

## **Tutorial S10 Outline:**

- I. What is Quantum Information?**
- II. Introduction**
  - A. 20<sup>th</sup> Century in Review**
  - B. History of Quantum Information**
- III. The Quantum Primer**
  - A. Quantum Nature of Matter: Wave vs Particle Properties**
  - B. Superposition**
  - C. Quantum Measurement**
  - D. Quantum Interference**
  - E. Quantum Entanglement**
- IV. Classical Bits vs. Quantum Bits**
  - A. Scaling of Quantum Information**
  - B. Quantum Entanglement and Einstein-Podolsky-Rosen Paradox**
  - C. Analog vs. Quantum Computing**
  - D. No Cloning Theorem and its Consequence**
  - E. Possible Applications of Quantum Information**
- V. Quantum Communication - 100% physically secure**
  - A. Quantum cryptographic key exchange: *eg.* BB84 Protocol**
  - B. Quantum Teleportation**
  - C. Technology from Single Photon Sources and Detectors**
  - D. State of the Art in Quantum Communication**
  - E. Schematic of a Quantum Communication System**
    - i. Error Reconciliation**
    - ii. Privacy Amplification**
    - iii. Physical Layer: Hardware Issues**
    - iv. Protocols Layer: Software Issues and Applications**
- VI. Quantum Computing**
  - A. Status of Quantum Algorithms including Shor's Algorithm**
  - B. Universal Quantum Logic**
    - i. Bell States and Teleportation**
    - ii. Quantum Error Correction**
    - iii. Shor's Algorithm as a Quantum Logic Circuit**
  - C. Experimental Requirements and Proposed Schemes**
    - i. The DiVincenzo Criteria for Quantum Computing**
    - ii. Beyond the Divincenzo Criteria**
  - D. Overview of Proposed Implementation Schemes and their Pros and Cons**
- VII. Quantum Information Outlook and Impact**
- VIII. Conclusions**