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**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**

**FACULTY OF SCIENCES**

**DEPARTMENT OF PURE AND APPLIED SCIENCE**

 **2018\_2 SEMESTER EXAMINATION**

**COURSE CODE: PHY 309**

**COURSE TITLE: QUANTUM MECHANICS 1**

**CREDIT UNIT 3**

**TIME ALLOWED (2½ HRS)**

**INSTRUCTION: *Answer question 1 and any other four questions***

**QUESTION 1**

a) Define the term vector space (3 marks)

b) List the properties of the inner product of a vector space $V$. (9 marks)

c) (i) Determine if the function $f\left(x\right)=\sec(x)$ is even or odd (2*½ marks)*

 (ii) Express the function $h\left(x\right)=e^{-x}\cosh(x)$ as a sum of odd and even

 functions. (2*½ marks)*

d) Find (i) the change in wavelength if a proton is scattered at an angle of $23°$

 after its collision with an electron initially at rest (2*½ marks)*

 (ii)the wavelength of the wave associated with an electron moving at $10^{6} m/s$.

(2*½ marks)*

**QUESTION 2**

 a) Define the following terms: (i) linear independence (2 marks)

 (ii) linear dependence (2 marks)

b) Check if the following sets are linearly independent or not (i) $\left\{i,2i,j\right\}$ (3 marks)

(ii) $\left\{\left(\begin{matrix}1\\0\\1\end{matrix}\right),\left(\begin{matrix}1\\1\\0\end{matrix}\right),\left(\begin{matrix}1\\2\\1\end{matrix}\right)\right\}$(2 marks)

c) Normalise each vector in the set $\left\{\left(\begin{matrix}1\\2\\3\end{matrix}\right),\left(\begin{matrix}-2\\0\\4\end{matrix}\right),\left(\begin{matrix}1\\2\\1\end{matrix}\right)\right\}$. (3 marks)

**QUESTION 3**

a) Find the coordinates of the vector$\left[\begin{matrix}1&2\\-2&i\end{matrix}\right]$ with respect to the basis

 $\left\{\left[\begin{matrix}1&0\\0&1\end{matrix}\right],\left[\begin{matrix}0&1\\1&0\end{matrix}\right],\left[\begin{matrix}0&-i\\i&0\end{matrix}\right],\left[\begin{matrix}1&0\\0&-1\end{matrix}\right]\right\}$ (4 *marks)*

b) Show whether or not the set $\left\{\left(\begin{matrix}1\\1\end{matrix}\right),\left(\begin{matrix}-1\\-1\end{matrix}\right)\right\}$ is a basis for two-dimensional Euclidean space. (4 *marks)*

c) Show that the following are vector spaces over the indicated fields: (i) The set of real numbers over the field of real numbers (2 *marks)*

(ii) The set of quadratic polynomials over the complex field (2 *marks)*

**QUESTION 4**

a) Define the following terms: (i) Norm of a vector (2 *marks)*

 (ii) Photoelectric effect (2 *marks)*

 (iii) Blackbody radiation (2 *marks)*

b) What value does Rayleigh-Jeans formula predict for the radiation of frequency $6×10^{13} Hz$ emitted by a blackbody per unit time, per unit area at $2500 °K$. (3 *marks)*

 c) Compare this value with that predicted by Planck. (3 *marks)*

**QUESTION 5**

 a) Define the following terms (i) odd function (2 *marks)*

 (ii) even function (2 *marks)*

 b) Generate the relations of writing any real-valued function as a sum of an odd and an even

 function. (6 *marks)*

 c) Write the function $h\left(x\right)=e^{2x}\sin(x)$as a sum of odd and even function (2 *marks)*

**QUESTION 6**

 a) Define the following terms (i) inverse matrix (*2 marks)*

 (ii) unitary matrix (*2 marks)*

 (iii) normal matrix (*2 marks)*

b) Write the matrix of transformation between the following bases in $R^{3}$, the 3-dimensional

 Euclidean plane.

 $\left\{\left(\begin{matrix}1\\0\\2\end{matrix}\right),\left(\begin{matrix}2\\1\\0\end{matrix}\right),\left(\begin{matrix}0\\3\\5\end{matrix}\right)\right\}$ (*3 marks)*

 and $\left\{\left(\begin{matrix}1\\2\\1\end{matrix}\right),\left(\begin{matrix}2\\-1\\1\end{matrix}\right),\left(\begin{matrix}1\\1\\-1\end{matrix}\right)\right\}$ (*3 marks)*