Course title: Energy System Infrastructure and Operations			
Course code: DSE 103	**No. of credits:** 3	**L-T-P:** 37-08-00	**Learning hours:** 45
Pre-requisite course code and title (if any):			
Department: Sustainable Engineering			
Course coordinator: Prof. Naqui Anwer		**Course instructor:** Prof. Naqui Anwer	
Contact details: naqui.anwer@terisas.ac.in			
Course type: Core		**Course offered in:** Semester 1	

Course Description:

The structure of power systems and their operations are vital for system reliability, control, security and power quality. Further many countries, including India, are witnessing restructured electricity markets. In this deregulation process, it is important to focus on managerial as well as technical aspects of energy system infrastructure and their operations. This course is designed to educate students regarding various components of energy system infrastructure and how the power market is assisting in the reliable operation of the grid.

Course objectives:

- To familiarize students with basic principles of power system elements
- To understand the energy market and services offered by these energy markets.
- To understand operational planning activities like economic load dispatch, unit commitment and power flow
- To impart knowledge about transmission and distribution systems
- To understand ancillary services management and their categorization

Course content

Module	Topic	L	T	P
1.	**Fundamentals of Electric Circuits and Power System** • Circuit concept • Circuit laws • Active & reactive power and electrical energy • 3-phase circuits • Elements/Structure of power systems	7	0	0
2.	**Power Markets** • Overview of the Indian Power sector • Market structure • Role of ISO (Independent System Operator) • Electricity market: Power trading in energy exchanges • Ancillary services: For maintaining generation and load balance, For bulk transmission system security, For emergency preparedness	6	0	0
3.	**Power Plant Engineering** • Basics of power generation (Schematics/layout of coal-based thermal, Gas turbine power plant and Hydroelectric power plant) • Load and load duration curves • Power station management (Regulatory performance standards)	5	0	0

4.	**Transformers and Synchronous generators** • Transformers: construction, working, equivalent circuit, losses, efficiency, voltage regulation • Synchronous generators: construction, principle of operation, equivalent circuits, phasor diagram, operation of synchronous generator on infinite busbar/grid, excitation	6	2	0
5.	**Transmission and Distribution** • HVAC & EHV AC transmission. Classification of transmission lines – short, medium and long transmission line, transmission line parameters, modelling of lines and transmission line performance: Voltage regulation and efficiency • Distribution systems configurations, Loadability of lines • Basic concepts of HVDC	6	3	0
6.	**Power Flows** • Power flow problem and Power flow solution • Control of Power Flow • Unit commitment and Economic Load Dispatch • Grid standards and Load dispatch centres (ISO-Independent System Operator, TSO-Transmission System Operator, NLDC- National Load Dispatch Centre, SLDC- State Load Dispatch Centre etc)	7	3	0
	Total	37	08	00

Evaluation criteria

Minor Test 1: Assignment (after completion of modules 1, 2 and 3)- 10%
Minor Test 2: Written test (after completion of modules 1, 2 and 3)- 25%
Minor Test 3: Written test/ Case Study Presentation (after completion of modules 4, 5 and 6)- 25%
Major Test: Written test/ Presentation (after completion of all modules) - 40%

Learning outcomes

- Appreciate the role of various components of the power system
- Analyze the energy market and their role
- Understand the significance of solutions to load flow problems, economic load dispatch centre and unit commitment
- Understand grid standards

Pedagogical approach

A combination of class-room interactions, tutorials, group discussions assignments, expert talks / site visits

Materials:

Text Books:

- Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder **Operation of Restructured Power Systems** (Kluwer Academic Publishers, 2001).
- John Graigner and William Stevenson, Jr.: **Power System Analysis** (McGraw Hill, 2017).

Reference Books:

- Daniel Kirschen and Goran Strbac: **Fundamentals of Power Systems Economics** (Wiley India, 2016)
- Stephen J. Chapman: **Electric Machinery and Power System Fundamentals** (McGraw Hill, 2001)
- Mohammad Shahidehpour, Hatim Yamin and Zuyi Li: **Market Operations in Electric Power System: Forecasting, Scheduling, and Risk Management** (Wiley-IEEE Press, 2002)
- Jin Zhang: **Power System Economic and Market Operations** (CRC Press, 2018)

Websites:

Central Electricity Regulatory Commission, CERC (http://www.cercindia.gov.in/)
IEX India (https://www.iexindia.com/)

Additional information (if any): N.A.

Student responsibilities
Attendance, discipline, feedback as per TERI SAS rules

Course reviewers:
Dr. Sanjay Agrawal, Professor, Pro-VC, Vivekananda Chhatishgarh Technical University,Bhilai
Dr. M. Rizwan, Professor, Department of Electrical Engineering, Delhi TechnologicalUniversity, New Delhi