Course title: Introduction to Energy Resources, Systems and Technologies			
Course code: DSE 101	**No. of credits:** 3	L-T-P:39-6-0	**Learning hours:** 45
Pre-requisite course code and title (if any): NA			
Department: Sustainable Engineering			
Course coordinator: Dr Ramkishore Singh		**Course instructor(s):** Dr Ramkishore Singh / Dr Amit Kaur	
Contact details: ramkishore.singh@terisas.ac.in			
Course type: Core		**Course offered in:** Semester 1	

Course description:

This introductory course has been designed to get the students acquainted with different energy resources (non-renewable and renewable), reserves and their potentials, accounting of the energy, global and Indian energy demand and supply, impact of energy consumption on the environment, climate change assessment and global impact of climate change. Also, introduces students with different energy conversion technologies and their functioning.

Course objectives:

1. To get students understand and familiarity with different types of energies and their measurements, availability and potential.
2. To inculcate skills using different methods for energy accounting.
3. To introduce students with conversion technologies and systems that are used for converting non-renewable and renewable energy resources to useful heat and power.

Module	Topic	L	T	P
1.	**Basics of Energy** System; property and variables; dimensions and units of measurement; temperature and heat; pressure, volume and sates; process; energy and power; forms of energy; grades of energy; transformation of energy; global energy system; energy units and scales; global energy flows; energy end uses; transitions in energy end use and energy supply systems; energy and economic growth; principles of energy resources; energy densities; quantities of energy	4		
2	**Accounting of energy** Energy accounting methods; importance of energy accounting; limitations of primary energy accounting; comparison of global primary energy supply using different accounting methods; main energy statistics and data sources; typical calorific values of solid, liquid and gaseous fuels	2	2	
3	**Energy and environment** Energy Flow Diagram; Global and Indian energy demand and supply; Emission Factor; Atmosphere and energy systems; major energy related sources of atmospheric pollution; greenhouse gas emissions, radiative forcing, climate sensitivity, global and regional impact of climate change, risks from climate change, environmental and social implications	4	2	
4.	**Fossil fuel reserves, resources and estimates** Concepts of McKelvey box; peak debate; Hubbert plot Oil: classification of conventional and unconventional oil, estimations of conventional oil and unconventional Natural gas: Conventional and unconventional natural gas classification, resources and reserves Coal: Coal classification, reserves and resources	4		
5.	**Introduction to energy conversion systems and technologies** Fire, furnaces and boilers; types of boilers; steam engines; principles of steam engines; carnot's law and carnot engine; temperature scales and absolute zero; laws of thermodynamics; steam turbines and condensers; types of steam	7	2	

	turbines; steam jets; marine engines; turbine systems; process flow in a MW thermal power station turbine system Petrol/spark ignition engine: four stroke and two stroke engines; diesel/compression ignition engine; gas turbine: principles of turbojet; propulsion and thrust; thrust and kinetic energy; Stirling engine: principle and operation; power to weight ratio of different engines			
6.	**Nuclear energy reserves, resources and technologies** Conventional and unconventional uranium resources and reserves; global annual uranium production and reactor requirements; thorium resources; Radioactivity; energy from neutron decay; measuring radioactivity; Nuclear fission, energy from fission, components of nuclear power plant; thermal fission reactor; safety aspects in nuclear reactor; types of thermal fission reactor; fast neutron reactors; energy from fusion reactor,	6		
7.	**Introduction to Renewable energy resources and technologies** Overview of hydropower; estimation of hydropower potential; technical and economic potential of hydropower; environmental and social implications Biomass energy: Overview and types of biomass; theoretical and technical potentials of bioenergy; biogas digesters; biomass briquetting; biofuels. Wind energy: theoretical, technical and practical potentials of wind energy; environmental and social implications; onshore and offshore wind turbines; Geothermal energy: Resources and reserves, uses of geothermal energy. Solar energy: theoretical and technical potential of solar energy; economic potential of large scale solar plants; Solar cookers; solar water heating systems; solar concentrators for power generation; solar photovoltaic; Ocean energy-tidal and waves, potential, utilisation technologies	11		
8.	Overall energy systems and technologies and their overall effect on the environment, society, and economics.	1		
	Total	39	6	

Evaluation criteria

Assignment1: 10% (after Module 1-4)
Assignment 2: 10% (after Modules 5-7)
Minor test 1: 15% (after Module 3)
Minor test 2: 15% (after Module 5)
Major test: 50% (after all module)

Learning outcomes:

This course inculcates the skills that shall make the students to:

1. be able to measure and compare the energy contents in different units used for different fossil fuel resources internationally.
2. be able to differentiate different forms of energy and their applications.
3. be able to differentiate and assess the theoretical, technical and economic potentials of the energy resources.
4. understand the impact of energy uses on the climate change and role of IPCC in assessment of climate change and mitigation strategies.
5. be able to understand energy demand and supply flow diagram.
6. learn about different energy conversion technologies and emission factors.
7. understand the functioning energy conversion technologies and systems

Pedagogical approach

A combination of class-room interactions, tutorials, practical and assignments.

Materials

Recommended readings

Text Books

1. Global Energy Assessment Writing Team. Global Energy Assessment: Toward a Sustainable Future. Cambridge University Press; 2012

2. Everett, Robert; Boyle, Godfrey; Peake, Stephen and Ramage, Janet eds. (2012). Energy Systems and Sustainability: Power for a Sustainable Future (2nd ed.). Oxford: Oxford University Press.

Reference Books

1. Tushar K. Ghosh and Mark A. Prelas eds. Energy Resources and Systems Volume 1: Fundamentals and Non-Renewable Resources, Springer Dordrecht
2. Energy: Production, conversion, storage, conservation and coupling by Yasar Demirel Springer ISSN 1865-3529
3. TERI Energy & Environment Data Diary and Yearbook (TEDDY) 2020-21. TERI Press
4. United States Department of Energy, International Energy Outlook, Energy Information Administration, DC. https://www.eia.gov/outlooks/ieo/narrative/index.php
5. IEA (2023), *World Energy Outlook 2023*, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2023, Licence: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A) https://www.iea.org/search?q=World%20Energy%20Outlook
6. bp Energy Outlook. **https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html**
7. Our World in Data**. https://ourworldindata.org/renewable-energy**

Journals

- Resource and Energy Economics
- Journal of Energy Resources Technology
- Liquid and Gaseous Energy Resources
- Progress in Energy and Combustion Science\
- Renewable and Sustainable Energy Reviews
- Nature Energy
- Energy

Additional information (if any): NA

Student responsibilities:
Attendance, feedback, discipline: as per university rules

Course Reviewers

1. Dr. O. P. Rao
   Scientist, CSIR (Retired)
2. Prof. Santanu Bandyopadhyay
   Indian Institute of Technology, Bombay