QUANTUM COMPUTATION AND QUANTUM INFORMATION

Unit 1: Overview and introductory material – physics of information, quantum information, quantum complexity, quantum parallelism, quantum hardware, axioms of quantum mechanics, the qubit, the density matrix, Schmidt decomposition, ambiguity of the ensemble interpretation

Unit 2: Quantum measurement – orthogonal measurement, superoperators, Kraus representation theorem, three quantum channels, master equation; quantum entanglement – nonseparability of EPR pairs, the Bell inequality, using entanglement, quantum cryptography, mixed-state entanglement

Unit 3: Quantum complexity and Quantum algorithms – classical circuits, quantum circuits, quantum algorithms, quantum database search, the grover algorithm, generalized search and structured search, distributed database search, periodicity, factoring, phase estimation, discrete log, simulation of quantum systems

Unit 4: Quantum error-correcting codes – criteria for quantum error correction, general properties of QECC, probability of failure, classical linear codes, Calderbank-Shor-Steane codes, 7-qubit code, constraints on code parameters, stabilizer codes, 5-qubit code, quantum secret sharing, codes over GF(4), good quantum codes, codes that correct multiple errors, quantum channel capacity; entanglement measures; quantum channel capacity

Unit 5: Fault tolerant quantum computation; topological quantum codes - quantum computing with anyons, flux-charge composites, spin and statistics, combining anyons, unitary representations of the braid group, topological degeneracy, toric code revisited, nonabelian Aharonov-Bohm effect, quantum computing with nonabelian fluxons, anyon models generalized, simulating anyons with a quantum circuit, Fibonacci anyons, quantum dimensions, pentagon and hexagon equations

Books and References:

1. Nielsen, Michael A. and Isaac L. Chuang. *Quantum Computation and Quantum Information.* Cambridge, UK: Cambridge University Press, September 2000.
2. Peres, Asher. *Quantum Theory: Concepts and Methods.* New York, NY: Springer, 1993.

Mrs. Shaela for Senate approval