Semester: II						
QUANTUM PHYSICS FOR ENGINEERS **Category: Applied Science Course** **Stream: Computer Science (Common to AI, BT, CS, CY, CD & IS Programs)** **(Theory and Practice)**						
Course Code	:	PHY221CI		**CIE**	:	100 Marks
Credits: L:T:P	:	3:0:1		**SEE**	:	100 Marks
Total Hours	:	42 L+30P		**SEE Duration**	:	3 Hours

Unit-I	08 Hrs
Quantum Mechanics: de Broglie Hypothesis and Matter Waves, Phase Velocity and Group Velocity, Heisenberg's Uncertainty Principle, and its application. **Wave Mechanics:** Wave Function, Time independent Schrodinger wave equation, Expectation value, Eigen functions and Eigen Values, Motion of a particle in a one-dimensional potential well of infinite depth, Numerical problems.	
Unit – II	**08 Hrs**
Principle of Quantum Computation **Matric Mechanics:** Wave Function in Ket Notation: Matrix form of wave function, Identity operator, determination of I | 0 > and I | 1 > , Pauli matrices and its operation on 0 and 1 states, mention of conjugate and transpose, unitary matrix U, Examples: Row and Column Matrices and their multiplication (Inner Product), Probability, Orthogonality. **Principles of Quantum information and Quantum Computing:** Introduction to Quantum Computing, Moore's law and its end. Single particle quantum interference, classical and quantum information comparison. Difference between classical and quantum computing, quantum superposition and the concept of qubit. **Properties of qubit:** Mathematical representation, summation of probabilities, representation of qubit by Bloch sphere. **Quantum Gates:** Single qubit gates: Quantum not gate, Pauli – Z gate, Hadamard gate, Pauli matrices, Phase gate (S gate), T gate. Multiple qubit gates: controlled gate, CNOT gate (discuss for 4 different input states)	
Unit –III	**09 Hrs**
Lasers and Optical Fibers **Lasers**: Characteristics of LASER, Interaction of radiation with matter, requisites of a Laser system. Construction and working of semiconductor laser. Application of laser: Bar Code scanner, Laser Printer, Laser Cooling, Numerical problems. **Optical Fibers:** Propagation mechanism, Numerical aperture derivation, Modes of propagation. Attenuation in fiber, Discussion of block diagram of Point-to-Point communication, Optical fiber sensor. Numerical problems.	
Unit –IV	**08 Hrs**
Electrical Conductivity in Solids: Postulates of Classical free electron theory (CFET), Concept of Phonon, Matheissen's rule. Quantum free electron theory (QFET), Density of states in three dimensions (qualitative) and Fermi factor. Fermi energy: variation of Fermi factor with temperature. **Band theory of solids** (qualitative approach), electron concentration in metals at 0K. Intrinsic semiconductors: electronic concentration in conduction band and hole concentration (qualitative), Fermi level in intrinsic semiconductors, Extrinsic semiconductors: Variation of carrier concentration with temperature and Fermi energy with doping, Hall effect for metals and semiconductors, Numerical problems.	
Unit –V	**09 Hrs**
Super conductivity: Introduction to superconductors, temperature dependence of resistivity, Meissner effect, critical current, types of superconductors, temperature dependence of critical field. **BCS theory (qualitative)**: Quantum tunneling, High temperature superconductivity, Josephson junction, DC and AC SQUIDs (qualitative), Applications in quantum computing, Numerical problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of quantum mechanics applicable to computer science engineering, basics of electrical and superconducting materials.
CO2	Apply the knowledge of quantum mechanics in lasers, semiconductors and super conductor devices for engineering applications.
CO3	Develop analytical thinking by solving numerical.
CO4	Design & develop simulating models and validate with real time experimentation.

Reference Books	
1	Physics for Engineers, M R Srinivasan, New Age International Publishers, 2011, ISBN: 978-81-224-2603-8.
2	A Textbook of Engineering Physics, M. N. Avadhanulu and P G Kshirsagar, 2019, S. Chand publications, ISBN: 978-93-528-3399-3.
3	Physics for Degree students, C.L. Arora and Dr. P. S. Hemne, S Chand, revised 2010, ISBN: 9788121933506.
4	Engineering Physics, R K Gaur and S L Gupta, Dhanpat Rai Publications, 2011, ISBN: 9788189928223.

Laboratory Experiments (CS Stream)	
1	Wavelength of laser by diffraction.
2	Numerical aperture of an optical fiber.
3	Transistor characteristics.
4	Band gap of thermistor.
5	Hall coefficient experiment.
6	Black box experiment.
7	Four probe experiment.
8	Fermi Energy.
9	Charging & discharging of a capacitor.
10	Photo Diode.
11	Exp Eyes experiment: LCR
12	Exp Eyes experiment: Wavelength of LED and I- V characteristics of Zener diode.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY WITH LAB)		
#	**COMPONENTS**	**MARKS**
1	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. **THE AVERAGE OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**10**
2	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**. **FINAL TEST MARKS WILL BE REDUCED TO 30 MARKS.**	**30**
3	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**) ADDING UPTO 30 MARKS**.	**30**
4	**LAB:** Conduction of laboratory exercises, lab report, observation and analysis **(30 Marks)**, lab test **(10 Marks)** and Innovative Experiment/ Concept Design and Implementation (**10 Marks)** adding up to 50 Marks. **THE FINAL MARKS WILL BE REDUCED TO 30 MARKS**	**30**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	10
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	14
3 & 4	Unit 2 : Question 3 or 4	14
5 & 6	Unit 3 : Question 5 or 6	14
7 & 8	Unit 4 : Question 7 or 8	14
9 & 10	Unit 5 : Question 9 or 10	14
11	Lab Component (Compulsory)	20
	MAXIMUM MARKS FOR THE SEE THEORY	**100**