NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES

ENGINEERING PHYSICS PROGRAM

IF411 – QUANTUM MECHANICS

I. GENERAL INFORMATION

CODE	:	IF411 Quantum Mechanics
SEMESTER	:	7
CREDITS	:	7
HOURS PER WEEK	:	9 (Theory–Practice)
PREREQUISITES	:	CF-371 Theoretical Mechanics I CF-391 Mathematical Methods for Physics II
CONDITION	:	Compulsory

II. COURSE DESCRIPTION

The course prepares students in understanding and applying the concepts of Quantum Mechanics for solving Engineering Physics problems related to Materials Sciences, Solid State Physics I, Nuclear Physics and Spectrometry courses.

III. COURSE OUTCOMES

1. Know and understand the phenomena of Modern Physics, explained by classical Physics and analyze their limitations.
2. Understand the fundamentals of Quantum Mechanics and its application to phenomena not explained by classical Physics.
3. Understand and use the Shrodinger's equation for solving problems.
4. Study the harmonic oscillator, the hydrogen atom and perturbation theory.

IV. LEARNING UNITS

1. **INTRODUCTION AND MODERN PHYSICS / 06 hours**

   Presentation / Classical Vision and Quantum Vision / Modern Physics: Radiation of a Black Body / Photoelectric Effect.

2. **CONTINUATION OF MODERN PHYSICS / 06 hours**

   Compton Effect / Franck-Hertz experiment / De Broglie Hypothesis: wavelike behavior of matter (electron diffraction) / Bohr model.

3. **CONTINUATION OF MODERN PHYSICS AND PROBABILITY CONCEPT / 06 hours**

   Duality and Principle of Heisenberg Uncertainty: Double Slit Experiment / Basic concepts of probability and probability density / State function and probability density.

4. **QUANTUM MECHANICS AS THEORY OF SCHRÖDINGER EQUATION MEASUREMENTS / 06 hours**

   Schrödinger´s equation under the time / Quantum Mechanics and Measurements Theory: BORN interpretation / Dynamic variables and operators / Expected values / Wave Packet / Conservation of probability.

5. **QUANTUM MECHANICS AS THEORY OF STATIONARY STATES MEASUREMENTS / 06 hours**

   Ehrenfest´s theorem / Time independent Schrödinger´s equation / Stationary states / Energy quantization / Space momentums / Relationship between the spaces of position and momentum variables.

6. **MOMENTUM SPACE AND UNCERTAINTY PRINCIPLE OF HEISENBERG / 06 hours**

   Action operators in momentum space / Ehrenfest´s theorem in the space of momentums / Generalized expression of Uncertainty Heisenberg Principle: commuting observables.

7. **SCHRÖDINGER EQUATION SOLUTION FOR POTENTIAL PIECEWISE CONSTANTS / 06 hours**

   Solution of the Ehrenfest´s theorem for one-dimensional potential piecewise constant: step potential, barrier, infinite well, finite well (problem of quantization) / Delta potential type.

8. **HARMONIC OSCILLATOR / 06 hours**

   Periodic potential / Harmonic oscillator: Solution via the differential equation (problem of quantization) and algebraic solution (using the up and down operators).

9. **DIRAC ALGEBRA / HYDROGEN ATOM / 06 hours**

   Dirac algebra: bra-ket notation / The hydrogen atom: Hamiltonian in spherical variables Hamiltonian in terms of projection operator and the square of the angular momentum operator / Radial solution of the differential equation of Schrodinger / Quantization problem / Getting own energies / Graphs of the probability density / Applications.

10. **HYDROGEN ATOM / 06 hours**

    The angular solution of the differential equation de Schrodinger / Spherical Harmonics / Concepts of quantum numbers / Rigid rotator / Calculation of the magnetic moment of hydrogen atom.

11. **STERN-GERLACH EXPERIMENT / 06 hours**

    Stern-Gerlach experiment / Total angular momentum / Commutation Relations / Relationship between the magnetic and angular moments / Pauli Matrices / Precession of the intrinsic magnetic moment of the electron.

12. **COMPOSITION OF MOMENTUM ANGLES / 06 hours**

    Continuation of the composition of angular momenta / Clebsch-Gordan coefficients / Normal and anomalous Zeeman Effect.

13. **TIME INDEPENDENT DISTURBANCES THEORY / 06 hours**

    Theory of perturbations independent of time: Non-degenerate and degenerate cases. Stark effect.

14. **TIME DEPENDENT DISTURBANCES THEORY / 06 hours**

    Disturbances dependent time / Periodic perturbation / Absorption and emission spectra / Fermi's golden rule.

VI. METHODOLOGY

The course is developed in theory and practical sessions. In the theory sessions, the instructor presents the concepts, theorems and applications. In the practical sessions, various problems are solved and their solutions are analyzed. In all sessions the active participation of the student is encouraged.

VII. EVALUATION FORMULA

The Average Grade PF is calculated as follow:

PF = (EP + EF + PP) / 3

EP: Mid-Term Exam
EF: Final Exam
PP: Average of practices

VIII. BIBLIOGRAPHY

1. **FERNÁNDEZ DE CÓRDOVA**
   Fundamentals of Quantum Physics for Engineering. Editorial Universidad Politécnica de Valencia, 2004.
2. **BRANSDEN, B.H.**
   Introduction to Quantum Mechanics. Second Edition.
3. **EISBERG, R.**
   Quantum Physics of Atom, Volume 1, Second Edition, University of California, Santa Barbara.