



UNIVERSITY OF GHANA

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BSc. (ENG) FIRST SEMESTER EXAMINATION: 2016/2017

MTEN 311: SOLID STATE TECHNOLOGY (3 Credits)

DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING

Answer All Questions

Time Allowed: 3 Hours

Section A: 40 Marks

1.
  - (a) Discuss the phenomena of superconductors and the quantum mechanical understanding of superconductivity as observed in some materials. 5 Marks
  - (b) The wave-particle duality is an essential theory for understanding various phenomena at the nano and atomic scale. How was the problems with blackbody radiation resolved? 5 Mark
2. Methods for depositing thin films in semiconductor technology are variants of physical vapour (PVD) and chemical vapour (CVD) depositions. Explain in detail the principles of PVD and CVD making emphasis on the distinction between the two process methods. 10 Marks
3. Describe and explain the Meissner Effect as observed in superconductivity. 5 Marks
4. Describe the metal-oxide-semiconductor (MOS) capacitor and its three (3) regimes of operation using a p-type semiconductor. 10 Marks
5. Sketch and label clearly the ideal band diagram of a p-type metal-oxide-semiconductor (pMOS) system in equilibrium. 5 Marks

### Section B: 60 Marks

1. Solar (or photovoltaic) cells convert the sun's energy into electricity. Whether they're adorning your calculator or orbiting our planet on satellites, they rely on charge separation in a PN junction. Explain with diagrams the fundamental basis for the operation of a solid state Solar Cell. *15 Marks*
2. Spintronics, or spin electronics, refers to the study of the role played by electron (and more generally nuclear) spin in solid state physics, and possible devices that specifically exploit spin properties instead of or in addition to charge degrees of freedom. This has led to huge increases in storage capacity and made possible the evolution of giant data centers. Discuss the fundamental principles of spin electronics. *15 Marks*
3. The purpose of a fuel cell is to produce an electrical current from a chemical reaction that can be directed outside the cell to do work, such as powering an electric motor or illuminating a light bulb or a city. Describe the fundamental basis of a solid oxide fuel cell using schematic diagrams. *15 Marks*
4. The MOS transistor is a type of transistor used for amplifying or switching electronic signals. Discuss in detail why the basic unit of the MOS transistor (MOS Capacitor) is very important in device fabrication and the study of MOS transistors. *15 Marks*