Semester	IV
Course	Major II
Paper Code	C2PH230421T
Paper Title	QM I (Foundations and Formulation) & Electronics II (Digital)
No. of Credits	2+2
Theory / Practical / Composite	Theory
Minimum No. of preparatory hours per week a student has to devote	Four hours
Number of Modules	2
Syllabus	Module A: QM I (Foundations and Formulation) Studying finite dimensional quantum systems (two / three level) without degeneracy and time evolution – basic vector space formulation. [4 lectures] Quantum measurements - Deterministic vs. probabilistic viewpoints - probability interpretation: Normalized wave functions as probability amplitude density. Quantum description of a particle: Particles as localized wave packets. Phase and group velocity. Spread of a Gaussian wave-packet for a free particle in one dimension. Fourier transform and momentum space wavefunction. [4 lectures] Position, momentum and energy (Hamiltonian) operators; Hermiticity; Operators for an arbitrary dynamical variable. Eigenvalues as the measurement outcomes; Probability of outcomes - Born rule. State resulting from a measurement. Expectation values. Simultaneous measurements: Compatible and incompatible observables. Relationship with commutativity. Heisenberg uncertainty principle: Position-momentum uncertainty.

	[6 lectures] Time evolution: Schrodinger equation. Equation of continuity for probability (in 1-Dimension), probability current. Stationary states. Time independent Schrodinger equation as an eigenvalue equation. [3 lectures] General discussion of bound states in an arbitrary potential: continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential and potential barrier. [7 lectures] Module B: Electronics II (Digital) Difference between Analog and Digital Circuits. Binary Numbers, Negative Numbers, BCD, Octal and Hexadecimal numbers. Conversions. AND, OR and NOT Gates (realization using Diodes and Transistors). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and applications. [4 lectures] Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. [4 lectures] Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition and Subtraction. Half and Full Adders. Half & Full Subtractors. [4 lectures]

	Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. [12 lectures]
Learning Outcomes	**Module A**: 1. This course will expose a student to the formulation of quantum mechanics 2. The exposure to the formulation of a theory with a completely different philosophy from classical mechanics will enable a student to appreciate of the various diverse ways in which physical reality can be perceived. 3. This course will underline the relevance of learning the language of linear vector space as the mathematical tool to frame the theory of quantum mechanics. 4. In this course, the students will be exposed to the application of quantum mechanics for some simple one-dimensional examples. **Module B**: 1. Understanding basic digital number systems and its conversions. 2. Learning Boolean expressions and the minimization of digital circuits. 3. Understanding the difference between combinational and sequential circuits and studying their applications. 4. Understanding basic digital circuits such as counters and registers.

<table>
<tr><td>Reading/Reference Lists</td><td colspan="2">Module A:

1. Feynman Lectures Vol.3, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
2. Introduction to Quantum Mechanics, David J. Griffiths, 2005, Pearson Education.
3. Basic Quantum Mechanics, A.K.Ghatak , 2004, Macmillan.
4. Quantum Mechanics by Liboff, Pearson Education.
5. Quantum Mechanics by Bransden & Joachain, Pearson Education.
6. Quantum Mechanics, A Textbook for Undergraduates, M. C. Jain, Prentice-Hall of India Private Limited.
7. Quantum Physics, Berkeley Physics Course, Vol.4.
8. Quantum Mechanics, S. N. Ghoshal

9. Quantum Mechanics, Volume I, C. Cohen-Tannoudji, B. Diu and F. Laloe, Wiley VCH.

10. Quantum Mechanics A Paradigms Approach, David H. McIntyre, CUP

Module B:

1. Digital Electronics: Principles, Devices and Applications by Anil K. Maini (John Wiley & Sons).

2. The Art of Electronics by P. Horowitz and W. Hill (Cambridge University Press).

3. Basic Electronics for Scientists and Engineers by Dennis L. Eggleston (Cambridge University Press).

4. Digital Logic and Computer Design by M. Morris Mano. (Prentice Hall).

5. Digital Principles and Applications by Malvino, Leach and Saha. (Tata McGraw Hill).

6. Electrical Technology Volume 4 by B. L. Theraja and A. K. Theraja (S. Chand & Co).</td></tr>
<tr><td>Evaluation</td><td>Theory CIA: 30 (2 x 10 + 5/assgn.+ 5/attn.) Semester Exam:70</td><td>Practical (if applicable) CA: Semester Exam:</td></tr>
<tr><td>Paper Structure for</td><td colspan="2">For each module of 35 Marks:</td></tr>
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Theory Semester Exam	15 Marks from 3 marks questions (5 out of 7) 20 Marks from 10 marks questions (2 out of 3)