



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3720730

Semester – II

Subject Name: RESTRUCTURED POWER SYSTEM

Type of course: Elective course

Prerequisite: Power System Analysis (3710711)

Rationale: 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.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	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

Content:

Sr. No.	Content	Total Hrs
1	Introduction to restructuring of power industry 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
2	Fundamentals of Economics Consumer and suppliers behavior, Total utility and marginal utility, Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Consumer and supplier surplus, Global welfare, Deadweight loss .	5
3	The Philosophy of Market Models 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 Stackelberg competition model.	5
4	Transmission Congestion Management Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, ATC, TTC, TRM, CBM, ATC calculation	7



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	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 .	
5	Ancillary Service Management Type and Classification of ancillary services, Sources of reactive power, Black start capability service, Provisions of ancillary services, Markets for ancillary services, Co-optimization of energy and reserve services, Loss of opportunity cost, International practices of ancillary services.	5
6	Pricing of transmission network usage and loss allocation 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 loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing based allocation .	6
7	Market power and generators bidding 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.	6
8	US and European market evolution: US Markets, The ERCOT Market, Standard Market Design (SMD), PJM market, The Nordic power market, Comparison of power markets.	3
9	Reforms in Indian power sector: Framework of Indian power sector, Reform initiatives during 1990-1995, The availability based tariff (ABT), The Electricity Act 2003, Open Access issues, Power exchange.	3

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.

Course Outcomes:

After learning this course the student will be able to.....



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Sr. No.	CO statement	Marks % weightage
CO-1	Acquire the knowledge of the new dimensions associated with the power system and fundamentals of microeconomics.	20
CO-2	Differentiate the various operating mechanism between conventional and restructured power system.	20
CO-3	Discover various power markets and market architectural aspects.	30
CO-4	Identify issues related to Efficient pricing and usage of the transmission network and generation entity in the power market operation.	30

List of Open Source Software/learning website:

[1] Bhanu Bhushan, ABC of ABT, Available online: www.nrldc.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. Khaparde and A. K. Sardana, Powering progress, IEEE Power and Energy Magazine, July / August 2007.

[4] www.ercot.com

[5] www.cercind.gov.in

[6] www.nrldc.org

[7] www.wrlde.com

[8] www.iexindia.com

[9] The Electricity Act 2003, Available Online: 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. Visit to SLDC and prepare a comprehensive report in context with restructured operation.
2. Tutorial on Pareto Efficiency, Global Welfare and Dead Weight loss.



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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.
9. Tutorial on calculation of ATC using PTDF.
10. Tutorial on Power flow tracing.