****

**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**14-16 AHMADU BELLO WAY, VICTORIA ISLAND LAGOS**

**SEPTEMBER/OCTOBER 2015 EXAMINATION**

**SCHOOL OF SCIENCE AND TECHNOLOGY**

**COURSE CODE: PHY 309**

**COURSE TITLE: QUANTUM MECHANICS I**

Time: 2hrs

**Instructions:** Answer any five questions

1. (a) Check if the set $\left\{i,2i, j\right\}$ is linearly independent. (b) Show that the set $\left\{\left(\begin{matrix}1\\0\\1\end{matrix}\right),\left(\begin{matrix}1\\1\\0\end{matrix}\right),\left(\begin{matrix}1\\2\\1\end{matrix}\right)\right\}$is a linearly independent.

2. Find the inner product of the following vectors:

 (a) $\left(\begin{matrix}i\\-2\\2\end{matrix}\right) and \left(\begin{matrix}2\\-1\\3\end{matrix}\right)$ (b) ix2+2 and 2x - 3i, 0 $\leq $ x $\leq $ 2.

3. Find the norm of the followings (a) $\left(\begin{matrix}2i\\-1\\3\end{matrix}\right)$(b) ix2 + 2, 0 $\leq $ x $\leq $ 1 (c) normalize each vector in the set $\left\{\left(\begin{matrix}1\\2\\3\end{matrix}\right),\left(\begin{matrix}-2\\0\\4\end{matrix}\right),\left(\begin{matrix}1\\2\\1\end{matrix}\right)\right\}$.

4. (a) Write the function h(*x*) = $e^{2x}\sin(x)$ as a sum of odd and even functions. (b) Show that sin*mx* and sin *nx* are orthogonal, m$\ne n$ (c) If the matrix $\left[\begin{matrix}y&i\\-i&2\end{matrix}\right]$ is Hermitian, find the value of *y*.

5. (a) Given the matrix $\left[\begin{matrix}3&-2\\1&2\end{matrix}\right]$, find the corresponding eigenvectors and eigenvalues. (b) Find the expectation value of a matrix operator, $\left[\begin{matrix}1&2&-1\\2&-1&1\\1&3&2\end{matrix}\right]$ in state $\left(\begin{matrix}2i\\1\\-1\end{matrix}\right)$. (c) Calculate $\left[\hat{x}, \hat{p}\right]$

6. (a) Find the maximum kinetic energy with which an electron is emitted from a photometal of work function 3.2 *x*10-39 J when a radiation of energy *E* = 3.313 *x*10-39 J falls on it, given that the work function is 3.2 *x*10-39 J. (b) What value does Rayleigh-jeans formula predict for the radiation f frequency 6*x*1013Hz emitted by a blackbody per unit time, per unit area at 2500K. Compare ths value with that predicted by Planck.

7. (a) By solving the time-dependent Schroedinger equation for a free particle (V = 0), find the condition imposed on the angular frequency and the wavenumber. $-\frac{ℏ^{2}∂^{2}}{2m∂x^{2}}Ψ\left(x,t\right)=ih\frac{∂}{∂t}Ψ\left(x,t\right)$ (b) By applying the method of separation of variables, solve the differential equation $\left(\frac{∂^{2}}{∂x^{2}}+\frac{∂^{2}}{∂y^{2}}+\frac{∂^{2}}{∂z^{2}}\right)ϕ=0$