GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

Faculty of Engineering

Department of Electrical, Electronic and Telecommunication Engineering

BSc Engineering Degree

Semester 4 Examination – November 2016

(Intake 32 - ET)

ET4082 – SEMICONDUCTOR AND SOLID STATE DEVICES

Time allowed: 2 hours 29th November, 2016

INSTRUCTIONS TO CANDIDATES

This paper contains 4 questions on 4 pages

Answer all **FOUR** questions

This is a closed book examination

This examination accounts for 70% of the module assessment. A total maximum mark obtainable is 100. The marks assigned for each question and parts thereof are indicated in square brackets

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script

Assume reasonable values for any data not given in or provided with the question paper, clearly make such assumptions made in the script

All examinations are conducted under the rules and regulations of the KDU

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$$C_{OX} = \frac{\varepsilon_{OX}}{t_{OX}}$$

$$k'_n = \mu_n C_{OX}$$

$$i_D = \frac{1}{2} k'_n \frac{W}{L} V^2_{OV}$$

$$r_{DS} = \frac{1}{k'_n \frac{W}{L} V_{OV}}$$

Question 1

Crystalline materials are solids with an atomic structure based on a regular repeated pattern

(a) Name three types that solid materials could classify, and explain the atomic structure of each type. [04]

(b) Explain the difference between intrinsic and extrinsic semiconductors [06]

(c) Explain the how increase conductivity by doping [07]

(d) Explain the relation of Fermi Level and Band Structure for n-type semiconductor [08]

Question 2

(a) Consider a processing technology for which $L_m = 40\mu m, t_{OX} = 8nm, \mu_n = 450\, cm^2/V.s$, $V_t = 0.7V$ for a MOSFET ($\varepsilon_{OX} = 3.45x10^{-11}$).

a. Calculate C_{OX} and k'_n [06]

b. Calculate the values of V_{OV}, V_{GS}, and V_{DSmin} needed to operate the transistor in the saturation region with a dc current I_D = 100 μA, For a MOSFET with $W/L = 8\mu m/0.8\mu m$. [06]

c. For the device in (b), find the values of V_{OV} and V_{GS} required to cause the device to operate as a 1000Ω resistor for very small v_{DS}. [07]

(b) Calculate the total charge stored in the channel of an NMOS transistor having C_{ox} = 6 fF/μm2, L = 0.25 μm, and W = 2.5 μm, and operated at V_{OV} = 0.5V and V_{DS} = 0V.

[06]

Question 3

(a) Explain the operation of pull – down Network constructed of NMOS transistors [04]

(b) Explain the operation of circuit diagram in Figure Q3.1 [06]

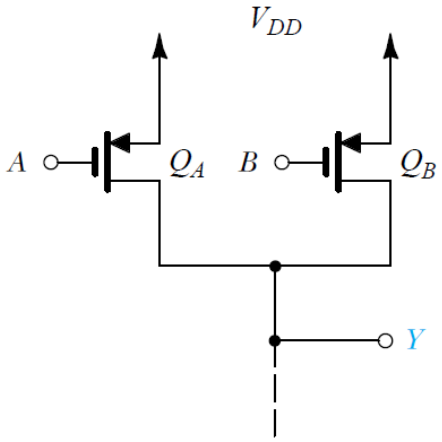

Figure Q3.1

(c) Construct following gate circuits using NMOS and PMOS transistors

a. Two-input NOR gate
b. Two-input NAND gate
c. Two-input XOR gate [15]

Question 4

The semiconductor manufacturing process consist of main four steps

(a) List four main steps in semiconductor manufacturing process [04]

(b) Explain the Czochralaki Process of silicon manufacturing [06]

(c) Write short note on any three topics listed below

a. Photoresist

b. Photomask and reticles

c. Ion Implantation

d. Local Oxidation [15]

End of question paper