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**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**University Village, Nnamdi Azikiwe Expressway, Plot 91, Cadastral Zone, Jabi, Abuja**

**FACULTY OF SCIENCE**

 2017\_1 SEMESTER EXAMINATION

COURSE CODE: PHY309

COURSE TITLE: QUANTUM MECHANICS

COURSE UNIT: 3 Units

TIME: 3 hours

INSTRUCTION: Answer question one (1) and any FOUR (4) questions

***Question 1***

1. Find the norms of the following vectors:

 and [3 marks]

1. What is the value of the real number in the normalized vector,

 ? [2 marks]

1. Given a set of vectors linearly dependent or independent?

[4.5 marks]

1. Which of the following functions are even and which ones are odd?
2. [0.5 mark]
3. [0.5 mark]
4. [1 mark]
5. i. Show that and are orthogonal, [3 marks]

ii. Evaluate the integral: [2.5 marks]

1. If the matrix is a proper orthogonal matrix, find the value of [5 marks]

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***Question 2***

1. You are given the set
2. Are they orthogonal? [1.5 marks]
3. Are they normalized? If not, normalize them. [2.5 marks]
4. Given that matrices, and .

Show that:

1. [1 marks]
2. [2.5 marks]
3. Find the eigenvalues and eigenvectors of the following matrix: [4.5 marks]

***Question 3***

1. Explain briefly the following
2. Black body radiation [1.5 marks]
3. Compton effect [1.5 marks]
4. Photoelectric effect [1.5 marks]
5. Wave-particle duality [1.5 marks]
6. By applying the method of separation of variables, solve the differential equation

 [3.5 marks]

1. What value does Rayleigh-Jeans formula predict for the radiation of frequency emitted by a blackbody per unit time, per unit area at 2500 oK. Compare this value with that predicted by Planck. [2.5 marks]

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***Question 4***

1. Write FIVE (5) interpretations of Schrodinger equation. [2.5 marks]
2. Which of the following functions would you recommend as a possible eigenfunction in quantum mechanics?
3. [1 mark]
4. [1 mark]
5. [1 mark]
6. The time-dependent Schrodinger equation can be written as:

1. Assuming the solution , separate the equation into two such that they have solutions that depend on only time (t) and position (x). [4 marks]
2. Show that the wave function that describe a wave packet is given: [2.5 marks]

Where all the symbols have their usual meanings.

***Question 5***

A particle in a one-dimensional box is in the state:

1. Find A so that is normalized [6 marks]
2. What are the possible results of the measurements of the energy, and what are the respective probabilities of obtaining each result? [4 marks]
3. The energy is measured and found to be . What is the state of the system immediately after measurement? [2 marks]

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***Question 6***

1. Given that the ladder operators , while the position and momentum operators are given by:
2. What is the value of the commutator [2 marks]
3. Show that and [2 marks]
4. For the ground state, find and [5 marks]
5. Given that the expectation of the position and the momentum operators under consideration are zero in the ground state of the oscillator, prove that the following expression holds:

 [3 marks]

END OF EXAMINATION PAPER