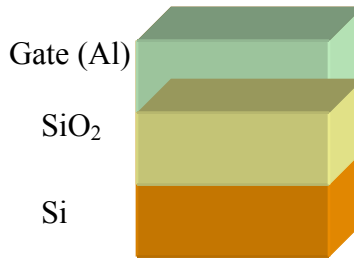


**COE 360 – 2nd Assignment – Dr. Muhammad Elrabaa**

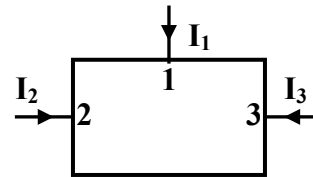
1. The gate capacitance of an MOS device with an Aluminum gate, Silicon substrate and SiO<sub>2</sub> insulator was measured to be  $3 \times 10^{-7} \text{ F/cm}^2$ . Also its threshold was measured to be  $-0.6 \text{ V}$ :
  - (a) What is the oxide thickness?
  - (b) Assuming that the oxide trapped charge is zero, what is the substrate type? Calculate the substrate doping.
  - (c) Redo (b) above with an oxide trapped charge of  $10^{-7} \text{ cm}^{-3}$ .

Hint: Get the constants you need from the text book, chapter 3. You can solve the resulting non-linear equations by hand (iterations) or write a simple program to do that. [4 marks]



2. An MOS transistor is made with a P-Type Polysilicon gate and an N-type Silicon substrate ( $N_D = 10^{15} \text{ cm}^{-3}$ ). The oxide thickness is 20nm and the oxide trapped charge is  $-5 \times 10^{-8} \text{ c/cm}^2$ .
  - (a) Calculate the threshold of this device and determine its type,
  - (b) Calculate the required substrate doping to make the threshold  $-0.8 \text{ V}$  [3 marks]
3. For the MOS transistor (shown in the figure below) the following measurements were made using the three terminals shown in the figure (none of them is the substrate):

Terminal Voltages			Terminal Currents		
V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	I <sub>1</sub>	I <sub>2</sub>	I <sub>3</sub>
0 V	0 V	0 V	0 mA	0 mA	0 mA
1 V	0 V	0 V	1 mA	-1 mA	0 mA
0 V	1 V	0 V	-1 mA	1 mA	0 mA
2 V	1 V	0 V	0 mA	0 mA	0 mA
1 V	2 V	0 V	0 mA	0 mA	0 mA
2 V	1 V	1 V	1 mA	-1 mA	0 mA



- Current into a terminal is positive
- Current out of a terminal is negative

- a. Which terminal is the gate?
- b. What is the type of this transistor (NMOS or PMOS)?
- c. What is the range of possible values of the threshold voltage? Is this a depletion mode or enhancement mode transistor? [3 marks]