CLIMATE SCIENCE

Programme Structure

Course Code	Course Title	Lecture (L) Hours Per Week	Tutorial (T) Hours Per Week	Practical (P) Hours Per Week	Total Credits
AST2151	Basics of Climate Science	3	-	-	3
AST2251	Introduction to Earth System Science Editing	3	-	-	3
AST2351	Cloud Microphysics and Chemistry	3	-	-	3
AST2451	Climate Change: Impact, Vulnerability and Adaption Foundations	3	-	-	3
AST2551	Primer of Oceanography Psychology	3	-	-	3
AST2651	Fundamentals of Climate Variability and Modeling	3	-	-	3
	TOTAL				**18**

CLIMATE SCIENCE

Syllabus - Semester First

BASICS OF CLIMATE SCIENCE

Course Code: AST2151 **Credit Units: 03**

Course Objectives:

The aim of this course is to provide the students a basic understanding about the climate system: its attributes, underlying processes, and the drivers of climate change. Knowledge of various components of climatic system, and their interactions with atmosphere/hydrosphere/lithosphere would further create interest amongst the students about the climate system modelling and climatic vulnerability. This course emphasizes the scientific basis for anthropogenic climate change. Students will learn the physics behind the climate system, how climate has changed in the past and reasons why contemporary climate change is different, the scientific basis for anthropogenic climate change theory and how scientists use models to predict future climate. The course will also provide an overview of the physical, ecological, biological, social and economic impacts of climate change. Finally, students will examine various mitigation and adaptation strategies which society can employ in a warmer world.

Course Contents:

Module I: Introduction to Climate Science and its Components

Fundamentals of meteorology; Vertical profiles of temperature, wind, pressure, water vapor, and microphysical processes in the atmosphere; Climate system and interaction among components (atmosphere, oceans, sea, ice and land surface) of climate system and feedback mechanisms; Atmospheric thermodynamics, radiation in the atmosphere, Greenhouse gases and climate forcing; Overview of weather systems: Extreme weather events and Western disturbance.

Module II: Remote Sensing Techniques

Types of remote sensing; Different remote sensing platforms; Principles of Remote Sensing; Radiometer, Lidar, Radar, Sodar, Sonar, Land-atmosphere-ocean satellites; Calibration and validation methods.

Module III: Climatology and Meteorology

Radiation budget and balance; Solar constant; Lapse rate and stability; Water cycle and role in weather; Mechanism of wind development; Fundamental forces (pressure gradient, centrifugal, gravity, Coriolis); Surface winds and upper air circulations; Jet streams; Planetary circulations.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; CT-Class Test; S/V/Q-Seminar/Quiz/Viva; HA-Home Assignment; EE-End Semester Examination

References:

- Marshall J. and plumb R.A.(2001) Atmosphere, Ocean and Climate, Elsevier, Amsterdam
- Climate Change Science: An analysis of some ket questions- National Academy Press, Washington, DC,2001.
- Oliver J.E. and Hidore J.J.(2008) Climatology:An Atmospheric Science, Prentice - Hall
- Atmospheric Thermodynamics by Bohren and Albrecht.
- IPCC(2001 and 2007) Working group I report" The physical basis of climate change"
- Remote Sensing : Principles and Interpretation, by Floyd F. Sabins, 3rd edition (August 1996).
- W H Freeman & Co.; ISBN: 0716724421.
- Remote Sensing and Image Interpretation, by Thomas M. Lillesand, Ralph W. Kiefer, 4th
- edition (October 1999) , John Wiley & Sons; ISBN: 0471255157.
- Remote Sensing : Models and Methods for Image Processing, by Robert A. Schowengerdt, 2nd edition (July 1997), Academic Pr; ISBN: 0126289816.
- Principles of Paleoclimtology, Ed. Thomas M. Cronin, Columbia University, USA.

Syllabus - Semester Second

INTRODUCTION TO EARTH SYSTEM SCIENCE

Course Code: AST2251 **Credit Units: 03**

Course Objectives:
This course embraces chemistry, biology, mathematics and applied sciences in transcending disciplinary boundaries to treat the Earth as an integrated system. Thus, it imparts knowledge to the students with basic understanding of the physico-chemical, biological and human interactions that determine the past, current and future states of the Earth. Earth system science seeks to integrate various fields of academic study to understand the Earth as a system. It considers interaction between the atmosphere, hydrosphere, lithosphere, biosphere and heliosphere.

Further, the Earth System Science program provides students with a fundamental understanding of the oceanographic, atmospheric, and terrestrial sciences. This program of study prepares students for careers in science, research, or technical fields. Students learn to apply basic sciences (physics, chemistry, mathematics, and biology) to understand the major processes and systems governing the Earth's climate, biogeochemical cycles, and global change. Central to the B.S. program is an understanding of relevant scientific literature, methods to collect/analyze data, and interpret results in the context of scientific theory. Students will learn to work collaboratively to understand and address complex problems and communicate scientific knowledge. Through the core course work, students will learn to explain the current and projected future state of the Earth system in the context of past climate change and current human activities.

Course Contents:

Module I: Fundamental Processes in Earth and Environmental Studies
An introduction to the physical environment, biological systems, and human-environmental interactions, Physical principles such as fluid transport and reaction rates using environmental examples as well as principles of populations, ecosystems, carrying capacity, and sustainable use of resources.

Module II: Hurricanes, Tsunamis and other Catastrophes
Introduction to the basic science and state of predictability of various natural catastrophic events such as hurricanes, tsunamis and volcanoes, future climate catastrophes including severe droughts, abrupt climate change, thermohaline circulation collapse and sea level rise.

Module III: Remote Sensing and Geographic Information System (GIS) for Earth System Science
Principles behind remote sensing, and the types of satellite data available for study of the oceans, land, and atmosphere, GIS Brief History, Techniques and Technology, Uncertainties, Spatial Analysis.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; CT-Class Test; S/V/Q-Seminar/Quiz/Viva; HA-Home Assignment; EE-End Semester Examination

References:

- The Blue Planet: An Introduction to Earth System Science, 3rd Edition, Brian J. inner, Barbara W. Murck, December 2010, ©201
- Maliene V, Grigonis V, Palevičius V, Griffiths S (2011). "Geographic information system: Old principles with new capabilities". *Urban Design International* 16 (1). pp. 1–6. doi:10.1057/udi.2010.25.
- Goodchild, Michael F (2010). "Twenty years of progress: GIScience in 2010". *Journal of Spatial Information Science*. doi:10.5311/JOSIS.2010.1.2
- Fu, P., and J. Sun. 2010. *Web GIS: Principles and Applications*.ESRI Press.Redlands, CA. ISBN 1-58948-245-X.
- Tim Foresman 1997 The History of GIS (Geographic Information Systems): Perspectives from the Pioneers. (Prentice Hall Series in Geographic Information Science) Prentice Hall PTR; 1st edition (November 10, 1997), 416 p.
- Coppock, J. T., and D. W. Rhind, (1991).The history of GIS. Geographical Information Systems: principles and applications. Ed. David J. Maguire, Michael F. Goodchild and David W. Rhind. Essex: Longman Scientific & Technical, 1991. 1: 21–43."The history of GIS.".Retrieved 2013-12-20.

Syllabus - Semester Third

CLOUD MICROPHYSICS AND CHEMISTRY

Course Code: AST2351 **Credit Units: 03**

Course Objectives:
This course focuses on understanding how transformation of aerosol particles to droplets or ice crystals, heterogeneous chemistry and acid rain, physics of aerosol and cloud element motion, the interaction of particles with water vapor, chemical composition of particles and the effect on cloud formation processes, and the effect of cloud processing on aerosol chemistry, geo-engineering, weather modification and volcanic effects. Thus, it provides the students an insight into one of the important complex drivers of the local/regional/continental/hemispheric/global climate system.

Course Contents

Module I: Basic Cloud Physics
Water vapour and its thermodynamic effects, mixing and convection, formation of cloud droplets, formation and growth of ice crystals, aerosol sources and sizes, condensation and growth of cloud droplets: curvature, Kelvin, solute effects, cloud growth and precipitation, rain, snow and hail processes.

Module II: Microphysical Processes in warm and cold clouds
Cloud condensation nuclei, microstructures of warm clouds, growth of cloud droplets in warm clouds, growth by condensation and collision-coalescence, microphysics of cold clouds, growth by collection, modification of warm and cold clouds, lightning and thunder.

Module III: Cloud and Precipitation Chemistry
Transport of particles and gases, nucleation scavenging, dissolution of gases in clouds droplets, precipitation scavenging, chemical composition of rain, production of aerosols by clouds.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; CT-Class Test; S/V/Q-Seminar/Quiz/Viva; HA-Home Assignment; EE-End Semester Examination

References

- Atmospheric Science-An Introductory Survey, 2nd Edition, Eds. John M. Wallace and Peter V. Hobbs, University of Washington, 2006, Elsevier Inc.
- The Physics of Clouds, Ed. B.J. Mason, Oxford University Press, Oxford, 1971.
- A Short Course in Physics, Eds. R.R. Rogers and M.K. Yau, 3rd Edition, 1989, Pergamon Press, Oxford.

Syllabus - Semester Fourth

CLIMATE CHANGE: IMPACT, VULNERABILITY AND ADAPTATION

Course Code: AST2451 **Credit Units: 03**

Course Objectives:
This course provides the students with an introduction to the vulnerability of climate change and potential adaptation options of natural as well as social systems. A critical view will be laid on the 'attribution problem', the prioritization of adaptation means, mal-adaptations, the implementation problem, ethical views and conflicts with development goals. Win-win-situations and trade-offs between the latter and climate change adaptation is part of this course too.

Course Contents

Module I: Introduction to the Impacts of Climate Change
Fundamentals of climate system and climate change, brief summary of Inter-Governmental Panel of Climate and Climate Change (IPCC) reports, future directions for mitigation processes.

Module II: Vulnerability
Introduction to the concept, ecological and social systems, coastal vulnerability, methods of evaluation of vulnerability and impacts.

Module III: Adaptation
Introduction to the concept, indicators of adaptation, options and limits of adaptation, food and energy security, autonomous versus planned adaptation, adaptation capacity.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; CT-Class Test; S/V/Q-Seminar/Quiz/Viva; HA-Home Assignment; EE-End Semester Examination

References

- McMichael, A.J., Cambell-Lendrum, D.H., Corvalan, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., Woodward, A. (Eds.) 2003, Climate change and human helth –Risks and Responses, Geneva, World Health Organization.
- Reckien, D., Hofmann, S., Kit, O., 2009: Qualitative Climate Change Impact Networks for Hyderabad/India. Report from the Project: Hyderabad as a megacity of tomorrow: Climate and energy in a complex transition towards sustainable Hyderabad- Mitigation and adaptation strategies by changing institutions, Governance structures, life styles and consumption patterns. Institute for Climate Research, 2009.
- Roy, J., 2006: The economics of Climate change. A review of studies in the context of South Asia with a special focus on India.
- Jerneck, A., Olsson, L., 2008: Adaptation and the poor, development, resilience and transition, Climate Polity, 8, 170-182.

Syllabus - Semester Fifth

PRIMER OF OCEANOGRAPHY

Course Code: AST2551 **Credit Units: 03**

Course Objectives:
Ocean-related science is relevant to many contemporary environmental issues and problems and central to understanding earth-system evolution, dynamics, climate and sustainability. This course offers a very flexible curriculum that serves students with a broad range of educational and career interests including environmental management and regulation, environmental law. The topics selected for this course, are expected to provide the students with a broad conception of the world's oceans; evaluation of its potential contributions to solution of problems presently confronting mankind.

Course Contents
Module I: Ocean Properties
Introduction to Oceans, physical and chemical properties of ocean water, composition of sea water, salinity and density.
Module II: Physical Oceanography
Thermal expansion of sea water, viscosity, surface tension, heat conduction, adiabatic temperature changes, optical properties, temperature-salinity relationship,
Module III: Bathymetry, Eco Systems and Pollution
Basic definition, oceanic life and ecosystems, measurement techniques, bathymetric chart, fish-zone detection, marine pollution.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; CT-Class Test; S/V/Q-Seminar/Quiz/Viva; HA-Home Assignment; EE-End Semester Examination

References

- Baker D.J. 1981. Ocean instruments and experiment design. In Evolution of PhysicalOceanography: Scientific Surveys in Honor of Henry Stommel. Edited by B. A.Warrenand C. Wunsch. 396–433. Cambridge: Massachusetts Institute of Technology Press.
- Bennett A.F. 1992. Inverse Methods in Physical Oceanography. Cambridge: UniversityPress.
- Philander S.G. 1990. El Ni˜no, La Ni˜na, and the Southern Oscillation. Academic Press.
- Ahn, YH; Hong, GH; Neelamani, S; Philip, L and Shanmugam, P (2006) Assessment of Levels of coastal marine pollution of Chennai city, southern India. Water Resource Management, 21(7), 1187-1206.
- Daoji, L and Dag, D (2004) Ocean pollution from land-based sources: East China sea. AMBIO – A Journal of the Human Environment, 33(1/2), 107-113.
- Laws, Edward A (2000) Aquatic Pollution John Wiley and Sons. ISBN 978-0-471-34875-7
- Slater, D (2007) Affluence and effluents. Sierra 92(6), 27
- UNEP/GPA (2006) The State of the Marine Environment: Trends and processes United Nations Environment Programme, Global Programme of Action, The Hague. 2006ISBN 92-807-2708-7.
- UNEP (2007) Land-based Pollution in the South China Sea. UNEP/GEF/SCS Technical Publication No 10.

Syllabus - Semester Sixth

FUNDAMENTALS OF CLIMATE VARIABILITY AND MODELLING

Course Code: AST2651 **Credit Units: 03**

Course Objectives:
This course essentially deals with fundamentals of climate variability and its modelling. This knowledge to the students makes them familiar with different types of climate models available not only for prediction purposes but also to undertake sensitivity tests and to simulate the future climate scenarios both regionally and globally.

Course Details

Module I: Climate Variability
Natural variability versus anthropogenic forcing to climate system, climate sensitivity, Greenhouse gases and global warming,

Module II: Climate Drivers
Climate Global distributions of temperature, precipitation, precipitation, climate classification, Natural and external forcings to climate variability,

Module III: Basics of Climate Modelling
Simple energy balance climate models, introduction to coupled ocean-atmosphere models, simple models for predicting climate change and impact assessment.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; CT-Class Test; S/V/Q-Seminar/Quiz/Viva; HA-Home Assignment; EE-End Semester Examination

References

- Climate Change and Climate Modelling, Ed. J. David Neelin, 2011.
- An Introduction to Three-dimensional Climate Modelling, Eds. Warren M. Washington and Clarie L. Parkinson, 2005.