INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
भारतीय प्रौद्योगिकी संस्थान तिरुपति
Yerpedu-Venkatagiri Road, Yerpedu Post, Chittoor District, Andhra Pradesh - 517 619

1.	Title of the course	Advanced Quantum Computing
2.	Course number	PH613L
3.	Structure of credits (L-T-P-C)	3-0-0-3
4.	New course/modification to	New
5.	To be offered by	Physics
6.	Prerequisite	CoT
7.	**Course Objective(s):** To discuss advanced concepts in quantum transforms and quantum algorithms. To introduce quantum gates and qubit schemes. To explore the advancement of different quantum computing platforms based on superconducting qubits and integrated photonics.	
8.	**Course Content:** Quantum gates and qubit schemes: qubit control, single- and two-qubit gates, qubit readout, real-time quantum feedback; Quantum phase estimation: single qubit interference, phase kickback, controlled-unitaries; Quantum Transforms: Hadamard transform, quantum Fourier transform; Quantum state preparation, circuit design and readout: role of state preparation, Jordan-Wigner mapping, Trotterization, quantum circuit design; Quantum algorithms: variants of phase estimation algorithm, many-body theory with quantum phase estimation algorithm, variational quantum algorithms; Variational quantum eigensolver (VQE): variational principle, state preparation, ansatz, quantum circuit design, inputs to the algorithm, expectation value evaluation, optimizer, feedback loop, calculating hydrogen molecule's ground state energy using the algorithm, Harrow-Hassidim-Lloyd (HHL) algorithm, variational quantum linear solver algorithms; Quantum computing platforms: superconducting quantum computing, photonic quantum computation, HBT (Hanbury-Brown and Twiss) experiments, KLM (Knill Laflamme Milburn) scheme, continuous variable quantum computing, integrated photonics for quantum computing, quantum computing practical realization, recipes required for realizing quantum computer.	
9.	**Textbook(s):** 1. Nielsen M A, and Chuang I L, *Quantum Computation and Quantum Information*, Cambridge University Press (2010). 2. Yanofsky N S and Mannucci M A, *Quantum Computing for Computer Scientists*, Cambridge University Press (2008).	
10.	**Reference(s):** 1. Foot C J, *Atomic Physics,* Oxford University Press (2004). 2. Grynberg G, Aspect A, and Fabre C, *Introduction to Quantum Optics from the Semi-classical Approach to Quantized Light,* Cambridge University Press (2010). 3. Pearsall T P, *Quantum Photonics*, Springer (2020). 4. Chen G, Church D A, Englert B-G, Henkel C, Rohwedder B, Scully M O, and Zubairy M S, *Quantum Computing Devices: Principles, Designs and Analysis*, Chapman & Hall (2019).	