# Topics in Contemporary Physics (I,III)

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**Course Objectives:**

(I) *Introducing selected topics and research forefronts in contemporary physics so to broaden a student's perspective.*
(II) *and/or to equip a student with practical knowledge in research.*

## *Syllabus*

This course will proceed with ***lectures, discussions, and oral presentations***. Topics covered include quantum computation and quantum information theory, particle physics, black hole physics etc..

## *Lectures (some special topics)*

- *Quantum Entanglement*
- *black hole information problem*
- Quantum computation and quantum information

## *Students' Presentations (~1hrs. for each presentation)*

- *Topics from your own research*
- *Topics from what I listed in the special topics*
- *Topics you read from the scientific journals or news…*

## *Discussions*

| Week | Subjects and topics (tentative) |
|---|---|
| 1(9/10) | Course outline |
| 2(9/17) | No class |
| 3(9/24) | Introduction to general relativity |
| 4(10/1) | Introduction to black holes |
| 5(10/8) | Introduction to black holes |
| 6(10/15) | Introduction to black holes |
| 7(10/22) | Introduction to quantum field theory |
| 8(10/29) | Introduction to quantum field theory |
| 9(11/5) | Midterm week,No class(draft the final report) |
| 10(11/12) | Quantum field theory on black holes |
| 11(11/19) | Quantum field theory on black holes |
| 12(11/26) | Introduction the black hole information problem |
| 13(12/3) | Introduction the black hole information problem |
| 14(12/10) | Student presentation |
| 15(12/17) | Student presentation |
| 16(12/24) | Student presentation |
| 17(12/31) | Final week, No class (due date for the final report) |

# Grading

| Items | Percentage |
|---|---|
| ***General Performance incl. discussion contributions*** | 20% |
| ***Oral presentations*** | 30% |
| ***Written report*** | 20% |
| ***Attendance*** | 30% |

# *Syllabus*

***What the students will learn in this course:***

***Getting rough ideas of research methods and fundamental concepts (Objective II)***

→ *Read assigned materials before each lecture, bring your questions to the class and join the discussions.*

***Grasping on-going research forefronts (Objective I)***

→ *Read regularly physics news and recent research highlights.*

→ *Attend physics colloquium (Mon. 16:00-17:00).*

→ *Share and discuss in the class what have interested you.*

***Acquiring helpful skills in oral presentations and scientific writing***

→ *Oral Presentations*

→ *Written report on selected topic, ~ 2-3 pages, incl. references. Due date: 1/3.*

*Topics may be selected from colloquium lectures, physics news, or research reports.*

## *Reading physics news and research reports*

**ArXive:** http://xxx.lanl.gov/

**Spires:** https://inspirehep.net/

**Physics Review:** http://www.nature.com/nature/research/physical-sciences.html

**Nature:** http://www.nature.com/nature/research/physical-sciences.html

***Physicsworld:*** http://physicsworld.com/cws/archive/news/19

**Science:** http://news.sciencemag.org/category/physics

***Physics Today:*** http://scitation.aip.org/content/aip/magazine/physicstoday

## References:


1. “Quantum computation and quantum information” by M. Nielsen and I. Chuang

2. “Introduction to elementary particle physics” by David Graffith

3. “In search of the ultimate building blocks” by Gerard ‘t Hooft

4. “The Black Hole Information Problem” by Joseph Polchiski ,arXiv:1609.04036 [hep-th]

5. “An introduction to black holes, information and the string theory revolution” by Leonard Susskind and James Lindesay

AdS/CFT

1. “Solving quantum field theories via curved spacetimes”, by I. Klebanov and J. Maldacena, Physics Today January 2009.
2. “Holographic derivation of entanglement entropy from AdS/CFT”, by S. Ryu and T. Takayanagi, Phys. Rev. Lett. 96, 181602(2006).

EPR

1. “Can Quantum-Mechanical description of physical reality be considered complete?”, by A. Einstein, B. Podolsky and N. Roson, Phys. Rev. 47 (1935)
2. “What’s wrong with these elements of reality?”, by D. Mermin, Physics Today June 1990.

Quantum Entanglement

1. “Quantum entanglement”, by R.Horodecki, P. Horodecki, M. Horodecki, and K. Horodecki, Rev. Mod. Phys. 81, 865 (2009)

2.”Description of States in Quantum Mechanics by Density Matrix and Operator Techniques”, by U. Fano, Rev. Mod. Phys. 29, 74 (1957)