration is  $1 \times 10^{17} \text{ cm}^{-3}$  and  $1 \times 10^{18} \text{ cm}^{-3}$ , calculate the  $V_{\text{th}}$ .
2. Suppose the gate oxide thickness is 50nm and the substrate doping concentration is  $1 \times 10^{16} \text{ cm}^{-3}$ , calculate  $V_{\text{th}}$ .

The following constants and equations may be used.

$$\kappa_{\text{SiO}_2} = 3.9$$

$$\kappa_{\text{Si}} = 11.9$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$$

$$q = 1.6 \times 10^{-19} \text{ C}$$

$$n_i = 1.45 \times 10^{10} \text{ cm}^{-3}$$

$$k_B = 1.38 \times 10^{-23} \text{ J/K}$$

$$\phi_F = \frac{k_B T}{q} \ln \left( \frac{N_A}{n_i} \right)$$