# Homework 1

## Computer Engineering 303

**Problem 1. (25 Points, CMOS Technology)**

(a) (15 Points) If the number of transistors per unit area (i.e., on the same chip size) doubles every 24 months, what is the annual scaling factor s for the length of the side of a transistor, assuming the area occupied by one transistor is a square?

Toral chip area at the start of a two year cycle = A_initial
Total number of transistors on chip at the start of a two year cycle = N
Initial Length of one side of the square shaped transistor area = L
Annual transistor scaling factor = s

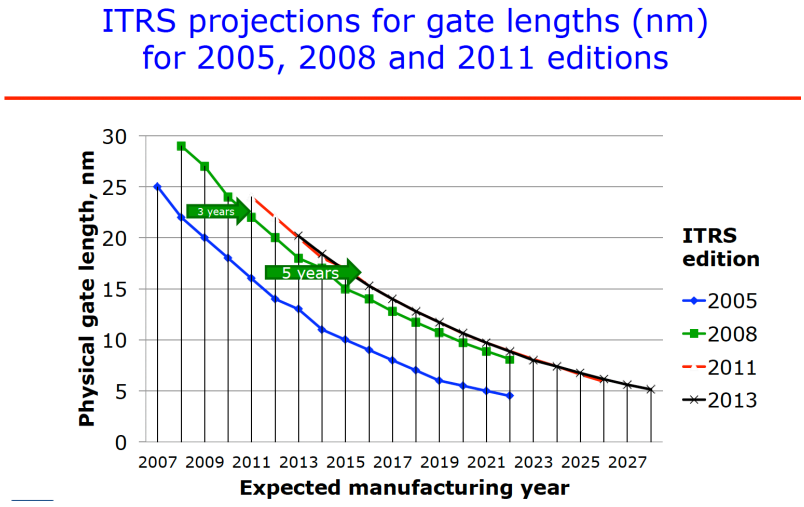
Derive the answer by solving the following steps:

A_initial =

A_one_year =

Using the equations above derive the value for annual scaling factor s =

(b) (10 Points) The International Technology Roadmap for Semiconductors published the trends depicted in the figure below. Starting with 18.4nm in 2014 what would be the transistor size according to the scaling trend s you calculated above in 2021? How does it compare to the predicted 10nm size in the report?



**Problem 2. (30 Points, 10 Points for each part) Switch Representation of Digital Circuits:**

Draw the CMOS circuit diagrams using NMOS and PMOS transistors for the following functions.

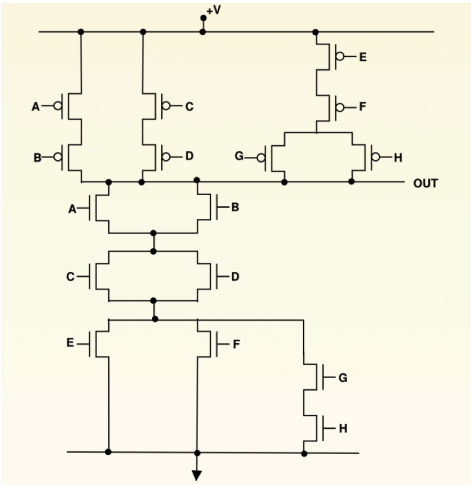
(1)

$F = \overline{(AB+C)D}$

(2)

$F = \overline{(A+B)(BC+D)}$

**(3)** What is the logic equation describing the behavior of the complex CMOS gate depicted in the figure below?




**Problem 3. (25 Points)** For the function f with the minterms {ABC'D, ABC'D', A'BC'D, A'B'C'D, ABCD, ABCD', A'B'CD}

| CD / AB | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | | | |
| 01 | | | | |
| 11 | | | | |
| 10 | | | | |

a. (20 Points) Using the K-Map layout above, identify all Prime Implicants

b. (5 Points) Identify the Essential Prime Implicants

**Problem 4. (25 Points)** Find all Prime Implicants for the following functions by applying the first step of the QM Method

a. F(A, B, C, D) = minterms of the ON-Set: {m1, m5, m7, m9, m11, m12, m14, m15}

b. F(A, B, C, D) = minterms of the ON-Set: {m0, m1, m3, m5, m6, m7, m8, m10, m14, m15}