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(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN PHYSICS

COURSE CODE: SPH 924E

COURSE TITLE: PHYSICS AND APPLICATIONS SEMICONDUCTOR NANOSTRUCTURES

DATE: THURSDAY 4TH AUGUST, 2022 **TIME:** 2 PM - 5 PM

INSTRUCTIONS TO CANDIDATES

TIME: 3 Hours

Answer Five Questions.

Symbols used bear the usual meaning.

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (14 MARKS)

1a) Heterostructures are semiconductor structures in which chemical composition changes with position, represent (i) Schematic illustration of a quantum well, (ii) representation of the energy barriers and the first three confined wave-functions, (iii) Energy dispersion for n = 1,2,3 as a function of $k_{\|}$, the wave vector perpendicular to the confining direction. (iv) Density of states as a function of the energy (12 marks)

1b) Show the energy dispersion relation for electrons in a quantum well (2 marks)

QUESTION TWO (14 MARKS)

Discuss the density of states for three, two, one and zero dimensional system structures (14 marks)

QUESTION THREE (14 MARKS)

Discuss the synthesis of the following varieties of quantum dots namely (i) Lithographically defined quantum dots (ii) Epitaxially self-assembled quantum dots (iii) colloidal quantum dots (14 marks)

QUESTION FOUR (14 MARKS)

Using the quantum mechanical approach estimate the size dependent energy gap of a spherical semiconductor quantum dot (14 marks)

QUESTION FIVE (14 MARKS)

Determine the electron wave function for an electron entering a multiple quantum well hence show the electron transition mechanisms (14 marks)

QUESTION SIX (14 MARKS)

Using Drude classical model of the magnetoresistance in semiconductors Derive the quantum Hall effect parameters for a semiconductor nanostructure (14 marks)