



**Prof. Dr. Muhammad  
Sabieh Anwar  
Syed Babar Ali School of  
Science and Engineering  
(LUMS), Pakistan**

This series of eight lectures will build up from the very basics of quantum physics, using the photon as an archetypal example of the working unit for quantum computing and quantum information processing (QIP) routines. Very little prior background of quantum information and quantum computing is expected. Starting from the fundamental mathematical tools and descriptions that are employed in QIP, revolving around the basic principles of quantum theory, the speaker will go on to discuss various implementations, focusing on optical or photonic devices. There will be a special focus on single photon based implementations. Other important facets of photonic QIP such as photon sources, measurement, quantum error correction and fault tolerance will also be discussed.

**Lecture Breakdown and syllabus:**

- 1: Quantum states, the qubit and the Bloch sphere, density matrices, the measurement problem, unitary operations and rotations on the Bloch sphere.
- 2: Quantum no-cloning, entanglement, Bell's inequalities, quantum state tomography, quantum communication protocols.
- 3: Interferometry with photons, interaction-free measurement, quantum imaging, Quantum Zeno effect.
- 4: Single photon experiments in the laboratory using heralded single photon sources (a practical outlook).
- 5 - 6: Measurement based quantum computing, the KLM protocol, comparison with finite Boson sampling.
- 7: Quantum error correction, composite rotations.
- 8: Future outlook and technological challenges, comparing with alternative quantum devices: SQUIDS, spins, ions and neutral atoms.

**Date and Location:**

22-26 July 2024

TÜBİTAK Gebze Yerleşkesi,

Temel Bilimler Araştırma Enstitüsü

Barış Mah. Dr. Zeki Acar Cad.

No:1 P.K. 21, 41470 Gebze / Kocaeli

**Application Deadline:**

**21 July 2024**

**Application Webpage:**

<https://tbae.tubitak.gov.tr/tr/haber/photonic-quantum-information-processing-pqip24>