NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B.Tech. Electronics & Communication Engineering
Course Code:	3EC604ME24
Course Title:	Quantum Computing
Course Type:	Departmental Elective
Year of Introduction:	2024-25

L	T	Practical component				C
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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to

1. comprehend the fundamentals of quantum computing. BL-2
2. simulate the quantum circuits using qiskit simulator. BL-3
3. develop the digital circuits using reversible logic. BL-4
4. evaluate the performance of single-qubit quantum circuits. BL-5

Unit No.	Contents	Teaching hours (Total 45)
I	**Introduction and Overview**: Global perspectives, history of quantum computation and quantum information	03
II	**Quantum Computation:** Quantum bits, multiple qubits, single qubit gates, multiple qubit gates, measurements, quantum circuits, Qubit copying circuit, bell states, quantum teleportation	08
III	**Quantum Algorithms:** Classical computations on a quantum computer, quantum parallelism, Deutsch's algorithm, Deutsch–Jozsa algorithm	08
IV	**Quantum Circuits:** Single qubit operations, Universal quantum gates, Two-level unitary gates, CNOT gate, discrete set of universal operations, approximating arbitrary unitary gates, quantum computational complexity, quantum circuit simulation and synthesis	10
V	**Quantum Semiconductor:** Quantum well structures, quantum wire, quantum dot, super lattices, reversible technology, quantum dot cellular automata (QCA) technology	08
VI	**Quantum Algorithms with Python and Qiskit:** Introduction, flow, Physical realisations of qubits, Introduction to IBM Q and Qiskit	08

Self-Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggest List of Tutorials (not restricted to the following):
(Only for information)

Sr. No.	Title of tutorial	Hours
1.	Linear algebra problem solving -1	01
2.	Linear algebra problem solving -2	01
3.	Study of an application of quantum computing in information theory	01
4.	Study of an application of quantum computing in photonics	01
5.	Study of an application of quantum computing in signal processing	01
6.	Design, implementation and verification of quantum gates	02
7.	Implementation of quantum algorithm-I	02
8.	Implementation of quantum algorithm-II	02
9.	Design of reversible gates	02
10.	Design of reversible combinational circuits	02

Suggested Readings:

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press
2. David J. Griffiths, Introduction to Quantum Mechanics, Prentice Hall
3. Hassi Norlén, Quantum Computing in Practice with Qiskit, Packt publishing Ltd,
4. J. L. Weaver and F. J. Harkins, Qiskit Pocket Guide, O'Reily Media,