**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE – PILANI, HYDERABAD CAMPUS**

**FIRST SEMESTER 2021 - 2022**

**COURSE HANDOUT**

Date: 20-08-2021

In addition to part I (General handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

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| **Course Number** | **:** | **BITS F386** |
| **Course Title** | **:** | **Introduction to Quantum Information and Computation** |
| **Instructor-in-Charge** | **:** | **Dr. K. V. S. Shiv Chaitanya** |

**Scope & Objective of the course:** This course is an elementary introduction to a new andfrontier multidisciplinary field of quantum computation and quantum information. This subject is of common interest to students of physics, computer science, mathematics and engineering. It will introduce the concept of information in a physical sense and develop how quantum physics becomes important in its realization. The course will introduce the basic ideas of quantum mechanics relevant to the presentation of information in terms of qubits and how this information can be processed (computed) and transmitted.

**Text Book:** Quantum Computation and Quantum Information", M A Nielsen and I L Chuang, CUP 2002 (Special Indian Edition: Foundation Books, Delhi).

**Reference Books :**

1. Principles of Quantum Computation and Information", Vol 1, Benenti, Casati and Strini, World Scientific
2. Online lecture notes by Mark Oskin:  [http://homes.cs.washington.edu/~oskin/quantum](http://homes.cs.washington.edu/~oskin/quantum-notes.pdf)- [notes.p](http://homes.cs.washington.edu/~oskin/quantum-notes.pdf)df
3. Online lecture notes by John Preskill:

[http://www.theory.caltech.edu/people/preskill/ph229](http://www.theory.caltech.edu/people/preskill/ph229/)/

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| **Course Plan**: | | |  |  |  |  |  |  |  |  |  |  |
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| **Lecture** |  | **Learning** | **Topics to be covered** | | |  | **Chapter in the Text Book** |  |  |
| **Number** |  | | **Objectives** |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  | | | |  | |  |  |
| 1-3 |  |  | Introduction |  | Why we need quantum computation, In | | | | 1.1, 1.2, | |  |  |
|  |  |  |  |  | formation | is | physical, | Classical | 1.6, 3.1, 3.2 | |  |  |
|  |  |  |  |  | computation: |  | Circuit | model, |  |  |  |  |
|  |  |  |  |  | Complexity, Turing machines, classical, | | | |  |  |  |  |
|  |  |  |  |  | probabilistic deterministic and quantum, | | | |  |  |  |  |
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4-12

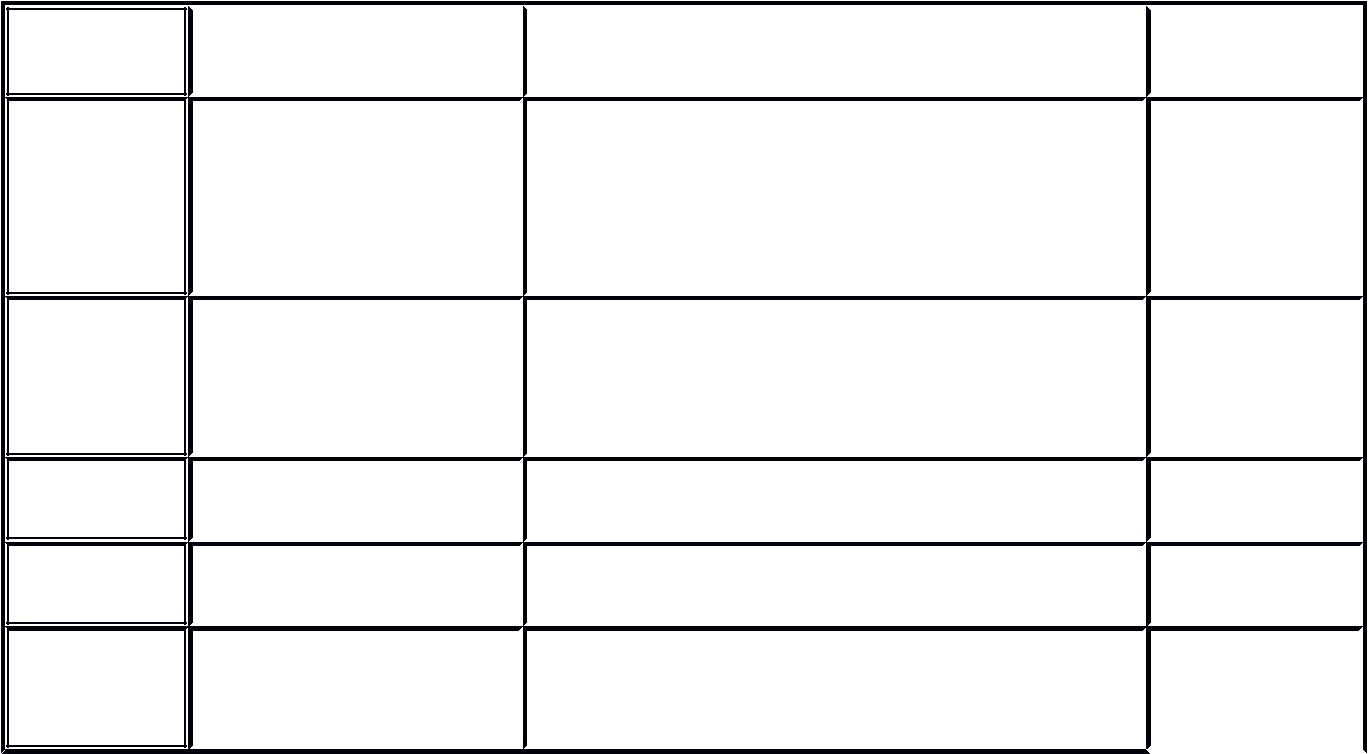
13-22

22-27

28-34

35-42

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|  |  |  | Energy and Information, | | | reversible | |  |  |  |  |
|  |  |  | computation |  |  |  |  |  |  |  |  |
| Basic |  |  |  | | | | | 1.3, 2.1, | |  |  |
| Concepts in |  | Quantum states: definition, Linear vector | | | | |  |  |
| Quantum | |  | spaces, Evolution of quantum states, | | | | | 2.2, | |  |  |
| Mechanics | |  | Composite systems, | | Superposition | | and |  |  |  |  |
|  |  |  | Entanglement | of | States, | Quantum | |  |  |  |  |
|  |  |  | Measurement, decoherence. Spin systems. | | | | |  |  |  |  |
|  | |  | Quantum Gates: single qubit, multiple | | | |  |  | Ch 4 |  |  |
| Quantum | |  |  |  |  |  |
| Computation | |  | qubit gates, Controlled gates, Universal | | | | |  |  |  |  |
|  |  |  | Gates, Measurement, Quantum algorithms, | | | | |  |  |  |  |
|  |  |  | quantum circuits. | |  |  |  |  |  |  |  |
|  | |  | Deutsch Algorithm, Shor Algorithm, | | | |  |  | Ch 5, Oskin |  |  |
| Examples of Quantum | |  |  |  |  |  |
| Algorithms | |  | Grover's Algorithm | |  |  |  |  | lecture notes |  |  |
|  |  |  |  |  |  | |  |  | Ch 5, 6 |  |  |
| More | detailed |  | Quantum | Fourier | Transform | | and |  |  |  |
| Examples | |  | applications, Quantum Search Algorithm | | | | |  |  |  |  |
|  | |  |  |  | |  | |  | Ch 12 |  |  |
| Quantum Information | |  | Quantum | information, | | Quantum | |  |  |  |
| Theory |  |  | cryptography, error-correction, coding, | | | | |  |  |  |  |
|  |  |  | complexity. |  |  |  |  |  |  |  |  |
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| **Evaluation Scheme:** | |  |  |  |  |
| **EC** | **Evaluation** | **Duration** | **Weightage** | **Date, Time** | **Nature of Component** |
| **No.** | **Component** |  | **(%)** |  |  |
| 1 | Midsem | 90 Min. | 35 | 23/10/2021 9.00 - 10.30AM | Open Book |
| 3 | Home |  | 35 |  |  |
|  | Assignment |  |  |  | Open Book |
| 4 | Comprehensive | 2 Hours | 30 | 27/12 AN | Open Book |

**Chamber Consultation Hour:** To be announced in the respective tutorials and lecture classes. **Notices:** Notices and solutions of tests & Final Comprehensive Examination will be displayedonly on **CMS**.

**Make-up Policy:** It is applicable to the following two cases and it is permissible on productionof evidential documents.

1. Debilitating illness.
2. Out of station with prior permission from the Institute.

**Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-Charge**

**BITS F386**