PH103 (Physics-I) **Tutorial-X (November 22, 2018)**

[Quantum Mechanics]

1. Consider the infinite potential box in 3-d (as discussed and solved in class) given by:

$$V(x,y,z) = \begin{cases} 0, & \text{if } 0 \le x \le a;\ 0 \le y \le a;\ 0 \le z \le a \\ \infty, & \text{otherwise} \end{cases}$$

Obtain the following:
(a) Energy of the 5^{th} excited state.
(b) Degeneracy of the 5^{th} excited state.
(c) Energy of the 7^{th} excited state.
(d) Energy difference between the the 7^{th} excited state and the 6^{th} excited state.

2. As shown in class, use the method of separation of variables to convert the Schrödinger equation for the Hydrogen atom into three separate differential equations in r, θ and ϕ coordinates, respectively (**Solved in class; please demonstrate the solution to this problem to your tutor**).

3. Obtain the following commutators:
(a) $[a, a^\dagger]$, (b) $[N, a]$, (c) $[N, a^\dagger]$, where N, a and $a^\dagger$ are the number operator ($N = a^\dagger a$), the annihilation operator and the creation operator, respectively (as discussed in the class).