Course no.:	ENR 134
Course title:	**Advanced Technologies for Environmental Protection and Climate Change Mitigation**
Core or Elective:	Core
Number of credits:	3
Number of lectures-tutorials-practicals:	26-16-0
Course coordinator:	Dr. O P Rao

Course outlines:

Main aim of this course is to impart enough knowledge to the student about the impact of use of energy resources on the environment particularly the climate change, which is physically evident now, and the mitigation options available to counteract the climate change. The climate change mitigation options the student will be taught include carbon capture and storage (carbon sequestration), biological sequestration, reuse of CO_2 etc. The use of non carbon energy resources as another option for climate change mitigation viz., electric vehicles and hydrogen will also be dealt in this course.

Evaluation procedure:

- Assignments: 20%
- Minor project: 30%
- Major test: 50%

Details of course content and allotted time

S. No.	Topic	Allotted time (hrs)		
		L	T	P
1	**Introduction** Climate change and global warming terminology, causes and consequences of climate change, physical evidence of climate change, overview of CO_2 emission sources, mitigating options to counteract climate change (sequestration and alternate options)	2		
2	**Carbon sequestration** Definition, separation and capture of CO_2, transportation of CO_2, various carbon storage methods ,	2		
3	Ocean storage, storage in geological formations (depleted oil, gas reserves, and unmineable coal seams, deep saline formations),	2		
4	environmental and safety concerns, leakage of stored of CO_2, economics of carbon capture & storage (CCS), examples of CCS internationally and in India	2		
5	Alternate approaches, terrestrial sequestration (afforestation), biological sequestration (capture by microalgae), soil sequestration	2		
6	Enhancing natural sequestration, ocean fertilization, mineral storage, reuse of CO_2 for production of hydrocarbons & industrial use, enhanced oil recovery	2		
7	Emission cuts, substitution of fossil fuels, reducing energy subsidies, taxes , policies & treaties	2	2	
8	**Electric vehicles** Overview, vehicle types, current production, advantages and disadvantages, issues, future developments,	2		

S. No.	Topic	Allotted time (hrs)		
		L	T	P
9	advanced battery systems, economics of battery powered vehicles, prospects in India Electric vehicle and CDM (carbon credits) prospects	2	2	
10	**Fuel Cells** Introduction to the principles and operation of fuel cells, overview of fuel cell technology, thermodynamics of fuel cells,	2		
11	fuel cell power and efficiency, electrode reaction kinetics, transport phenomena in fuel cells, stack configurations and fuel cell systems,	2		
12	Fuel cell system design, optimization and economics. Fuel cell based power generation and CDM (emission rights)	2	2	
13	**Hydrogen energy** Overview of hydrogen energy, Production options, storage, handling, usage, safety, environmental concerns, hydrogen economy, hydrogen energy and CDM	2	2	
14	**Case studies**		10	
	Total	**26**	**16**	**0**

Suggested readings

Books:

1. Fraser Armstrong and Katherine Blundell: **Energy … Beyond Oil (Oxford University Press).**
2. **The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs** (The National Academics Press, Washington DC)

References:

1. Dealing with Climate Change: setting a global agenda for mitigation and adaptation, Editor: R K Pachauri TERI Publication
2. Simplifying Climate Change (Based on the findings of the IPCC Fourth Assessment Report), TERI Publication
3. Carbon Capture and Storage from Fossil Fuel Use , Howard Herzog and Dan Golomb, Massachusetts Institute of Technology
4. Climate Change: India's Perceptions, Positions Policies and Possibilities, Jyoti K Parikh and Kirit Parikh, Indira Gandhi Institute of Development Research, OECD 2002
5. Climate change, sustainable development and India: Global and national concerns, Jayant Sathaye1, P. R. Shukla2 and N. H. Ravindranath3, CURRENT 314 SCIENCE, VOL. 90, NO. 3, 10 FEBRUARY 2006
6. Climate Change, Perspectives From India, Sunita Narain, Prodipto Ghosh, NC Saxena, Jyoti Parikh, Preeti Soni, UNDP
7. Climate change mitigation in developing countries**,** PEW centre on global climate change
8. Climate change mitigation, what do we do, OECD, 2008
9. Climate Change, USEPA

Reviewers

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