

UNIVERSITY OF GHANA

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**FACULTY OF ENGINEERING SCIENCES
BSc. (ENG) MATERIALS SCIENCE AND ENGINEERING**

First Semester Examinations: 2012/2013

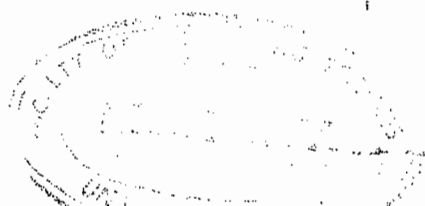
MTEN 311: Solid State Technology (3 CREDITS)

Time Allowed: 3 Hours

Answer ALL questions in Section A & B

SECTION A: 30MARKS

1. List four semi-conducting materials important to solid state electronics. (2marks)
2. List four basic components in modern day electronic gadgets. (2marks)
3. Why is electrical conductivity of semiconducting materials different for different materials? (2marks)
4. Briefly describe a junction diode? (2marks)
5. What is your understanding of the term photolithography as used in semiconductor device fabrication? (2marks)
6. Define the following terms: (10marks)
 - i. Work function of a metal
 - ii. Band gap
 - iii. Drift velocity
 - iv. Flat band voltage
 - v. Threshold voltage
7. Sketch the equilibrium band diagram of a p-n junction. (2marks)
8. Sketch and label clearly a p-MOSFET and an n-MOSFET. (2marks)
9. State the following equation:
 - i. Intrinsic concentration of electrons in the conduction band and define all variables and constants. (2marks)



- ii. The Fermi-Dirac distributions function and define all variables and constants. (2marks)
10. Sketch the flat band diagram of a Metal-Oxide-Semiconductor (MOS, where S is a p-type is Silicon) (2marks)

SECTION B: 40MARKS

1. The Metal Oxide Semiconductor (MOS) capacitor is an important structure which is incorporated in the surface of most semiconductor devices:
- (a) Describe the MOS capacitor as used in solid state electronics (5marks)
 - (b) Why is the study of the electrical behavior of a MOS capacitor important as a semiconductor device? (2marks)
2. A MOS capacitance will vary with an applied gate to substrate voltage. The Capacitance verses Voltage characteristics of a MOS capacitance have been found to be extremely useful in the evaluation of the electrical properties of some solid state devices.
- (i) Briefly review the 3 most important regions of interest during a voltage sweep using a P-type Silicon to treat your case. (6marks)
 - (ii) Give a qualitative description of an n-MOSFET in operation, using different voltage regimes. (6marks)
 - (iii) Sketch the IV characteristics of a MOSFET. (1mark)
3. One of the crucial keys to solid state electronics is the nature of PN junctions.
- (i) Briefly describe the equilibrium state, forward and reverse bias characteristics of a PN junction. (6marks)
 - (ii) What is the single most important behavior of PN junctions under normal conditions? (2marks)
4. There are several steps in the fabrication process of solid state devices. Using based laboratory process modules, describe in detail the various steps involved in the fabrication of a MOS capacitor. (6marks)
5. Explain in detail the basic operating principle of a semiconductor laser diode (6marks)