

## Tools for Research in Cosmology

Programme: PhD (Physics)

Year: 1/2

Semester : 1/2

Course : Elective

Credits : 4

Hours : 60+0+0

### Course Overview:

Cosmology or the scientific study of the Universe not surprisingly involves drawing on a number of sub-disciplines of Physics. This makes it challenging for a new PhD student trying to enter the field of Cosmology. In this course, we address this challenge by pulling together the topics that will allow a new PhD student entering the field of Cosmology to acquire all the necessary tools needed in order to carry out research in the field of Cosmology.

### Prerequisite Courses:

Knowledge of Lagrangian and Hamiltonian mechanics, Special relativity, Maxwell equations and the basic results of quantum mechanics.

**On completion of this course students will have the ability to:**

**CO1: Use the General Theory of Relativity to understand the dynamics of space-time.**

**CO2: Use the FRW cosmology to understand the evolution of the Universe**

**CO3: Use Thermodynamics to understand the Thermal history of the Universe**

**CO4: Use Field Theory to Understand Phase Transitions and their role in our Universe.**

### Course Topics:

Topics	Contact Hours
<b>General Theory of Relativity: metric, connection, curvature, stress-energy tensor, Einstein Equation.</b>	15
<b>FRW Cosmology: Metric for homogeneous, isotropic Universe, Friedmann Equations, Age of the Universe, Dark Energy.</b>	15
<b>Thermodynamics: Distribution functions, number density, energy density, pressure, high temperature expansion, low temperature expansion, effective degrees of freedom.</b>	15
<b>Field theory and Phase Transitions: Effective potential, Temperature dependence of the Effective Potential, Vacua or ground states of the Potential and the formation of topological defects such as domain walls and cosmic strings during phase transitions.</b>	15

### Text Book:

The Early Universe, by E. W. Kolb and M.S. Turner.

### Additional References:

Field Theoretical Methods in Cosmology, by Anupam Singh.

Thesis (PH.D.)--CARNEGIE-MELLON UNIVERSITY, 1995.Source:Dissertation Abstracts International, Volume: 56-10, Section: B, page: 5563.

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arXiv: [arXiv:hep-ph/9509241](https://arxiv.org/abs/hep-ph/9509241)

**Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):**

**Evaluation Method:**

Item	Weightage
Assignments and presentations	50
Midterm	20
Endterm	30

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**Last Update:** 8, March 2023.