Course Type	Course Code	Name of the Course	L	T	P	Credits
DE	NESD511	Climate Change and Modelling	3	0	0	3

Course Objectives

- The objective of the course is to explore the climate change on local, national and international prospect through specified models.

Learning Outcomes

Upon successful completion of this course, students will be able to:

- Explain and critically evaluate the current state of climate change science and relationship between Earth's climate system.
- Recognize the key factors influencing global and regional climate in the past, present, and future.
- Interpret, and critically evaluate different approaches to incorporate uncertainty into climate modelling.

Unit No.	Topics to be covered	Lecture Hours	Learning outcomes
1.	Description of the climate system and its components: Atmosphere, Ocean Composition and properties, The cryosphere and the land surface and the terrestrial biosphere. The Energy balance, hydrological and carbon cycles: The Earth's energy budget, The heat balance at the top of the atmosphere: a global view, Heat storage and transport, Heat balance at the surface, The hydrological cycle and The carbon cycle.	8	Understand the fundamental concepts of climate systems, its components and climate balance.
2.	Modelling of the climate system: Introduction to a climate model, Types of models, A hierarchy of model, Energy balance models, Intermediate complexity models, General circulation models, Components of a climate model (Atmosphere, Ocean, Sea ice, Land surface, Marine biogeochemistry and Ice sheets), Testing the validity of models.	10	Develop the concepts necessary for modelling the earths climatic system.
3.	The response of the climate system to a perturbation: Climate forcing and climate response, Notion of radiative forcing, Major radiative forcings, Equilibrium response of the climate system - a definition of feedback, Transient response of the climate system, Direct physical feedbacks, Water vapor feedback and lapse rate feedback, Cloud feedback, Cryospheric feedbacks, Geochemical, biogeochemical and biogeophysical feedbacks.	7	Develop the concepts of climate balance and various types of climate feedbacks.
4.	Brief history of climate: causes and mechanisms, Internal climate variability, The climate since the Earth's formation, The last million years: glacial interglacial cycles.	7	Get the knowledge of past-climate history through the geological time scale.
5.	Future climate changes: Emission scenarios, the purpose of the scenarios and scenario development, Special Report on Emission Scenarios (SRES), Representative concentration pathways (RCPs), Climate projections for the 21st century, Changes in global mean surface temperature, The spatial distribution of surface temperature and precipitation changes, Changes in the ocean and sea ice, Changes in the carbon cycle and climate-carbon feedbacks, Long-term climate changes, The carbon cycle and Sea level and ice sheets.	10	Develop the key concepts for future climate modelling and scenarios involved in future climate projection.
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Text Books:

1. Goosse H., P.Y. Barriat, W. Lefebvre, M.F. Loutre, and V. Zunz. Introduction to climate dynamics and climate modelling. Universitécatholique de Louvain; Online textbook available at http://www.climate.be/textbook. 2010.
2. C. Donald Ahrens, Essentials of Meteorology: An Invitation to the Atmosphere, Cengage Learning, 2015
3. K. McGuffie and A. Henderson-Sellers. The Climate Modelling Primer, Wiley Blackwell, 2014. Environmental Control in Petroleum Engineering, John C Reis, Elsevier Science & Technology Books, 1996.

Reference Books:

1. Stull, R. "Practical Meteorology: An algebra-based survey of atmospheric science" – version 1.02b. Univ. of British Columbia. 2017.
2. Lazaridis, M., First principles of meteorology and air pollution, Environmental pollution series volume 19, Springer 2011.