NPTEL Syllabus Template

Course Title	An Introduction to Climate Dynamics, Variability and Monitoring
Discipline	Climate and Environmental Science and Technology
Duration of course 4/8/12 weeks (10/20/30 hours @2.5 hrs/week)	12 weeks
Number of times you have taught this course totally and in the last 5 years (2-3 times is preferable, if not more)	3 times
Is this course syllabus approved by AICTE or by Senate in your/any institute? If yes, please give the course name and institute under which this is approved.	Approved by the Senate as a core masters level course in the Department of Climate Change at IIT Hyderabad. Course Name: Climate Monitoring and Variability (CC5120)
The time frame of when you would want to offer the course: (Jan 2024/July 2024)	July 2024
Will it map to any course in the AICTE model curriculum? LINK to AICTE Curriculum LINK 1 LINK 2 LINK 3 LINK 4	AICTE model curriculum for Sustainable Energy Engineering. SEE-202:- Climate Change: Understanding and Observation
Will it map onto any of the NPTEL domain? LINK to Domain page: https://nptel.ac.in/noc/Domain/	Domain:- Environment under Civil Engineering

Name of the Instructor(s)	Dr. Sayak Banerjee	
Department	Department of Climate Change Department of Mechanical and Aerospace Engineering	
Institute	IIT Hyderabad	
Email ID	sayakb@mae.iith.ac.in	
Mobile Phone Number	9051085930	
Website of Instructor	https://www.iith.ac.in/mae/sayakb/	

Intended audience	Graduate Students in Science and Engineering Disciplines related to Climate, Environment and Sustainability. Undergraduate students in Engg. Science, Environmental Science as well as those interested on minor in Sustainable Energy/Engg. Professionals interested in Climate Change Science.
Is it a core/elective course?	Elective
Is it a UG/PG/PhD level course?	PG, but can be taken by UG students.
Is this course relevant for GATE exam preparation?	GATE Curriculum Correspondence:- XE-H:- Atmospheric Science Section and Oceanic Science Section ES:- Section 8, Global and Regional Environmental Issues GG:- Part B, Basic Principles of Remote Sensing
Which degrees would it apply to? (BE/ME/MS/BSc/MSc/PhD etc)	M. Tech, MS, MSc. Also B Tech in Env Sci or Engg Science.
What are the next set of courses that can be taken by students who complete this?	Climate Modelling; GIS and Remote Sensing; Climate Policy
Pre-requisites in terms of educational qualification of participants, or if any other courses should be done before this course can be taken	Students and Professionals with Civil Engg, Env and Atmospheric Science, Mechanical Engineering, Chemical Engineering, Geology and Geophysics Background. While a PG course, materials learnt upto 2nd year UG should be sufficient.
Industry recognition of this course – List of companies/industry that will recognize/value this online course	NA
Will the final certification exam be– paper/pen type or computer based - both are proctored	Computer based
Will the course require use of any software such as MATLAB or any programming language, etc. or any other tool? If yes, does it have a Linux based compiler available or if licensed, can we get the educational license for the same?	No
Names of 2 reviewers for the course (can be from other institutes – will be used if we need any additional inputs on the course) – Name, Dept, email id, Institute	Name : Dr. Pritha Chatterjee Dept. : Civil Engg. and Climate Change Dept. Institute : IIT Hyderabad Email : pritha@ce.iith.ac.in Name : Dr. Satish Regonda Dept. : Civil Engg and Climate Change Dept

	Institute : IIT Hyderabad Email : satishr@ce.iith.ac.in
List of reference materials/books	1) An Introduction to Atmospheric Physics, David G. Andrews, Cambridge University Press, 2010. ISBN: 9780511800788 2) Global Physical Climatology, Elsevier 2nd Edition - December 3, 2015. Author: Dennis L. Hartmann Hardback ISBN: 9780123285317 3) Meteorological Measurements and Instrumentation Author(s):R. Giles Harrison, 2015 John Wiley & Sons, Ltd, Print ISBN:9781118745809. 4) Physical Principles of Remote Sensing, W. G. Rees, 3rd Edition, Cambridge University Press, ISBN 9781139017411

FOR GETTING THE INTRODUCTORY COURSE PAGE READY – TO OPEN FOR ENROLLMENTS

1. Introduce the course in about 4-5 lines

As climate change and associated climate mitigation and adaptation strategies become an increasingly important concern for the government, the industry as well as multiple disciplines within the academia, there is need for a course that provides a physics-based understanding of the parameters controlling climatic variability and human influence on climate variability to UG/PG students from diverse science/technology backgrounds. A basic grounding on instruments and methodologies to monitor climate relevant variables will also prove useful and interesting to students of engineering disciplines. Such a course will also prove beneficial to industry professionals who are interested in developing technology/policy/business solutions for climate change.

This course will provide the participant with a thorough introductory grounding of climate physics, climatic patterns of variability, and the human influences in the ongoing climate change. In addition, the participant will also gain an understanding of how various climatological and meteorological variables are measured using ground based, upper air and satellite based instrumentation. The course will also be very useful for those who wish to specialize further in climatological modelling, satellite based observation of weather and climate etc.

2. Photograph of instructor(s)

3. About the instructor(s)

Dr. Sayak Banerjee is an Assistant Professor at the Mechanical and Aerospace Department at the Indian Institute of Technology, Hyderabad and is also an Adjunct Professor at the Climate Change Department at IIT Hyderabad. He had completed his M Tech in Mechanical Engineering from IIT Kanpur and his PhD and Post-Doctoral research on bio-aviation fuel combustion kinetics from the Stanford University, USA.
His research specialization is in the field chemical kinetics experimentation and modelling associated with the gasification, pyrolysis and combustion of novel carbon neutral fuels (biomass, hydrogen, biodiesel, biojet fuels etc.). He has taught the Climate Monitoring and Variability Course at IIT Hyderabad as an M. Tech core course of the Climate Change Department for over 3 years

4. An introductory video about the course (2-5 minutes' duration)
Will be added at the time of course lecture recording.

Logical Structure of the Course:-
Week 1 and Week 2:- Introduction to key Atmospheric and Oceanic Variables and how they control the spatio-temporal variabilities in the climate system.
Week 3 and Week 4:- Introduction to the Global Atmospheric Energy Balance and its spatio-temporal variations. Radiative energy fluxes through the atmosphere and how atmospheric gas concentrations influence these fluxes. The radiative equilibrium model and the greenhouse effect.
Week 5 and Week 6:- Fluid dynamics of the atmosphere and the ocean, the general circulation patterns and how they change with location and seasons. Impact of these circulation patterns on regional climates.
Week 7 and Week 8:- How atmospheric and oceanic interactions cause the major intra-seasonal and inter-annual variabilities in climate. How various forcings and feedback effects drive the climate from one equilibrium state to another. Introduction to current anthropogenic forcing and associated climate perturbations.
Week 9 to Week 12:- An introduction to how land based, upper atmospheric and satellite based measurements of climate relevant parameters are performed, how to process and analyze these data and their role in our understanding of modern climate and climate change.

Weekly Course Plan			
Weeks		Lecture Names	Assignments
Week 1	:	Introduction to Climatology and Climatic Variables; Atmospheric Variables:- Temperature, Composition, Pressure. Variations in weather and climate influenced by these Atmospheric Variables.	Online
Week 2	:	Atmospheric Variables Continued:- Humidity, Hydrostatic Balance, Lapse Rate and Stability. Influence of these variables on geographical variations in Climate . Impact of Global Warming on Stability and Lapse Rates The Oceanic Variables: Temperature and Salinity; The Cryosphere.	Online
Week 3	:	The Global Energy Balance and Spatio-Temporal Heterogeneities in Energy Balance. Energy flux from the Sun and Variabilities in Solar Insolation, Emissions from Earth, Mean temperature and the Greenhouse Effect, global radiative flux balance, poleward energy flux.	Online
Week 4	:	The Radiative Energy fluxes in the atmosphere, transmission and absorption of SW and LW radiation by the gases, the Lambert-Beer law, the infrared radiative transfer equations	Online

		and the radiative equilibrium model, Greenhouse effect in a continuously stratified atmosphere, radiation and the clouds.	
Week 5	:	Atmospheric Fluid Dynamics; the Atmospheric General Circulation : energy balance, atmospheric motions, meridional energy transport, angular momentum balance, large scale circulation patterns and climate types.	Online
Week 6	:	Oceanic Fluid Dynamics; Oceanic General Circulation : mixed layers, wind driven circulation, thermohaline circulation, energy transport in the oceans and their influence on regional climate.	Online
Week 7	:	Climatic Variabilities due to Atmosphere-Ocean Interactions. Intra-seasonal and inter-annual variabilities, PNA, NAO, SAM, MJO and ENSO variabilities, Decadal variations of weather and climate.	Online
Week 8	:	Physics of Climate Change: Climate Forcing, Climate Sensitivity and Feedback - Measures of forcing, sensitivity and feedback, Radiative feedback, Dynamical feedback in energy transport, Cloud feedback, bio-geochemical feedback. Overview of current anthropogenic forcing.	Online
Week 9		Principles of Measurement and Instrumentation: Measuring systems, response times, errors and uncertainties, data acquisition. Land Based Measurements of Temperature and Pressure.	Online
Week 10		Land based measurements of humidity, precipitation and wind speed. Measurement of Radiation: SW and LW	Online
Week 11		Upper Air measurements using Radiosondes; Principles of Atmospheric Remote Sounding	Online
Week 12		Satellite based Remote Sensing for Climatological Applications. Satellite based Weather Imaging; VNIR and TIR imaging systems and applications. Wrap Up.	Online

TA Details (Not yet determined)			
	:	Teaching Assistant 1	Teaching Assistant 2
Name	:		
Department	:		
Email ID	:		

Mobile Number	:		
Currently pursuing degree	:		