

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE – PILANI, HYDERABAD CAMPUS
FIRST SEMESTER 2020 - 2021
COURSE HANDOUT

Date: 17-08-2020

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

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 and frontier 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-notes.pdf>
3. Online lecture notes by John Preskill: <http://www.theory.caltech.edu/people/preskill/ph229/>

Course Plan:

Lecture Number	Learning Objectives	Topics to be covered	Reference Chapter/ Section
1-3	Introduction	Why we need quantum computation, Information is physical, Classical computation: Circuit model, Complexity, Turing machines, classical, probabilistic deterministic and quantum,	1.1, 1.2, 1.6, 3.1, 3.2

		Energy and Information, reversible computation	
4-12	Basic Concepts in Quantum Mechanics	Quantum states: definition, Linear vector spaces, Evolution of quantum states, Composite systems, Superposition and Entanglement of States, Quantum Measurement, decoherence. Spin systems.	1.3, 2.1, 2.2,
13-22	Quantum Computation	Quantum Gates: single qubit, multiple qubit gates, Controlled gates, Universal Gates, Measurement, Quantum algorithms, quantum circuits.	Ch 4
22-30	Examples of Quantum Algorithms	Deutsch Algorithm, Shor Algorithm, Grover's Algorithm	Ch 5, Oskin lecture notes
28-34	More detailed Examples	Quantum Fourier Transform and applications, Quantum Search Algorithm	Ch 5, 6
35-42	Quantum Information Theory	Quantum information, Quantum cryptography, error-correction, coding, complexity.	Ch 12

Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage (%)	Date, Time	Remarks
1	Test I	30 Min.	15	September 11 th (During scheduled class hour)	Open Book
2	Test II	30 Min.	15	October 09 th (During scheduled class hour)	Open Book
3	Test III	30 Min.	15	November 13 th	
3	Home Assignment		30		Open Book
4	Comprehensive	2 Hours	25	December 11 th	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 displayed only on the **Physics** notice board **and CMS**.

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

(i) Debilitating illness.

(ii) 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