Jashore University of Science and Technology
Department of Physics
Bachelor of Science with Honours in Physics
First semester of Third year

Course no.: PHY 3103 **Course title: Quantum Mechanics I**
Assignment no.: 01 **Date: May 02, 2022**

Last date of submission: May 12, 2022

1. Let $\hat{\mathbf{L}}$ be a quantum-mechanical angular momentum operator. Evaluate $[[\hat{L}_x, \hat{L}_y], [\hat{L}_y, \hat{L}_z]]$. [3]

2. Derive the expressions to write angular momentum operators $\hat{L}_x$, $\hat{L}_y$, $\hat{L}_z$ and $\hat{\mathbf{L}}^2$ in spherical coordinates. [5]

3. If $\hat{L}_z Y_{lm} = \hbar m Y_{lm}$, where Y_{lm} is the spherical harmonics show that $m \in \mathbb{Z}$. [4]

4. For a hydrogen atom write down the Schrödinger equation in terms of the relative coordinate $\mathbf{r}$ and center of mass coordinate $\mathbf{R}$. Hence find the wave functions that describe (a) the motion of center of mass as a particle of mass M and (b) the ground state of the hydrogen atom. [8]