



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code: ME02000751

Course / Subject Name: Restructured Power System

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

<b>Prerequisite:</b>	Power System Analysis
<b>Rationale:</b>	The restructuring of power industry has changed the way of operation of the power systems. Along with the secured and reliable operation of power systems, the economic efficiency has become an equally important consideration. Unlike the knowledge of conventional operation of power systems, understanding the restructured power systems requires basic knowledge of electrical engineering, power systems, and also the economics. This course is intended to provide a comprehensive treatment towards understanding of the new dimensions associated with the operation of power systems.

Sr. No.	CO statement	BL	Marks% weightage
CO-1	Describe the restructuring process of power systems and the fundamentals of market models.	Understand	15
CO-2	Explain the operational roles and activities of Independent System Operators (ISOs) and Generation Companies (GENCOs) in competitive environments.	Apply	15
CO-3	Analyze transmission congestion management methods and pricing mechanisms for efficient power system operation.	Analyze	30
CO-4	Evaluate ancillary services, market dynamics, and their impact on system stability and reliability.	Evaluate	25
CO-5	Compare the evolution of power markets in the US, Europe, and India, highlighting regulatory and operational reforms.	Analyze	15

## Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA(M)	ESE (V)	PA(I)		
3	0	2	4	70	30	30	20	150



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## Content:

Sr. No.	Content	Total Hrs	Weight age %
1	<b>Introduction to restructuring of power industry</b> Reasons for restructuring of power industry; Understanding the restructuring process, Entities involved, the levels of competition, the market place mechanisms, Sector-wise major changes required; Reasons and objectives of deregulation of various power systems across the world.	4	5
2	<b>The Philosophy of Market Models</b> Monopoly model, Single buyer model, Wholesale competition model, Retail competition model, distinguishing features of electricity as a commodity, Four pillars of market design, Cournot, Bertrand and Stackel berg competition model	4	10
3	<b>Operation of the Power Grid under Competitive Environment:</b> Power System Operation in Competitive Environment Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational planning activities of a GENCO: GENCOs in Pool and Bilateral markets	3	10
4	<b>Transmission Congestion Management</b> Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, Concept of Open Access, ATC, TTC, TRM, CBM, ATC calculation using DC and AC model, Nodal pricing, Locational Marginal Prices (LMPs), Implications of nodal pricing, Price area congestion management Capacity alleviation methods, Re-dispatching, Counter-trade, Curtailment.	6	15
5	<b>Ancillary Service Management</b> Type and Classification of ancillary services, Introduction to Ancillary Service Regulations in India: PRAS, SRAS, TRAS, FRAS, RRAS, VCAS and Black start capability service, Provisions of ancillary services, Markets for ancillary services, international practices of ancillary services.	6	15
6	<b>Pricing of transmission network usage and loss allocation</b> Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and de-merits of different paradigms, Classification of	6	15



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	loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing-based allocation. introduction to Financial Transmission Rights (FTR) and Power Purchase Agreement (PPA).		
7	<b>Market power and generation bidding</b> Attributes of a perfectly competitive market, The firm's supply decision under perfect competition, Imperfect competition, Monopoly, Oligopoly, Electricity markets under imperfect competition Sources of market power, Effect of market power, Identifying market power, HHI Index, Entropy coefficient, Lerner index, Market power mitigation, Effects of contract for differences, Role of demand side bidding, Financial markets, Introduction to optimal bidding by a generator company. Computation Tools for Electricity Markets	6	15
8	<b>US and European market evolution:</b> US Markets, The ERCOT Market, Standard Market Design (SMD), PJM market, The Nordic power market, Comparison of power markets.	4	5
9	<b>Reforms in Indian power sector:</b> Evolution of Indian power sector, The ABT & Deviation Settlement Mechanism (DSM), The Electricity Act 2003 with Electricity (Amendment) Bill, 2022 and Electricity (Amendment) Rules, 2024, Open Access issues, Types of Power Markets in India and Power exchange. RE policies, RPO.	6	10
<b>TOTAL</b>		<b>45</b>	<b>100</b>

## Reference Books:

1. NPTEL Course - Restructured Power Systems, A.R. Abhyankar, S.A. Khaparde, Available: <http://nptel.iitm.ac.in/courses/108101005/>
2. Fundamentals of Power System Economics Daniel Kirschen and Goran Strbac, John Wiley & Sons Ltd, 2004 (for chapter 1, 2, 3 & 5)
3. Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc., 2002
4. Power system restructuring and deregulation by Loi Lei Lai, Wiley India.
5. Operation of restructured power systems by Kankar Bhattacharya, Jaap E. Daalder, Math Bollen, Springer publication, 2001.
6. Restructured Electric Power Systems Analysis of Electricity Markets with Equilibrium Models, edited by XIAO-PING ZHANG, IEEE, Wiley publications, 2010.
7. Power System Economic and Market Operations, by Jin Zhong, CRC Press, 2018

## List of Open Source Software/learning website:

1. Bhanu Bhushan, ABC of ABT, Available online: [www.nrlc.org](http://www.nrlc.org)
2. R.G. Yadav, A. Roy, S.A. Khaparde and P. Pentayya, India's fast growing power sector, IEEE Power and Energy Magazine, July/August 2005.



3. S.A.KhpardeandA.K.Sardana,Poweringprogress,IEEEPowerandEnergyMagazine,July/August2007.
4. www.ercot.com
5. www.cercind.gov.in
6. www.nrlc.org
7. www.wrlc.com
8. www.iexindia.com
9. TheElectricityAct2003,AvailableOnline:www.powermin.nic.in
10. www.pjm.com

**List of suggested tutorials:**

**This is Just a Suggested list of Experiments. The teachers are encouraged to include the experiments from above topics.**

1. 1. Visit to SLDC and prepare a comprehensive report in context with restructured operation.
2. Tutorial on Pareto Efficiency, Global Welfare and Dead Weight loss.
3. Tutorial on various cost of production.
4. Tutorials on Elasticity and Cross Elasticity.
5. Tutorial on various models of competition.
6. Tutorial on generator bidding.
7. Tutorial on LMP calculations. 8. Tutorial on calculation of PTDF.
8. Tutorial on calculation of ATC using PTDF. 10. Tutorial on Power flow tracing.
9. Study of unbundling of Gujarat power system
10. Study of Open Access in the context of Indian Power System operations

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