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**University Examinations 2016/2017**

FOURTH YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE PHYSICS AND BACHELOR OF EDUCATION SCIENCE

**SPH 2403: QUANTUM MECHANICS II**

**DATE: December, 2016 TIME: HOURS**

**INSTRUCTIONS:** *Answer questions* ***one*** *and any other* ***two*** *questions.*

**QUESTION ONE - (30 MARKS)**

1. Differentiate between differential cross sections and integral cross sections. (2 Marks)
2. State the Pauli’s exclusion principle. (2 Marks)
3. Define the following terms; (4 Marks)
4. Normal Zeeman effect
5. Stalk effect
6. Differentiate between degenerate and none degenerate states. (4 Marks)
7. Normalize the wave function in the region 0$\leq x\leq 2π$ (4 Marks)
8. Show that the commutation f the angular momentum component is (4 Marks)
9. The total Hamiltonian for helium atom is given by,



Explain each of the terms on the right side of the equation above. (4 Marks)

1. Dirac-Delta functions are defined such that;

 and 

Show that the function below is a Dirac-Delta function

  (5 Marks)

**QUESTION TWO (20 MARKS)**

1. Use Pauli matrices to show that the only matrix which commute with Pauli matrices is a multiple of the unit matrix. (8 Marks)
2. Consider a particle of mass m moving in one dimension in a potential V(x). Then the one dimensional Schrodinger wave equation for state n corresponding to the energy eigenvalue  is  and another one for state m corresponding to the energy eigenvalue  is  show that the energy eigenvalues are real. (12 Marks)

**QUESTION THREE (20 MARKS)**

1. Given that A is Hermitian operator, show that all its eigenvalues are real using  (4 Marks)
2. What is the first-order correction to the energies of a doubly degenerate pair of orthogonal states for the secular determinant given below? (6 Marks)



1. For known Eigen functions and eigenvalues of a system with Hamilton $H^{(0)}$ and having a solution of the form

  for n = 1,2,3….,

 Show that for degenerate case, the first-order correction to the energy of the state

  (10 Marks)

**QUESTION FOUR (20 MARKS)**

1. State four properties of wavefunctions. (2 Marks)
2. Show that the square of the magnitude of angular momentum operate commutates with the components of angular momentum.

 (7 Marks)

1. The quantum mechanical Hamiltonian of a system has the form;



Find the energy Eigen value of the two lowest lying states given that in spherical coordinates . (11 Marks)