QUANTUM TECHNOLOGY AND QUANTUM PHENOMENA IN MACROSCOPIC SYSTEMS

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TYPE OF COURSE : New | Elective | UG/PG
COURSE DURATION : 12 Weeks (24 Jan' 22 - 15 Apr' 22)
EXAM DATE : April 24, 2022

PRE-REQUISITES : An elementary course on Quantum Mechanics

INTENDED AUDIENCE : Students from B.Tech. Engineering Physics, M.Sc. Physics and B.Tech. Electrical Engineering. Also, Ph.D. students working in the area of Condensed Matter Physics and Quantum Optics.

INDUSTRIES APPLICABLE TO : Nil

COURSE OUTLINE :
In recent times, owing to the rapid advancement in technology a variety of solid-state nano-systems have been realized. One needs quantum optics to describe these systems. It is understood that the next phase of technology revolution needs to use quantum mechanics. This course will enable the students to understand the fundamentals behind these upcoming quantum technologies. The course will prepare and motivate them to take a research carrier in this highly promising modern area of inter-disciplinary research.

ABOUT INSTRUCTOR :
Prof. Amarendra Kumar Sarma is a Professor of Physics, in the department of Physics, IIT Guwahati. He works on a multitude of frontier areas, covering both fundamental and applied aspects of theoretical quantum and nonlinear optics. His current focus of research is Cavity Quantum Optomechanics and quantum correlations. He has successfully guided 8 Ph.D. students so far and currently another 5 students are working in his group towards their Ph.Ds. Prof. Sarma has published many high quality research articles in prestigious physics journals.

COURSE PLAN :

Week 1: Introduction; Review of classical and quantum harmonic oscillator

Week 2: Basic idea of quantization of electromagnetic fields; Density matrices and other related concepts

Week 3: Coherent and squeezed states. Wigner density

Week 4: Two-level atomic systems; Bloch vectors, Rabi oscillations

Week 5: Cooper pair box and its approximation as a two-level system; Microwave transmission line

Week 6: Quantization of transmission line and Jaynes-Cummings model

Week 7: Application of Jaynes-Cummings model in Circuit Quantum Electrodynamics; Linblad mater equation and its applications

Week 8: Circuit Quantum Electrodynamics (QED) and its technological applications; Discussion of Assignment 1.

Week 9: Cavity Quantum Optomechanics: Classical perspectives

Week 10: Linearized Quantum Optomechanics; Discussion of Assignment 2.

Week 11: Optomechanical cooling, normal-mode splitting. Squeezing

Week 12: Discussion of Assignment 3; Current research trends in the area of circuit QED and Quantum Optomechanics.