ELIZADE UNIVERSITY
ILARA-MOKIN
ONDO STATE

FACULTY: Basic and Applied Sciences
DEPARTMENT: Physical and Chemical Sciences
SECOND SEMESTER EXAMINATIONS
2017/2018 ACADEMIC SESSION

COURSE CODE: PHY 402
COURSE TITLE: QUANTUM MECHANICS II
DURATION: 3 HOURS

HOD's SIGNATURE

TOTAL MARKS:

Matriculation Number: _____

INSTRUCTIONS:

1. Write your matriculation number in the space provided above and also on the cover page of the exam booklet.
2. This question paper consists of 2 pages with printing on both sides.
3. Answer all questions in the examination booklet provided.
4. More marks are awarded for problem solving method used to solving problems than for the final numerical answer.
5. Box your final answers.
6. **Attempt 2 of the 3 questions in each of the sections, making it a total of 4 out of 6 questions.**

SECTION A

1. (a) Consider the second and third quantum numbers, the azimuthal (l) and magnetic (ml) quantum numbers, respectively.
   (i) Give a short description of the physical meaning of each of these two quantum numbers
   (ii) Give the range of allowed values for these two quantum numbers

   (b) Each row in the table represents a set of orbitals (e.g. the 2p orbitals). Complete the table

n	l	m_l	Orbital designation	Number of orbitals
1				1
3		-1, 0, 1		3
4	3			7
5			5p	

2. Given that the 1s wavefunction for the ground state of hydrogen is given by $R_{1s} = Ae^{-r/a_B}$. Determine:
   (a) The constant A
   (b) The expectation value of the potential energy.

3. (a). Explain the term "degeneracy".
   (b). Consider a particle of mass M in a two-dimensional, rigid rectangular box with sides a and b. Using the method of separation of variables, find the allowed energies and wavefunction for this particle.

SECTION B

4. Consider a particle in the two-dimensional, symmetrical, infinite potential well. The particle is subject to the perturbation W = Cxy, where C is a constant.
   (a). Compute the first order correction to the Eigen-energies.
   (b). The wavefunction of the first excited level.

5. A given wavefunction is $\Psi = N\sin\theta\cos\phi$
   (a). Find the normalization constant N.
   (b). What is the mean value of L^2 and Lz for this state?

6. Consider a one-dimensional harmonic oscillator with $\widehat{H} = \frac{-h^2}{2m}\frac{d^2}{dx^2} + \frac{1}{2}mw^2x^2$. For the one-parameter family of wavefunctions, $\varphi_\alpha(x) = e^{-\alpha x^2} (\alpha > 0)$. Compute:
   (a). The wavefunction that minimizes $\langle \widehat{H} \rangle$.
   (b). The value of $\langle \widehat{H} \rangle min$